Project design document form for CDM project activities

(Version 08.0)

Complete this form in accordance with the Attachment "Instructions for filling out the project design document form for CDM project activities" at the end of this form.

PROJECT DESIGN DOCUMENT (PDD)	
Title of the project activity	Use of Charcoal from Renewable Biomass Plantations as Reducing Agent in Pig Iron Mill in Brazil
Version number of the PDD	04
Completion date of the PDD	29/09/2016
Project participant(s)	**Brazil:** Plantar ; Plantar Siderurgica ; Plantar Carbon Ambiental **Netherlands:** International Bank for Reconstruction and Development as Trustee of the Prototype Carbon Fund ; Netherland's Ministry of Infrastructure and the Environment (IenM) **Japan:** Idemitsu Kosan Co., Ltd. ; Japan Petroleum Exploration Co., Ltd. ; The Okinawa Electric Power Co., Inc. ; Sumitomo Joint Electric Power Co., Ltd. ; Suntory Holdings Limited ; Tokyo Electric Power Company, Incorporated ; Sumitomo Chemical ; The Japan Iron and Steel Federation **Italy:** Italian Ministry for the Environment Land and Sea **Luxembourg:** Ministry of Sustainable Development and Infrastructure **Spain:** Kingdom of Spain- Ministry of the Agriculture, Food and Environment & Ministry of Economy and Competitiveness **Switzerland:** Marubeni Corporation
Host Party	Brazil
Applied methodology(ies) and, where applicable, applied standardized baseline(s)	AM0082 - Use of charcoal from planted renewable biomass in the iron ore reduction process through the establishment of a new iron ore reduction system
Sectoral scope(s) linked to the applied methodology(ies)	9 : Metal production
Estimated amount of annual average GHG emission reductions	329,068

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

>> The production of iron and steel requires the provision of a substance that provides both thermal energy and reducing power to convert iron ore into primary iron (called pig iron when solid or hot metal when in liquid form). This process is known as the iron ore reduction, which is mostly done with the use of coal coke, produced from coal of fossil origin (98.55% of the world's primary iron reduction in 2005)[1]. The basic equipment used in this process is the blast furnace.

This project activity proposes to use 100% of renewable charcoal - a solid source of bioenergy produced from sustainably grown wood biomass, established for the project - as the reducing agent in the iron ore reduction process. The use of renewable charcoal in the iron production process results in the replacement of fossil fuel - coal coke. The stock of renewable biomass grown for charcoal production also restores degrading grassland ecosystems, generating carbon stocks. These multiple environmental benefits are given attention by the project entity through the implementation of an integrated project, which complies with the respective applicable methodologies and decisions of 17/CP.7 and 19/CP.9. The project design documents of each component were prepared as a separate project, supported by the respective applicable methodologies[2]. As per EB25 paragraph 38, the emissions from the plantations establishment (A/R CDM component) are accounted in the same registered project and not accounted in the industrial project to avoid double counting. However, some of the project entity's new planted forests to supply the industrial production of iron with renewable biomass based energy are established on lands not included in the boundaries of the A/R CDM component. These lands contained forest plantations after its last rotation established before 31st December 1989[3], as the project entity has historically used charcoal, and are, therefore, included in the boundaries of this CDM project activity. The production of iron under the new iron ore reduction system started in 2008, when the newly developed plantations reached the stage of harvesting. However, emission reductions will only be claimed when this project activity is duly registered. The planted forest removals (CDM A/R Project 2569) do not induce double-counting, since they are not taken into account under this project CDM-PDD.

The baseline for this project activity is the use of coal coke as the reducing agent in the pig iron production (see details in Section B.4). Considering the available evidence on the increasing trend of coal coke use as the main reducing agent, the emission reductions are estimated on a highly conservative basis. The carbon fixed in the hot metal is accounted for in the baseline but not in the project scenario, reducing the net process emissions reduction by almost 10% of the total ERs. Moreover and following the conservativeness guidance in the methodology, the net difference between baseline upstream emissions (emissions in the extraction of primary carbon sources, i.e.

[1] Source: Research on IISI, 2006; SINDIFER, 2006 and AMS, 2006; Except for a few countries, which still have minor supplies of different reducing agents, the world production of iron and steel is based on coal coke.

[2] The project entity's A/R-CDM component is treated under AR-AM0005 and is registered as "Reforestation as Renewable Source of Wood Supplies for Industrial Use in Brazil", project activity number 2569.

[3] By definition, the harvesting of such planted forests was foreseen before the existence of the CDM and would occur regardless of the CDM (as per the rotation period of eucalyptus plantations in Brazil). These plantations were at its last rotation at the time the Plantar Project started. As such, the project entity decided to establish new plantations in these lands as part of its integrated CDM project to produce renewable-charcoal-based iron. In as much as these areas would be harvested regardless of the CDM, the establishment of new plantations on them is also subject to the same barriers and incentives applicable to the establishment of new plantations within the current boundaries of the A/R CDM component. Thus, they would also follow the same baseline land-use patterns, i.e. grassland. In spite of such facts, these lands are currently excluded of the project boundaries of the A/R CDM component, given the doubts regarding the interpretation of the eligibility rules at the time it was written. Areas with forests at its last rotation are in lands in MG02 Unit – Buenos Aires Farm and MG15 – Tamandua/Poções Farm.

coal mines[4]) and the correspondent project upstream emissions is accounted as zero, although upstream emissions are higher in the baseline.

The data and information that relate to the components are used to establish and corroborate the baseline scenarios, and to transparently fulfill the additionality criteria of the respective components and of the integrated project. The integrated project's activities have been conceived before the year 2000 and are implemented in response to the CDM incentive. Together they allow the project entity to overcome major barriers to the use of renewable charcoal in the pig iron production process.

To implement this project activity, the Plantar Group has decided to constitute a sustainable and *new iron ore reduction system* undertaking a major two-folded new investment: (i) the establishment of new dedicated wood plantations to enable the sustainable production of renewable charcoal, and (ii) the refurbishment of its pig iron facilities. The latter is deeply related to the new investments in the plantations, supporting the establishment of a sustainable productive arrangement. Considering the maturity period of the tree species and rotation cycle in Brazil[5], the investment decision to implement such a project activity needed to be taken seven years before the starting date of the iron production. In the project activity case, the decision was made in 2000 and the new plantations started the same year, with the support of the World Bank's Prototype Carbon Fund (PCF) and Rabobank International. As such, the CDM-PDD analyses take into consideration the context and scenarios of the year 2000, the integrated project's decision making moment.

The renewable charcoal used in the project activity is produced under controlled and certified conditions, ensuring that the project activity results in the use of sustainable sources of charcoal in lieu of fossil fuels and/or non-renewable reducing agents. The project entity holds environmental management systems (ISO 14001) and quality management based on ISO 9001, which are applied to the new iron ore reduction system established by the project activity. The use of conservative factors and assumptions, strict additionality and monitoring criteria allow for a transparent and conservative assessment of the emission reductions.

With carbon finance, the project entity is expected to become the first company in its industry sector to manufacture iron totally based on renewable charcoal. The project is expected to result in various social and environmental benefits, and contributes to the generation of more than one thousand direct jobs. There is a significant gender component, with a larger participation of women in the production of cloned sprouts as well as environmental benefits such as biodiversity (fauna and flora) preservation and soil conservation. The multiple benefits of the project arise from long-term backward and forward linkages within the iron industry supply chain. It integrates rural and industrial development through the production and use of renewable biomass, in an industry locked in fossil fuels (see Unruh, 2000).

The proposed project is a pioneer activity within its sector and has a substantial potential to be replicated by other organizations in Brazil, in Latin America and the Caribbean, as well as in many African and Asian developing countries. The project and its sustainability indicators clearly contribute to the CDM's sustainable development dividend at an industrial scale.

[4] As per the methodology, emissions from coal mines and international transportation were not considered since they occur outside the country's boundaries. This is conservative in the case of the project activity as international transportation of reducing agents occurs in the baseline but not in the project.

[5] The eucalyptus rotation in Brazil usually follows three cycles of seven years, whereas the last two cycles of seven years are based on the practice of coppice (AMS, 2003 and EMBRAPA, 2003).

A.2. Location of project activity

A.2.1. Host Party

>> Federative Republic of Brazil

A.2.2. Region/State/Province etc.

>> State of Minas Gerais

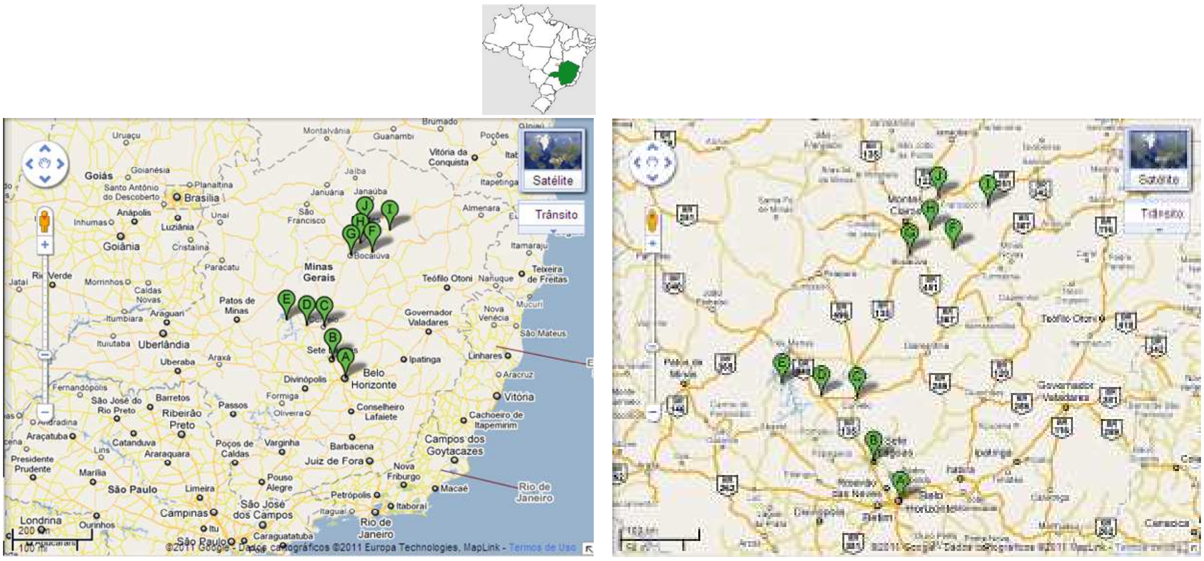
A.2.3. City/Town/Community etc.

>> Municipalities of Belo Horizonte (headquarters); Sete Lagoas (pig iron mill); Curvelo (dedicated plantations and carbonization units), Felixlândia, Morada Nova de Minas (carbonization units) and Bocaiuva, Juramento, Itacambira, Grão Mogol e Francisco Sá [6] (dedicated plantations and carbonization unit)

A.2.4. Physical/Geographical location

>> The new iron ore reduction system established by the project activity is located in the center region of Minas Gerais State. *Plantar Siderúrgica* (the iron ore reduction facility - pig iron mill) is located in Sete Lagoas, situated 70km away from Belo Horizonte (the capital of Minas Gerais State) and the dedicated plantations and carbonization units are located in the municipalities and surroundings of Curvelo, Felixlândia, Morada Nova de Minas, Bocaiuva, Juramento, Itacambira, Grão Mogol and Francisco Sá, respectively 164km, 189km, 241km, 377km, 456km, 512km, 560km and 474km away from Belo Horizonte.

Figure 1: Location of the project's components (dedicated plantations and carbonization activities), where (A) Belo Horizonte (headquarters), (B) Sete Lagoas (pig iron mill), (C) Curvelo, (D) Felixlandia, (E) Morada Nova de Minas (dedicated plantations and carbonization units) and (F) Itacambira, (G) Bocaiuva, (H) Juramento, (I) Grao Mogol and (J) Francisco Sa (dedicated plantations and carbonization units), in the State of Minas Gerais, Brazil. For the geographical coordinates, refer to Table 1**.**



(Source: GoogleMaps, 2011).

[6] MG15 Unit has lands in all these municipalities and, therefore, is hereinafter called only **Itacambira**.

Figure 2: ***Plantar Siderúrgica*** **– Plantar's pig iron mill (Sete Lagoas – MG)**

Pig Iron mill address:

Rodovia BR 040, km 465.
35701-970 - Sete Lagoas - MG - Brasil

Region	Coordinates	
Sete Lagoas	LATITUDE	19°26'21" S
Pig iron mill	LONGITUDE	44°20'25" W

A.3. Technologies and/or measures

>> The technology employed by the project activity encompasses some of the most advanced techniques in the iron ore reduction system, including: i) in the production of reducing agents - the adoption of advanced clones and management practices for the establishment of dedicated plantations, and carbonization practices based on unprecedented research and development by the project entity[7] and; ii) in the iron ore reduction facility - pig iron manufacturing based on the blast furnace technology and use of pulverized charcoal. Information on each of these production stages is provided below. Together, these production stages constitute the new iron ore reduction system enabled by the project activity.

The purpose of this project activity is to reduce GHG emissions through the use of 100% of renewable charcoal, produced with planted biomass from dedicated Eucalyptus plantations, as the main reducing agent in the iron ore reduction process, instead of fossil fuels. Considering the integrated nature of the project and as it relies on the technology developed by the project entity in Brazil, it has not required transfer of technology from Annex 1 countries to Brazil. However, the project may result in the transfer of the applied technology to non-Annex 1 countries with a substantial potential of implementing similar CDM project activities, especially in Africa, other parts of Latin America and Southeast Asia.

In 2000, the context of the charcoal based pig iron sector was not optimistic. The end of the fiscal incentives in 1988 made it difficult for companies to continue planting forests to supply charcoal to mills. Plantar was one of the companies affected and practically ceased its planting activities in the 1990s in response to this context. In 2000 the scenario was of forests plantations reaching the end of their rotation cycle and of a decision making moment for the company. As described in Section B.4 below, with the decline of the planted forests stocks, no access to capital to continue investing in planted forests and no forests or charcoal available in the market, Plantar was facing the

[7] The project entity is responsible, together with the World Bank's Prototype Carbon Fund (PCF), for the conception and registration of the CDM approved methodology AM0041.

imminent possibility of turning off its blast furnaces and adopting the only remaining viable option that was the adaptation of its blast furnaces to use coal coke as a reducing agent for its pig iron production, the baseline scenario of this project activity. This was reversed with the CDM incentive, which made it possible to implement new and additional dedicated planted forests to supply renewable charcoal as the main reducing agent to the iron ore reduction process as part of a new iron ore reduction system.

Technology employed in the production of reducing agents:

- **Technology used in the establishment of dedicated plantations**

The project activity relies on sustainable production practices and advanced plantation technology developed by the project entity. The plantations are managed using sustainable management practices according to the principles of international recognized environmental and based on quality management systems certification (e.g. FSC, ISO, etc). The production of seedlings in large-scale nurseries and localized irrigation systems are designed to make the use of water and other inputs more efficient. The fire protection and set asides of preservation areas enhance the biodiversity of the project area. The following features illustrate the technology employed:

- *Research and Development*: The project entity has established a research and development program aimed at providing high-yielding eucalyptus clones. With the objective of producing quality and productive provenances, field experiments are conducted using advanced scientific protocols. The rigorous selection process and propagation methods assure the production of quality seedlings for plantation purposes**. Figure 3** and **Figure 4** illustrate the large-scale greenhouses and scientific nursery management processes.

Figure 3: Clonal garden used in the selection and propagation of Eucalyptus clones.

- *Reproduction of cloned sprouts*: Mini-sprouts are selected from sprout matrices, developed in the field experiments, and propagated in a plantation nursery that is fully equipped with clonal gardens, and greenhouses with electronic controls for temperature and moisture. The production process of one sprout takes approximately 100 days. After this period of time, the sprouts are taken to the field for planting.

- *Planting process*: The planting process involves minimum cultivation techniques, which minimizes soil impacts and optimizes the use of water. Fertilizers, herbicides and pest control substances are used as per recommended silvicultural practices.

Figure 4: Greenhouse

Figure 5: Fire watch-tower model

- Productivity management: It is implemented to ensure that the expected production results are monitored since the first planting months in a scientifically devised inventory system. The survival rates of plantings are monitored. When necessary, replanting will occur. In addition, to minimize the risk of fires, the project entity will maintain ongoing vigilance at strategically located fire-watch towers. Fire monitoring is conducted in conjunction with fire-fighting brigades.

- Quality management system: Operations are fully integrated into the project entity's quality management system, which is based on ISO 9001. Each operational procedure is registered, described and monitored as per the norms and standard operational procedures (which will be made available to the DOE). Social and environmental aspects are managed by a specific department within the project entity in order to ensure maximum compliance with legislation, corporate principles, and forestry certification schemes.

- **Technology employed in the carbonization process**

The processing of wood into charcoal is based on the same improved technology as the one adopted in the approved methodology AM0041. The major features of this carbonization technology are briefly described below.

The three major phases of carbonization are – ignition, carbonization, and cooling. The carbonization phase is the most important part of the charcoal production. It requires high temperatures at which combustible gases ignite and guarantee the supply of heat for wood carbonization. Optimizing the air flow through suitable air inlets, locally called *tatus, baianas* and *pegadeiras*, helps to control the heat in the kiln furnace. The thermal demand of the carbonization phase influences the gravimetric yield and the resulting methane emissions. Factors such as wood moisture, temperature, and carbonization time are important in the amount of methane emitted.

Figure 6: Controled process

Figure 7: Newly designed kilns

Improvements in kiln design and operations of the project activity allow for greater control of carbonization variables and enable the project entity to reduce methane emissions. Furthermore,

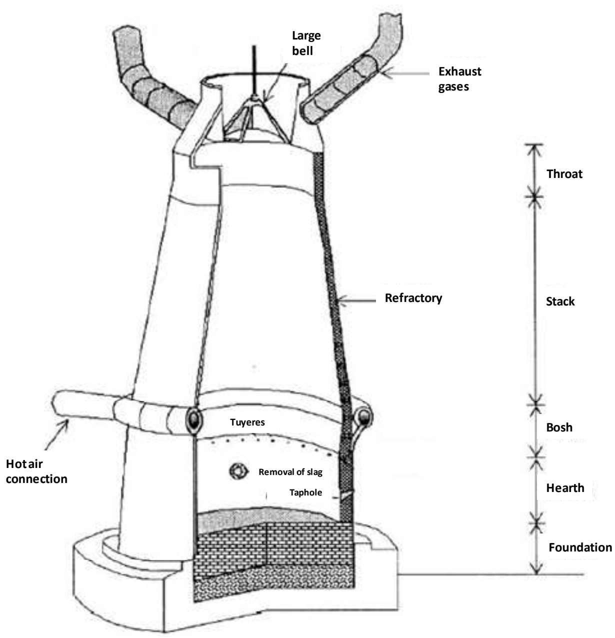
the project activity includes standardisation of production processes, provision for training operational personnel and adoption of instrumentation to measure and monitor emissions.

- **Technology employed in the iron ore reduction process:**

The iron ore reduction technology applied in this project activity is based on mini-blast furnaces. Renewable charcoal sourced from the project's dedicated plantations coupled with iron ore are fed into the blast furnace and undergo the reduction process, resulting in pig iron.

The blast furnace is designed to reduce iron oxides into liquid iron, called "hot metal", or solid iron, called "pig iron". It basically consists of a counter-current reactor in which the iron ore (and/or sinter), and reducing agents are charged and the preheated air is blown to remove oxygen from iron oxide. The oxygen in the furnace reacts with the carbon from the reducing agent, generating heat and reducing gases. The oxygen from the hot air blown into the bottom of the furnace ascends to the top and the raw materials then descend to the bottom of the furnace where they are transformed into liquid slag and liquid iron. Thus, heat and reducing gases are generated through the use of carbon. The iron oxides are reduced and result in the liquid metallic iron, called hot metal. The liquid form of hot metal is used in steel manufacturing and the molded solid form is the pig iron.

Figure 8: schematic illustration of a blast furnace



Source: MINASAMBIENTE, 1998

As part of the modifications implemented in the iron ore reduction plant, the adaptation of the blast furnace for using pulverized charcoal (charcoal fines) was implemented in 2007 and is the most significant modification, allowing for the total utilization of the once residues of charcoal production and handling.

Charcoal fines are produced by handling and transportation of charcoal to the point of use. Charcoal fines can contain more than 50% charcoal (but also fragments of the bark and fuelwood and mineral sand and clay picked up from the earth). But it is difficult to find uses for it as it cannot be burned by the usual charcoal burning methods and therefore it is depreciated (FAO, 1983). Around 12% of the charcoal production of the project entity is fines that used to be sold for insignificant prices or even used as bed for charcoal storage. The injection of charcoal fines into the blast furnace allows for optimization in the usage of carbon. This technology enables an

increase in the blast furnace efficiency with gain in the process control, which means lessen the need for area to plant forests to supply the pig iron mill with charcoal.

The mean specific consumption of granulated charcoal in the top of Plantar's blast furnace is approximately 589kg/ton of pig iron, meaning a demand for approximately 430kg of fixed carbon/ton pig iron produced (SAMPAIO, 2000). The proper injection of pulverized charcoal as an auxiliary fuel into these blast furnaces, with rates of 120kg charcoal powder / ton pig iron, reduces the dependency on the main energy source by 20%.

Assuming the density of the dry charcoal as 215 to 225kg/m3, the blast furnaces' demand varies from 2.6 to 2.8m^3 of charcoal charged into the furnaces in the top per ton of pig iron produced, without the injection of the auxiliary fuel. The existing charcoal screening system generates approximately 7 to 10% of charcoal powder relative to the total weight (called *moinha*, fraction below 6mm).

The total need for charcoal in a mini blast furnace without auxiliary fuel injection is the sum of the charcoal charged in the top + screening + capture of suspended solids. The sum of these values shows that to produce 1 ton of pig iron the total input of charcoal should be 3.0 to 3.2m^3.

General information on Plantar Siderúrgica's pulverized charcoal injection unit:

- Pendullum roller mills with rotary feeder and static classifier with double cone (production of 3.5 tons charcoal powder/hour);
- Simple single stage cyclone dust collector, with external isolation, rotary valve and pressure relief valve;
- Sleeve filter with filter area of 80m^2, external isolation, rotary valve, temperature sensor for thermal control of drying;
- Three exhaust fans: to guide the exhaust gases from the glendons to mill, guide "gas + dust" to the cyclone and "gas + dust" to the sleeve filter;
- A funnel-shaped bottom in a silo (*silo pulmão*), 90m^3 internal volume, cylindrical body, cone-shaped bottom, guillotine valve and able to manually discharge to drain.
- Injector, capacity for 2,000kg charcoal powder /hour, automatic and continuous system, working pressure at 3.0 bar, pressure sensor, relief valve;
- Two air compressors, one operating and one spare. Total air flow rate of 42m^3/min, performance pressure of 50 to 115 psig with air filter;
- Air dryer with maximum air flow rate intake of 180Nm^3/hour;
- Nine pipelines for pulverized charcoal injection made from stainless steel with spherical isolation valve ¾" and 10mm in internal diameter;
- One splitter, nine static separators through exits 10mm in internal diameter;
- O_2 and N_2 gases individual control panels controlled by PLC (Programmable Logic Controller).

The pulverized charcoal injection system started operating in Plantar Siderúrgica in January and December 2007, respectively in blast furnaces 02 and 01. Grinding charcoal fines reduces granulometry to 90% minus 100 mesh allowing reutilization of this material by injection in blast furnaces.

The injection plant comprises the equipment shown in the figures below.

Figure 9: overview of Plantar Siderúrgica's pulverized charcoal injection plant

Figure 10: injector vessels (capacity to inject up to 2,000Kg of charcoal/hour)

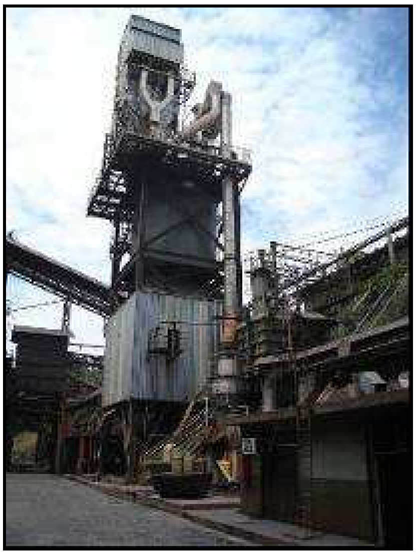


Figure 11: charcoal grinding mill (grinding capacity of 5,000Kg charcoal/hour)

Figure 12: four pulverized charcoal conveying vessels (Capacity: 1,600Kg of charcoal fines/hour/each vessel)

Source: Plantar Siderúrgica

The production of pig iron based on coal coke is also performed in blast furnaces, but with peculiarities. The transition from one reducing agent to another, that is, from charcoal to coal coke, do not simply mean a change in the reducing agent used, but would demand technical and procedural adaptations. The differences between the two reducing agents explain the need for modifications in equipment, procedures and in the process itself. According to a study[8] promoted in 1990 in Companhia Siderúrgica Belgo Mineira, and carried out by Prof. Paulo Cesar da Costa Pinheiro, from UFMG – Federal University of Minas Gerais, which switched its production based in charcoal for a coal coke based one, the main changes required are:

- Installation of bell-less top system
- Installation of silicon carbide refractories
- Replacing of hearth silicon-aluminous lining for carbon bricks

Also, some activities need to be implemented in order to absorb the new technology:

[8] http://www.demec.ufmg.br/disciplinas/ema003/solidos/coque/altern.htm

- Hire technical assistance to use coal coke;
- Hire technical assistance to work with bell-less top system
- Hire specific training on the use of coal coke based blast furnace.

The proposed project activity reduces greenhouse gases emissions by establishing new dedicated planted forests to supply the project entity's pig iron production with charcoal from renewable and additional forests as reducing agent.

A.4. Parties and project participants

Party involved (host) indicates host Party	Private and/or public entity(ies) project participants (as applicable)	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Brazil	Plantar; Plantar Siderurgica; Plantar Carbon Ambiental	No
Netherlands	International Bank for Reconstruction and Development as Trustee of the Prototype Carbon Fund ; Netherland's Ministry of Infrastructure and the Environment (IenM)	Yes
Japan	Idemitsu Kosan Co., Ltd. ; Japan Petroleum Exploration Co., Ltd. ; The Okinawa Electric Power Co., Inc. ; Sumitomo Joint Electric Power Co., Ltd. ; Suntory Holdings Limited ; Tokyo Electric Power Company, Incorporated ; Sumitomo Chemical ; The Japan Iron and Steel Federation	No
Italy	Italian Ministry for the Environment Land and Sea	Yes
Luxembourg	Ministry of Sustainable Development and Infrastructure	Yes
Spain	Kingdom of Spain- Ministry of the Agriculture, Food and Environment & Ministry of Economy and Competitiveness	Yes
Switzerland	Marubeni Corporation	No

A.5. Public funding of project activity

>> The project does not involve Official Development Assistance (ODA) and other sources of public funding from Annex 1 countries.

SECTION B. Application of selected approved baseline and monitoring methodology and standardized baseline

B.1. Reference of methodology and standardized baseline

>> The proposed CDM activity is based on version 1 of the approved 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**”.

The methodology AM0082 derives elements from the following approved methodologies and refers to the latest approved version of the tools below:

- AM0042 - Grid-connected electricity generation using biomass from newly developed dedicated plantation, version 02;
- ACM0003 - Emissions reduction through partial substitution of fossil fuels with alternative fuels or less carbon intensive fuels in cement manufacture, version 7.3;
- AM0041 - Mitigation of Methane Emissions in the Wood Carbonization Activity for Charcoal Production, version 1;
- AR-AM0005 - Afforestation and Reforestation project activities implemented for industrial and commercial uses, version 1;
- Combined tool to identify the baseline scenario and demonstrate additionality, version 04.0.0;
- Tool to calculate baseline, project and/or leakage emissions from electricity consumption, version 01;
- Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion, version 02;
- Tool for the identification of degraded or degrading lands for consideration in implementing CDM A/R project activities, version 01;
- Estimation of non-CO_2 GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity, version 04.0.0 (new version for the former 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, version 01);
- Estimation of direct nitrous oxide emission from nitrogen fertilization, version 01.

B.2. Applicability of methodology and standardized baseline

>> According to the approved methodology AM0082, the approach 48(b) *Emissions from a technology that represents an economically attractive course of action, taking into account barriers to investment*, as provisions of Decision 17/cp7, Modalities and Procedures, item G, paragraph 48, is considered appropriate. It relies on publicly available data to determine the GHG emissions for the use of the reducing agent options, which represents the most economically attractive course of action, taking into account barriers to investment.

In view of the investment barriers, production risks associated with the use of renewable reducing agents originated from dedicated planted forests are evaluated (e.g. long-term rotation cycles, the analysis of historical and future scenarios). The project meets the applicability conditions of the proposed new methodology, as outlined below:

- Project activities would generate emission reductions from partial or complete use of renewable reducing agents instead of fossil fuel based reducing agents in the iron ore reduction process.

The project activity completely relies on the use of renewable charcoal, a renewable reducing agent sourced from dedicated planted biomass.

- Blast furnace technology is used in the iron ore reduction process.

The iron ore reduction facility adopts the blast furnace technology to reduce iron ore within the project activity.

- The methodology is applicable to projects 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 the methodology are listed below and, hence, the methodology is only applicable 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. The eligible types of new investments for projects under this methodology are:
    - 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;
    - 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;
    - Type 3: Refurbishment/replacement of blast furnace;
    - Type 4: Establishment/acquisition of blast furnace;
    - Type 5: Adaptation of existing blast furnace to the use of charcoal.

The project proponent conducted the following investment types to establish a *new iron ore reduction system*:

- *Type of new investment 1:* Production of reducing agents from dedicated plantations by the project entity; and
- *Type of new investment 3:* Refurbishment / replacement of blast furnace;

The project entity, with the support of carbon finance (PCF World Bank), decided to make a major two-fold investment supporting the establishment of a new iron ore reduction system in order to implement the project activity. The project proponent invested in the establishment of dedicated plantations and in the refurbishment of its iron ore reduction facility to allow the injection of pulverized charcoal into the blast furnace, among other renewals, enabling a sustainable and new iron ore reduction system.

- 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 system identified.

The project entity plantations are identified in Section B.3 of the present document accordingly. The lands in Felixlândia and Morada Nova de Minas are covered by an A/R CDM project activity (project 2569). Dedicated plantations established in Curvelo and Itacambira are established on lands of forest plantations after its last rotation.

- The renewable reducing agent shall be sourced from dedicated plantations[9] 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:

The renewable reducing agents used in the project, i.e. renewable charcoal, will be sourced 100% from dedicated plantations established and managed by the project entity in response to the project activity. Part of these dedicated plantations is covered by an A/R CDM project activity (project 2569).

[9] As per Annex 8 of the 20th 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.

- The dedicated plantation as required by this methodology shall be located only in tropical conditions[10];

The dedicated plantations are located in Minas Gerais State within the tropical zone.

- 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;
  (iii) Degraded areas.

The project activity will be 100% supplied by dedicated plantations established and managed by the project entity. Part of these dedicated plantations is covered by an A/R CDM project activity (project 2569, lands in the municipalities of Felixlandia and Morada Nova de Minas[11]).

Lands in the municipality of Curvelo and Itacambira[12] are under the category of forest plantation after its last rotation (see **Table 1**). Clarifications on the barriers regarding the replanting of these areas are presented in **Section B.4**, Step 2, *2b.2 Assessment of the identified barriers to establish a renewable charcoal iron ore reduction system based on new plantations* of this CDM-PDD. Eucalyptus plantations in Brazil commonly cover a 21-years period, with the first harvest occurring after 7 years, usually followed by one or two successive periods of 7-years rotations through coppicing (EMBRAPA, 2003 and AMS, 2003). The replanting of an area hosting forest plantations after its last rotation occurs due to the decrease of productivity of the trees when compared to newly researched genetic material.

- 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;

The project activity will be supplied 100% by dedicated plantations established and managed by the project entity, and part of it is already covered by an A/R CDM project activity (Project 2569). Only lands in Curvelo and Itacambira (see **Appendix 5**) are considered part of the project boundaries under this project activity.

- 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 CDM project activity);

The project activity only uses in the new iron ore reduction system charcoal supplied from renewable sources from dedicated plantations newly established and managed by the project entity within the new iron ore reduction system. This supply will be monitored throughout the life-

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[10] 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.

[11] These lands cover a total area of 11,642.06 hectares.

[12] These areas cover an area of 6,881.11 hectares (Curvelo) and 20,513.97 (Itacambira).

time of the project and data will be made available to the DOE at time of validation and verifications. **Renewable charcoal coming from outside the boundaries of the new iron ore reduction system or not demonstrably having generated tCERs under the A/R CDM activity will not be accounted.**

- In compliance with 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.

As explained in Section A.1, this project activity is developed in conjunction with an A/R CDM project activity (project 2569), whereby potential tCERs for the plantations net GHG removals will be claimed (as per Annex 8, EB 20). Accordingly, the estimation and monitoring of baseline and project emissions within this project activity follow the guidance provided by EB 25 and by the above mentioned approved methodology so as to avoid double counting. As per decision of EB 25, the emissions in the establishment of plantations outside this project activity's boundaries are discounted in the respective A/R CDM project activity.

- 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. 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 at the time of verification of the CDM project activity under this methodology (i.e., the change 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;

The project activity will take into consideration exclusively charcoal coming from dedicated plantations' biomass established within the new iron ore reduction system, that is, biomass duly verified as having generated tCERs (Project 2569) or biomass generated by dedicated plantations established within this project activity's boundaries (see Appendix 5). Renewable charcoal coming from outside the boundaries of the new iron ore reduction system or not demonstrably having generated tCERs under the A/R CDM activity will be disregarded from the scope of this proposed project activity.

- 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 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.

The land area of the project's dedicated plantations is established through direct planting.

- 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 AR project activity, this condition is not applicable only to this part of the plantations.

Flooding irrigation is not practiced by the project entity. Instead, as per its forest management plan, the project entity adopts local irrigation only during the planting activity, and only during dry weather conditions.

- 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 planted forests;

Part of the dedicated plantations (Felixlandia e Morada Nova de Minas) established within the new iron ore reduction system are currently part of A/R CDM project activity 2569, which already complies with this applicability condition based on the CDM eligibility criteria. The other part of the lands (Curvelo and Itacambira) is under the category of forest plantations after its last rotation and therefore this condition does not apply.

- 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.

There is no blast furnace gas recovery for electricity and/or heat generation purposes in the baseline of this project activity. Therefore there is no need to apply monitoring procedures.

- In cases the project scenario involves partial consumption of the coal coke in the project's new iron ore reduction system this methodology is only applicable if the production of the coal coke is undertaken within the host country (ies). Thus, the methodology is not applicable to project activities that rely on the use of imported coal coke in the project scenario.

As the upstream emissions of this project activity occur within the national boundaries of the host country, they will be accounted in this project activity. As the project activity relies on 100% of renewable charcoal produced within the national boundaries and under control of the project participant, this project activity complies with this applicability condition.

- 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.

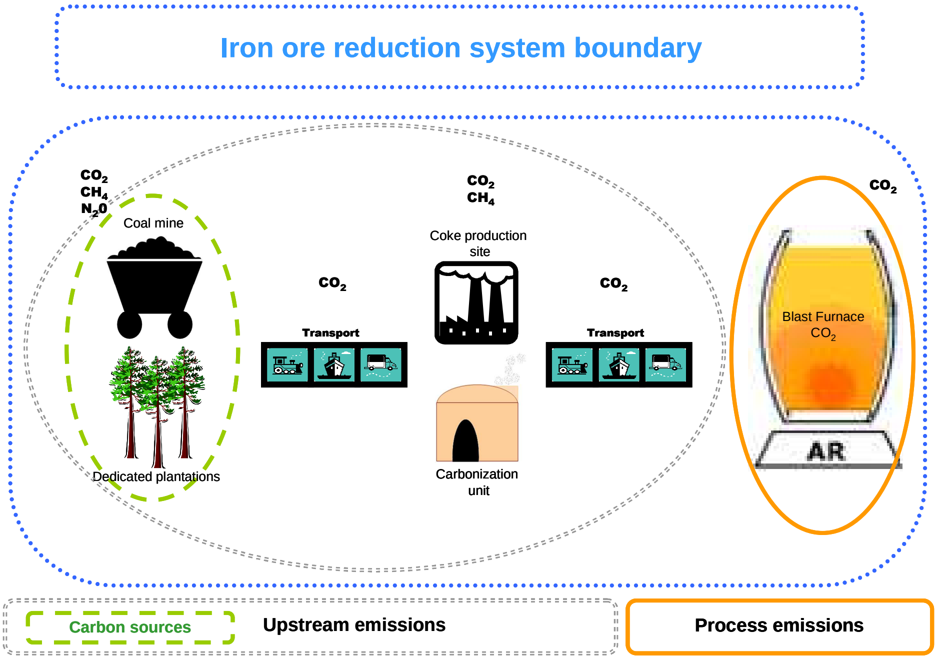
As further discussed in Section B4, Sub-step 1a, the iron ore reduction system based on non-renewable charcoal is not a plausible baseline scenario for this project activity. The country's legislation restricts the use of non-renewable reducing agents. Thus, the operation of the iron mill based on non-renewable charcoal as the most plausible baseline scenario would be illegal. The most plausible baseline scenario for this project activity is the use of coal coke as a reducing agent for the pig iron production, as presented in Section B4.

B.3. Project boundary

>> As per the baseline methodology, the physical delineation of the project boundary is the physical extent of the new iron ore reduction system constituted by the project activity. It includes: (i) the geographic boundaries of the reducing agents production sites, i.e. the plantation areas and the carbonization units, (ii) the physical site of the blast furnace where the iron ore reduction process takes place and (iii) the transportation of the wood until the carbonization units and of the charcoal from the carbonization units to the blast furnace.

It is important to recall that whereas the production of renewable reducing agents in the project activity involves the establishment of dedicated plantations and the production of charcoal, the production of coal coke involves the process of distillation of coal in coke oven devices. Both processes encompass the transportation of the reducing agents from their production sites to the iron ore reduction facility. The following figure summarizes the basic components of the project boundaries:

Figure13: CDM Project Boundary Diagram



Source: Plantar 2009

This project activity only claims GHG emission reductions associated with the use of the renewable charcoal produced within the new iron ore reduction system boundaries instead of the use of fossil fuel based reducing agents, i.e. coal coke. As explained in Section A.1., this project activity is developed in conjunction with an A/R CDM project activity (project 2569) which claims for the net GHG removals associated with the additional plantation stocks, under version 1 of AR-AM0005, for the lands in Felixlandia and Morada Nova de Minas. Therefore, these areas are outside this project activity's boundary. Curvelo and Itacambira lands are under the category of forest plantation after its last rotation and thus are considered within this project activity's boundary (the list of stands is presented in **Appendix 5** of this CDM-PDD). In light of these features, the treatment of the project boundaries within this project activity is explained below, according to each of its integrated components:

Emissions in the establishment of the dedicated plantations under A/R CDM project activity:

As per the guidance provided by EB25 paragraph 38, the project emissions in the establishment of the dedicated plantations will be discounted in the A/R CDM project 2569 and these lands are not part of this project activity boundary.

Emissions in the establishment of the dedicated plantations under category of forest plantations after its last rotation:

The dedicated plantations within this project activity's boundary are under category of forest plantations after its last rotation and are located in Curvelo and Itacambira, respectively at the Center-North and North regions of the State of Minas Gerais. These areas were previously covered with productive forests reaching its last rotation by the time the Plantar Project was conceived. Eucalyptus plantations in the project activity's region usually cover a 21-years period, with the first harvest occurring after 7 years, followed by two successive periods of 7-years rotations through coppicing (EMBRAPA, 2003 and AMS, 2003). The first planting of the new iron ore reduction system dedicated plantation in MG02 Farm was on stand Lagoa do Capim 61, with 29.23ha, planted in 15/11/2000 and in MG15 Farm was 10/11/2000 stand Saracura 464, 33.42ha.

- The spatial boundaries of the project's dedicated plantations are identified by land use maps, GPS coordinates based and cartographic-based geo-referenced information on the project area. Satellite images are also used as a complementary tool. All information on the area and limits of project plantations are recorded in a forestry inventory system (see

Appendix 5). The documentation will be made available to the DOE and used for monitoring and verification purposes.

Table 1: Geographic information on the dedicated plantations and carbonization units related with the project activity.

Region	Unit Number	Plantation Farm Name	Overall geo-referenced points
Curvelo Forest plantations after its last rotation and carbonization units	MG 02	Buenos Aires	- West extreme point: 18º50’08S/ 44º46’14W - Northeast extreme point: 18º44’35S/ 44º30’55W - Southeast extreme point: 18º55’05S/ 44º30’12W
Felixlândia Carbonization units	MG 03	Jacaré/Riachão	- Northeast extreme point: 18º36’19S/ 45º00’38W - Southeast extreme point: 18º40’15S/ 44º59’41W - Northwest extreme point: 18º35’30S/ 45º07’07W - Southwest extreme point: 18º43’19S/ 45º06’22W
Morada Nova de Minas Carbonization units	MG 04	Buriti Grande	- West extreme point: 18º47’52S/ 45º23’32W - Northeast extreme point: 18º41’07S/ 45º14’35W - Southeast extreme point: 18º47’48S/ 45º17’07W
Itacambira Forest plantations after its last rotation and carbonization unit	MG 15	Tamanduá/ Poçoes	- Northeast extreme point: 16º43’04S/ 43º20’03W - Southeast extreme point: 16º56’56S/ 43º23’19W - Northwest extreme point: 16º41’12S/ 43º28’00W - Southwest extreme point: 16º54’04S/ 43º31’32W

CO_2 from the emission of fossil fuel combustion in the establishment of the dedicated planted forests and N_2O of the use of fertilizers will be accounted and monitored.

Emissions in the carbonization process:

This project activity relies on the same procedures of the approved methodology AM0041 “Mitigation of Methane Emissions in the Wood Carbonization Activity for Charcoal Production” as for the CH_4 emissions in the carbonization process. Accordingly, CH_4 emissions will be monitored in the project and the result will be included in the estimation of project emissions and emission reductions. Carbonization units currently built or to be built will be monitored, registered and presented for audit teams during validation and verification.

Emissions in the iron ore reduction process:

CO_2 emissions in the iron ore reduction process are calculated and monitored. The emissions reduction conservatively account for the carbon fixed in the hot metal under the baseline calculation and do not account it in the project scenario, reducing the net process emissions reduction by almost 10% of the total ERs.

Leakage

According to the AM0082 methodology, leakage emissions are to be calculated only if the primary carbon extraction activity (dedicated plantations) is not part of an A/R CDM project activity due to the nature of the system. Since part of the renewable/dedicated plantations is covered by an A/R

CDM project activity (project 2569) the displacement related to leakage emissions of these areas (Felixlandia and Morada Nova de Minas) is not applicable to this project activity in this CDM-PDD. As for the areas under category of forest in its last rotation (Curvelo and Itacambira), leakage will be assessed as per the provisions of the approved methodology AM0082.

In accordance with the approved methodology, the following table summarizes the emissions included in the project boundary:

Table 2: Emissions sources included in or excluded from the project boundary

	Source	GHGs	Included?	Justification/Explanation
Baseline scenario	Iron ore Reduction Process	**CO_2**	**Yes**	**Main source of baseline emissions**
		CH_4	No	Negligible
		N_2O	No	Negligible
	Reducing agents transportation	CO_2	No	Existent but conservatively neglected
		CH_4	No	Negligible
		N_2O	No	Negligible
	Reducing agent production	**CO_2**	**Yes**	**Coal coke production emissions**
		CH_4	No	Existent but conservatively neglected
		N_2O	No	Negligible
	Transportation of primary carbon sources	**CO_2**	**Yes**	**Fossil fuel combustion**
		CH_4	No	Negligible
		N_2O	No	Negligible
	Primary Carbon source	CO_2	No	Existent but conservatively neglected
		CH_4	No	Existent but conservatively neglected
		N_2O	No	Existent but conservatively neglected
Project scenario	Iron ore Reduction Process	**CO_2**	**Yes**	**Main source of project emissions**
		CH_4	No	Negligible and excluded because the differences in the baseline and project activity are not substantial
		N_2O	No	Negligible and excluded because the differences in the baseline and project activity are not substantial
	Reducing agents transportation	**CO_2**	**Yes**	**Fossil fuel combustion**
		CH_4	No	Negligible and excluded because the differences in the baseline and project activity are not substantial
		N_2O	No	Negligible
	Reducing agent production	CO_2	No	CO_2 emissions in the carbonization process are expected to be neutral since all the wood carbonized will come from renewable sources
		CH_4	**Yes**	**Biomass carbonization process**
		N_2O	No	Negligible and excluded because the differences in the baseline and project activity are not substantial.
	Transportation of primary carbon source	**CO_2**	**Yes**	**Yes**[13]
		CH_4	No	Negligible.
		N_2O	No	Negligible.
	Primary Carbon source	**CO_2**	**Yes**	**Yes**[14]
		CH_4	No	Not applicable
		N_2O	**Yes**	**Yes**[15]

[13] CO_2 referring to combustion of fossil fuels by machinery & vehicles

[14] CO_2 referring to fossil fuels combustion in the establishment of plantation.

[15] N_2O referring to the use of fertilizers.

B.4. Establishment and description of baseline scenario

>> In accordance with the provisions of the approved methodology AM0082, this CDM-PDD uses the "Combined Tool to Identify the Baseline Scenario and Demonstrate Additionality", Version 04.0.0, EB66 and incorporates issues that are specific to the new iron ore reduction system, as per the methodology.

For the purposes of this PDD, the applicable geographical area shall be considered Brazil and the Measure falls in the category (a) of fuel and feedstock switch according to the "Combined Tool to Identify the Baseline Scenario and Demonstrate Additionality", Version 04.0.0.

Step 1 - Identification of alternative scenarios

As per the approved methodology, the basic equipment in the iron ore reduction process is the blast furnace. The blast furnace technology corresponds to nearly 98.5% of the Brazilian primary iron ore reduction process (IBS, 2007). The reduction of iron ore removes oxygen from iron oxides and releases CO_2 in a series of chemical reactions at different temperature regimes (AISI, 2007). The choice of reducing agent used in the iron ore reduction process, either coal coke or charcoal plays a significant role in determining the intensity of CO_2 emissions in the iron and steel production (CCAP, 2006). However, the metal demand for iron and steel is not sensitive to the type of reducing agent used in the iron ore reduction process as the demand and supply dynamics of iron is not affected by the use of different reducing agents, and there is no price differentiation because of the different use of reducing agents. The reduction process is almost always based on coal coke.

In light of the above, and considering the methodology provision regarding new iron ore reduction system, the following alternative scenarios are listed for the use of reducing agents in the project entity's metal production in the absence of the proposed project activity:

- <u>Alternative Scenario 1</u> - Coal coke[16] iron ore reduction system with pulverized coal injection;

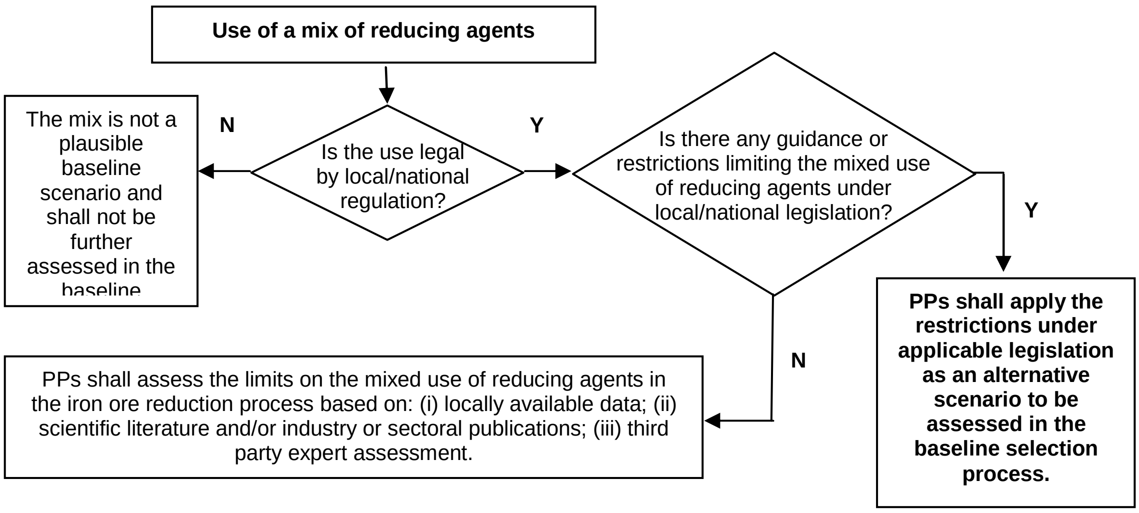
- <u>Alternative Scenario 2</u> - Renewable charcoal iron ore reduction system produced with renewable planted forests sources, based on new plantations (project scenario);

- <u>Alternative Scenario 3</u> - Non-renewable charcoal iron ore reduction system (produced with non-renewable sources);

- <u>Alternative Scenario 4</u> - Iron ore reduction system based on the use of a mix of reducing agents.

    - In accordance with the methodology guidance on how to address the mix of reducing agents as baseline alternatives, the decision-tree provided by the methodology has been applied to this case. In the State of Minas Gerais, environmental licensing regulation restricts the use of a mix of reducing agents in the reduction process to a maximum of 20% of coal coke, combined with 80% of renewable charcoal in the blast furnace or to a maximum of 10% of non-renewable charcoal (see COPAM N^{o} 49 and Law 14309). Thus, as per the methodology's decision-tree, the assessment on the alternative Scenario 4 will be based on these regulatory constraints as per restriction henceforth.

[16] Coal coke is a reducing agent used in iron and steel manufacturing worldwide. Normally, it is added in the top of the blast furnace and pulverized coal is injected at the bottom (LACROIX e*t al*, 2001).



- Alternative Scenario 5 - Renewable charcoal from planted biomass iron ore reduction system based on existing plantations.

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

Legislation related to the use of reducing agents

Legislation related to the use of coal coke (Alternative Scenario 1)

In an attempt to restrain imports and to stimulate quantitatively and qualitatively the development of the national production of coal coke, the Brazilian coal coke industry has been given priority as an industrial development tool (*CNP* Resolution n.18/11 November 1980). The resolution provided the basis for the regulation of the national supply of coal coke. The imports of coal were only allowed to complement the Brazilian production. Brazilian producers had to declare their expected production for the following year and only then the quota of coal to be imported was defined.

In the 1990's, the National Department for Fuel, through the Decree 99.244, was designated to supervise and control imports, production and transportation of coal coke. As a result of new democratic and free trade governmental policies, the quantitative controls on companies' imports, as well as the prohibition for imports (in force since 1975) were eliminated in March 1990. In June 1990, through the Portaria MEFP n.365, the government settled its general guidance for industrial and international trade policies, aiming to boost internal competitiveness and industrial modernization.

The establishment of coke making facilities in Brazil faces no regulatory restrictions. The emissions of pollutants to the atmosphere are ruled by CONAMA Resolution 382, dated 26 December 2006[17], but, apart from that, there are no other restrictions to this sort of entrepreneurship.

Thus, there are no legal restrictions in what concerns the use of coal coke in the iron ore reduction process.

Legislation related to the use of charcoal (renewable and non-renewable) and a mix of reducing agents (Alternative Scenarios 2, 3, 4 and 5)

Since the 1930's, different regulatory mechanisms have affected the production of renewable and non-renewable charcoal in Brazil. The Brazilian Forestry Code, issued in 1934 (Decree 23.973/34)

[17] CONAMA Resolution 382, dated 26 December 2006: http://www.mma.gov.br/port/conama/res/res06/res38206.pdf , accessed in May 2011.

and reedited in 1965 (Law n.4771/65), was an important instrument to regulate the forestry activities, establishing a minimum percentage for the preservation of native forests, and introducing the concept of permanent preservation areas and legal reserves. Article n.21 required that mills, transportation companies, and other units based on wood or other forestry raw materials, have their own plantations established over a five to ten year period to achieve the requisite plantation-based wood supplies. The transportation of, acceptance and storage of wood, firewood or charcoal originated from native forests, as well as the production of charcoal using first quality native wood without proper licenses have all been qualified as criminal offenses. The sanctions resulting from these contraventions vary from three months to one-year imprisonment and fines.

In 1989, the Decree 97.628/89, under the Brazilian Forestry Code, required all large-scale wood consuming industries to be responsible for creation of the required plantation sources to supply their production activities. However, the 1988's Federal Constitution[18] had established a new role for the Federation, States and Municipalities in the preservation and maintenance of forests, fauna and flora. It allowed States to simultaneously legislate on environmental issues. In 1991 Minas Gerais became the first Brazilian State to have its own forestry regulation, with the creation of the State Forestry Law (Law n.10.561). It was then revoked and replaced by Law n.14.309, which obliged all companies that consume or commercialize forest products to use a minimum of 90% of wood coming from planted forests. This regulation provides the legal basis for the possibility of using a mix of renewable and non-renewable charcoal, since a maximum of 10% for native forests consumption has been allowed, provided a fee is paid.

In September 2001, the State Council for Environmental Policy[19] issued a new regulation (COPAM N^{o} 49, Art.12) allowing charcoal based mills to substitute charcoal for coal coke until a maximum percentage of 20% in weight, within the environmental licensing process. As per the proposed methodology this regulatory restriction provides the basis for the assessment of the possibility of using a mix of coal coke and charcoal in the iron ore reduction system.

In the past, several illegal schemes of commercialization of products deriving from illegal logging and falsification of licenses for charcoal production and transportation have been reported. Technical and human resources for more thorough inspections were not sufficient to cover the national territory. The effects of such a lack of enforcement over public property rights have often led to a classic common pool resource problem, posed by the availability of native wood and its obvious economic attractiveness compared with any alternatives that require major new investments, e.g. renewable charcoal or coal coke. This has resulted in market failures in the sustainable production of renewable charcoal-based iron. However, inspection operations have significantly increased both in terms of frequency and strictness. Criminal and financial penalties have been applied, such as apprehensions, embargoes, fines and imprisonment[20]. In the state of

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[18] Chapter VI, Articles 23 and 24 deal with forestry matters.

[19] Substitution must consider the sulphur percentages set in the legislation.

[20] See articles on several of these operations at:

http://www.ibama.gov.br/novo_ibama/paginas/materia.php?id_arq=3299

http://www.ibama.gov.br/novo_ibama/paginas/materia.php?id_arq=4798

http://www.ibama.gov.br/novo_ibama/paginas/materia.php?id_arq=3185

http://www.ibama.gov.br/novo_ibama/paginas/materia.php?id_arq=3572

http://www.ibama.gov.br/novo_ibama/paginas/materia.php?id_arq=3502

http://www.ibama.gov.br/novo_ibama/paginas/materia.php?id_arq=4589

http://www.ief.mg.gov.br/index.php?option=com_content&task=view&id=310&Itemid=139

http://www.cedefes.org.br/new/index.php?conteudo=materias/index&secao=5&tema=1&materia=2855

http://www.pm.sc.gov.br/website/redirantenor.php?site=40&act=1&id=1895

Minas Gerais, the culmination of this trend has taken place by the end of 2007, early 2008, when the executive branch has proposed a new law, gradually banning the use of non-renewable sources of charcoal for the iron ore reduction process.[21] In 2009, the State Governor approved Law18.365, regulating the use of native wood sources by companies in Minas Gerais. It presents a schedule for gradual reduction of consumption of native wood and establishes its use in maximum 5% from 2018 on. New companies have to prove they start their activities relying 95% on planted forests. The law also considers the electronic monitoring of forest goods, such as wood and charcoal, tracking down the transporting trucks via electronic chip.

Conclusion → Based on the legal framework applicable to the use of reducing agents in the iron ore reduction process in Brazil and on the scenarios initially identified in Step 1, the following conclusions are put forward:

(i) There are no legal restrictions in what concerns the use of coal coke in the iron ore reduction process (*Alternative Scenario 1*)
(ii) There is no legal restriction in terms of the maximum amounts of renewable charcoal that can be used in the process (*Alternative Scenario 2* and *5*)
(iii) It is illegal to base the production of iron totally on non-renewable charcoal (*Alternative Scenario 3*). Therefore, it would be unrealistic and non-conservative to assume that project entities would plan new and long-term investments to establish a new iron ore reduction system, in light of the severe restrictions in terms of the maximum amounts of non-renewable charcoal, coupled with all risks derived from the illegal and unsustainable practices involving the use of non-renewable charcoal.
(iv) There are legal restrictions to the use of a mix of reducing agents. For the same reasons stated in the previous topic, it would be illegal to have a scenario based on the large scale use of non-renewable charcoal even in a mix with renewable charcoal. Also, the regulation on the use of coal coke and renewable charcoal is quite restrictive within the environmental licensing process (maximum 20% of coal coke as explained above).

Outcome of Sub-step 1a: the plausible alternative scenarios to the project activity are *Scenarios 1, 2, 4* and *5*.

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

Sector level

As the availability of reducing agents has a major impact for the assessment of baseline scenarios, this section seeks to analyze the extent to which the supply and demand dynamics of coal coke and/or of charcoal from renewable plantations are the underpinning constraints to the definition of realistic alternative scenarios.

In order to identify possible supply and demand unbalances, a comparative analysis has been conducted for (i) the total share of reducing agents consumed (effective demand) in the production of pig iron and, (ii) the amount of plantations established for such an end-use seven years before (available supply).

Figure 14 and **Figure 15** demonstrate a large demand-supply gap. Even though the absolute amount of plantations has increased since 2001, the consumption of reducing agents has increased significantly more, resulting in an increase of the *ex post* plantation deficit. In spite of cyclical fluctuations, historical and current data demonstrate the plantation deficits have always been observed based on the consumption of reducing agents by the iron industry.

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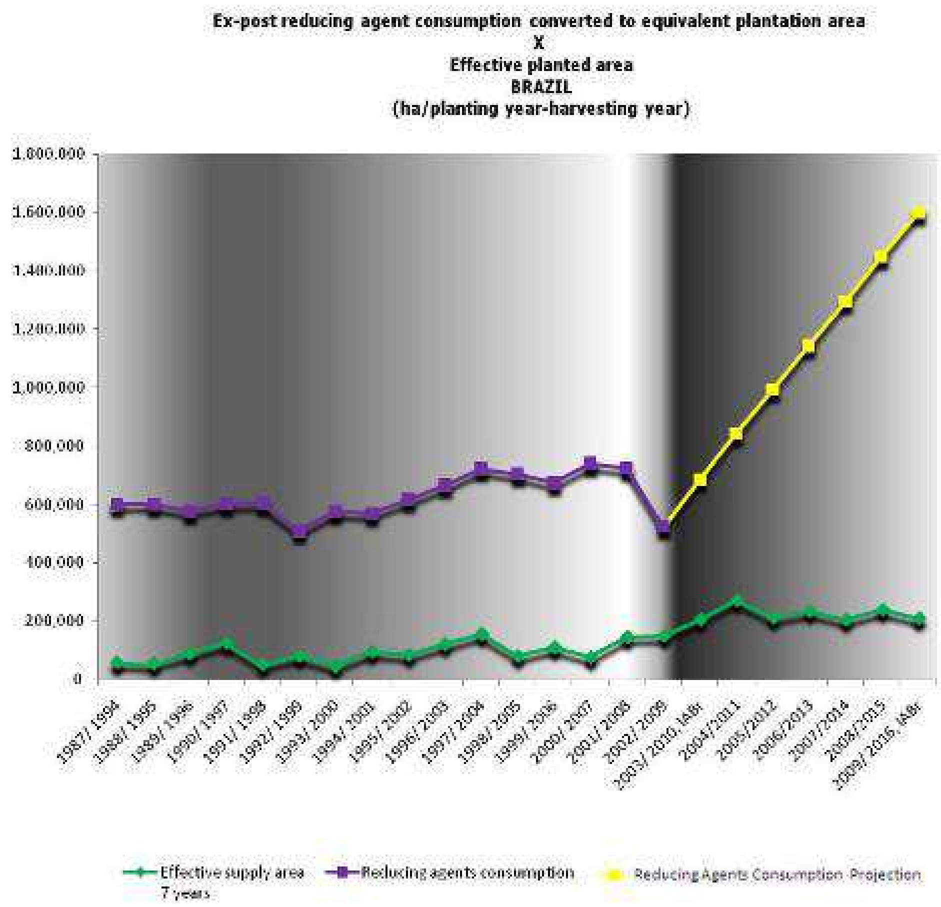
http://www.aaitmg.org.br/pages/1_news_old/2006/07_20_06.html

http://www.revistareferencia.com.br/index.php?principal=ver_noticia.php&uid=174

[21] Secretaria de Estado de Meio Ambiente e Desenvolvimento Sustentável (SEMAD/2007).

Figure 14: Comparison between (i) the *ex post* consumption of reducing agents expressed in equivalent plantation area and (ii) effective planted area, as per the seven year rotation of eucalyptus (Brazil).



Sources: SINDIFER 2007; AMS 2010; IABr, 2009

Figure 14 shows an average of approximately 85% gap for the period assessed (1994 to 2009). In 2000, when the major project investment decision was taken the supply deficit reached approximately 90%. Due to the economical crisis that swept the world in 2008 and 2009[22], the demand for reducing agent was exceptionally low creating an anomalous decrease shown in the graph[23]. Yellow data for 2010 and 2016 are IABr (Brazil Steel Institute) projections. The data for the in between years (2011 to 2015) are linear projections based on the IABr (2009) data.

Figure 15: Planted area balance in terms of the gap between the renewable plantations area available and the requirement to meet the industry's demand for reducing agents.

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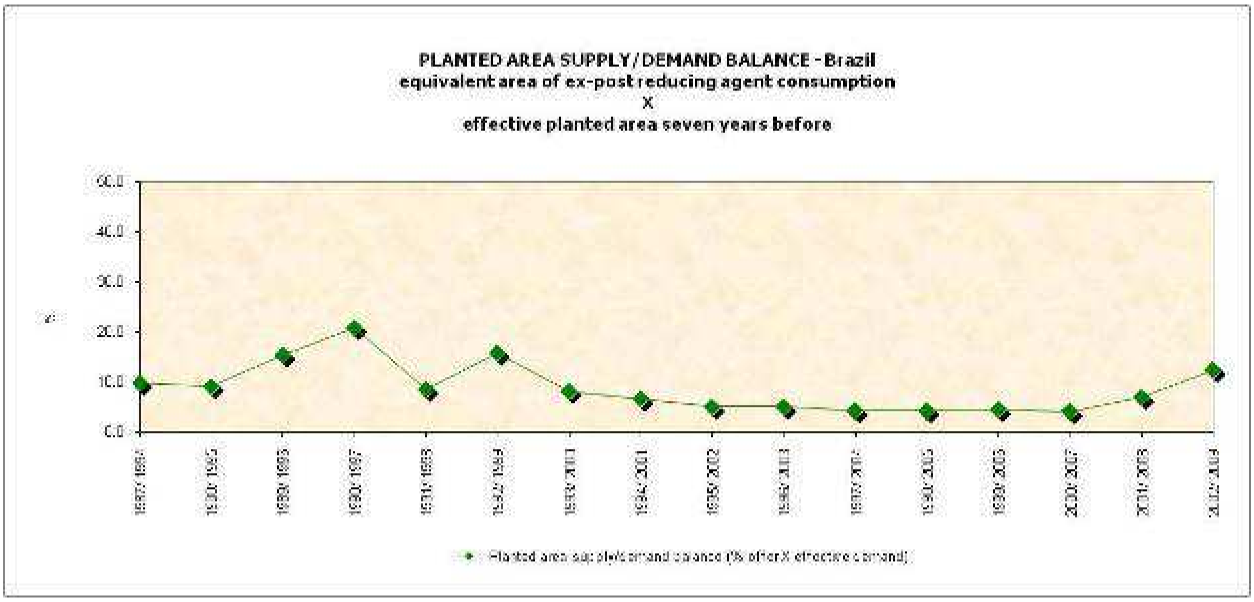
[22] AMS, accessed in April 2010: http://www.silviminas.com.br/principal/iConteudo.aspx?cty=44&cnt=34&ano=5&mn=0

[23] AMS, accessed in April 2010: http://www.silviminas.com.br/principal/iConteudo.aspx?cty=44&cnt=81&ano=5&mn=0



Sources: Research on AMS 2010; SINDIFER, 2007

As a matter of fact, the historical, current and expected plantation deficit in Brazil is widely recognized by local, state and federal governments, universities, research institutes, NGOs' and private sector entities. Several governmental and non-governmental organizations have published reports on the deficit of dedicated plantations for charcoal consumption in Brazil, including the Brazilian Institute of Geography and Statistics (IBGE), National Social and Economic Development Bank (BNDES), Ministry of the Environment (MMA), Brazilian Silviculture Society (SBS), Brazilian Institute on Forestry Research (IPEF), Silviculture Association of Minas Gerais (AMS, former ABRACAVE), the University of Viçosa (UFV), the University of São Paulo (ESALQ/USP), STCP Engenharia and the Environment Defense Association of Minas Gerais (AMDA).

Although specific numbers may vary, depending on the research focus, vintage of the data, and wood end-uses, most researches report a common conclusion, pointing to severe shortages in the supply of plantation wood (renewable wood) in Brazil, widely referred to as the "forestry blackout". The most frequent causes are: lack of adequate debt funding, inadequate long-term policy, high interest rates, complex environmental policy and plantation legislation. In most cases, these issues provide the basis for the lack of attractiveness of plantation establishment and for the ongoing pressure on native vegetation, which is a common conclusion reached in the published literature. The causes of these and other potential barriers will be discussed in Step 2. It is also worth stressing that there are no significant imports of renewable charcoal in Brazil.

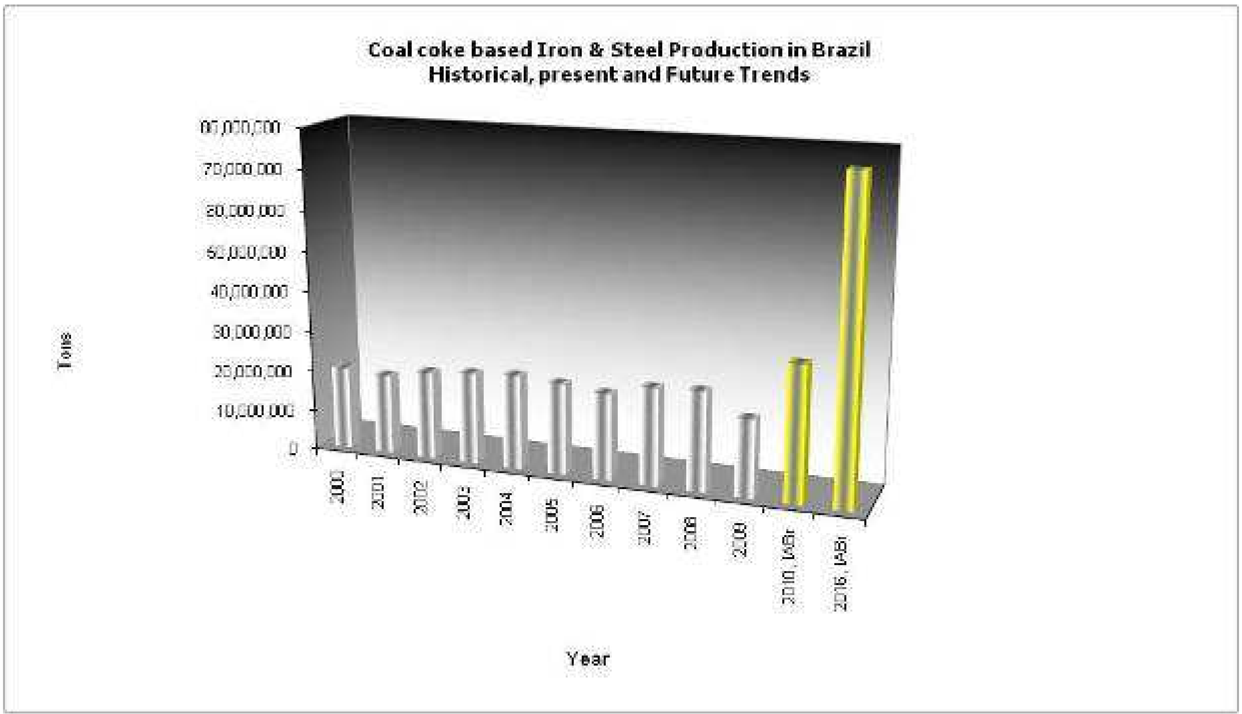
In accordance to the National Social and Economic Development Bank (BNDES), the charcoal industry is currently the most affected by the ever increasing demand for wood sources, given the near exhaustion of the forest plantations established under the fiscal incentives, and the lack of new plantations (BNDES, 2002). An IBGE research further corroborates such a trend. The research highlights that the decreasing rate of plantation-based charcoal is attributable to a decline in the establishment of plantations aimed at supplying the iron and steel industry (IBGE – Brazilian Institute of Geography and Statistics, 2003).

At the international level, the economic growth in countries like China and India has been creating an enormous demand for iron and steel, which is expected to continue for a long time due to their development needs. As a consequence of that, the iron and steel production in Brazil and in other parts of the world has been pushed to an unprecedented level of growth. The Brazilian iron and steel industry is known for the widespread use of coal coke since the 1940's (UFLA and CEDEPLAR 2006)[24]. Recently, the Brazilian coal coke based iron companies have significantly grown in importance and are considered relevant market players at the global level. The graph

[24] http://www.cedeplar.ufmg.br/seminarios/seminario_diamantina/2006/D06A069.pdf

below presents the Brazilian coal coke based iron and steel historical, current and projected trends, which points to a significant expansion.

Figure 16: Coal coke based Iron & Steel Production in Brazil Historical, Actual and Future Trends[25]



Source: Research on SINDIFER, AMS and IABr, 2010

The supply availability of coal cannot be considered at risk. As opposed to renewable charcoal, coal resources are available in several countries, with recoverable reserves in more than 70 countries and, at current production levels, estimated to last for at least 133 years (World Coal Institute, 2008). Moreover, the logistical structure of a global commodity such as coal provides a substantial basis for internal and external economies of scale (Krugman and Obstfeld, 2003).

In conclusion, the analysis of the supply and demand dynamics of dedicated plantations for renewable charcoal points to a major supply shortage of renewable charcoal as iron ore reducing agent. On the contrary, coal, a widely distributed global commodity, is identified as the business as usual and most common reducing agent used nationally and internationally in the iron and steel industry due to its substantial availability and external economies of scale.

Project level

The project entity was founded in 1967 in response to the fiscal incentives provided by the Brazilian federal government. It is an entrepreneurial family firm whose capital is 100% Brazilian, which works in reforestation, pig iron making and treated wood (Amaru©) business' sectors. Initially as a forestry management services company (service provider to third parties) the project entity has managed plantation consortia based on fiscal incentives. By rendering forestry management services, the project entity has been able to acquire quotas of some consortia, which allowed the establishment of its own plantation stocks to further produce renewable charcoal. As a result of that, Plantar's pig iron mill was established in 1985. As an exception in the iron industry, the project entity had established its own plantation stocks before starting business activities associated with the end-use attributable to the planted wood. From 1988 to the end of the 1990's

[25] The graph presents two projected productions for 2010 and 2016, from IABr (see **Table 6**). The data in between, years, from 2011 to 2015, are linear projections, based on this IABr data.

the project entity's annual plantations have varied from zero to irrelevant figures, while its previously existing plantations terminated. The sector trends of plantation activities over the last decade indicate very small rates of plantation establishment since the end of the fiscal incentives (see **Table 3**).

Table 3: Iron industry's historic rate of reforestation for the production of charcoal for iron production, since the end of the fiscal incentives.

Year	Total planted area (ha) energy Brazil	A/R activities to supply the iron industry (%)
1988	54,352	8
1989	88,357	14
1990	125,000	19
1991	51,305	8
1992	80,067	14
1993	46,653	7
1994	37,026	6
1995	30,351	5
1996	32,752	5
1997	30,756	4
1998	30,000	4
1999	30,000	4
Average Area	**53,052**	
Average Rate(%)	***8.20***	

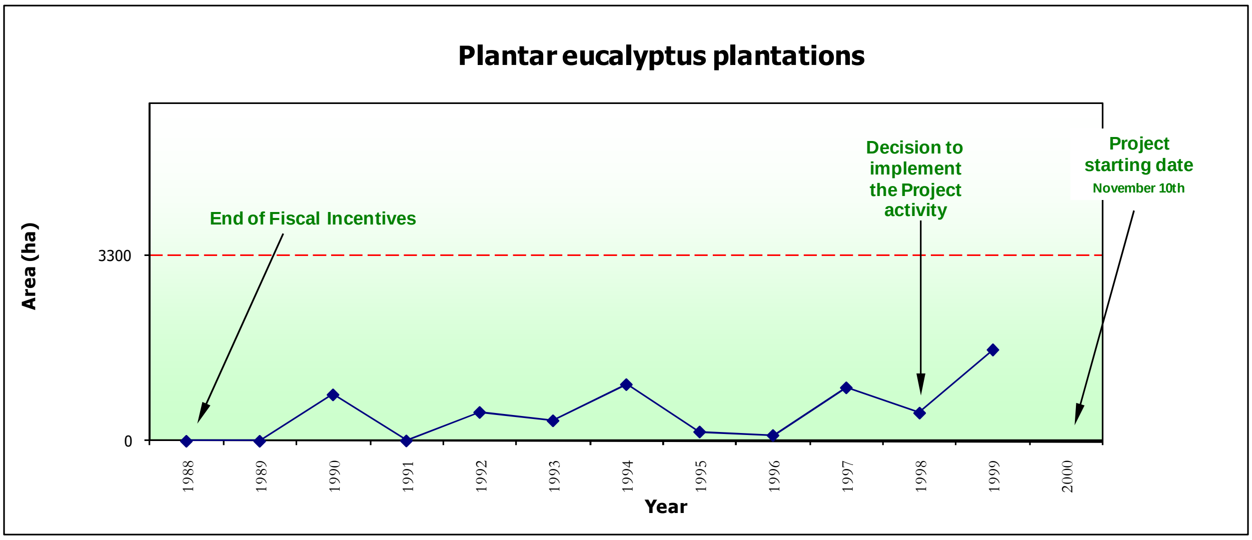
Source: Plantar Records

This data reflects trends associated with the relevant regulatory/policy constrains and incentives to the establishment of fuel wood plantation activities developed by the project entity. As presented in Step 1b, the end of fiscal incentives in 1988 caused a major impact on the regional and national forestry sector. Plantar's forest plantation activities to supply the recently established pig iron mill followed the same downward market trend due to the lack of adequate financing opportunities and other barriers presented in Step 2. Ironically, such a lack of renewable plantations has taken place precisely when the company most needed fuel wood to supply its then recently established iron mill. Consequently, the *lato-sensu* sustainability of its plantation-based activities was seriously affected, with the absence of the required planted forests.

Thus, the suspension of the fiscal incentives and the prevailing barriers (further analyzed below), have critically prevented the project entity from establishing planted forests for the production of iron and, as a result, its previous plantation stocks reached the end of their rotation cycle.

Figure 17 presents the plantations activities undertaken by the project entity since the end of fiscal incentives.

Figure 17: Plantar's plantations before the project's conception (until 1999).

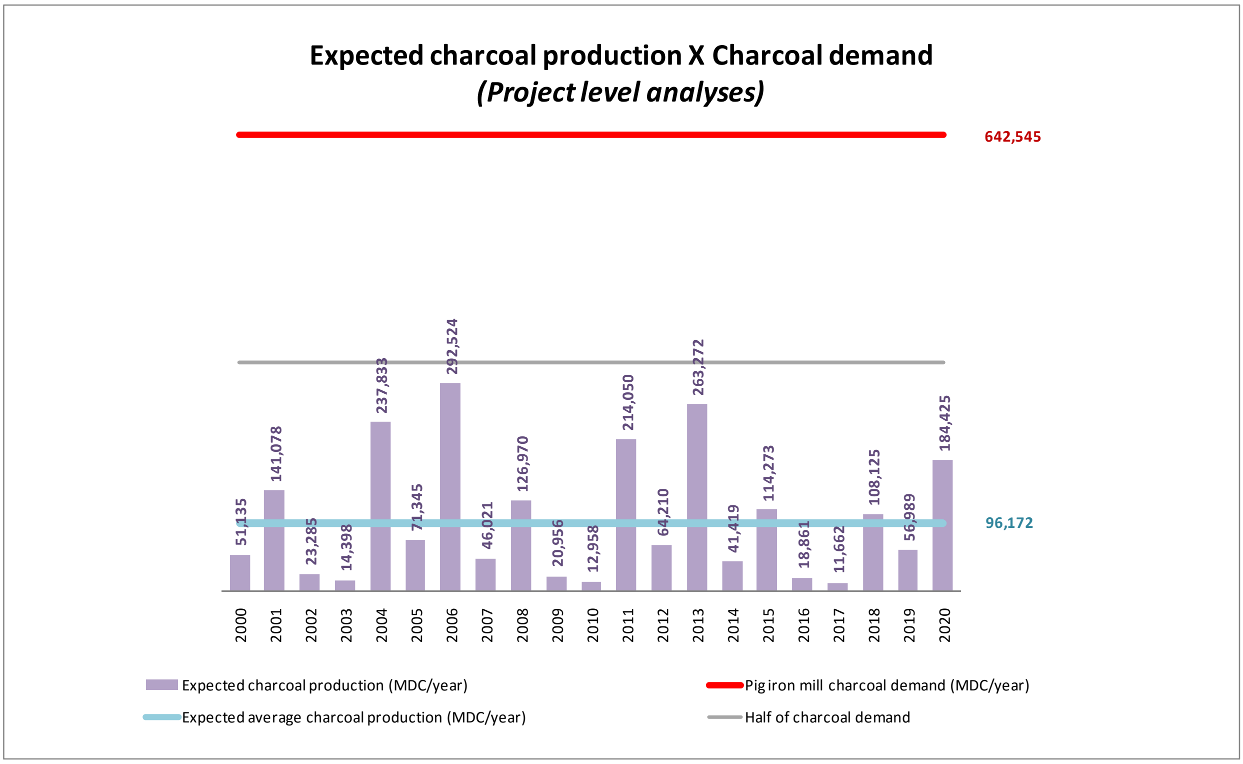


Source: Project entity's records

Therefore, the scenario in which the project entity was immersed in early 2000 indicated that by 2007 the iron ore reduction process in the pig iron mill could not rely on the company's own fuel wood stocks for the production of renewable charcoal (see **Figure 18**). Likewise, there was and, there is still no availability of renewable charcoal in the market, as indicated in the supply and demand analysis above.

The graph below was based on the effective planted areas from 1988 until 1999 (see **Figure 17**). The charcoal production of the project entity was projected throughout the lifetime of the project (2000 to 2020), taking into consideration the three productive cycles of eucalyptus forest production.

Figure 18: Project level analyses of charcoal demand and expected production



Source: Project entity's records

Figure 18 shows the actual pig iron mill demand for charcoal, based on its rated capacity (642,545 MDC/year), the expected charcoal production for the project lifetime, based on the effective forest plantings until the project starting date, and the consequent mean expected charcoal production (15% of the pig iron mill demand for charcoal).

It is clear the nonviability of running a pig iron mill business based only in the forests effectively planted. The expected charcoal production based on these areas is not sufficient to supply even half the pig iron mill's demand, even in its higher peaks.

With the adoption of the Kyoto Protocol's CDM in 1997, the project entity considered it an alternative to enable the new investments required to commence the implementation of the project activity in 2000, i.e. the implementation of the new iron ore reduction system, including the establishment of new dedicated plantations whose harvesting started in 2008, i.e. the starting date of this proposed CDM project activity. The project decision has been strongly supported by the already advanced and publicly known negotiations with other project participants and investors, including the World Bank's Prototype Carbon Fund[26]. The CDM incentives, related to this and associated project activities allowed the project entity to curb wood supply deficit and became self-sufficient in 2007/2008. As the plantations mature, the project entity is likely to be the sole company in its industry to be self-sufficient in renewable charcoal supply, which will be further discussed in the common practice analysis.

Hence, without the CDM incentives, which supported the implementation of new dedicated plantations, the project entity would have to change its reducing agent in order to keep its pig iron business. Otherwise, its share in the pig iron production would be absorbed by coal coke based market.

The analysis conducted in the sub-steps above point to the following conclusions:

- Based on national and state legislation, it is not possible or realistic to use non-renewable charcoal produced from native forests to completely supply iron production in industrial scale, although the use of a share of non-renewable charcoal can be legally possible (up to 10% of total reducing agent used in the production).

- In addition to the lack of renewable plantations, substantive legal restrictions apply to the mixed use of coal coke and renewable charcoal in the iron ore reduction process, limiting the mixed use of coal coke to the maximum of 20% of the total amount used in the process.

- The analysis of the supply and demand dynamics of the reducing agents related to the alternative scenarios identified points to a severe supply shortage of renewable charcoal, making clear that there is no structured spot market for the purchase of renewable charcoal and no existing plantation stocks that third parties could sell directly to the project entity on a long-term and sustainable basis. On the other hand, the coal coke market benefits from significantly lower transaction costs benefits from major external economies of a global commodity.

- The deficit of renewable charcoal provides an underpinning constraint to the types of new investments to be analyzed within this combined additionality assessment. Given the absence of the required plantations, the only realistic alternative scenario which encompasses the use of renewable charcoal is the establishment of new dedicated plantations.

Thus, the following alternatives are identified as realistic and provide the basis for the remainder of the analysis under the combined tool assessment:

- <u>Alternative Scenario 1</u> – Coal coke iron ore reduction system with pulverized coal injection;

[26] Letters of Intent and official correspondence are available and will be presented to the DOE.

- Alternative Scenario 2 - Renewable charcoal (produced with renewable planted forests sources) iron ore reduction system based on new plantations (project scenario);

- Alternative Scenario 4 - Iron ore reduction system based on the use of a mix of reducing agents.

Outcome of Step 1b: the plausible alternative scenarios to the project activity are *Scenarios 1, 2* and *4*.

Conclusion of Step 1: as per provisions of the AM0082, the remaining realistic alternative scenarios, *Scenario 1*, *Scenario 2* and *Scenario 4* are evaluated in the subsequent steps below, in order to allow for the identification of the most likely baseline scenario at the end of this Section B.4.

Step 2. Barrier analysis

The barrier analysis hereinafter assesses the three remaining alternatives described in **Step 1** above, use of coal coke iron ore reduction system with pulverized coal injection (*Alternative Scenario 1*), iron ore reduction system based on renewable charcoal from planted biomass sources based on new plantations (*Alternative Scenario 2*) and an iron ore reduction system based on a mix of reducing agents (*Alternative Scenario 4*). This barrier analysis takes into consideration the "Guidelines for objective demonstration and assessment of barriers", Annex 13 of the Executive Board 50th meeting report, version 01.

Sub-step 2a) Identify barriers that would prevent the implementation of alternative scenarios

The identified barriers include:

a) Barriers/incentives to investment and financing.
b) Sectoral barriers and policies.
c) Regulatory and/or technical barriers, e.g. different environmental licensing requirements for different reducing agents.

Outcome of Sub-step 2a: the barriers that may prevent one or more alternative scenarios to occur are the ones listed above.

Sub-step 2b) Eliminate alternative scenarios which are prevented by the identified barriers

2b.1. Assessment of the identified barriers to establish a coal coke iron ore reduction system with pulverized coal injection (Alternative Scenario 1):

a) Barriers/incentives to investment and financing.
   - During the last 15 years, the coal coke-based iron and steel industry in Brazil benefited from the Brazilian program for modernization. The investments in the sector have reached so far approximately USD 12.1 billion, of which USD 8.6 billion were undertaken between 1994 and 1999.

   - There is no offer of coal coke in Brazilian domestic market. Major integrated steel companies build their own coke making facilities to process coal, mainly imported, into coke[27]. Other alternative is to import coal coke. However, even large scale mills partially

[27] Coke-making process is a chemical process in which coal releases gases contained in its structure when subjected to high temperatures in the absence of oxygen, forming a solid residue, powerful and infusible, called coal coke.

relying on coal coke imports suffer due to price variation in external markets. Substitution from coke imports to own production of coke is a great opportunity for industries to significantly reduce its operational costs[28], consistent with the mill production scale.

- There is no investment and financing barriers to install a coke making facility since it is possible to built an efficient and competitive small coke making facility that do not require a huge amount of investment (SCHERER, 1995).

b) Sectoral barriers and policies.

- In early 1990s, the Brazilian economy was opened to free trade, following the redemocratization process that culminated with national elections in 1989, ending an era of nationalism and protectionist trade (Chang, 2003). A more liberal development policy was adopted. Import taxes were reduced, stimulating the imports of coal coke and broad privatization policy was also implemented. A specific privatization program for the iron and steel industry was put into practice. By the second half of 1990, all major iron and steel public companies were privatized, and in parallel the tax incentives for forestry plantations aimed at supplying renewable charcoal were eliminated by the Federal Government. "With the privatization many companies integrated with the charcoal production were shut down and the process shifted to imported coal." [29]

  According to the MME (Ministry of Mines and Energy, 2006), an important policy incentive supported by the National Social and Economic Development Bank (BNDES) is to finance new researches and investments to reach self sufficiency in coal and coal coke by 2010 (Gazeta Mercantil, 2004[30]). By this means, the aim of the Federal Government is to develop a national market infrastructure to explore and to produce 13 million tons of coal per year. As such the country would become less dependent on imports by the Iron and Steel Industry (Gazeta Mercantil, 2004)[31].

c) Regulatory barriers and/or technical barriers.

- There are no major regulatory issues concerning the use of coal coke as a reducing agent other than the ones related to import and external trade.

- According to the engineering study "Assessment for Reducing Agent Change in Pig Iron Production of Plantar Siderúrgica" developed by iron and steel experts RS Consultants for the project entity in 2000 (SAMPAIO, 2000), there are no technical restrictions to the conversion of the installed blast furnaces operations into coal coke and pulverized coal injection, provided that the experts recommendations are observed.

- The implementation of a mini coke making facility adjacent to the pig iron mill is a doable solution to guarantee self-sufficiency in reducing agent supply to the mill. As shown in item (a) above, there is no offer of coal coke in Brazilian domestic market and the most economic solution is the implementation of a coke making facility for self supply. There is technology available in the market to implement a feasible mini coke making facility using the so called "non recovery" or "heat recovery" technology. "Non recovery" or "heat recovery" technology exist in all scales ranging from tiny facilities of approximately 40

See DEMEC/UFMG, http://www.demec.ufmg.br/disciplinas/ema003/solidos/coque/processo.htm . Accessed in May 2011.

[28] Siderurgia Brasil magazine, no. 67: http://www.siderurgiabrasil.com.br/novosb/component/content/article/207-materiassb67/1865-usiminas-inicia-operacao-de-nova-coqueria, accessed in May 2011.

[29] - Brazil's Initial National Communication to the United Nations Framework Convention on Climate Change, 2004, page 195

[30] http://infoener.iee.usp.br/infoener/hemeroteca/imagens/78561.htm

[31] According IBS (2006) 72% of the Brazilian pig iron is produced using coal coke.

thousand tonnes of coke/year to huge facilities with production capacity of 2 million tonnes of coke/year (PFEIFER, 2008). "Non recovery" or "heat recovery" technology burns all coal volatile matter while still inside the coke ovens instead of releasing toxic gases to the atmosphere[32], representing low environmental impacts. It also recovers heat from hot gases to generate energy[33]. Mini coke making facilities demand a relatively low investment and are simple to operate and maintain (SCHERER, 1995).

Figure 19: Mini coke making facility "non recovery", Sidymetal S.A, Buenos Aires, Argentina

Source: PFEIFER, 2008

- o There are no regulatory or environmental barriers to install a small "non recovery" or "heat recovery" coke making facility. Their gases and smoke are totally burned before being released to the atmosphere or could be used to generate energy, with low pollution rate (PFEIFER, 2008).

2b.2. Assessment of the identified barriers to establish <u>a renewable charcoal iron ore reduction system</u> <u>based on new plantations</u> (Alternative Scenario 2):

a) Barriers/incentives to investment and financing.

- o To comply with Guideline 1 of the aforementioned Annex 13, EB50, information related to the nature of company, organization and its ownership and previous experience with similar projects is given: Plantar was founded in 1967 in response to the fiscal incentives provided by the Brazilian federal government. It is an entrepreneurial family firm whose capital is 100% Brazilian, which works in reforestation, pig iron making and treated wood business' sectors. It is not publicly listed and has no access to capital markets in Brazil or abroad.

- o To produce renewable charcoal it is necessary to establish sustainable sources of fuel wood. The most common way to achieve this scenario is through the establishment of dedicated forest plantations that requires large amounts of upfront investment with overwhelmingly long payback periods. Although the productivity of eucalyptus plantations in Brazil is currently considered the best in the world, the first harvesting period for most economic uses, including charcoal, cannot occur before year 7. The primary revenues are only obtained after 7 years and the project's maturity only occurs in year 21, which makes the structuring of project finance schemes highly complex.

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[32] Atmospheric pollutants emissions ruled by CONAMA Resolution 382, dated 26 December 2006 (see Footnote 17).

[33] CST-Arcelor Brasil - http://www.cst.com.br/expansao/in/sol_coke/environmental_aspects/environmental_aspects.shtml. Accessed in May, 2011.

- o In order to cope with the intrinsic characteristics of the renewable charcoal-based sector, the loans must have at least a 7-year grace period (first harvesting period), and a minimum duration of about 10 years, which is almost non-existent in the Brazilian financial market, as well as in most developing countries. The situation is worsened by the fact that these types of loans are not offered by Brazilian private banks. As a result, the entire funding demands on governmental bodies increase, which have competing priorities for the limited resources available to them.

- o Even within the Brazilian public banks, the availability of proper debt funding for the project activity was extremely limited during the period in which the project investment decision was made. In 1988, the Minas Gerais Development Bank (BDMG) has created the only applicable funding facility to which the project entity had access (Proflorestas). The fund started its operations in 1994 with limited resources (US$28 million). In addition, most companies are not able to meet the collateral requirements and other governmental restrictions. At the time the project activity started, and in the subsequent years, the total amount of annual resources made available by this facility has only covered a very minor portion of the sector's needs. In 2005, only R$16 million were available and, in 2006 and 2007, R$10 million and R$8 million were available to the entire forestry based sector in the state of Minas Gerais (BDMG, 2005). **Table 4** presents the Minas Gerais Development Bank's disbursement of Proflorestas loans from 2000 to 2007.

Table 4: Minas Gerais Development Bank (BDMG) Proflorestas Disbursement of loans for the forestry sector during 2000-2007

Proflorestas Loans - BDMG	
Year	**Total Values (R$)**
2000	1 269 323
2001	10 960 131
2002	17 014 601
2003	11 947 910
2004	4 538 000
2005	16 000 000
2006	10 000 000
2007	8 000 000*
TOTAL	79 729 965
* Estimated value for 2007.	

Plantar was able to obtain loans under the Proflorestas scheme as per the cap within the program. Although these resources were used to implement part of the project activity, they only covered a smaller portion of the total investment required for the project implementation. The acquisition of these loans was also facilitated by carbon finance, since the project entity's CDM projects and the PCF transaction have positively influenced the BDMG risk assessment procedures, as further explained below. Plantar was the sole company in the iron sector to obtain this sort of debt funding.

The Brazilian Development Bank (BNDES), which is the main source of long-term funding in Brazil - and is an alternative for these producers – could not attend the sector's debt financing needs. Four out of five long-term forestry loans offered by the Bank had duration of five years or less. The other funds made available to forestry plantations are not applicable to the project activity, as they are exclusively devoted to small-scale enterprises (i.e. BNDES Pronaf - for rural households only, and BNDES Propflora) or are only dedicated to supply finance to the pulp and paper industry. The Propflora facility has been created to support the implementation of plantation activities. However, it is capped at R$150,000, which is negligible considering the investment requirements of large-

scale plantations. The Propflora scheme has been the only additional funding facility created after the official launch of the PNF in 2004.

Likewise, the location of the plantation activity in the state of Minas Gerais also makes it ineligible for receiving other sources of official funds, such as the special funds structured for the less privileged regions of Brazil, which also lack sufficient resources (e.g. North, Mid-West and Northeast regional funds). In addition to the scarcity of funding and the level of importance, most companies, including the project entity, have serious difficulties in providing the collateral and loan warranty. Nearly all banks only accept permanent and real assets other than the plantations, a fact that further limits the access to debt-funding resources. Therefore, the project entity has restricted access to the extremely scarce and expensive long-term financing in Brazil. All of the relevant data will be provided to the DOE.

The project entity had no access to international capital markets due to its small size and due to the international investors' risk-aversion on lending to establish dedicated plantation activities to produce renewable charcoal in developing countries, with a very unstable institutional and regulatory environment as discussed in Step 1. Thus, no alternative sources of debt or financing, other than the limited domestic resources, were available to the project entity, especially at the time the investment decision was made (year 2000).

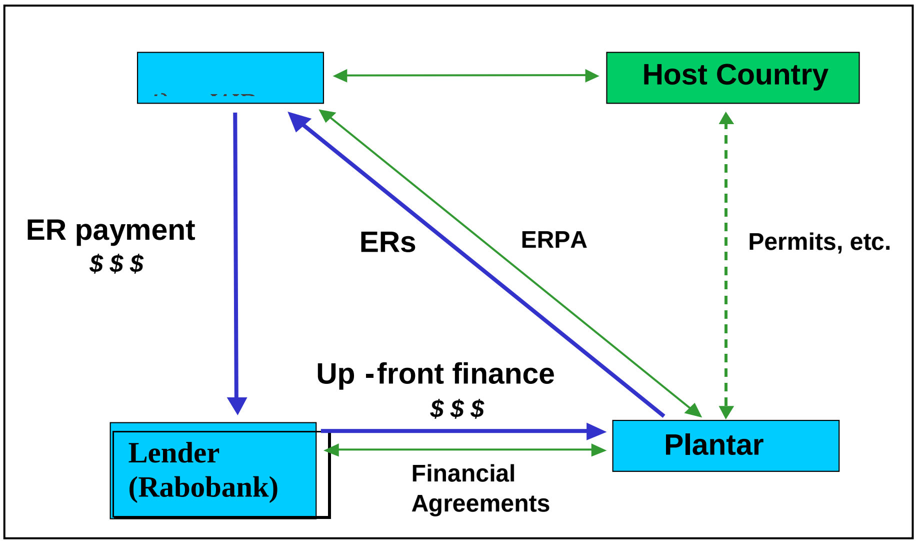
The expected CDM registration of the Plantar projects has already alleviated a major part of the lack of funding for the project activity[34]. Besides enhancing shareholder confidence in domestic investment, especially in light of the historically supply-constrained charcoal-based iron industry, the project entity has been able to seek marginal sources of revenues by selling part of the project's emission reductions and removals under associated project activities (a total of USD 5.3 million) to the World Bank's Prototype Carbon Fund.

In addition to the plantation establishment to supply the charcoal based iron ore reduction demand, the nature of the carbon credits and their qualitative impact in the project finance structure has also been an equally relevant issue. The mismatch between the upfront cash requirements for large-scale investments and the *ex-post* payments[35] for the ERs were partially alleviated with a financial engineering scheme, called monetization / securitization of receivables (i.e. a pioneer up-front loan based on the carbon credits structured by a commercial bank matching the payment for the ERs with the loan's repayment schedule). **Figure 20** illustrates the above-mentioned financing structure, where the World Bank's PCF pays for the ERs directly into the lender's account, amortizing the loan taken by Plantar with the commercial bank, Rabobank International.

Figure 20: Plantar Project financing structure

[34] To comply with Guideline 2 of Annex 13 EB50.

[35] As in most emission reduction/removals transactions, the PCF payments are only made against delivery. In the project activity most of the credits from emission removals will be delivered at the end of the initial 7-year plantation establishment period.



This transaction has only been possible and the project only became bankable due to its eligibility to CDM and carbon credits. The sale of ERs anticipated part of the project's original income from 7 years. Also, the ERs provide a source of hard currency to the project entity, which enabled the company to repay the external loan in hard currency. The support provided by the PCF's ERPA[36] (Emission Reductions Purchase Agreement) allows the payment for the ERs directly in the lender's account and to limit the exchange rate risk. Therefore, the cash convertibility and transferability risks are reduced, and the overall risk and respective interest rates for the loan decrease, making it feasible for the project entity to repay the loan.

As important as the marginal source of revenue provided by the CDM and its impact on the project finance is the effect of CDM eligibility in helping the project entity to obtain additional sources of the debt financing mentioned above. It has significantly reduced the Plantar risk at the domestic level as well, by providing confidence to lenders. A clear example is the fact that the project activity has contributed to remove constraints on the long-term financing from local institutions such as the Minas Gerais Development Bank (BDMG). The ERPA signed with the PCF has also played an important role as a potential collateral support in the above-mentioned debt funding arrangements with the BDMG. Therefore, it is reasonable to consider that without the additional confidence and revenues provided by the carbon credits, the Plantar projects would face severe difficulties to be implemented and would hardly happen.

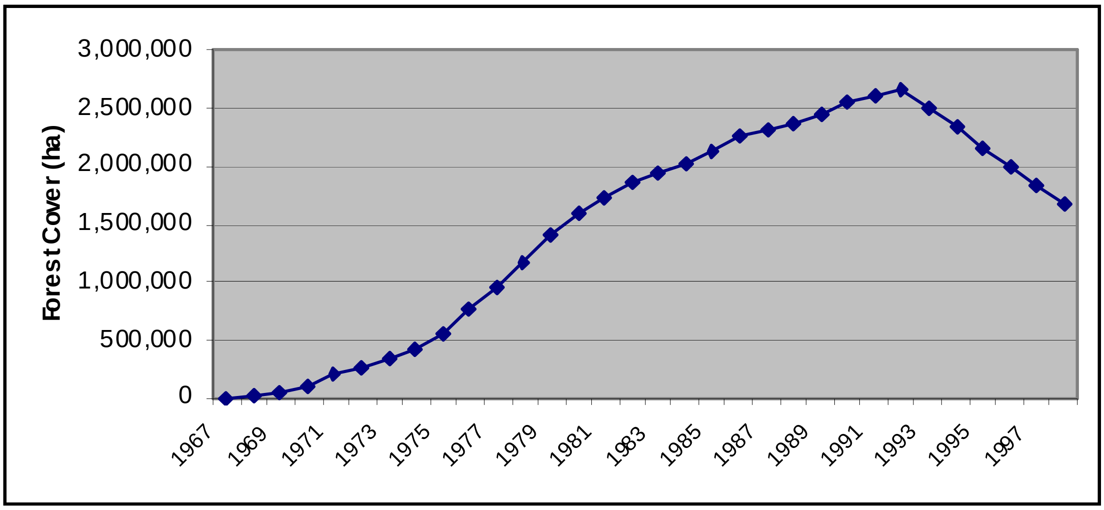
The CDM registration is expected to have an unprecedented impact on the charcoal-based pig iron industry within the Brazilian context - the project entity's sector. Besides, other industries that require wood resources could be encouraged to use renewable charcoal from dedicated plantations in iron manufacturing. Indeed other companies in Brazil have already been considering the CDM incentive as a means of accomplishing sustainable plantations supply. Over the past years, major iron and steel producers, such as Acesita S/A and Belgo Mineira (both owned by the ArcelorMittal Group), have started the development of similar project activities in response to the CDM incentive. Both companies had previously reverted part of their plantation-based industrial operations to fossil fuel-based ones, such as coal coke-based iron manufacturing. Likewise, in the independent pig iron sector, some companies, such as Siderpa and Siderurgica Alterosa have also started developing CDM project activities aimed at providing sustainable charcoal supply sources.

b) Sectoral barriers and policies

[36] To comply with Guideline 6 of Annex 13 EB50. The ERPA will be presented to the DOE during validation audit.

The development of planted forests has started in 1967, resulting from a federally subsidized reforestation program, enacted by the national government under law 5.106, on September 2nd, 1966. In response to the growing demand for wood-based industries and to limit deforestation practices, a fiscal incentives program (which was later referred to as *FISET*) was implemented to stimulate the establishment of plantations. The program lasted up to 1988 and the state of Minas Gerais accounted for over 70% of the plantation projects under this program.

Figure 21: Forest plantation stock in Minas Gerais (ha) until 1999



Source: IPEF, 2000

The plantation area has grown in response to the program. The total area of plantations in Brazil, almost non-existent before, increased to 6.5 million hectares in 1992 (REIS, 1994 and IPEF, 2000). With the discontinuation of the Program in 1988, plantation establishment decreased, while harvesting of existing plantations continued at a rapid rate. The declining trends in plantation activities were strongly observed in the state of Minas Gerais (the project state), as it has historically dominated the Brazilian forestry plantation sector[37], especially in terms of plantations for charcoal supply. The forestry plantation sector in the state has evolved hand-in-hand with the charcoal and the iron and steel industry. The rich-deposits of iron ore and the need for a thermal reduction agent (carbon) have led to the rapid depletion of the regional native forests. The end of the FISET led to a market drop in area under plantation establishment in Minas Gerais. This was followed by a reduction in the forest cover in the state, as the harvesting levels continued high, with almost no replanting (**Figure 21**). In 1992, the state of Minas Gerais was covered with over 2.6 million hectares of planted forests. By 1998, this figure had reduced to 1.67 million ha (REIS, 1994 and IPEF, 2000). In 2003 and 2004, plantations stock in Minas Gerais respectively accounted for 1.16 and 1.15 million hectares, 75% of which were established for charcoal supply (AMS, 2004).

The replacement of the Brazilian Institute for Forestry Development (IBDF) with the Brazilian Institute of Environment and Natural Resources (IBAMA), in 1989, also emphasized a focus away from forest plantation establishment on to native forest preservation and its sustainable management.

Recognizing the threatening deficit of plantations in Brazil, the federal government created the National Forestry Program (PNF) in 2000. The objective of the program was to expand the forestry plantation base through multi-purpose initiatives, such as increasing funding, removing regulatory bottlenecks and strengthening governmental institutional capacity. However, according to the State's Forestry Authority (IEF) and to the Federal University of Lavras - UFLA (2006), the stock of fuel wood plantation had decreased reaching to approximately 1,167,200.00 hectares in the State of Minas Gerais.

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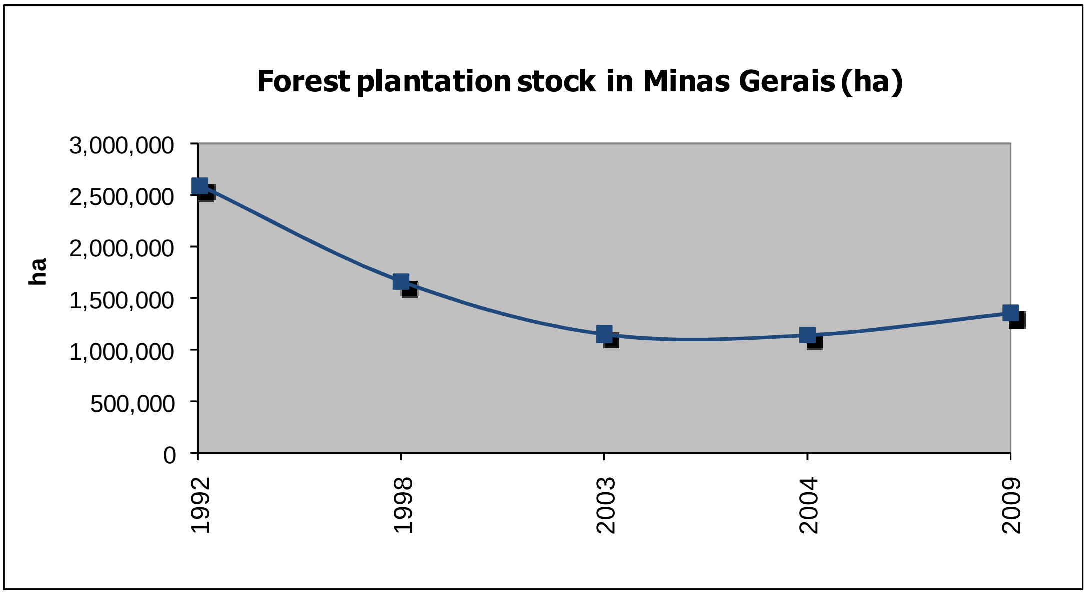
[37] SEAPA, 2009, accessed in April 2010 http://www.agricultura.mg.gov.br/noticias/849

In 2004, the PNF was re-launched by the federal government. However, as per the trends presented in **Step 1b**, due to the prevailing barriers discussed in this section, the recent measures seem far from resolving the current and projected deficits of dedicated plantations for renewable charcoal, as recognized by several organizations (see **Step 1**). Thus, in spite of governmental efforts, there is a lack of adequate policies capable of generating incentives to curb the critical supply shortage.

In 2009 the state had 1,218 million hectares of planted eucalyptus forests[38].

Figure 22: Forest plantation stock in Minas Gerais (ha) until 2009



Source: IPEF 2000; REIS 1994; AMS 2010 and SEAPA 2009

c) Regulatory barriers

- In comparison to the coal coke option, a major regulatory/institutional barrier is identified in relation to the use of renewable charcoal originated from planted forests – land use environmental licensing. Although a long period is required to issue licenses for the operation of mills (both coal coke and renewable charcoal facilities) the coal coke system is based on an imported good (coal) simplifying the licensing process [39] compared to the route of renewable charcoal originated from planted forests that require an extra licensing process. Under the current procedures in the region of this project, the process to obtain the environmental license to establish large scale planted forests takes a minimum period of 6 to 12 months (State Decree 44.844) placing an extra time burden to the seven-year-rotation-period before the first harvesting of the planted forest.

  Along with the time length to acquire the environmental license (EL), there are several further regulatory constraints that affect the usage of renewable charcoal:
  - Land acquisition, including geo-referencing provisions which demands a significant amount of time as per the National Institute for colonization and Land Reform (INCRA);
  - Establishment of the Legal reserve areas and Permanent Preservation areas, which oblige producers of planted forests to acquire extra portions of land that can not be economically exploited (usually 30% more than the

[38] SEAPA, 2009, accessed in April 2010 http://www.agricultura.mg.gov.br/noticias/849

[39] The environmental impacts of the mining activities do not occur inside the national boundaries. Hence, no environmental license is required.

required area for the plantations: 20% for legal reserves as required in the project region + 10%, on average, for permanent preservation areas);

- Preparation for licensing, which includes:
    - Environmental study EIA/RIMA, recovery of degraded areas and other environmental obligations;
    - Public hearings regarding the request to obtain the EL;
    - Judgment of the EL by the State's Environmental Policy Council (COPAM);
- After acquiring the EL, there are the environmental operating license conditions that must be followed;
- Development of an Environmental Control Plan;
- Re-validation of the EL every 4 or 6 years (depending on the rural area size and its locale);

o The above mentioned regulatory requirements pose significant constraints when the use of renewable charcoal is compared to the use of coal coke, which does not have to cope with severe land-use regulations. Coupled with the other barriers referred to in this section, such regulatory constraints also help one understanding the enduring deficit of renewable charcoal faced by the iron industry, as discussed throughout this document.

2b.3. Assessment of the identified barriers to an iron ore reduction system based on the use of a mix of reducing agents (Alternative Scenario 4):

a) Barriers/incentives to investment and financing.

o For the share of renewable charcoal, see analysis presented in item *2b.2(a) Barriers/Incentives to investment and financing*.

o For the share of non-renewable charcoal, it is legally impossible to obtain government incentives, public or private debt-funding, as well as to obtain support from the scientific community or from NGOs for industrial activities based on the unsustainable use of native forests. Thus, this is an important step in clarifying why the use of non-renewable charcoal is not likely to be an appropriate baseline scenario for a 21-year-long iron ore reduction project activity, even if within the maximum limit of 5%.

o For the share of coal coke, no major barriers regarding investment and financing have been identified.

b) Sectoral barriers

o As per the methodology's *Guidance on how to address the mix of reducing agents as an alternative scenario*, the demonstration that the mixed reducing agents scenario is not realistic "shall be based on the availability of renewable wood at a reasonable price in the region". The assessment provided in **Sub-step 1b** above, identified points to a severe supply shortage of renewable charcoal, making clear that there is no structured spot market for the purchase of renewable charcoal and no existing plantation stocks that third parties could sell directly to the project entity on a long-term and sustainable basis.

o Brazil holds the largest concentration of forests proportionally to its territory, covering 64.3% (544 million hectares) of the land area. The tree plantations or forestry practices represent only 0.9% of the country's total forested area, the remaining 99.1% refers to native vegetation (LEITE, 2003). Historically, natural forests have supplied the country's demand for wood, which resulted in the large-scale degradation of several of the country's original biomes, specially the Atlantic Rainforest, the *Cerrado* (Brazilian savannah) and a significant proportion of the Amazon Rainforest[40]. Unfortunately, as

[40] Several surveys, including one conducted by IBAMA (Brazilian Institute on the Environment/Ministry of the Environment) indicate that illegal deforestation conducted in the Amazon rainforest has been a major source of charcoal supply for pig iron manufacturing activities (Source: O Estado de S.Paulo, September 16th, 2005 – available at http://www.estadao.com.br/ciencia/noticias/2005/set/15/246.htm#

presented in Brazil's Initial Communication to the UNFCCC, the majority of the wood transformed into charcoal comes from non-renewable sources, e.g. unsustainably managed forests or natural formations[41]. As a natural consequence of that, the term "non-renewable charcoal" refers to charcoal produced with non-renewable wood sources. The governmental surveillance is precarious, the illegal logging is observed even in indigenous reserves. According to official data (IBAMA), 80% of the Amazon exploitation occurs under illegal conditions[42]. The illegal practice causes not only the depletion of the natural forests but also environmental and biodiversity degradation due to the production of non-renewable charcoal, which most of the time leads to some highly precarious labor conditions. In many cases, the non-renewable charcoaling process is connected with slavery practices, other appalling situation occurring in some secluded parts of Brazil. Brazilian legislation prohibits the use of slave labor, but it can still be found mainly in the countryside, especially in agricultural, logging and non-renewable charcoal production activities[43]. Some Brazilian companies have been accused of using forced labor by paying little or no wages to workers especially in the northern area of the country[44] to produce non-renewable charcoal from illegal biomass sources. It is a double violation of both labor and environmental laws. Although some of these companies have denied illegal practices[45], a large number of articles has been published by many news agencies in Brazil and internationally. It has caused a vicious response by American companies, which use Brazilian pig iron in their products. They are avoiding purchasing the iron from companies related to suppliers that use forced labor.[46] In late November 2006 and again in April 2007, Vale (former CVRD - *Companhia Vale do Rio Doce*), the world's largest iron ore producer and exporter (sold 296.2 million tonnes in 2008)[47], announced that it would no longer supply iron ore to pig iron mills related to charges of either slavery or illegal non-renewable charcoal production originated from natural forests[48]. Vale supplies almost all iron ore to pig iron companies in Brazil and its new police is likely to stop the operations of pig iron companies; as they are heavily dependant on the quasi-monopolistic status of Vale[49]. Also, some major companies of the automotive industry, such as General Motors, Ford, DaimlerChrysler and Honda, announced their intention to train auto industry suppliers about how to avoid buying materials made by slaves[50]. The companies' decisions and sector policies associated with the Brazil's most important iron ore supplier and some of the major consumers of the iron and steel industry have a huge impact in questioning the non-renewable charcoal as a real reducing agent alternative to the Brazilian iron ore reduction facilities in short, medium and long term.

- As per the methodology's *Guidance on how to address the mix of reducing agents as an alternative scenario*, "the availability of wood during the lifetime of the steel mill shall also

[41] Brazil's Initial National Communication to the United Nations Framework Convention on Climate Change, 2004, page 194.

[42] See http://www.ibama.gov.br/recursos-florestais/areas-tematicas/desmatamento/ , accessed April 2010.

[43] See http://www.observatoriosocial.org.br/download/er6bx.pdf , accessed April 2010.

[44] See http://www.bloomberg.com/apps/news?pid=20601109&refer=home&sid=a4j1VKZq34TM , accessed April 2010.

[45] See http://www.reuters.com/article/latestCrisis/idUSN03433976 , accessed April 2010.

[46] See http://www.mre.gov.br/index.php?option=com_content&task=view&id=1286&Itemid=397 , accessed April 2010.

[47] See http://www.vale.com/vale/cgi/cgilua.exe/sys/start.htm?sid=485 , accessed April 2010.

[48] See http://noticias.ambientebrasil.com.br/clipping/2007/08/23/33061-companhia-vale-do-rio-doce-deixara-de-fornecer-para-quem-desrespeitar-leis-ambientais.html , accessed April 2010.

[49] See http://economia.estadao.com.br/noticias/not_11981.htm accessed April 2010.

[50] See http://www.bloomberg.com/apps/news?pid=20601086&sid=aqs8kA0Qrpzw&refer=news accessed April 2010.

be one of the main determinants for the definition of the mix". Although there are legislation that restricts the use of coal coke and non-renewable charcoal in a mix with renewable charcoal (see COPAM N° 49 and Law 14.309), the shortage of renewable wood to supply the demand of the industry is to be considered the focal point that would make the use of a mix of reducing agents non realistic.

- Also, in a decision making moment, a company would not analyze its future investments based on fragmented sources of raw materials e.g. a mix of reducing agents. It would most certainly base its investment decision on an analysis of either one or another sort of reducing agent, to supply the whole enterprise (e.g. renewable charcoal or coal coke) so as to minimize transaction costs.

c) Regulatory and/or technical barriers

- To produce non-renewable charcoal, it is necessary to have access to non-renewable sources of wood by intervening in the natural forests stocks. According to the Minas Gerais Forest Institute (*IEF*), it is possible to intervene in native forests for different uses. In order to classify native forest intervention, the *IEF* states the following:

"Intervention in native vegetation is the clearcut (…), cleaning of an area with wood productivity, (…) the suppression of rustic vegetation, the suppression of isolated trees, the exploitation of wood and firewood for domestic use, including in a Legal Reserve, as well as the exploitation in a forestry stewardship regime"[51].

The competence for the ratification of processes must respect the provisions in **Table 5** below:

Table 5: Competence for land use alterations in hectares

Competence for land use alterations in hectares					
Up to 30	Up to 60	60.1 to 100	100.1 to 400	400.1 to 800	>800
Technician	Forestry or Agro Engineer	Agro or AFLOBIO Forestry Engineer approved by the Center Manager	Regional Supervisor	Monitoring and Controlling Director (DMC)	COPAM

The limit for exploitation is of 8st/ha in Atlantic Forests and 18 st/ha to other types of forests[52]. If one conservatively assumes that to reduce a ton of hot metal is necessary to convert around 8 wooden steres into non-renewable charcoal, a pig iron mill to supply the production of the project activity (240,000 tonnes of pig iron annually) would necessarily require annual interventions on natural vegetation, varying from 104,000 to 240,000 hectares *per year*. This area is substantially larger than the *total* amount of land required by high-yielding eucalyptus plantations, e.g approximately 3,300 per year (23,100 ha for the whole project period 21 years).

Apart from that, in order to legally intervene in a native forest, there is a long and complex process which the interested party must undergo. As presented in the table above, virtually

[51] Manual de Normas de Controle da Intervenção em vegetação Nativa e Plantada do Estado de Minas Gerais. Item 2. 1ª Edição, Junho de 2006. Belo Horizonte – MG (*Handbook on Control Norms for Intervention in Native and Planted forests in Minas Gerais State. Item 2. 1st Edition, June 2006. Belo Horizonte – MG*)

[52] Portaria 191, dated 16 September 2005 issued by the State's Forestry Authority (IEF - Instituto Estadual de Florestas). See Art.3, http://www.siam.mg.gov.br/sla/download.pdf?idNorma=11212.

all licenses would need to be authorized by the Environmental Policy Council (*COPAM)* so as to allow for the intervention in such large portions of lands. Only after fulfilling all the conditions and presenting the proper documentation that the permit is issued. There are 14 institutional steps to be followed, which can be found at the *IEF*'s manual. For any land-use change, it is necessary to have an Intended Use Plan, established by ordinance 191/2005. After the approval of all documents and doing all the procedures, the applicant receives the *APEF* document (Authorization for Forestry Exploitation) and then is able to do the expected intervention.

The great number of procedures and the complexity of the process make the access to the non-renewable wood sources from native forest legal exploitation something quite unattractive and virtually non-existent. Considering that a non-stop blast furnace demands a constant and regular amount of input, it is possible to conclude that the reliance on non-renewable charcoal supplies to establish a new iron ore reduction system is not a legal, practical or viable alternative.

- As for the use of coal coke coupled with renewable charcoal, technical barriers also influence the choice for such a mix. In addition to the regulatory restrictions outlined in **Step 1a** and the shortage of renewable wood in the market, the use of larger shares of coal coke with renewable charcoal is technically not a good option. As an example, in a mix of 80% of charcoal and 20% of coal coke, the charcoal alkalis react with the coal coke diminishing its mechanical resistance and enlarging its reactivity. Any alkalis in the blast furnace affect the refractories creating crusts and also reacting with the cargo jeopardizing the gases flow and the smooth descend of the cargo. Other example is that the use of coal coke also implies the need of a desulphurization installation. Other different characteristics that have significant influence in the blast furnace performance are found between charcoal and coal coke, such as sulphur content, percentage of ashes, mechanical resistance (MINASAMBIENTE[53], 2000). The table below shows the main characteristics of each reducing agent.

Property	Item	Unit	Value	
			Charcoal	Coal coke
Chemical	Fixed carbon	%	70~75	86~89
	Volatile matter	%	20~25	1~3
	Ashes	%	2~3	10~12
	Sulphur	%	0.03~0.10	0.45~0.70
	Composition of ashes			
	SiO_2	%	5~10	50~55
	CaO	%	37~56	4~5
	MgO	%	5~7	4~5
	Al_2O_3	%	2~12	25~30

[53] See information on Minas Ambiente Project in http://www.ufmg.br/boletim/bol1350/sexta.shtml and reference to this 2000 work in http://www.abes-dn.org.br/publicacoes/engenharia/resaonline/v7n34/v7n34n03.pdf.

	Fe_2O_3	%	6~13	5~7
	P_2O_5	%	8~12	0.40~0.80
	K_2O	%	15~25	2~4
	Na_2O	%	2~3	1~3
Physical	Resistance to compression	kg/cm^2	10~80	130~160
	Granulometric range	mm	9~101.6	25~75
	Density	t/m^3	0.250	0.550
Metallurgical	Reactivity (at 950^{o}C)	%	60	15
	Resistance after reaction	%	-	60
	Density	(%)	100	30

(DEMEC, 2004)[54]

It is also important to consider the establishment of a mini coal coke making facility adjacent to the pig iron mill, in order to guarantee its self-sufficiency in reducing agent supply (refer to Sub-step 2b, item 2b.1 (c) for this analyses) and also the construction of coal coke silos in the plant.

Considering that:

- the technology that suits the project activity's final output is the blast furnace and that it admits three choices of reducing agents, coal coke, renewable charcoal and non-renewable charcoal;
- the liberalization of the Brazilian market has facilitated the import of coal coke, the governmental attempts to make Brazil self-sufficient in the production of coal coke and that the large amounts of investments to modernize and expand the Brazilian coal coke base integrated industrial park have boosted the attractiveness of the use of coal coke in the iron ore reduction process vis-a-vis a long-term investments in dedicated plantations for the supply of renewable charcoal;
- the end of fiscal incentives to planted forests and other major barriers, such as the lack of proper debt-funding, have resulted in a major supply shortage of dedicated plantations to supply the production of pig iron within the context of the project entity;
- In addition to the absence of renewable plantations, there are legal and technical restrictions to the mixed use of coal coke and renewable charcoal in the thermo-reduction process. These technical differences mean the need of changes in the blast furnace and other reducing plant's equipments to use one or the other reducing agent. Coupled with the lack of renewable plantations both at the sector level and at the project entity, these restrictions make the use of a mix of reducing agents in the baseline unrealistic.
- the use of non-renewable charcoal is closely linked to environmental and illegal labor practices, facing the risk of jeopardizing a company's reputation among the iron ore suppliers and pig iron buyers, and as such, major companies are restraining negotiations with raw material suppliers that perform illegal logging and labor practices;
- the access to legal non-renewable sources is bureaucratic and slow, limited to small amounts of wood, and it is virtually impossible to comply with all the requirements for the

[54] http://www.demec.ufmg.br/disciplinas/ema003/solidos/coque/altern.htm

legal use of non-renewable sources at the scale capable of meeting the project activity's envisaged capacity;

- among the three options of reducing agents considered (coal coke, non-renewable charcoal, and renewable charcoal) **renewable charcoal faces the greatest investment barriers due to the long-term nature, and specially due to the lack of proper debt-funding, which is likely to prevent the implementation of the project activity even if it were more attractive than the use of coal coke in the short term.**

The analysis leads to the conclusion that there are no consistent barriers that would prevent the implementation of a new coal coke iron ore reduction system with pulverized coal injection (*Alternative Scenario 1*), in comparison with those that prevent the implementation of a renewable charcoal one. On the other hand, the establishment of a new renewable charcoal iron ore reduction system (*Alternative Scenario 2*) would demand new long term investments in the establishment of dedicated plantations in order to guarantee the company's supply, which will otherwise face a lack of dedicated and sustainable wood plantations for the production of renewable charcoal. Given such deficit, the reliance on fossil fuel based reducing agents (i.e. coal coke) emerges as the only realistic alternative. Moreover, the use of a mix of reducing agents (*Alternative Scenario 4*) would mean incurring most of the barriers identified for *Alternative Scenario 2*, since dedicated plantations for renewable charcoal would have to be implemented anyway, and the risks and technical limitations to the mix with use of non-renewable and to the mix with coal coke are substantive and often prohibitive. Thus *Alternative Scenario 4* is not realistic.

Thus, the most likely alternative to the project entity in the absence of the CDM project activity is the establishment of a coal coke iron ore reduction system with pulverized coal injection. Due to the CDM incentive, the Plantar Group has decided to constitute a new iron ore reduction system undertaking a major two-folded and interdependent new investment: (i) in the establishment of new dedicated wood plantations to enable the sustainable production of renewable charcoal, and (ii) in the refurbishment of its pig iron facilities and adaptation of its blast furnaces to the use of charcoal fines. Although important, the latter is deeply related with the new investments in the plantations, supporting the establishment of a sustainable and *new iron ore reduction system.*

Compliance with the methodology's "Guidance for situation when the plantation (or part of) is covered under an A/R project activity":

The current project activity is part of an integrated development project, which also involves an A/R CDM project activity developed by the same project proponents based on AR-AM0005. The A/R CDM project activity registration number under UNFCCC is 2569. Most importantly, there are several evidences that make clear the prior consideration of the CDM for their establishment and the integrated nature with the iron ore reduction project covered by this CDM-PDD (see **Section B.5** below). The integrated project is a well publicized initiative by the same project proponents, i.e. the Plantar Group and the World Bank's Prototype Carbon Fund, which was conceived as a whole and started in the year 2000. Hence the integrated projects comply with EB41 Annex 46 "Guidance on the demonstration and assessment of prior consideration of the CDM". Some of the evidences available on the prior consideration of the CDM for all cases and on the integrated nature of the projects include: emission reduction purchase agreement entered by Plantar and the World Bank's PCF, officially registered communication between project developers and DOEs, validation and initial verification reports by DOEs, *inter alia*. All of them are already publically available and shall be assessed during the validation of this CDM-PDD.

Conclusion: the barriers related to the implementation of the plantation shall also be used throughout the baseline and additionality assessments, which shall be performed on an integrated basis with the respective sections of the A/R CDM project activity.

Outcome of Sub-step 2b: the alternative scenario to the project activity that is not prevented by any barrier is *Scenario 1*. Therefore, *Alternative Scenario 1*, coal coke iron ore reduction system with pulverized coal injection, is the baseline scenario.

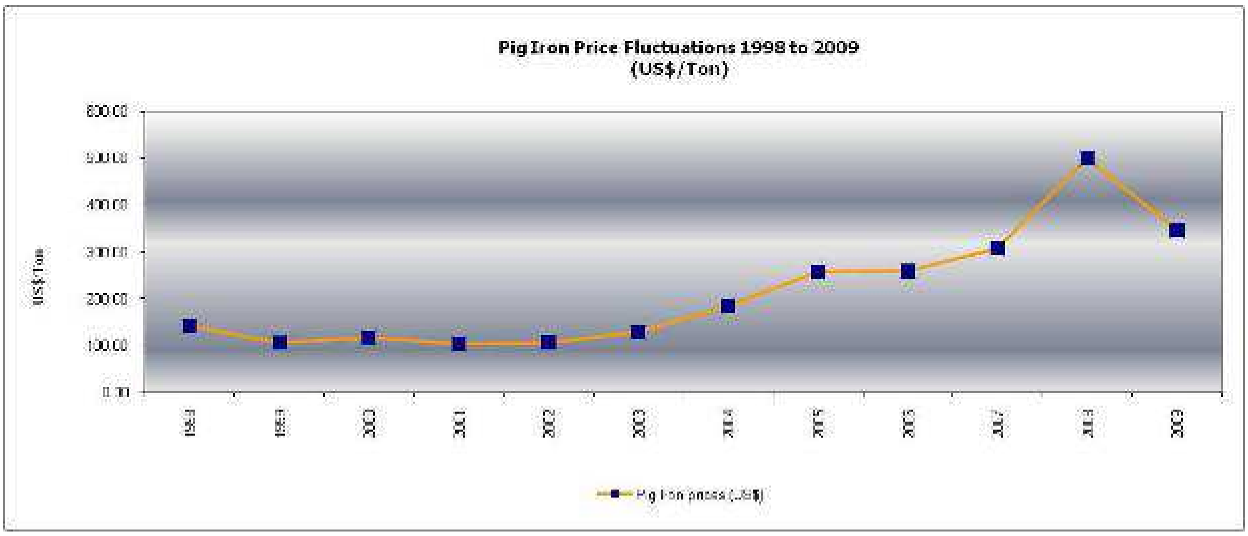
Step 3. Investment analysis

According to the “Combined Tool to Identify the Baseline Scenario and Demonstrate Additionality”, Version 04.0.0, EB66, the investment analysis is not applicable to this proposed project activity once **Step 2** above has resulted in only one realistic alternative scenario, the coal coke iron ore reduction system with pulverized coal injection (*Alternative Scenario 1*). Whereas the use of coal coke is the most economically attractive scenario taking into account barriers to investment, the following considerations reinforce and clarify such a conclusion. They ultimately point to the difficulty of applying and the questionable accuracy of a traditional cash flow analysis in the demonstration of additionality for this project. The chronic supply shortage of renewable charcoal and the limitations of the price mechanism in curbing such deficits also seem to point to the existence of major market failures in the use of renewable charcoal as a reducing agent. The following points help one to understand why and how investment barriers and other barriers have overwhelmingly influenced the baseline scenario as well as the decisions regarding the use of renewable charcoal compared to coal coke within this project activity, and also how the reliance of traditional cash flow methods seem inadequate to the case:

- The shortage of debt-financing in Brazil at the time of the investment decision had a dominant role in the risk-aversion and non-attractiveness of a long term project activity. That is, even if the short and medium term prices of renewable charcoal were more attractive, the project entity would not have been able to implement the project activity.

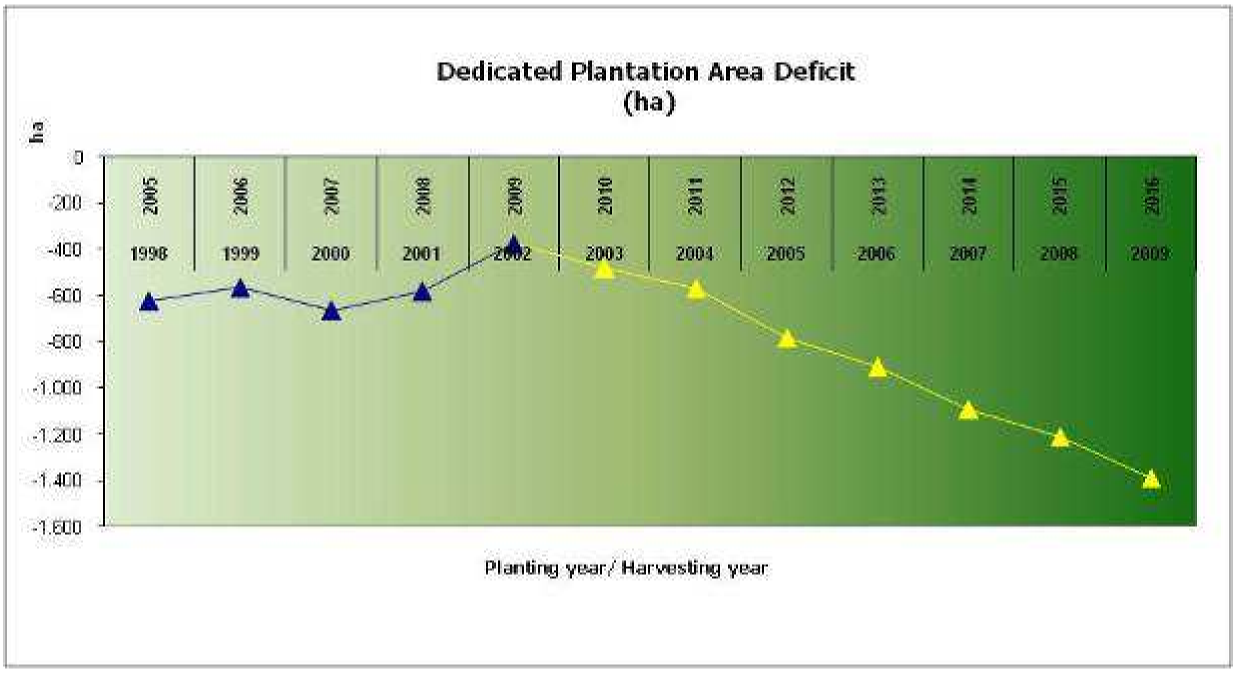
  In spite of substantial increases in the price of pig iron over the last 10 years, the deficit of dedicated plantations for pig iron production based on renewable charcoal has not decreased; **Figures 23** and **24** suggest that historical changes in pig iron prices, which, in the financial *stricto-sensu*, could turn the use of renewable charcoal from dedicated plantations more attractive, have not resulted in a proportional increase of its use as a reducing agent. On the contrary, the deficit in terms of the use of renewable charcoal as a reducing agent has worsened. This less than elastic relationship between the plantation establishment and the use of reducing agents corroborates the large risks perceived in the use of renewable charcoal. Thus, there seems to be no direct relationship between the availability of dedicated plantations and the consumption of pig iron, making explicit the limitations of the price mechanism in such a case.

Figure 23: Pig Iron Price Fluctuations



Source: AMS; Brazilian Ministry of Development, Industry and Foreign Trade, AliceWeb

Figure 24: Dedicated Plantation Area Deficit (difference between effective planted area and ex-post reducing agent consumption converted to equivalent plantation area)



Source: AMS 2010; Brazilian Ministry of Development, Industry and Foreign Trade, AliceWeb 2010

At last, there are no structured spot markets for wood or renewable charcoal in Brazil, which is a further indicator of a market failure in this sector. On the other hand, coal is the most widely available fossil fuel in the World. Coal coke based iron production benefits from several external economies of scale, such as the standardization of a global commodity and the existence of an extensive logistics network.

Step 4. Common practice analysis

As identified in **Step 1** and evaluated in the subsequent steps, the project entity and the market in general have been undergoing a severe supply shortage of renewable charcoal as a reducing agent. **Figures 14** and **15** (Sub-step 1b above) can be used as a conservative proxy for the assessment of common practices in market for iron ore reducing agents. Both of them reflect that it is not a common practice to use charcoal from dedicated plantations. In order to further corroborate this conclusion, this section builds upon data from the company-specific level to ensure consistency with the aggregate date presented above.

Since the early 1990’s, major companies of the charcoal-based sector switched their charcoal blast furnaces to coal coke, responding to the increasing difficulties associated with the supply of charcoal. The former Brazilian company Belgo Mineira, currently an Arcelor-Mittal company which had been using charcoal as a reducing agent since its initial operations in 1937, followed this trend switching to coal coke. In 2002, a business plan of Companhia Vale do Rio Doce (CVRD now Vale) initially included a plant to run with charcoal in Northern Brazil with possible future expansions, but the company changed plans and recently announced an investment in a plant using coal coke, in partnership with the Chinese giant BaoSteel. The plant will have a rated capacity of 5 million tons of steel per year. Some other projections are presented in **Table 6** below, showing the expansion plans for the sector (completely dominated by the coal coke based systems) announced by Brazilian National Development Bank (BNDES) and Brazilian Iron and Steel Institute (IBS) in 2006. It is important to notice that the projections below are independent from each other and adopt different initial years as well as projection times. For example, IABr has a projection for 2010 and another for 2016.

Table 6: Announced expansion of the iron and steel production capacity in Brazil

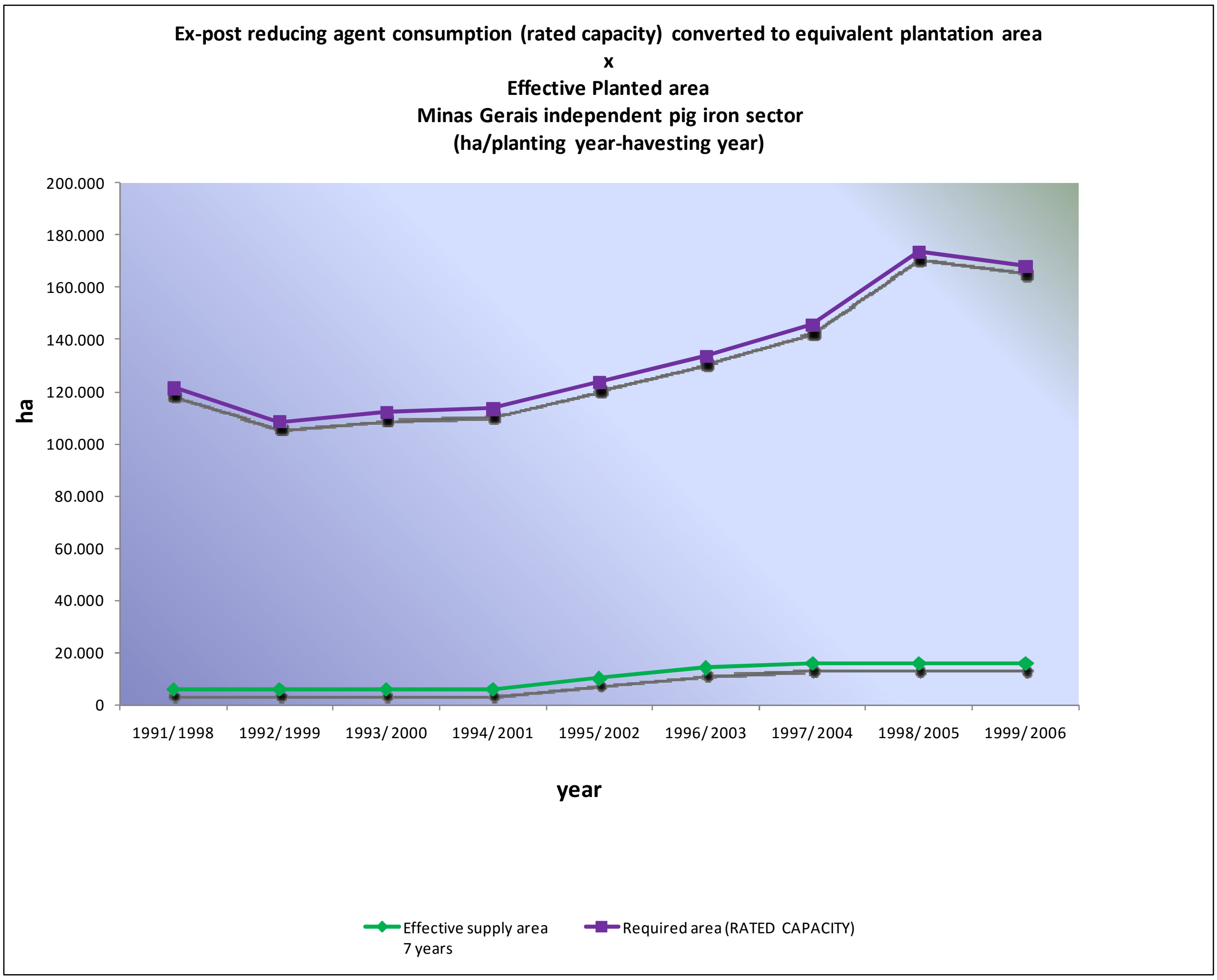
Company	Current capacity (t/year)	Expanded capacity (t/year)	Deadline for expansion
Brazil (IABr)	26.7 million (2009)	33.1 million	2010
Brazil (BNDES)	26.7 million (2009)	43.1 million	2014
Brazil (IABr)	26.7 million (2009)	77.0 million	2016
Gerdau /Ouro Branco	3.0 million (2006)	4.5 million	Concluded
CST/ArcelorMittal	5.0 million (2006)	7.5 million	2007
Grupo Gerdau	7.0 million (2006)	10.5 million	2008
MMX	(new)	1.5 million	2008
MMX	(new)	not announced	2008
ThyssenKrupp Siderúrgica do Atlântico	(new)	5.0 million	2009
Sumitomo/V&M	(new)	600 thousand	2010
Ceara Steel	(new)	1.5 million	2010
Usiminas/Cosipa	9.0 million (2006)	14.5 million	2015
CSN Itaguaí (RJ)	(new)	4.5 million	not announced
CSN Congonhas (MG)	(new)	4.5 million	not announced
CSN Ceará	(new)	4.5 million	not announced
CVRD/ BaoSteel	(new)	5.0 million	not announced

Sources: IBS, BNDES, ALMG, ABM Brasil, companies (several years)

Hence, the iron and steel production is projected to practically double the current rated capacity in Brazil (IBS, 2007). On the other hand, although the figures for 2006 (**Figure 14** and **Figure 15)** show a slight decrease in the huge gap between charcoal from planted forests participation in national production and the use of other fossil reducing agents it is certain that the lack of planted forests will remain in the next years. Although the above mentioned date goes beyond the year 2000, it helps one understanding the major expansion planned for the Brazilian iron and steel industry since the project's major investment decision.

There is no distinction in quality or intrinsic characteristics in the pig iron produced by independent and integrated companies, which corroborates an integrated analysis of the sector. However, an analysis of the situation of the independent segment in Minas Gerais is also incorporated in this common practice section (see **Figure 25** below). Accordingly the results further strengthen the analysis, as they indicate an outstanding gap between the necessary area of planted forests to completely supply the independent pig iron sector and the area effectively available, as per the seven year rotation of eucalyptus.

Figure 25: Comparison between (i) the rated capacity expressed in equivalent plantation area and (ii) effective planted area, as per the seven year rotation of eucalyptus, Minas Gerais.



Source: SINDIFER (several years), AMS (2011)

It is important to note that the situation depicted in **Figure 25** is consistent with the timing of the project's major investment decisions. In the year 2000, the supply gap was of 90%, indicating a major supply shortage, which endures in the following years. If the specific context of the independent sector in Minas Gerais is taken into account, the scenario becomes even more conservative since there is a major deficit and legislation on the use of charcoal is strict. Also, independent companies are significantly more vulnerable and face more barriers on the establishment of long term investments in the production of planted forests for renewable charcoal, in comparison with larger integrated companies, e.g. lack of access to international capital markets, less fundraising capacity and less capacity to meet debt-funding regulations. Therefore, the analysis of the independent sector in Minas Gerais is consistent with the structural trends for the entire industry.

Following provisions of the "Combined Tool to Identify the Baseline Scenario and Demonstrate Additionality", version 04.0.0, a credibility check was prepared.

Step 4a: The proposed CDM project activity applies measure(s) that are listed in the definitions section

Brazil is considered the applicable geographical area for this project activity and "Fuel and feedstock switch" is the suitable measure. The technology applied in the proposed project activity is the use of 100% of renewable charcoal as a reducing agent in the pig iron production.

Sub-step 4a(1): The project range was calculated based on the rated capacity of the project activity, that is 240,000 tons of pig iron/year. Forty other facilities that provide the same output (pig iron) were considered in the range between 120,000 and 360,000 tons of pig iron/year and none of

the 40 companies use 100% renewable charcoal as a reducing agent in their production of pig iron. Plantar is the only company that has 100% of its production based on renewable charcoal[55].

Sub-step 4a(2): The geographical area for this project activity is Brazil and the companies that deliver the same output (pig iron) were listed in **Figure 26**. Companies outside the range established in Sub-step 4a(1) were excluded from the analysis.

Sub-step 4a(3): N_{diff} refers to the companies identified in Sub-step 4a(2) that apply technologies different from the technology applied in the project activity, i.e. companies that do not use 100% of renewable charcoal.

Sub-step 4a(4): Factor F was calculated representing the share of companies applying a technology similar to the one used in the project activity, i.e. companies that use 100% of renewable charcoal. According to the "Combined Tool to identify the Baseline Scenario and demonstrate additionality", version 04.0.0 criteria, the project activity is NOT common practice (see **Figure 26**).

[55] See articles at:

http://www.semad.mg.gov.br/noticias/1/1132-governo-assina-memorando-para-atenuar-mudanca-climatica

http://painelflorestal.com.br/noticias/florestas-plantadas/9757/plantar-carbon-recebe-aprovacao-da-onu-para-investir-em-floresta-plantada-de-eucalipto

http://www.ecodesenvolvimento.org.br/ecomanagement/projeto-de-reflorestamento-de-empresa-brasileira-e

Figure 26: credibility check calculation

CREDIBILITY CHECK

According to the provisions of Methodological Tool

"Combined tool to identify the baseline scenario and demonstrate additionality", version 04.0.0

Insert data in the yellow cells

Output		Pig iron
Project rated capacity (t pig iron/year)		240.000
Range (+/- 50% of capacity)	120.000	360.000
Geographical area		Brazil

Companies [1]	Pig Iron rated capacity (tonnes/ month)	Pig Iron rated capacity (tonnes / year)	Fits the range? [2]	Fits the range and has a CDM project activity undergoing validation? [2]	Fits the range, does not have a CDM project activity and apply technology different to the proposed project activity? [2]
AVG Siderúrgia Ltda.	21.000	252.000	1	0	1
Calsete - Indústria Calc. Sete Lagias Ltda.	18.000	216.000	1	0	1
Cia Oriente Ltda.	13.000	156.000	1	0	1
Cia Setelagoana Siderurgia - COSSISA	18.000	216.000	1	0	1
Cia Siderúrgica Pitangui	26.000	312.000	1	0	1
Cisam Siderúrgica Ltda	12.000	144.000	1	0	1
Cofergusa (Fermix S/A)	23.000	276.000	1	0	1
Coirba Siderugia Ltda / Rede Gusa	15.500	186.000	1	0	1
Cosima - Cia. Siderurgica do Maranhão	22.000	264.000	1	0	1
Cosimat - Siderúrgica Matozinhos Ltda.	14.000	168.000	1	0	1
Divigusa Siderurgia Ltda.	18.000	216.000	1	0	1
Fergumar - Ferro Gusa do Maranhão Ltda.	18.000	216.000	1	0	1
Ferguminas	22.500	270.000	1	0	1
Ferro Gusa Carajás	30.000	360.000	1	0	1
Gagé	10.000	120.000	1	0	1
Gusa Nordeste S/A	30.000	360.000	1	0	1
Insivi - Ind. Siderúrgica Viana Ltda.	17.000	204.000	1	0	1
Lucape Siderurgia Ltda	22.000	264.000	1	0	1
Margusa - Maranhão Gusa S/A	15.000	180.000	1	0	1
Matprima Comércio de Metais Ltda.	14.700	176.400	1	0	1
MGS - Minas Gerais Siderurgia Ltda.	12.000	144.000	1	0	1
RVR Siderurgia / Harma Ltda.	12.000	144.000	1	0	1
SBL Indústria e Comércio Ltda.	12.000	144.000	1	0	1
Sicafe Produtos Siderúrgica Ltda.	10.500	126.000	1	0	1
Sidepar Sid. Do Pará S/A	30.000	360.000	1	0	1
Sidebras - Sid. Brasileira	10.500	126.000	1	0	1
Sidermin Siderurgia	15.000	180.000	1	0	1
Sidenorte	15.000	180.000	1	0	1
Siderpa - Siderurgica Paulino Ltda	17.500	210.000	1	0	1
Siderurgia Santo Antônio Ltda	12.000	144.000	1	0	1
Siderúrgica Alterosa Ltda.	26.000	312.000	1	0	1
Siderúrgica São Luiz Ltda.	10.000	120.000	1	0	1
Siderúrgica Valinho S/A	10.000	120.000	1	0	1
Simara - Sid. Marabá S/A	22.000	264.000	1	0	1
Simasa - Sid. Maranhão S/A	18.000	216.000	1	0	1
Terra Metais Ltda.	15.000	180.000	1	0	1
Usimar - Usina Siderúrgica Marabá	30.000	360.000	1	0	1
Usipar	15.000	180.000	1	0	1
Usisete Ltda.	12.000	144.000	1	0	1
Vetorial	20.000	240.000	1	0	1

N_{all} =	40
N_{diff} =	40

F =	$1 - (N_{diff} / N_{all})$
F =	0,0

$N_{all} - N_{diff}$ =	0

The Project is NOT common practice

"The proposed project activity is regarded as 'common practice' within a sector in the applicable geographical area if both the following conditions are fulfilled:

(a) The factor F is greater than 0.2; and

(b) $N_{all} - N_{diff}$ is greater than 3."

EB66, Annex 48, page 14

[1] Sindifer

[2] Where 0 = No and 1 = Yes

Source: Sindifer[56]

At last, as previously mentioned, Plantar is the first company in the Brazilian industry to achieve self-sufficiency in renewable charcoal supply for its pig iron mill and to have its production 100% based on renewable charcoal. This has been enabled by the CDM incentive.

Therefore, similar activities to the proposed project activity that is iron and steel production relying 100% in renewable charcoal, cannot be observed in the project region and so the proposed project activity **is additional**.

[56] www.sindifer.com.br

Outcome of Step 4: The project activity was not regarded as "common practice". Therefore, the proposed project activity is **additional.**

The following table summarizes this section presenting the final results of each of the alternatives analyzed under the provisions of the "Combined tool to identify the baseline scenario and demonstrate additionality", within the establishment of a new iron ore reduction system (version 04.0.0).

Table 7: Baseline and Additionality Alternatives Assessment

Baseline and Additionality Assessment Alternatives selection	STEP 1a Compliance with actual laws and regulations	STEP 1b Assessment of Supply and Demand	STEP 2 Barriers Analysis	STEP 3 Investment Analysis[57]	STEP 4 Common practice
Alternative 1: coal coke iron ore reduction system with pulverized coal injection	Yes	Yes	Yes	Most economic attractive option	Yes
Alternative 2: renewable charcoal iron ore reduction system	Yes	Yes	Alternative eliminated		Alternative eliminated
Alternative 3: non-renewable charcoal iron ore reduction system based on new plantations	Alternative eliminated				Alternative eliminated
Alternative 4: iron ore reduction system based on the use of a mix of reducing agents	Yes	Yes	Alternative eliminated		Alternative eliminated
Alternative 5: renewable charcoal from planted biomass iron ore reduction system based on existing plantations	Yes	Alternative eliminated			Alternative eliminated

B.5. Demonstration of additionality

>> Following the provisions of the methodology AM0082, this project activity applies the latest version of the "Combined tool to identify the baseline scenario and demonstrate additionality"

[57] Under the provisions of the proposed methodology this step was not mandatory once the coal coke option was identified as the only available alternative after the Barriers Analysis.

(version 04.0.0). Therefore, based on the described detailed assessment of baseline and the demonstrated results identified in Section B.4 above, this proposed project activity is additional.

The starting date of this project activity is 10 November 2000. The incentives of the CDM were seriously considered in the decision to implement the project activity, as the list of documents below attest. Due to the integrated nature of the project entity's CDM projects activities (see Section A.1), this prior consideration of the CDM traces back to the conception of the integrated project as a whole:

- 25 October 1999: Plantar internal agreement related to CERs rights;
- 26 October 1999: Communication with World Bank on future CDM reforestation project hosted by Plantar;
- March 2000: "Pre-PDD", issued by Plantar;
- July 2000: development of the engineering study "Assessment for Reducing Agent Change in Pig Iron Production of Plantar Siderúrgica" carried out by iron and steel experts RSConsultants for the project entity (SAMPAIO, 2000);
- 30 August 2000: Non-objection letter on Plantar Reforestation Project in the context of future CDM project, by Ronaldo Mota Sardenberg, State Minister of Science and Technology (Interministrial Commission of Global Climate Change);
- 10 November 2000: date of the first planting of the project entity dedicated planted forests. This date is the starting date of the project entity's project activities under the CDM;
- 23 March 2001: Signing of the Letter of Intention with PCF - PCF's Investors Comittee approval;
- 17 October 2001: the Prototype Carbon Fund in partnership with Ecosecurities produced the documents " 'Plantar' Project – Project Design Document", "Baseline determination for Plantar: Evaluation of the emission reduction potential of the Plantar Project" and "Monitoring and Verification Protocol for Plantar coal coke to charcoal substitution project" and submitted to DNV as part of validation process.
- 18 October 2001: the document "Environmental Assessment of Plantar Project/ Minas Gerais" was produced by the Prototype Carbon Fund team and submitted to DNV as part of validation process;
- October 2001: first period for stakeholders comments that encompassed contractual requisites of the World Bank and of the Forestry Certification entity, considering the components of the integrated carbon project of Plantar
- 14 March 2002: the revised documents " 'Plantar' Project – Project Design Document", "Baseline determination for Plantar: Evaluation of the emission reduction potential of the Plantar Project" and "Monitoring and Verification Protocol for Plantar coal coke to charcoal substitution project" were resubmitted to DNV as part of validation process;
- 12 June 2002: DNV issued a validation report recommending the project to registration taking into account the applicable UNFCCC regulations at that time;
- 04 September 2002: ERPA – Emission Reductions Purchase Agreement signed with The World Bank's Prototype Carbon Fund;
- October 2002: IPCC experts visit to MG02 site and Plantar Siderúrgica;

- 29 November 2002: Indian Mission (Kerala Forestry Project) visit to MG02 site and Plantar Siderúrgica;
- 20 May 2003: Assignment agreement and loan agreement between Plantar and Rabobank Curaçao N.V.;
- 06 to 08 October 2004: China Afforestation Department of State Forestry Administration visit to MG02 site and Plantar Siderúrgica;
- 17 to 23 August 2005: Prototype Carbon Fund Mission to the Plantar Project;
- 13 September 2005: final verification report issued by SGS;
- 05 December 2005: presentation at the CEBDS – Brazilian Business Council for Sustainable Development side event workshop *"New CDM Market in Brazil: Structure and Opportunities"* during COP11 & COP/MOP1;
- 10 September 2006: final verification report issued by SGS;
- 10 November 2006: presentation at the CEBDS – Brazilian Business Council for Sustainable Development side event during COP12 & COP/MOP2;
- 14 November 2006: presentation at the Carbon Finance Event, official parallel event during COP12 & COP/MOP2 organized by The International Emissions Trading Association & The World Bank Carbon Finance Unit;
- November and December 2006: second period for stakeholders comments regarding the forest component of the integrated project, according to the Brazilian DNA instructions for CDM project registration, Resolution nº 1 of September 11th, 2003 (Article 3, Paragraph II).
- 15 December 2006: Approval by the CDM Executive Board of methodology AR-AM0005 prepared by the Plantar Carbon Team and The World Bank Carbon Finance Unit;
- January 2007: starting of the pulverized charcoal injection system for Blast Furnace 02[58];
- 10 January 2007: Center for Clean Air Policy (CCAP) visit to MG02 site and Plantar Siderúrgica;
- 03 to 06 June 2007: World Bank's Safeguards Thematic Supervision of Minas Gerais Plantar Project;
- December 2007: starting of the pulverized charcoal injection system for Blast Furnace 01;
- 23 to 31 May 2008: TUV-SUD validation audit field visit;
- 10 December 2008: presentation at the CEBDS – Brazilian Business Council for Sustainable Development side event during COP14 & COP/MOP4;
- 17 July 2009: Approval by the CDM Executive Board of methodology AM0082 prepared by the Plantar Carbon Team and The World Bank Carbon Finance Unit;

[58] According to Plantar Siderurgica's accountability report the total investments in pulverized charcoal injection system was 6,129,493.03.

- 14 December 2009: presentation at the BRACELPA – Brazilian Pulp and Paper Association side event during COP15 & COP/MOP5.

The table below is only applicable if the proposed project activity is a type of project activity which is deemed automatically additional, as defined by the applied approved methodology or standardized baseline.

Specify the methodology or standardized baseline that establish automatic additionality for the proposed project activity (including the version number and the specific paragraph, if applicable).	N/A
Describe how the proposed project activity meets the criteria for automatic additionality in the relevant methodology or standardized baselines.	N/A

B.6. Emission reductions

B.6.1. Explanation of methodological choices

>> The project applies the proposed new methodology to demonstrate the emission reductions in the project relative to the baseline. In accordance with the proposed methodology, the following sections present the formulae that were used to estimate the new iron ore reduction system baseline emissions, project emissions, leakage and emission reductions. The results calculated from the equations will be monitored as per the provisions of this CDM-PDD.

Baseline emissions

$$BE_y = RAE_{BL,y} + IRE_{BL,y} \quad (1)$$

Where:

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

Baseline upstream emissions

The baseline upstream emissions are attributable to the primary carbon extraction, reducing agent production and transportation inside national boundaries within the new iron ore reduction system. The assessment of baseline upstream emissions is carried out as per the equations below.

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

Where:

$RAE_{BL,y}$	=	*Baseline* upstream emissions associated with the supplies of the reducing agent (tCO_2e)
$PCE_{BL,y}$	=	Emissions from the *Primary carbon extraction* in the *baseline* scenario during year *y* (tCO_2e)
$RAP_{BL,RA,y}$	=	GHG emissions from the production of reducing agents within the boundary under the baseline scenario during year *y*; (tCO_2e /yr)

$RAT_{Vehicle,BL,y}$	= CO_2 emissions in fossil fuel combustion in the transport of reducing agent(s) to iron ore reduction facility during year *y* in the baseline scenario; (tCO_2e /yr)

As the baseline scenario encompasses only the use of coal coke as reducing agent in the new iron ore reduction system, no emissions associated to the establishment of plantation shall be considered in the upstream baseline emission calculations.

Although the baseline scenario involves the complete use of coal coke as reducing agent in the new iron ore reduction system, for conservativeness purposes the primary carbon sources extraction GHG emissions attributable to the coal mining related activities are not taken into account. However, emissions from the coal transportation from the seaport to the mill and the emissions of its processing into coal coke are accounted in this CDM-PDD due to the fact that they occur within national boundaries.

1 - Coal coke reducing agent in the baseline scenario

$$PCE_{BL,y} = CM_{BL,y}$$

Where:

$PCE_{BL,y}$	= Emissions from the *Primary carbon extraction* in the *baseline* scenario during year *y* (tCO_2e)
$CM_{BL,y}$	= GHG emissions associated with coal mining activities in the baseline scenario during year *y* (tCO_2)

a) Coal mining emissions

$$CM_{BL,y} = (CM_{BL,machine,y} + CM_{BL,fugitive,y}) \cdot RA_{BL,i} \cdot P_{PJ,y} + CM_{BL,\ Vehicle,\ y} \qquad (3)$$

Where:

$CM_{BL,y}$	= GHG emissions due to the coal mining activities in the baseline scenario during year *y* (tCO_2)
$CM_{BL,\ machine,\ y}$	= GHG emissions due to the coal mining machinery in the baseline scenario during year *y* (tCO_2/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_2/t Coal)
$CM_{BL,\ Vehicle,\ y}$	= CO_2 emissions from fossil fuel combustion in the vehicles used to transport coal to the coal coke production units within the project boundary (tCO_2/yr)
$RA_{BL,i}$	= Quantity of coal coke necessary to produce one tonne of hot metal; (t Coal coke /t of hot metal)
$P_{PJ,y}$	= Hot metal production in year *y* (expected hot metal production of the new iron ore reduction system) (tonnes of hot metal)

b) Emissions from the operation of mining machinery and fugitive methane emissions from coal mines, coal cleaning, ammonium nitrate usage and mine reclamation

Even though there is coal mining in Brazil due to its chemical outputs and operational status, almost 100% of the coal used in the coal coke production in the Brazilian iron and steel industry is imported from several countries.

According to the Mineral Summary 2005 from the National Department of Mineral Production (DNPM), in terms of quantity, Brazil imports its mineral coal from countries like Australia (28%), United States of America (21%), China (19%), Canada (9%) and South Africa (5%), among others. Therefore, when calculating emissions sources outlined in the above formula it was identified that the project entity primary carbon extraction (coal extraction) in the upstream baseline emissions mainly occurs outside the project entity's national boundaries.

In this sense, GHG emissions due to the coal mining machinery ($CM_{BL,machine,y}$) and fugitive methane emissions from the coal mines and coal cleaning, ammonium nitrate use and mine reclamation activities ($CM_{BL,fugitive,y}$) in the *baseline* scenario are conservatively considered as zero under this CDM-PDD.

c) Coal transport to the coal coke production sites

Despite coal origin, only the routes within the country's borders have been considered increasing conservativeness of the upstream baseline emission calculations. The origin of the coal will be considered the Vitória Seaport, where coal is shipped to and has a connection with the Vitória-Minas Railway (EFVM), run by the mining company Vale (former Companhia Vale do Rio Doce - CVRD). The **Option 2** (Project emissions from transport based on distance traveled by vehicles) was adopted to further calculate the **Coal transport to the coal coke production sites** as per the Annex I of the AM0082 methodology.

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

$$CM_{BL,\ Vehicle,\ y} = N_{v,BL,\ y} \bullet AVD_{j,\ y} \bullet EF_{v,\ km,\ CO2,\ y} \qquad (4)$$

Where:

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

It was considered the number of 240 wagons per train, the emission factor for diesel (2.622312kgCO_2/l)[59], and the total of 160,000 tons of coal[60]. The volume of a wagon, according to Vale is 25.7 cubic meters and the weight capacity of the coal – with a density of 0.550 ton/m³[61] - is

[59] Sources: GHG Protocol Brazilian Program, 2010, http://www.ghgprotocolbrasil.com.br/ and 2006 IPCC Guidelines for National GHG Inventories, Volume 2, Chapter 1, Table 1.4, calculated as: 0.00003612TJ/l*72600kgCO_2/TJ=2.622312kgCO_2/l

[60] This amount is based in the amount necessary to produce 120,000 tonnes of coal coke under a gravimetric yield of 75% (SAMPAIO, 2000) of the coal coke oven productivity to supply the production of 240,000 tonnes of pig iron annually.

[61] Source: Mechanical Engineering Department (DEMEC), Minas Gerais Federal University (UFMG), http://www.demec.ufmg.br/disciplinas/ema003/solidos/coque/carvao.htm

14.135 t of coal per wagon. The fuel consumption for train is 2.91 L/1000TKU[62] (Liter per 1,000 ton of cargo per useful kilometer).

Figure 27: route from Vitoria seaport (A) to Sete Lagoas (B), the pig iron mill

Source: GoogleMaps, 2010

Coal transport by Rail (within national boundary)		**Results**	**Calculations**
$AVD_{j,y}$	(Km/y)	600	Distance from Vitoria (seaport) to Sete Lagoas (pig iron mill)
$N_{v,BL,y}$	(round trips)	45.99	(240,000t pig iron * 0.4875[63]t coal coke/t pig iron)/(240 wagons * 14.135t per wagon)/0.75t coal coke/t coal
$EF_{v,km,CO2,y}$	(tCO_2/Km)	0.02589	2.91 L/1000TKU * (240 wagons * 14.135t per wagon)*(2.622312 kg CO_2/l /1000)
$CM_{BL,\ Vehicle,\ y}$	(tCO_2/y)	714	45.99 * 600 * 0.02589

$CM_{BL,\ Vehicle,\ y}$ **= 714 tCO_2/y**

Therefore, by substituting the parameters of **Equation 3** for the numbers above and adopting a conservative approach the following results are presented to account under the upstream emissions of the *Primary carbon sources extraction*:

$$CM_{BL,y} = (0 + 0) * 0.4875 * 240,000 + 714$$

Primary Carbon extraction (Upstream Baseline Scenario)
$CM_{BL,y} = PCE_{BL,y} = 714$ (tCO_2/y)

d) Coal coke production

[62] Source: *Agência Nacional de Transportes Terrestres – ANTT* (National Agency for Ground Transportation) http://www.antt.gov.br/relatorios/ferroviario/concessionarias2009/6_EFVM2009.pdf

[63] Calculated as 0.170 t pulverized coal/ t hot metal * 0.75 t coal coke/ t coal + 0.360 t coal coke/ t hot metal = 0.4875 total t coal coke/ t pig iron.

As presented above the upstream baseline scenario only includes emissions attributable to the reducing agent production and transportation within the iron ore reduction system, inside national boundaries. In this sense, the following equations are used to calculate emissions.

$$RAP_{BL,RA,y} = RAP_{BL,coalcoke,y} \quad (5)$$

Where:

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

$$RAP_{BL,\ coal\ coke,y} = P_{PJ,y} \bullet EF_{CO2e,coal\ coke,y} \bullet RA_{BL,i} \quad (6)$$

Where:

$RAP_{BL,\ coal\ coke,\ y}$	=	GHG emissions within the project boundary due to production of coal coke used in the iron ore reduction facility in the baseline scenario during year *y*; (tCO_2/yr)
$P_{PJ,y}$	=	Hot metal production in year *y* (expected hot metal production of the new iron ore reduction system). (tonnes of hot metal)
$EF_{CO2e,\ coal\ coke,\ y}$	=	Emission factor to produce one tonne of coal coke in the iron ore reduction system baseline scenario; (tCO_2e/ t of Coal coke)
$RA_{BL,i}$	=	Quantity of coal coke necessary to produce one tonne of hot metal; (t Coal coke /t of hot metal)

To calculate the emission factor to produce one tonne of coal coke in the iron ore reduction system baseline scenario it is used:

Total CO_2e coal coke oven gas (Kg/t of coal) = 402.6[64]
Gravimetric yield of coal coke = 0.75[65]

So,

$EF_{CO2e,coal\ coke,y}$ = 402.6 /0.75/ 1,000

$EF_{CO2e,coal\ coke,y}$ **= 0.5368**

Applying the baseline parameters in the formula:

$RAP_{BL,coalcoke,y}$ = 240,000 * 0.5368 * 0.358

Production of coal coke (Baseline Scenario)
$RAP_{BL,coalcoke,y}$ = $RAP_{BL,RA,y}$ = 46,122 tCO_2/y

[64] Default emission factors provided by AM0082 in Annex I, Table 3

[65] SAMPAIO, 2000

2 – Baseline emissions in the transportation of reducing agent

In accounting the CO_2 emissions within the project boundary due to fossil fuel combustion from vehicles used to transport reducing agent(s) to iron ore reduction facility ($RAT_{Vehicle,BL,y}$) a conservative approach is applied assuming that the coal coke production sites are located close to the iron ore reduction facility and the cargo rail station. In this sense, those emissions are neglected under the baseline scenario calculations.

Transportation of reducing agent (Baseline Scenario)
$RAT_{Vehicle,BL,y} = 0$

Nevertheless, applying the numbers identified above the following results corresponds to the *total reducing agents components emissions in the upstream baseline,* **Equation 2**.

$$RAE_{BL,y} = 714 + 46{,}122 + 0$$

Baseline Upstream Emissions
$RAE_{BL,y} = 46{,}836\ tCO_2$

Baseline process emissions

The project entity has historically used charcoal and the baseline scenario for the proposed project activity is the use of coal coke as a reducing agent in the iron ore reduction system with pulverized coal injection; therefore, engineering data developed for the baseline assessment[66] shall be used for the calculation of baseline process emissions.

For conservativeness reasons, the methodology AM0082 caps the coal coke rate in 0.358 tonnes of coal coke per tonne of hot metal, according to IPCC 2006 Guidelines (see AM0082, page 16 for the cap value of 0.358 t coal coke/t hot metal).

The Integrated Pollution Prevention and Control – IPPC 2001 study "Best Available Techniques Reference Document on the Production of Iron and Steel" (IPPC, 2001) mentions the consumption of pulverised coal injection technology estalishing it at a level of approximately 180kg/t pig iron. The study also states in its Chapter 6 item 6.5 "Emerging techniques and Future Developments" that, "*at a coal injection rate of 180 kg/t pig iron, (...) approximately 30% less coke is consumed*". Similar data is also available in the study "High Blast Funaces Productivity Operations with Low Coke Rates in the European Union" (LACROIX, 2001)

Therefore, the project entity following the methodology guidance, adopted a cap of 0.358 tons of coke per ton of hot metal. In order to calculate the baseline process emissions in adition to the coal coke it also considered the use of pulverized coal injection.

So, according to engineering data specific for the project entity case (SAMPAIO, 2000) to produce one tonne of pig iron it is necessary approximately 0.440 tonnes of carbon. To supply this amount

[66] Refer to Section B.4 for further details.

of carbon 0.360 tonnes of coal coke with 87.05% of carbon are added to the blast furnace from the top and 0.170 tonnes of pulverized coal with 78.90% of carbon are injected into the blast furnace at bottom level.

a) Calculation of the baseline process emissions

The formula below is used to calculate the project entity baseline process emissions

$$IRE_{BL,y} = \left(P_{PJ,y} \bullet EF_{Ind,BL}\right) - \left(P_{PJ,y} \bullet Cc_{HM,BL,y} \bullet \frac{44}{12}\right) \quad (7)$$

Where:

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

b) Calculation of emission factor for baseline process emissions

The following formula is used to calculate the baseline process emission factor

$$EF_{Ind,BL} = \sum_i \frac{(\%C_{BL,i} \bullet RA_{BL\,i})}{100} \bullet \frac{44}{12} \quad (8)$$

Where:

$EF_{Ind,BL}$	= *Baseline* emission factor to produce one tonne of hot metal (tCO_2e/ t of hot metal)[67]
$\%C_{BL,i}$	= Carbon content in percent of reducing agent *i* (e.g. coal coke, charcoal, etc.) used in the baseline scenario. It is equal to zero for renewable charcoal.
$RA_{BL\,i}$	= Reducing agent type *i* (e.g. coal coke, charcoal, etc.) required to produce one tonne of hot metal (tonne of reducing agent/ tonne of hot metal)
$\left(\frac{44}{12}\right)$	= Conversion factor from carbon to CO_2e (dimensionless)
i	= Type of reducing agent *i* (e.g. coal coke, charcoal, etc.)

<u>Coal coke added to blast furnace top:</u>

$$EF_{Ind,BL,i} = \frac{87.05 \bullet 0.358}{100} \bullet \frac{44}{12}$$

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

$EF_{Ind,BL,i}$ **= 1.1427**

Injection of pulverized coal at blast furnace bottom level:

$$EF_{Ind,BL,j} = \frac{78.90 \bullet 0.170}{100} \bullet \frac{44}{12}$$

$EF_{Ind,BL,j}$ **= 0.4918**

Then:

$$EF_{Ind,BL} = 1.1427 + 0.4918$$

Process emission factor Baseline Scenario
$EF_{Ind,BL}$ = 1.6345 tCO_2e

c) Calculation of carbon fixation factor under the baseline scenario

Calculation of carbon fixation factor under the baseline scenario

$$Cc_{HM,BL,y} = \frac{\%C_{HM,PJ,y}}{100} \qquad (9)$$

Where:

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

The percentage of carbon in the hot metal is 0.

Carbon content fixed in hot metal Baseline Scenario
$Cc_{HM,BL,y}$ = 0 t

Applying the results to **Equation 7**:

$$IRE_{BL,y} = (240{,}000 \bullet 1.6345) - (240{,}000 \bullet 0 \bullet \frac{44}{12})$$

$$IRE_{BL,y} = 392{,}277 - 0$$

Baseline Process Emissions

$IRE_{BL,y}$ = 392,277 tCO_2e

Calculation of total baseline emissions

$$BE_y = RAE_{BL,y} + IRE_{BL,y}$$

Applying the above stated:

$BE_y = RAE_{BL,y} + IRE_{BL,y}$		
BE_y	46,836	392,277
BE_y	439,113	

Therefore, by substituting the numbers above in the formula and adopting a conservative approach, the following results are presented to account under the baseline emissions:

Coal coke iron ore reduction system with pulverized coal injection Baseline Scenario
BE_y **= 439,113 tCO_2/y**

Project emissions

The following equations focus on the emissions associated with renewable charcoal iron ore reduction system boundary, adopting a complete use of renewable charcoal produced in self established dedicated plantation and combining its two interdependent components: upstream and process. The emissions associated with the upstream component encompass the emissions directly attributable to the renewable charcoal production (including the establishment of the forest dedicated plantation), while the emissions related to the consumption of the renewable charcoal in the iron ore reduction facility are aggregated under the process emissions component.

$$PE_y = RAE_{PJ,y} + IRE_{PJ,y} \quad (10)$$

Where:

PE_y	=	*Total project* emissions in the new iron ore reduction system in year *y* (tCO_2e)
$RAE_{PJ,y}$	=	*Project* upstream emissions associated with the reducing agent production and transportation in year y in the project scenario (tCO_2e)
$IRE_{PJ,y}$	=	*Project process* emissions in the iron ore facility in year *y* (tCO_2e)

Project upstream emissions

The formula below is used to calculate the project upstream emissions.

$$RAE_{PJ,y} = PCE_{PJ,y} + RAP_{PJ,RA,y} + RAT_{Vehicle,PJ,y} \quad (11)$$

Where:

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

Considering that the project scenario encompass only the use of renewable charcoal as reducing agent in the new iron ore reduction system, there are some GHG activities related to the forest establishment to supply the new iron ore reduction system in the project scenario such as:

- CO_2 emissions from combustion of fossil fuels within the project boundary;
- N_2O emissions as a result of direct nitrogen application within the project boundary;
- CO_2 emissions within the project boundary due to fossil fuel combustion from vehicles used to transport biomass to carbonization units during year *y* of the project scenario;

The investment decision undertaken by the project proponent to establish Plantar's new iron ore reduction system involves also the establishment of dedicated planted forests part of which are in the registered project 2569 under the A/R CDM approved methodology AR-AM0005 "Afforestation and reforestation project activities implemented for industrial and/or commercial uses" (lands in Felixlandia and Morada Nova de Minas). As per the new proposed methodology and under the "Guidance on avoiding double counting of emission sources" of the EB 25, paragraph 38, in case it is demonstrated that for a project activity using biomass for energy, which uses biomass originating from a registered A/R CDM project activity "the GHG emissions related to the correspondent area of land shall not be accounted in the project upstream emissions". Therefore, under this CDM-PDD the *Primary carbon source extraction related* emissions ($PCE_{PJ,y}$) for the areas under the A/R CDM project activity will be <u>considered as zero</u> within the upstream emissions in the project scenario.

Also, part of these dedicated forests plantations are under the category of plantations after last rotation (Curvelo and Itacambira). These areas are owned by the project entity and were covered with productive forests before the establishment of the dedicated plantations and therefore no activity displacement occurred in those areas. For the same reason neither land use change or fuelwood collection took place in these areas. Evidence on the ownership of these lands shall be presented to the DOE.

1 - Emissions in the establishment of plantations and production of biomass

For the lands under category of plantations after last rotation, apply the following formulas:

To calculate the emissions attributable to the establishment of the dedicated plantations in lands of plantations after last rotation, formulae from Annex 2 of the approved methodology AM0082 are applied.

$$PCE_{PJ,y} = EP_{PJ,y}$$

Where:

$PCE_{PJ,y}$	*Primary carbon source extraction* emissions in the project scenario; (tCO_2e)

$EP_{PJ,y}$	=	GHG emissions of the establishment of plantations to produce biomass in the project scenario during year *y*; (tCO_2/t biomass)

$$EP_{PJ,y} = E_{FuelBurn,PJ,y} + PE_{BB,y} + N_2O_{direct-N_{fertilizer},PJ,y} + EP_{Vehicle,PJ,y} \quad (12)$$

Where:

$EP_{PJ,y}$	=	GHG emissions of the establishment of plantations to produce biomass in the project scenario during year *y*; (tCO_2/t biomass)
$E_{FuelBurn,PJ,y}$	=	CO_2 emissions from combustion of fossil fuels within the project boundary in the project scenario; tonnes CO_{2-}–e yr^{-1} in year *y*
$PE_{BB,y}$	=	Project emissions arising from field burning of biomass at the plantation site (tCO_2e/yr)
$N_2O_{direct-N_{fertilizer}PJ,y}$	=	N_2O emissions as a result of direct nitrogen application within the project boundary in the project scenario; (tonnes CO_{2-}–e yr^{-1} in year *y)*
$EP_{Vehicle,PJ,y}$		CO_2 emissions within the project boundary due to fossil fuel combustion from vehicles used to transport biomass to carbonization unit during year *y* of the project scenario; (tCO_2/yr)

a. Calculation of CO_2 emissions from burning fossil fuels

This calculation uses the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion", version 02.

$$E_{FuelBurn,PJ,y} = PE_{FC,j,y}$$

Where:

$E_{FuelBurn,PJ,y}$	=	CO_2 emissions from combustion of fossil fuels within the project boundary in the project scenario; tonnes CO_{2-}–e yr^{-1} in year *y*
$PE_{FC,j,y}$	=	CO_2 emissions from fossil fuel combustion in process *j* during the year *y* (tCO_2/yr);

$$PE_{FC,j,y} = \sum_i FC_{i,j,y} * COEF_{i,y} \quad (13)$$

Where:

$PE_{FC,j,y}$	=	CO_2 emissions from fossil fuel combustion in process *j* during the year *y* (tCO_2/yr);
$FC_{i,j,y}$	=	Quantity of fuel type *i* combusted in process *j* during the year *y* (litres/yr);
$COEF_{i,y}$	=	Is the CO_2 emission coefficient of fuel type *i* in year *y* (tCO_2/litres)
i	=	Are the fuel types combusted in process *j* during the year *y*

Considering to the availability of data of fossil fuel type *i*, this project activity uses **Option 2** from the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion", version 02.

$$COEF_{i,y} = NCV_{i,y} * EF_{CO2,i,y} \quad (14)$$

Where:

$COEF_{i,y}$	=	CO_2 emission coefficient of fuel type *i* in year *y* (tCO_2/ litres)
$NCV_{i,y}$	=	Weighted average net calorific value of the fuel type *i* in year *y* (GJ/ litres)
$EF_{CO2,i,y}$	=	Weighted average CO_2 emission factor of fuel type *i* in year *y* (tCO_2/ GJ)
i	=	Fuel types combusted in process *j* during year *y*

$COEF_{i,y}$ = 0.03612[68]GJ/l diesel * 0.0748[69] tCO_2/GJ diesel

$COEF_{i,y}$ = 0.0027018 tCO_2/l diesel

And

$FC_{i,j,y}$ = 1,900,892 l

So,

$PE_{FC_{j,y}}$ = 1,900,892 l * 0.0027018 tCO_2/l

$PE_{FC_{j,y}}$ **= 5,136 tCO_2/y**

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

The project entity does not burn biomass for site preparation as a forestry management practice. Therefore, parameter $PE_{BB,y}$ shall be <u>considered zero</u> where applicable.

$PE_{BB,y}$ **= 0**

c. Calculation of nitrous oxide emissions from nitrogen fertilization practices

As per AM0082, this CDM-PDD uses the tool for "Estimation of direct nitrous oxide emission from nitrogen fertilization", version 01 to estimate nitrous oxide emissions from fertilizers application within the project boundary.

As the project entity does not use organic fertilizer, the parameter $F_{ON,i}$ shall be <u>considered as zero</u>.

$$N_2O_{direct-N_{fertilizer}PJ,y} = N_2O_{direct-N,t}$$

Where:

$N_2O_{direct-N_{fertilizer}PJ,y}$	=	N_2O emissions as a result of direct nitrogen application within the project boundary in the project scenario; (tonnes CO_2–e yr^{-1} in year *y)*

[68] GHG Protocol Brazilian Program, 2010 - http://www.ghgprotocolbrasil.com.br/

[69] Source: 2006 IPCC Guidelines for National GHG Inventories, Volume 2, Chapter 1, Table 1.4

$N_2O_{direct-N,t}$	=	Direct N_2O emission as a result of nitrogen application within the project boundary; (t CO_2–e in year *t*)

$$N_2O_{direct-N,t} = (F_{SN,i} + F_{ON,i}) \cdot EF_1 \cdot MW_{N2O} \cdot GWP_{N2O} \quad (15)$$

$$F_{SN,t} = \sum_{i}^{I} M_{SFi,t} \cdot NC_{SFi} \cdot (1 - Frac_{GASF}) \quad (16)$$

Where:

$N_2O_{direct-N,t}$	=	Direct N_2O emission as a result of nitrogen application within the project boundary; (t CO_2–e in year *t*)
$F_{SN,t}$	=	Mass of synthetic fertilizer nitrogen applied adjusted for volatilization as NH_3 and NO_X, t-N in year *t*
$F_{ON,t}$	=	Mass of organic fertilizer nitrogen applied adjusted for volatilization as NH_3 and NO_X, t-N in year *t*
EF_1	=	Emission Factor for emissions from N inputs, tonne-N_2O-N (t-N input)$^{-1}$ (1% - IPCC default, 2006 Guidelines, Chapter 11, Table 11.1)
MW_{N2O}	=	Ratio of molecular weights of N_2O and N (44/28), tonne-N_2O (t-N)$^{-1}$
GWP_{N2O}	=	GlobalWarming Potential for N_2O, kg-CO_2-e (kg-N_2O)$^{-1}$ (310 - IPCC default, valid for the first commitment period)
$M_{SFi,t}$	=	Mass of synthetic fertilizer type *i* applied, tonne in year *t*
NC_{SFi}	=	Nitrogen content of synthetic fertilizer type *i* applied, g-N (100 g fertilizer)$^{-1}$ (6% of NPK fertilizer)
$Frac_{GASF}$	=	Fraction that volatilises as NH_3 and NO_X for synthetic fertilizers, dimensionless (IPCC default 0.10 - 2006 Guidelines, Chapter 11, Table 11.3)
I	=	Number of synthetic fertilizer types

$F_{SN,t}$ = 786.63 * 0.06 *(1 – 0.10)

$F_{SN,t}$ = 42,48 t N

So,

$N_2O_{direct-N,t}$ = (42,48 + 0) * 0.01 * 44/28 * 310

$N_2O_{direct-N,t}$ **= 207 tCO_2e/y**

d. Biomass transport to the carbonization sites

The project participant should collect data on the origin and transportation of biomass under the project scenario. The project participants chose to calculate the GHG emissions associated with transportation of biomass based on distance travelled by vehicles (**Option 2**).

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

$$EP_{Vehicle,PJ,y} = N_{v,PJ,y} \bullet AVD_{i,PJ,y} \bullet EF_{v,km,CO2,PJ,y} \quad (17)$$

Where:

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

The average distance between the harvesting sites and the carbonization units in the Farms is 15.7km. This is the distance considered for the biomass transport calculations. The mean of transportation (each truck transports 38m^3 of wood[70]) with the round trip of 31.4km is considered. The amount of wood transported is 308 m^3/ha[71] or 1,205,384 m^3/y[72]; the fuel consumption 0.6667[73] L/km and the emission factor for diesel is 0.0027018 tCO_2/l [74].

Transport of biomass by Truck (project boundary)		**Results**	**Calculations**
$N_{v,PJ,y}$	(round trips)	31,721	1,205,384m^3/y / 38m^3/truck
$AVD_{i,PJ,y}$	(Km)	31.4	N/A
$EF_{v,km,CO2,PJ,y}$	(tCO_2/km)	0.00180	0. 0027018 tCO_2/l of diesel * 0.6667 l of diesel/Km

So,

$$EP_{Vehicle,PJ,y} = 31{,}721 * 31.4 * 0.00180$$

$$EP_{Vehicle,PJ,y} = \mathbf{1{,}794\ tCO_2e}$$

Applying all the results to **Equation 12**, the emissions in the establishment of plantations and production of biomass are:

$$EP_{PJ,y} = E_{FuelBurn,PJ,y} + 0 + N_2O_{direct-N_{fertilizer},PJ,y} + EP_{Vehicle,PJ,y}$$

$$EP_{PJ,y} = 5{,}136 + 0 + 207 + 1{,}794$$

Establishment of plantations and production of biomass

[70] Project entity records.

[71] Project entity records.

[72] (6,881.11ha + 20,513.97) * 308 m^3/ha / 7 year-cycle = 1,205,384m^3/ y

[73] Project entity records.

[74] Sources: GHG Protocol Brazilian Program, 2010, http://www.ghgprotocolbrasil.com.br/ and 2006 IPCC Guidelines for National GHG Inventories, Volume 2, Chapter 1, Table 1.4, calculated as: 0.00003612TJ/l*74800kgCO_2/TJ=2.7018kgCO_2/l

(Project Scenario)
$EP_{PJ,y} = PCE_{PJ,y}$ = 7,137tCO_2/t biomass

2 - Emissions in the production of charcoal, the renewable reducing agent

The following formulae is used as per the proposed new methodology to calculate GHG emissions within the project boundary due to production of reducing agents used in the iron ore reduction facility in the project scenario.

$$RAP_{PJ,RA,y} = RAP_{PJ,charcoal,y}$$

Where:

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

As presented above, the project activity involves a complete use of renewable charcoal as the reducing agent within the iron ore reduction system. Hence, only the emissions related to these renewable reducing agents will be accounted as an applicable source of the emissions in the $RAP_{PJ,RA,y}$ calculation.

The formulae below were considered in order to calculate the GHG emissions for the charcoal production.

$$RAP_{PJ,charcoal,y} = P_{PJ,y} \bullet EF_{CH4,charcoal,y} \bullet F_{PJ,charcoal} \bullet GWP_{CH4} \qquad (18)$$

Where:

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

The project activity uses **Option 1** (see Annex 2 of AM0082) "Methane emission factor as function of the gravimetric yield" (tonnage of charcoal per tonnage of biomass) to monitor the methane emission factor as per the gravimetric yield results obtained in charcoal production. The gravimetric yield in the carbonization process will be monitored by the project entity according to the provisions

of the AM0041 "Mitigation of methane emissions in the Wood carbonization Activity for Charcoal Production".

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

$$EF_{CH4,charcoal,PJ,y} = f\,(Y_{PJ}) \qquad (19)$$

Where:

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

f (Y_{PJ}) = A - B * Y_{PJ} /1,000

	A	B	Y_{PJ}
EF	139.13	313.8	0.34
EF	**0.0324**		

In the project scenario of 240,000 tonnes of hot metal (pig iron) production, we have considered the emission factor of the charcoal based on the variation in the gravimetric yield measured in accordance with the statistical guidance presented in the methodology and it is estimated from the weighted average of the measurement conducted.

Therefore, applying project expected results in the formula:

$$RAP_{PJ,charcoal,y} = 240{,}000 * 0.0324 * 0.589 * 21$$

$$RAP_{PJ,charcoal,y} = \mathbf{96{,}294}$$

Emissions from Charcoal production (Project Scenario)
$RAP_{PJ,charcoal,y} = RAP_{PJ,RA,y}$ = 96,294tCO_2/y

3 - Project emissions in the transportation of reducing agent

This CDM-PDD uses **Option 2** (Project emissions from transport based on distance traveled by vehicles) to calculate GHG emissions related to transportation of reducing agents.

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

In the project scenario, the supply facilities for renewable charcoal are in the Plantar Group Carbonization Units. Plantar has three dedicated plantations to supply its needs and every plantation has inside its area one or more carbonization units.

In order to produce 1,000 kg of pig iron, it is necessary to use approximately 580kg of renewable charcoal as reducing agent. The table below shows the distances[75] between the iron ore reduction facility to the project activity renewable charcoal production sites (carbonization units). According to

[75] Project entity records, based on road maps

it, the carbonization units are not farther than 440km from the plant and this distance will be considered for conservative purposes in the calculation. It will also be accounted both ways (round trip) of the truck, summarizing 880km.

	Renewable Charcoal		
	Origin	**Destination**	**Distance (Km)**
Railway	N/A		
Roadway	MG02 (Curvelo)	Plant (Sete Lagoas)	102
	MG03 (Felixlândia)	Plant (Sete Lagoas)	141
	MG04 (Morada Nova de Minas)	Plant (Sete Lagoas)	214
	MG15 (Itacambira)	Plant (Sete Lagoas)	440

The map below shows the distances from carbonization units – which are located a few kilometers from the dedicated plantations – and the Pig Iron Mill in Sete Lagoas.

Figure 28: Distances from reducing agents production sites to pig iron mill where (A) Sete Lagoas (pig iron mill), (B) Curvelo – MG02 (dedicated plantations and carbonization units), (C) Felixlandia – MG03, (D) Morada Nova de Minas – MG04 (dedicated plantations and carbonization units) and (F) Itacambira – MG15 (dedicated plantations and carbonization unit), in the State of Minas Gerais, Brazil. For the geographical coordinates, refer to **Table 1**.

Source: GoogleMaps, 2011

On the project scenario, the renewable charcoal comes from Plantar's Carbonization Units located in a conservative distance of 440km from the plant and trucks are the mean of transportation (each truck transports approximately 24,2 tonnes of charcoal[76]). As previously stated, the round trip was

[76] Project entity records

considered – 880km. The amount of charcoal transported was 141,360 tons[77], the fuel consumption 0.48 L/km and the emission factor for diesel that is 0.0027018 tCO_2/l[78].

Transport of charcoal by Truck (project boundary)		**Results**	**Calculations**
$N_{v,PJ,y}$	(round trips)	5,841	141,360t of charcoal/ 24,2t capacity of each truck
$AVD_{i,PJ,y}$	(Km)	880	Round trip
$EF_{v,km,CO2,PJ,y}$	(tCO_2/km)	0.001287	0. 0027018 tCO_2/l of diesel * 0.4762 of diesel/Km

As provided by the proposed new methodology, the following procedure is undertaken to conservatively calculate the emissions derived from the renewable reducing agents transportation.

$$RAT_{Vehicle,PJ,y} = N_{v,PJ,y} \bullet AVD_{j,PJ,y} \bullet EF_{v,km,CO2,PJ,y} \quad (20)$$

Where:

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

By substituting the numbers in the formula, the following results are presented:

$$RAT_{Vehicle,PJ,y} = 5{,}841 * 880 * 0.001287$$

Renewable Charcoal Route (Project activity Scenario)
$RAT_{Vehicle,PJ,y} = 6{,}614\ tCO_2/y$

Finally, applying the numbers identified above to **Equation 10**, the following results correspond to the <u>total upstream emissions in the project scenario</u>.

$$RAE_{PJ,y} = 7{,}137 + 96{,}294 + 6{,}614$$

Project Upstream Emissions

[77] Necessary amount to produce 240,000t of pig iron: 240,000 t pig iron * 0.589t charcoal

[78] See Footnote 72.

$$RAE_{PJ,y} = \textbf{110,045 tCO}_2\textbf{e}$$

Project process emissions

a) Calculation of the project process emissions

The formula below is used to calculate the project scenario process emissions.

$$IRE_{PJ,\ y} = \left(P_{PJ,\ y} \bullet EF_{Ind,\ PJ,\ y}\right) - \left(P_{PJ,\ y} \bullet Cc_{HM,\ PJ,\ y} \bullet \frac{44}{12}\right) \qquad (21)$$

Where:

$IRE_{PJ,\ y}$	= *Project process* emissions in the iron ore reduction facility in year y (tCO_2e)
$P_{PJ,y}$	= Hot metal production in year *y* (expected hot metal production of the new iron ore reduction system). (tonnes of hot metal)
$EF_{Ind,PJ,y}$	= Emission factor of one tonne of hot metal production under the project scenario (tCO_2e/ t of hot metal)[79]
$Cc_{HM,PJ,y}$	= Carbon content per t of hot metal produced in the year *y* (tC / t of hot metal)
$\left(\frac{44}{12}\right)$	= Conversion factor from carbon to CO_2e; (dimensionless)

b) Calculation of project process emission factor

$$EF_{Ind,\ PJ,\ y} = \sum_i \frac{(\%C_{PJ\ i} \bullet RA_{PJ\ i})}{100} \bullet \frac{44}{12} \qquad (22)$$

Where:

$EF_{Ind,\ PJ,\ y}$	= Emission factor of one tonne of hot metal production under the project scenario (tCO_2e/ t of hot metal)[80]
$\%C_{PJ\,i,j,k...}$	= 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.
$RA_{PJ\,i,j,k...}$	= Reducing agent type *i* (e.g. coal coke, charcoal, etc.) required to produce one tonne of hot metal (tonne of reducing agent/ tonne of hot metal)
$\left(\frac{44}{12}\right)$	= Conversion factor from carbon to CO_2e (dimensionless)
i	= Type of reducing agent *i* (e.g. coal coke, charcoal, etc.)

Due to the new investment characteristics identified under the project assessment to determine $\%C_{PJ,i}$ and $RA_{PJ,i}$, the project proponent applied the most conservative publicly available data. In

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

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

the project activity case, as it totally relies on renewable charcoal, parameter $\%C_{PJ,i}$ is <u>equal to zero</u>. Parameter $RA_{PJ,i}$ is considered 0.58t.

So,

$\%C_{PJ,i}$ **= 0**

$RA_{PJ,i}$ **=** 0.58 **t**

Therefore:

$$EF_{Ind,\ PJ,\ y} = \frac{0.00 \bullet 0.589 \bullet 0.00}{100} \bullet \frac{44}{12}$$

Emission factor hot metal (Project activity scenario)
$EF_{Ind,PJ,y}$ = 0

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

$$Cc_{HM,\ PJ,\ y} = \frac{\%C_{HM,\ PJ,\ y}}{100} \quad (23)$$

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

According to the provisions of the AM0082, to increase conservativeness in the calculations of the project emissions the hot metal carbon content shall be <u>accounted as zero</u>.

Carbon content in hot metal (Project activity scenario)
$Cc_{HM,PJ,y}$ = 0

Applying the results to **Equation 23**:

$$IRE_{PJ,\ y} = (240{,}000 \bullet 0.00) - (240{,}000 \bullet 0.00 \bullet \frac{44}{12})$$

Project Process emissions
$IRE_{PJ,y} = 0.00$ **tCO_2e**

Calculation of total project emissions

$$PE_y = RAE_{PJ,y} + IRE_{PJ,y}$$

Applying the above stated:

$PE_y = RAE_{PJ,y} + IRE_{PJ,y}$		
PE_y	110,045	0.00
PE_y	110,045	

Therefore, by substituting the numbers above in the formula and adopting a conservative approach the following results are presented:

Renewable charcoal Route Project Scenario
PE_y = 110,045 tCO_2/y

Leakage

The leakage emissions calculations conservatively followed the procedures to evaluate the change in upstream emissions associated with the establishment of the primary carbon extraction activity. In this sense, activities assessed are the ones that are measurable and attributable to the project activity and occur outside the new iron ore reduction system under the project scenario.

The assessment of leakage emissions under the AM0082 is carried out considering emissions associated with primary carbon extraction activities in the project scenario relative to the emissions of the baseline scenario. Therefore, increased emissions from the displacement of economic activities to areas outside the project that lead to deforestation and land use change for agriculture/non-agricultural purposes, harvest of fuel wood for meeting domestic energy needs, and use of lands as pastures for grazing/fodder collection are taken into account under the approved methodology AM0082 comparing baseline and project scenarios. The following formula is used to calculate leakage emissions under this CDM-PDD.

$$LK_y = LK_{PJ,Activity\_Disp,y} - LK_{BL,Activity\_Disp,y} \quad (24)$$

Where:

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

The baseline scenario, as it was presented in the section above, involves the complete use of coal coke as a reducing agent in the iron ore reduction facility. It is widely known that under the establishment and operation of a coal mine there are GHG intensive activities that are measurable and attributable to its operation and that may occur outside its boundary such as possible economic and household displacement activities in the establishment of the coal mine that would lead to increase in deforestation, among others. However, in order to adopt a conservative approach all those sources of leakage emissions associated with the primary carbon extraction

identified in the baseline will be considered as zero as they occur outside the project proponent national boundaries.

The project activity involves the complete use of renewable charcoal originated from dedicated planted forests established as a result of new investments taking into account CDM incentives. As it was presented in the sub-sections above, the new investment decision undertaken by the project proponent involves also the establishment of dedicated planted forests. In this sense, the emissions measurable and attributable to the project that occur outside the project boundary are related to the establishment of those planted forests. Part of these dedicated forest plantations are registered as A/R CDM project activity 2569 under the AR-AM0005 “Afforestation and reforestation project activities implemented for industrial and/or commercial uses”. As per the approved methodology AM0082 and under the “Guidance on avoiding double counting of emission sources” of the EB 25, paragraph 38, in case it is demonstrated that for a project activity using biomass for energy, which uses biomass originating from a registered A/R project activity, “it need not account for emissions related to the biomass production”. Also, according to the project entity’s A/R CDM project activity 2569, source of information for the approved methodology AR-AM0005 referred to above, there is no activity displacement related to the A/R CDM activities of this project entity.

The dedicated forests plantations within this project activity’s boundary are under the category of plantations after last rotation. As these areas are owned by the project entity and were covered with productive forests before the establishment of the dedicated plantations no activity displacement occurred in those areas. For the same reason neither land use change took place in these areas nor fuelwood collection.

Therefore, under this CDM-PDD, the leakage emissions associated with the primary carbon extraction identified in the project activity will be considered as zero as the lands within this project activity boundary were previously covered with productive plantations owned by the project entity. The following table shows the results identified in the assessment of leakage under this proposed project activity.

Leakage Coal Coke Route (Baseline Scenario)	**Leakage Renewable Charcoal Route (Project activity Scenario)**
$LK_{BL,Activity\_Disp,y}$ = 0.00 tCO_2/y	$LK_{PJ,Activity\_Disp,y}$ = 0.00 tCO_2/y
Leakage emissions	
LK_y **= 0**	

B.6.2. Data and parameters fixed ex ante

Data / Parameter	$\%C_{BL,i}$
Unit	%
Description	Carbon content in percent of in the non-renewable reducing agent *i* in the baseline scenario
Source of data	Engineering data (SAMPAIO, 2000)
Value(s) applied	87.05%
Choice of data or Measurement methods and procedures	Data used for baseline assessment based on a report made by a metallurgical engineering expert.
Purpose of data	Calculation of baseline emissions

Additional comment	N/A

Data / Parameter	$RA_{BL,i}$
Unit	tonne of reducing agent/ tonne of hot metal
Description	Reducing agent type *i* (i.e. coal coke) required to produce one tonne of hot metal
Source of data	Engineering data (SAMPAIO, 2000)
Value(s) applied	0.358
Choice of data or Measurement methods and procedures	Data used for baseline assessment based on a report made by a metallurgical engineering expert = 0.360 tons of reducing agent. The above used datum was established as cap, as per the methodology AM0082 provisions.
Purpose of data	Calculation of baseline emissions
Additional comment	N/A

Data / Parameter	$RA_{BL,i}$
Unit	tonne of reducing agent/ tonne of hot metal
Description	Reducing agent type *i* (i.e. pulverized coal) required to produce one tonne of hot metal
Source of data	Engineering data (SAMPAIO, 2000)
Value(s) applied	0.170
Choice of data or Measurement methods and procedures	Data used for baseline assessment based on a report made by a metallurgical engineering expert.
Purpose of data	Calculation of baseline emissions
Additional comment	N/A

Data / Parameter	$EF_{vf,BL}$
Unit	kg CO_2/litre
Description	Emission factor for vehicle type *v* with fuel type *f* (diesel) in the baseline scenario and the project scenario
Source of data	GHG Protocol Brazilian Program, 2010, http://www.ghgprotocolbrasil.com.br/ and 2006 IPCC Guidelines for National GHG Inventories, Volume 2, Chapter 1, Table 1.4
Value(s) applied	2.622312
Choice of data or Measurement methods and procedures	Calculated (see Section B.6.1)
Purpose of data	Calculation of baseline emissions
Additional comment	Diesel is the fuel used by the project entity. Vehicle type: Train Calculated using IPCC lower limit 72600 kgCO_2e/TJ

Data / Parameter	$EF_{vf,PJ}$
Unit	kg CO_2/litre
Description	Emission factor for vehicle type *v* with fuel type *f* (diesel) in the project scenario

Source of data	GHG Protocol Brazilian Program, 2010, http://www.ghgprotocolbrasil.com.br/ and 2006 IPCC Guidelines for National GHG Inventories, Volume 2, Chapter 1, Table 1.4
Value(s) applied	2.7018
Choice of data or Measurement methods and procedures	Calculated (see Section B.6.1, Footnote 69)
Purpose of data	Calculation of project emissions
Additional comment	Diesel is the fuel used by the project entity. Vehicle type: Truck Calculated using IPCC upper limit 74800 kgCO_2e/TJ This parameter is the same value as parameter $COEF_{i,y}$, CO_2 emission coefficient of fuel type *i* in year *y* (t CO_2/l)

Data / Parameter	$N_{V,BL,y}$
Unit	Unit numbers
Description	Number of round trips (to and from) per type *v* of vehicle had during the year *y* in the baseline scenario
Source of data	Vale mining company (see: http://www.vale.com)
Value(s) applied	45.99
Choice of data or Measurement methods and procedures	Calculated (see Section B.6.1, Baseline Emissions, Item 1 (c))
Purpose of data	Calculation of baseline emissions
Additional comment	Train transportation is not considered as round trip as a train does not return empty to its point of departure; it is always loaded with some other type of cargo to make the return travel and therefore this different cargo transportation is not accounted.

Data / Parameter	$AVD_{j,BL,y}$
Unit	Km
Description	Average round trip distance (to and from) between the reducing agent type *v* production site (s) and the site of the iron ore reduction facility in the baseline scenario during the year *y*
Source of data	Average distance estimated based on road map (Source: Google Maps, 2010)
Value(s) applied	600
Choice of data or Measurement methods and procedures	Distance from Vitória/Espírito Santo State (seaport) to Sete Lagoas/ Minas Gerais State (pig iron mill)
Purpose of data	Calculation of baseline emissions
Additional comment	Train transportation is not considered as round trip as a train does not return empty to its point of departure; it is always loaded with some other type of cargo to make the return travel and therefore this different cargo transportation is not accounted.

Data / Parameter	$EF_{v,km,CO2,BL,y}$
Unit	tCO_2/km

Description	CO_2 emission factor for the type *v* of vehicle during the year *y* in the baseline scenario
Source of data	ANTT/Vale, 2009; GHG Protocol Brazilian Program, 2010; IPCC, 2006
Value(s) applied	0.02589
Choice of data or Measurement methods and procedures	Calculated (see Section B.6.1, Baseline Emissions, Item 1 (c))
Purpose of data	Calculation of baseline emissions
Additional comment	Vehicle type: Train

Data / Parameter	$EF_{CO2e,coal,coke,BL,y}$
Unit	tCO_2e/ t of Coal coke
Description	Emission factor to produce one tonne of coal coke in the baseline scenario supply chain
Source of data	AM0082, Annex 1, Table 3 and SAMPAIO, 2000
Value(s) applied	0.537
Choice of data or Measurement methods and procedures	Calculated (see Section B.6.1, Baseline Emissions, Item 1 (d))
Purpose of data	Calculation of baseline emissions
Additional comment	N/A

Data / Parameter	GWP_{CH4}
Unit	(tCO_{2e}/tCH_4)
Description	Global warming potential of methane valid for the commitment period
Source of data	IPCC default
Value(s) applied	21 until 31/12/2012 25 from 01/01/2013
Choice of data or Measurement methods and procedures	N/A
Purpose of data	Calculation of project emissions
Additional comment	N/A

Data / Parameter	MW_{N2O}
Unit	Tonne
Description	Ratio of molecular weights of N_2O and N (44/28), tonne-N_2O $(t\text{-}N)^{-1}$
Source of data	IPCC default
Value(s) applied	44/28
Choice of data or Measurement methods and procedures	N/A
Purpose of data	Calculation of project emissions
Additional comment	N/A

Data / Parameter	EF_1
Unit	t-N_2O-N (t-N input)$^{-1}$
Description	Emission Factor for emissions from N inputs
Source of data	IPCC default, 2006 Guidelines, Chapter 11, Table 11.1
Value(s) applied	1%
Choice of data or Measurement methods and procedures	N/A
Purpose of data	Calculation of project emissions
Additional comment	N/A

Data / Parameter	NC_{SFi}
Unit	g-N (100 g fertilizer)$^{-1}$
Description	Nitrogen content of synthetic fertilizer type *i* applied; producers of synthetic fertilizer purchased and used.
Source of data	Producers of NPK fertilizer
Value(s) applied	6
Choice of data or Measurement methods and procedures	N/A
Purpose of data	Calculation of project emissions
Additional comment	N/A

Data / Parameter	$Frac_{GASF}$
Unit	dimensionless
Description	Fraction that volatilises as NH_3 and NO_X for synthetic fertilizers
Source of data	IPCC 2006 Guidelines, Chapter 11, Table 11.3
Value(s) applied	0.10
Choice of data or Measurement methods and procedures	N/A
Purpose of data	Calculation of project emissions
Additional comment	N/A

Data / Parameter	$EF_{CO2,i,y}$
Unit	tCO_2/ GJ
Description	Weighted average CO_2 emission factor of fuel type *i* in year *y*
Source of data	2006 IPCC Guidelines for National GHG Inventories, Volume 2, Chapter 1, Table 1.4 (upper limit)
Value(s) applied	0.0748
Choice of data or Measurement methods and procedures	N/A
Purpose of data	Calculation of project emissions
Additional comment	Diesel is the fuel type used

Data / Parameter	GWP_{N2O}
Unit	(tCO_{2e}/tN_2O)
Description	Global warming potential of nitrous oxide valid for the commitment period
Source of data	IPCC default
Value(s) applied	310 until 12/31/2012 298 from 01/01/2013
Choice of data or Measurement methods and procedures	N/A
Purpose of data	Calculation of project emissions
Additional comment	N/A

B.6.3. Ex ante calculation of emission reductions

>> Applying the procedures of the proposed new methodology the emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y - LE_y - MAX(0, RAE_{BL,y} - RAE_{PJ,y}) \qquad (27)$$

Where:

ER_y	=	Emission reductions during the year *y* (tCO_2/yr)
BE_y	=	Baseline emissions during the year *y* (tCO_2/yr)
PE_y	=	Project emissions during the year *y* (tCO_2/yr)
LE_y	=	Leakage emissions during the year *y* (tCO_2/yr)
$RAE_{BL,y}$	=	Baseline upstream emissions in the reducing agent supply in year *y* (tCO_2e)
$RAE_{PJ,y}$		Project upstream emissions associated with production of reducing agents and transport in year *y* in the project scenario (tCO_2e)

Therefore,

$$ER_y = \mathbf{439{,}113} - 110{,}045 - 0{,}00 - 0$$

$$ER_y = \mathbf{329{,}068\ tCO_2e}$$

B.6.4. Summary of ex ante estimates of emission reductions

Year	Baseline emissions (t CO_2e)	Project emissions (t CO_2e)	Leakage (t CO_2e)	Emission reductions (t CO_2e)
From Jun 2012	256,149	64,193	0	191,957
2013	439,113	110,045	0	329,068
2014	439,113	110,045	0	329,068
2015	439,113	110,045	0	329,068

2016	439,113	110,045	0	329,068
2017	439,113	110,045	0	329,068
2018	439,113	110,045	0	329,068
Until May 2019	182,964	45,852	0	137,112
Total	**3,073,791**	**770,315**	**0**	**2,303,477**
Total number of crediting years	7			
Annual average over the crediting period	439,113	110,045	0	329,068

B.7. Monitoring plan

B.7.1. Data and parameters to be monitored

Data / Parameter	$P_{PJ,y}$
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	Project entity records
Value(s) applied	240,000
Measurement methods and procedures	Total production is weigthed. Measurements are carried out daily by the Project Entity. Accuracy class: Class III ±10kg Maximum cargo 80000kg/ Minimum cargo 200kg
Monitoring frequency	Measured daily, aggregated annually.
QA/QC procedures	100% of the total pig iron production shall be weighted. Scales are calibrated according to Standard Operating Procedures based on ISO 9001 standards.
Purpose of data	Calculation of baseline emissions
Additional comment	N/A

Data / Parameter	$N_{v,PJ,y}$
Unit	Unit numbers
Description	Number of round trips (to and from) per type *v* of vehicle during year *y* in the project scenario
Source of data	Project entity records
Value(s) applied	31,721
Measurement methods and procedures	Estimated and/or calculated (calculation presented in Section B.6.1, Project Emissions, item 1 (d))
Monitoring frequency	Annual
QA/QC procedures	N/A
Purpose of data	Calculation of project emissions
Additional comment	This parameter applies to the calculations for $EP_{Vehicle,PJ,y}$ biomass transport to the carbonization sites.

Data / Parameter	$N_{v,PJ,y}$

Unit	Unit numbers
Description	Number of round trips (to and from) per type *v* of vehicle during year *y* in the project scenario
Source of data	Project entity records
Value(s) applied	5,841
Measurement methods and procedures	Estimated and/or calculated based on the trucks entrance in the pig iron mill (Calculation presented in Section B.6.1, Project Emissions, item 3)
Monitoring frequency	Annual
QA/QC procedures	Standard Operating Procedures based on ISO 9001 standards.
Purpose of data	Calculation of project emissions
Additional comment	This parameter applies to the calculations for $RAT_{Vehicle,PJ,y}$, transport of reducing agent to iron ore reduction facility in the project scenario.

Data / Parameter	$AVD_{i,PJ,y}$
Unit	Km
Description	Average round trip distance (to and from) between the biomass *i* production site(s) and the site of the project plantation during year *y*
Source of data	Project entity records.
Value(s) applied	31.4
Measurement methods and procedures	Distance calculated based on road maps; the highest value shall be considered (Calculation presented in Section B.6.1, Project Emissions, item 1 (d))
Monitoring frequency	Annual
QA/QC procedures	Standard Operating Procedures based on ISO 9001 standards.
Purpose of data	Calculation of project emissions
Additional comment	This parameter applies to the calculations for $EP_{Vehicle,PJ,y}$ biomass transport to the carbonization sites.

Data / Parameter	$AVD_{i,PJ,y}$
Unit	Km
Description	Average round trip distance (to and from) between the reducing agent type *i* production site(s) and the site of the project activity during the year *y*
Source of data	Project entity records
Value(s) applied	880
Measurement methods and procedures	Distance calculated based on road maps; the highest value shall be considered.
Monitoring frequency	Annual
QA/QC procedures	Standard Operating Procedures based on ISO 9001 standards.
Purpose of data	Calculation of project emissions
Additional comment	This parameter applies to the calculations for $RAT_{Vehicle,PJ,y}$, transport of reducing agent to iron ore reduction facility in the project scenario.

Data / Parameter	$EF_{v,km,CO2,PJ,y}$
Unit	tCO_2/km

Description	CO_2 emission factor for the type *v* of vehicle during year *y* in the project scenario
Source of data	Mechanical Engineering Department (DEMEC), Minas Gerais Federal University (UFMG), http://www.demec.ufmg.br/disciplinas/eng032-BL/aula_04.pdf, accessed May 2010; GHG Protocol Brazilian Program 2010 and Project entity records
Value(s) applied	0.00180 and 0.00129
Measurement methods and procedures	Calculated (see calculation in Section B.6.1, Project Upstream Emissions, item 1, (d)) and item 3, respectively.
Monitoring frequency	Annual
QA/QC procedures	Standard Operating Procedures based on ISO 9001 standards.
Purpose of data	
Additional comment	This parameter applies to the calculations for $EP_{Vehicle,PJ,y}$ biomass transport to the carbonization sites, and $RAT_{Vehicle,PJ,y}$ transport of reducing agent to iron ore reduction facility in the project scenario.

Data / Parameter	$EF_{CH4,charcoal,PJ,y}$
Unit	tCH_4 / t of charcoal
Description	Emission Factor to produce one tonne of renewable charcoal identified in the project supply chain
Source of data	Project entity records
Value(s) applied	0.0324
Measurement methods and procedures	Calculation based on AM0041 provisions;
Monitoring frequency	Annual
QA/QC procedures	Standard Operating Procedures should be applied based on provisions of AM0041 and ISO 9001 standards.
Purpose of data	Calculation of project emissions
Additional comment	

Data / Parameter	$F_{PJ,charcoal}$
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 entity records
Value(s) applied	0.589
Measurement methods and procedures	Charcoal and hot metal are weighted daily and calculated annually by the PP. Accuracy class: Class III ±10kg Maximum cargo 80000kg/ Minimum cargo 200kg
Monitoring frequency	Annual
QA/QC procedures	Standard Operating Procedures based on ISO 9001 standards.
Purpose of data	Calculation of project emissions
Additional comment	N/A

Data / Parameter	Y_{PJ}
Unit	Tonne of charcoal / tonne of wood on dry basis
Description	Carbonization gravimetric yield

Source of data	Project entity records
Value(s) applied	0.34
Measurement methods and procedures	Measurements performed according to AM0041 provisions, Appendix 4
Monitoring frequency	Annual
QA/QC procedures	Standard Operating Procedures should be applied based on provisions of AM0041 and ISO 9001 standards.
Purpose of data	Calculation of project emissions
Additional comment	

Data / Parameter	$FC_{i,j,y}$
Unit	Liters per year
Description	Quantity of fuel type *i* combusted in process *j* during the year *y*
Source of data	Project entity records
Value(s) applied	1,900,892 Annual average
Measurement methods and procedures	Measured, estimated and calculated by machinery type: a) Measured: the quantity of machine working hours; b) Estimated: based on the machinery consumption/ hour; c) Calculated: fuel (diesel) consumption. **c = a * b**
Monitoring frequency	Annual
QA/QC procedures	Standard Operating Procedures based on ISO 9001 standards.
Purpose of data	Calculation of project emissions
Additional comment	

Data / Parameter	$NCV_{,i,y}$
Unit	GJ/ l
Description	Weighted average net calorific value of fuel type *i* in year *y*
Source of data	Regional or national default values: GHG Protocol Brazilian Program
Value(s) applied	0.03612
Measurement methods and procedures	Review appropriateness of the values annually.
Monitoring frequency	Annual
QA/QC procedures	Verify if value is within the uncertainty range of the IPCC default values as provided in Table 1.2, Vol. 2 of the 2006 IPCC Guidelines (Upper limit for diesel: 43.3 TJ/Gg).
Purpose of data	Calculation of project emissions
Additional comment	0.03612 GJ/l = 42.98 TJ/Gg Diesel density (Source: GHG Protocol Brazilian Program): 0.84 Kg/l = 1.190 l/Kg 36.12 MJ/l * 1.190 l/Kg = 42.98 MJ/Kg = **42.98 TJ/Gg**

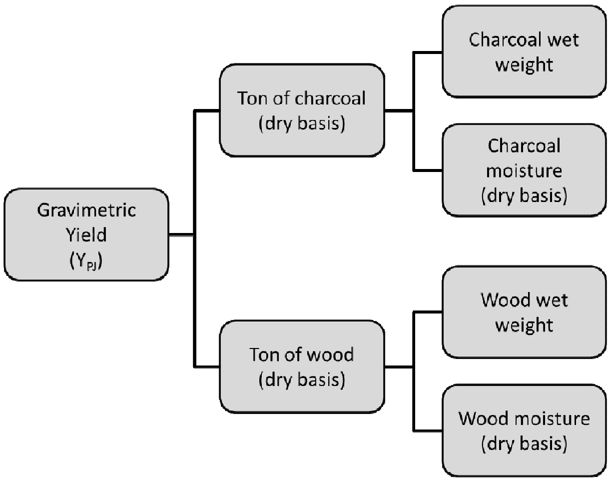
Data / Parameter	$M_{SFi,t}$
Unit	Tonne
Description	Mass of synthetic fertilizer type *i* applied, tonne in year *t*
Source of data	Record of synthetic fertilizer purchased and used
Value(s) applied	786.63

Measurement methods and procedures	Keep record of quantities purchased and used, annually
Monitoring frequency	Annually
QA/QC procedures	Standard Operating Procedures based on ISO 9001 Standards
Purpose of data	Calculation of project emissions
Additional comment	NPK is the type of fertilizer used

B.7.2. Sampling plan

>> Objectives and reliability

A sampling plan may be applied for parameter Y_{PJ} in accordance with the provisions of the "Guidelines for sampling and surveys for CDM project activities and programme of activities". To calculate the parameter Y_{PJ} it is necessary to calculate other four inputs, as seen below:



The guideline requires that the sampling plan of a large scale project activity meets an estimate error not higher than ±10% in relative terms considering 95% confidence to the error margin. This confidence margin will be taken into account when sampling the inputs to the parameter. Whenever possible, it is preferable that the measurements of the inputs consider all population rather than a sampling.

Target Population

The forest stand is the reference point for the determination of the population although when sampling an input each one has its target population: to calculate the input "wood wet weight" the population is all wood logs originated from a forest stand; to calculate input "wood moisture" the population is the wood logs originated from a stand stacked to fill each carbonization kiln. To calculate "charcoal wet weight" the population is all charcoal produced using the wood originated from a forest stand, and to calculate "charcoal moisture" the population is the total of kilns used to carbonize the wood originated from a forest stand.

Sampling Method

The sampling method used to each input is determined by internal procedures and can be either simple random sampling or stratified random sampling.

Sample size

If the PP uses sampling to calculate an input, it shall develop a technical report to estimate the minimum number of samples for the estimation of the data. To determine a minimum number of samples a sampling method shall be chosen, be it simple random sampling or stratified random sampling. For example, the stratified random sampling is used to calculate wood moisture stratified by the diameter of the wood logs, as it directly affects moisture results. To determine the minimum number of samples by sampling methods the PP will use at least the minimum number of samples requested by the guidelines.

Simple random sampling

$$n = \frac{1.96^2\, NV}{(N-1) * 0.1^2 + 1.96^2\, V}$$ Equation (1)

Where:

V	=	$\left(\frac{SD}{mean}\right)$
n	=	Sample size
N	=	Population total
mean	=	Expected mean
SD	=	Expected standard deviation
1.96	=	Represents the 95% confidence required
0.1	=	Represents the 10% precision

Stratified random sampling

Equation (1) is used to calculate the minimum number of samples. However, the mean and standard deviation are replaced by overall mean and overall standard deviation, calculated as per Equation (2) and (3) below.

$$mean = \frac{(g_a * m_a) + (g_b * m_b) + (g_c * m_c) + \cdots + (g_k * m_k)}{N}$$ Equation (2)

Where:

mean	=	Weighted overall mean
g_i	=	Size of the i^{th} group where i=1,…,k
m_i	=	Mean of the i^{th} group where i=1,…,k
N	=	Population total

$$SD = \sqrt{\frac{(g_a * SD_a^2) + (g_b * SD_b^2) + (g_c * SD_c^2) + \cdots + (g_k * SD_k^2)}{N}}$$ Equation (3)

Where:

SD	=	Weighted overall standard deviation
g_i	=	Size of the i^{th} group where i=1,…,k
SD_i	=	Standard deviation of the i^{th} group where i=1,…,k
N	=	Population total

Finally, the result for minimum number of samples is allocated to each stratum according to proportional allocation.

$$n_i = \frac{g_i}{N} * n$$ Equation (4)

Where:

n_i	=	Sample size of the strata I where i=1,…,k
g_i	=	Size of the i^{th} group where i=1,…,k
N	=	Population total
n	=	Sample size

In order to standardize the process the PP fixes the number of samples and uses standard operational procedures (SOPs) and laboratory analysis for sampling. In addition to the required number of samples, the PP may estimate the relative precision as defined by the guideline for sampling to demonstrate the reliability of calculations.

Data to be collected

Field measurements and Quality assurance/Quality control

All field measurements necessary to the calculations of the inputs are described in internal procedures based on ISO quality standards. The data are registered and archived according to the PP's internal quality operational procedures also based on ISO quality standards. The data measured for each input are:

- Wood wet weight: weighed in scales in tonnes;
- Wood moisture: determined by lab analyses (described in internal procedures) in %;
- Charcoal wet weight: weighed in scales in tonnes;
- Charcoal moisture: determined by lab analyses (described in internal procedures) in %.

Analysis

Whenever sampling is necessary, the analyses of the data to determine the inputs are to follow the provisions of the latest version of the "Guidelines for sampling and surveys for CDM project activities and programme of activities". Basic statistical values such as average, standard deviation and standard error are calculated according to the guidelines and the results are evaluated in order to meet the requirements for the reliability of data.

B.7.3. Other elements of monitoring plan

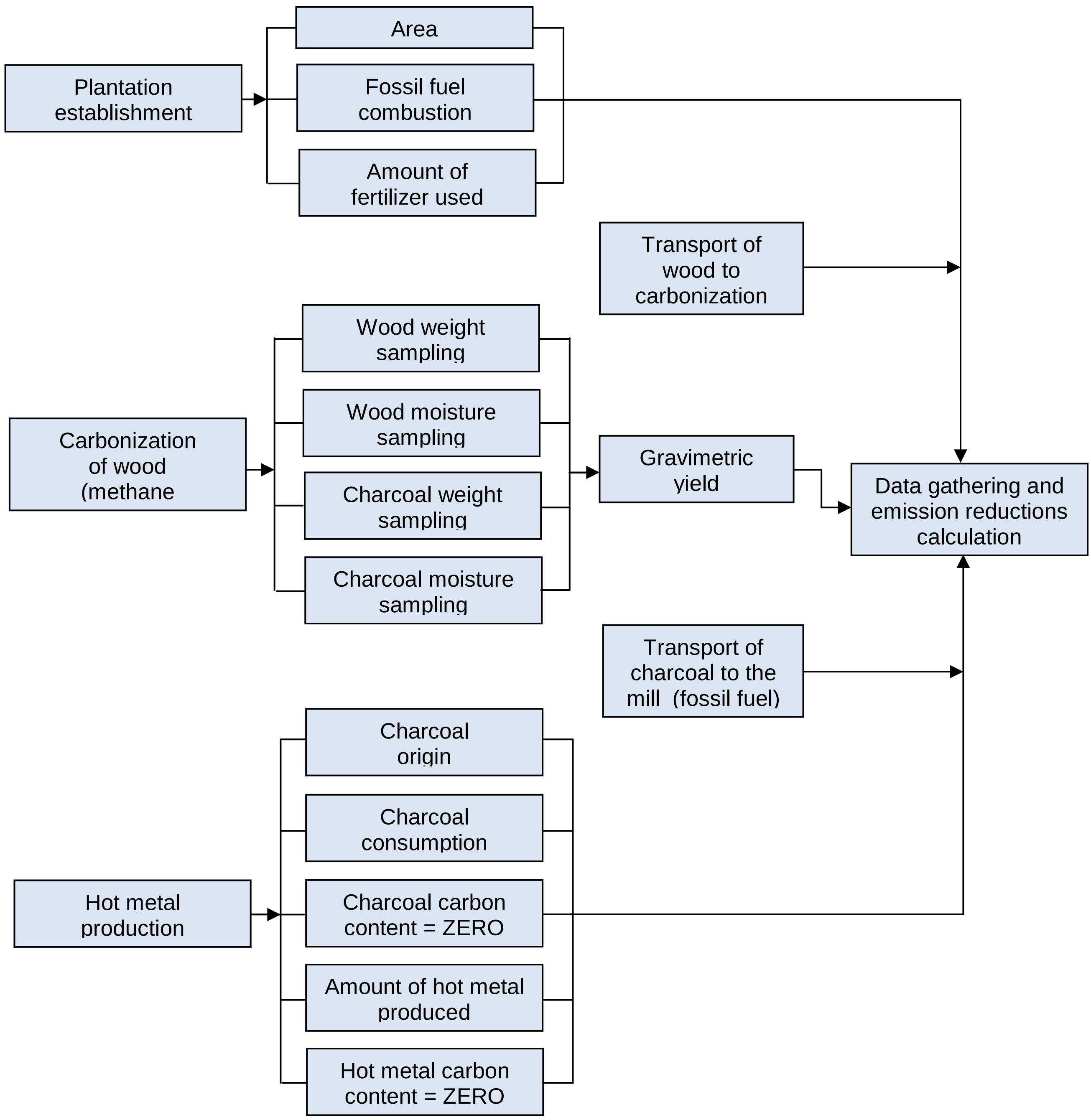
>> **1 – Monitoring of project emissions parameters**

Considering that the monitoring data forms the basis for estimating the CO_2 emissions, the correct application of the recommended operational procedures for monitoring and recording of data will be periodically verified by the supervisory personnel to ensure the integrity of data. The sources of data and periodicity of data collection are outlined in Section B.7.1 above. According to the AM0082, all data collected as part of monitoring should be electronically archived and be kept at least for 2 years after the end of the last crediting period.

The carbon content of the pig iron produced with renewable charcoal will always be considered zero leading to conservative results for project emissions and emissions reductions. Therefore, the

renewable charcoal carbon content will be excluded from the project emissions monitoring flow, as per provisions from the AM0082. As the project activity only uses renewable reducing agent, monitoring of planted areas and wood volume transported to the carbonization units will also be included.

Figure 29: Monitoring and calculating project emissions of the new iron ore reduction system



As per chart above, regarding the production of the primary carbon, the planted area and the volume of primary carbon transported to the carbonization sites will be monitored.

Methane emissions of the carbonization process will be estimated based on the identification of the gravimetric yield according to a regression equation expressing statistical relationship, as provided by the approved methodology AM0041 "Mitigation of Methane Emissions in the Wood

Carbonization Activity for Charcoal Production". In addition to the gravimetric yield, the transport of the reducing agent produced to the iron ore reduction facility will be monitored.

The operational and management structure for collecting and monitoring the project activity's data is presented in **Table 8** below.

Table 8: Monitoring of project's activities organizational chart

Activity/task/variable	Unit	Project Entity	Department
Monitoring the emissions of plantations establishment			
- Planted area; - Diesel combusted in forest establishment and maintenance; - Synthetic fertilizer applied.	Ha Liters Tons	Plantar	**Branch Management**
Emissions from transport of biomass to the reducing agents production sites			
- Number of round trips; - Average round trip distance from the harvesting site to carbonization units; - Emission factor per type of vehicle.	Number Km Ton CO_2/liter	Plantar	**Planning Management**
Emissions from the carbonization of wood (methane emissions)			
- Gravimetric yield as per AM0041: 1. Wood weight sampling (dry basis) 2. Charcoal weight sampling (dry basis) 3. Wood moisture sampling 4. Charcoal moisture sampling	Ton./m^3 Ton./m^3 % %	Plantar Siderúrgica	**Production Management**
Emissions from transport of charcoal to the iron ore reduction facility			
- Number of round trips per type of vehicle; - Average round trip distance from the carbonization site to the pig iron mill; - Emission factor per type of vehicle	Number Km Ton CO_2/km	Plantar Siderúrgica	**Production Management**
Emissions from hot metal production			
- Renewable reducing agent origin - Reducing agent consumption (quantity of reducing agent used in the iron ore reduction process) - Amount of hot metal produced in the iron ore reduction process	Dimensionless Tons. Tons	Plantar Siderúrgica	**Production Management**
Data gathering and Project emissions reductions calculation			
- Data gathering and calculation of emission reductions through spreadsheet database	Dimensionless	Plantar Carbon	**Project Management**

1.1 – Monitoring of project reducing agents component emissions parameters

The project proponent has a Quality Management system in place which documents and records the significant activities related to forest establishment, including activities related to site preparation and vegetation affected as part of site preparation. The monitoring intervals and specific activities/ staff responsibilities are provided in the Standard Operating Procedures which are based on ISO rationale and are constantly updated based on the continuous improvement approach, including compliance with safety and quality regulations.

Monitoring the emissions in the establishment of plantations and production of biomass

Field surveys will be undertaken to verify that the delineated project boundary is congruent with the ex-ante description presented in **Appendix 5** of this CDM-PDD. Any significant changes shall be recorded and integrated in the Forest Inventory System based on the standard operating procedures. Only biomass sourced by the areas within this project activity's boundaries, as well as areas treated in the AR/CDM Project number 2569, will be accounted for emission reductions calculations, as they integrate the new iron ore reduction system.

a. Calculation of CO_2 emissions from burning of fossil fuels

Diesel consumption monitoring is either per unit of area (planted area; standard yield hour/hectare; standard machine consumption liters/hour) for site preparation, planting and maintenance, or per unit volume logged (volume logged; standard yield hour/m^3; standard machine consumption liters/hour). Therefore, the quantity of fossil fuels used in the forest management and operations during each year of the project is collected and recorded.

b. Calculation of nitrous oxide emissions from nitrogen fertilization practices

Fertilizers application occurs in years 1, 2 and 3 of planting and replanting stages. The fertilizer used is an N type (NPK).

The project entity will monitor the following parameters, in relation to emissions in the establishment of the dedicated planted forests within the project boundary:

- Liters of diesel combusted in forest establishment and maintenance;
- Tons of synthetic fertilizer applied.

<u>1.1.1 - Data on transportation variables of primary carbon sources to be monitored</u>

<u>Emissions from transport of biomass to the reducing agents production sites based on fuel consumption of vehicles.</u>

The following data shall be monitored:

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

<u>1.1.2 - Data on reducing agents production emissions to be monitored (carbonization)</u>

Data to be monitored:

- Gravimetric yield as per AM0041

According to the approved methodology for the monitoring of emissions in the reducing agent production the provisions of the AM0041 methodology are considered. Therefore, the following data are monitored:

5. Wood weight sampling
6. Charcoal weight sampling
7. Wood moisture sampling
8. Charcoal moisture sampling

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

Emissions from transport of charcoal to the iron ore reduction facility based on fuel consumption of vehicles

The following data shall be monitored:

- Number of round trips per type of vehicle;
- Average round trip distance from the carbonization site to the pig iron mill;
- Emission factor per type of vehicle.

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

- Reducing agent consumption (quantity of reducing agent used in the iron ore reduction process)
- Reducing agent renewable origin

Only charcoal produced with biomass sourced by the areas within this project activity's boundaries, as well as areas treated in the A/R CDM Project number 2569, will be accounted for emission reductions calculations, as they integrate the new iron ore reduction system.

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

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

2 – Monitoring of leakage emissions parameters

This project activity bears no leakage associated with activity displacement. Considering the fact that the project entity has the ownership of the lands, it was able to assure, based on land acquisition documentation and procedures that no displacement of activities occurred in these lands due to the project activity, either for lands under the A/R CDM project activity or lands covered with plantations after last rotation. Supporting documentation will be available to the DOE at the time of validation.

Also, since there is no leakage related to blast furnace gas recovery for electricity generation, as the baseline scenario of this project activity does not include such activity, no related monitoring is necessary.

3 – Monitoring the project emission reductions through electronic spreadsheet

Detailed information regarding the monitoring of the project emissions parameters is the spreadsheet database to estimate emission reductions of the project activity.

4 - Standard Operating Procedures and quality control/quality assurance (QA/QC)

The QA/QC procedures under the project aim to follow standard procedures for monitoring and collection of reliable field measurements. To ensure that the emissions reductions are estimated and monitored accurately, the quality assurance and quality control (QA/QC) procedures such as (1) quality assurance of field monitoring; (2) collection of field data and; (3) data entry and analysis, are implemented, according to a quality system based on ISO 9001 standards.

Quality assurance of field monitoring
The personnel involved in the project monitoring are carefully trained in data collection and analyses. The data collection and organization is based on Standard Operating Procedures (SOPs) developed for this purpose. These SOPs contain provisions for documentation and

verification so that continuity in the field monitoring is maintained and measurements can be verified. In order to ensure consistency in field monitoring and measurements, the team members are trained in all procedures of data collection. The monitoring and data collection unit is organized and the team's responsibilities are clearly outlined.

Data collection
The field data collection is prescribed by SOPs and personnel are trained in data collection and analyses. Field data collection is followed by senior personnel in order to assure robustness of data.

Data entry and analysis
The data entry process is reviewed by a senior member of the monitoring team.

Monitoring frequency
Monitoring interval for each parameter is predicted in the tables in Section B.7.1 above.

All project activities subject to monitoring are presented in **Figure 29** and detailed in **Table 8**.

Plantation establishment

Based on standard operational procedures field surveys were done by the inventory team in order to delineate project boundary and increase measurement accuracy. Any significant changes will be recorded and integrated in the Forest Inventory System and shown to the DOE during verification.

The following two major sources of GHG emissions are recorded, reported and accounted in the calculation of actual net GHG removals by sinks from the project activity.

- GHG emissions from fossil fuel consumption;
- GHG emissions from nitrogenous fertilizer application.

These data were collected in field through specific paper form and inputted in RM SOLUM System, a module of an integrated system designed for budgetary control, and for forest operating control. The Solum system generated a set of reports with detailed data on forestry activities, e.g. activities carried out, stand and farm ID, responsible personnel, fuels and fertilizers consumed, total labor days consumed, and these reports supplied the Plantar Green Pig Iron Control Tool with the necessary information to calculate GHG emissions by sources.

Carbonization of wood (methane emissions)

The Project Entity adopts a detailed work instruction for the calculation of gravimetric yield under its quality management system based on ISO 9000 criteria. Instructions for the measurement of wood and charcoal moisture are registered and followed within the Project Entity's quality management system. Wood and charcoal weight sampling are ruled by a sample plan registered within the Project Entity's quality management system.

Emissions form transport of wood to the carbonization sites and charcoal to the mill are based on the quantity of wood/charcoal transported the number of round trips and the average distance. The quantity of goods transported is subject to strict control via operation procedures based on ISO 9000 standards

Hot metal production

Charcoal origin is strictly controlled via Environmental Control Form - GCA, an official form from the State's Forestry Authority (IEF – Instituto Estadual de Florestas). The GCA presents the origin of the wood, to which forestry authorization it is linked to (another official form from the same

Authority called DCC – Declaration of Harvesting and Commercialization of Planted Forests) and even the route of the charcoal transportation.

The amount of hot metal produced is weighted and the scale is duly calibrated (see Section B.7.1 above).

All data gathered are checked by a senior supervisor and inputted in the Plantar Green Pig Iron Control Tool.

B.8. Date of completion of application of methodology and standardized baseline and contact information of responsible persons/ entities

>> The project participants have conducted several baseline studies, reports and monitoring, due to the integrated nature of the project. In 2000 the engineering study "*Avaliação de mudança do agente termo redutor na produção de ferrogusa da Plantar Siderúrgica"* ("Assessment for Reducing Agent Change in Pig Iron Production of Plantar Siderúrgica") was prepared by RS Consultants expert Eng. Ronaldo Santos Sampaio.

In 2001, the Prototype Carbon Fund in partnership with Ecosecurities had also produced the following documents (original version of 17 October 2001):

- " 'Plantar' Project – Project Design Document";
- "Baseline determination for Plantar: Evaluation of the emission reduction potential of the Plantar Project";
- "Monitoring and Verification Protocol for Plantar coal coke to charcoal substitution project"..

Those documents and the "Environmental Assessment of Plantar Project/ Minas Gerais" (also produced by the Prototype Carbon Fund team in 18 October 2001) were revised and resubmitted on March 14, 2002 to DNV validation process, which issued a validation report on June 2002 recommending the project to registration taking into account the applicable UNFCCC regulations at that time.

The date of approval of the 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 --- Version 1.0, in which this CDM-PDD is based on, is 16 July 2009. The CDM-PDD version 1 sent to the DOE for validation is dated 24 November 2010. Therefore, the date of completion of the application of the baseline study and monitoring methodology is considered 24 November 2010.

The entities responsible for the application of the baseline and monitoring methodologies are Plantar Carbon, contact information plantarcarbon@plantar.com.br and the International Bank for Reconstruction and Development as Trustee of the Prototype Carbon Fund / World Bank - Carbon Finance Unit, Washington DC, US, IBRD-carbonfinance@worldbank.org (for details see **Annex 1**).

SECTION C. Duration and crediting period

C.1. Duration of project activity

C.1.1. Start date of project activity

>> The starting date is 10/11/2000, date of the first planting of the dedicated plantations for the new iron ore reduction system, occurred in stand Buritis 6, with 57.74ha, located in MG03 Farm (part of the A/R project activity 2569).

C.1.2. Expected operational lifetime of project activity

>> Considering that the project scenario is based on the establishment and management of renewable planted forests to supply the pig iron mill with sustainable charcoal, the operational life time of the project can be considered indefinite, at least as long as the incentives for undertaking project activities are sufficiently strong.

C.2. Crediting period of project activity

C.2.1. Type of crediting period

>> The project is implemented adopting the renewable crediting period (First crediting period).

C.2.2. Start date of crediting period

>> 28/12/2012.

C.2.3. Length of crediting period

>> 7 years 0 months.

SECTION D. Environmental impacts

D.1. Analysis of environmental impacts

>> Following the new iron ore reduction system rationale, the environmental impacts were also grouped into two components, that is, upstream impacts, related to the impacts caused by the project activity associated with the production of the reducing agent (establishment of plantations and carbonization) and process impacts, related with the use of the reducing agent in the iron ore reduction process (pig iron mill).

Upstream Impacts

MG02 Farm

The project's entity compromise to the sustainability of its activities was reinforced with an assessment of biodiversity indicators prepared by Daniel Nepstad and Luis Carlos Cardoso Vale[81], which occurred in 2001 to comply with baseline determination procedures required by the World Bank's Prototype Carbon Fund. It served as the basis for the project entity's monitoring program, which includes: (a) the conservation and maintenance of protected areas; (b) fauna and flora characterization; (c) monitoring of the quality of the superficial and ground waters; (d) the establishment of management programs in the protected areas to ensure their preservation and expansion; (e) the monitoring of natural resources, accounting all changes in relation to the flora, fauna, and water resources; and (f) the establishment, when needed, of a restoration program of degraded areas.

The assessment of the project's biodiversity and environmental impacts was developed in accordance with Brazilian environmental legislation, the Environmental Impact Assessment (EIA), the Environmental Control Report (ECR) and the Environmental Control Plan. It was prepared for the plantation unit MG02[82], within the boundaries of this project activity, by a multidisciplinary technical team and included detailed analyses developed based on diagnosis of geophysical, biotic

[81] Prototype Carbon Fund. Brazil Plantar Baseline Report.

[82] These studies also assess the forest plantation units MG03 (Felixlandia) and MG04 (Morada Nova de Minas), already treated under AR/CDM Project Activity 2569.

and social economical environments. The environmental assessment framework below presents all the environmental impacts caused by the project activity found in the study and its correspondents categories.

Table 9: Environmental Impacts

Environmental impacts – physical environment Dedicated plantations in MG02 (Curvelo) Geophysical	Analyses of the Environmental Impacts						
	(I) P/N/T	(II) D/I	(III) R/I	(IV) T/P/C	(V) S/M/L	(VI) L/R/S	(VII) L/M/H
Erosive processes during soil preparation	N	D	R	C	S	L	M
Erosive processes due to the implementation and maintenance of infrastructures (roads, firebreaks, towers, conservation units)	N	D	R	C	S	L	M
Protection against erosive processes and nutrients recycling	P	D	R	C	M	L	H
Soil and water contamination due to the use of pesticides	N	D	R	C	S	L	M
Correction of soil's acidity and neutralization of the Al+++ through the use of phosphate	P	D	R	C	M	L	L
Soil fertilization through the use of fertilizers	P	D	R	C	M	L	L
Increase of concentration of solids in suspension, nutrients and organic matter in the water streams	N	I	R	C	M	R	H
Contamination of water streams with pesticides and phenolic compounds	N	D	R	C	L	R	L
Contaminations of water capture sources by oil and grease	N	D	R	P	S	R	M
Changes in the pluvial regime and in the water quality of the basin	T	I	R	P	L	R	H
Suppression of native vegetation	N	D	I	P	S	L	M
Compromise of the native vegetation due to the production of sediments and the silting up of natural streams	N	D	I	P	M	L	M
Degradation of remaining native vegetation due to fire	N	D/I	I	P	S	L	L
Suppression of pastureland areas	N	D	I	T	S	L	L
Chemical weed control (extirpation of pasture)	N	D	R	T	M	R	M
Chemical weed control (vegetation control)	N	D	I	C	M	R	L
Forest harvest	N	D	R	C	S	L	L
Risks of Forest Fire	N	I	R	P	S	R	M
Deficiency on Communication and Surveillance	N	I	R	P	M	L	M
Environmental Noise	N	D	R	C	S	L	L

(I) Impact quality: Positive (P), Negative (N), Tough Qualification (T)	(II) Sequence: Direct (D) e Indirect (I)	(III) Reversibility: Reversible (R), Irreversible (I)	(IV)Periodicity: Temporary (T), Permanent (P), Cyclic (C)
(V)Temporality: Short-term (S), Medium (M), Long-term (L)	(VI) Spacial Scope: Local (L), Regional (R), Strategic (S)	(VII) Magnitude and Relative Importance: Low (L), Medium (M), High (H)	

As per the table above, there are positive and negative environmental impacts of the project activities and each of them is classified per its nature, temporality, reversibility, periodicity, type, and scope. Considering the study's scope and analysis results, the most significant environmental positive impact of the project activity is the protection against erosive processes and nutrients recycling. The plantations establishment of Eucalyptus protects the soil, since it provides efficient cover due to the formation of a thick layer of litter. The decomposition of the litter promotes an increase of organic matter and the recycling of nutrients in the soil. In addition to these benefits, the dead wood left over the soil improves the micro-climate conditions, especially of the most superficial soils.

Eucalyptus plantations silviculture practices can also promote soil fertilization through the use of fertilizers. Natural phosphate is used for the planting and maintenance of the Eucalyptus forests in order to neutralize the aluminum and add phosphorus in the long run as a vegetal nutrient. In addition, calcium carbonate is added to correct the soil's acidity, a procedure called "calagem". The artificial fertilization and the correction of the acidity of the soils intensify the microbial activity and, consequently, increase the composition velocity of the pesticides. Furthermore, a good aeration and hydric equilibrium of the *latossols* also contribute to the pesticides decomposition.

This project activity also contributes to the increase of carbon sinks through the implementation of dedicated eucalyptus plantations, which are not claimed under this CDM-PDD; other positive impacts on the environment promoted by the project activities include:

- an increase in the size of permanent preservation and protected areas comparing to the pre-existence land use conditions;
- the preservation of expressive native areas of the *Cerrado* ecosystem;
- the adoption of the mosaic management practice;
- the formation of fauna corridors to interconnect vast native conservation areas with planted forests, favouring the transit of wild animals and biodiversity enhancement;
- the establishment of monitoring parameters and indicators;
- the implementation of several environmental initiatives, such as the fire control program and the environmental education program.

The relevant negative impacts were classified based on the assessment results indications of the parameter "High" for the magnitude and relative importance criteria and parameter "negative" for the impact quality criteria. Thus, out of the enlisted negative impacts, only one was identified with both criteria at the same time. However, adopting the application of the environmental precaution concept another impact is also being considered as highly relevant. Hence, only two significant negative impacts were identified in the study. They are indicated below and described in detail in the next section (D.2) of this CDM-PDD document.

1) Increase in the concentration of solids in suspension, nutrients and organic matter in the water streams;
2) Changes in the pluvial regime and in the water quality of the basin.

The dedicated plantation areas within the project boundaries are certificated by the FSC – Forest Stewardship Council, the most renowned and acknowledged forest management certification scheme in the world. It certifies that the project entity is capable of implementing the project related activities within an environmentally and socially sustainable manner, provided that the recommended monitoring provisions are adequately implemented. The FSC Certification is a strong case for environmental control. The forestry service unit MG02 is annually audited as per the FSC's principles and criteria for sustainable forest management.

As the project activity only uses renewable biomass sourced by the project entity's dedicated plantations in its charcoal production and refers to the control of gravimetric yield in the production of charcoal under the provisions of AM0041, no relevant negative environmental impacts are expected within the project boundaries regarding the renewable reducing agent production. In addition, the areas of MG02, MG03 and MG04 farm units, where the carbonization units (UCs) are located, are certified by the FSC, as previously stated.

The following table summarizes the measures implemented to address environmental and social issues deriving from the implementation of the dedicated plantations.

Table 10: Summary of environmental programs performed by the project activity in the dedicated plantations area within the project boundary (which is already part of the FSC certification scope)

Plantar - Social and Environmental Development Administration Environmental Impact Study (EIS) – Environmental Programs MG02 Unit –Buenos Aires Farm – Curvelo/MG	
Environmental Program	**Description/Objective**
Soil and Water Preservation	Soil management to optimize the pluvial waters drainage system. Planning the extraction and regeneration of the rubble field and clayey soil and optimize the usage and occupation of soil.
Monitoring the Quality of Superficial Waters	Characterization of the water quality conditions in the areas directly influenced by the entrepreneurship, considering physical, chemical, bacteriologic and hydrobiologic parameters, its seasonal variations and parametric behavior due to the drainage basin occupation and management practices.
Hydrologic Monitoring of micro-basins	Monitoring of the environmental and physical changes implemented by the entrepreneurship's silvicultural practices, by delimitating a small hydrographic basin where the results of the activities will be shown by quantity and quality of the hydric resources in the long run.
Characterization and Monitoring of the Flora	Measuring the structural changes in vegetation and permanent parcels (parcels of 50mx10m, subdivided into five parcels) in six different types of environment (phytophysiognomy).
Management and Preservation of Protected Areas	Preservation of native flora through the maintenance of the remaining native vegetation areas, with a protection system that includes fire prevention and control, regular inspection to prevent illegal logging and hunting, and identifying these areas as environmentally protected areas.
Surveillance	It aims at establishing a more effective surveillance system aiming to guarantee the integrity of the company's whole area, including the native vegetation areas, in a way to eliminate the action of third parties involved with hunting and harvesting of native species and fires.
Regeneration of Degraded Areas	Promotion of the rehabilitation of the rubble field through the control of erosive processes and reestablishment of vegetation cover with local native species.
Fire Control and Prevention	Implementation of efficient actions to prevent and control fire occurrence in the Project's area and surroundings.
Characterization and Monitoring of the Fauna	Measurement of the changes in bird and other communities in the parcels established for the Program
Program for the "lobo-guara" (*Chrysocyon brachyurus*) conservation	To characterize the trophic ecology, analyze the behavioral aspects and study the life of the lobos-guara (*Chrysocyon brachyurus*).

Program for the “guariba” (*Allouata* sp) conservation	To confirm the presence and species of “guariba” (*Allouata* sp), define where they happen, structure of groups (gender, age, number of individuals) and usage areas.
Program to Register the Mammals	To promote the continuous registration of information about the occurrence of big and medium sized mammals as a way to assess the evolution of the natural picture resulting from the implementation of several environmental programs.

Source: Environmental Management Department, Plantar

As the project activity proposes an alternative by using renewable charcoal as a main reducing agent in the new iron ore reduction system, no relevant negative environmental impacts are expected within the project boundaries. In order to make sure that the wood used in this project activity comes from sustainable sources, the project entity will rely on plantations managed in accordance with the legal provisions and/or appropriate quality control systems. One of these legal requirements are the Operating Licenses which allows the activity to operate after having a set of documents verified by government bodies to attest the company’s compliance with the environmental control measures and conditions that may be required for the activity’s operation, and is subject to revalidation (see details in Section D.2). The Operating Licenses for the MG02 Farm Unit in Curvelo will be monitored under this CDM-PDD.

In addition, the project entity forest management and charcoal production system is based on the principles and criteria of internationally respected standards such as ISO 9001 and/or others reliable forest certification schemes.

Regarding the baseline scenario, social and environmental impacts of the activity tend to be really severe. In developing countries coal mining related activities have been widely known by the poor safety standards for mine workers and high impacts on the environment due to coal extraction from both surface and underground methods.

MG15 Farm

The project entity’s expertise on eucalyptus silviculture practices is implemented in all dedicated plantations of the project activity. As such, the forestry management practices and most of the environmental programs are the same for all plantation areas (as presented for MG02 Farm above), which comprises, among other standard practices, soil fertilization through the use of fertilizers, minimum cultivation and fire control program. Also, the adoption of the mosaic management practice, increase in the size of permanent preservation and protected areas, preservation of expressive native areas of the *Cerrado* ecosystem, formation of fauna corridors to interconnect vast native conservation areas with planted forests, favouring the transit of wild animals and biodiversity enhancement, and other positive impacts are observed.

As in MG02 Farm dedicated plantation areas, the project entity will rely on plantations managed in accordance with legal provisions and/or appropriate quality control systems. One of these legal requirements is the Operating License which allows the activity to operate after having a set of documents verified by government bodies to attest the company’s compliance with the environmental control measures and conditions that may be required for the activity’s operation, and is subject to revalidation (see details in Section D.2).

The assessment of the project’s biodiversity and environmental impacts for the plantation unit MG15, Environmental Control Report (RCA)/ Environmental Control Program (PCA), was developed in 2005 in accordance with Brazilian environmental legislation, by a multidisciplinary technical team and included detailed analyses based on diagnosis of geophysical, biotic and social economical environments. It was developed for the first operating licencing process of MG15 Farm, valid until 2011.

In 2011 the project entity prepared an Assessment of Environment Performance Report (RADA[83]) and submitted it in due time to the Regional Superintendence for Environment and Sustainable Development (SUPRAM) for technical assessment. The project entity is currently awaiting for the environmental body's review.

The Operating License for the MG15 Farm Unit in Itacambira will be monitored under this CDM-PDD.

Process Impacts

The assessment of the pig iron mill environmental impacts was conducted in accordance with Brazilian environmental legislation to obtain the Operating License for the pig iron mill (see details of the process in Section D.2). The Operating License allows the activity to operate after strict verification to attest the company's compliance with the environmental control measures and conditions that may be required for the activity's operation, and is subject to revalidation. The Plantar Siderúrgica Operating License will be monitored by the project entity.

Also, according to the Minas Gerais legislation the Normative Deliberation 49 (DN-49) rules the environmental control of the State's pig iron mills. The observance of DN-49 covers the major impacts caused by the industry, such as particulate matter emissions and air quality standard, and will be subject to monitoring under this CDM-PDD.

The Plantar Siderúrgica holds ISO 14001 certificate for its environmental management system which illustrates the company's concern and respect regarding the environment, aiming to ensure that its products and processes are accomplished within a sustainable basis, with minimum environmental impact.

It is expected that the project activity creates positive environmental impacts once the subject of the project is the decision to use 100% of renewable reducing agents in the pig iron production.

D.2. Environmental impact assessment

>> *Upstream Impacts*

MG02 Farm

In the previous section all environmental impacts, positive and negative, concerning the establishment of the dedicated plantations in the forestry service unit MG02 were listed based on the Environmental & Social Impact Assessment Studies prepared in compliance with the Brazilian environmental regulations, as provided by the *Conselho de Política Ambiental* (COPAM/MG)[84]. They were classified and assessed under the following parameters: impact quality; sequence; reversibility; periodicity; temporality; spatial scope; and magnitude and relative importance.

For the classification of the most relevant negative impacts of the project activities in the environment, it was considered the parameter "High" for the magnitude and relative importance criteria and parameter "negative" for the impact quality criteria. Thus, out of the twenty one negative impacts, only one was identified with both criteria at the same time. However, another impact is also being considered in this analysis due to its high relevance. Specific monitoring program and remedial measures for this relevant negative impact are detailed ahead.

Based on the study results presented in the previous section and considering the classification criteria mentioned above, the most significant negative environmental impact of the project activity

[83] *Relatório de Avaliação de Desempenho Ambiental (RADA)*

[84] Environmental Policy Council of the State of Minas Gerais

is the increase of concentration of solids in suspension, nutrients and organic matter in the water streams.

Although *it was not detected in the study analyses*, the increase of the concentration of solids in suspension, nutrients and organic matter in the water streams, is a negative effect that may be caused by the reforestation activity and therefore to be monitored. Taking that into account a strict monitoring process is adopted by the project proponent to observe and control the possible damages on the water quality due to changes in its hydro biological and physic-chemical characteristics such as: increase of pH, reduction of oxygen levels, increase of the salt mixture and conductivity, changes in the aquatic communities prevailing species more resistant to pollution, silting up of water streams, and changes in the water's physical aspect (odour and taste).

Another relevant environmental impact, but of difficult qualification (whether positive or negative), and which needs further scientific studies, is the changes in the pluvial regime and in the water quality of the basin. This study is applicable to the Central region of Minas Gerais state, where common characteristics of soil, climate and topography are found.

The changes in the pluvial regime and in the water quality of the micro-basin constitute a phenomenon of difficult qualification as there are no technical elements available for immediate assessment. The management of the eucalyptus plantations can either increase the water quantity of the basin or decrease, depending on the procedures adopted. Small dams may not continue to store water after the planted forests establish due to the interception of the pluvial water by the trees' crowns and reduction of superficial water flow as per soil conservation practices.

According to the study, there are two alternatives for the minimization of the possible losses caused by silviculture activities mentioned above. First, silviculture practices that effectively result in a lower erosion rate must be adopted. Second, practices of soil and water conservation also must be adopted. In order to achieve more effective control, a combination of both practices is recommended in order to prevent erosive processes and increase water infiltration rate in the soil due to the minimization of superficial flowage.

In the specific cases of the planted forests within the project activity area, the study identified the adoption of both practices mentioned above. The minimum cultivation planting technique adopted seeks to preserve the environmental integrity of the area where the project activity is implemented. It includes soil preparation techniques and monitoring of nutrients consumed in order to prevent erosion; minimum use of fertilizers as per the best practices in silviculture; and the practice of leaving the harvesting remainders in the soil to function as a protection cover, among others. The adoption of the minimum cultivation planting technique, with the reduction of soil disturbance for the planting activities and the complete elimination of fuel burning practices, has resulted in an effective solution to prevent soil's direct exposure to erosion effects. It has also promoted residual organic matter incorporation in the soil.

In relation to soil and water conservation practices, although the project activities' plantation areas are located mostly in flat lands slightly uneven, part of these areas reveal small declines but with long slopes, which increases the risks to erosion. In order to mitigate the risks, retention systems are implemented in these areas, such as the locally called "camalhões", which promotes water drainage into the stands, and the "bacias de contenção", which aims to retain sediments from the superficial flowage. In the specific case of the project activity lands, their flat and slightly uneven characteristics and the high permeability of the *latossols* promotes the prevalence of pluvial water infiltration over the superficial flowage.

In adequate conditions, eucalyptus plantations can help to control the water superficial flow. However, this effect will depend on the plant growth conditions and on the cover and declivity of the soil. As such, soil and water conservation practices adopted in the plantations management play a major role as in their absence the soil is vulnerable to erosive processes. Thus, various factors need to be considered, such as landscape and soil characteristics and, the planting

technology, including spacing used.

The eucalyptus, if sustainably managed (keeping the residues in the area and replacing the nutrients lost during the harvesting), does not damage the soil's fertility (SCOLFORO, 2008).

Public data present clear evidence that the eucalyptus plantations, in respect to the hydric balance of the river basins, do not differ from other forest species, showing a medium increase of the flow due to harvesting and a decrease of the flow due to the reforestation of the basin, of same magnitude of results as those of similar forest species (SCOLFORO, 2008)).

In addition to the environmental assessments mentioned above, the project activity area have also been certified in accordance with the FSC Principles and Criteria and audited by SCS (Scientific Certification Systems). Related documentation will be presented to the DOE, in conjunction with the Environmental & Social Impact Assessment Studies. FSC certification reports are also available on the Internet at www.scscertified.com. Overall, the referred reports conclude that the project entity is capable of implementing the project related activities within an environmentally and socially sustainable manner, provided that the recommended monitoring provisions are adequately implemented. The project activity is expected to stimulate local and regional development and has allowed the project entity to implement pioneer social and environmental indicators in its industry.

The following tables summarize monitoring and remedial measures implemented to address the most significant negative impacts referred to above.

Tables 11 and 12: Planned monitoring and remedial measures to address significant environmental impact

Impact:	**Increase of concentration of solids in suspension, nutrients and organic matter in the water streams**
Action:	Establishment of Monitoring Program of the Quality of the Superficial Water.
Justification:	The activities implemented in the project activity forest unit may modify the quality condition of the micro-basin water so as to compromise the multiple and integrated use of the water streams.
Objective:	To assess the effectiveness of the silviculture practices on the quality of the physical, chemical and bacteriological parameters of the superficial water that drains the areas of the dedicated planted forests within the project activity.
Parameters:	Physical, chemical, and bacteriological parameters of the water.
Monitoring frequency:	Based on results of laboratory samples collected twice a year, one during the dry season and the other during a rainy season. Monitoring has been in place since December 2003.
Responsible:	Plantar's Environmental Management Department

Impact:	**Changes in the pluvial regime and in the water quality of the basin**
Action:	Establishment of Monitoring Program of the Microbasin of the Riacho Fundo Stream.
Justification:	Changes in the pluvial regime of the microbasins are difficult to measure, quantify and understand as there are many technical variables that modify or change the water dynamics in a micro-basin. The land use change of great areas may increase or decrease the flowing water of the micro-basin, lower the ground water levels, or dry small dams. As such, further studies and assessments on the eucalyptus plantations effects in the project activity region are necessary.

Objective:	Developed in partnership with the Federal University of Viçosa, under the supervision of Professor Dr. Herly Carlos Teixeira Dias. It aims at monitoring the variables that interfere in the water dynamics versus the forest silviculture practices and management in a microbasin with eucalyptus plantations. The program has a minimum duration of 14 years, and will be an important tool to determine the most appropriate silviculture techniques for the region.
Parameters:	The flow variation in relation to the microbasin and local pluvial characteristics; the ground water level variation in a piezometer; an estimation of the evapotranspiration based on the use of an atmometer; superficial flow within the plantations due to effective precipitation; and the infiltration rate in different sites of the land.
Monitoring frequency:	Results are collected daily and assessment reports issued each semester. The project is currently in a fine tuning phase.
Responsible:	Plantar's Environmental Management Department

Other programs developed to mitigate or minimize the other environmental impacts are verified by the FSC certification and by the State Environment and Sustainable Development Secretary – SEMAD.

Another item subject to monitoring is the project activities' Operating Licenses. In the process to obtain the operating license for the forestry service unit MG02, the Environmental & Social Impact Assessment Studies prepared in compliance with the Brazilian environmental regulations, as provided by the *Conselho de Política Ambiental* (COPAM/MG)[85], were submitted for a technical and legal evaluation by the SEMAD.

In addition to the Environmental & Social Impact Assessment Studies, an Environmental Control Program (PCA) was submitted. The license was then judged by the council board of the COPAM/MG and granted under certain conditions.

During the validation period of the operating license, annual reports assuring the compliance with the Environmental Control Program (PCA) and with the conditions imposed must be prepared. Before the expiration date of each license, the Environmental Performance Evaluation Report (RADA) shall be prepared by a technical team and submitted in order to request the license's revalidation. The RADA report is then analyzed by the SEMAD which issues a statement to the council board of the COPAM/MG.

The monitoring of the operating license shall be executed as per details on the following table.

Table 13: Operating license for MG02 forestry service unit

Item subject to monitoring:	**Operating licenses for MG02 forestry service unit**
Objective:	Monitor the validation of the operating licenses.
Action:	Prepare report assuring the compliance with the Environmental Control Program (PCA) and with the conditions imposed for the forestry service unit within the project boundary (MG02).
Justification:	Operating licenses expire every 6 years and it is necessary to present an Environmental Performance Evaluation Report (RADA) to the State environmental body to renew them.
Parameters:	The current validation dates of the license are the following: MG02 – valid from 2005 to 2011
Monitoring	Annually

[85] Environmental Policy Council of the State of Minas Gerais

frequency:	
Responsible:	Plantar's Environmental Management Department

Also, a specific Environmental and Biodiversity Plan, tailored by the World Bank in conjunction with the project entity and local experts, is also being undertaken. The Plan consists of a series of indicators that are monitored. The establishment of the project activity's dedicated plantations under such careful control is expected to strongly contribute to sustainable development within the project region[86].

MG15 Farm

As presented in Section D.1 above, the Operating Licence for MG15 Farm is currently undergoing revalidation. Therefore, the project entity does not have the environmental body's final report and conditions, if any, for the next valid licenced period. However, it is the project entity's commitment to properly address every condition that might result from the licencing revalidation process.

The Operating License for the MG15 Farm Unit in Itacambira will be monitored under this CDM-PDD. The monitoring of the operating license shall be executed as per details on the following table.

Table 14: Operating license for MG15 forestry service unit

Item subject to monitoring:	**Operating licenses for MG15 forestry service unit**
Objective:	Monitor the validation of the operating licenses.
Action:	Prepare report assuring the compliance with the Environmental Control Program (PCA) and with the conditions imposed for the forestry service unit within the project boundary (MG15).
Justification:	Operating licenses expire every 6 years and it is necessary to present an Environmental Performance Evaluation Report (RADA) to the State environmental body to renew them.
Parameters:	The current validation dates of the license are the following: MG15 – under revalidation process
Monitoring frequency:	Annually
Responsible:	Plantar Siderúrgica Environmental and Quality Management

Process Impacts

The process to obtain the operating license for the pig iron mill require filling an Integrated Form to Characterize the Entrepreneurship (FCEI), which will determine in which category the activity is subjected. After that the company receives the Integrated Form for Basic Orientation (FOBI) in which the necessary documentation to present is detailed. In Plantar Siderúrgica's case it was necessary the submission of an Environmental Control Report (RCA)/ Environmental Control Program (PCA) to the Regional Superintendence for Environment and Sustainable Development (SUPRAM) for technical assessment, following to SEMAD, for juridical assessment. These assessments then followed to the council board of the COPAM/MG for the operating license issuing.

The monitoring of the operating license shall be executed as per details on the following table.

Table 15: Operating licenses for the pig iron mill

[86] The set of indicators and the methodology adopted by the project activity to assess the sustainable development generated by the project can be considered pioneer in the project region and industry.

Item subject to monitoring:	**Operating licenses for the pig iron mill**
Objective:	Monitor the validation of the operating licenses.
Action:	Observance of the operating licenses conditions imposed for the pig iron mill and submission of due reports.
Justification:	Environmental licence for the pig iron production unit expires every 6 years subject to one year extension. Environmental licences for pulverized charcoal injection and glendons, ladle metallurgy and casting expire every 4 years subject to one year extension.
Parameters:	The current validation dates of the licenses are the following: Pig Iron mill – valid from 2003 to 2010 (undergoing revalidation process) Pulverized charcoal injection – valid from 2007 to 2012 Tuyères, ladle metallurgy, casting – valid from 2007 to 2012
Monitoring frequency:	Annually
Responsible:	Plantar Siderúrgica's Environment and Quality Management

Plantar Siderúrgica also monitors the requirements of COPAM/MG Normative Deliberation number 49 (DN-49), issued in September 28th, 2001. This deliberation addresses the environmental control of the pig iron mills in the State of Minas Gerais.

Table 16: Normative Deliberation COPAM #49 (DN-49)

Item subject to monitoring:	**Norms under Normative Deliberation COPAM #49 (DN-49) (or any other that may replace it)**
Objective:	Monitor the observance of DN-49 requirements
Action:	Observance of requirements and submission of due reports.
Justification:	DN-49 establishes rules for the environmental control of the pig iron mills in the state, such as particulate matter emission and air quality standard, among others.
Parameters:	Biannual reports related to all items covered by DN-49
Monitoring frequency:	Biannual
Responsible:	Plantar Siderúrgica's Environment and Quality Management

It is expected that this new iron ore reduction system creates positive environmental impacts as 100% of the reducing agents used in the pig iron production will come from renewable sources.

The project activity is expected to result in positive social and environmental impacts, especially if compared to its absence and relevant measures are implemented to address the minor social and environmental impacts. The project is expected to strongly contribute to sustainable development within the project region.

SECTION E. Local stakeholder consultation

E.1. Solicitation of comments from local stakeholders

>> The project entity elicited comments from local stakeholders regarding its projects activities as an integrated project in October 2001. It encompassed contractual requisites of the World Bank and of the Forestry Certification entity, considering the three components of the iron ore reduction system project of Plantar.

During consultation, the project's documents were made available for comments in the Prototype Carbon Fund (PFC)'s website, in the UNFCCC's website and in the local offices of the project entity. The list of stakeholders consulted is presented below.

List of stakeholders that received invitation-for-comments letters during the *first* stage:

<u>**Organization / Individual**</u>
Brazilian Association of Eucalyptus Producers for Domestic Use
Curvelo citizens
Curvelo City Hall
Curvelo Humanities College (Educational Foundation of Curvelo)
FASE-ES
Folha de Curvelo - Curvelo Newspaper
Forestry State Institute
Kudokai-Brasil Association (Curvelo Unit)
Ministry of Science and Technology – Non-objection letter
Municipal School Joao Batista (Curvelo/MG)
NGO *Amigos da Terra* (Friends of the Earth)
Plantar Neighbours
Rural Workers Union of Sao Mateus (ES)
Senator Eduardo Azeredo (MG)
Silviculture Brazilian Society
State Secretary for Environmental and Sustainable Development of Minas Gerais
State Secretary for Industry and Trade of Minas Gerais
The Curvelo Hospital
The Curvelo Retailers Association (*CDL Curvelo*)
The Divine Providence Human Promotion Association / Home of the Sao Vicente de Paulo
The Environmental Defence Association of Minas Gerais (*AMDA*)
The Lions Club of Curvelo
The Minas Gerais Land Institute (*ITER-MG*)
The Minas Gerais State Secretary for the Environment and Sustainable Development
The Regional Labor Office of Curvelo (Ministry of Labor)
The Town Council of Curvelo
The Union of Rural Workers, Small Producers and Curvelo Township Employees – CUT Affiliate
World Rainforest Movement

As a second stage, the stakeholders' consultation was triggered in 16/12/2010 and invited local stakeholders' comments in regard to the proposed project activity, in compliance with the guidelines of the Interministerial Commission on Global Climate Change (CIMGC) for registration of CDM projects, Resolution No. 7 of 05 March 2008 (Art.3 Paragraphs I, II, V) and the "Handbook for Submission of Project Activities within the Scope of the CDM to the Inter-ministerial Commission on Global Climate Change aiming at obtaining a Letter of Approval from the Brazilian Government", version 2, of 01 July 2008. Registered letters with invitation for comments and a summary of the entity's environmental management plan were mailed to the official address of stakeholders listed in the DNA's Resolution mentioned above. Extra stamped envelopes for easy and free of charge mailing return were also sent.

From the date of the invitation letters' posting, the CDM-PDD was made available in Portuguese in Plantar's website www.plantar.com.br and at the project entity's headquarters at Av. Raja Gabaglia, 1380, Belo Horizonte/MG.

List of stakeholders that received invitation-for-comments letters during the *second* stage:

Cobu Citizens Association
Curvelo City Council
Curvelo City Hall
Curvelo Attorney General
ADESA - Environmental Development Association – Sete Lagoas
Estate School Sérgio Eugênio da Silva
Federal Public Prosecutor
Felixlândia City Hall
Felixlândia City Council
Curvelo and Felixlândia Public Prosecutor
Felixlândia Rural Union
Felixlândia Rural Workers Union
Fishermen Cooperative – COOPEIXE – Morada Nova de Minas
Forestry State Institute – IEF – Belo Horizonte
Forestry State Institute – Sete Lagoas
Forestry, Fish and Biodiversity Institute – AFLOBIO – Curvelo
Forestry, Fish and Biodiversity Institute – AFLOBIO – Felixlândia
Forestry, Fish and Biodiversity Institute – AFLOBIO – Morada Nova de Minas
Meleiro Citizens Association
Minas Gerais State Public Prosecutor
Morada Nova de Minas City Council
Morada Nova de Minas City Hall
Morada Nova de Minas Community Leader
Morada Nova de Minas Municipal Counsel of Environmental Defense and Conservation - CODEMA
Morada Nova de Minas Public Prosecutor
Morada Nova de Minas Rural Producers Union
Curvelo Rural Workers Union
Municipal School Duque de Caxias
Municipal School João Batista
Municipal School Pedro Epifânio (Felixlândia/MG)
FBOMS - NGOs and Social Movements Brazilian Forum for the Environment
Parents and Friends of the Exceptional Children Association – APAE
Paulo de Tarso Religous House
Rural Producers and Citizens of Traçadal and region Association – AMPTRE
São José Operário Association Sete Lagoas
Sete Lagoas City Council
Sete Lagoas City Hall
Sete Lagoas Municipal Counsel of Environmental Defence and Conservation - CODEMA
Sete Lagoas Public Prosecutor
Municipal School Dom Orione – Morada Nova de Minas
Advisete –Association for the Blind of Sete Lagoas

AMPCAR - Rural Producers and Citizens of Cacimbas and Region Association

On 06/06/2011 a supplementary stakeholder consultation was carried out in the municipalities of Bocaiuva, Juramento, Itacambira, Grão Mogol and Francisco Sá due the insertion of additional areas into the project boundary.

List of stakeholders that received invitation-for-comments letters during the *supplementary* stage:

Itacambira City Hall
Juramento City Hall
Bocaiúva City Hall
Grão Mogol City Hall
Francisco Sá City Hall
Itacambira City Council
Juramento City Council
Bocaiúva City Council
Grão Mogol City Council
Francisco Sá City Council
Itacambira Rural Workers Union
Juramento Rural Workers Union
Bocaiúva Rural Workers Union
Grão Mogol Rural Workers Union
Francisco Sá Rural Workers Union
Congonhas Community Development Council
Venda Nova Rural Producers Association
Juramento Young Producers Association
Barreirinho Community Development Association
Santa Cruz Community Development Association
Nova Tolda Community Association
Buritis Community Association
Rio das Pedras Community Association

E.2. Summary of comments received

>> As a response to the first consultation most of the comments received regarding the iron ore reduction system project activities emphasize the importance of the project for sustainable development at the local, regional and national levels, recognizing the project's GHG emission reduction potentials. Other comments have raised concerns on the sustainability of large-scale eucalyptus plantations.

As a response to the second consultation the PE received four replies congratulating the initiative, emphasizing the importance of the project sustainable development. Two of these comments wished success and praised the PE for its social and environmental policies.

E.3. Report on consideration of comments received

>> Regarding the comments received in the first consultation, the project participants have addressed the GHG related comments as per responses and reports made publicly available on the World Bank's Prototype Carbon Fund Website and, also, in several public presentations carried out by the project entity and by the PCF over the past years. Other comments related to the social and environmental aspects of eucalyptus plantations have been addressed by means of the socio-environmental impact assessment studies and of the forestry certification reports available at www.scscertified.com. Accordingly, the related documentation will be presented to the DOE. The Participant Committee of the PCF has also provided detailed replies. The comments and replies are posted at www.prototypecarbonfund.org for public review.

As all comments in the second stage stated the project's relevancy and none of them demanded any further clarification, the comments were received and archived.

SECTION F. Approval and authorization

>> The letters of approval from Parties for the project activity were available at the time of submitting the PDD to the DOE for validation.

Appendix 1. Contact information of project participants and responsible persons/ entities

Project participant and/or responsible person/ entity	☒ Project participant ☐ Responsible person/ entity for application of the selected methodology (ies) and, where applicable, the selected standardized baselines to the project activity
Organization name	Plantar
Street/P.O. Box	Av. Raja Gabaglia, 1380, Gutierrez
Building	Plantar
City	Belo Horizonte
State/Region	Minas Gerais
Postcode	30.440-194
Country	Brazil
Telephone	55 31 3290 4088
Fax	55 31 3290 4087
E-mail	plantarcarbon@plantar.com.br
Website	http://www.plantar.com.br
Contact person	Geraldo Alves de Moura
Title	Business and Financial Director
Salutation	Mr.
Last name	Moura
Middle name	Alves de
First name	Geraldo
Department	
Mobile	
Direct fax	55 31 3290 4087
Direct tel.	55 31 3290 4088
Personal e-mail	plantarcarbon@plantar.com.br

Project participant and/or responsible person/ entity	☒ Project participant ☐ Responsible person/ entity for application of the selected methodology (ies) and, where applicable, the selected standardized baselines to the project activity
Organization name	Plantar Siderúrgica
Street/P.O. Box	Av. Raja Gabaglia, 1380, Gutierrez
Building	Plantar
City	Belo Horizonte
State/Region	Minas Gerais
Postcode	30.440-194
Country	Brazil
Telephone	55 31 3290 4088
Fax	55 31 3290 4087

E-mail	plantarcarbon@plantar.com.br
Website	http://www.plantar.com.br
Contact person	Geraldo Alves de Moura
Title	Business and Financial Director
Salutation	Mr.
Last name	Moura
Middle name	Alves de
First name	Geraldo
Department	
Mobile	
Direct fax	55 31 3290 4087
Direct tel.	55 31 3290 4088
Personal e-mail	plantarcarbon@plantar.com.br

Project participant and/or responsible person/ entity	☒ Project participant ☒ Responsible person/ entity for application of the selected methodology (ies) and, where applicable, the selected standardized baselines to the project activity
Organization name	Plantar Carbon Ambiental
Street/P.O. Box	Av. Raja Gabaglia, 1380, Gutierrez
Building	Plantar
City	Belo Horizonte
State/Region	Minas Gerais
Postcode	30.440-194
Country	Brazil
Telephone	55 31 3290 4088
Fax	55 31 3290 4087
E-mail	plantarcarbon@plantar.com.br
Website	http://www.plantar.com.br
Contact person	Geraldo Alves de Moura
Title	Business and Financial Director
Salutation	Mr.
Last name	Moura
Middle name	Alves de
First name	Geraldo
Department	
Mobile	
Direct fax	55 31 3290 4087
Direct tel.	55 31 3290 4088
Personal e-mail	plantarcarbon@plantar.com.br

Project participant and/or responsible person/ entity	☒ Project participant ☐ Responsible person/ entity for application of the selected methodology (ies) and, where applicable, the selected standardized baselines to the project activity
Organization name	International Bank for Reconstruction and Development as Trustee of the Prototype Carbon Fund
Street/P.O. Box	H St NW
Building	1818
City	Washington. DC.
State/Region	District of Columbia
Postcode	20433
Country	USA
Telephone	202-458-1873
Fax	202-522-7432
E-mail	IBRD-carbonfinance@worldbank.org
Website	http://carbonfinance.org
Contact person	Joelle Chassard
Title	Manager
Salutation	Ms.
Last name	Chassard
Middle name	
First name	Joelle
Department	
Mobile	
Direct fax	202-522-7432
Direct tel.	202-458-1873
Personal e-mail	Jchassard@worldbank.org

Project participant and/or responsible person/ entity	☒ Project participant ☐ Responsible person/ entity for application of the selected methodology (ies) and, where applicable, the selected standardized baselines to the project activity
Organization name	Netherlands' Ministry of Infrastructure and the Environment (IenM)
Street/P.O. Box	Rijnstraat 8
Building	
City	The Hague
State/Region	
Postcode	2515 XP
Country	The Netherlands
Telephone	0031-70-339.5199
Fax	0031-70-339.1306
E-mail	cdm.dna@minvrom.nl
Website	
Contact person	Mr. Maas Goote

Title	Deputy Director for International Environmental Affairs
Salutation	Mr.
Last name	Goote
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First name	Maas
Department	Directorate of International Environmental Affairs
Mobile	
Direct fax	+31-70-339.1306
Direct tel.	+31-70-339.5199
Personal e-mail	cdm.dna@minvrom.nl

Appendix 2. Affirmation regarding public funding

The project does not involve Official Development Assistance (ODA) and other sources of public funding from Annex 1 countries.

Appendix 3. Applicability of methodology and standardized baseline

Please refer to the Section B.1 of the PDD.

Appendix 4. Further background information on ex ante calculation of emission reductions

In accordance with the Baseline Methodology, the determination of the baseline emissions was based on the total carbon content (percentage) in the reducing agent, the quantity of reducing agent necessary to produce one ton of hot metal and the total carbon fixed that remains in the hot metal produced.

The amounts of carbon content and of reducing agent used in the production of pig iron are used to calculate the baseline emissions factor presented in section B.6.1 (see table below). The carbon fixed in the pig iron is also accounted for and then used to calculate the total CO_2 equivalent that remains fixed in the hot metal. These values are then applied to the Baseline Emission calculations as presented in Section B.6.1.
Summarized results are presented in section B.6.1. All calculations were performed in compliance with the equations set forth in this CDM-PDD. Detailed registries are stored and will be made available to the DOE at validation.

Input Data Summary for Estimation of Baseline Emissions in the Hot Metal Production Process in the iron ore reduction system.

Process Emissions		
Parameter	**Input**	**Data**
$P_{PJ,y}$	Annual hot metal production (ton)	240,000

$RA_{BL, i}$	Amount of coal coke to produce one ton of hot metal (t of coal coke/ t of hot metal) (capped according to AM0082)	0.358
	Amount of pulverized coal necessary to produce one ton of hot metal (t pulverized coal/ t hot metal)	0.170
$\%C_{BL,i}$	% of carbon content in coal coke	87.05%
	% of carbon content in pulverized coal	78.90%
$EF_{Ind, BL}$	Baseline emissions factor (tCO_2e)	1.6345
$\%C_{HM, BL, y}$	% of carbon residual in the hot metal	0%
Upstream Emissions		
Parameter	**Input**	**Data**
$P_{PJ, y}$	Annual hot metal production (ton)	240,000
$EF_{CO2e, coal\ coke, BL, y}$	Emission factor to produce one tonne of coal coke (tCO_2/ t coal coke)	0.537
Transport Emissions		
Parameter	**Input**	**Data**
$EF_{v, km, CO2, BL, y}$	CO_2 Emission factor for the type *v* of vehicle during year *y* (tCO_2e/km)	0.02589
$N_{V, BL, y}$	Number of round trips per type *v* of vehicle during year *y*	45.99
$AVD_{j, BL, y}$	Average round trip distance (km)	600

Appendix 5. Further background information on monitoring plan

Farm Unit	PROJECT	STAND ID NUMBER	AREA (ha)
MG02	Campo Alegre	01	12.68
MG02	Campo Alegre	01A	0.92
MG02	Campo Alegre	02	9.25
MG02	Campo Alegre	02A	2.81
MG02	Campo Alegre	02B	2.15
MG02	Campo Alegre	03	18.74
MG02	Campo Alegre	05	2.44
MG02	Campo Alegre	07	17.73
MG02	Campo Alegre	08	3.69
MG02	Campo Alegre	09	13.00
MG02	Campo Alegre	10	23.88
MG02	Campo Alegre	11	14.79
MG02	Campo Alegre	14	24.45
MG02	Campo Alegre	15	23.91
MG02	Campo Alegre	16	34.93
MG02	Campo Alegre	17	25.36
MG02	Campo Alegre	18	39.28
MG02	Campo Alegre	19	13.00
MG02	Campo Alegre	20	13.65
MG02	Campo Alegre	21	27.63
MG02	Campo Alegre	23	25.25
MG02	Campo Alegre	24	30.15
MG02	Campo Alegre	25	35.04
MG02	Campo Alegre	26	45.42

MG02	Campo Alegre	27	8.98
MG02	Campo Alegre	28	17.94
MG02	Campo Alegre	28A	0.72
MG02	Campo Alegre	29	6.71
MG02	Campo Alegre	29A	2.41
MG02	Campo Alegre	30	28.13
MG02	Campo Alegre	31	35.66
MG02	Campo Alegre	32	30.03
MG02	Campo Alegre	33	8.07
MG02	Campo Alegre	34	14.92
MG02	Campo Alegre	38	26.45
MG02	Campo Alegre	39	25.62
MG02	Campo Alegre	40	6.47
MG02	Campo Alegre	41	11.84
MG02	Campo Alegre	42	5.26
MG02	Campo Alegre	43	13.47
MG02	Campo Alegre	44	20.56
MG02	Campo Alegre	49	33.46
MG02	Campo Alegre	50	27.46
MG02	Campo Alegre	54	46.49
MG02	Campo Alegre	55	54.51
MG02	Campo Alegre	57	27.60
MG02	Campo Alegre	58	55.85
MG02	Campo Alegre	59	44.14
MG02	Campo Alegre	60	25.51
MG02	Campo Alegre	61	8.37
MG02	Campo Alegre	62	10.78
MG02	Campo Alegre	63	24.99
MG02	Campo Alegre	63A	4.88
MG02	Campo Alegre	64	36.74
MG02	Campo Alegre	65	37.64
MG02	Campo Alegre	66	10.11
MG02	Campo Alegre	67	13.51
MG02	Campo Alegre	68	35.67
MG02	Campo Alegre	69	9.47
MG02	Campo Alegre	70	30.29
MG02	Campo Alegre	71	27.81
MG02	Campo Alegre	72	22.07
MG02	Campo Alegre	73	6.75
MG02	Campo Alegre	74	23.00
MG02	Campo Alegre	75	29.01
MG02	Campo Alegre	76	22.94
MG02	Campo Alegre	77	25.12
MG02	Campo Alegre	78	27.06
MG02	Campo Alegre	79	15.26
MG02	Campo Alegre	80	20.10
MG02	Campo Alegre	81	10.44
MG02	Campo Alegre	82	5.22
MG02	Campo Alegre	83	3.01
MG02	Falcão	01	44.37
MG02	Falcão	02	35.89
MG02	Falcão	03	13.07
MG02	Falcão	03A	19.36
MG02	Falcão	03B	1.12

MG02	Falcão	04	21.41
MG02	Falcão	05	6.06
MG02	Falcão	07	52.59
MG02	Falcão	10	34.07
MG02	Falcão	13	13.08
MG02	Falcão	14	12.08
MG02	Falcão	18	39.13
MG02	Falcão	19	46.11
MG02	Falcão	20	22.81
MG02	Falcão	22	12.09
MG02	Falcão	27	2.01
MG02	Falcão	31	17.99
MG02	Falcão	32	27.30
MG02	Falcão	34	27.97
MG02	Falcão	34A	8.10
MG02	Falcão	35	28.99
MG02	Falcão	36	28.69
MG02	Falcão	37	37.55
MG02	Falcão	38	40.54
MG02	Falcão	39	36.65
MG02	Falcão	40	38.43
MG02	Falcão	41	41.05
MG02	Falcão	42	2.88
MG02	Falcão	46	40.21
MG02	Falcão	55	41.35
MG02	Falcão	56	39.90
MG02	Falcão	57	36.43
MG02	Falcão	58	41.22
MG02	Falcão	59	15.34
MG02	Falcão	59A	0.90
MG02	Falcão	61	38.22
MG02	Falcão	62	41.78
MG02	Falcão	63	35.37
MG02	Falcão	64	40.62
MG02	Falcão	65	40.85
MG02	Falcão	73	11.48
MG02	Falcão	77	21.33
MG02	Falcão	82	11.85
MG02	Falcão	83	12.58
MG02	Falcão	84	5.11
MG02	Falcão	85	39.25
MG02	Falcão	86	49.17
MG02	Falcão	90	5.04
MG02	Falcão	95	7.84
MG02	Jaboticaba	01	24.65
MG02	Jaboticaba	02	15.40
MG02	Jaboticaba	03	35.89
MG02	Jaboticaba	05	33.34
MG02	Jaboticaba	07	27.93
MG02	Jaboticaba	08	33.90
MG02	Jaboticaba	09	6.11
MG02	Jaboticaba	10	34.91
MG02	Jaboticaba	11	48.84
MG02	Jaboticaba	13	9.44

MG02	Jaboticaba	14	1.17
MG02	Jaboticaba	16	23.69
MG02	Jaboticaba	17A	13.30
MG02	Jaboticaba	19	37.76
MG02	Jaboticaba	20	22.45
MG02	Jaboticaba	22	16.49
MG02	Jaboticaba	24	52.17
MG02	Jaboticaba	24A	10.81
MG02	Jaboticaba	25	19.05
MG02	Jaboticaba	26A	0.19
MG02	Jaboticaba	27	33.72
MG02	Jaboticaba	28	27.91
MG02	Jaboticaba	29	20.49
MG02	Jaboticaba	30	36.90
MG02	Lagoa do Capim	01	29.56
MG02	Lagoa do Capim	02	36.23
MG02	Lagoa do Capim	03	40.86
MG02	Lagoa do Capim	04	38.48
MG02	Lagoa do Capim	05	40.31
MG02	Lagoa do Capim	06	41.62
MG02	Lagoa do Capim	07	34.38
MG02	Lagoa do Capim	08	23.95
MG02	Lagoa do Capim	09	40.80
MG02	Lagoa do Capim	10	40.71
MG02	Lagoa do Capim	11	37.01
MG02	Lagoa do Capim	12	28.57
MG02	Lagoa do Capim	13	29.67
MG02	Lagoa do Capim	14	27.10
MG02	Lagoa do Capim	16	31.75
MG02	Lagoa do Capim	17	35.99
MG02	Lagoa do Capim	18	20.63
MG02	Lagoa do Capim	20	25.36
MG02	Lagoa do Capim	21	27.15
MG02	Lagoa do Capim	23	9.42
MG02	Lagoa do Capim	27	34.51
MG02	Lagoa do Capim	30	24.71
MG02	Lagoa do Capim	31	46.56
MG02	Lagoa do Capim	32	46.13
MG02	Lagoa do Capim	34	48.84
MG02	Lagoa do Capim	35	24.48
MG02	Lagoa do Capim	35A	24.26
MG02	Lagoa do Capim	37	24.64
MG02	Lagoa do Capim	38	32.92
MG02	Lagoa do Capim	39	17.62
MG02	Lagoa do Capim	40	20.19
MG02	Lagoa do Capim	42	7.19
MG02	Lagoa do Capim	43	9.25
MG02	Lagoa do Capim	44	9.88
MG02	Lagoa do Capim	45A	1.55
MG02	Lagoa do Capim	46	28.48
MG02	Lagoa do Capim	49	49.38
MG02	Lagoa do Capim	51A	24.91
MG02	Lagoa do Capim	53	23.63
MG02	Lagoa do Capim	54	39.06

MG02	Lagoa do Capim	54A	10.03
MG02	Lagoa do Capim	55	48.61
MG02	Lagoa do Capim	56	23.86
MG02	Lagoa do Capim	57	48.60
MG02	Lagoa do Capim	58	48.55
MG02	Lagoa do Capim	59	25.76
MG02	Lagoa do Capim	60	31.94
MG02	Lagoa do Capim	61	29.23
MG02	Meleiro	01	5.62
MG02	Meleiro	02	23.52
MG02	Meleiro	03	33.92
MG02	Meleiro	03A	4.25
MG02	Meleiro	04	38.87
MG02	Meleiro	04A	7.00
MG02	Meleiro	05	14.34
MG02	Meleiro	05A	3.20
MG02	Meleiro	06	22.07
MG02	Meleiro	06A	16.81
MG02	Meleiro	07	14.48
MG02	Meleiro	08	21.90
MG02	Meleiro	09	35.22
MG02	Meleiro	09A	3.20
MG02	Meleiro	10	34.27
MG02	Meleiro	11	13.85
MG02	Meleiro	11A	9.64
MG02	Meleiro	12	24.01
MG02	Meleiro	12A	0.58
MG02	Meleiro	13	20.21
MG02	Meleiro	14	12.97
MG02	Meleiro	15	22.81
MG02	Meleiro	16	23.36
MG02	Meleiro	17	17.09
MG02	Meleiro	18	15.62
MG02	Meleiro	19	40.11
MG02	Meleiro	20	41.25
MG02	Meleiro	21	22.62
MG02	Meleiro	22	31.13
MG02	Meleiro	23	30.23
MG02	Meleiro	24	8.58
MG02	Meleiro	24A	9.91
MG02	Meleiro	25	3.20
MG02	Meleiro	26	23.87
MG02	Meleiro	27	20.03
MG02	Meleiro	28	26.16
MG02	Meleiro	28A	5.41
MG02	Meleiro	29	31.59
MG02	Meleiro	30	21.91
MG02	Meleiro	31	36.91
MG02	Meleiro	32	12.84
MG02	Meleiro	33	41.73
MG02	Meleiro	34	52.82
MG02	Meleiro	35	28.62
MG02	Meleiro	35A	18.55
MG02	Meleiro	36	40.54

MG02	Meleiro	37	33.85
MG02	Meleiro	38	18.76
MG02	Meleiro	39	22.84
MG02	Meleiro	40	47.90
MG02	Meleiro	41	12.18
MG02	Meleiro	42	2.81
MG02	Meleiro	43	20.19
MG02	Meleiro	44	19.77
MG02	Meleiro	45	11.48
MG02	Meleiro	46	25.48
MG02	Meleiro	47	16.52
MG02	Meleiro	48	34.96
MG02	Meleiro	49	22.05
MG02	Meleiro	50	43.32
MG02	Meleiro	51	19.15
MG02	Meleiro	52	23.41
MG02	Meleiro	53	46.62
MG02	Meleiro	54	40.39
MG02	Meleiro	55	23.28
MG02	Meleiro	56	22.48
MG02	Meleiro	57	3.70
MG02	Meleiro	58	20.61
MG02	Meleiro	58A	6.44
MG02	Meleiro	59	9.94
MG02	Meleiro	60	36.22
MG02	Meleiro	61	35.10
MG02	Meleiro	62	15.79
MG02	Meleiro	63	16.48
MG02	Meleiro	64	25.70
MG02	Meleiro	65	37.83
MG02	Meleiro	65A	3.61
MG02	Meleiro	66	28.20
MG02	Meleiro	67	14.21
MG02	Meleiro	68	4.83
MG02	Meleiro	68A	2.86
MG02	Meleiro	69	5.32
MG02	Meleiro	70	22.53
MG02	Meleiro	71	30.58
MG02	Meleiro	72	32.14
MG02	Meleiro	73	11.37
MG02	Meleiro	74	17.77
MG02	Meleiro	75	33.76
MG02	Meleiro	76	35.98
MG02	Meleiro	77	40.93
MG02	Meleiro	78	31.87
MG02	Meleiro	79	6.56
MG02	Meleiro	80	11.38
MG02	Meleiro	80A	3.51
MG02	Meleiro	81	24.92
MG15	Aeroporto	198	21.45
MG15	Aeroporto	199	49.32
MG15	Aeroporto	200	36.42
MG15	Aeroporto	202	38.50

MG15	Aeroporto	203	0.04
MG15	Aeroporto	204	39.14
MG15	Aeroporto	205	39.38
MG15	Aeroporto	206	38.45
MG15	Aeroporto	207	38.39
MG15	Aeroporto	208	18.74
MG15	Aeroporto	209	43.06
MG15	Aeroporto	210	39.47
MG15	Aeroporto	211	39.45
MG15	Aeroporto	212	39.24
MG15	Aeroporto	213	32.38
MG15	Aeroporto	325	47.03
MG15	Aeroporto	326	16.85
MG15	Aeroporto	327	39.94
MG15	Aeroporto	328	31.35
MG15	Aeroporto	329	12.39
MG15	Aeroporto	330	39.73
MG15	Aeroporto	331	34.72
MG15	Aeroporto	332	13.95
MG15	Aeroporto	333	18.69
MG15	Aeroporto	334	22.52
MG15	Aeroporto	335	39.75
MG15	Aeroporto	336	29.59
MG15	Aeroporto	337	23.50
MG15	Aeroporto	338	21.12
MG15	Aeroporto	339	10.77
MG15	Aeroporto	340	21.39
MG15	Aeroporto	341	40.01
MG15	Aeroporto	342	40.73
MG15	Aeroporto	343	10.62
MG15	Aeroporto	344	24.23
MG15	Aeroporto	345	37.29
MG15	Aeroporto	346	38.24
MG15	Aeroporto	347	25.20
MG15	Aeroporto	348	18.10
MG15	Aeroporto	349	17.95
MG15	Aeroporto	350	12.83
MG15	Aeroporto	351	16.74
MG15	Aeroporto	352	5.30
MG15	Aeroporto	353	12.96
MG15	Aeroporto	354	14.05
MG15	Aeroporto	355	24.38
MG15	Aeroporto	356	10.98
MG15	Aeroporto	357	14.65
MG15	Aeroporto	358	19.99
MG15	Aeroporto	360	12.76

MG15	Aeroporto	361	30.28
MG15	Aeroporto	362	28.62
MG15	Aeroporto	363	24.96
MG15	Aeroporto	364	20.42
MG15	Aeroporto	365	40.11
MG15	Aeroporto	366	34.85
MG15	Aeroporto	367	26.91
MG15	Aeroporto	368	40.18
MG15	Aeroporto	369	34.73
MG15	Aeroporto	370	18.69
MG15	Aeroporto	371	37.15
MG15	Aeroporto	372	22.78
MG15	Aeroporto	472	18.84
MG15	Aeroporto	473	41.06
MG15	Aeroporto	497	34.70
MG15	Aeroporto	498	47.26
MG15	Aeroporto	499	38.71
MG15	Aeroporto	500	48.83
MG15	Aeroporto	501	49.94
MG15	Aeroporto	502	42.31
MG15	Aeroporto	503	49.10
MG15	Aeroporto	504	48.29
MG15	Aeroporto	505	23.17
MG15	Aeroporto	506	34.32
MG15	Aeroporto	524	16.01
MG15	Aeroporto	525	36.05
MG15	Aeroporto	526	25.59
MG15	Aeroporto	527	35.99
MG15	Aeroporto	528	33.71
MG15	Aeroporto	529	44.83
MG15	Aeroporto	530	44.38
MG15	Aeroporto	531	40.24
MG15	Aeroporto	532	41.07
MG15	Aeroporto	533	36.50
MG15	Aeroporto	534	40.41
MG15	Aeroporto	535	40.21
MG15	Aeroporto	536	30.12
MG15	Aeroporto	537	28.42
MG15	Aeroporto	538	34.39
MG15	Aeroporto	539	18.73
MG15	Aeroporto	540	29.60
MG15	Aeroporto	541	8.37
MG15	Aeroporto	201A	15.91
MG15	Aeroporto	201B	6.07
MG15	Aeroporto	362A	3.23
MG15	Aeroporto	362B	0.27

MG15	Agua Preta	617	21.36
MG15	Agua Preta	618	25.20
MG15	Agua Preta	619	47.09
MG15	Agua Preta	620	17.52
MG15	Agua Preta	621	34.23
MG15	Agua Preta	622	12.13
MG15	Agua Preta	623	8.84
MG15	Agua Preta	624	22.43
MG15	Agua Preta	625	44.01
MG15	Agua Preta	626	7.97
MG15	Agua Preta	627	44.19
MG15	Agua Preta	628	46.09
MG15	Agua Preta	629	47.19
MG15	Agua Preta	630	49.42
MG15	Agua Preta	631	11.43
MG15	Agua Preta	632	31.45
MG15	Agua Preta	633	17.61
MG15	Agua Preta	634	47.96
MG15	Agua Preta	635	23.62
MG15	Agua Preta	636	5.86
MG15	Agua Preta	637	7.03
MG15	Agua Preta	638	24.66
MG15	Agua Preta	640	36.68
MG15	Agua Preta	641	19.44
MG15	Agua Preta	642	6.19
MG15	Agua Preta	643	0.49
MG15	Agua Preta	644	20.66
MG15	Agua Preta	645	17.89
MG15	Agua Preta	646	25.70
MG15	Agua Preta	647	11.64
MG15	Agua Preta	648	21.27
MG15	Agua Preta	649	48.41
MG15	Agua Preta	650	47.87
MG15	Agua Preta	651	13.62
MG15	Agua Preta	652	32.10
MG15	Agua Preta	654	2.71
MG15	Agua Preta	655	38.69
MG15	Agua Preta	656	48.18
MG15	Agua Preta	657	47.48
MG15	Agua Preta	658	47.78
MG15	Agua Preta	659	32.66
MG15	Agua Preta	660	3.52
MG15	Agua Preta	661	8.22
MG15	Agua Preta	662	34.95
MG15	Agua Preta	663	17.13
MG15	Agua Preta	664	48.20

MG15	Agua Preta	665	45.88
MG15	Agua Preta	666	30.58
MG15	Agua Preta	667	22.39
MG15	Agua Preta	668	41.67
MG15	Agua Preta	669	47.98
MG15	Agua Preta	670	6.55
MG15	Agua Preta	671	39.98
MG15	Agua Preta	672	48.11
MG15	Agua Preta	673	39.99
MG15	Agua Preta	674	38.66
MG15	Agua Preta	675	26.23
MG15	Agua Preta	676	48.14
MG15	Agua Preta	677	24.15
MG15	Agua Preta	678	43.79
MG15	Agua Preta	679	33.69
MG15	Agua Preta	680	32.14
MG15	Agua Preta	681	16.98
MG15	Agua Preta	683	13.23
MG15	Agua Preta	684	16.58
MG15	Agua Preta	685	6.25
MG15	Agua Preta	686	45.92
MG15	Agua Preta	687	47.24
MG15	Agua Preta	688	12.76
MG15	Agua Preta	689	10.42
MG15	Agua Preta	690	3.94
MG15	Agua Preta	691	21.32
MG15	Agua Preta	692	4.75
MG15	Agua Preta	693	7.52
MG15	Agua Preta	694	15.35
MG15	Agua Preta	695	14.96
MG15	Agua Preta	697	5.19
MG15	Agua Preta	698	11.68
MG15	Agua Preta	699	11.68
MG15	Agua Preta	700	12.27
MG15	Agua Preta	701	14.86
MG15	Agua Preta	702	15.70
MG15	Agua Preta	703	15.32
MG15	Agua Preta	704	20.14
MG15	Agua Preta	666A	0.62
MG15	Agua Preta	695A	12.54
MG15	Agua Preta	617	21.36
MG15	Agua Preta	618	25.20
MG15	Agua Preta	619	47.09
MG15	Castelo	1	38.38
MG15	Castelo	2	15.67
MG15	Castelo	3	30.25

MG15	Castelo	4	32.39
MG15	Castelo	5	49.76
MG15	Castelo	6	33.86
MG15	Castelo	7	30.69
MG15	Castelo	8	21.96
MG15	Castelo	9	46.80
MG15	Castelo	10	35.60
MG15	Castelo	11	28.46
MG15	Castelo	12	24.58
MG15	Castelo	13	40.16
MG15	Castelo	14	40.26
MG15	Castelo	15	28.00
MG15	Castelo	16	37.11
MG15	Castelo	17	20.42
MG15	Castelo	18	17.15
MG15	Castelo	19	52.35
MG15	Castelo	20	42.75
MG15	Castelo	21	41.39
MG15	Castelo	22	15.93
MG15	Castelo	23	13.06
MG15	Castelo	24	10.01
MG15	Castelo	25	43.85
MG15	Castelo	26	16.60
MG15	Castelo	27	36.75
MG15	Castelo	28	39.89
MG15	Castelo	29	40.31
MG15	Castelo	30	38.72
MG15	Castelo	31	19.01
MG15	Castelo	32	15.13
MG15	Castelo	34	45.79
MG15	Castelo	35	29.27
MG15	Castelo	36	25.28
MG15	Castelo	37	33.75
MG15	Castelo	38	24.19
MG15	Castelo	39	14.06
MG15	Castelo	40	5.66
MG15	Castelo	41	20.60
MG15	Castelo	42	40.84
MG15	Castelo	43	40.00
MG15	Castelo	44	37.20
MG15	Castelo	45	27.40
MG15	Castelo	46	32.20
MG15	Castelo	47	10.90
MG15	Castelo	48	17.34
MG15	Castelo	49	36.38
MG15	Castelo	50	42.61

MG15	Castelo	51	39.08
MG15	Castelo	52	38.16
MG15	Castelo	53	33.58
MG15	Castelo	54	39.64
MG15	Castelo	55	38.89
MG15	Castelo	56	39.51
MG15	Castelo	57	39.89
MG15	Castelo	58	39.14
MG15	Castelo	59	39.82
MG15	Castelo	60	39.21
MG15	Castelo	61	39.41
MG15	Castelo	62	39.26
MG15	Castelo	63	39.12
MG15	Castelo	64	35.76
MG15	Castelo	65	18.99
MG15	Castelo	66	15.05
MG15	Castelo	67	12.78
MG15	Castelo	68	19.66
MG15	Castelo	69	33.13
MG15	Castelo	71	1.47
MG15	Castelo	72	25.75
MG15	Castelo	73	39.03
MG15	Castelo	74	25.51
MG15	Castelo	75	26.72
MG15	Castelo	76	27.56
MG15	Castelo	77	37.98
MG15	Castelo	78	39.29
MG15	Castelo	79	39.71
MG15	Castelo	80	38.89
MG15	Castelo	81	39.89
MG15	Castelo	82	40.44
MG15	Castelo	83	22.04
MG15	Castelo	84	40.74
MG15	Castelo	85	36.72
MG15	Castelo	86	19.17
MG15	Castelo	87	20.96
MG15	Castelo	88	24.64
MG15	Castelo	89	26.70
MG15	Castelo	90	24.46
MG15	Castelo	91	35.32
MG15	Castelo	92	33.36
MG15	Castelo	93	44.14
MG15	Castelo	94	39.24
MG15	Castelo	95	32.69
MG15	Castelo	96	40.22
MG15	Castelo	97	28.81

MG15	Castelo	98	27.37
MG15	Castelo	99	22.80
MG15	Castelo	100	20.33
MG15	Castelo	101	18.40
MG15	Castelo	102	32.68
MG15	Castelo	103	36.49
MG15	Castelo	104	25.72
MG15	Castelo	105	15.97
MG15	Castelo	106	33.56
MG15	Castelo	22A	24.11
MG15	Castelo	23A	24.94
MG15	Castelo	24A	13.48
MG15	Castelo	25A	9.76
MG15	Castelo	33A	10.47
MG15	Castelo	33B	3.55
MG15	Castelo	45A	16.47
MG15	Castelo	47A	18.37
MG15	Castelo	78A	3.74
MG15	Castelo	83A	17.55
MG15	Castelo	92A	5.85
MG15	Pindaíbas	220	20.40
MG15	Pindaíbas	221	12.46
MG15	Pindaíbas	222	30.16
MG15	Pindaíbas	223	22.61
MG15	Pindaíbas	224	31.14
MG15	Pindaíbas	225	18.59
MG15	Pindaíbas	226	43.09
MG15	Pindaíbas	227	10.30
MG15	Pindaíbas	228	48.85
MG15	Pindaíbas	229	10.28
MG15	Pindaíbas	230	25.50
MG15	Pindaíbas	231	18.54
MG15	Pindaíbas	232	29.96
MG15	Pindaíbas	233	27.83
MG15	Pindaíbas	234	27.73
MG15	Pindaíbas	235	39.76
MG15	Pindaíbas	236	39.90
MG15	Pindaíbas	237	39.39
MG15	Pindaíbas	238	35.70
MG15	Pindaíbas	239	18.11
MG15	Pindaíbas	240	29.21
MG15	Pindaíbas	241	39.65
MG15	Pindaíbas	242	40.12
MG15	Pindaíbas	243	40.13
MG15	Pindaíbas	244	33.92
MG15	Pindaíbas	245	7.83

MG15	Pindaíbas	246	25.77
MG15	Pindaíbas	247	39.03
MG15	Pindaíbas	248	37.45
MG15	Pindaíbas	249	38.09
MG15	Pindaíbas	250	29.09
MG15	Pindaíbas	251	26.15
MG15	Pindaíbas	252	33.73
MG15	Pindaíbas	253	4.57
MG15	Pindaíbas	254	17.18
MG15	Pindaíbas	255	24.91
MG15	Pindaíbas	256	49.29
MG15	Pindaíbas	257	26.25
MG15	Pindaíbas	258	14.73
MG15	Pindaíbas	259	24.48
MG15	Pindaíbas	260	23.69
MG15	Pindaíbas	261	29.91
MG15	Pindaíbas	262	28.93
MG15	Pindaíbas	263	22.86
MG15	Pindaíbas	264	33.93
MG15	Pindaíbas	265	5.21
MG15	Pindaíbas	266	40.24
MG15	Pindaíbas	267	15.95
MG15	Pindaíbas	268	29.43
MG15	Pindaíbas	269	31.33
MG15	Pindaíbas	270	11.88
MG15	Pindaíbas	271	17.70
MG15	Pindaíbas	272	7.72
MG15	Pindaíbas	273	40.85
MG15	Pindaíbas	274	40.31
MG15	Pindaíbas	275	38.51
MG15	Pindaíbas	276	6.20
MG15	Pindaíbas	277	28.78
MG15	Pindaíbas	278	17.83
MG15	Pindaíbas	279	29.79
MG15	Pindaíbas	280	40.17
MG15	Pindaíbas	281	39.10
MG15	Pindaíbas	282	34.50
MG15	Pindaíbas	283	15.41
MG15	Pindaíbas	284	20.18
MG15	Pindaíbas	285	10.35
MG15	Pindaíbas	286	31.88
MG15	Pindaíbas	287	38.85
MG15	Pindaíbas	288	35.62
MG15	Pindaíbas	289	38.86
MG15	Pindaíbas	290	14.64
MG15	Pindaíbas	291	35.72

MG15	Pindaíbas	292	29.62
MG15	Pindaíbas	293	24.16
MG15	Pindaíbas	294	13.23
MG15	Pindaíbas	220A	15.01
MG15	Pindaíbas	255A	14.72
MG15	Pindaíbas	275A	0.60
MG15	Pindaíbas	293A	14.79
MG15	Salto	507	2.95
MG15	Salto	508	9.61
MG15	Salto	509	1.27
MG15	Salto	510	1.08
MG15	Salto	511	3.19
MG15	Salto	512	2.39
MG15	Salto	513	41.08
MG15	Salto	514	36.81
MG15	Salto	515	37.61
MG15	Salto	516	51.31
MG15	Salto	517	37.82
MG15	Salto	518	40.48
MG15	Salto	519	35.31
MG15	Salto	520	34.37
MG15	Salto	521	15.10
MG15	Salto	522	44.85
MG15	Salto	523	42.04
MG15	Salto	542	33.54
MG15	Salto	543	24.10
MG15	Salto	544	37.53
MG15	Salto	545	11.67
MG15	Salto	546	12.40
MG15	Salto	547	22.75
MG15	Salto	548	48.24
MG15	Salto	549	37.75
MG15	Salto	551	20.12
MG15	Salto	552	6.91
MG15	Salto	553	20.45
MG15	Salto	554	45.49
MG15	Salto	555	44.88
MG15	Salto	556	42.43
MG15	Salto	557	40.91
MG15	Salto	558	6.80
MG15	Salto	559	21.30
MG15	Salto	560	46.18
MG15	Salto	561	42.93
MG15	Salto	562	17.35
MG15	Salto	563	24.80
MG15	Salto	564	39.73

MG15	Salto	565	40.45
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MG15	Salto	567	22.93
MG15	Salto	568	43.46
MG15	Salto	569	26.58
MG15	Salto	570	19.57
MG15	Salto	571	44.49
MG15	Salto	572	26.19
MG15	Salto	573	26.82
MG15	Salto	574	32.68
MG15	Salto	575	5.07
MG15	Salto	576	15.45
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MG15	Salto	578	10.91
MG15	Salto	579	13.24
MG15	Salto	580	31.20
MG15	Salto	581	11.37
MG15	Salto	582	21.92
MG15	Salto	583	17.77
MG15	Salto	584	16.21
MG15	Salto	585	19.57
MG15	Salto	586	18.07
MG15	Salto	587	8.60
MG15	Salto	588	26.20
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MG15	Salto	590	3.63
MG15	Salto	591	40.76
MG15	Salto	592	10.21
MG15	Salto	594	40.71
MG15	Salto	595	32.34
MG15	Salto	596	32.12
MG15	Salto	597	22.61
MG15	Salto	598	29.36
MG15	Salto	599	48.39
MG15	Salto	600	45.87
MG15	Salto	601	35.53
MG15	Salto	602	33.35
MG15	Salto	603	48.08
MG15	Salto	604	47.78
MG15	Salto	605	39.99
MG15	Salto	606	48.39
MG15	Salto	607	23.40
MG15	Salto	608	17.72
MG15	Salto	609	48.36
MG15	Salto	610	41.57
MG15	Salto	611	30.37

MG15	Salto	612	37.87
MG15	Salto	613	26.28
MG15	Salto	614	23.09
MG15	Salto	615	8.05
MG15	Salto	616	19.24
MG15	Saracura	214	20.06
MG15	Saracura	215	25.06
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MG15	Saracura	217	28.79
MG15	Saracura	218	33.48
MG15	Saracura	219	48.34
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MG15	Saracura	374	49.42
MG15	Saracura	375	16.99
MG15	Saracura	376	38.41
MG15	Saracura	377	46.49
MG15	Saracura	378	16.12
MG15	Saracura	379	26.24
MG15	Saracura	380	26.74
MG15	Saracura	381	50.94
MG15	Saracura	382	30.75
MG15	Saracura	383	47.80
MG15	Saracura	384	25.29
MG15	Saracura	385	37.17
MG15	Saracura	386	43.42
MG15	Saracura	387	39.60
MG15	Saracura	388	47.82
MG15	Saracura	389	39.57
MG15	Saracura	390	24.18
MG15	Saracura	391	48.02
MG15	Saracura	392	36.36
MG15	Saracura	393	28.73
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MG15	Saracura	402	43.60
MG15	Saracura	403	24.14
MG15	Saracura	404	48.35
MG15	Saracura	405	31.07
MG15	Saracura	406	44.17
MG15	Saracura	407	42.29

MG15	Saracura	408	48.17
MG15	Saracura	409	18.98
MG15	Saracura	410	5.15
MG15	Saracura	411	36.83
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MG15	Saracura	413	20.19
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MG15	Saracura	415	41.35
MG15	Saracura	416	9.73
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MG15	Saracura	421	39.04
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MG15	Saracura	426	19.90
MG15	Saracura	427	27.27
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MG15	Saracura	459	10.62
MG15	Saracura	460	18.48
MG15	Saracura	461	14.34
MG15	Saracura	462	39.64
MG15	Saracura	463	44.69
MG15	Saracura	464	33.42
MG15	Saracura	465	21.31
MG15	Saracura	466	43.36
MG15	Saracura	467	35.23
MG15	Saracura	468	39.38
MG15	Saracura	469	41.17
MG15	Saracura	470	39.00
MG15	Saracura	471	45.98
MG15	Saracura	474	10.74
MG15	Saracura	475	34.25
MG15	Saracura	476	31.01
MG15	Saracura	477	18.74
MG15	Saracura	478	25.09
MG15	Saracura	479	30.68
MG15	Saracura	480	15.43
MG15	Saracura	481	47.51
MG15	Saracura	482	49.78
MG15	Saracura	483	35.64
MG15	Saracura	484	37.71
MG15	Saracura	485	24.40
MG15	Saracura	486	20.54
MG15	Saracura	487	48.81
MG15	Saracura	488	15.14
MG15	Saracura	489	12.88
MG15	Saracura	490	46.05
MG15	Saracura	491	42.97
MG15	Saracura	492	12.13
MG15	Saracura	493	26.44
MG15	Saracura	494	28.63
MG15	Saracura	495	16.00
MG15	Saracura	496	42.43
MG15	Saracura	375A	27.33
MG15	Saracura	397A	19.77
MG15	Saracura	410A	1.29
MG15	Saracura	426A	11.90
MG15	Saracura	493A	21.09
MG15	Tiadosia	107	6.21

MG15	Tiadosia	108	16.37
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MG15	Tiadosia	110	39.09
MG15	Tiadosia	111	20.57
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MG15	Tiadosia	114	19.20
MG15	Tiadosia	115	16.64
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MG15	Tiadosia	117	27.87
MG15	Tiadosia	118	23.07
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MG15	Tiadosia	121	20.99
MG15	Tiadosia	122	17.80
MG15	Tiadosia	123	22.97
MG15	Tiadosia	124	18.45
MG15	Tiadosia	125	22.57
MG15	Tiadosia	126	22.29
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MG15	Tiadosia	128	37.57
MG15	Tiadosia	129	36.50
MG15	Tiadosia	130	39.79
MG15	Tiadosia	131	30.59
MG15	Tiadosia	132	12.24
MG15	Tiadosia	133	18.78
MG15	Tiadosia	134	47.30
MG15	Tiadosia	135	47.82
MG15	Tiadosia	136	47.76
MG15	Tiadosia	137	44.60
MG15	Tiadosia	138	26.00
MG15	Tiadosia	139	48.00
MG15	Tiadosia	140	47.89
MG15	Tiadosia	141	24.32
MG15	Tiadosia	142	30.64
MG15	Tiadosia	143	36.42
MG15	Tiadosia	144	23.34
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MG15	Tiadosia	146	39.55
MG15	Tiadosia	147	39.91
MG15	Tiadosia	148	24.16
MG15	Tiadosia	150	16.94
MG15	Tiadosia	151	50.11
MG15	Tiadosia	152	29.11
MG15	Tiadosia	153	47.88
MG15	Tiadosia	154	48.05

MG15	Tiadosia	155	30.45
MG15	Tiadosia	156	46.86
MG15	Tiadosia	157	47.39
MG15	Tiadosia	158	47.83
MG15	Tiadosia	159	33.41
MG15	Tiadosia	160	33.69
MG15	Tiadosia	161	31.82
MG15	Tiadosia	162	29.93
MG15	Tiadosia	163	42.94
MG15	Tiadosia	164	37.45
MG15	Tiadosia	165	40.25
MG15	Tiadosia	166	14.82
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MG15	Tiadosia	186	35.08
MG15	Tiadosia	187	43.15
MG15	Tiadosia	188	28.82
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MG15	Tiadosia	190	17.98
MG15	Tiadosia	193	12.09
MG15	Tiadosia	194	17.28
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MG15	Tiadosia	196	14.63
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MG15	Tiadosia	114A	14.10
MG15	Tiadosia	121A	13.49
MG15	Tiadosia	132A	23.14
MG15	Tiadosia	155A	2.72
MG15	Tiadosia	166A	24.46

MG15	Venda Nova	296	10.48
MG15	Venda Nova	297	31.48
MG15	Venda Nova	298	10.34
MG15	Venda Nova	299	7.40
MG15	Venda Nova	300	36.68
MG15	Venda Nova	301	40.07
MG15	Venda Nova	302	28.06
MG15	Venda Nova	303	23.74
MG15	Venda Nova	304	17.13
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MG15	Venda Nova	306	18.92
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MG15	Venda Nova	309	40.20
MG15	Venda Nova	310	36.53
MG15	Venda Nova	311	40.15
MG15	Venda Nova	312	40.04
MG15	Venda Nova	313	10.13
MG15	Venda Nova	314	8.40
MG15	Venda Nova	315	37.54
MG15	Venda Nova	316	39.81
MG15	Venda Nova	317	46.69
MG15	Venda Nova	318	43.31
MG15	Venda Nova	319	40.21
MG15	Venda Nova	320	41.52
MG15	Venda Nova	321	34.73
MG15	Venda Nova	322	43.71
MG15	Venda Nova	323	13.95
MG15	Venda Nova	324	35.82

Appendix 6. Summary of post registration changes

Corrections:

- To remove the references to specific characteristics of the equipment to be used for monitoring described in section B.7.1 and include accuracy class of scales.
- To list Project Participants as per the UNFCCC webpage since the registered PDD was not consistent with it.
- To include the default values to be applied from 01/01/2013 to parameters GWPCH4 and GWPN2O in accordance with paragraph 57 of the CDM Project Standard version 09.0.
- To simplify or delete the information presented in the appendixes when redundant or not required for its inclusion on the revised PDD.

Permanent Changes from the monitoring plan:

- To complete section B.7.2 of the revised PDD including the sampling plan defined according to the Standard: Sampling and surveys for CDM project activities and programme of activities" version 05.0.

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Document information

Version	*Date*	*Description*
08.0	22 July 2016	EB 90, Annex 1 Revision to include provisions related to automatically additional project activities.
07.0	15 April 2016	Revision to ensure consistency with the "Standard: Applicability of sectoral scopes" (CDM-EB88-A04-STAN) (version 01.0).
06.0	9 March 2015	Revisions to: • Include provisions related to statement on erroneous inclusion of a CPA; • Include provisions related to delayed submission of a monitoring plan; • Provisions related to local stakeholder consultation; • Provisions related to the Host Party; Editorial improvement.
05.0	25 June 2014	Revisions to: • Include the Attachment: Instructions for filling out the project design document form for CDM project activities (these instructions supersede the "Guidelines for completing the project design document form" (Version 01.0)); • Include provisions related to standardized baselines; • Add contact information on a responsible person(s)/ entity(ies) for the application of the methodology (ies) to the project activity in B.7.4 and Appendix 1; • Change the reference number from *F-CDM-PDD* to *CDM-PDD-FORM;* • Editorial improvement.
04.1	11 April 2012	• Editorial revision to change version 02 line in history box from Annex 06 to Annex 06b
04.0	13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the project design document form for CDM project activities" (EB 66, Annex 8).
03.0	26 July 2006	EB 25, Annex 15
02.0	14 June 2004	EB 14, Annex 06b
01.0	03 August 2002	EB 05, Paragraph 12 Initial adoption.

Version	*Date*	*Description*

Decision Class: Regulatory
Document Type: Form
Business Function: Registration
Keywords: project activities, project design document