Monitoring report form
(Version 05.1)

Complete this form in accordance with the Attachment "Instructions for filling out the monitoring report form" at the end of this form.

MONITORING REPORT	
Title of the project activity	Use of Charcoal from Renewable Biomass Plantations as Reducing Agent in Pig Iron Mill in Brazil
UNFCCC reference number of the project activity	7577
Version number of the monitoring report	01
Completion date of the monitoring report	04/05/2017
Monitoring period number and duration of this monitoring period	Monitoring period Nº3 01/01/2016 – 31/12/2016
Project participant(s)	**Brazil:** Plantar; Plantar Siderúrgica; 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
Sectoral scope(s)	Sectoral Scope 9: Metal production
Selected methodology(ies)	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 01
Selected standardized baseline(s)	N/A
Estimated amount of GHG emission reductions or net GHG removals by sinks for this monitoring period in the registered PDD	329,068

Total amount of GHG emission reductions or net GHG removals by sinks achieved in this monitoring period	GHG emission reductions or net GHG removals by sinks reported up to 31 December 2012	GHG emission reductions or net GHG removals by sinks reported from 1 January 2013 onwards
	--	237,173

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

>> The CDM Project 7577 proposes the use of renewable charcoal 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 and also restores degrading grassland ecosystems.

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 related to the new investments in the plantations, supporting the establishment of a sustainable productive arrangement.

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 quality certification (e.g. FSC, ISO, etc) systems. 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 processing of wood into charcoal occurs in improved brick kilns and applies operations allowing for greater control of carbonization variables and enabling the project entity to reduce methane emissions.

The iron ore reduction technology is based on mini-blast furnaces into which renewable charcoal coupled with iron ore are fed and undergo the reduction process, resulting in pig iron. Pulverized charcoal is injected into the blast furnaces. (**Figure 1**)

By the time of its registration on 28 December 2012 the project's implementation was already complete and fully operating. **Table 1** shows some relevant dates of the project activity.

Table 1: relevant dates of the project activity

Date	Milestone
July 2000	Development of the engineering study "Assessment for Reducing Agent Change in Pig Iron Production of Plantar Siderúrgica". Author RSConsultants (SAMPAIO, 2000).
10 November 2000	Starting date of the project activity. This refers to the first planting of the dedicated plantations.
04 September 2002	ERPA signed with the World Bank's Prototype Carbon Fund.
January 2007	Starting of the pulverized charcoal injection system for Blast Furnace 02.
December 2007	Starting of the pulverized charcoal injection system for Blast Furnace 01.

During this second monitoring period the total GHG emission reductions achieved was **237,173 tCO_2e**.

Pig iron patio

Source: Plantar records

A.2. Location of project activity

>> The project activity Host Party is Federative Republic of Brazil, and is located in Minas Gerais state. The municipalities and geographical locations of the project activity are presented in **Table 1** below:

Table 1: Geographical Location of the Project Activity:

Region	Farm ID number	Dedicated Plantation Farm Name	Overall geo-referenced points
Curvelo *Municipality: Curvelo* Dedicated forest plantations and carbonization units	MG 02	Buenos Aires	- West extreme point: 18.835556º S / 44.770556º W - Northeast extreme point: 18.743056º S / 44.515278º W - Southeast extreme point: 18.918056º S / 44.503333º W
Felixlandia *Municipality: Felixlandia* Dedicated forest plantations and carbonization units	MG 03	Jacaré/Riachão	- Northeast extreme point: 18.605278º S / 45.010556º W - Southeast extreme point: 18.670833º S / 44.994722º W - Northwest extreme point: 18.591667º S / 45.118611º W - Southwest extreme point: 18.721944º S / 45.106111º W

Morada Nova de Minas *Municipality: Morada Nova de Minas* Dedicated forest plantations and carbonization units	MG 04	Buriti Grande	- West extreme point: 18.797778º S / 45.392222º W - Northeast extreme point: 18.685278º S / 45.243056º W - Southeast extreme point: 18.796667º S / 45.285278º W
Itacambira *Municipalities: Itacambira, Bocaiuva, Juramento, Grão Mogol and Francisco Sá*[1] Dedicated forest plantations and carbonization units	MG 15	Tamanduá/ Poçoes	- Northeast extreme point: 16.717778º S / 43.334167º W - Southeast extreme point: 16.948889º S / 43.388611º W - Northwest extreme point: 16.686667º S / 43.466667º W - Southwest extreme point: 16.901111º S / 43.525556º W
Sete Lagoas *Municipality: Sete Lagoas* Pig iron mill	-	-	LATITUDE 19.439167º S LONGITUDE 44.340278º W

[1] MG15 Farm is located in all these municipalities and, therefore, is hereinafter called **Itacambira**.

A.3. Parties and project participant(s)

Party involved ((host) indicates a host Party)	Private and/or public entity(ies) project participants (as applicable)	Indicate whether the Party involved wishes to be considered as project participant (yes/no)
Brazil (host)	Plantar; Plantar Siderúrgica; 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.4. Reference of applied methodology and standardized baseline

>> The CDM Project 7577 uses the approved methodology CDM-AM0082[2] "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.

The methodology CDM-AM0082 version 1 derives elements from the following approved methodologies and refers to the latest approved version of the tools below:

- ACM0003[3] - Emissions reduction through partial substitution of fossil fuels with alternative fuels or less carbon intensive fuels in cement manufacture, version 8.0;
- AM0041[4] - Mitigation of Methane Emissions in the Wood Carbonization Activity for Charcoal Production, version 1;
- AM0042 [5] - Grid-connected electricity generation using biomass from newly developed dedicated plantations --- Version 2.1;
- A/R-AM0005 [6] - Afforestation and Reforestation project activities implemented for industrial and commercial uses, version 4;

[2] http://cdm.unfccc.int/methodologies/DB/ZDKO7TGQR2OHHKMMI1VL9L49LDPR94

[3] http://cdm.unfccc.int/methodologies/DB/DPP1VND7USZ0IGEPCABT2DF8JCPGG3

[4] https://cdm.unfccc.int/methodologies/DB/B2SCH5WZLQYHTVSHQ4BIADMCBQ1P9U

[5] http://cdm.unfccc.int/methodologies/DB/6IN615EENAIGXWBLS0FGNZ206BA058

- Combined tool to identify the baseline scenario and demonstrate additionality[7], version 06.0;
- Estimation of direct nitrous oxide emission from nitrogen fertilization[8], 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[9] (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);
- Tool to calculate baseline, project and/or leakage emissions from electricity consumption[10], version 01;
- Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion[11], version 02;
- Tool for the identification of degraded or degrading lands for consideration in implementing CDM A/R project activities[12], version 01.

A.5. Crediting period of project activity

>> The CDM Project 7577 adopts a renewable crediting period. The first 7 years starts on 28/12/2012 and ends on 27/12/2019.

A.6. Contact information of responsible persons/entities

>> Plantar Carbon Ambiental Ltda (Project Participant).

Mr. Fábio Marques (Director), phone number +55 31 3290.4032; plantarcarbon@plantarcarbon.com.br

SECTION B. Implementation of project activity

B.1. Description of implemented registered project activity

>> The technology employed by the project activity includes:

In the production of reducing agents - the adoption of advanced clones and management practices for the establishment of dedicated plantations and carbonization practices that allows for methane emission reductions.

i) *Establishment of dedicated plantations*: In order to produce high-yielding eucalyptus clones, advanced scientific protocols, rigorous selection and propagation methods were adopted to assure the production of quality seedlings for plantation purposes**.** Mini-sprouts were selected from sprout matrices (**Figure 2**), 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 planting process involves minimum cultivation techniques to minimize soil impacts and optimize the use of water. Fertilizers, herbicides and pest control substances were used as per recommended silvicultural practices. Operations are fully integrated into the project entity's quality management system, which is based on ISO 9001. All dedicated plantations areas are fully planted (**Figure 3**).

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[6] https://cdm.unfccc.int/methodologies/DB/QAM97WQWX94URIJXOJMTJFIS8KSE28

[7] http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-02-v6.0.pdf

[8] http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-07-v1.pdf

[9] http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-08-v4.0.0.pdf

[10] http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-05-v1.pdf

[11] http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-03-v2.pdf

[12] http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-13-v1.pdf

Figure 2: Selection of mini-sprouts matrices at the greenhouses

Source: Plantar's records

Figure 3: Eucalyptus dedicated plantations

Source: Plantar's records

ii) *Charcoal production*: carbonization is the most important part of the charcoal production requiring high temperatures at which combustible gases ignite and guarantee the supply of heat to carbonize wood. The thermal demand of the carbonization phase influences the gravimetric yield and the resulting methane emissions. The project entity's operation allows for greater control of carbonization variables and enables methane emissions reductions. Optimizing the air flow through suitable air inlets helps to control the heat inside the kiln. Factors such as wood moisture, temperature, and carbonization time are important in the amount of methane emitted. The carbonization process occurs in two types of kiln:

a. Rectangular kiln (**Figure 5**): masonry kiln built with ceramic bricks.
   - Dimension: 32 meters width, 4 meters length and 5.27 meters height.

- Mechanized loading and unloading.
- Air supply system consists of chambers and underground pipelines. Smoke exits through lateral chimney.
- Capacity: 270 cubic meters of wood
- Production: 190 cubic meters of charcoal.
- Total production period: 18 days (7 days for the carbonization process and 11 days cooling).

b. Circular kiln: kiln built with ceramic bricks.

- Diameter: 3.8 meters
- Height: 3.0 meters
- Manual loading and unloading.
- Air supply system consisted of “*tatus*” (small chambers) and smoke exits through lateral chimney.
- Capacity: 15.5 cubic meters of wood
- Production: 12.5 cubic meters of charcoal.
- Total production period: 10 days (4 days for the carbonization process and 6 days cooling).

For the circular kilns, the quality control process is performed at standardized periods of time by checking the internal temperature of the kiln and performing visual analysis of the smoke volume and quality. A thermocouple is used to check the ideal temperature in each time period.

For the rectangular kilns, the quality control process uses the following apparatus: a pyrometer, a thermometer, a thermocouple and a rebar. The rebar is used to control the homogeneity of the carbonization process inside the kiln by checking the existence of non-carbonized wood detected by the presence of pyroligeneous acid. The air entry and circulation into the kiln is controlled by chambers and underground pipelines. The temperature is controlled in each carbonization step and monitored through specific software. The inflow air is controlled according to the internal temperature in each step of the carbonization process.

All actions necessary to keep the quality of the carbonization process are described in standard operation procedures, specific to each kind of carbonization kiln.

The flow chart below (**Figure 4**) shows the carbonization production flow and presents the steps to calculate the gravimetric yield.

Figure 4: flow chart of the charcoal production process

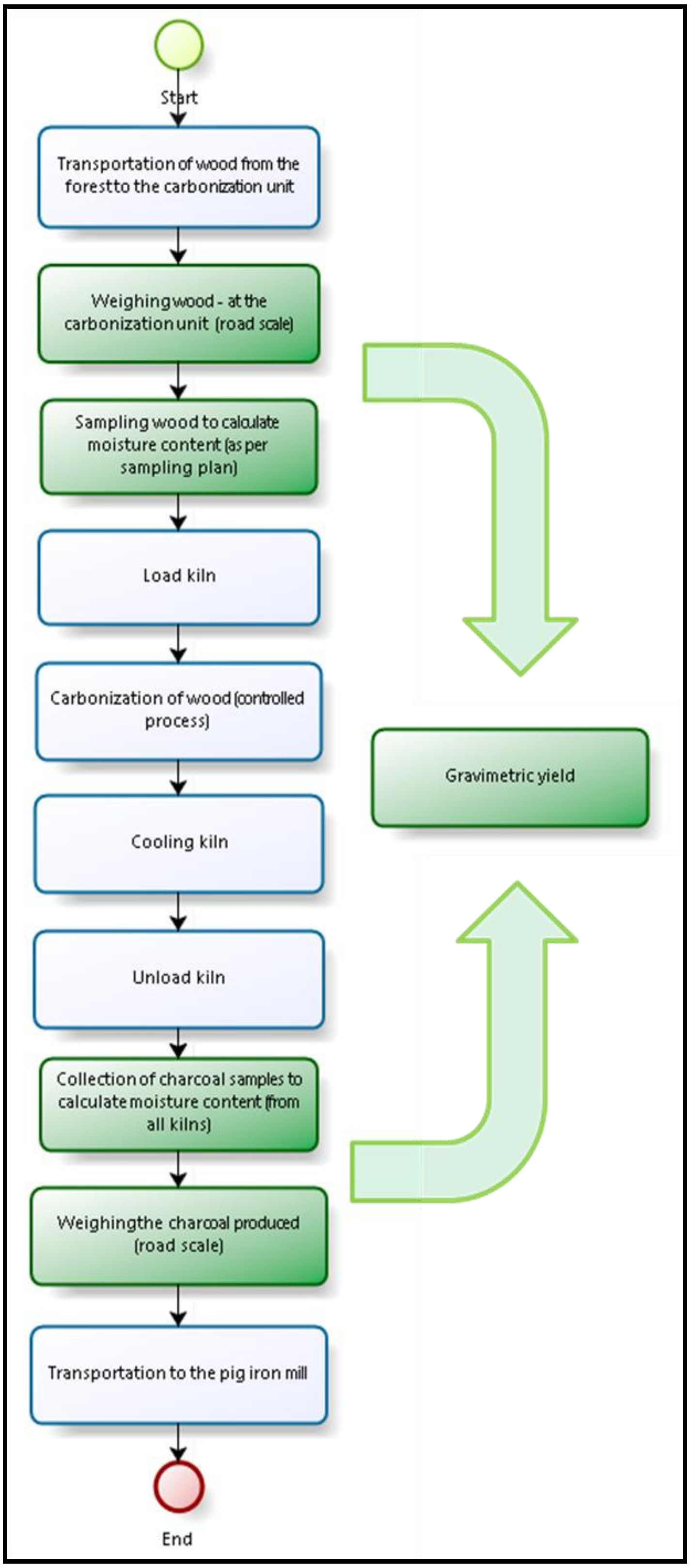
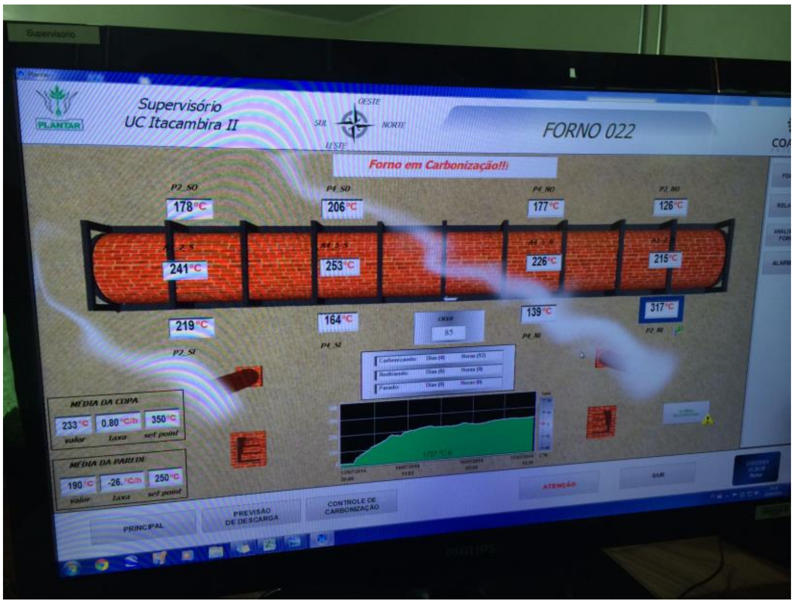


Figure 5: control of the carbonization process in Itacambira (rectangular kilns)



Source: Plantar Siderúrgica's records

In the iron ore reduction facility - pig iron manufacturing is based on the blast furnace technology (see **Figure 6**) and use of pulverized charcoal.

The iron ore reduction technology applied in this project activity is based on mini-blast furnaces.

As part of the modifications implemented in the iron ore reduction plant, the adaptation of the blast furnace for using pulverized charcoal was implemented in 2007 and is the most significant modification, allowing for the total utilization of all fractions of charcoal production and handling. Prior to this upgrade, the smaller particles of the charcoal could not be used in the blast furnace.

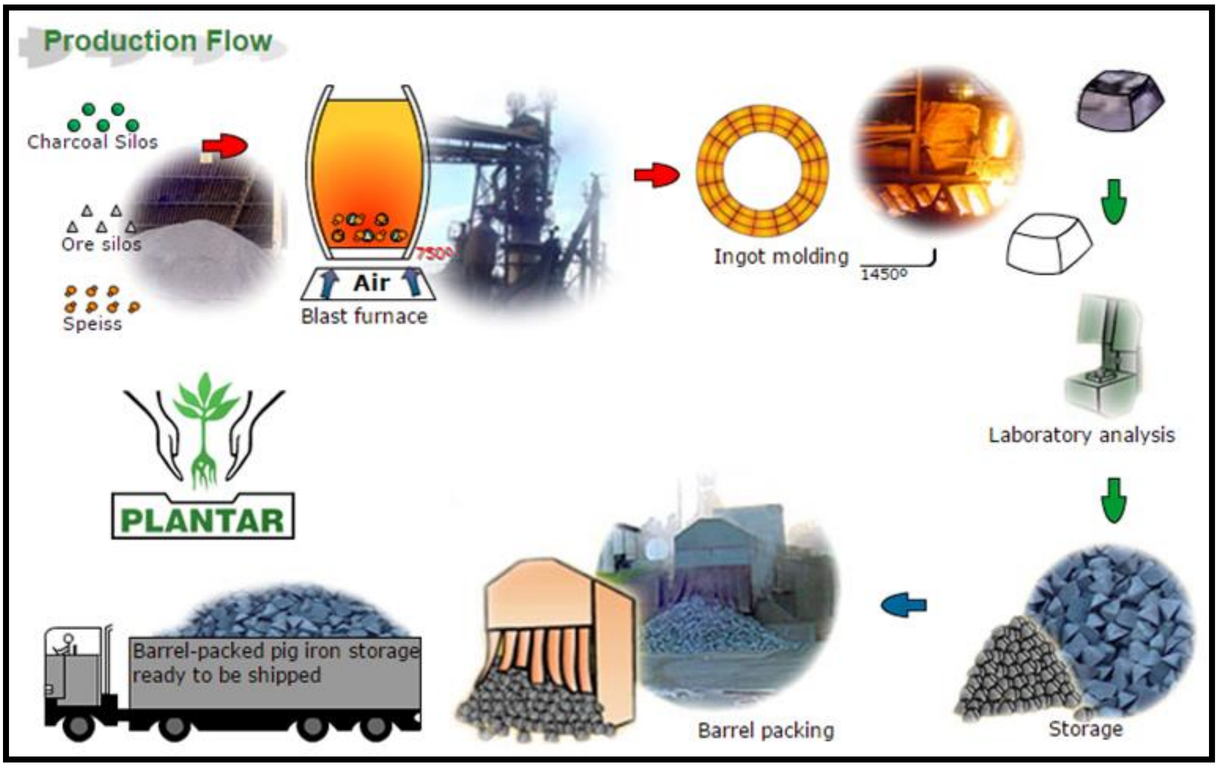
The pulverized charcoal injection system started operating in Plantar Siderúrgica in blast furnaces 02 and 01 in January and December 2007, respectively.

All charcoal entering the pig iron mill is weighed and all pig iron produced is weighed after cooling.

Together, the production of reducing agents and the production of pig iron constitute the new iron ore reduction system enabled by the project activity.

There was no interruption of the blast furnaces during this monitoring period.

Figure 6: pig iron production flow



Source: The Plantar Group website 2015, http://www.grupoplantar.com.br/en

Figure 7: Plantar Siderúrgica

Source: Plantar Siderúrgica records

B.2. Post-registration changes

B.2.1. Temporary deviations from registered monitoring plan, applied methodology or applied standardized baseline

>> N/A

B.2.2. Corrections

>> N/A

B.2.3. Changes to start date of crediting period

>> N/A

B.2.4. Inclusion of a monitoring plan to the registered PDD that was not included at registration

>> N/A

B.2.5. Permanent changes from registered monitoring plan, applied methodology or applied standardized baseline

>> N/A

B.2.6. Changes to project design of registered project activity

>> N/A

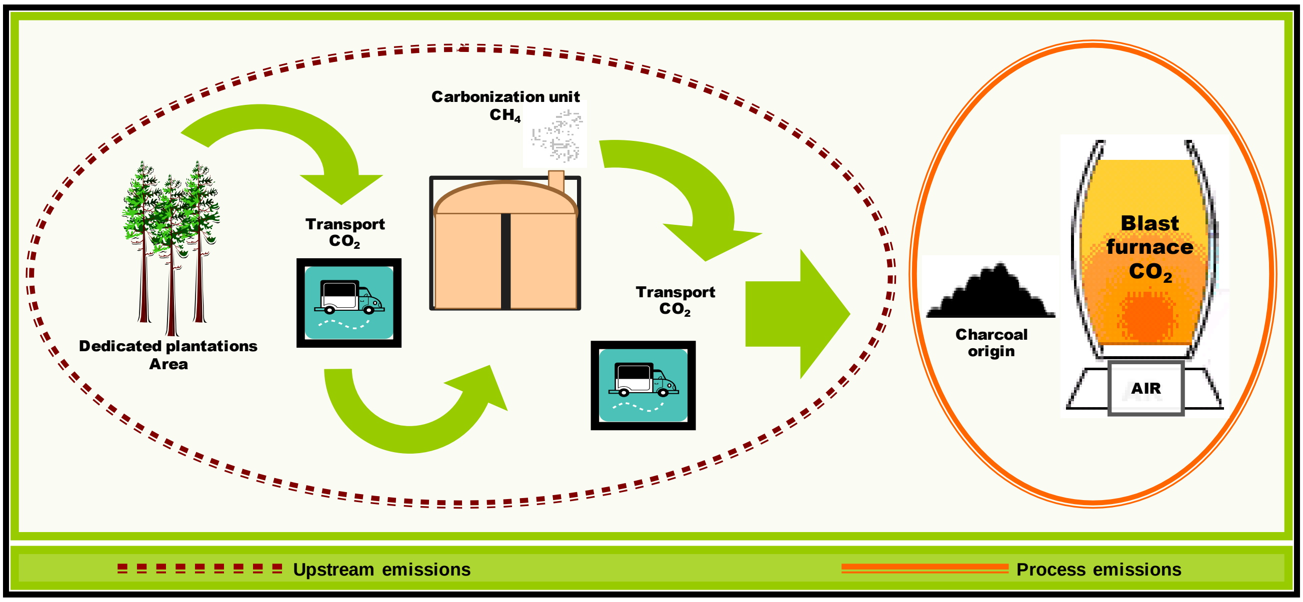
B.2.7. Types of changes specific to afforestation or reforestation project activity

>> N/A

SECTION C. Description of monitoring system

>> The monitoring plan for CDM Project 7577 focuses on the two phases of the new iron ore reduction system that are, upstream emissions and process emissions (see **Figure 8**).

Figure 8: Iron ore reduction system monitoring phases



<u>Upstream emissions</u>

The monitoring of upstream emissions monitors the emissions in the production of the primary carbon, the renewable charcoal.

a. Establishment of dedicated plantations

The planted area, the burning of fossil fuel during planting activities, the amount of nitrogen (N) fertilizer applied, the volume of wood transported to the carbonization sites and the burning of fossil fuel in the transportation of wood to the carbonization sites are monitored.

Field surveys were undertaken to verify that the delineated project boundary was congruent with the ex-ante description presented in the PDD.

Data monitored:

- Area of the dedicated plantations
- Diesel consumption in silvicultural activities
- N fertilizer applied
- Number of round trips per type of vehicle for wood transportation to the carbonization units
- Average round trip distance from plantation site to the carbonization unit site
- Emission factor per type of vehicle.

b. Renewable charcoal production

All the wood (population) from a forest stand entering the carbonization unit is weighed on truck scales and its origin is registered. After that, the wood is stocked in piles beside the carbonization kilns. According to the sample plan (described in Section D.3), wood samples are taken from the stock piles in order to determine the wood moisture.

The carbonization process occurs in two types of kilns (described in section B.1). PP[13]keeps registry of all forest stand origin.

Charcoal moisture was determined for all carbonization kilns (population). PP keeps registry of the charcoal moisture and forest stand origin. All charcoal (population) leaving the carbonization unit was weighed on truck scales. All the process is summarized in **Figure 4** above.

Methane emissions from the carbonization process were estimated based on the identification of the gravimetric yield according to the regression equation expressing statistical relationship provided in the PDD. In addition to the gravimetric yield, the transport of the reducing agent to the iron ore reduction facility was monitored. Emissions are based on the quantity of wood transported, the number of round trips and the average distance. The average distance is the average linear distance from the centroid of the stands to the centroid of the carbonization unit. Conservatively, PP considered the biggest CO_2 emitter vehicle type for wood transportation from the planted area to the carbonization units.

Data monitored:

- Gravimetric yield (**Figure 9**)
    - Wood weight - population

[13] The Plantar Group companies, presented in Section A.3 of this MP, are hereinafter called **PP**.

- Charcoal weight - population
- Wood moisture – samples (see item D.3 of this Monitoring Report for details)
- Charcoal moisture – population

- Number of round trips per type of vehicle for charcoal transportation to the pig iron mill
- Average round trip distance from the carbonization unit site to the pig iron mill (**Figure 10** below)
- Emission factor per type of vehicle.

Figure 9: monitoring system within the carbonization unit

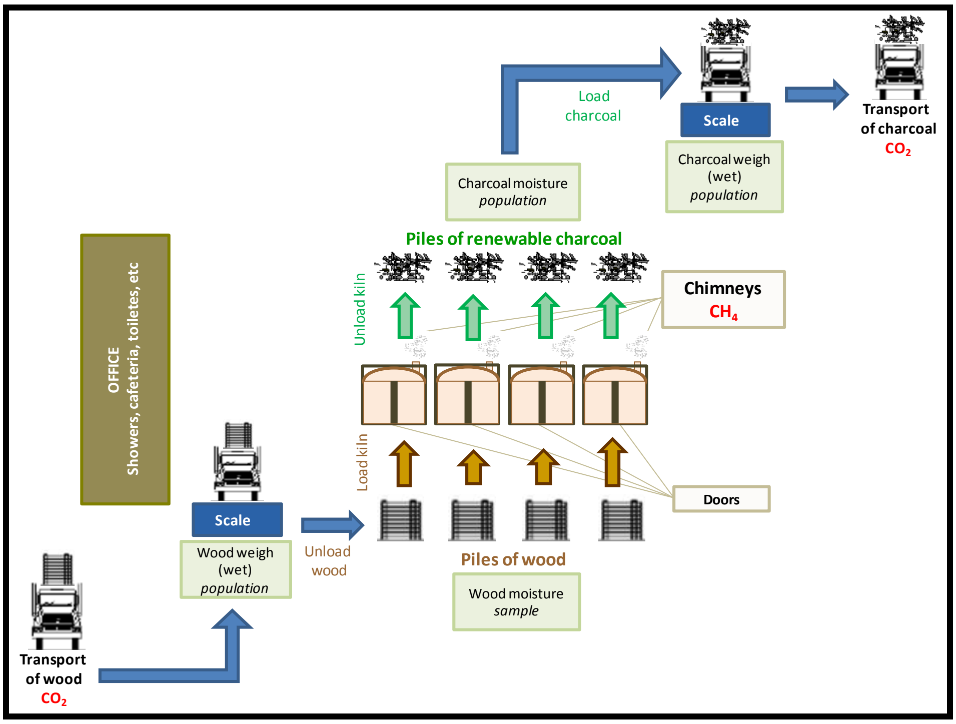
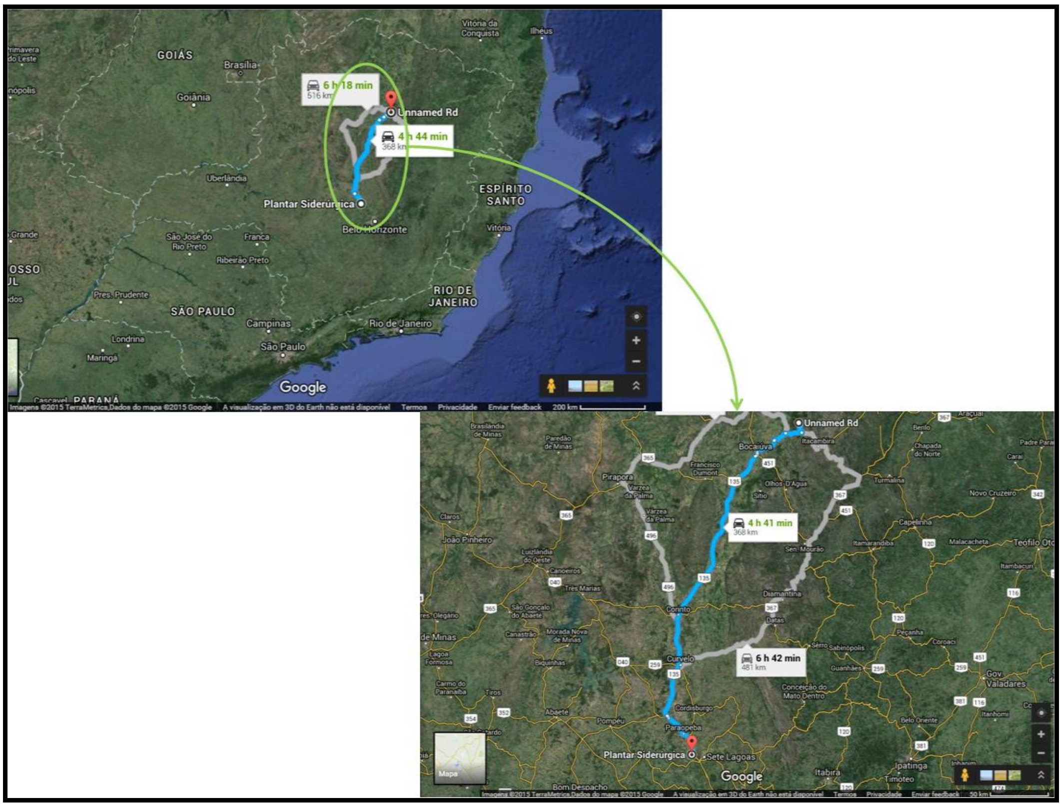


Figure 10: Route from carbonization unit to Plantar Siderúrgica



Source: GoogleMaps, 2015

<u>Process emissions</u>

c. *Pig iron production*

Charcoal origin is registered upon arrival at the mill 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 is linked to (another official form from the same Authority called DCC – Declaration of Harvesting and Commercialization of Planted Forests) and even the charcoal transport route. As per the PDD, only charcoal produced with biomass sourced by the areas within the project boundaries, as well as areas treated under the A/R CDM Project number 2569, are accounted for emission reductions calculations, as they integrate the new iron ore reduction system. All pig iron produced is weighed.

Data monitored:

- Renewable charcoal origin
- Renewable charcoal consumption (quantity of renewable charcoal used in the iron ore reduction process)
- Amount of pig iron produced in the iron ore reduction process.

Figure 11: Pig iron production

Source: Plantar Siderúrgica

The operational and management structure for collecting and monitoring the project activity's data is presented in **Table 2** below.

Table 2: Monitoring of project's activities organizational table

Activity/task/variable Unit	Responsible Entity	Responsible Department
Upstream emissions		
Area of the dedicated plantations (ha)	Plantar Plantar Siderúrgica (MG15 Farm)	Forestry Planning Forestry Management
Diesel consumption for silvicultural activities	Plantar Plantar Siderúrgica (MG15 Farm)	Forestry Planning Forestry Management
N fertilizer applied	Plantar Plantar Siderúrgica (MG15 Farm)	Forestry Planning Forestry Management
Number of round trips per type of vehicle for wood transportation to the carbonization units (number)	Plantar Siderúrgica (MG15 Farm)/ Plantar Carbon	Forestry Management/ CDM Projects
Average round trip distance from plantation site to the carbonization unit site (km)	Plantar/ Plantar Carbon	Forestry Planning/ CDM Projects
Emission factor per type of vehicle (tCO_2e /liter)	Plantar Carbon	CDM Projects
Gravimetric yield Wood weight – population (t/m^3) Charcoal weight – population (t/m^3) Wood moisture - sampling (%) Charcoal moisture – population (%)	Plantar Siderúrgica (MG15 Farm)	Forestry Management

Number of round trips per type of vehicle for charcoal transportation to the pig iron mill (number)	Plantar Siderúrgica/ Plantar Carbon	Forestry Management/ CDM Projects
Average round trip distance from the carbonization unit sites to the pig iron mill (km)	Plantar Carbon	CDM Projects
Emission factor per type of vehicle (tCO_2e/liter)	Plantar Carbon	CDM Projects
Process emissions		
Renewable charcoal origin (dimensionless)	Plantar Siderúrgica	Production Management
Renewable charcoal consumption (quantity of renewable charcoal used in the iron ore reduction process) (tonne)	Plantar Siderúrgica	Production Management
Amount of pig iron produced in the iron ore reduction process (tonne)	Plantar Siderúrgica	Production Management
CDM training, data gathering and emission reductions calculations	Plantar Carbon	CDM Projects

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

According to the CDM-AM0082 version 1, all data collected as part of monitoring should be electronically archived and kept for at least two years after the end of the last crediting period. The responsible staff was trained to monitor, gather and record all relevant data for the project activity according to its monitoring plan. All equipment and data are covered by emergency procedures to avoid data loss.

SECTION D. Data and parameters

D.1. Data and parameters fixed ex ante or at renewal of crediting period

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[14])
Value(s) applied)	Coal coke: 87.05% Pulverized coal: 78.90%
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 comments	N/A

[14] SAMPAIO, R.S. *Avaliação de mudança do agente termo redutor na produção de ferro-gusa da Plantar Siderúrgica (*Assessment for Reducing Agent Change in Pig Iron Production of Plantar Siderúrgica)*.* July, 2000.

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 comments	N/A

Data/parameter:	$RA_{BL,j}$
Unit	tonne of reducing agent/ tonne of hot metal
Description	Reducing agent type *j* (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 comments	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	See Section B.6.1 of the PDD. Calculated as: 0.00003612TJ/l * 72600kgCO_2/TJ = 2.622312kgCO_2/l

Purpose of data	Calculation of baseline emissions
Additional comments	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	See Section B.6.1 of the PDD. Calculated as: 0.00003612TJ/l * 74800$kgCO_2$/TJ = 2.7018$kgCO_2$/l
Purpose of data	Calculation of baseline emissions
Additional comments	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* (tCO_2e /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	See Section B.6.1 of the PDD. Calculated as: (240,000t pig iron * 0.487563t coal coke/t pig iron)/(240 wagons * 14.135t per wagon)/0.75t coal coke/t coal
Purpose of data	Calculation of baseline emissions
Additional comments	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: GoogleEarth, 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 comments	Distance from Vitória, Espírito Santo State (Tubarão seaport) to Plantar Siderúrgica (Sete Lagoas, Minas Gerais). 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_2e /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	See Section B.6.1 of the PDD. Calculated as: 2.91 L/1000TKU * (240 wagons * 14.135t per wagon)*(2.622312 kg CO_2/l /1000)
Purpose of data	Calculation of baseline emissions
Additional comments	Vehicle type: Train

Data/parameter:	$EF_{CO2e,coalcoke,BL,y}$
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	CDM-AM0082 version 1, Annex 1, Table 3 and SAMPAIO, 2000
Value(s) applied)	0.537

Choice of data or measurement methods and procedures	See Section B.6.1 of the PDD. Calculated as: 402.6 /0.75/ 1,000
Purpose of data	Calculation of baseline emissions
Additional comments	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)	25[15]
Choice of data or measurement methods and procedures	N/A
Purpose of data	Calculation of baseline emissions and project emissions
Additional comments	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 comments	N/A

Data/parameter:	EF_1
Unit	t-N_2O-N $(t\text{-}N\ input)^{-1}$
Description	Emission Factor for emissions from N inputs
Source of data	IPCC default, 2006 Guidelines, Chapter 11, Table 11.1
Value(s) applied)	1%

15 According to Annex 3, EB69.

Choice of data or measurement methods and procedures	N/A
Purpose of data	Calculation of project emissions
Additional comments	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 comments	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 comments	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 comments	N/A

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)	298[16]
Choice of data or measurement methods and procedures	N/A
Purpose of data	Calculation of project emissions
Additional comments	N/A

D.2. Data and parameters monitored

Data/parameter:	$P_{PJ,y}$
Unit	Tonnes of Hot Metal (t)
Description	Hot metal production in project scenario in year *y* (hot metal production of the new iron ore reduction system).
Measured/calculated/default	Measured
Source of data	Project entity records
Value(s) of monitored parameter	189,588

[16] According to Annex 3, EB69.

Monitoring equipment	Type: Scale – Weightech WT211 Accuracy class: Class III ±10kg Maximum cargo 80000kg/ Minimum cargo 200kg Serial number: P1338A12707002 Calibration frequency: quarterly. Dates of calibration during the monitoring period: 17/10/2015, 16/01/2016, 17/04/2016, 09/07/2016, 15/10/2016, 07/01/2017 Validity: 1 year
Measuring/reading/recording frequency:	Measured daily, aggregated annually.
Calculation method (if applicable):	N/A
QA/QC procedures:	100% of the total pig iron production shall be weighed. Scales are calibrated according to ISO 9001 Standard Operating Procedures.
Purpose of data:	Calculation of project emissions
Additional comments:	N/A

Data/parameter:	$N_{v,PJ,i,y}$
Unit	Unit numbers
Description	Number of round trips (to and from) per type *v* of vehicle during year *y* to transport biomass to the carbonization sites.
Measured/calculated/default	Calculated
Source of data	Project entity records
Value(s) of monitored parameter	19,801
Monitoring equipment	N/A
Measuring/reading/recording frequency:	Annually
Calculation method (if applicable):	Calculated as amount of wood transported (m^3) per year over vehicle capacity (m^3). Conservatively, PP considered the biggest CO_2 emitter vehicle type.
QA/QC procedures:	Standard Operating Procedures based on ISO 9001 standards
Purpose of data:	Calculation of project emissions
Additional comments:	This parameter applies to the calculations for $EP_{Vehicle,PJ,y}$ biomass transport to the carbonization sites.

Data/parameter:	$N_{v,PJ,j,y}$
Unit	Unit numbers

Description	Number of round trips (to and from) per type *v* of vehicle during year *y* to transport renewable charcoal from the carbonization site to the iron ore reduction facility.
Measured/calculated/default	Calculated based on the trucks entrance in the pig iron mill
Source of data	Project entity records
Value(s) of monitored parameter	4,739
Monitoring equipment	N/A
Measuring/reading/recording frequency:	Annually
Calculation method (if applicable):	Calculated as amount of charcoal transported (t) over vehicle capacity (t). Conservatively, PP considered the biggest CO_2 emitter vehicle type.
QA/QC procedures:	Standard Operating Procedures based on ISO 9001 standards.
Purpose of data:	Calculation of project emissions
Additional comments:	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 carbonization unit during year *y*
Measured/calculated/default	Calculated
Source of data	Project entity records.
Value(s) of monitored parameter	21.78 (round trip)
Monitoring equipment	N/A
Measuring/reading/recording frequency:	Annually
Calculation method (if applicable):	It is the average linear distance from the centroid of the stands to the centroid of the carbonization unit.
QA/QC procedures:	Standard Operating Procedures based on ISO 9001 standards.
Purpose of data:	Calculation of project emissions
Additional comments:	This parameter applies to the calculations for $EP_{Vehicle,PJ,y}$ biomass transport to the carbonization sites.

Data/parameter:	$AVD_{j,PJ,y}$
Unit	Km
Description	Average round trip distance between the renewable charcoal *i* production site(s) and the iron ore reduction facility during the year *y*

Measured/calculated/default	Calculated
Source of data	Google Earth, 2014
Value(s) of monitored parameter	738 (round trip)
Monitoring equipment	N/A
Measuring/reading/recording frequency:	Annually
Calculation method (if applicable):	Calculated via Google Earth 2014.
QA/QC procedures:	Standard Operating Procedures based on ISO 9001 standards.
Purpose of data:	Calculation of project emissions
Additional comments:	This parameter applies to the calculations for $RAT_{Vehicle,PJ,y}$,transport of renewable charcoal to the iron ore reduction facility in the project scenario.

Data/parameter:	$EF_{v,km,CO2,PJ,y}$
Unit	tCO_2e /km
Description	CO_2 emission factor for the type *v* of vehicle during year *y* in the project scenario
Measured/calculated/default	Calculated
Source of data	GHG Protocol Brazilian Program, 2016, http://www.ghgprotocolbrasil.com.br/ and 2006 IPCC Guidelines for National GHG Inventories, Volume 2, Chapter 1, Table 1.4 and Plantar records.
Value(s) of monitored parameter	0.00294: transport of biomass 0.00157: transport of renewable charcoal
Monitoring equipment	N/A
Measuring/reading/recording frequency:	Annually
Calculation method (if applicable):	See Section E.2 Project Upstream Emissions item “d” in this MR.
QA/QC procedures:	Standard Operating Procedures based on ISO 9001 standards.
Purpose of data:	Calculation of project emissions
Additional comments:	This parameter applies to the calculations for $EP_{Vehicle,PJ,y}$ biomass transport to the carbonization sites, and $RAT_{Vehicle,PJ,y}$ transport of renewable charcoal to the 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

Measured/calculated/default	Calculated
Source of data	Project entity records
Value(s) of monitored parameter	0.0310
Monitoring equipment	N/A
Measuring/reading/recording frequency:	Annually
Calculation method (if applicable):	Based on provisions of AM0041 version 1
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 comments:	The sample weight was adjusted as per CDM-EB65-A04-STAN Version 07.0, item 9.4.4.

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.
Measured/calculated/default	Measured and Calculated
Source of data	Project entity records
Value(s) of monitored parameter	0.6875

Monitoring equipment	Type: Scale - Toledo 9091 Accuracy class: Class III ±10kg Maximum cargo 80000kg/ Minimum cargo 200kg Serial number: 92551 Calibration frequency: quarterly. Calibration dates during the monitoring period: 17/10/2015, 16/01/2016, 17/04/2016, 09/07/2016, 15/10/2016, 07/01/2017 Validity: 1 year Type: Scale – Weightech WT211 Accuracy class: Class III ±10kg Maximum cargo 80000kg/ Minimum cargo 200kg Serial number: P1338A12707002 Calibration frequency: quarterly. Calibration dates during the monitoring period: 17/10/2015, 16/01/2016, 17/04/2016, 09/07/2016, 15/10/2016, 07/01/2017 Validity: 1 year
Measuring/reading/recording frequency:	Charcoal and hot metal are weighed daily and calculated annually.
Calculation method (if applicable):	N/A
QA/QC procedures:	Standard Operating Procedures based on ISO 9001 standards.
Purpose of data:	Calculation of project emissions
Additional comments:	$FP_{J,charcoal} = RA_{PJ,i}$

Data/parameter:	Y_{PJ}
Unit	Tonne of charcoal / tonne of wood on dry basis
Description	Carbonization gravimetric yield
Measured/calculated/default	Measured
Source of data	Project entity records
Value(s) of monitored parameter	0.3447

Monitoring equipment	<u>Truck scales</u> Location: UC Itacambira Type: ALFA 3101C Serial number: 101954 Accuracy class: Class III ±10kg Maximum 40,000kg/ minimum 10kg Calibration frequency: semestral. Calibration dates: 22/12/2015, 03/05/2016, 15/12/2016 Validity: 1 year Location: UC Aeroporto Type: ALFA 3101C Serial number: 1019F2 Accuracy class: Class III ±10kg Maximum 40,000kg/ minimum 10kg Calibration frequency: semestral. Calibration dates: 22/12/2015, 03/05/2016, 15/12/2016 Validity: 1 year <u>Lab scales</u> Location: UC Itacambira Type: Marte ID200 Serial number: 295287 Accuracy class: Class III ±0.01g Maximum 200g/ minimum 0.01g Calibration frequency: semestral. Calibration dates: 22/12/2015, 03/05/2016, 15/12/2016 Validity: 1 year Location: UC Itacambira Type: Filizola MF 3/1 Serial number: 5478/03 107102 Accuracy class: Class III ±0.5g Maximum 3,000g/ minimum 10g Calibration frequency: semestral. Calibration dates: 22/12/2015, 03/05/2016, 15/12/2016 Validity: 1 year Location: UC Itacambira Type: Marte ID200

	Serial number: 322711 Accuracy class: Class III ±0.01g Maximum 200g/ minimum 0.01g Calibration frequency: semestral. Calibration dates: 22/12/2015, 03/05/2016, 15/12/2016 Validity: 1 year
Measuring/reading/recording frequency:	Annually
Calculation method (if applicable):	Based on provisions of AM0041 version 1
QA/QC procedures:	Standard Operating Procedures should be applied based on provisions of AM0041 version 1 and ISO 9001 standards.
Purpose of data:	Calculation of project emissions
Additional comments:	N/A

Data/parameter:	$NCV_{i,y}$
Unit	GJ/ l
Description	Weighted average net calorific value of fuel type *i* in year *y*
Measured/calculated/default	Default
Source of data	Regional or national default values: GHG Protocol Brazilian Program 2016
Value(s) of monitored parameter	0.03612
Monitoring equipment	N/A
Measuring/reading/recording frequency:	Review appropriateness of the values annually.
Calculation method (if applicable):	N/A
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 comments:	0.03552 GJ/l = 42.2688 TJ/Gg. Diesel density (Source: GHG Protocol Brazilian Program 2016): 0.84 Kg/l = 1.190 l/Kg 35.52 MJ/l * 1.190 l/Kg = 42.2688 MJ/Kg = **42.2688 TJ/Gg**

Data/parameter:	$FC_{i,j,y}$
Unit	Liters per year
Description	Quantity of fuel type *i* combusted in process *j* during the year *y*

Measured/calculated/default	Measured, estimated and calculated
Source of data	Project entity records
Value(s) of monitored parameter	808,745
Monitoring equipment	N/A
Measuring/reading/recording frequency:	Annual
Calculation method (if applicable):	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**
QA/QC procedures:	Standard Operating Procedures based on ISO 9001 standards.
Purpose of data:	Calculation of project emissions
Additional comments:	N/A

Data/parameter:	$M_{SFi,t}$
Unit	Tonne
Description	Mass of synthetic fertilizer type *i* applied, tonne in year *t*
Measured/calculated/default	Measured
Source of data	Record of synthetic fertilizer purchased and used
Value(s) of monitored parameter	87.56
Monitoring equipment	N/A
Measuring/reading/recording frequency:	Keep record of quantities purchased and used, annually
Calculation method (if applicable):	N/A
QA/QC procedures:	Standard Operating Procedures based on ISO 9001 standards.
Purpose of data:	Calculation of project emissions
Additional comments:	NPK is the type of fertilizer used

D.3. Implementation of sampling plan

>> As presented in Section D.2 the carbonization gravimetric yield (Y_{PJ}) is calculated by a sampling approach. The carbonization gravimetric yield was calculated as charcoal weight over wood weight, both on dry basis. The wood and charcoal dry weights were monitored using samples extracted from the forest stands so the project carbonization gravimetric yield results from the weighted average of all forest stands' gravimetric yield. The wood and charcoal moisture and the wood and charcoal wet weights were monitored using proper samples in order to calculate the wood and charcoal dry weights.

The wet wood was weighed on truck scales when entering the carbonization unit. All the wood was weighed and data were automatically registered on a forest stand basis. Inside the carbonization unit, the wood was allocated in stock piles beside the carbonization kilns. The frequency of the diametric classes of the forest stands was determined from the stock piles in order to determine the wood moisture. PP keeps registry of the forest stands' origin for all piles of wood.

The wood moisture was determined according to a stratified random sampling. According to the CDM Guideline "Standard Sampling and surveys for CDM project activities and programme of activities version 04.1", the minimum number of samples for a CDM large scale project needs to attain a 10% error with 95% probability.

According to the PP's Standard Operational Procedure, at least 60 samples are collected from each forest stands covering all diameter classes. Each sample is collected from a wood log and 5 samples of each diameter classes (there are 4 diameter classes) are taken from 3 piles of wood, resulting in 60 samples per forest stand. The laboratory analysis methodology used to calculate the wood moisture of each sample and its data registry are described in a Standard Operational Procedures. The wood moisture of a forest stand was determined covering all the frequency of the wood diameter classes.

The sample plan *"Relatório técnico – Dimensionamento da amostra para estimação da umidade da madeira (base seca) na Unidade de Carbonização MG15"* concluded that 39 samples are required from each forest stand to meet the confidence level of 3% error with 95% probability. Therefore, the PP's actual sampling procedures exceed the requirements of the CDM Guidelines and the sample plan.

Charcoal moisture is determined for all carbonization kilns (population). A Standard Operational Procedure is defined in the PP Quality System in order to determine the charcoal moisture. PP keeps a registry of charcoal moisture and forest stand origin for all loads of charcoal sent to the pig iron mill.

All charcoal produced was weighed in truck scales and was automatically registered. PP keeps registry of the charcoal moisture and forest stand origin for all trucks loaded with charcoal.

SECTION E. Calculation of emission reductions or GHG removals by sinks

E.1. Calculation of baseline emissions or baseline net GHG removals by sinks

>>

$$BE_y = RAE_{BL,y} + IRE_{BL,y} \qquad (1)$$ [17]

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)

<u>Baseline upstream emissions</u>

The baseline upstream emissions are attributable to the primary carbon extraction, reducing agent production and transportation inside national boundaries as applicable to the new iron ore reduction system.

The assessment of baseline upstream emissions is carried out as per the equations below.

[17] This MR maintained the itemization and formulae numbering as per AM0082 version 1, preferably, or PDD 7577 version 3.

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

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)

Although the baseline scenario involves the complete use of coal coke as reducing agent in the new iron ore reduction system, for conservativeness, the primary carbon sources extraction GHG emissions attributable to the coal mining related activities are not taken into account (items (a) and (b) in the CDM Project 7577 PDD version 3). 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 MR because they occur within national boundaries.

1- Coal coke reducing agent in the baseline scenario

$$PCE_{BL,y} = CM_{BL,y} \qquad (A1.1)$$

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_2e)

a) Coal mining emissions

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

Where:

$CM_{BL,y}$	=	GHG emissions due to the coal mining activities in the baseline scenario during year *y* (tCO_2e)
$CM_{BL,machine,y}$	=	GHG emissions due to the coal mining machinery in the baseline scenario during year *y* (tCO_2e/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_2e/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_2e/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

As per CDM Project 7577's PDD version 3, 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.

c) Coal transport to the coal coke production sites

The origin of the coal is considered to be the Vitória Seaport, where coal is shipped to and has a connection with the Vitória-Minas Railway, run by the mining company Vale.

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

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_2e/yr)

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

$AVD_{j,BL,y}$ = Average round trip distance (to and from) between the reducing agent type *v* production site (s) and the site of the project activity during the year *y* (km)

$EF_{v,km,CO2,y}$ = CO_2 emission factor for the type *v* of vehicle during the year *y* (tCO_2e/km)

It was considered the number of 240 wagons per train, the emission factor for diesel (2.622312kgCO_2/l)[18], and the total of 160,000 tonnes of coal[19]. 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 tonne/m^3[20] - is 14.135 t of coal per wagon. The fuel consumption for a train is 2.91 L/1000TKU[21] (Liter per 1,000 tonne of cargo per useful kilometer).

[18] Sources: Fixed ex ante in the PDD.

[19] 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.

[20] Source: Mechanical Engineering Department (DEMEC), Minas Gerais Federal University (UFMG).

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

Coal transport by Rail (within national boundary)		**Results**	**Calculations**
$AVD_{j,BL,y}$	(Km/y)	600	Fixed ex ante in the PDD
$N_{v,BL,y}$	(round trips)	01/01/2016 to 31/12/2016: 45.99	Fixed ex ante in the PDD
$EF_{v,km,CO2,BL}$	(tCO_2e/Km)	0.02589	Fixed ex ante in the PDD
$CM_{BL,Vehicle,y}$	(tCO_2e /y)	01/01/2016 to 31/12/2016: 714	45.99 * 600 * 0.02589

01/01/2016 to 31/12/2016: $CM_{BL,y}$ = (0 + 0) * 0.4875 * 189,588 + 714

Primary Carbon extraction (Upstream Baseline Scenario)	
$CM_{BL,y} = PCE_{BL,y}$	
$PCE_{BL,y} =$ 714 tCO_2e /y	(01/01/2016 to 31/12/2016)

d) Coal coke production

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

Where:

$RAP_{BL,\ coal\ coke,y}$	=	GHG emissions within the project boundary due to production of coal coke used in the iron ore reduction facility in the baseline scenario during year *y*; (tCO_2e 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)

The emission factor to produce one tonne of coal coke in the iron ore reduction system baseline scenario was fixed ex ante in the PDD:

$EF_{CO2e,coal\ coke,y}$ = 0.537

Applying the baseline parameters in the formula:

01/01/2016 to 31/12/2016: $RAP_{BL, coal coke, y}$ = 189,588 * 0.537 * 0.358

Production of coal coke (Baseline Scenario)	
$RAP_{BL, coal coke, y} = RAP_{BL, RA, y}$	
$RAP_{BL, RA, y}$ = 36,447 tCO_2e/y	(01/01/2016 to 31/12/2016)

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

Applying the numbers identified above, the following results correspond to the *total reducing agent components emissions in the upstream baseline,* **Equation 2**.

01/01/2016 to 31/12/2016: $RAE_{BL, y}$ = 714 + 36,447 + 0

Baseline Upstream Emissions		
$RAE_{BL, y}$ =	37,162 tCO_2e	(01/01/2016 to 31/12/2016)

Baseline process emissions

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[22] shall be used for the calculation of baseline process emissions.

For conservativeness reasons, the methodology AM0082 caps the coal coke rate at 0.358 tonnes of coal coke per tonne of hot metal, according to IPCC 2006 Guidelines (see CDM-AM0082 version 1, page 16 for the cap value of 0.358 t coal coke/t hot metal). In order to calculate the baseline process emissions in addition to the coal coke it also considered the use of pulverized coal injection. 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 of carbon 0.360 tonnes of coal coke with

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

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

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

Where:

$IRE_{BL,y}$	=	*Baseline process* emissions within the iron ore reduction facility (tCO_2e)
$P_{PJ,y}$	=	Hot metal production in year *y* (expected hot metal production of the new iron ore reduction system); tonnes of hot metal
$EF_{Ind,BL}$	=	*Baseline* emission factor to produce one tonne of hot metal (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 tCO_2e; (dimensionless)

b) Calculation of emission factor for baseline process emissions

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

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

Where:

$EF_{Ind,BL}$	=	*Baseline* emission factor to produce one tonne of hot metal (tCO_2e/ t of hot metal)[23]
$\%C_{BL,i}$	=	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 tCO_2e (dimensionless)

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

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

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

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

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

<u>Injection of pulverized coal at blast furnace bottom level:</u>

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

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

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

Where:

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

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 3** of the methodology

01/01/2016 to 31/12/2016: $IRE_{BL,y} = (189{,}588 \bullet 1.6345) - (189{,}588 \bullet 0 \bullet \frac{44}{12})$ = 309,878 – 0

Baseline Process Emissions			
$IRE_{BL,y}$	=	309,878 tCO_2e	(01/01/2016 to 31/12/2016)

Calculation of total baseline emissions

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

Applying the above stated:

01/01/2016 to 31/12/2016: BE_y = 37,162 + 309,878

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	=	347,040 tCO_2e /y	(01/01/2016 to 31/12/2016)

E.2. Calculation of project emissions or actual net GHG removals by sinks

>>

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

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

Calculating the upstream emissions takes into consideration the emissions in the production of the primary carbon, the renewable charcoal.

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

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

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_2e /yr)
$RAT_{Vehicle,PJ,y}$	=	CO_2 emissions due to fossil fuel combustion from vehicles used to transport reducing agent(s) to iron ore reduction facility within the project boundary during year *y* of the project scenario; (tCO_2e /yr)

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

a) Establishment of dedicated plantations

To calculate the emissions attributable to the establishment of the dedicated plantations the following formulae were used:

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

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_2e /t biomass)

So,

$$EP_{PJ,y} = E_{FuelBurn,PJ,y} + PE_{BB,y} + N_2O_{direct-N_{fertilizer},PJ,y} + EP_{Vehicle,PJ,y} \quad (A2.1)$$

Where

$EP_{PJ,y}$	=	GHG emissions of the establishment of plantations to produce biomass in the project scenario during year *y*; (tCO_2e /t biomass)
$E_{FuelBurn,PJ,y}$	=	CO_2 emissions from combustion of fossil fuels within the project boundary in the project scenario; tCO_2e 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; (tCO_2e 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_2e /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*

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

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[24]GJ/l diesel * 0.0748[25] tCO_2/GJ diesel

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

And

01/01/2016 to 31/12/2016: $FC_{i,j,y}$ = 808,745 l

So,

01/01/2016 to 31/12/2016: $PE_{FC,j,y}$ = 808,745 l * 0.0027018 tCO_2/l = 2,185 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 considered zero where applicable. So,

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

[24] GHG Protocol Brazilian Program, 2016 - http://www.ghgprotocolbrasil.com.br/

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

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

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

Where:

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

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

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

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}	=	Global Warming Potential for N_2O, kg-CO_2-e (kg-N_2O)$^{-1}$ (298 - IPCC default)
$M_{SFi,t}$	=	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

01/01/2016 to 31/12/2016: $F_{SN,t} = 87.56 * 0.06 *(1 – 0.10) = 4.73$ t N

So,

01/01/2016 to 31/12/2016: $N_2O_{direct-N,t}$ = (4.73 + 0) * 0.01 * 44/28 * 298 = 22 tCO_2/y

d. Biomass transport to the carbonization sites

The project participants chose to calculate the GHG emissions associated with transportation of biomass based on distance travelled by vehicles.

$$EP_{Vehicle,PJ,y} = N_{v,PJ,i,y} \bullet AVD_{i,PJ,y} \bullet EF_{v,km,CO2,PJ,y} \quad (A2.4)$$

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_2e /yr)
$N_{v,PJ,i,y}$	=	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_2e /km)

The average distance between the harvesting sites and the carbonization units in the Farms is 10.89km (see Section D.2). This is the distance considered for the biomass transport calculations. The wood is transported by truck (each truck transports 35m^3 of wood[26]) and the round trip distance from the plantation sites to the carbonization unit is 21.78km (see Section D.2). The amount of wood transported is 693,033 m^3/y[27]; the fuel consumption is 1,0871[28] (see Section D.2) L/km and the emission factor for diesel is 0.0027018 tCO_2e /l [29].

Transport of biomass by Truck (project boundary)		Results	Calculations
$N_{v,PJ,i,y}$	(round trips)	01/01/2016 to 31/12/2016: 19,801	693,033 m^3/y / 35m^3/truck
$AVD_{i,PJ,y}$	(Km)	21.78	Round trip
$EF_{v,km,CO2,PJ,y}$	(tCO_2e /Km)	0.00294	0. 0027018 tCO_2e /l of diesel * 1.0871 l of diesel/Km

[26] Project entity records. Conservatively, PP considered the biggest CO_2 emitter vehicle type.

[27] Project entity records.

[28] Project entity records. Conservatively, PP considered the biggest CO_2 emitter vehicle type.

[29] Sources: GHG Protocol Brazilian Program, 2016, 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 (see Section D.2 parameter $EF_{vf,PJ}$).

01/01/2016 to 31/12/2016: $EP_{Vehicle, PJ, y}$ = 19,801 * 21.78 * 0.00294

Biomass Transport		
$EP_{Vehicle, PJ, y}$ =	1,267 tCO_2e	(01/01/2016 to 31/12/2016)

Applying all the results to **Equation A2.1**, the emissions in the establishment of plantations and production of biomass are:

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

01/01/2016 to 31/12/2016: $EP_{PJ, y}$ = 2,185 + 0 + 22 + 1,267

Establishment of plantations and production of biomass (Project Scenario)		
$EP_{PJ, y} = PCE_{PJ, y}$		
$PCE_{PJ, y}$ =	3,474 tCO_2e /t biomass	(01/01/2016 to 31/12/2016)

b) Renewable charcoal production

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.

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

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_2e /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_2e /yr).

$$RAP_{PJ, charcoal, y} = P_{PJ, y} \bullet EF_{CH4, charcoal, y} \bullet F_{PJ, charcoal} \bullet GWP_{CH4} \qquad (A2.5)$$

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_2e /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 monitors the methane emission factor as per the gravimetric yield results obtained in charcoal production.

$$EF_{CH4,charcoal,PJ,y} = f\ (Y_{PJ}) \quad \text{(A2.6)}$$

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} 01/01/2016 to 31/12/2016
$EF_{CH4,charcoal,PJ,y}$	139.13	313.8	0.3447

01/01/2016 to 31/12/2016: $EF_{CH4,charcoal,PJ,y}$ = (139.13 – (313.8 * 0.3447))/1,000

Emission Factor	
$EF_{CH4,charcoal,PJ,y}$ = 0.0310 tCO_2e	(01/01/2016 to 31/12/2016)

Therefore, applying project results in the formula:

01/01/2016 to 31/12/2016: $RAP_{PJ,charcoal,y}$ = 189,588 * 0.0310 * 0.6875 * 25

Emissions from Charcoal production (Project Scenario)	
$RAP_{PJ,charcoal,y} = RAP_{PJ,RA,y}$	
$RAP_{PJ,RA,y}$ = 100,894 tCO_2e /y	(01/01/2016 to 31/12/2016)

a. Transport of charcoal to the pig iron mill

On the project scenario, the renewable charcoal comes from PP's Carbonization Units located in a conservative distance of 369km from the plant and is transported by truck (each truck transports approximately 27.64 tonnes of charcoal[30]). As previously stated, the round trip was considered – 738km. The amount of charcoal transported was 130,995 tonnes, the fuel consumption 0.5819 L/km[31] and the emission factor for diesel that is 0.0027018 tCO_2e /l [32].

Transport of charcoal by Truck (project boundary)		**Results**	**Calculations**
$N_{v,PJ,j,y}$	(round trips)	01/01/2016 to 31/12/2016: 4,739	130,995 t of charcoal/ 27.64 t capacity of each truck
$AVD_{j,PJ,y}$	(Km)	738	Round trip
$EF_{v,km,CO2,PJ,y}$	(tCO_2e /Km)	0.00157	0.0027018 tCO_2e /l of diesel * 0.5819 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.

$$RAT_{Vehicle,PJ,y} = N_{v,PJ,j,y} \bullet AVD_{j,PJ,y} \bullet EF_{v,km,CO2,PJ,y} \qquad \text{(A2.9)}$$

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_2e /yr)
$N_{v,PJ,j,y}$	=	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_2e /km)

[30] Project entity records.

[31] Project entity records.

[32] See Section D.2 parameter $EF_{vf,PJ}$.

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

01/01/2016 to 31/12/2016: $RAT_{Vehicle, PJ, y}$ = 4,739 * 738 * 0.00157

Renewable Charcoal Route (Project activity Scenario)	
$RAT_{Vehicle, PJ, y}$ = 5,498 tCO_2e /y	(01/01/2016 to 31/12/2016)

Finally, applying the numbers identified above to **Equation 7**, the following results correspond to the total upstream emissions in the project scenario.

01/01/2016 to 31/12/2016: $RAE_{PJ, y} =$ 3,474 + 100,894 + 5,498

Project Upstream Emissions	
$RAE_{PJ, y} =$	109,866 tCO_2e (01/01/2016 to 31/12/2016)

Project process emissions

a) Calculation of the project process emissions

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

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

Where:

$IRE_{PJ, y}$	=	*Project process* emissions in the iron ore reduction facility in year y (tCO_2e)
$P_{PJ, y}$	=	Hot metal production in year *y* (expected hot metal production of the new iron ore reduction system). (tonnes of hot metal)
$EF_{Ind,PJ,y}$	=	Emission factor of one tonne of hot metal production under the project scenario (tCO_2e/ t of hot metal)[33]
$Cc_{HM,PJ,y}$	=	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 tCO_2e; (dimensionless)

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

b) Calculation of project process emission factor

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

Where:

$EF_{Ind,PJ,y}$	=	Emission factor of one tonne of hot metal production under the project scenario (tCO_2e/ t of hot metal)[34]
$\%C_{PJ,i,j,k...}$	=	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 tCO_2e (dimensionless)
i	=	Type of reducing agent *i* (e.g. coal coke, charcoal, etc.)

As the project activity totally relies on renewable charcoal, parameter $\%C_{PJ,i}$ is equal to zero.

Parameter $RA_{PJ\,i}$ = $F_{PJ,charcoal}$ (see Section D.1).

So,

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

01/01/2016 to 31/12/2016: $RA_{PJ\,i}$ = 0.6875 t

Therefore:

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

Emission factor hot metal (Project activity scenario)	
$EF_{Ind,PJ,y}$ = 0	01/01/2016 to 31/12/2016

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

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

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

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 version 1, to increase conservativeness in the calculations of the project emissions the hot metal carbon content shall be accounted as zero.

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

Applying the results to **Equation 8**:

01/01/2016 to 31/12/2016: $IRE_{PJ,y} = (189{,}588 \bullet 0.00) - (189{,}588 \bullet 0.00 \bullet \frac{44}{12})$

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

Calculation of total project emissions

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

Applying the above stated:

01/01/2016 to 31/12/2016: PE_y = 109,866 + 0

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 = 109,866 tCO_2e /y (01/01/2016 to 31/12/2016)

E.3. Calculation of leakage

>> As per the Leakage section of the CDM Project 7577 PDD leakage emissions associated with the primary carbon extraction identified in this project activity is considered as zero. Therefore, no leakage emissions were accounted under this Monitoring Report.

E.4. Summary of calculation of emission reductions or net GHG removals by sinks

Item	Baseline emissions or baseline net GHG removals by sinks (t CO_2e)	Project emissions or actual net GHG removals by sinks (t CO_2e)	Leakage (t CO_2e)	GHG emission reductions or net GHG removals by sinks (t CO_2e) achieved in the monitoring period		
				Up to 31/12/2012	From 01/01/2013	Total amount
Total	347,040	109,867	0	---	237,173	237,173

E.5. Comparison of actual emission reductions or net GHG removals by sinks with estimates in registered PDD

Item	Values estimated in ex ante calculation of registered PDD	Actual values achieved during this monitoring period
Emission reductions or GHG removals by sinks (t CO_2e)	329,068	237,173

E.6. Remarks on difference from estimated value in registered PDD

>> N/A

Appendix 1. Contact information of project participants and responsible persons/entities

Project participant and/or responsible person/ entity	☒ Project participant ☒ Person/entity responsible for completing the CDM-MR-FORM
Organization name	Plantar Carbon Ambiental Ltda
Street/P.O. Box	Av. Raja Gabaglia, 1380
Building	--
City	Belo Horizonte
State/region	Minas Gerais
Postcode	30441-194
Country	Brazil
Telephone	+55 31 3290.4032
Fax	--
E-mail	plantarcarbon@plantarcarbon.com.br
Website	http://www.grupoplantar.com.br/en/negocios/consultoria-em-mudancas-do-clima-e-sustentabilidade/
Contact person	Fábio Nogueira de Avelar Marques
Title	Director
Salutation	Mr.
Last name	Marques
Middle name	Nogueira de Avelar
First name	Fábio
Department	--
Mobile	--
Direct fax	--
Direct tel.	+55 31 3290.4032
Personal e-mail	plantarcarbon@plantarcarbon.com.br

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Document information

Version	*Date*	*Description*
05.1	4 May 2015	Editorial revision to correct version numbering.
05.0	1 April 2015	Revisions to: • Include provisions related to delayed submission of a monitoring plan; • Provisions related to the Host Party; • Remove reference to programme of activities; • Overall editorial improvement.
04.0	25 June 2014	Revisions to: • Include the Attachment: Instructions for filling out the monitoring report form (these instructions supersede the "Guideline: Completing the monitoring report form" (Version 04.0)); • Include provisions related to standardized baselines; • Add contact information on a responsible person(s)/ entity(ies) for completing the CDM-MR-FORM in A.6 and Appendix 1; • Change the reference number from *F-CDM-MR* to *CDM-MR-FORM*; • Editorial improvement.
03.2	5 November 2013	Editorial revision to correct table in page 1.
03.1	2 January 2013	Editorial revision to correct table in section E.5.
03.0	3 December 2012	Revision required to introduce a provision on reporting actual emission reductions or net GHG removals by sinks for the period up to 31 December 2012 and the period from 1 January 2013 onwards (EB70, Annex 11).
02.0	13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the monitoring report form" (EB 66, Annex 20).
01	28 May 2010	EB 54, Annex 34. Initial adoption.

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