CLEAN DEVELOPMENT MECHANISM
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V&M do Brasil Renewable Reducing Agent Project in Brazil

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SECTION A. General description of project activity

A.1 Title of the project activity:

V&M do Brasil Renewable Reducing Agent Project.

A.2. Description of the project activity:

The V&M project consists of investments to enable the maintenance and improvement of the charcoal-based production of pig iron of V&M do Brasil, located in Minas Gerais, Brazil. The income from emissions reductions sold via the procedures set forth by Clean Development Mechanism (CDM) of the Kyoto Protocol will offset the additional costs, risks, and barriers for using charcoal in place of coke in this production process. By choosing to continue using charcoal rather than coke use, V&M will slow down the decline of the charcoal-based pig iron industry; an industry, that has been in the process of being displaced by coal-based steel mills since the mid 1990s. V&M uses charcoal that it produces from its sustainably managed (certified to the Forest Stewardship Council standards) tree plantations[1].

The project and baseline scenarios are, as follows:

Baseline scenario	Project Activity
V&M would use coke for the production of its pig iron, beginning in October 2001 and sell its forestry assets.	V&M will use charcoal for pig iron production beginning in October 2001.

The project has the potential to generate 15,8 million tonnes of CO_2 emission reduction equivalents over a 21-year timeframe.

In addition to lowering GHG emissions, the project also results in social (employment, health, and labour conditions), environmental (biodiversity, air quality) and economic benefits, and it contributes to the sustainable development objectives of the Brazilian Government.

[1] V&M's plans are to ensure that all its charcoal will be supplied from its own forests, which are certified as being sustainably managed according to the requirements of the Forest Stewardship Council. At the moment, however, its forests do not produce sufficiently to attend V&M's charcoal needs. In an initial stage of this project, V&M will buy charcoal from plantations owned by third parties, until their new plantations produce enough for its needs. These plantations still constitute a renewable source of charcoal, preventing the use of coke, a non-renewable fossil fuel.

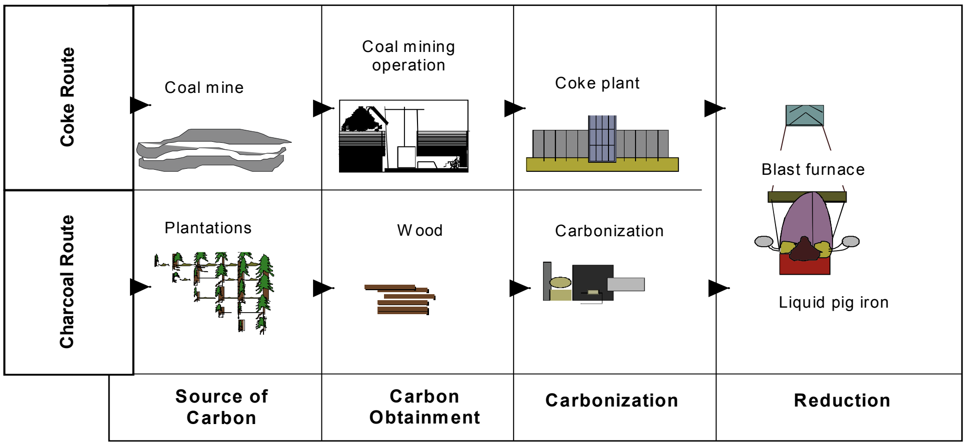

Plate 1. Comparison of coke and charcoal-based pig iron manufacture. Source: Biodiversitas (2001)

A.3. Project participants:

- Carbon credit originator and project operator: V&M do Brasil Ltda., to be authorized by the Brazilian DNA
- Carbon buyer: IFC-Netherlands Carbon Facility (INCaF), on behalf of the Dutch government, to be authorized by the Dutch DNA
- Carbon buyer: Toyota Tsusho, Japan, to be authorized by the Japanese DNA

Further contact information of project participants is provided in Annex 1.

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

A.4.1.1. Host Party(ies):

Brazil. (the "Host Country")

A.4.1.2. Region/State/Province etc.:

Minas Gerais state.

A.4.1.3. City/Town/Community etc:

Barreiro, Belo Horizonte

A.4.1.4. Detail of physical location, including information allowing the unique identification of this project activity (maximum one page):

The project is located at V&M do Brasil's main industrial complex, the Barreiro Integrated Steel Plant, located in Barreiro, Belo Horizonte, Minas Gerais. (V&M do Brasil S.A. - AV. Olinto Meireles, 65 Barreiro – Belo Horizonte, MG 30640 000), where the company's headquarters is located.

A.4.2. Category(ies) of project activity:

Sectoral Category 9, metal production

A.4.3. Technology to be employed by the project activity:

The V&M project is based on the use of charcoal for the production of pig iron, and a new technology is not required at this stage.

A.4.4. Brief explanation of how the anthropogenic emissions of anthropogenic greenhouse gas (GHGs) by sources are to be reduced by the proposed CDM project activity, including why the emission reductions would not occur in the absence of the proposed project activity, taking into account national and/or sectoral policies and circumstances:

In the V&M do Brasil project, the emissions reductions are a result of the use of charcoal from renewable plantations (i.e., carbon neutral) as a source of reduction agent for the production of pig iron instead of coke. From the mid-90s through 2001, V&M corporate management evaluated a conversion to coke and the sale of its forestry assets. This evaluation demonstrated that coke was the most economically attractive alternative, considering financial costs, risks, and barriers. The projected income from CERs was a significant factor in its decision to continue with charcoal use. The project has the potential to generate 14.7 million tonnes of CO_2 emission reduction equivalents over a 21-year timeframe.

V&M began to consider using coke in the mid-90s because a combination of the changes in macro-economic conditions and government policies, particularly the elimination of the FISET program, a government subsidy to forestry producers, significantly increased the production costs of charcoal, causing coke to be a more economical alternative.

The results of the economic analysis conducted by V&M during its decision making process is corroborated by industry trends in this sector:

- **Decreased Forestry Base:** An accelerated reduction in the plantation forestry base in the state of Minas Gerais, The plantation forest area in Minas Gerais was 2.6 million hectares in 1989, when the FISET fiscal incentive programme was discontinued, by 1998 it was reduced to 1.67 million ha (IPEF, 2000, May and Chomitz, 2001), and in 2002 this was already 1.2 million ha (Abracave, 2003).

- **Decreased Charcoal Production:** The reduction of the forest base has led to a scarcity of charcoal as a raw material for the charcoal-based pig iron mills. This has caused many charcoal based pig iron producers to exit the market. From the 67 pig iron companies operating in Minas Gerais in 1992, only 37 were in operation in 2001 (May and Chomitz 2001).

- **Increased Coke Use in Pig Iron Production:** With the reduction in the number of charcoal based pig iron producers, the use of coke in this industry has steadily risen. According to a survey

by Ferreira et al. (2000), the use of coke in the steel and sector in Brazil has risen from approximately 45% in 1970 to 75% in 2000, while the use of charcoal reduced from 55% to 25% in the same period.

These trends demonstrate a large shift toward greenhouse gas (GHG) intensive pig iron production processes and the reduction of the plantation forestry sector in the Minas Gerais state. Revenues from the sale of emissions reductions would decrease the cost of charcoal use, making it more cost competitive in relation to coke use. CDM could therefore play a vital role in increasing charcoal demand and decreasing coke use, thereby reverting those trends described above.

A.4.4.1. Estimated amount of emission reductions over the chosen crediting period:

The project will prevent the emissions of around 754,000 tCO_2e of emissions per year, 2,688,000tCO_2e during the first 7 years and 15,841,000 tCO_2e during 21 years.

Refer to section E for further details on the quantification of GHG emission reductions associated with the project.

A.4.5. Public funding of the project activity:

The project will not receive any public funding from Parties included in Annex I of the UNFCCC.

SECTION B. Application of a baseline methodology

B.1. Title and reference of the approved baseline methodology applied to the project activity:

This project uses the proposed new methodology "Use of renewable reducing agents for the production of pig iron and steel", submitted as a new baseline methodology in parallel with this document.

B.1.1. Justification of the choice of the methodology and why it is applicable to the project activity:

The methodology was developed based on the V&M project, so it is the most appropriate for it. The methodology uses Option (b) "emissions from a technology that represents an economically attractive course of action, taking into account barriers to investment", and uses the Additionality Tool as a means to determine project additionality. As either coke or charcoal can be used in V&M's pig iron production facilities, an economic comparison of the two alternatives, which includes an analysis of the different risks and barriers, is warranted.

B.2. Description of how the methodology is applied in the context of the project activity:

The methodology consists of two stages: firstly, the future baseline scenario is determined based on a comparative financial analysis of the use of charcoal versus the use coke for the production of pig iron. Secondly, the emissions that would take place in this baseline scenario are estimated. The actual emissions of the project activity are then compared to the emissions from the baseline scenario to calculate the emissions reductions.

The methodology is applied within the context of the decision making process of V&M do Brasil when it evaluated the two long term alternatives of either using charcoal or coke for the production of pig iron. The inputs used by V&M to make its decision are used in the application of the methodology to determine what the most economically attractive alternative, considering all barriers and risks, would be. This most economically attractive alternative is considered the baseline scenario.

Demonstration of the starting date of the project activity is shown in Step 0 of the Additionality Test, described in the next section.

B.3. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered CDM project activity:

The determination of how it can be demonstrated that the project activity is additional and therefore not the baseline scenario (i.e., determination of additionality) is done using the Tool for Demonstration and Assessment of Additionality released by the CDM Executive Board at its 16th Meeting, as follows:

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

Given that this project has started operations in 2001, following encouragement for a prompt-start of CDM activities, it is necessary to demonstrate that CDM revenue has been considered from the early stages of development of the project, and it is an integral part of the financial package of the project.

V&M do Brasil, formerly Mannesmann, S.A., began to consider using coke in 1995. During the subsequent years, Mannesmann took several actions that demonstrate its concerns over the raising costs of charcoal production and the potential for revenues from emissions reductions that could be used to counter the increased costs. In 1995, it began discussions with Acesita, Gerdau, and Belgo Mineira, other steel producers, and was invited to participate in a consortium to invest in a coking plant to produce coke from coal (this plant is expected to start operating in 2005, with capacity for 2 million t coke per year). Beginning in 1990, V&M began to reduce substantially investments in its plantations and to over-harvest its crop (see Table 1 below). V&M Florestal was a loss making entity whose last profitable year was in 1996. In 2000, Mannesmann formed a joint venture with the French company Vallourec, forming V&M Tubes, in which Vallourec has the controlling share. V&M Tubes then purchased Mannesmann, S.A. After the management change, Vallourec voiced concerns over the risks and costs of the production and use of charcoal and requested an evaluation of the use of coke. A final decision was to be made in a board meeting in July 2001.

Table 1. V&M's planting areas since 1985. Notice reduction in planting from 1990, when of the discontinuation of the FISET, and replanting from 2002 onwards.

Year	Planting area (ha)
1985	17,643
1986	16,681
1987	18,112
1988	9,625
1989	14,964
1990	5,857
1991	4,443
1992	4,320
1993	4,190
1994	3,152
1995	3,124
1996	1,873
1997	2,938
1998	2,902
1999	1,771
2000	3,485
2001	3,500
2002	6,019
2003	6,000

At the same time, as charcoal was becoming more expensive vis-à-vis coke, Mannesmann (the company name at the time) was looking for alternatives to continue operating in charcoal. Since 1995 Mannesmann had been evaluating the potential revenues from emissions reductions that would enable it to off-set losses in charcoal production. In 1996, Winrock International concluded an evaluation of the potential to generate emissions reductions. In early 2000, Mannesmann signed an agreement with EcoSecurities to market emissions reductions, whose initial evaluation showed a large potential for carbon finance to support the use of charcoal.

During V&M's board meeting of July 2001, a decision was taken to continue with charcoal after it was established that V&M do Brasil would be eligible to sell emissions reductions under the CDM. Following this decision, V&M Florestal received corporate approval and funding to re-start the investment program in the eucalyptus plantations. In addition, V&M approved the acquisition of an existing 22,000 hectare eucalyptus plantation to supplement the amount of charcoal needed in the immediate future (this investment represented a capital expenditure of US$ 7,230,000, incurred in 2001). Documentation of the decision making process, including internal memos and reports are available for inspection by the DOE.

It is clear, therefore, that the company has always considered carbon revenue when it decided the decision making process that led to the implementation of this project.

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

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

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

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

Alternative 2: The use of coke for the production of pig iron, following trends in the industry. These trends are well documented, as shown in Annex 3.1.

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

Both alternatives listed above comply with the laws and regulatory requirements for the production of pig iron in Brazil.

Step 2. Investment Analysis

Sub-step 2a: Determine appropriate analysis method

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

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

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

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

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

As required by the Additionality Tool, the NPV for the two scenarios described in Step 1a should be calculated. Given that revenue should remain unaffected by the choice of the reducing agent used for both scenarios (pig iron production levels using coke or charcoal can be assumed to be the same), this analysis is based on the costs and investments to be made, and the costs and savings associated with each scenario. This will be done according to the following equation:

NPV of Cost Savings of Coke (Charcoal[2]) = NPV [(C $PI_{charcoal}$ + $Capex_{charcoal}$) – (C PI $_{coke}$ – $Capex_{coke}$)]

Where:

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

C $PI_{charcoal}$ is the projected annual production costs of pig iron using charcoal for a specified long term period based on the calculation of the internal production cost of charcoal.

$Capex_{Charcoal}$ is the annual amount of capital expenditures required to operating with charcoal. This is based on the investments related to establishing and maintaining a forestry operation for the production of renewable charcoal, and the renovation of any equipment currently used in the pig iron factory. Forestry investments amount to R$ 242 million (spread over 8 years) for the replanting of V&Ms plantations, starting in 2001. xxxxx. Costs of maintaining the existing blast furnace operating are included.

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

$Capex_{Coke}$ is the amount of capital expenditures required to convert to coke use, including investments related to the adaptation of blast furnaces for the use of coke In the case of V&M this would include an investment in a de-sulphurization plant and the anticipation of the scheduled timing for the relining of its blast furnaces, which are considered in the analysis. This component also includes a "negative Capex", which is the positive cash injection derived from the sale of the degraded forest assets of V&M (these are at the end of their 28-year cycle, but have a residual value) after starting using coke.

If the company had started to use coke, it would have had to build a desulphurisation plant to allow it to operate with 100% coke. It was expected that this plant would have taken 9 months to be built, during which the company would have been operating with 30% coke. This gradual introduction of coke expected in the baseline scenario is captured in the quantification of emission reductions for the project, e.g. a baseline scenario of 30% coke use in first 9 months followed by 100% coke use.

The production and revenue assumptions and input data for the investment analysis do not differ between the two scenarios. There are no differences in the revenues generated by any of the alternative production lines, and no subsidies or fiscal incentives are likely to become available for any of the two alternative production lines.

The discount rate selected for the calculation of NPV is 22 %, and is based on local interest rates in the host country, and accounts for the risks of the project, in accordance with Step 2b-Option II of the Additionality Tool.

As this type of decision reflects a long term corporate strategy, The financial analysis was conducted for a period of 10 years (N = 10 years). This period is longer than the depreciation period of the investments made, and longer than the initial crediting period of 7 years to be chosen. Consequently, the choice of a 10 year period provides for a conservative analysis. A residual value based on a ten year perpetuity was added to the tenth year's cashflow.

Given that this project and all its associated investments were initiated in 2001, the financial data was conducted with the economic parameters available to the company's management at that time of the

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

management decision on the long term strategy to use either coke or charcoal.

The results of this analysis is displayed in the table below and the data used for the calculation of costs of production of pig iron using charcoal or coal by V&M are shown in Annex 3.. As it can be seen from the analysis, the NPV of using coke is positive making it clear that this is the most financially attractive option for the company.

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Production of Pig Iron, tonnes	125,104	476,118	532,724	593,437	594,000	625,838	625,838	625,838	625,838	625,838	625838
Cost Pig Iron produced w/charcoal (R$/t)	146	146	146	146	146	146	146	146	146	146	
Operating Costs, Charcoal (1000 R$/yr)	18,252	69,463	77,721	86,579	86,661	91,306	91,306	91,306	91,306	91,306	
Re-lining Costs, Charcoal (1000 R$/yr)						30,000					
Investment in forest replanting (1000 R$)	44,688	28,224	28,224	28,224	28,224	28,224	28,224	28,224			
Forestry maintenance costs (1000 R$/yr)	7,903	7,903	7,903	7,903	7,903	7,903	7,903	7,903	7,903	7,903	
Total costs of operating with charcoal (1000 R$)	**70,843**	**105,589**	**113,848**	**122,705**	**122,788**	**157,432**	**127,432**	**127,432**	**99,208**	**99,208**	**-**
Cost Pig Iron produced w/coke (R$/t)	190	190	190	190	190	190	190	190	190	190	
Operating Costs, Coke (1000 R$/yr)	23,757	90,413	101,163	112,692	112,799	118,845	118,845	118,845	118,845	118,845	
Re-lining Costs, Coke (1000 R$/yr)				30,000							
Conversion costs to coke (1000 R$)	4,000	-	-	-	-	-	-	-	-	-	
Sale of forest assets (1000 R$)	(107,904)										
Total costs of operating with coke (1000 R$)	**(80,147)**	**90,413**	**101,163**	**142,692**	**112,799**	**118,845**	**118,845**	**118,845**	**118,845**	**118,845**	
Savings from using coke (1000 R$)	**150,990**	**15,176**	**12,685**	**(19,987)**	**9,989**	**38,588**	**8,588**	**8,588**	**(19,636)**	**(19,636)**	**(77,037)**
Discount rate (%)	22%										
NPV of Cost Savings of Coke, R$	**136,593**										

Terminal Value of Cost Savings:
10 year annuity

Sub-step 2d: Sensitivity analysis

In order to confirm the results above, a sensitivity analysis was conducted by altering the following parameters:

- Reduction in operating costs of charcoal use;
- Increases in operating costs of coke use;
- Reduction in project capital (CAPEX) and running costs (Operational and Maintenance costs) of charcoal use.
- Increase in project capital (CAPEX) and running costs (Operational and Maintenance costs) of coke use.

Financial analyses were performed altering each of these parameters by:

- 15%, for the reduction in operating costs of charcoal use. This is the standard deviation of the mean costs of pig iron production using charcoal in V&M, for the previous 5 years prior to the beginning of the project;
- 11.1% for the increases in operating costs of coke use. This is the standard deviation of the mean of costs of coke delivered in Brasil for the previous 5 years prior to the beginning of the project;
- 20% for reduction in project capital costs (CAPEX) related to the conversion to charcoal use (i.e., investment in reforestation);
- 20% for the increase in project capital costs (CAPEX) related to the conversion to coke use.

After doing the modifications, their impact on the project NPV is assessed (see Table below). As it can be seen, the project NPV remains positive (i.e., the cost savings of using coke remain positive and significant) even in the case where these parameters change in favour of the project.

Scenario	**NPV (1000 Reais $)**
Original	136,593
Reduced operating costs charcoal	84,696
Increased operating costs coke	91,545
Reduced Capex Charcoal	116,163
Increased Capex coke	135,937

Note: NPV uses 22% discount rate.

Step 3. Barrier Analysis

Sub-step 3a. Identify the relevant barriers to the proposed project activity.

The use of this step is optional. However, in addition to the direct financial costs related to the choice of reducing agent (charcoal or coke), it is also important to recognize and take into account the risks associated with using charcoal. The following barriers were also identified as affecting the decision to continue using charcoal:

- Increased labour costs of charcoal production;
- Labour liabilities associated with large labour force necessary for charcoal production;
- Operational risk of charcoal production, including fire, pests and diseases, and reduced yields on harvested forests;
- Significant amount of immobilised capital required for plantation investments;
- High perceived risk by V&M's shareholders in regards to maintaining a large forestry operation exposed to environmentalist criticism, biological damage and human accidents.

- Lower risk associated with coke supply: Availability of long term contracts for coke purchase from creditworthy counterparties. This allows the pig iron producer to predict costs and enable it to have a relatively risk free supply of reductant.

As the results of the financial analysis are conclusive enough, no further analysis will be conducted on the effects of these barriers. In summary, however, the use of charcoal faces a series of barriers that have led V&M's management to consider conversion into coke if carbon finance does not materialise.

Step 4. Common Practice Analysis

As required in the Additionality Tool, the generic additionality tests shall be complemented with an analysis of the extent to which the proposed project type (e.g. technology or practice) has already diffused in the relevant sector and region. In this case, it should be an analysis of the trends of the pig iron production sector in relation to the reducing agent used.

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

Please refer to Annex 3.2 for a full analysis of trends in this sector.

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

If similar activities are widely observed and commonly carried out, it calls into question the claim that the proposed project activity is financially unattractive (as contended in Step 2) or faces barriers (as contended in Step 3). Please refer to Annex 3.2 for a full analysis of trends in this sector.

Step 5. Impact of CDM registration

As shown in Step 2 (or Step 3) above, the project is unlikely to move forward without the additional financial support of the CDM. If the developer was able to generate 14 million tonnes of emission reduction credits from the project activity, the additional revenue generated by carbon sales would be reduce the price differential between the fuels and make the project go ahead. This is particularly important in the case of V&M, as the parent company is located in France and exposed to the caps imposed by the EU Emissions Trading System.

B.4. Description of how the definition of the project boundary related to the baseline methodology selected is applied to the project activity:

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

The emissions associated with the mining and transportation of coal imported to Brazil must not included in the analysis. This is because, a) if these emissions were included, one would also need to take into consideration the possible sources of transnational leakage that the project could generate; and b) there is still a lack of definition regarding 'ownership' of emissions (and consequently emission reductions) associated with international transport. The complexity of this type of analysis, coupled with the lack of

definitions regarding international 'property rights' related to emission reductions, were determinant in limiting the boundaries of this analysis to the limits of Brazil.

While it is expected that the implementation of the project activity will lead to additional carbon sequestration in relation to the baseline (see below for an analysis), this will not be claimed by the project proponent.

Table 2 below provides a list of the gases and sources to be included for the evaluation of emissions of both project and baseline scenarios.

Table 2: Summary of system and project boundaries, as well as sources and gases included in the assessment.

Emissions	Project Scenario	Baseline Scenario
Direct on-site	CO_2 Emissions from the use of renewably produced charcoal for pig iron production ($tC0_2$/t charcoal). By definition, charcoal from renewable sources is a 'carbon neutral' fuel and therefore this factor is zero. CO_2 Emissions from the use of non renewably produced charcoal for pig iron production ($tC0_2e$/t charcoal). This charcoal is not considered "carbon neutral" and therefore all GHG emitted must be accounted for. CO_2 Emissions from the use of coke for pig iron production ($tC0_2e$/t coke): carbon content of coke (tCO_2e/t coke) + CO_2 emissions during coking (tCO_2/t coke used) – CO_2 fixed in pig iron (carbon fixed in iron, in tCO_2e/t coke used). Methane (CH_4) emissions that occur during production of renewable charcoal (tC02e /t charcoal produced) Methane (CH_4) emissions that occur during production of non-renewable charcoal (tC02e /t charcoal produced). Methane (CH_4) emissions that occur during the coking process (tC02e /t coke). Most coking plants do not emit CH_4, therefore it is assumed that this value is zero. Please note that by definition a greater quantity of coke will be used in the Baseline Scenario than in the Project Activity, therefore this assumption enhances the conservativeness of the analysis. Nitrous oxide (N_2O), both from thermal and chemical processes taking place during carbonisation ($tC0_2e$/t charcoal produced). **Note:** N_2O emissions are usually difficult to measure and are usually lower in the case of carbonisation, as opposed to the coking process. Given that they are expected to be lower in the case of the project activity (see below for an analysis), these will be excluded from the estimation of emission reductions generated by the project activity. Nitrous oxide (N_2O), both from thermal and chemical processes taking place during the coking process ($tC0_2e$/t coke produced).	
Direct off-site	Given that If the carbon stocks in the forests are expected to reduce as a consequence of the project (see below for an analysis), this "negative emissions" will be excluded from the calculations. Fossil fuel emissions associated with planting and harvesting. Emissions related to the mining and international transportation of coal – excluded, as there will be no use of coke in the project activity and for the reasons mentioned for the use of coke in the baseline scenario	CO2 emissions from forestry operations if the pig iron company stops using charcoal. While in the baseline this would result in a reduction in carbon stocks in the forest (and thus, emissions), the methodology conservatively assumes that there will not be any emissions associated with forestry activities in the baseline. Emissions related to the mining and international transportation of coal – excluded. Given that the use of coal/coke is higher in the baseline scenario, this provides for a conservative analysis.
Indirect on-site	Emissions from electricity use for operation of lights and fans of on-site workshops – excluded, as it is expected to be the same in both scenarios	
Indirect off-site	CO_2 emissions associated with the transportation of charcoal or coke (the 'reductants') from its origin to the pig iron mill ($tC0_2$/t reductant transported). **Note**: transport emissions are difficult to measure and in general very small in relation to the overall emission reductions generated by this type of project. Given that are expected to be lower in the case of the project activity (section below for an analysis), these are excluded from the estimation of emission reductions generated by the project.	

Justification for the exclusion of certain sources from the calculations of emissions in baseline and project scenarios

Three sources of emissions will be excluded from the calculations, as it is deemed to result in more conservative estimations of emissions reductions, namely N_2O emissions, transport emissions, and forestry emissions. These are discussed in further detail below.

N_2O emissions

In the case of the carbonisation process (utilised in the project scenario), this leads to the emissions of 0.0000304 tN_2O per t of charcoal produced (according to measurement conducted in V&M). In the case of the coking process, this leads to the emissions of 0.000221 t N_2O per t of coke produced (UK Emission Factors Dbase). Considering the relative amounts of charcoal and coke to be used in the project and baseline scenarios, respectively, it can be calculated that the charcoal route would lead to a reduction in N_2O emissions. Given that these are difficult to measure accurately, these will be excluded from the calculations, contributing to a more conservative approach.

Transport emissions

Those related to the transportation of charcoal or coke from its origin to the pig iron mill. Charcoal would be transported from V&M's forests to the mills, 350 km away, in 27-tonne trucks, requiring an average of 5.19 litres of diesel per tonne of pig iron produced. Coke would need to be transported from the coking plants to the factory by train, at least 750 km away, requiring an average of 6.25 litres of diesel per tonne of pig iron produced. Although the charcoal route would lead to a small reduction in transport emissions, these are difficult to measure accurately and will be excluded from the calculations.

Forestry emissions

These are related to the fate of V&M's forests in the project and baseline scenarios. A full analysis is given in Annex 3.B, and the results are summarised below.

In the case of V&M do Brasil, the company currently owns 200,000 hectares of land, of which 130,000 hectares contain plantation forests for charcoal production. These forests currently store an average of 250 tonnes of CO2 per hectares. This gives a total of 32,500,000 tonnes of CO2 over the entire estate (excluding conservation areas).

In the case of the continuing use of charcoal, V&M do Brasil would invest in the amelioration of 50,000 hectares of existing forests, increasing the average storage of the estate to 264.5 tonnes of CO2 per hectare over a 20 year period. This corresponds to a yearly increase in carbon stock of 0.7 tonnes of CO2 per hectare. For the total forest estate, this change in land use would lead to an increase in carbon stock of 89,324 tonnes of CO2 per year.

In case V&M do Brasil stopped using charcoal for its industrial operations, it was assumed that the all existing forests would be gradually harvested, as they reach maturity, and the land would be sold and converted into pasture land. Over a period of 20 years, the average storage in the site would reduce to 163.7 tonnes of CO2 per hectare, corresponding to a reduction in carbon stocks of 4.4 tonnes of CO2 per hectare per year. For the total forest estate, this change in land use would lead to the emissions of 565,707 tonnes of CO2 per year.

Therefore, the maintenance and amelioration of the forest estate associated with the use of charcoal for the production of steel by V&M do Brasil would have an impact equivalent to 655,031 tonnes of CO2 emission reductions per year (89,324 tonnes of CO2 from additional storage and 565,707 tonnes of CO2 from avoided emissions).

Table 3: Summary of emissions and sequestration associated with the land use processes related to the use of charcoal and coal for the production of liquid steel. The full analysis behind these figures is shown in Annex 3.B.

	Charcoal	**Coal**
Existing carbon stock in forest (t CO2/ha)	250.7	
Average carbon storage over project duration (tCO2/ha)	264.5	163.7
Project duration (years)	20	
Change in stock over project duration (tCO2/ha)	13.7	-87.0
Yearly change in carbon stock (tCO2/yr)	0.7	-4.4
Number of ha	130,000	
Sequestration per year (tCO2)	**89,324**	**-565,707**[a]

a. A negative sign denotes an emission

For these reason, the net emissions from forestry activities in the project scenario are positive (i.e., there will be a sequestration effect), and these can be excluded from the calculation of emission reductions for the project.

B.5. Details of baseline information, including the date of completion of the baseline study and the name of person (s)/entity (ies) determining the baseline:

This revised baseline study was concluded in April 2005, based on reviews of the studies conducted in November 2000 and August 2003. The entities responsible for the determination of the baseline are EcoSecurities Ltd., UK and the IFC-Netherlands Carbon Facility (INCaF), International Finance Corporation, World Bank Group

SECTION C. Duration of the project activity / Crediting period

C.1 Duration of the project activity:

C.1.1. Starting date of the project activity:

01/10/2001

The corporate decision on whether to convert to use coke or charcoal was made in July, 2001 With the decision to avoid the coke conversion in favour of continued charcoal came the corporate approval to fund the investment plan for V&M Florestal, the company's subsidiary that produces charcoal The project start date is 1st October 2001, when V&M do Brasil would have begun to use coke in the event it had chosen the baseline scenario. V&M do Brasil and when it started investing in new forest assets for the production of charcoal. (see Step 0 of Additionality Tool for more details).

C.1.2. Expected operational lifetime of the project activity:

21 years

C.2 Choice of the crediting period and related information:

C.2.1. Renewable crediting period

C.2.1.1. Starting date of the first crediting period:

10/01/2001

C.2.1.2. Length of the first crediting period:

7 (seven) years.

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

Not applicable

C.2.2.2. Length:

Not applicable

SECTION D. Application of a monitoring methodology and plan

D.1. Name and reference of approved monitoring methodology applied to the project activity:

'Monitoring Emission Reductions from Using a Renewable Reducing Agent in the Pig Iron Industry', submitted as new methodology in parallel with this PDD.

D.2. Justification of the choice of the methodology and why it is applicable to the project activity:

The methodology allows the monitoring and calculation of emission reductions from the use of charcoal as opposed to coke as a reducing agent in pig iron and steel production. This methodology was developed specifically for use by the V&M do Brasil Renewable Reducing Agent Project., although it is also applicable to similar projects.

D.2. 1. Option 1: Monitoring of the emissions in the project scenario and the baseline scenario

D.2.1.1. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:

ID	Data variable	Source of data	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
1	Q_{Ch-R} - Quantity of renewable charcoal used by the project	To be measured by project developer	tonnes	M	Daily	100%	Electronic / paper	Weighted at different points: production site, factory gate, and production line. Double checked by receipts or internal production and utilisation records.
2	Q_{Ch-U} - Quantity of non-renewable charcoal used by the project	To be measured by project developer	tonnes	M	Daily	100%	Electronic / paper	Weighted at different points: factory gate, and production line. Double checked by receipts or internal production and utilisation records.
3	Q_{Co} - Quantity of coke used in the project	To be measured by project developer	tonnes	M	Daily	100%	Electronic / paper	Weighted at different points: factory gate, and production line. Double checked by receipts or internal production and utilisation records.
4	CEF_{CH-R} - Carbon Emissions Factor of renewable charcoal	-	tCO_2e/t coke used	E	Once at the beginning of each crediting period		Electronic / paper	Same data used forr quantification of project and baseline emissions
5	CEF_{Ch-U} - Carbon Emissions Factor of non-renewably produced charcoal	662.71 F981c – Fundação Centro Tecnologico De Minas Gerais Cetec. Carvão Vegetal; destilação, propriedades e controle de qualidade. Belo Horizonte, 1982. 1v. 662.71 F981p – Fundação Centro Tecnologico De Minas Gerais CETEC – Produção e Utilização de Carvão Vegetal, Belo Horizonte, 1982, 1v.	tCO_2/t charcoal	C	Yearly		Electronic / paper	Calculated as $CF_{ch} + Ca_{ch} - C_{I-CH}$
6	Cf_{ch} - Carbon content of	662.71 F981c – Fundação	tCO_2e/t	M	Yearly	Sample	Electronic /	Value of 2.933 used. 662.71 F981c –

	charcoal	Centro Tecnologico De Minas Gerais Cetec . Carvão Vegetal; destilação, propriedades e controle de qualidade. Belo Horizonte, 1982. 1v. 662.71 F981p – Fundação Centro Tecnologico De Minas Gerais CETEC – Produção e Utilização de Carvão Vegetal, Belo Horizonte, 1982, 1v.	charcoal				paper	Fundação Centro Tecnologico De Minas Gerais Cetec . Carvão Vegetal; destilação, propriedades e controle de qualidade. Belo Horizonte, 1982. 1v. 662.71 F981p – Fundação Centro Tecnologico De Minas Gerais CETEC – Produção e Utilização de Carvão Vegetal, Belo Horizonte, 1982, 1v.. Same data used for quantification of project and baseline emissions
7	Ca_{ch} - CO2 emissions during carbonisation	Same reference as in lines 5.	tCO_2e/t charcoal	M	Yearly	sample	Electronic / paper	Value of 3.751 used, 662.71 F981c – Fundação Centro Tecnologico De Minas Gerais Cetec. Carvão Vegetal; destilação, propriedades e controle de qualidade. Belo Horizonte, 1982. 1v. 662.71 F981p – Fundação Centro Tecnologico De Minas Gerais CETEC – Produção e Utilização de Carvão Vegetal, Belo Horizonte, 1982, 1v. Same data used for quantification of project and baseline emissions
8	$C_{I\text{-}CH}$ - Carbon Fixed in Pig Iron produced using charcoal	Average gross specific charcoal consumption of V&M do Brasil. Can be replaced with data specific to other project developers.	tCO2/t charcoal	M	Yearly	Sample	Electronic / paper	Value of 0.203 used, Average gross specific charcoal consumption of V&M do Brasil.
9	CEF_{CO} - Carbon Emissions Factor of coke used in the pig iron production process	Calculated using parameters below	tCO_2e/t coke used	C	Once at the beginning of each crediting period		Electronic / paper	Calculated as $CF_{co} + C_{co} - C_{I\text{-}CO}$
10	Cf_{co} - Carbon content of coke	Prototype Carbon Fund, Brazil Plantar Baseline Report, Final: March 14, 2002, at site: http://prototypecarbonfund.org	tCO_2e/t coke used	M	Yearly	Sample	Electronic / paper	Value of 3.234 used, (Prototype Carbon Fund, Brazil Plantar Baseline Report, Final: March 14, 2002, at site: http://prototypecarbonfund.org)
11	C_{co} - CO2 emissions during coking	Prototype Carbon Fund, Brazil Plantar Baseline Report, Final: March 14,	tCO_2e/t coke used	E	Once, at the beginning of each		Electronic / paper	Value of 0.654 used, (Prototype Carbon Fund, Brazil Plantar Baseline Report, Final: March 14, 2002, at site:

		2002, at site: http://prototypecarbonfund.org			crediting period			http://prototypecarbonfund.org). Same data used for quantification of project and baseline emissions
12	C_{I-CO} - Carbon Fixed in Pig Iron produced using coke	Prototype Carbon Fund, Brazil Plantar Baseline Report, Final: March 14, 2002, at site: http://prototypecarbonfund.org	tCO2/t coke	M	Once, at the beginning of each crediting period	Sample	Electronic / paper	Value of 0.315 used, Prototype Carbon Fund, Brazil Plantar Baseline Report, Final: March 14, 2002, at site: http://prototypecarbonfund.org
13	M_{Ch-R-p} - Methane emissions from carbonisation process (renewable)	Smith, R.K., at al , 1999. Charcoal-Making Kilns in Thailand, US EPA study EPA-600/R-99-109, Washington DC	TCH_4e/t charcoal	M	Yearly	Sample	Electronic / paper	Value of 0.0462 used, measured according to measurements carried by Smith et al., 1999.
14	M_{Ch-U} - Methane emissions from carbonisation process (non-renewable)	Smith, R.K., at al , 1999. Charcoal-Making Kilns in Thailand, US EPA study EPA-600/R-99-109, Washington DC	tCH_4/t charcoal	M	Once at the beginning of each crediting period	Sample	Electronic / paper	Value of 0.056 used, according to measurements carried by Smith et al., 1999. This value is assumed to reflect the emissions of the least advanced technology available in Brasil, and it should be assumed that all charcoal from third parties have the same emissions level Same data used for quantification of project and baseline emissions
15	M_{Co} – Methane emissions from coking		tCH_4/t coke	E	Once at the beginning of each crediting period		Electronic / paper	Value of 0 used, as most modern coke mills in Brasil do not emit methane. By using 0 as the emissions factor, this leads to a conservative estimate, as more coke is used in the baseline. Same data used for quantification of project and baseline emissions
16	N_{Ch} - Nitrous oxide taking place during carbonisation	Fundação Centro Tecnologico De Minas Gerais Cetec. Carvão Vegetal; destilação, propriedades e controle de qualidade. Belo Horizonte, 1982.	tN_2O/t charcoal	M	Once at the beginning of each crediting period	Sample	Electronic / paper	Value of 0.0000304 used, measured in V&M do Brasil laboratories. Same data used for quantification of project and baseline emissions. These are smaller in the project activity in relation to the baseline, and will be excluded from the calculations
17	N_{Co} - Nitrous oxide taking place during coking	UK Emission Factors database	tN_2O/t coke	M	Once at the beginning of each crediting period	Sample	Electronic / paper	Value of 0.000221 used, based on UK Emissions Factor database. Same data used for quantification of project and baseline emissions. These are smaller in the project activity in relation to the baseline, and will be

								excluded from the calculations
18	Total quantity of charcoal required per year	To be determined by project developer	tonnes	M	Continuousl y	100%	Electronic / paper	
19	Capacity of trucks transporting charcoal to pig iron mill	To be determined by project developer	tonnes	M	Yearly, to account for any changes in transport technology	Sample	Electronic / paper	Transport emissions are smaller in the project activity in relation to the baseline, and will be excluded from the calculations
20	Average one-way distance charcoal is transported	-	To be determined by project developer	M	Yearly, to account for any changes in supply points	100%	Electronic / paper	Transport emissions are smaller in the project activity in relation to the baseline, and will be excluded from the calculations
21	Fuel used by trucks	-	To be determined by project developer	C	Yearly, to account for any changes in fuel mix used in the project country	Sample	Electronic / paper	Transport emissions are smaller in the project activity in relation to the baseline, and will be excluded from the calculations
22	Average fuel economy of trucks	-	To be determined by project developer	C	Yearly, to account for any changes in transport technology	Sample	Electronic / paper	Transport emissions are smaller in the project activity in relation to the baseline, and will be excluded from the calculations
23	Fuel CEFs	Dependent on fuel	IPCC	E	Once at the beginning of each crediting period		Electronic / paper	Transport emissions are smaller in the project activity in relation to the baseline, and will be excluded from the calculations
24	Global Warming Potential values for CH_4 and N_2O	21 and 310, respectively	IPCC	E	Once at the beginning of each crediting period		Electronic / paper	Same in the project and baseline scenarios.
25	Carbon stocks and emissions in project company's forests		To be determined by project developer, following	M and e	Yearly	100%	Electronic / paper	As forestry emissions will be higher in the baseline than in the project scenario, this will include only the fossil fuel emissions associated with forestry activities in the project.

			approach determined in sections D7 and D8					
26	Costs of production of charcoal	-	To be determined by project developer	C	Yearly	100%	Electronic / paper	
27	Price of coke and charcoal purchased from third parties	-	Past invoices, suppliers' data, or national statistics and projections	E	Yearly	100%	Electronic / paper	

D.2.1.2. Description of formulae used to estimate project emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

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

Where,

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

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

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

$\mathbf{CEF_{ch-R}}$ = Carbon Emissions Factor of the use of renewably produced charcoal for pig iron production ($tC0_2$/t charcoal). By definition, charcoal from renewable sources is a ‘carbon neutral’ fuel and therefore this factor is zero.

$\mathbf{CEF_{ch-U}}$ = Carbon Emissions Factor of the use of non renewably produced charcoal for pig iron production ($tC0_2e$/t charcoal): carbon content of charcoal (tCO_2e/t charcoal) + CO_2 emissions during carbonisation (tCO_2/t charcoal used) - C_i (carbon fixed in iron, in tCO_2e/t charcoal used). This charcoal is not considered “carbon neutral” and therefore all CO_2 emitted must be accounted for.

$\mathbf{CEF_{co}}$ = Carbon Emissions Factor of the use of coke for pig iron production ($tC0_2e$/t coke): carbon content of coke (tCO_2e/t coke) + CO_2 emissions during coking (tCO_2/t coke used) - C_i (carbon fixed in iron, in tCO_2e/t coke used).

$\mathbf{M_{ch-R}}$ = Methane (CH4) emissions that occur during production of renewable charcoal (tC02e /t charcoal produced), assuming a Global Warming Potential for CH4 = 21).

$\mathbf{M_{ch-U}}$ = Methane (CH4) emissions that occur during production of non-renewable charcoal (tC02e /t charcoal produced), assuming a Global Warming Potential for CH4 = 21).

$\mathbf{M_{co}}$ = Methane (CH4) emissions that occur during the coking process (tC02e /t coke), assuming a Global Warming Potential for CH_4 = 21). Most coking plants do not emit CH_4, therefore it is assumed that this value is zero. Please note that by definition a greater quantity of coke will be used in the Baseline Scenario than in the Project Activity, therefore this assumption enhances the conservativeness of the analysis.

$\mathbf{N_{ch}}$ = Nitrous oxide (N_2O), both from thermal and chemical processes taking place during carbonisation ($tC0_2e$/t charcoal produced, assuming a Global Warming Potential for N_2O = 310). **Note:** N_2O emissions are usually difficult to measure and are usually lower in the case of carbonisation, as opposed to the coking process. As these are expected to be lower in the case of the project activity (see Section B.4), they will be excluded from the estimation of emission reductions generated by the project activity.

N_{co} = Nitrous oxide (N_2O), both from thermal and chemical processes taking place during the coking process ($tC0_2e$/t coke produced, assuming a Global Warming Potential for N_2O = 310).

T_{ch} and **T_{co}** =CO_2 emissions associated with the transportation of charcoal or coke (the 'reductants') from its origin to the pig iron mill ($tC0_2$/t reductant transported). To calculate the emissions from the transportation of reductants the following information is required:

- Total quantity of reductant required per annum (tonnes);
- Capacity of trucks/trains etc transporting the reductant to the pig iron mills (tonnes). This capacity should be checked annually, or if the type of transportation is changed;
- Number of trips required. This equals the quantity of reductant required divided by the capacity of trucks/trains, therefore there are no additional variables to be monitored;
- Average one-way distance from the port to the pig iron mills (km). This value will remain constant over the lifetime of the project;
- Total trip distance for reductant transportation per annum (km); equals the number of trips multiplied by the average return distance, multiplied by 2 to give the average return distance (to be conservative it is assumed that the truck/train will return to its origin empty), there are no additional variables to be monitored for this step;
- Fuel type used by the trucks/trains. The fuel type should be checked annually, or if the type of transportation is changed;
- Average fuel economy of trucks/trains used (km/l). Default factors from reputable references may be used. This value should remain constant however it is recommended that the fuel economy be checked at the start of each crediting period, or if the type of transportation is changed;
- Fuel consumed for the transportation of reductant (litres), equals the total trip distance multiplied by the average fuel economy of the trucks used to transport the reductant, there are no additional variables to be monitored for this step;
- Fuel CEF ($kgCO_2$/l), which can be found in a reputable reference. This value will remain constant over the lifetime of the project, however it is recommended that the project developer checks this value at the start of each crediting period;
- Therefore, **T_{ch}** or T_{co} ($tC0_2$/t reductant transported) equals the amount of fuel consumed for the transportation of reductant, multiplied by the CEF for the fuel used, divided by the total quantity of reductant transported.
- **Note**: transport emissions are usually difficult to measure and in general very small in relation to the overall emission reductions generated by this type of project. As these are expected to be lower in the case of the project activity, they will be excluded from the estimation of emission reductions generated by the project.

Forestry emissions$_{project}$ = Emissions associated with V&M forestry activities if it does not start using coke and remains using charcoal. As the carbon stocks in the project scenario are expected to increase in relation to the baseline scenario, as demonstrated in Section B.4, there are no net emissions increase as compared to the baseline scenario. For this reason, forestry emissions will be excluded from the calculations, but all fossil fuel emissions associated with planting and harvesting taking place in the project scenario will still be accounted for, as these are expected to be higher than in the baseline scenario.

D.2.1.3. Relevant data necessary for determining the baseline of anthropogenic emissions by sources of GHGs within the project boundary and how such data will be collected and archived :

ID	Data variable	Source of data	Data unit	M, C or e	Recording frequency	Proportion of data to be monitored	How will the data be archived?	Comment
28	Q_{Ch-R} - Quantity of renewable charcoal used in the baseline	Project developer	*tonnes*	E	Proportion of reductants to be used is fixed at the beginning of each crediting period. The actual volume is measured in the project scenario, continuously		Electronic / paper	Derived from the actual amount of reductants used in the project scenario, that will be monitored continued throughout the project lifetime.
29	Q_{Ch-U} - Quantity of non-renewable charcoal used in the baseline scenarios	Project developer	tonnes	E	" " " " "		Electronic / paper	Derived from the actual amount of reductants used in the project scenario, that will be monitored continued throughout the project lifetime.
30	Q_{Co} - Quantity of coke used in the baseline	Project developer	tonnes	E	" " " " "		Electronic / paper	Derived from the actual amount of reductants used in the project scenario, that will be monitored continued throughout the project lifetime.
31	Total quantity of reductant required per year in the baseline scenario	Project developer, transport company	tonnes	M	" " " " "	Sample	Electronic / paper	Derived from the actual amount of reductants used in the project scenario, that will be monitored continued throughout the project lifetime.
32	Capacity of trains transporting coke to pig iron mill	Project developer, transport company	tonnes	M	Yearly, to account for any changes in transport technology	Sample	Electronic / paper	Transport emissions are smaller in the project activity in relation to the baseline, and will be excluded from the calculations
33	Average one-way distance coke is transported	Project developer, transport company	Km	M	Yearly, to account for any changes in supply points	100%	Electronic / paper	Transport emissions are smaller in the project activity in relation to the baseline, and will be excluded from the calculations
34	Fuel used by trains	Project developer, transport company	Litres	C	Yearly, to account for any changes in	Sample	Electronic / paper	Transport emissions are smaller in the project activity in relation to the

					fuel mix used in the project country			baseline, and will be excluded from the calculations
35	Average fuel economy of trains	Project developer, transport company	Km/l	C	Yearly, to account for any changes in transport technology	Sample	Electronic / paper	Transport emissions are smaller in the project activity in relation to the baseline, and will be excluded from the calculations
36	Carbon stocks and emissions in project company's forests in baseline scenario	Project developer	tCO_2e	e	Yearly	sample	Electronic / paper	As forestry emissions will be higher in the baseline than in the project scenario, this will be excluded from the calculation of baseline emissions
37	CAPEX investments and maintenance costs	To be selected by project developer, based on manufacturers' information or previous investments of a similar nature made by the company	$	E and C	Once at the beginning of each crediting period	100%	Electronic / paper	
38	Discount rate used for NPV calculation	To be selected by project developer	%	E	Once at the beginning of each crediting period		Electronic / paper	Same for project and baseline
Additionality, the following data are also used, but these are the same as listed in the project scenario table D.2.1.1.1 (hence the same ID number)								
4	CEF_{CH-R} - Carbon Emissions Factor of renewable charcoal	-	tCO_2e/t coke used	E	Once at the beginning of each crediting period		Electronic / paper	Same data used for quantification of project and baseline emissions
5	CEF_{Ch-U} - Carbon Emissions Factor of non-renewably produced charcoal	662.71 F981c – Fundação Centro Tecnologico De Minas Gerais Cetec. Carvão Vegetal; destilação, propriedades e controle de qualidade. Belo Horizonte, 1982. 1v. 662.71 F981p – Fundação Centro Tecnologico De Minas Gerais CETEC – Produção e Utilização de Carvão Vegetal, Belo Horizonte, 1982, 1v.	tCO_2/t charcoal	C	Yearly		Electronic / paper	Calculated as $CF_{ch} + Ca_{ch} - Cic_h$
6	Cf_{ch} - Carbon content of charcoal	662.71 F981c – Fundação Centro Tecnologico De	tCO_2e/t charcoal	M	Yearly	Sample	Electronic	Same data used for quantification of

		Minas Gerais Cetec . Carvão Vegetal; destilação, propriedades e controle de qualidade. Belo Horizonte, 1982. 1v. 662.71 F981p – Fundação Centro Tecnologico De Minas Gerais CETEC – Produção e Utilização de Carvão Vegetal, Belo Horizonte, 1982, 1v.					/ paper	project and baseline emissions
7	Ca_{ch} - CO2 emissions during carbonisation	Same reference as in lines 5.	tCO_2e/t charcoal	M	Yearly	sample	Electronic / paper	Same data used for quantification of project and baseline emissions
9	CEF_{CO} - Carbon Emissions Factor of coke used in the pig iron production process	Calculated using parameters below	tCO_2e/t coke used	C	Once at the beginning of each crediting period		Electronic / paper	Calculated as $CF_{co} + C_{co} - Ci_{co}$
10	Cf_{co} - Carbon content of coke	Prototype Carbon Fund, Brazil Plantar Baseline Report, Final: March 14, 2002, at site: http://prototypecarbonfund.org	tCO_2e/t coke used	M	Yearly	Sample	Electronic / paper	Same data used for quantification of project and baseline emissions
11	C_{co} - CO2 emissions during coking	Prototype Carbon Fund, Brazil Plantar Baseline Report, Final: March 14, 2002, at site: http://prototypecarbonfund.org	tCO_2e/t coke used	E	Once, at the beginning of each crediting period		Electronic / paper	Same data used for quantification of project and baseline emissions
13	M_{Ch-R-p} - Methane emissions from carbonisation process (renewable)	Smith, R.K., at al , 1999. Charcoal-Making Kilns in Thailand, US EPA study EPA-600/R-99-109, Washington DC	tCO_2e/t charcoal	M	Yearly	Sample	Electronic / paper	Same data used for quantification of project and baseline emissions
14	M_{Ch-U} - Methane emissions from carbonisation process (non-renewable)	Smith, R.K., at al , 1999. Charcoal-Making Kilns in Thailand, US EPA study EPA-600/R-99-109, Washington DC	tCH_4/t charcoal	M	Once at the beginning of each crediting period	Sample	Electronic / paper	Same data used for quantification of project and baseline emissions
15	M_{Co} - Methane emissions from coking		tCH_4/t coke	E	Once at the beginning of each		Electronic / paper	Same data used for quantification of project and baseline emissions

					crediting period			
16	N_{Ch} - Nitrous oxide taking place during carbonisation	Fundação Centro Tecnologico De Minas Gerais Cetec. Carvão Vegetal; destilação, propriedades e controle de qualidade. Belo Horizonte, 1982.	tN_2O/t charcoal	M	Once at the beginning of each crediting period	Sample	Electronic / paper	Same data used for quantification of project and baseline emissions. These are smaller in the project activity in relation to the baseline, and will be excluded from the calculations
17	N_{Co} - Nitrous oxide taking place during coking	UK Emission Factors database	tN_2O/t coke	M	Once at the beginning of each crediting period	Sample	Electronic / paper	Same data used for quantification of project and baseline emissions. These are smaller in the project activity in relation to the baseline, and will be excluded from the calculations
23	Fuel CEF	IPCC	$kgCO_2/l$	E	Once at the beginning of each crediting period		Electronic / paper	Transport emissions are smaller in the project activity in relation to the baseline, and will be excluded from the calculations
24	Global Warming Potential values for CH_4 and N_2O	IPCC	tCO_2e/t gas	E	Once at the beginning of each crediting period		Electronic / paper	Same in the project and baseline scenarios.
26	Costs of production of charcoal	To be determined by project developer	$/t	C	Yearly	100%	Electronic / paper	
27	Price of coke and charcoal purchased from third parties	Past invoices, suppliers' data, or national statistics and projections	$/t	E	Yearly	100%	Electronic / paper	

D.2.1.4. Description of formulae used to estimate baseline emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

Emissions in Baseline scenario (coke use) =
$[Q_{Ch\text{-}R\text{-}b} * (CEF_{ch\text{-}R} + M_{ch\text{-}R} + N_{ch} + T_{ch})] +$
$[Q_{Ch\text{-}U\text{-}b} * (CEF_{ch\text{-}U} + M_{ch\text{-}U} + N_{ch} + T_{ch})] +$
$[Q_{Co\text{-}b} * (CEF_{co} + M_{co} + N_{co} + T_{co})] +$
Forestry $\text{emissions}_{baseline}$

Where,

$\mathbf{Q_{Ch\text{-}R\text{-}b}}$ = Quantity of renewably produced charcoal used in the Baseline Scenario (tonnes).

$\mathbf{Q_{Ch\text{-}U\text{-}b}}$ = Quantity of charcoal used in the Baseline Scenario that has not been renewably produced (tonnes).

$\mathbf{Q_{Co\text{-}b}}$ = Quantity of coke used in the Baseline Scenario (tonnes). The quantity of coke required is such that the carbon content of the coke is equivalent to the carbon content of the combined reductants used in the project activity (i.e. $Q_{Ch\text{-}R\text{-}p} + Q_{Ch\text{-}U\text{-}p} + Q_{Co\text{-}p}$).

All the other parameters are the same as in the project scenario (section D.2.1.2 above), with the exception of:

Forestry $\text{emissions}_{baseline}$ = Emissions associated with the existing forestry activities after V&M stops using charcoal for pig iron production. As the carbon stocks are expected to reduce in the baseline scenario (see Section B4), this will lead to higher emissions than in the project scenario. For conservativeness, these will be excluded from the calculation of baseline emissions.

D. 2.2. Option 2: Direct monitoring of emission reductions from the project activity (values should be consistent with those in section E).

Not applicable, as this will not be done.

D.2.2.1. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:								
ID number *(Please use numbers to ease cross-referencing to table D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e),	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment

Not applicable

D.2.2.2. Description of formulae used to calculate project emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.):

Not applicable

D.2.3. Treatment of leakage in the monitoring plan

A. Leakage Due to Use of Plantations: Baseline Scenarios vs. Project Activity

The first step in this determination is to define what are the possible baseline scenarios and which one is the most likely. Once the baseline scenario is described, the project activity will be reviewed to evaluate its effects on this baseline scenario and any potential for leakage. Finally, the amount of potential leakage must be estimated.

The analysis of carbon stocks in V&M's forests were conducted based on model which uses a vast number of factors, including carbon stocks and flows in trees (above and belowground fractions), understorey, soil carbon, necromass and wood products (Wilson, 1998). Most of the data used were collected by a very thorough carbon inventory process that was initiated by the company in 1995, in collaboration with Winrock Foundation (see MacDicken 1997).

Potential Baseline Scenarios

I. V&M Continues to produce charcoal

The first baseline scenario is that V&M converts to coke use but still retains ownership and operations of the plantations using the remaining timber to produce and sell charcoal to the market, until these forests become exhausted, when the land would be sold to a third party. During the course of 21 years, the carbon stock in these forests would have reduced from its original 21.9 4 million tCO_2e (estimated stock in V&M's forests in 2001) to nearly 0 tCO_2e, leading to the emissions of about 21.9 million tCO_2e. Annual production of charcoal would decrease, as these forests become exhausted

The project activity of a continuance of charcoal use, on the other hand, will have the following potential effects:

Plantation stock: Carbon stocks in the plantations would increase to 30.3 million tCO_2e, as in this case V&M will gradually renovate its forests using better tree varieties.

Annual production of charcoal: Production of charcoal will increase in relation to the baseline scenario as V&M will reach self-sufficiency in charcoal production and will not purchase charcoal from third parties.

Coke supply/demand and impact on prices: V&M's demand for coke would decrease compared to the baseline scenario. There could be an accompanying increase in coke use from other pig iron producers in the event charcoal was not available to these companies (see below – charcoal market). However, as coke was shown to be cheaper in the baseline scenario, those users that could have switched to coke would have already done so anyway; therefore, the net result would be a decrease in coke use. As amount of coke that would have been used by V&M compared the total coke demand is so small, the project activity would not effect coke prices.

Charcoal supply/demand and impact on the market: The project activity would result in an increased amount of charcoal supply, as V&M will become self-sufficient in charcoal. Demand for charcoal would increase even more, due to V&M's charcoal use. The effect could be a shortfall in the supply of charcoal, which could cause some pig iron producers that can only use charcoal to exit the market. This shortfall

could also increase charcoal prices, eventually causing more charcoal producers to enter the market, leading to a medium term increased charcoal supply.

Conclusion: Leakage due to charcoal using pig iron producers exiting the market and being replaced by coke-produced pig iron elsewhere (i.e., a continuation of current trends).

Likelihood of Scenario: Unlikely to occur, given that one of the main drivers of the baseline is the desire to discontinue the forest operations and sell the forest assets. At the time of its decision, V&M determined that the charcoal business was not profitable and exposed the company to significant risks and liabilities. In the event it choose to stop using charcoal and start using coke, it would have sold its plantation assets. Therefore, this scenario is not likely and the potential leakage from this scenario is not relevant to the project.

II. V&M sells forests to a charcoal producer.

The second potential baseline scenario is that V&M converts to coke use and sells its forestry assets and operations to a pig iron or charcoal producer that would continue to use the forest assets to produce charcoal. As it is unlikely that such charcoal producer would invest heavily in the improvement of these forest assets (see discussion on 'Likelihood, below), the carbon stock in these forests would reduce from its original 21.9 4 million tCO_2e (estimated stock in V&M's forests in 2001) to nearly 0 tCO_2e, in a similar way as in Baseline Scenario I. Annual production of charcoal would decrease, as these forests become exhausted

<u>The project activity</u> of V&M's continuance of charcoal use would have the following potential effects:

<u>Carbon stocks in the plantations</u> will increase to 30.3 million tCO_2e, as in this case V&M will gradually renovate its forests using better tree varieties.

<u>Annual production of charcoal:</u> Production of charcoal will increase in relation to the baseline scenario as V&M will reach self-sufficiency in charcoal production and will not purchase charcoal from third parties.

<u>Coke supply/demand and impact on prices:</u> V&M's demand for coke would decrease compared to the baseline scenario. There could be an accompanying increase in coke use from other pig iron producers in the event charcoal was not available to these companies (see below – charcoal market). However, as coke was shown to be cheaper in the baseline scenario, those users that could have switched to coke would have already done so anyway; therefore, the net result would be a decrease in coke use. As amount of coke that would have been used by V&M compared the total coke demand is so small, the project activity would not effect coke prices.

<u>Charcoal supply/demand and impact on the market:</u> The project activity would result in an increased amount of charcoal supply, as V&M will become self-sufficient in charcoal. Demand for charcoal would increase even more, due to V&M's charcoal use. The effect could be a shortfall in the supply of charcoal, which could cause some pig iron producers that can only use charcoal to exit the market. This shortfall could also increase charcoal prices, eventually causing more charcoal producers to enter the market, leading to a medium term increased charcoal supply.

Conclusion: Leakage due to charcoal-based pig iron producers exiting the market and being replaced by coke-produced pig iron.

Likelihood of Scenario: The lack of supply of charcoal is a main driver to the reduction of the charcoal based pig iron sector in Brazil; if the supply was increased, it could lead to a temporary extension of the operational lifetime of these companies. However, lack of capital to replant existing forests is the main reason for the drastic reduction in the plantation cover in Minas Gerais and reduction in the number of pig iron operators in this state. Indeed, if these producers had the financial resources, they would more likely replant their own exhausted forest areas instead of buying a third-party's plantations. Finally, the baseline analysis demonstrated that at the time of V&M's decision, charcoal production was not a profitable business. Therefore, it is highly unlikely that charcoal producers would have purchased V&M's assets or that a new charcoal producer would have entered the market and purchased V&M's assets.

III. V&M sells forestry assets sold to pulp and paper company

This final baseline scenario is that V&M converts to coke use and sells its forestry assets and operations to a pulp and paper company that is seeking new land to cover requirements from expansion. In this scenario, it is likely that this company would also invest in the improvement of the forest assets, and carbon stocks in the plantations could increase to 30.3 million tCO_2e through the use of better tree varieties.

The project activity of a continuance of charcoal use would have the following potential effects:

Plantation stock: Carbon stocks in the plantations would increase to 30.3 million tCO_2e, from today's levels, which could be more or equal to the baseline scenario, depending on whether the pulp and paper company would have increased the plantation stock to the extent V&M is doing in the project activity.

Annual production of charcoal: Production of charcoal would be higher than in the baseline scenario, as in the case of the project activity the wood would be used for charcoal rather than for pulp and paper.

Coke supply/demand and impact on prices: Demand for coke would decrease compared to the baseline scenario as V&M would use charcoal in place of coke. This decrease in demand could reduce prices, thereby eventually increasing use. Coke, however, is a global commodity whereby local prices are highly correlated to global prices. In the case of this project activity, the amount of coke that would have been used by V&M compared the total coke demand is so small that it would not affect coke prices.

Charcoal supply/demand and impact on the market: The project activity would increase charcoal supply as V&M would continue to produce charcoal instead of selling the assets to the pulp and paper company. However, the demand for charcoal would also increase due to V&M's charcoal use. The net effect would be negligible and would likely not affect the charcoal market

Conclusion: No Leakage.

Likelihood of Scenario: This is the most likely baseline scenario for V&M's forests. When a neighbouring steel plant, Acesita, converted most of its pig iron production to coke, it sold a large part of its forest assets to Suzano, a large pulp and paper company in Sao Paulo. In the Brazilian market, many pulp and paper companies are looking for existing sources of fibre to increase their production capacity. Aracruz Celulose, one of the largest pulp companies in Brazil, has been actively pursuing forest assets in Minas Gerais (where V&M is based) to enable expansion of their pulp production capacity. Prior to the beginning of the project, V&M entertained a series of discussions with potential buyers of forest assets and determined that the most likely candidates would come from the pulp and paper sector.

B. Other Sources of Leakage

Other sources of emissions outside the boundary of the project are those associated with the mining and transportation of coal from the country where mining would take place to Brazil. The emissions associated with the mining and transportation of coal to Brazil were not included in the analysis because:

If this emissions were included, one would also need to take into consideration the possible sources of transnational leakage that the project could generate. There is still a lack of definition regarding 'ownership' of emissions (and consequently emission reductions) associated with international transport. The complexity of this type of analysis, associated with the lack of definitions regarding international 'property rights' related to emission reductions, were determinant in limiting the boundaries of this analysis to the limits of Brazil.

Another possibility of leakage would occur if while the project company is not self-sufficient in charcoal production it may purchase charcoal that would be used by third parties forcing them to shift to coke. The project company has to demonstrate that this is not the case. In the case of V&M, this is not expected to occur as the volume of charcoal purchased by third parties has not increased since the inception of the project, and the sources of third party charcoal used are supplied by long term contracts with established suppliers. (full documentation available for inspection by the DOE).

C. Leakage - conclusion

As mentioned above, no leakage is expected from the implementation of project activities. For this reason, this will be excluded from the calculation of emission reductions from this project.

D.2.3.1. If applicable, please describe the data and information that will be collected in order to monitor leakage effects of the project activity								
ID number	Data variable	Source of data	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment

No sources of leakage have been identified.

D.2.3.2. Description of formulae used to estimate leakage (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

No sources of leakage have been identified.

D.2.4. Description of formulae used to estimate emission reductions for the project activity (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

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

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

Where

Emissions in Baseline scenario (coke use) =

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

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

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

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

and

Emissions of Project Activity (charcoal use) =

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

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

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

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

D.3. Quality control (QC) and quality assurance (QA) procedures are being undertaken for data monitored		
Data *(Indicate table and ID number e.g. 3.-1.; 3.2.)*	Uncertainty level of data (High/ Medium/ Low)	Explain QA/QC procedures planned for these data, or why such procedures are not necessary.
1- Q_{Ch-R} - Quantity of renewable charcoal used by the project	Low	These data will be directly used for calculation of emission reductions. These data are the most accurately measured, as they are measured both by the production and the utilisation units of the company. To guarantee QC/QA, they will be double checked by receipts or internal production and utilisation records.
2 - Q_{Ch-U} - Quantity of non-renewable charcoal used by the project	Low	Double checked by receipts and utilisation records.
3 - Q_{Co} - Quantity of coke used in the project	Low	Double checked by receipts and utilisation records.
4 - CEF_{CH-R} - Carbon Emissions Factor of renewable charcoal	Low	Assumed to be zero – no monitoring needed
5 - CEF_{Ch-U} - Carbon Emissions Factor of non-renewably produced charcoal	Low	Calculated as $CF_{ch} + Ca_{ch} - Ci_{ch}$
6 - Cf_{ch} - Carbon content of charcoal	Low	Multiple measurements taken, mean value used.
7 - Ca_{ch} - CO2 emissions during carbonisation	Medium	Multiple measurements taken, mean value used.
8 - C_{I-CH} - Carbon fixed in pig iron produced using charcoal	Low	Multiple measurements taken, mean value used.
9 - CEF_{CO} - Carbon Emissions Factor of coke used in the pig iron production process	Low	Multiple measurements taken, mean value used.
10 - Cf_{co} - Carbon content of coke	Low	Multiple measurements taken, mean value used.
11 - C_{co} - CO2 emissions during coking	Low	Data from literature, based on multiple measurements
12 - C_{I-CO} - Carbon fixed in pig iron produced using coke	Low	Data from literature, from reputable sources
13 - M_{Ch-R-p} - Methane emissions from carbonisation process (renewable)	Medium	Multiple measurements taken, mean value used.
14 - M_{Ch-U} - Methane emissions from carbonisation process (non-renewable)	Medium	Multiple measurements taken, mean value used.
15 - M_{Co} – Methane emissions from coking	Medium	Data from literature, from reputable sources
16 - N_{Ch} - Nitrous oxide taking place during carbonisation	Medium	Original data from literature and V&M's labs. Because these are smaller in the project activity in relation to the baseline, these will be excluded from the calculations
17 - N_{Co} - Nitrous oxide taking place during coking	Medium	Original data from literature. Because these are smaller in the project activity in relation to the baseline, these will be excluded from the calculations
18 - Total quantity of reductant required per year	Low	Double checked by receipts and utilisation records.
19 - Capacity of trucks transporting charcoal to pig iron mill	Low	Transport emissions are smaller in the project activity in relation to the baseline, and will be excluded from the calculations

20 - Average one-way distance charcoal is transported	Low	Transport emissions are smaller in the project activity in relation to the baseline, and will be excluded from the calculations
21 - Fuel used by trucks	Low	Transport emissions are smaller in the project activity in relation to the baseline, and will be excluded from the calculations
22 - Average fuel economy of trucks	Low	Transport emissions are smaller in the project activity in relation to the baseline, and will be excluded from the calculations
23 - Fuel CEFs	Low	Transport emissions are smaller in the project activity in relation to the baseline, and will be excluded from the calculations
24 - Global Warming Potential values for CH_4 and N_2O	Low	From IPCC, internationally accepted.
25 - Carbon stocks and emissions in project company's forests	Low	As forestry emissions will be higher in the baseline than in the project scenario, this will include only the fossil fuel emissions associated with forestry activities in the project. Fossil fuel usage will be double checked by receipts and utilisation records.
26 - Costs of production of charcoal	Low	Double checked by internal financial records and intradepartmental receipts and utilisation records.
27 - Price of coke and charcoal purchased from third parties	Low	Double checked by receipts and utilisation records.
28 - Q_{Ch-U} - Quantity of-renewable charcoal used in the baseline scenario	Low	Derived from the actual amount of reductants used in the project scenario, that will be monitored continued throughout the project lifetime. Double checked by receipts and utilisation records.
29 - Q_{Ch-U} - Quantity of non-renewable charcoal used in the baseline scenario	Low	Derived from the actual amount of reductants used in the project scenario, that will be monitored continued throughout the project lifetime. Double checked by receipts and utilisation records.
30 - Q_{Co} - Quantity of coke used in the baseline	Low	Derived from the actual amount of reductants used in the project scenario, that will be monitored continued throughout the project lifetime. Double checked by receipts and utilisation records.
31 - Total quantity of reductant required per year in the baseline scenario	Low	Derived from the actual amount of reductants used in the project scenario, that will be monitored continued throughout the project lifetime. Double checked by receipts and utilisation records.
32 - Capacity of trains transporting coke to pig iron mill	Low	Transport emissions are smaller in the project activity in relation to the baseline, and will be excluded from the calculations
33 - Average one-way distance coke is transported	Low	Transport emissions are smaller in the project activity in relation to the baseline, and will be excluded from the calculations
34 - Fuel used by trains	Low	Transport emissions are smaller in the project activity in relation to the baseline, and will be excluded from the calculations
35 - Average fuel economy of trains	Low	Transport emissions are smaller in the project activity in relation to the baseline, and will be excluded from the calculations
36 - Carbon stocks and emissions in project company's forests in baseline scenario	Low	As forestry emissions will be higher in the baseline than in the project scenario, this will be excluded from the calculation of baseline emissions
37 - CAPEX investments and maintenance costs	Low	
38 - Discount rate used for NPV calculation	Low	

D.4 Please describe the operational and management structure that the project operator will implement in order to monitor emission reductions and any leakage effects, generated by the project activity

This project will be managed by the Monitoring Division of the V&M do Brasil. The division already counts with a complete forestry inventory team, laboratories for chemical analysis of charcoal, iron, and other industrial processes, monitoring procedures for measuring emissions of carbonisation activities, on-line continuous monitoring of industrial production, charcoal and coke usage, and production parameters.

Additionally, the company has continually aimed at introducing more sophisticated monitoring and quality control systems, and the V&M Group has been awarded a series of internationally recognized certifications, including ISO 9002, API, Shell, SQ 9000 and ISO 14001. V&M will use these systems to ensure that data collected for the project are subject to the most rigid quality control systems.

D.5 Name of person/entity determining the monitoring methodology:

This revised baseline study was concluded in April 2005, based on reviews of the studies conducted in November 2000 and August 2003. The entities responsible for the determination of the baseline are EcoSecurities Ltd., UK and the IFC-Netherlands Carbon Facility (INCaF), International Finance Corporation, World Bank Group.

SECTION E. Estimation of GHG emissions by sources

E.1. Estimate of GHG emissions by sources:

Emissions of Project Activity =
Total emissions of renewably charcoal used +
Total emissions of non-renewably charcoal used +
Total emissions of coke used +
Forestry $Emissions_{project}$

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

Where:

Q_{Ch-R-p} The actual amount of renewably produced charcoal used in 2001 and 2002, and the estimated amounts needed for the following years, based on projections of pig iron production.

Q_{Ch-U-p} The actual amount of non-renewably produced of charcoal used in 2001 and 2002. It is assumed for the calculations that the use of non-renewably produced charcoal will be discontinued once V&M's new forest assets created through the project reach maturity.

Q_{Co-p} The actual amount of coke used in 2001 and 2002. It is assumed for the calculations that coke will not be used going forward (V&M's ERPA includes an obligation not to use coke).

CEF_{ch-R} 0 tCO_2/t charcoal. By definition, charcoal from renewable sources is a 'carbon neutral' fuel and therefore this factor is zero.

CEF_{ch-U} Calculated as $Cf_{ch} + Ca_{ch} - Ci_{ch}$ where, Cf_{ch} = Carbon fixed in charcoal (2.933 tCO_2e/ t charcoal[3]), Ca_{ch} = CO_2 emissions during carbonisation (3.751 tCO_2, a conservative value for standard kilns in Brazil, based on the mass balance of timber required for charcoal production[4]) and CI_{ch} = CO_2e of carbon fixed in iron (0.203 tCO_2e/ t charcoal, as measured in V&M's laboratory). CEF_{ch-u} consequently is 6.481 t CO_2e/ t unsustainable charcoal used.

CEF_{co} Calculated as $Cf_{co} + C_{co} – Ci_{co,}$ where, Cf_{co} = Carbon content of coke (3.234 tCO_2e/t coke[5]), C_{co} = CO_2 emissions during coking (0.807 tCO_2/t coke used[6]) and CI_{co} =CO_2e of carbon fixed in iron (0.315 t CO_2e/ t coke[7]). CEF_{co} consequently is = 3,67 t CO_2e/ t coke used.

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[3] 662.71 F981c – Fundação Centro Tecnologico De Minas Gerais Cetec . Carvão Vegetal; destilação, propriedades e controle de qualidade. Belo Horizonte, 1982. 1v.

[4] 662.71 F981c – Fundação Centro Tecnologico De Minas Gerais Cetec. Carvão Vegetal; destilação, propriedades e controle de qualidade. Belo Horizonte, 1982. 1v. ; and 662.71 F981p – Fundação Centro Tecnologico De Minas Gerais CETEC – Produção e Utilização de Carvão Vegetal, Belo Horizonte, 1982, 1v.

[5] The assumed average carbon content of a coke in Brasil is 88.2% with 10% ash. The total specific coke consumption is 500 kg/t of pig iron. The coal mix considered has 25% volatile material and 7.5 % ash. The coal carbon content is assumed to be 82.7 %. Prototype Carbon Fund, Brazil Plantar Baseline Report, Final: March 14, 2002, at site: http://prototypecarbonfund.org

M_{ch-R-} Methane (CH_4) emissions that occur during production of renewable charcoal. V&M's charcoal production process does produce emissions of methane. On average, these currently represent approximately 0.0462 tCH_4 per tonne charcoal produced according to measurements carried by Smith et al., 1999.

M_{ch-U} Methane (CH_4) emissions that occur during production of non-renewable charcoal. The value used is from measurements of the emissions of circular kilns commonly used in Brazil (0.056 tCH_4 per tonne charcoal produced according to measurements carried by Smith et al., 1999.

M_{co} This value was assumed to be nil (0 tCH4/ t coke produced), as most coking plants do not emit CH_4, as is the case of the modern coking plants in Brazil. Please note that by definition a greater quantity of coke will be used in the Baseline Scenario than in the Project Activity, therefore this assumption enhances the conservativeness of the analysis.

N_{ch} Nitrous oxide (N_2O), both from thermal and chemical processes. In the case of the carbonisation process, this leads to the emissions of 0.0000304 tN_2O per t of charcoal produced (according to measurement conducted in V&M). Although the charcoal route would lead to a reduction in N_2O emissions (see value of N_{co}), these are difficult to measure accurately and will be excluded from the calculations, contributing to a more conservative approach.

N_{co} In the case of the coking process, this leads to the emissions of 0.000221 t N_2O per t of coke produced (UK Emission Factors Dbase). Excluded from calculations.

T_{ch} Emissions related to the transportation of charcoal from its origin to the pig iron mill ($tC0_2$). Charcoal would be transported from V&M's forests to the mills, 350 km away, in 27-tonne trucks, requiring an average of 5.19 litres of diesel per tonne of pig iron produced. Although the charcoal route would lead to a small reduction in transport emissions (see T_{co}), these are difficult to measure accurately and will be excluded from the calculations.

T_{co} Emissions related to the transportation of coke from the coking plants to the factory by train, at least 750 km away, requiring an average of 6.25 litres of diesel per tonne of pig iron produced.

Forestry emissions = Given that the net emissions associated with forestry in the project scenario are expected to be negative (i.e., there will be a sequestration effect in relation to the baseline – see Section B4), these will be excluded from these calculations. The only emissions associated with forestry that will be included in the calculations are those associated with the use of fossil fuels. V&M uses approximately 3.7 million litres of gasoline and diesel per year. Assuming a carbon content of 80%, it can be calculated that this results in the emissions of 10,887 t CO_2e/year.

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[6] The elemental analyses utilized are conservative due to the utilization of a mix of coals for coking with only 25% volatile material. See references for a better comprehension. Prototype Carbon Fund, Brazil Plantar Baseline Report, Final: March 14, 2002, at site: http://prototypecarbonfund.org

[7] Average gross specific coke consumption for the baseline scenario (500 kg/pig iron). (43*44/12) tCO2/tpig iron*1/0.5 t coke/tpig iron. Prototype Carbon Fund, Brazil Plantar Baseline Report, Final: March 14, 2002, at site: http://prototypecarbonfund.org.

Based on these calculations, it is estimated that the project activity will lead to the emissions of 5,803,888 tCO_2e over the course of 7 years.

E.2. Estimated leakage:

Based on the analysis of the alternatives of the use of the plantations under the baseline scenario, the V&M Project is unlikely to result in significant amount of leakage. While the project is based on the reduction of fossil fuel (imported coal) consumption, thus "making available" this amount of coal to the rest of the world, in global terms the project is relatively small and unlikely to have any effect on the price and consumption in the global coal market. Consequently, no leakage is expected. On the contrary, it is expected that the project will result in positive offsite impacts, since the maintenance of their charcoal production activities will reduce the pressure on native forests, both for commercial charcoal production and for fuel wood. See discussion in Section D.2.3.

E.3. The sum of E.1 and E.2 representing the project activity emissions:

The sum of E.1 and E.2 is 5,803,888 tCO_2e over the course of 7 years.

E.4. Estimated anthropogenic emissions by sources of greenhouse gases of the baseline:

Emissions of Baseline Scenario =
Total emissions of renewably charcoal expected to be used +
Total emissions of non-renewably charcoal expected to be used +
Total emissions of coke expected to be used

$$= [Q_{Ch\text{-}R\text{-}b} * (CEF_{ch\text{-}R} + M_{ch\text{-}R} + N_{ch} + T_{ch})] + [Q_{Ch\text{-}U\text{-}b} * (CEF_{ch\text{-}U} + M_{ch\text{-}U} + N_{ch} + T_{ch})] + [Q_{Co\text{-}b} * (CEF_{co} + M_{co} + N_{co} + T_{co})] + \text{Forestry emissions}_{baseline}$$

Where:

$Q_{Ch\text{-}R\text{-}b}$ The amount of renewably produced charcoal expected to be used in the Baseline Scenario. If V&M were to use coke, they would start adding 30% coke in its blast furnaces from October 2001, until a new desulphurisation plant was ready by July 2002, at which point they would be able to operate 100% with coke. It is assumed that 90% of the charcoal used during these initial 9 months would come from renewable sources, with the remaining 10% coming from non-renewable sources (10% is the maximum amount allowed by law).

$Q_{Ch\text{-}U\text{-}b}$ The amount of non-renewably produced of charcoal used in this initial phase (2001 and 2002), before V&M could operate 100% on coke. It is assumed that this would be 10% of the total amount of charcoal used during these initial 9 months (10% is the maximum amount allowed by law).

$Q_{Co\text{-}b}$ In the initial 9 months of operation, only 30% of the carbon intake in V&M's blast furnaces will come from coke due to operational restrictions. 100% coke use would be achieved after a new desulphurisation plant would begin operations in July 2002.

The total quantity of carbon used in this mix must be the same as in the project scenario, so that a similar amount of pig iron can be produced in both scenarios.

CEF_{ch-R} 0 tCO_2/t charcoal. By definition, charcoal from renewable sources is a 'carbon neutral' fuel and therefore this factor is zero.

CEF_{ch-U} Calculated as Cf_{ch} + Ca_{ch} -Ci_{ch} where, Cf_{ch} = Carbon fixed in charcoal (2.933 tCO_2e/ t charcoal[8]), Ca_{ch} = CO_2 emissions during carbonisation (3.751 tCO_2, a conservative value for standard kilns in Brazil, based on the mass balance of timber required for charcoal production[9]) and CI_{ch} = CO_2e of carbon fixed in iron (0.203 tCO_2e/ t charcoal, as measured in V&M's laboratory). CEF_{ch-u} consequently is 6.481 t CO_2e/ t unsustainable charcoal used.

CEF_{co} Calculated as Cf_{co} + C_{co} – $Ci_{co,}$ where, Cf_{co} = Carbon content of coke (3.234 tCO_2e/t coke[10]), C_{co} = CO_2 emissions during coking (0.807 tCO_2/t coke used[11]) and CI_{co} =CO_2e of carbon fixed in iron (0.315 t CO_2e/ t coke[12]). CEF_{co} consequently is = 3,67 t CO_2e/ t coke used.

M_{ch-R-} Methane (CH_4) emissions that occur during production of renewable charcoal. V&M's charcoal production process does produce emissions of methane. On average, these currently represent approximately 0.0462 tCH_4 per tonne charcoal produced according to measurements carried by Smith et al., 1999.

M_{ch-U} Methane (CH_4) emissions that occur during production of non-renewable charcoal. The value used is from measurements of the emissions of rectangular kilns commonly used in Brazil (0.056 t CH_4 per tonne charcoal produced according to measurements carried by Smith et al., 1999).

M_{co} This value was assumed to be nil (0 tCH4/ t coke produced), as most coking plants do not emit CH_4, as is the case of the modern coking plants in Brazil. Please note that by definition a greater quantity of coke will be used in the Baseline Scenario than in the Project Activity, therefore this assumption enhances the conservativeness of the analysis.

N_{ch} Nitrous oxide (N_2O), both from thermal and chemical processes. In the case of the carbonisation process, this leads to the emissions of 0.0000304 tN_2O per t of charcoal produced (according to measurement conducted in V&M). Although the charcoal route would lead to a reduction in N_2O emissions (see value of N_{co}), these are difficult to measure

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[8] 662.71 F981c – Fundação Centro Tecnologico De Minas Gerais Cetec . Carvão Vegetal; destilação, propriedades e controle de qualidade. Belo Horizonte, 1982. 1v.

[9] 662.71 F981c – Fundação Centro Tecnologico De Minas Gerais Cetec. Carvão Vegetal; destilação, propriedades e controle de qualidade. Belo Horizonte, 1982. 1v. ; and 662.71 F981p – Fundação Centro Tecnologico De Minas Gerais CETEC – Produção e Utilização de Carvão Vegetal, Belo Horizonte, 1982, 1v.

[10] The assumed average carbon content of a coke in Brasil is 88.2% with 10% ash. The total specific coke consumption is 500 kg/t of pig iron. The coal mix considered has 25% volatile material and 7.5 % ash. The coal carbon content is assumed to be 82.7 %. Prototype Carbon Fund, Brazil Plantar Baseline Report, Final: March 14, 2002, at site: http://prototypecarbonfund.org

[11] The elemental analyses utilized are conservative due to the utilization of a mix of coals for coking with only 25% volatile material. See references for a better comprehension. Prototype Carbon Fund, Brazil Plantar Baseline Report, Final: March 14, 2002, at site: http://prototypecarbonfund.org

[12] Average gross specific coke consumption for the baseline scenario (500 kg/pig iron). (43*44/12) tCO2/tpig iron*1/0.5 t coke/tpig iron. Prototype Carbon Fund, Brazil Plantar Baseline Report, Final: March 14, 2002, at site: http://prototypecarbonfund.org.

accurately and will be excluded from the calculations, contributing to a more conservative approach.

N_{co} In the case of the coking process, this leads to the emissions of 0.000221 t N_2O per t of coke produced (UK Emission Factors Dbase). Excluded from calculations.

T_{ch} Emissions related to the transportation of charcoal from its origin to the pig iron mill ($tC0_2$). Charcoal would be transported from V&M's forests to the mills, 350 km away, in 27-tonne trucks, requiring an average of 5.19 litres of diesel per tonne of pig iron produced. Although the charcoal route would lead to a small reduction in transport emissions (see T_{co}), these are difficult to measure accurately and will be excluded from the calculations.

T_{co} Emissions related to the transportation of coke from the coking plants to the factory by train, at least 750 km away, requiring an average of 6.25 litres of diesel per tonne of pig iron produced.

Forestry emissions$_{baseline}$ = = Given that the net emissions associated with forestry in the baseline scenario are expected to be higher than in the project scenario (i.e., there will be a reduction of carbon stocks in the baseline – see Section B4), this will lead to substantial emissions. For conservativeness, these will be excluded from these calculations. Additionally, there would also be emissions associated the use of fossil fuels in forestry activities, but again for conservativeness these will be excluded.

Based on these calculations, it is estimated that the baseline scenario would lead to the emissions of 8,492,577 tCO_2e over the course of 7 years.

E.5. Difference between E.4 and E.3 representing the emission reductions of the project activity:

In tCO_2e	**Until year 7**	**Until year 21**
Total emissions in project activity	5,803,888	12,664,769
Total emissions in baseline scenario	8,492,577	28,506,345
Total emission reductions	2,688,689	15,841,575

E.6. Table providing values obtained when applying formulae above:

	Project year	1	2	3	4	5	6	7	8	9	10
	Calendar year	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Data used											
Generic data	**Data source**										
Amount of pig iron produced (Qi), t	SAP	125,104	476,118	532,724	593,437	594,000	625,838	625,838	625,838	625,838	625,838
Carbon content in charcoal (tC/t charcoal)	literature	0.799	0.799	0.799	0.799	0.799	0.799	0.799	0.799	0.799	0.799
Carbon content in coke (tC/t coke)	literature	0.881	0.881	0.881	0.881	0.881	0.881	0.881	0.881	0.881	0.881
CO2 emissions during carbonisation (tCO2/t charcoal)	literature	3.751	3.467	3.467	3.467	3.467	3.467	3.467	3.467	3.467	3.467
CO2 emissions during coking (tCO2/t coke produced)	literature	0.807	0.807	0.807	0.807	0.807	0.807	0.807	0.807	0.807	0.807
Ci-ch - carbon fixed in pig iron (tCO2/t charcoal)	literature	0.203	0.203	0.203	0.203	0.203	0.203	0.203	0.203	0.203	0.203
Ci-co - carbon fixed in pig iron (tCO2/t coke)	literature	0.315	0.315	0.315	0.315	0.315	0.315	0.315	0.315	0.315	0.315
Forestry net emissions (nil, if higher in baseline) (tCO2/yr)	PSF	-	-	-	-	-	-	-	-	-	-
Petrol consumption in forestry operators in project (l/yr)	PSF	927,000	3,708,000	3,708,000	3,708,000	3,708,000	3,708,000	3,708,000	3,708,000	3,708,000	3,708,000
		3.234	0.881	1.69	1.373						
Baseline data (coke use)											
% carbon coming from coke	projected	30%	65%	100%	100%	100%	100%	100%	100%	100%	100%
% charcoal from non-renewable sources	projected	10%	10%	0%	0%	0%	0%	0%	0%	0%	0%
Qch-R-b - Quantity of renewable charcoal used (t)	projected	57,281	116,285	-	-	-	-	-	-	-	-
Qch-U-b - Quantity of non-renewable charcoal used (t)	projected	5,728	11,629	-	-	-	-	-	-	-	-
Qco-b - Quantity of coke used (t)	projected	24,490	215,444	386,160	397,986	391,739	391,739	391,739	391,739	383,049	383,049
Project data (charcoal use)											
Amount of V&M charcoal used (t)	SAP	71,184	240,563	260,682	263,224	266,000	241,000	240,000	242,000	254,000	269,000
Amount of plantation charcoal purchased (t)	SAP	17,179	64,450	74,386	45,319	86,142	118,642	119,942	117,342	117,560	126,460
Total amount of renewable charcoal used (t)	SAP	88,363	305,013	335,068	308,543	352,142	359,642	359,942	359,342	371,560	395,460
Amount of non-renewable charcoal purchased (t)	SAP	-	49,659	90,722	130,286	79,800	72,300	72,000	72,600	50,800	26,900
Total charcoal used in V&M's mills (t)	SAP	88,363	354,672	425,790	438,829	431,942	431,942	431,942	431,942	422,360	422,360
Qch-R-p - Quantity of renewable charcoal used (t)	SAP	88,363	305,013	335,068	308,543	352,142	359,642	359,942	359,342	371,560	395,460
Qch-U-p - Quantity of non-renewable charcoal used (t)	SAP/PSF	-	49,659	90,722	130,286	79,800	72,300	72,000	72,600	50,800	26,900
Qco-p - Quantity of coke used (t)	SAP	1,496	9,791	-	-	-	-	-	-	-	-

	11	12	13	14	15	16	17	18	19	20	21
	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Data used											
Generic data											
Amount of pig iron produced (Qi), t	625,838	625,838	625,838	625,838	625,838	625,838	625,838	625,838	625,838	625,838	625,838
Carbon content in charcoal (tC/t charcoal)	0.799	0.799	0.799	0.799	0.799	0.799	0.799	0.799	0.799	0.799	0.799
Carbon content in coke (tC/t coke)	0.881	0.881	0.881	0.881	0.881	0.881	0.881	0.881	0.881	0.881	0.881
CO2 emissions during carbonisation (tCO2/t charcoal)	3.467	3.467	3.467	3.467	3.467	3.467	3.467	3.467	3.467	3.467	3.467
CO2 emissions during coking (tCO2/t coke produced)	0.807	0.807	0.807	0.807	0.807	0.807	0.807	0.807	0.807	0.807	0.807
Ci-ch - carbon fixed in pig iron (tCO2/t charcoal)	0.203	0.203	0.203	0.203	0.203	0.203	0.203	0.203	0.203	0.203	0.203
Ci-co - carbon fixed in pig iron (tCO2/t coke)	0.315	0.315	0.315	0.315	0.315	0.315	0.315	0.315	0.315	0.315	0.315
Forestry net emissions (nil, if higher in baseline) (tCO2/yr)	-	-	-	-	-	-	-	-	-	-	-
Petrol consumption in forestry operators in project (l/yr)	3,708,000	3,708,000	3,708,000	3,708,000	3,708,000	3,708,000	3,708,000	3,708,000	3,708,000	3,708,000	3,708,000
Baseline data (coke use)											
% carbon coming from coke	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
% charcoal from non-renewable sources	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Qch-R-b - Quantity of renewable charcoal used (t)	-	-	-	-	-	-	-	-	-	-	-
Qch-U-b - Quantity of non-renewable charcoal used (t)	-	-	-	-	-	-	-	-	-	-	-
Qco-b - Quantity of coke used (t)	383,049	383,049	383,049	383,049	383,049	383,049	383,049	383,049	383,049	383,049	383,049
Project data (charcoal use)											
Amount of V&M charcoal used (t)	300,000	359,006	359,006	359,006	359,006	359,006	359,006	359,006	359,006	359,006	359,006
Amount of plantation charcoal purchased (t)	122,360	63,354	63,354	63,354	63,354	63,354	63,354	63,354	63,354	63,354	63,354
Total amount of renewable charcoal used (t)	422,360	422,360	422,360	422,360	422,360	422,360	422,360	422,360	422,360	422,360	422,360
Amount of non-renewable charcoal purchased (t)	-	-	-	-	-	-	-	-	-	-	-
Total charcoal used in V&M's mills (t)	422,360	422,360	422,360	422,360	422,360	422,360	422,360	422,360	422,360	422,360	422,360
Qch-R-p - Quantity of renewable charcoal used (t)	422,360	422,360	422,360	422,360	422,360	422,360	422,360	422,360	422,360	422,360	422,360
Qch-U-p - Quantity of non-renewable charcoal used (t)	-	-	-	-	-	-	-	-	-	-	-
Qco-p - Quantity of coke used (t)	-	-	-	-	-	-	-	-	-	-	-

	Project year	1	2	3	4	5	6	7	8	9	10
	Calendar year	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Equation parameters calculated using basic data											
Project											
CEFch-R (tCO2/t charcoal)	C neutral	-	-	-	-	-	-	-	-	-	-
CEFch-U (tCO2/t charcoal)		6.48	6.20	6.20	6.20	6.20	6.20	6.20	6.20	6.20	6.20
CEFco (tCO2/t coke)		3.73	3.73	3.73	3.73	3.73	3.73	3.73	3.73	3.73	3.73
Mch-R-p - methane emissions carbonisation (tCO2e/t charcoal)		0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Mch-U - methane emissions carbonisation (tCO2e/t charcoal)	constant	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18
Mco - methane emissions coking (tCO2e/t coke)	nil	-	-	-	-	-	-	-	-	-	-
Nch - N2O emissions during carbonisation (tCO2e/tcharcoal)	excluded	-	-	-	-	-	-	-	-	-	-
Nco - N2O emissions during coking (tCO2e/t coke)	excluded	-	-	-	-	-	-	-	-	-	-
Tch - transport emissions charcoal (tCO2/t charcoal)	excluded	-	-	-	-	-	-	-	-	-	-
Tco - transport emissions coke (tCO2/t coke)	excluded	-	-	-	-	-	-	-	-	-	-
Net forestry emissions project (nil, if higher in baseline)	excluded	-	-	-	-	-	-	-	-	-	-
Fossil fuels used in forestry operation (tCO2e/yr)	monitored	2,722	10,887	10,887	10,887	10,887	10,887	10,887	10,887	10,887	10,887
Baseline											
CEFch-R (tCO2/t charcoal)	C neutral	-	-	-	-	-	-	-	-	-	-
CEFch-U (tCO2/t charcoal)		6.48	6.20	6.20	6.20	6.20	6.20	6.20	6.20	6.20	6.20
CEFco (tCO2/t coke)		3.73	3.73	3.73	3.73	3.73	3.73	3.73	3.73	3.73	3.73
Mch-R-b - methane emissions carbonisation (tCO2e/t charcoal)		0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Mch-U - methane emissions carbonisation (tCO2e/t charcoal)	constant	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18
Mco - methane emissions coking (tCO2e/t coke)	nil	-	-	-	-	-	-	-	-	-	-
Nch - N2O emissions during carbonisation (tCO2e/tcharcoal)	excluded	-	-	-	-	-	-	-	-	-	-
Nco - N2O emissions during coking (tCO2e/t coke)	excluded	-	-	-	-	-	-	-	-	-	-
Tch - transport emissions charcoal (tCO2/t charcoal)	excluded	-	-	-	-	-	-	-	-	-	-
Tco - transport emissions coke (tCO2/t coke)	excluded	-	-	-	-	-	-	-	-	-	-
Calculations											
Baseline emissions											
$Q_{Ch\text{-}R\text{-}b} * (CEF_{ch\text{-}R} + M_{ch\text{-}R} + N_{ch} + T_{ch})$	calculated	55,574	112,820	-	-	-	-	-	-	-	-
$Q_{Ch\text{-}U\text{-}b} * (CEF_{ch\text{-}U} + M_{ch\text{-}U} + N_{ch} + T_{ch})$	calculated	43,860	85,737	-	-	-	-	-	-	-	-
$Q_{Co\text{-}b} * (CEF_{co} + M_{co} + N_{co} + T_{co})$	calculated	91,251	802,745	1,438,833	1,482,894	1,459,621	1,459,621	1,459,621	1,459,621	1,427,242	1,427,242
Baseline emissions (tCO2e)		**190,685**	**1,001,302**	**1,438,833**	**1,482,894**	**1,459,621**	**1,459,621**	**1,459,621**	**1,459,621**	**1,427,242**	**1,427,242**
Project emissions											
$Q_{Ch\text{-}R\text{-}p} * (CEF_{ch\text{-}R} + M_{ch\text{-}R} + N_{ch} + T_{ch})$	calculated	85,730	295,924	325,083	299,348	341,648	348,924	349,215	348,633	360,487	383,675
$Q_{Ch\text{-}U\text{-}p} * (CEF_{ch\text{-}U} + M_{ch\text{-}U} + N_{ch} + T_{ch})$	calculated	-	366,136	668,893	960,599	588,365	533,068	530,856	535,280	374,548	198,334
$Q_{Co\text{-}p} * (CEF_{co} + M_{co} + N_{co} + T_{co})$	calculated	5,575	36,481	-	-	-	-	-	-	-	-
Forestry emissions project		2,722	10,887	10,887	10,887	10,887	10,887	10,887	10,887	10,887	10,887
Project emissions (tCO2e)		**94,026**	**709,427**	**1,004,863**	**1,270,834**	**940,900**	**892,879**	**890,958**	**894,800**	**745,923**	**592,896**
Gross emission reductions		**96,659**	**291,875**	**433,970**	**212,061**	**518,721**	**566,742**	**568,663**	**564,821**	**681,320**	**834,346**
Leakage		-	-	-	-	-	-	-	-	-	-
Net emission reductions (adjusted)		**96,659**	**291,875**	**433,970**	**212,061**	**518,721**	**566,742**	**568,663**	**564,821**	**681,320**	**834,346**

	11	12	13	14	15	16	17	18	19	20	21
	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Equation parameters calculated using basic data											
Project											
CEFch-R (tCO2/t charcoal)	-	-	-	-	-	-	-	-	-	-	-
CEFch-U (tCO2/t charcoal)	6.20	6.20	6.20	6.20	6.20	6.20	6.20	6.20	6.20	6.20	6.20
CEFco (tCO2/t coke)	3.73	3.73	3.73	3.73	3.73	3.73	3.73	3.73	3.73	3.73	3.73
Mch-R-p - methane emissions carbonisation (tCO2e/t charcoal)	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Mch-U - methane emissions carbonisation (tCO2e/t charcoal)	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18
Mco - methane emissions coking (tCO2e/t coke)	-	-	-	-	-	-	-	-	-	-	-
Nch - N2O emissions during carbonisation (tCO2e/tcharcoal)	-	-	-	-	-	-	-	-	-	-	-
Nco - N2O emissions during coking (tCO2e/t coke)	-	-	-	-	-	-	-	-	-	-	-
Tch - transport emissions charcoal (tCO2/t charcoal)	-	-	-	-	-	-	-	-	-	-	-
Tco - transport emissions coke (tCO2/t coke)	-	-	-	-	-	-	-	-	-	-	-
Net forestry emissions project (nil, if higher in baseline)	-	-	-	-	-	-	-	-	-	-	-
Fossil fuels used in forestry operation (tCO2e/yr)	10,887	10,887	10,887	10,887	10,887	10,887	10,887	10,887	10,887	10,887	10,887
Baseline											
CEFch-R (tCO2/t charcoal)	-	-	-	-	-	-	-	-	-	-	-
CEFch-U (tCO2/t charcoal)	6.20	6.20	6.20	6.20	6.20	6.20	6.20	6.20	6.20	6.20	6.20
CEFco (tCO2/t coke)	3.73	3.73	3.73	3.73	3.73	3.73	3.73	3.73	3.73	3.73	3.73
Mch-R-b - methane emissions carbonisation (tCO2e/t charcoal)	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Mch-U - methane emissions carbonisation (tCO2e/t charcoal)	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18
Mco - methane emissions coking (tCO2e/t coke)	-	-	-	-	-	-	-	-	-	-	-
Nch - N2O emissions during carbonisation (tCO2e/tcharcoal)	-	-	-	-	-	-	-	-	-	-	-
Nco - N2O emissions during coking (tCO2e/t coke)	-	-	-	-	-	-	-	-	-	-	-
Tch - transport emissions charcoal (tCO2/t charcoal)	-	-	-	-	-	-	-	-	-	-	-
Tco - transport emissions coke (tCO2/t coke)	-	-	-	-	-	-	-	-	-	-	-
Calculations											
Baseline emissions											
$Q_{Ch-R-b} * (CEF_{ch-R} + M_{ch-R} + N_{ch} + T_{ch})$	-	-	-	-	-	-	-	-	-	-	-
$Q_{Ch-U-b} * (CEF_{ch-U} + M_{ch-U} + N_{ch} + T_{ch})$	-	-	-	-	-	-	-	-	-	-	-
$Q_{Co-b} * (CEF_{co} + M_{co} + N_{co} + T_{co})$	1,427,242	1,427,242	1,427,242	1,427,242	1,427,242	1,427,242	1,427,242	1,427,242	1,427,242	1,427,242	1,427,242
Baseline emissions (tCO2e)	**1,427,242**	**1,427,242**	**1,427,242**	**1,427,242**	**1,427,242**	**1,427,242**	**1,427,242**	**1,427,242**	**1,427,242**	**1,427,242**	**1,427,242**
Project emissions											
$Q_{Ch-R-p} * (CEF_{ch-R} + M_{ch-R} + N_{ch} + T_{ch})$	409,774	409,774	409,774	409,774	409,774	409,774	409,774	409,774	409,774	409,774	409,774
$Q_{Ch-U-p} * (CEF_{ch-U} + M_{ch-U} + N_{ch} + T_{ch})$	-	-	-	-	-	-	-	-	-	-	-
$Q_{Co-p} * (CEF_{co} + M_{co} + N_{co} + T_{co})$	-	-	-	-	-	-	-	-	-	-	-
Forestry emissions project	10,887	10,887	10,887	10,887	10,887	10,887	10,887	10,887	10,887	10,887	10,887
Project emissions (tCO2e)	**420,660**	**420,660**	**420,660**	**420,660**	**420,660**	**420,660**	**420,660**	**420,660**	**420,660**	**420,660**	**420,660**
Gross emission reductions	**1,006,582**	**1,006,582**	**1,006,582**	**1,006,582**	**1,006,582**	**1,006,582**	**1,006,582**	**1,006,582**	**1,006,582**	**1,006,582**	**1,006,582**
Leakage	-	-	-	-	-	-	-	-	-	-	-
Net emission reductions (adjusted)	**1,006,582**	**1,006,582**	**1,006,582**	**1,006,582**	**1,006,582**	**1,006,582**	**1,006,582**	**1,006,582**	**1,006,582**	**1,006,582**	**1,006,582**

SECTION F. Environmental impacts

F.1. Documentation on the analysis of the environmental impacts, including transboundary impacts:

The main direct environmental impacts of this project are expected to take place in relation to V&M's carbonisation activities. An indirect environmental impact of the project relates to forestry activities required for the production of charcoal for pig iron production. These are discussed below.

No impact is expected in relation to the steel mill/pig iron production facility, given that the project will not alter existing operations. However, an argument could be made that the project activity will prevent the existing facility from converting to coke use and therefore would avoid a series of impacts related to coke use (e.g. sulphur emissions).

Air quality in carbonisation areas
The current levels of hydrocarbons and particulates in carbonisation areas are high, but the project includes the introduction of more advanced kiln designs that will reduce the levels of these pollutants in the air, improving overall air quality in the carbonisation areas. A reduction of respiratory diseases among staff working in this area is expected.

Forestry impacts
To produce raw material for charcoal production, V&M will have to invest in large areas of sustainably managed forest plantations. One main criticism of plantation forestry is based on the argument of biodiversity suppression. The V&M project, however, is expected to bring a series of benefits in relation to biodiversity:

- V&M's forest plantations are currently certified to the standards of the Forest Stewardship Council, perhaps the strictest environmental standard related to sustainable forestry worldwide. The standard requires forest operations to ensure the maintenance of biodiversity within managed areas. The company also has ISO 14,000 certification.
- Maintenance of plantation-based charcoal production reduces pressure on native forests. Even V&M has purchased third party charcoal produced from native forests because of the lack of renewably produced charcoal (although this charcoal was certified to be from legal and authorized deforestation). With the development of the project, V&M will become fully self-sufficient in charcoal.
- Sustainably managed plantations have demonstrated a significant biodiversity benefit due to fire suppression and the cessation of grazing on degraded native forest lands in the legal reserves of native forests required by the Brazilian law (the Brazilian law requires forest plantations to set aside 20% of the total area for biodiversity conservation).
- V&M's corporate policy is to set aside native reserve areas that far exceed the requirements of local regulations. While the law requires a minimum reserve of 20%, V&M currently maintains 35% of its area as a refuge for native vegetation and conservation of biodiversity.
- Fire suppression - by maintaining its current fire monitoring and control system, V&M could allow native vegetation ecosystems (e.g., cerrado) on its land holdings to partially recover their original species composition through the process of secondary succession. Additionally, V&M already provides neighbouring landholders with the benefit of a series of fire watch towers, expanding the impact of the fire protection program.

F.2. If environmental impacts are considered significant by the project participants or the host Party, please provide conclusions and all references to support documentation of an environmental impact assessment undertaken in accordance with the procedures as required by the host Party:

Not applicable.

SECTION G. Stakeholders' comments

G.1. Brief description how comments by local stakeholders have been invited and compiled:

A stakeholders consultation process was conducted in October 2002 by *Magister Consultores Associados,* an independent institution specialised in social and environmental impact assessments. The consultation process was done by qualitative interviews based on a questionnaire, which included sufficient scope for additional comments and suggestions. The interviews were conducted either personally, by telephone, or by fax.

A total of 36 key stakeholders was consulted, including government agencies, trade unions, social and environmental NGOs, research institutions, service providers, and private sector associations. A full list of stakeholders consulted and their comments will be presented to the DOE.

G.2. Summary of the comments received:

Most comments indicated that this project is positive for the development of the country, improving its image and contributing to the economic growth. Most parties consider V&M a serious institution, able to conduct this type of activity in a responsible manner.

Most stakeholders requested to be kept informed of the development of the project. Some stakeholders expressed concern about the self-sustainability of the company, which in some cases could cause the company to feel 'disconnected' from the surrounding community. Some stakeholders expressed concern about the level of employment in V&M's forest operations.

There were no objections to the implementation of the project.

G.3. Report on how due account was taken of any comments received:

V&M will aim to keep all stakeholders more actively involved throughout the implementation of the project, improving the existing consultation processes already in place as part of the FSC certification system. This may be done through a newsletter, or by creating a dedicated page in their website to post all relevant information related to the GHG mitigation project.

With regards to employment, the project will enable V&M to maintain over 1,800 jobs associated with charcoal production activities; most of these jobs would likely be lost in the event company shifted to the use of coke.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Carbon credit originator and Project sponsor:

Organization:	V & M do BRASIL
Street/P.O.Box:	Av. Olinto Meireles 65
Building:	Barreiro Integrated Steel Plant
City:	Barreiro, Belo Horizonte
State/Region:	Minas Gerais
Postfix/ZIP:	MG 30640-000
Country:	Brazil
Telephone:	+55 31 3328 2606
FAX:	+55 31 3328 2631
FAX:	acosite@vmtubes.com.br
E-Mail:	http://www.vmtubes.com.br
URL:	
Represented by:	
Title:	President
Salutation:	
Last Name:	R. S. Azevedo
Middle Name:	
First Name:	Flávio
Department:	
Mobile:	
Direct FAX:	
Direct tel:	+55 31 3328 2600
Personal E-Mail:	flavioa@vmtubes.com.br

Carbon Buyer 1

Organization:	IFC-Netherlands Carbon Facility, International Finance Corporation, World Bar Group
Street/P.O.Box:	2121 Pennsylvania Ave, NW
Building:	
City:	Washington
State/Region:	DC
Postfix/ZIP:	20433
Country:	USA (on behalf of the Netherlands)
Telephone:	202-473-4194
FAX:	202-974-4404
E-Mail:	carbonfinance@ifc.org
URL:	www.ifc.org/carbonfinance
Represented by:	
Title:	Program Manager
Salutation:	Mr.
Last Name:	Widge
Middle Name:	
First Name:	Vikram
Mobile:	
Direct FAX:	202-974-4404
Direct tel:	202-473-1368
Personal E-Mail:	vwidge@ifc.org

Carbon buyer 2

Organization:	Toyota Tsusho Corporation
Street/P.O.Box:	7-23, Meieki 4-Chome, Nakamura-ku,
Building:	
City:	Nagoya,
State/Region:	
Postfix/ZIP:	450-8575
Country:	Japan
Telephone:	+(81)-52-584-5334
FAX:	+(81)-52-584-5081
E-Mail:	TATSUNORI_KAIDEN@gw.toyotsu.co.jp
URL:	http://www.toyotsu.co.jp/
Represented by:	
Title:	Project General Manager
Salutation:	Mr.
Last Name:	Sasaki
Middle Name:	
First Name:	
Mobile:	
Direct FAX:	+(81)-52-584-5081
Direct tel:	+(81)-52-584-5334
Personal E-Mail:	

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

This project will not receive any public funding. A confirmation of the non-diversion of this public funding from ODA towards the host country will be delivered at a later stage.

Annex 3

BASELINE INFORMATION

As in part B of this document. In addition, in order to assist in the determination of the baseline scenario, and to substantiate the assumptions used in the PDD, the following additional data and analyses are provided:

- Financial data used for calculation of costs of using charcoal or coke for pig iron production
- Determination of the future scenario of the steel iron and forestry sectors in Brazil
- Analysis of sequestration potential of land use component of V&M do Brasil activities in both project and baseline scenarios.

Finally, a list of references used is given in the end.

Annex 3.A. Financial data used for the calculation of costs of pig iron production using different reducing agents

Production costs of pig iron using coke as reducing agent - Exchange rate 2,35 R$ / US$

Description	Unit	Price	Blast furnace 1		Production	372,600	Blast furnace 2		Production	167,400	Production	540,000
			Consumption		Cost		Consumption		Cost		M I X	
			Yearly	Espec.	R$ / ano	R$/t	Yearly	Espec.	R$ / year	R$/t	R$ / year	R$/t
Pellets	t	60.17	485,498	1,303.00	29,212,415	78.40	179,603	1,072.90	10,806,713	64.56	40,019,127	74.11
Iron ore	t	16.59	85,214	228.70	1,413,700	3.79	76,602	457.60	1,270,827	7.59	2,684,527	4.97
Manganese	t	13.00	3,316	8.90	43,110	0.12	1,406	8.40	18,280	0.11	61,390	0.11
Stag	t	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Limestone	t	7.00	13,041	35.00	91,287	0.25	7,198	43.00	50,387	0.30	141,674	0.26
Quartz	t	14.50	12,668	34.00	183,692	0.49	8,035	48.00	116,510	0.70	300,202	0.56
Dolomite	t	10.39	21,611	58.00	224,536	0.60	11,383	68.00	118,271	0.71	342,808	0.63
Charcoal	m3	282.66	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Credit charcoal	m3	0.1868	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Fine solids injection	Kg	0.0458	59,616,000	160.00	2,728,638	7.32	21,762,000	130.00	996,052	5.95	3,724,690	6.90
Coke	t	242.05	156,902	421.10	37,978,742	101.93	75,397	450.40	18,250,145	109.02	56,228,886	104.13
Credit coke	t	45.77	12,594	33.80	-576,425	-1.55	5,993	35.80	-274,297	-1.64	-850,722	-1.58
Gas consumption	Nm3		172,886,400	464.00	2,463,631	6.61	79,180,200	473.00	1,128,318	6.74	3,591,949	6.65
Credit gas	Nm3		579,393,000	1,555.00	-8,256,350	-22.16	264,994,200	1,583.00	-3,776,167	-22.56	-12,032,518	-22.28
Sum Raw Materials					65,506,976	175.81			28,705,039	171.48	94,212,015	174.47
Investments in railwail linke			-	-	413,586	1.11	-	-	185,814	1.11	599,400	1.11
Interest on stocks			-	-	741,662	1.99	-	-	333,211	1.99	1,074,873	1.99
Desulphurisation investments			-	-	4,590,432	12.32	-	-	2,062,368	12.32	6,652,800	12.32
SUM OPERATIONAL COSTS					5,745,680	15.42			2,581,393	15.42	8,327,073	15.42
TOTAL COSTS OF PLANT					71,252,656	191.23			31,286,431	186.90	102,539,087	189.90

Production costs of pig iron using charcoal as reducing agent - Exchange rate 2,35 R$ / US$

Description	Unit	Price	Blast Furnace 1		Production	360,000	Blast Furnace 2		Production	180,000	Production	540,000
			Consumption		Cost		Consumption		Cost		M I X	
			Yearly	Espec.	R$ / ano	R$/t	Yearly	Espec.	R$ / year	R$/t	R$ / year	R$/t
Pellets	t	60.17	275,904	766.40	16,601,144	46.11		0.00	0	0.00	16,601,144	30.74
Iron ore	t	16.59	274,608	762.80	4,555,747	12.65	270,000	1,500.00	4,479,300	24.89	9,035,047	16.73
Manganese	t	13.00	3,096	8.60	40,248	0.11	1,404	7.80	18,252	0.10	58,500	0.11
Stag	t	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Limestone	t	7.00	12,600	35.00	88,200	0.25	0	0.00	0	0.00	88,200	0.16
Quartz	t	14.50	12,240	34.00	177,480	0.49	5,040	28.00	73,080	0.41	250,560	0.46
Dolomite	t	10.39	20,880	58.00	216,943	0.60	9,000	50.00	93,510	0.52	310,453	0.57
Charcoal	m3	182.81	234,000	650.00	42,777,540	118.83	117,000	650.00	21,388,770	118.83	64,166,310	118.83
Credit charcoal	m3	0.2352	55,692,000	154.70	-13,097,134	-36.38	27,846,000	154.70	-6,548,567	-36.38	-19,645,702	-36.38
Fine solids injection	Kg	0.2441	57,600,000	160.00	14,062,464	39.06	19,800,000	110.00	4,833,972	26.86	18,896,436	34.99
Coke	t	242.05		0.00	0	0.00	0	0.00	0	0.00	0	0.00
Credit coke	t	45.77	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Gas consumption	Nm3		172,080,000	478.00	3,269,520	9.08	86,040,000	478.00	1,634,760	9.08	4,904,280	9.08
Credit gas	Nm3		576,720,000	1,602.00	-10,957,680	-30.44	288,360,000	1,602.00	-5,478,840	-30.44	-16,436,520	-30.44
Sum Raw Materials					57,734,471	160.37			20,494,237	113.86	78,228,708	144.87
Interest on Forests			-	-		25.30	-	-	4,553,679	25.30		0.00
Interest on Stocks			-	-	365,620	1.02	-	-	182,810	1.02	548,430	1.02
Interest on land			-	-		9.26	-	-	1,666,667	9.26		0.00
SUM OPERATIONAL COSTS					365,620	1.02			6,403,156	35.57	548,430	1.02
TOTAL COSTS OF PLANT					58,100,091	161.39			26,897,392	149.43	78,777,138	145.89

Annex 3.B. Determination of the future scenario of the steel, iron, and forestry sectors

Determination of the baseline of the V&M project is based on determining the future scenario in the absence of this carbon-financed project. Establishing this future scenario requires an analysis of the steel sector, the long term price and availability of raw materials (coke and charcoal), and in the case of the latter, the long term health of the forestry sector in the region. This section has drawn much information from a couple of previous studies conducted for the World Bank about the pig iron sector in Minas Gerais (Peter H. May & Kenneth Chomitz, 2001; and Fundação Biodiversitas, 2001).

1. Characterization of the steel and iron production sector in Brasil

The Minas Gerais iron industry is today segmented into three principal groups: (i) independent small pig iron producers; (ii) large non-integrated steel mills using charcoal with or without mineral coke; and (iii) integrated coke-based steel mills. The total production of pig iron in 2000 was 27.7 million tonnes (Table 1), of which 14% was exported and the rest consumed in Brazil (IBS 2001).

The group of small independent pig iron producers is the most numerous of these groups. SINDIFER lists 43 independent firms in existence in Minas in 2001, with a total of 83 blast furnaces (May and Chomitz, 2001). These companies are mainly focused on the supply of iron to foundries and mini-mills in the international market and to replace scrap used by the electric arc furnace steel producers in the domestic market (for companies of Group ii, described below, see Tables 1 and 2). Their plants usually have established capacity between 60 and 400 thousand tons per year (Biodiversitas), much smaller than any of the other two groups listed above. Technological and financial/economic constraints render unfeasible the conversion of small blast furnaces for use with coke, consequently maintaining this sector dependent on the forestry sector as a main source of raw material.

The second group comprises of four large private companies that originally produce steel mainly from charcoal: V&M do Brasil, Gerdau (still reliant on charcoal), Acesita and Belgo-Mineira (which previously used both coke and charcoal as a reducer). This type of enterprise, charcoal-based steel making, is only found in Brazil. Because of their production volumes (which range from 600,000 to 4,1 million tonnes of steel per year), their economics allow them the choice of conversion from charcoal to coke, which indeed has been done by some of these companies (see Section 1.4). This group is, thus, the most responsive to market factors in relation to the reducing agent (charcoal or coke) used.

The third group, integrated coke-based mills currently account for 74% of total pig-iron production in Brasil. These comprise of five large-scale enterprises (CST, Usiminas, Açominas, Cosipa, CSN), previously parastatals that have been privatized since the early 1990s. The current trend has been toward an increasing concentration of the industry in integrated mills. These companies produce most of the pig iron produced in Brasil, to supply their own for steel mills (see Tables 1 and 2).

Table 1: Iron production in Brasil. Group i refers to companies producing exclusively pig iron. Source: (IBS 2001).

Company	1995	1996	1997	1998	1999	2000
Group i: Independent producers:	***4,919***	***4,156***	***4,564***	***4,732***	***5,169***	***5,916***
Group ii: Large non-integrated mills:	***2,460***	***2,406***	***2,362***	***2,394***	***2,356***	***2,854***
Acesita	471	496	562	587	623	685
Belgo-Mineira	770	777	697	769	696	935
Gerdau	701	621	622	625	669	722
V & M do Brasil	518	512	481	413	368	512
Group iii: Large integrated coke mills:	***17,642***	***17,416***	***18,087***	***17,985***	***17,024***	***18,953***
Usiminas	3,929	3,826	3,738	3,817	2,851	4,134
Açominas	2,342	2,286	2,273	2,260	2,316	2,538
Barra Mansa	82	-	-	-	0	0
Cosipa	3,404	3,427	3,656	3,369	2,477	2,748
CSN	4,383	4,358	4,791	4,561	4,650	4,517
CST	3,502	3,519	3,629	3,978	4,730	5,016
TOTAL	**25,021**	**23,978**	**25,013**	**25,111**	**24,549**	**27,723**

Table 2: Steel production in Brazil.

Company	1995	1996	1997	1998	1999	2000
Group ii: Large non-integrated mills:	***5,586***	***6,079***	***6,293***	***6,241***	***6,677***	***7,442***
Acesita	612	624	632	687	786	856
Belgo-Mineira	1,661	2,054	2,117	2,157	2,267	2,571
Gerdau	2,752	2,878	3,043	2,964	3,259	3,496
V & M do Brasil	561	523	501	433	365	519
Group iii: Large integrated coke mills:	***18,580***	***18,331***	***18,971***	***18,744***	***17,583***	***19,731***
Usiminas	4,160	4,039	3,930	4,023	2,980	4,438
Açominas	2,435	2,400	2,376	2,330	2,355	2,620
Barra Mansa	308	351	364	346	390	393
Cosipa	3,598	3,604	3,791	3,519	2,593	2,746
CSN	4,340	4,364	4,796	4,708	4,851	4,782
CST	3,739	3,573	3,714	3,818	4,414	4,752
TOTAL	**24,166**	**24,410**	**25,264**	**24,985**	**24,260**	**27,173**

Source: IBS (2001).

2. Raw material: trends in the forestry sector

The survival of the charcoal-based steel and iron production sector in Brasil is totally dependent on the availability of raw material: charcoal, which depends on the conditions of the plantation forestry sector in Brasil or the Minas Gerais state. To a large extent, the health of the plantation forestry sector in Brasil is, in turn, dependent on the survival of the charcoal-based pig iron and steel sectors. The primary destination for plantation wood in Minas Gerais is for use as industrial charcoal. Figures from the Instituto de Pesquisas e Estudos Florestais (IPEF) indicate that the state of Minas Gerais consumes 73% of the charcoal in Brazil, with iron and steel production accounting for 91% of the consumption by volume (Tables 3 and 4). Therefore, a close relationship exists between demand of the steel and iron industries and trends in the forestry sector. This analysis must, consequently, understand the dynamics of the forestry sector as a source of raw material, and its interlinks with the steel and pig iron sectors.

Table 3. Consumption of charcoal by state (1997).

State	**Consumption (1000 m^3)**	%
Minas Gerais	17271	73
São Paulo	330	1.4
Bahia	663	2.8
Rio de Janeiro	413	1.8
Espírito Santo	972	4.1
Others	3951	16.9
TOTAL	**23600**	**100**

Source: Instituto de Pesquisas e Estudos Florestais (IPEF, 2000)

Table 4. Consumption of charcoal by different industrial sectors in Brazil (1997)

Industrial sector	**Consumption (million m^3)**	**%**
Integrated steel production	4.5	19
Independent production of pig-iron	14.3	61
Iron products	1.2	5
Primary metal	1.6	6
Others	2.0	9
TOTAL	**23.6**	**100**

Source: Instituto de Pesquisas e Estudos Florestais (IPEF, 2000)

2.1 Forest plantations establishment trends in Brazil

Plantation forests in Brazil are dominated by species of *Eucalyptus*. The first commercial *Eucalyptus* plantations in Brazil were established in the early twentieth century and between 1909 and 1965 470,000 hectares of *Eucalyptus* spp. were planted (primarily *Eucalyptus globulus*) to substitute native woodland for use as firewood in railroad construction.

In 1967 the Brazilian Government introduced the FISET Programme, a fiscal incentive programme to encourage investment in afforestation for use in the pulp, paper and charcoal-based pig-iron and steel industries[13]. The rate of plantation establishment rapidly increased, and the total area of plantations in Brazil increased from 470,000 hectares to 6.5 million hectares in 1992. This increase in plantation establishment was also correlated with an increase in utilization of fuelwood (especially charcoal) following surges in the price of petroleum in the 1970s.

In 1989, the FISET Program was discontinued. Following the end of the fiscal incentives, plantation establishment decreased while harvesting of existing plantations continued at the existing rate. 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 plantation forest establishment onto native forest preservation and sustainable management, with native forests at that time still contributing 99.8 % of total harvest in northern Brazil (1989). The implementation of further restrictions on native forest harvesting did sustain the rate of establishment of new forest plantations by artificially supplementing the benefits of plantation-grown wood. However, a trend away from plantation establishment can clearly be seen over the last five years with the total of 6.5 millions hectares of planted forest in 1992 dropping to 4.8 million in 1998 (IPEF, 2000).

[13] Under Law 5106/66, under the FISET Programme individuals and companies were able to set-aside 50 % of income tax payments for reforestation projects, and all projects had to be submitted to analysis by the Brazilian Institute for Forestry Development (IBDF).

2.2. Forestry Trends in Minas Gerais

The trends mentioned above were even stronger in the state of Minas Gerais, given that it has historically dominated the Brazilian plantation forestry sector.

The plantation forestry sector in Minas Gerais has evolved hand-in-hand with the pig iron and steel manufacturing sectors. The rich-deposits of iron ore in the state and the need for a cost effective thermal reduction agent has led firstly to the rapid depletion of the local native forest. In October 1951, a meeting of steel industry representatives from the states of Sâo Paulo and Minas Gerais discussed their concerns on the unsustainable consumption of a diminishing native forest resource and afforestation projects were implemented over the following years. This phase of rapid establishment continued with the further development of the pig-iron and steel industries and accelerated over the last years of eligibility under fiscal incentives (1967-1988).

The end of fiscal incentives for forest investment correlated with a marked drop in area under plantation establishment in Minas Gerais (Figure 1). This was followed by a reduction in the forest cover in the state. In 1992, Minas Gerais was covered by over 2.6 million hectares of forest plantations and accounted for 40% of the plantations in Brazil (Companhia Vale do Rio Doce, 1994). By 1998, this figure had reduced to 1.67 million ha (Figure 2). This is because the level of harvesting continued high, with no replanting. It has been estimated that, in order to maintain the current timber supply, the state would need to initiate a replanting program in the order of 130,000 ha per year (Abracave, pers. comm.). A separate projection of forest stocks and demand for forest products indicate that there is currently a deficit of 7% of supply of charcoal per year, and it is expected that this will increase to a deficit of over 50% by 2007 (Peter May, ProNatura).

Apart from the lack of fiscal incentives, this reduction in forest cover was also a result in the reduction in demand for charcoal by the steel sector. This is due to a series of factors, as discussed in Section 4 below.

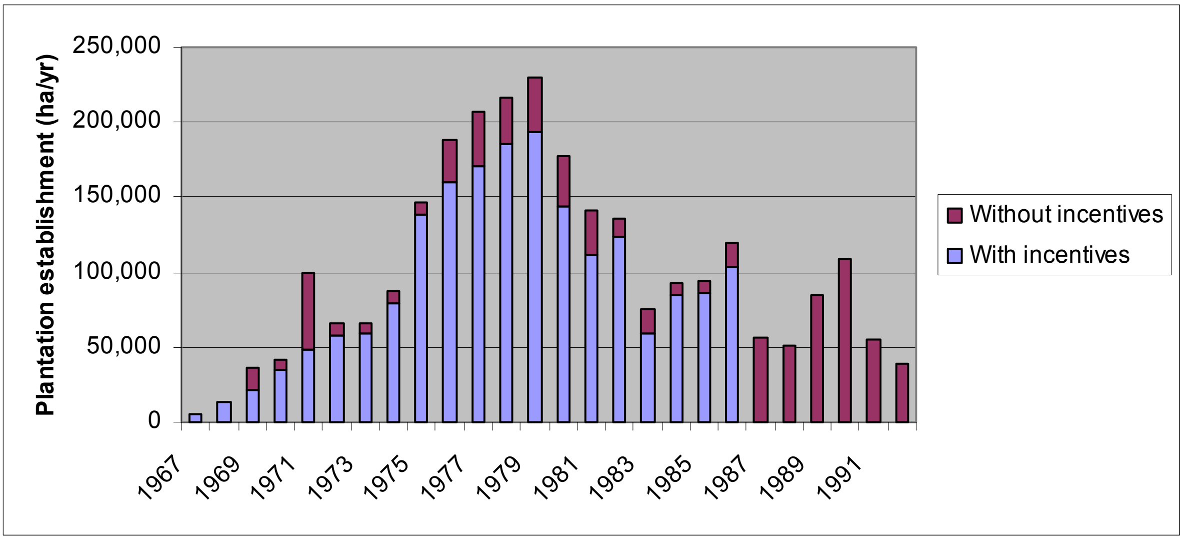

Figure 1: Rate of plantation establishment in Minas Gerais, with and without fiscal incentives (ha/yr). Source: Companhia Vale do Rio Doce, 1999

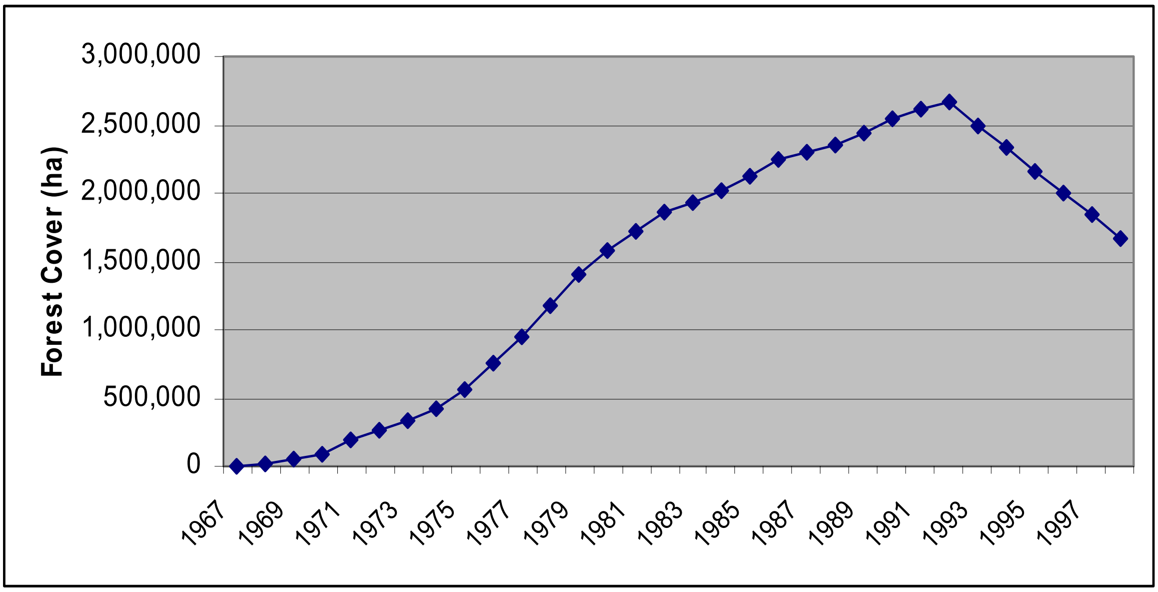

Figure 2: Plantation forest cover in Minas Gerais (ha). Source: IPEF (2000)

Given the ongoing trend of decline in the forest base in the state, charcoal-based pig iron producers would need to invest in order to ensure the supply of raw material. Barriers to investment are discussed below.

2.3 Forest finance and ProFlorestas

The only source of forest finance currently available for plantings in the state of Minas Gerais is the Program for Conservation and Forest Production in Minas Gerais (ProFlorestas) funding line, supported by the Government of Minas Gerais and the World Bank (BIRD). ProFlorestas was established as an effort of the Minas Gerais state to increase the wood supply for industrial use and, at the same time, to reduce the strong pressure on the native forest remnants. The ProFlorestas Fund started its operations in 1995 and adopted the following parameters and conditions of lending for companies producing wood for industrial uses (Biodiversitas 2001):

- limit of financing: up to 80% of the investments, excluding land costs;
- term: 14 years, with 7 years of grace period (while these plantations are managed on 28-year rotations);
- maximum loan size: R$ 4 million (currently U$ 1.4 million), too small for most companies in the sector;
- guarantees required: mortgage in 1st grade of holdings and urban real estates and pledge of the forest plantations at a value at least 130% of the financed value. The bank had also the collateral security of the main shareholders of the company. A Letter of Bank Security as an exclusive guarantee can replace the mortgage;
- monetary correction: according to variation of General Index of Market Prices;
- interest rate: to be defined by World Bank every six months but limited to 11% a.a. Interest must be paid every semester during the grace period and monthly in the period of amortization simultaneously with the capital.

The terms of the loans offered by ProFlorestas, associated with the guarantees required have not led to much borrowing among the pig iron sector.

3. Trends in the large non-integrated steel producers

The group of non-integrated large steel producers (group ii above, including V&M) is presently in a transitional phase in relation to their choice of reducing agent. Decisions related to the choice of reducing agent are based on series of factors, predominantly linked to the relative prices of coal and charcoal, aspects related to investment in the forestry and its risks, and reasons related to investments of long gestation in the Brazilian macro-economic context.

The initial development of the steel and pig-iron industries was very dependent on the local availability of forest resources. This is because the Brazilian transportation network was insufficient to allow cost-effective utilization of mineral coal. The depletion of local forest reserves has led to the need to procure wood further away, increasing transportation costs for charcoal production. At the same time, the expansion of the existing transport network gradually led to an increase in cost-effectiveness of utilization of imported coal by the steel and iron industries. In the 1950s, the installation of the coal-based Volta Redonda Plant signaled the start of competition between the two thermal-reducing agents.

The beginning of the Minas Gerais Government's Charcoal Program in the 1970s has led to a rapid rise in consumption of charcoal in the state. At a later stage, though, it also highlighted severe problems with maintaining levels of sustainable supply. Key problems included exceptionally low yields from badly managed plantations, further utilization of native *cerrado* woodland, and the need for large capital investment to challenge the expanding coal-based industry.

In 1994, the Brazilian government introduced the Plano Real economic plan, which resulted in the pegging of a new Brazilian currency (Real) to the dollar, on an equal level (1:1). This artificially high exchange rate has made the costs of imports relatively lower in relation to goods produced locally. In relation to reduction agents for the steel and iron industries, it made the utilization of imported coal much more cost effective than the use of locally produced charcoal (Figure 3). In 2001, however, a devaluation of the Brazilian Real in relation to the U$ dollar has somewhat altered this situation, but most experts in this sector believe that the trends shown in Figure 3 are likely to persist in the long term (e.g., Biodiversitas 2001).

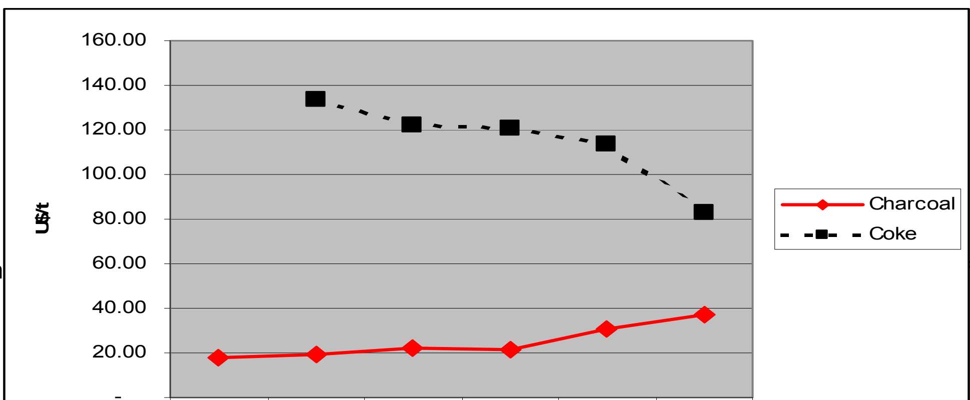

Figure 3: Historical series of charcoal and coal prices in Brasil. Data from Abracave (charcoal) and IBS (coke).

At the same time, Brasil has been through several years of hyper inflation and high interest rates, strongly discouraging any long term investment in real assets. Associated with the risks related to exchange rate fluctuations and social uncertainty, this lack of incentives has led to a major halt of investment in reforestation activities in Brasil.

Given their dependency on forests as a source of raw material for the steel & pig iron production sector, investment in the forestry sector is essential to guarantee their survival. This is particularly important at the moment, given that most of the forests created during the FISET period are now reaching the end of their 21-year rotation, and will need to be replanted. Replanting (or "renovation") is a costly activity: in the case of V&M, the company will have to invest over U$ 50 million in order to renovate its existing forest base. In general, however, investment is not taking place for a series of reasons:

- Lack of access to capital for investment in forestry – there is currently no long term finance lines available for the forestry sector in Brasil. The ProFloresta Program available in Minas Gerais is not adequate to this sector, as explained in the previous section.
- Lack of fiscal incentives for forestry investment– since the discontinuation of the FISET program in 1989.
- No access to low interest finance – interest rates in Brazil are very high compared to external rates, and the sector does not have access to external sources of finance.
- Inherent low profitability of the forestry activity in Brasil.

In the absence of investment, the forestry sector is been gradually liquidated, as described in Section 2 above. It is expected that without the introduction of financial incentives or concessional funding lines, this trend will continue into the future.

Another factor related to the shift from charcoal to coke is linked to cultural perceptions of forestry. While charcoal-based steel production only occurs in Brasil, companies of Group ii belong or have been acquired by foreign groups that feel uncomfortable about maintaining large forest assets in a foreign developing country. A senior executive of Companhia Belgo Mineira, for instance, pointed out that the area of forests owned by the company are larger than Luxembourg, the country of its mother company ARBED (Aciéres Réunis de Burbache Eich-Dudelange, a Belgian-Luxembourger partnership). Indeed, the same concerns were raised by the new shareholders in the V&M joint venture. The following points have been mentioned as major factors of preoccupation to charcoal based companies:

- environmental liabilities;
- the maintenance of large labor contingents, and their inherent management requirements, risks, and liabilities;

- risks associated with forestry (natural, anthropogenic);
- lack of asset liquidity and immobilization of large amounts of capital.

These problems, consequently, have resulted in a general trend away from charcoal-based production to the use of more cost-effective, "trouble-free" coal (Figure 4). A recent study for the Ministry of Science and Technology (Ministério da Ciência e Tecnologia – MCT, 2000), includes a comparison between the two thermal reduction agents, indicating a trend towards market domination by the coal-based sector (Figure 5). Simple extrapolation of figures suggests elimination of charcoal-based metallurgic production by 2050.

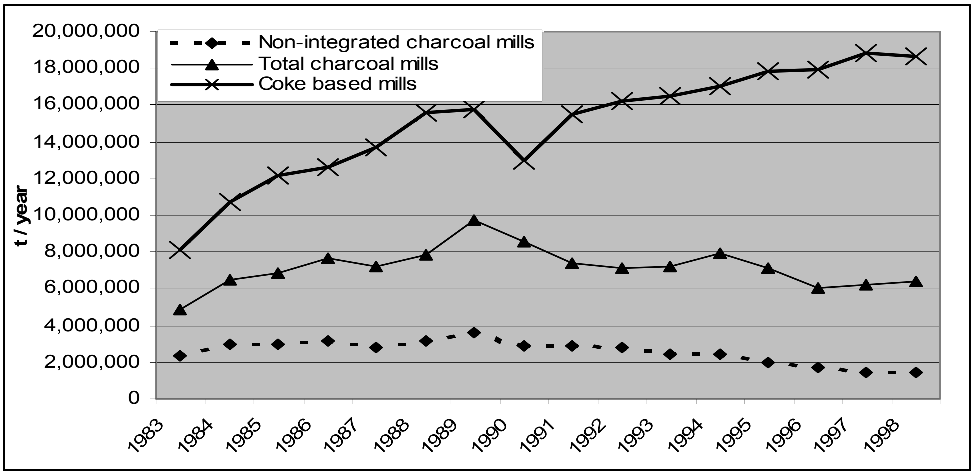

Figure 4: Historical series of coal and charcoal use for steel and pig iron production. Source: Abracave (1999, in Biodiversitas 2001)

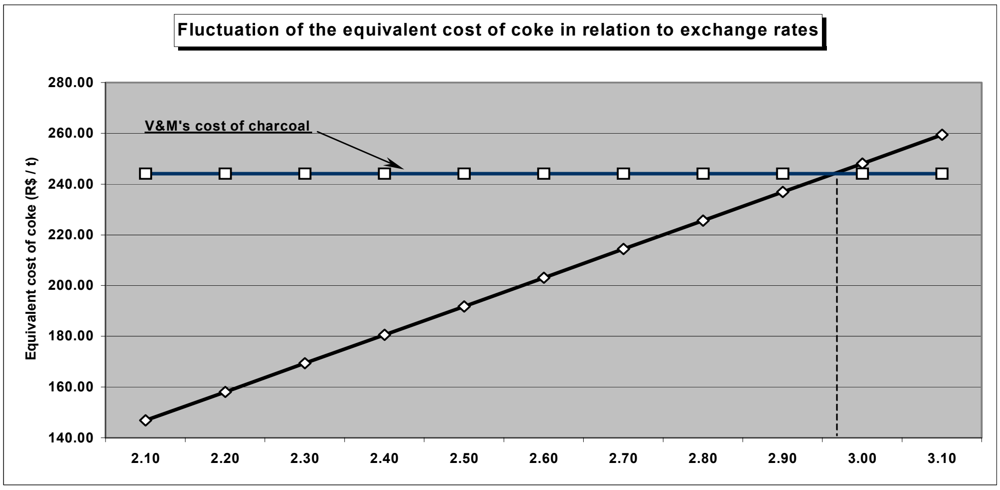

Figure 5: Percentage use of coal and charcoal in the steel and pig iron production sector. Adapted from Ferreira *et al*, 2000.

Recent examples of this economic trend abound. A recent study by the Brazilian Steel Institute (Instituto Brasileiro de Siderurgia - IBS) shows that the consumption of charcoal has reduced from 8 million tonnes in 1993 to 4.2 million tonnes in 1999. In parallel, important steel manufacturers are selling their plantation forest assets. Since 1996, Acesita (the only Brazilian producer of stainless steel) has reduced its forest assets from 250,000 ha to 101,500 ha, and adapted one of its furnaces to operate on coke alone, while still maintaining the others operating on charcoal. Companhia Belgo-Mineira, the second largest producer of steel in Brasil, has recently completed its total conversion into

coal and has already started slowing down its forestry operations (although part of its forestry operations are currently focused on supplying small independent pig iron producers which resell their production back to Belgo-Mineira).

A general feeling among experts in this industry is that unless incentives are put in place to support either the forestry sector or the use of charcoal the current trend of substitution to coal is going to persist.

4. The production of reducing agents: coking and carbonisation

4.1 The coking activity

An assumption of the baseline is that in the absence of carbon finance there will be a decline in the use of charcoal as a reducing agent for the production of pig iron in Minas Gerais, with its market share taken by coke-based mills. Apart from the emissions derived from the use of coke in the blast furnaces used for iron/steel production, a substantial amount of emissions (about 0.342 tonnes CO_2 per tonne of pig iron produced, Sampaio and Lopes, 2000) are generated during the coking process (i.e., the transformation of coal in coke, through a dry distillation process). It is important, therefore, to ascertain where coking is going to take place, i.e., whether inside or outside Brasil, given that the assumed project boundaries for this study is Brasil.

As discussed in Section 1, it is assumed that the market share currently occupied by charcoal-based mills will be taken by companies of the group ii and iii (large non-integrated and integrated companies). Currently, Brasil imports 100% of the coal used by the steel sector but only 16% of the coke used in the country is imported (IBS 2001). The large integrated companies of group iii own coking plants that produce 100% of their needs. Most companies of group ii, though, still do not own coking plants, given that they originally used charcoal for their production process, but with those moving into coke are already planning investments in new coking plants. Belgo-Mineira, Acesita, Usiminas and CST plan to invest U$300 million in a joint coking plant with capacity to produce 1.5 million tonnes per year (Gazeta Mercantil, 2001).

4.2. Carbonization and methane emissions

Traditionally, the charcoal kilns in Brasil generate a substantial amount of methane in the carbonization process. While eucalyptus improvement and plantation techniques have improved productivity dramatically over the past 20 years, the same cannot be said for charcoal technology (May and Chomitz, 2001). At least 90% of charcoal produced in Brazil is obtained from beehive type masonry kilns with low caloric efficiency known as "*rabo quente*" (hot tail), whose gaseous emissions are significant (Ferreira et al., 2000; Smith et al., 1999). While technology exists in Brazil and elsewhere that would enhance both carbonization efficiency and reduce emissions, there are no environmental standards for this segment of the industry, and their improvement has been generally ignored (May and Chomitz, 2001). In the V&M case, there will be an investment in the amelioration of the charcoal production methodology, leading to additional social and environmental benefits.

5. The V&M's case

V&M has historically used charcoal in its pig iron production, which it produces internally through its subsidiary V&M Florestal. While in the rest of the world pig iron is typically produced with coke, in Brazil, due in large part to the government FISET subsidy program, many pig iron producers used charcoal. Those [steel and] pig iron companies that use charcoal as a reductant produce their own

charcoal to minimize supply and quality risks of an important input. Furthermore, the Brazilian law requires that the plantation forestry sector be self sufficient, i.e., the plantation forestry sector as a whole has to be able to supply at least 90% of the wood needs of the main users (mainly bakeries, iron & steel, and pulp & paper sectors), since the use of native wood from authorized deforestations is limited to a maximum of 10%. In order to support the production of plantation wood, the government created the FISET fiscal incentive programme (Law 5106/66) to encourage investment in afforestation for use in the pulp, paper and charcoal-based pig-iron and steel industries, which caused charcoal to be cheaper than coke.

In 1989, however, the FISET program was discontinued. The end of FISET, coupled with a strengthening of the local currency, the Brazilian Real, began to erode the competitive cost of charcoal in favour of coke. Furthermore, the privatisation of the steel sector in Brazil brought foreign owners into the Brazilian steel and pig iron business who were not comfortable with the risks of charcoal production and use. Therefore, beginning in the mid-1990s, several Brazilian vertically integrated steel producers (defined as steel producers that manufacture their pig iron input) began to convert to coke use. Smaller pig iron producers, on the other hand, cannot operate with coke, and their inability to invest in reforestations to produce charcoal (since the discontinuation of FISET) has led to the closure of many of these companies. From the 67 pig iron companies operating in Minas Gerais in 1992, only 37 operate today (May and Chomitz 2001)

V&M do Brasil, formerly Mannesmann, S.A., began to consider a switch to coke in 1995. During the subsequent years, Mannesmann took several actions that demonstrate its concerns over the raising costs of charcoal production and the potential for revenues from emissions reductions that could be used to counter the increased costs. In 1995, it began discussions with Acesita, Gerdau, and Belgo Mineira, other steel producers, and was invited to participate in a consortium to invest in a coking plant to produce coke from coal (this plant is expected to start operating in 2005, with capacity for 2 million t coke per year). Beginning in 1990, V&M began to reduce substantially investments in its plantations and to over-harvest its crop (see Table 5 below). V&M Florestal was a loss making entity whose last profitable year was in 1996. In 2000, Mannesmann formed a joint venture with the French company Vallourec, forming V&M Tubes, in which Vallourec has the controlling share. V&M Tubes then purchased Mannesmann, S.A. After the management change, Vallourec voiced concerns over the risks and costs of the production and use of charcoal and requested an evaluation towards a conversion to coke. A final decision was to be made in a board meeting in July 2001.

Table 5. V&M's planting areas since 1985. Notice reduction in planting from 1990, when of the discontinuation of the FISET, and replanting from 2002 onwards.

Year	Planting area (ha)
1985	17,643
1986	16,681
1987	18,112
1988	9,625
1989	14,964
1990	5,857
1991	4,443
1992	4,320
1993	4,190
1994	3,152
1995	3,124
1996	1,873
1997	2,938
1998	2,902
1999	1,771
2000	3,485
2001	3,500
2002	6,019
2003	6,000

Based on the factors described above, the baseline scenario identified for this project consists of the following trends, which would take place in the absence of carbon finance and/or other financial incentives:

- An accelerated reduction in the plantation forestry base in the state of Minas Gerais, within the next decade, caused by harvesting of existing forests (now in the last cycle of their rotations) and lack of investment into replanting;
- The reduction of the forest base leads to scarcity of charcoal as a raw material for the charcoal-based mills. This will lead to the gradual decline and eventual death of this market segment.
- This market segment becomes occupied by predominantly the large integrated mills of group iii (see Section 1 for definitions), which is already totally coke-based.

The combination of these factors suggest a large shift into greenhouse gas (GHG) intensive steel and pig iron production processes, together with the abandonment of the plantation forestry sector in the Minas Gerais state. Carbon trading, providing an incentive for both the establishment and maintenance of forest assets, as well as for the use of charcoal as opposed to fossil fuels, could play a vital role in preventing/reverting this trend.

In this context, the baseline adopted for the V&M project is based on the assumption that in the absence of carbon finance the company would have converted its factory to operate on coke, in October 2001, following the trends in the sector as a whole. V&M would not have invested in the replanting of its forests, abandoning them after the final harvest of the existing plantations. This production would be sold to third parties in the state of Minas Gerais. This process would take place during the initial 7 years of the project (since Oct 2001), given that all the plantations were already in the last 7-year cycle. After abandonment of the plantations, the land would be sold, most likely for cattle ranching (the most common land use in areas abandoned by forestry, Biodiversitas 2001)[14].

[14] According to a study by the IEF (the Minas Gerais state forestry institute), the most common land use in deforested areas are cattle ranching (55.12% of the are) and farming (25.5 %), both sustaining similarly low levels of biomass.

Annex 3.C. Analysis of the sequestration potential of the land use component of V&M do Brasil activities in the project and baseline scenarios

1. Methodology

The projections of carbon stocks and flows for the project were conducted utilising through a model that quantifies the carbon budget of forest systems at the stand level, scaled to 1 hectare, using annual time steps and allowing for multiple rotations or cutting cycles. Carbon flows through the system are calculated as inputs (additions) and outputs (reductions) to the five carbon pools on which the model is structured: trees, other vegetation, coarse and fine necromass, soil, and wood products. The carbon flows which inter-link these pools are influenced by factors that are both natural (e.g., growth) and anthropogenic (e.g., harvests).

The initial total carbon budget of the system is calculated from the input data. Subsequent changes are then quantified by tracking carbon flows between the five pools on a yearly basis. Final annual volumes (m^3/ha) for the pools are converted into biomass (t/ha) and then carbon (tC/ha) using appropriate conversion factors. The carbon stored in each pool is then summed to give the annual system-wide carbon budget, profiled over the length of the model run.

The model requires a range of data inputs that describe the forest system to be modelled. To keep uncertainty margins low, it is always preferable for such data to be empirically determined on site. Where such data was not available, appropriate inputs were sourced from EcoSecurities' own database of defaults, as well as from relevant literature data. Details of all the input data and assumptions used are outlined in Section 6.

One of the key characteristics of project-level carbon offsets is that they are 'additional', meaning that they can only be generated by actions taken specifically to this end. In practice therefore, the carbon offset by any given forestry project is calculated as the difference between:

- the baseline scenario – what would have happened in the absence of the project.
- the project scenario – what will happen as a result of the project's activities.

2. Stratification of the forestry area

In order to model the effect of different baseline and project scenarios on the carbon pools and flows it is necessary to first stratify the whole area into groups of similar total biomass per hectare. In practice, dividing the area into vegetation types usually accomplishes this objective. After stratifying the area, separate analyses are conducted for each strata, to estimate what would be the carbon flows in the baseline and project scenarios, using the ECO_2Forestry™ model. In order to calculate the net carbon offsets resulting from project activities, the number of hectares in each strata is also required.

For the purposes of modelling of the afforestation activities, the project was divided into the following strata (further information on the project and baseline are given later):

Vegetation type	Baseline scenario	Project intervention
Eucalyptus plantations (with Mean Annual Increment of 15 m^3/ha/yr)	As the stands of different ages reach the end of their 21-year cycle, no re-planting of *Eucalyptus* will take place and the area will be gradually converted to pasture.	A proportion of new plantings will be replaced with higher yield varieties of Eucalyptus (MAI 35 m^3/ha/yr). The remaining project area will be maintained with the lower yield varieties (MAI 15 m^3/ha/yr).

3. Forestry data assumptions

The tables given in the Section 6 list the input data and assumptions used for the model baseline and project scenario runs for the strata outlined above. Wherever possible the data assumptions were based on project specific measurements, with the sampling methodologies and calculation assumptions given alongside. In the case where data was not provided by the project, it was sourced from other scientific studies relevant to the project's region and vegetation type, or other literature data, and full references are given.

A number of key general assumptions are made about the project area and the carbon flux modelling:

- areas are net values and exclude roads, camps and other minor forest land-uses.
- no change is expected in the land-use type during the 63-year period considered here.
- the land will not be significantly affected by natural disasters such as fire, flooding, drought, nor human interference.
- fossil fuel use in the project and baseline scenarios is assumed to be similar, or the difference insignificant in terms of carbon, and has therefore been excluded from the model.
- carbon dynamics in both vegetation and soil are expected to show short-term fluctuations, but total carbon sequestered will generally be steady over the long-term (i.e., the 63 year period considered).
- offsite emissions, such as those resulting from fossil fuels used in harvesting operations, and subsequent wood transport and processing, have not been included in the modelling. This is due to a lack of data on offsite emissions and also the belief that such emissions are likely to be negligible as compared to the other pools and flows being modelled.

3.1. The baseline scenario

The baseline scenario for the area is based on what would have happened in the absence of the project activities. In this case the baseline scenario assumes that following the completion of the existing 21 year cycle no further planting will take place, due to economic factors that have been described in Annex 3.A. It is assumed that plantation activity will remain on a given hectare in the baseline scenario for the full 21 years, since only the first of the three 7-year cycles is planted and the others will regenerate from coppice (and therefore require little additional cost to the developer). At the end of the 21 years, the land is assumed to be converted to pasture or agricultural land. The data assumptions used for quantification of carbon stocks and flows of the baseline scenario can be found in the Section 6.

3.2. The project scenario

The project scenario is the activity undertaken by the project in the area. In this case the project scenario is the continuation of *Eucalyptus* plantations in this area. As described above and in the Annex 3.A, the trend in the region represents a decrease in the number of plantations, and their abandonment and conversion into agriculture or pasture lands. In addition, a certain proportion of plantations will be replaced with higher yield *Eucalyptus* varieties (MAI of 35 rather than 15). The schedule of planting and the proportion of high to low yield varieties proposed by the project are outlined in the table below. The data assumptions used for quantification of carbon stocks and flows of the project scenario can be found in the Section 6.

Project and baseline activities by area (hectares):

Year	Area to be replanted with species with high yields (MAI 35)	Area to be maintained with low yielding species (MAI 15)
2000	6,076	10,924
2001	6,177	10,823
2002	5,890	11,110
2003	7,639	9,361
2004	7,116	9,884
2005	6,159	10,841
2006	3,669	13,331
2007	3,030	13,970
2008	2,569	14,431
2009	2,088	14,912
Total (ha)	**50,413**	**119,587**

4. **Preliminary projections (per hectare)**

The initial stage of the modelling considered the main flows between the key carbon pools in the project and baseline situations. It was done separately, on a one-hectare basis, and then the baseline total was subtracted from the project total in order to give the net carbon sequestration over the project lifetime (3 rotations). The graphs given below show firstly, a breakdown of the carbon sequestered under project activities only, and secondly the net carbon sequestration (project – baseline).

4.1. Modelling of carbon stocks and flows for the project activities

Figures 1a and 1b show the results of a projection of carbon stocks for the two project scenarios: the area which will be maintained as is (low productivity) and the area to be renewed (Figure 1a).

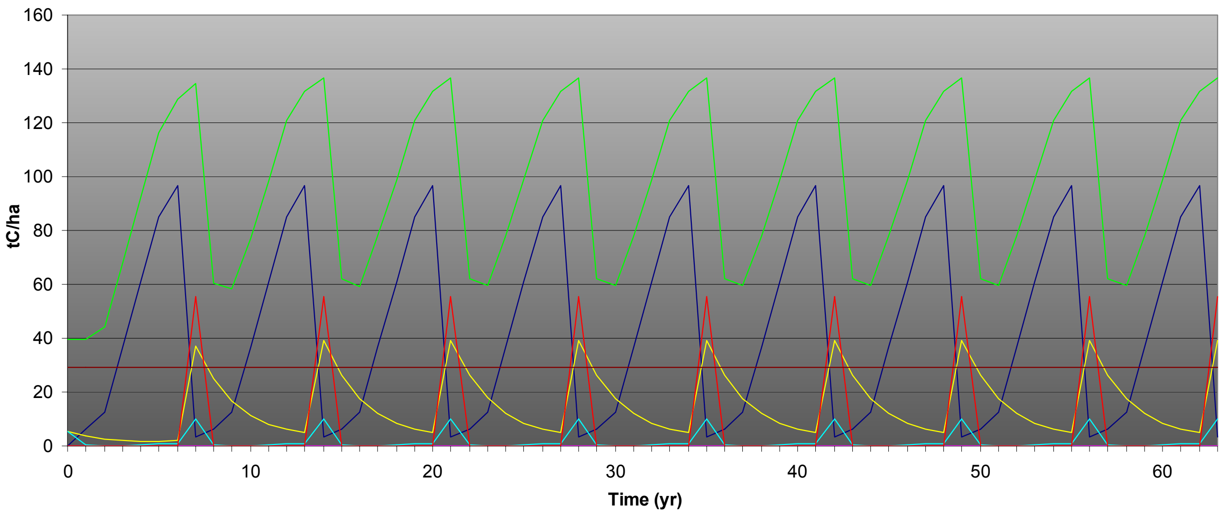

Figure 1a: Carbon stocks and flows for one hectare of *Eucalyptus* plantation – MAI 35 (the "project"). Dark blue line = trees; pink = other vegetation; yellow = course necromass; light blue = fine necromass; brown = soils; red = wood products; green = total.

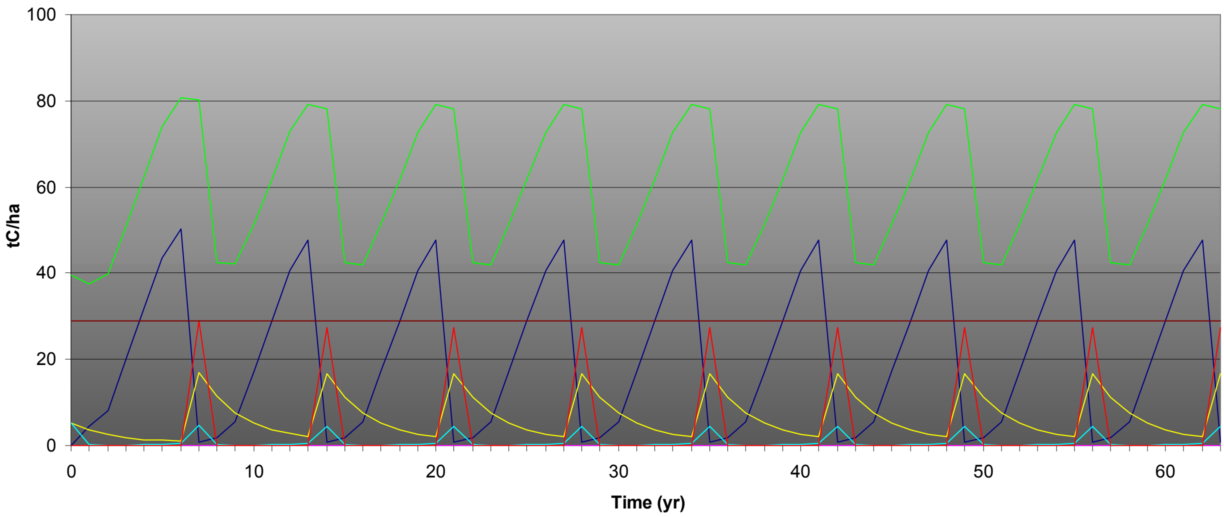

Figure 1b: Carbon stocks and flows for one hectare of *Eucalyptus* plantation – MAI 15 (the "project"). Dark blue line = trees; pink = other vegetation; yellow = course necromass; light blue = fine necromass; brown = soils; red = wood products; green = total.

4.2. Modelling of carbon stocks and flows for the baseline

Figure 2 shows the projection of carbon stocks for the baseline scenario: abandonement of forestry activities after the end of the 21-year rotation.

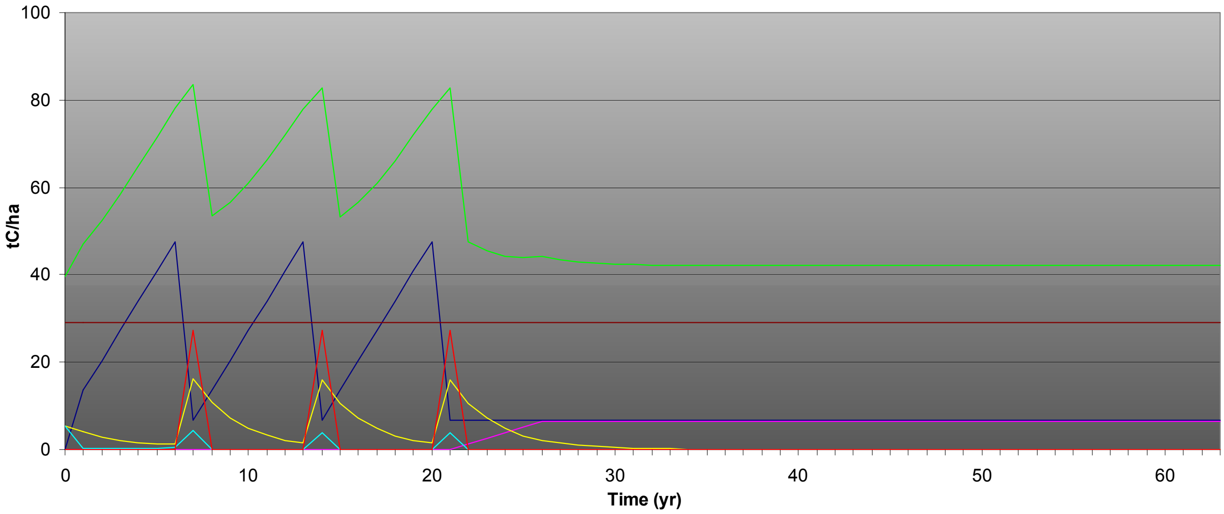

Figure 2: Stocks and flows for one hectare of *Eucalyptus* that is then converted to pasture or agricultural land (the “baseline”). Dark blue line = trees; pink line = other vegetation; yellow = course necromass; light blue = fine necromass; brown line = soil; green line = total.

4.3. Net carbon sequestration (project – baseline)

In order to calculate the net carbon sequestration resulting from project activities it was necessary to multiply the activities by the relevant number of hectares. This was done according to the activity schedule described earlier and summed for the both the baseline and project scenarios. Figure 3 and the table below show the results of this analysis.

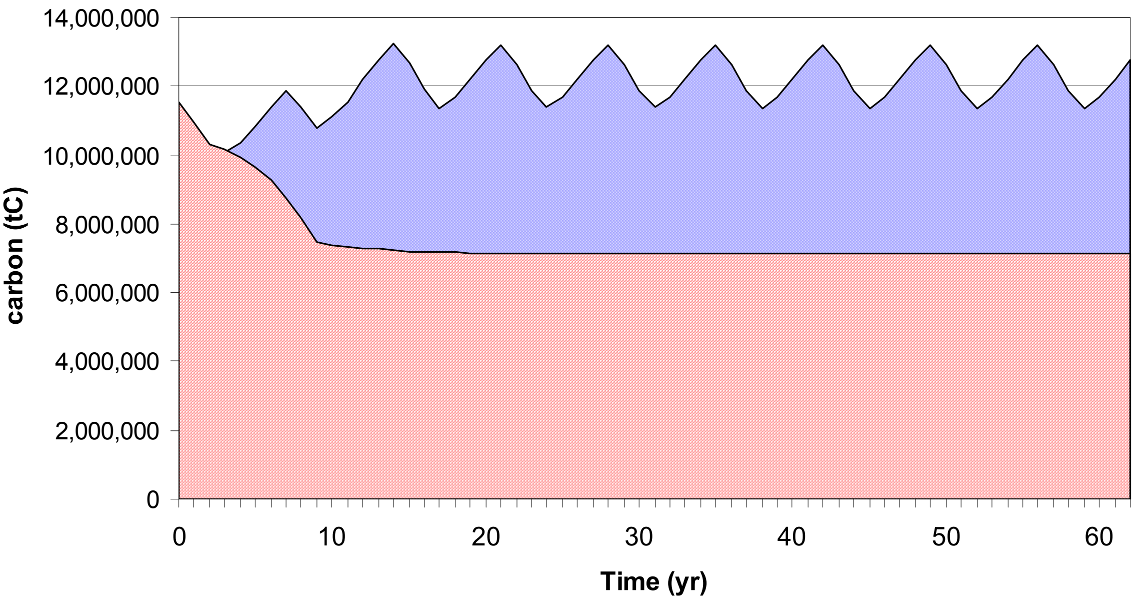

Figure 3: Net carbon storage resulting from project activities (project total – baseline total). Area in red represents the carbon stored in the baseline scenario (conversion of *Eucalyptus* plantations into pasture). This is overlying the area representing the carbon stored in the *Eucalyptus* plantations or project scenario. The difference (blue striped area) represents the ‘additional’ carbon stored as a result of the project activities.

Year:		hectares	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2,000	Baseline	17,000	810,197	772,052	753,563	748,244	751,749	739,746	731,704	726,316	722,705	720,287	718,666	717,580	716,853	716,365	716,039	715,820
	Project 1 - MAI 35	6,076	240,300	239,919	269,428	411,790	558,308	706,778	782,124	818,262	368,114	355,242	469,285	596,829	734,138	800,365	830,483	376,302
	Project 2 - MAI 15	10,924	432,033	410,373	433,912	554,522	679,878	807,817	883,075	875,995	464,244	459,710	561,664	674,521	795,274	864,460	854,364	462,950
	TOTAL		**-137,864**	**-121,760**	**-50,223**	**218,067**	**486,437**	**774,849**	**933,496**	**967,942**	**109,652**	**94,665**	**312,283**	**553,771**	**812,559**	**948,459**	**968,808**	**123,432**
2,001	Baseline	17,000	1,406,082	810,197	772,052	753,563	748,244	751,749	739,746	731,704	726,316	722,705	720,287	718,666	717,580	716,853	716,365	716,039
	Project 1 - MAI 35	6,177	510,904	244,294	243,908	273,906	418,635	567,588	718,527	795,126	831,864	374,233	361,147	477,086	606,750	746,342	813,669	844,288
	Project 2 - MAI 15	10,823	895,178	428,039	406,579	429,900	549,395	673,592	800,348	874,911	867,896	459,952	455,460	556,471	668,285	787,921	856,467	846,465
	TOTAL		**0**	**-137,864**	**-121,566**	**-49,756**	**219,785**	**489,431**	**779,129**	**938,333**	**973,445**	**111,479**	**96,320**	**314,891**	**557,455**	**817,410**	**953,771**	**974,714**
2,002	Baseline	17,000	1,325,449	1,406,082	810,197	772,052	753,563	748,244	751,749	739,746	731,704	726,316	722,705	720,287	718,666	717,580	716,853	716,365
	Project 1 - MAI 35	5,890	459,229	487,166	232,944	232,575	261,180	399,184	541,216	685,142	758,182	793,213	356,845	344,367	454,919	578,559	711,665	775,864
	Project 2 - MAI 15	11,110	866,220	918,916	439,389	417,360	441,300	563,963	691,454	821,571	898,111	890,911	472,148	467,538	571,228	686,006	808,815	879,179
	TOTAL		**0**	**0**	**-137,864**	**-122,117**	**-51,083**	**214,903**	**480,922**	**766,967**	**924,589**	**957,808**	**106,288**	**91,618**	**307,480**	**546,985**	**803,627**	**938,677**
2,003	Baseline	17,000	1,222,001	1,325,449	1,406,082	810,197	772,052	753,563	748,244	751,749	739,746	731,704	726,316	722,705	720,287	718,666	717,580	716,853
	Project 1 - MAI 35	7,639	549,110	595,594	631,827	302,115	301,637	338,736	517,719	701,927	888,591	983,319	1,028,753	462,808	446,625	590,004	750,359	922,989
	Project 2 - MAI 15	9,361	672,891	729,854	774,255	370,218	351,657	371,828	475,181	582,602	692,235	756,726	750,658	397,820	393,935	481,302	578,011	681,487
	TOTAL		**0**	**0**	**0**	**-137,864**	**-118,758**	**-42,999**	**244,656**	**532,780**	**841,080**	**1,008,341**	**1,053,096**	**137,923**	**120,273**	**352,640**	**610,790**	**887,623**
2,004	Baseline	17,000	1,124,472	1,222,001	1,325,449	1,406,082	810,197	772,052	753,563	748,244	751,749	739,746	731,704	726,316	722,705	720,287	718,666	717,580
	Project 1 - MAI 35	7,116	470,691	511,515	554,817	588,570	281,431	280,985	315,544	482,274	653,870	827,754	915,997	958,320	431,122	416,047	549,610	698,986
	Project 2 - MAI 15	9,884	653,781	710,486	770,631	817,513	390,902	371,304	392,602	501,730	615,152	730,910	799,004	792,598	420,046	415,945	508,192	610,305
	TOTAL		**0**	**0**	**0**	**0**	**-137,864**	**-119,763**	**-45,416**	**235,759**	**517,273**	**818,918**	**983,297**	**1,024,602**	**128,463**	**111,704**	**339,136**	**591,710**
2,005	Baseline	17,000	1,035,776	1,124,472	1,222,001	1,325,449	1,406,082	810,197	772,052	753,563	748,244	751,749	739,746	731,704	726,316	722,705	720,287	718,666
	Project 1 - MAI 35	6,159	375,256	407,390	442,724	480,202	509,415	243,582	243,197	273,108	417,415	565,934	716,433	792,809	829,440	373,142	360,094	475,695
	Project 2 - MAI 15	10,841	660,521	717,083	779,277	845,246	896,667	428,751	407,255	430,615	550,309	674,713	801,679	876,366	869,339	460,717	456,218	557,397
	TOTAL		**0**	**0**	**0**	**0**	**0**	**-137,864**	**-121,600**	**-49,839**	**219,479**	**488,898**	**778,366**	**937,471**	**972,464**	**111,154**	**96,025**	**314,426**
2,006	Baseline	17,000	960,264	1,035,776	1,124,472	1,222,001	1,325,449	1,406,082	810,197	772,052	753,563	748,244	751,749	739,746	731,704	726,316	722,705	720,287
	Project 1 - MAI 35	3,669	207,247	223,545	242,688	263,737	286,063	303,466	145,105	144,876	162,694	248,660	337,135	426,789	472,287	494,109	222,286	214,513
	Project 2 - MAI 15	13,331	753,016	812,231	881,785	958,265	1,039,386	1,102,617	527,228	500,795	529,521	676,705	829,683	985,812	1,077,653	1,069,013	566,536	561,003
	TOTAL		**0**	**0**	**0**	**0**	**0**	**0**	**-137,864**	**-126,382**	**-61,348**	**177,121**	**415,069**	**672,854**	**818,236**	**836,806**	**66,116**	**55,230**
2,007	Baseline	17,000	904,428	960,264	1,035,776	1,124,472	1,222,001	1,325,449	1,406,082	810,197	772,052	753,563	748,244	751,749	739,746	731,704	726,316	722,705
	Project 1 - MAI 35	3,030	161,201	171,153	184,612	200,421	217,804	236,242	250,614	119,833	119,644	134,359	205,353	278,419	352,458	390,032	408,054	183,572
	Project 2 - MAI 15	13,970	743,227	789,111	851,164	924,052	1,004,198	1,089,207	1,155,469	552,500	524,799	554,902	709,142	869,452	1,033,065	1,129,308	1,120,254	593,692
	TOTAL		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**-137,864**	**-127,609**	**-64,301**	**166,251**	**396,122**	**645,777**	**787,637**	**801,992**	**54,558**
2,008	Baseline	17,000	1,406,363	904,428	960,264	1,035,776	1,124,472	1,222,001	1,325,449	1,406,082	810,197	772,052	753,563	748,244	751,749	739,746	731,704	726,316

	Project 1 - MAI 35	2,569	212,526	136,675	145,113	156,524	169,928	184,666	200,299	212,484	101,601	101,441	113,917	174,109	236,059	298,834	330,691	345,970
	Project 2 - MAI 15	14,431	1,193,837	767,753	815,151	879,252	954,545	1,037,335	1,125,150	1,193,598	570,732	542,117	573,214	732,543	898,144	1,067,155	1,166,575	1,157,221
	TOTAL		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**-137,864**	**-128,494**	**-66,432**	**158,409**	**382,453**	**626,243**	**765,562**	**776,876**
2,009	Baseline	17,000	1,325,868	1,406,363	904,428	960,264	1,035,776	1,124,472	1,222,001	1,325,449	1,406,082	810,197	772,052	753,563	748,244	751,749	739,746	731,704
	Project 1 - MAI 35	2,088	162,848	172,734	111,085	117,943	127,218	138,112	150,091	162,796	172,700	82,578	82,448	92,588	141,510	191,861	242,882	268,775
	Project 2 - MAI 15	14,912	1,163,020	1,233,629	793,343	842,321	908,558	986,361	1,071,911	1,162,652	1,233,382	589,755	560,187	592,320	756,960	928,080	1,102,725	1,205,458
	TOTAL		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**-137,864**	**-129,418**	**-68,655**	**150,226**	**368,192**	**605,861**	**742,529**
	TOTALS:	**ha**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
	TOTAL Baseline	170,000	11,520,900	10,967,085	10,314,285	10,158,100	9,949,586	9,653,556	9,260,787	8,765,101	8,162,358	7,476,562	7,385,031	7,330,560	7,293,850	7,261,971	7,226,261	7,202,336
	Subtotal Project 1 - MAI 35	50,413	3,349,312	3,189,986	3,059,144	3,027,782	3,131,617	3,399,338	3,864,436	4,395,828	4,474,675	4,466,733	4,587,312	4,604,123	4,705,309	4,879,295	5,219,794	5,106,956
	Subtotal Project 2 - MAI 15	119,587	8,033,724	7,517,474	6,945,487	7,038,649	7,216,486	7,432,775	7,529,673	7,496,969	6,946,380	6,336,401	6,512,840	6,945,441	7,483,929	7,889,906	8,018,156	7,555,156
	TOTAL Project scenario		11,383,036	10,707,461	10,004,632	10,066,430	10,348,103	10,832,113	11,394,109	11,892,797	11,421,055	10,803,134	11,100,151	11,549,565	12,189,237	12,769,201	13,237,949	12,662,111
	TOTAL		**-137,864**	**-259,624**	**-309,653**	**-91,670**	**398,517**	**1,178,558**	**2,133,322**	**3,127,696**	**3,258,697**	**3,326,571**	**3,715,120**	**4,219,005**	**4,895,388**	**5,507,230**	**6,011,688**	**5,459,776**

Year:		hectares	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
2,000	Baseline	17,000	715,820	715,674	715,575	715,510	715,465	715,436	715,416	715,403	715,394	715,388	715,384	715,381	715,380	715,378	715,378	715,377
	Project 1 - MAI 35	6,076	376,302	360,728	472,961	599,292	734,238	800,522	830,589	376,373	361,182	473,241	599,480	734,364	800,607	830,645	376,411	360,800
	Project 2 - MAI 15	10,924	462,950	458,844	561,083	674,132	793,825	863,559	853,760	462,546	458,938	561,125	674,160	793,844	863,571	853,768	462,551	458,576
	TOTAL		**123,432**	**103,898**	**318,469**	**557,915**	**812,597**	**948,645**	**968,933**	**123,515**	**104,726**	**318,978**	**558,256**	**812,826**	**948,798**	**969,036**	**123,584**	**104,000**
2,001	Baseline	17,000	716,039	715,820	715,674	715,575	715,510	715,465	715,436	715,416	715,403	715,394	715,388	715,384	715,381	715,380	715,378	715,378
	Project 1 - MAI 35	6,177	844,288	382,557	366,724	480,822	609,254	746,443	813,829	844,396	382,629	367,186	481,108	609,445	746,571	813,915	844,453	382,668
	Project 2 - MAI 15	10,823	846,465	458,670	454,601	555,896	667,900	786,485	855,574	845,866	458,269	454,695	555,937	667,927	786,504	855,587	845,875	458,275
	TOTAL		**974,714**	**125,407**	**105,652**	**321,143**	**561,644**	**817,463**	**953,968**	**974,846**	**125,495**	**106,487**	**321,657**	**561,988**	**817,693**	**954,122**	**974,949**	**125,565**
2,002	Baseline	17,000	716,365	716,039	715,820	715,674	715,575	715,510	715,465	715,436	715,416	715,403	715,394	715,388	715,384	715,381	715,380	715,378
	Project 1 - MAI 35	5,890	775,864	805,060	364,783	349,685	458,482	580,946	711,761	776,017	805,163	364,851	350,125	458,754	581,129	711,883	776,098	805,217
	Project 2 - MAI 15	11,110	879,179	868,911	470,833	466,656	570,637	685,611	807,341	878,262	868,297	470,421	466,752	570,680	685,639	807,360	878,275	868,305
	TOTAL		**938,677**	**957,932**	**119,795**	**100,668**	**313,544**	**551,048**	**803,637**	**938,843**	**958,043**	**119,869**	**101,484**	**314,046**	**551,384**	**803,862**	**938,994**	**958,144**
2,003	Baseline	17,000	716,853	716,365	716,039	715,820	715,674	715,575	715,510	715,465	715,436	715,416	715,403	715,394	715,388	715,384	715,381	715,380
	Project 1 - MAI 35	7,639	922,989	1,006,252	1,044,118	473,103	453,522	594,626	753,455	923,114	1,006,450	1,044,251	473,191	454,093	594,978	753,691	923,272	1,006,556
	Project 2 - MAI 15	9,361	681,487	740,773	732,122	396,711	393,192	480,804	577,678	680,245	740,001	731,604	396,365	393,274	480,840	577,702	680,261	740,012
	TOTAL		**887,623**	**1,030,660**	**1,060,201**	**153,994**	**131,041**	**359,854**	**615,623**	**887,893**	**1,031,015**	**1,060,439**	**154,153**	**131,972**	**360,430**	**616,009**	**888,152**	**1,031,189**
2,004	Baseline	17,000	717,580	716,853	716,365	716,039	715,820	715,674	715,575	715,510	715,465	715,436	715,416	715,403	715,394	715,388	715,384	715,381
	Project 1 - MAI 35	7,116	698,986	859,797	937,360	972,633	440,712	422,472	553,915	701,870	859,914	937,544	972,757	440,795	423,004	554,243	702,090	860,061
	Project 2 - MAI 15	9,884	610,305	719,561	782,160	773,026	418,876	415,160	507,667	609,953	718,250	781,345	772,479	418,510	415,246	507,704	609,978	718,267
	TOTAL		**591,710**	**862,506**	**1,003,15**	**1,029,62**	**143,767**	**121,958**	**346,006**	**596,313**	**862,698**	**1,003,45**	**1,029,82**	**143,902**	**122,855**	**346,560**	**596,684**	**862,947**

					5	**0**						**3**	**0**					
2,005	Baseline	17,000	718,666	717,580	716,853	716,365	716,039	715,820	715,674	715,575	715,510	715,465	715,436	715,416	715,403	715,394	715,388	715,384
	Project 1 - MAI 35	6,159	475,695	604,982	744,167	811,298	841,828	381,442	365,655	479,421	607,479	744,268	811,458	841,935	381,514	366,116	479,706	607,669
	Project 2 - MAI 15	10,841	557,397	669,397	789,231	857,892	847,872	459,433	455,357	556,820	669,010	787,793	856,997	847,273	459,031	455,451	556,862	669,038
	TOTAL		**314,426**	**556,798**	**816,546**	**952,824**	**973,662**	**125,055**	**105,339**	**320,666**	**560,979**	**816,595**	**953,019**	**973,792**	**125,142**	**106,173**	**321,180**	**561,323**
2,006	Baseline	17,000	720,287	718,666	717,580	716,853	716,365	716,039	715,820	715,674	715,575	715,510	715,465	715,436	715,416	715,403	715,394	715,388
	Project 1 - MAI 35	3,669	214,513	283,378	360,396	443,310	483,301	501,488	227,230	217,826	285,598	361,883	443,370	483,396	501,552	227,273	218,100	285,767
	Project 2 - MAI 15	13,331	561,003	685,422	823,146	970,505	1,054,935	1,042,615	564,957	559,945	684,713	822,671	968,737	1,053,836	1,041,878	564,463	560,061	684,764
	TOTAL		**55,230**	**250,134**	**465,962**	**696,962**	**821,871**	**828,064**	**76,367**	**62,098**	**254,735**	**469,045**	**696,641**	**821,796**	**828,014**	**76,333**	**62,767**	**255,143**
2,007	Baseline	17,000	722,705	720,287	718,666	717,580	716,853	716,365	716,039	715,820	715,674	715,575	715,510	715,465	715,436	715,416	715,403	715,394
	Project 1 - MAI 35	3,030	183,572	177,153	234,025	297,629	366,103	399,129	414,148	187,656	179,889	235,858	298,857	366,152	399,207	414,201	187,691	180,115
	Project 2 - MAI 15	13,970	593,692	587,894	718,276	862,602	1,017,025	1,105,502	1,092,591	592,037	586,785	717,534	862,104	1,015,171	1,104,349	1,091,819	591,520	586,906
	TOTAL		**54,558**	**44,760**	**233,635**	**442,651**	**666,274**	**788,265**	**790,700**	**63,872**	**51,001**	**237,816**	**445,452**	**665,858**	**788,121**	**790,603**	**63,808**	**51,628**
2,008	Baseline	17,000	726,316	722,705	720,287	718,666	717,580	716,853	716,365	716,039	715,820	715,674	715,575	715,510	715,465	715,436	715,416	715,403
	Project 1 - MAI 35	2,569	345,970	155,643	150,200	198,419	252,346	310,402	338,403	351,138	159,105	152,520	199,973	253,387	310,444	338,470	351,182	159,135
	Project 2 - MAI 15	14,431	1,157,221	613,283	607,294	741,979	891,067	1,050,586	1,141,983	1,128,646	611,574	606,149	741,212	890,553	1,048,671	1,140,792	1,127,848	611,039
	TOTAL		**776,876**	**46,220**	**37,207**	**221,732**	**425,833**	**644,135**	**764,020**	**763,744**	**54,858**	**42,995**	**225,609**	**428,431**	**643,650**	**763,826**	**763,614**	**54,771**
2,009	Baseline	17,000	731,704	726,316	722,705	720,287	718,666	717,580	716,853	716,365	716,039	715,820	715,674	715,575	715,510	715,465	715,436	715,416
	Project 1 - MAI 35	2,088	268,775	281,193	126,501	122,078	161,268	205,099	252,285	275,043	285,393	129,315	123,963	162,532	205,945	252,319	275,097	285,429
	Project 2 - MAI 15	14,912	1,205,458	1,195,793	633,724	627,536	766,710	920,768	1,085,603	1,180,046	1,166,264	631,958	626,352	765,917	920,236	1,083,625	1,178,816	1,165,440
	TOTAL		**742,529**	**750,671**	**37,520**	**29,327**	**209,312**	**408,286**	**621,034**	**738,724**	**735,619**	**45,453**	**34,642**	**212,873**	**410,672**	**620,478**	**738,477**	**735,454**
	TOTALS:	**ha**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
	TOTAL Baseline	170,000	7,202,336	7,186,305	7,175,565	7,168,369	7,163,548	7,160,317	7,158,153	7,156,703	7,155,732	7,155,081	7,154,645	7,154,352	7,154,157	7,154,025	7,153,937	7,153,879
	Subtotal Project 1 - MAI 35	50,413	5,106,956	4,916,745	4,801,234	4,748,269	4,801,054	4,942,569	5,261,271	5,132,853	4,932,801	4,810,916	4,754,282	4,804,852	4,944,950	5,262,756	5,134,100	4,933,418
	Subtotal Project 2 - MAI 15	119,587	7,555,156	6,998,547	6,572,472	6,926,935	7,422,039	7,810,521	7,942,510	7,494,366	6,962,102	6,565,296	6,921,097	7,416,984	7,805,966	7,938,272	7,492,046	6,960,624
	TOTAL Project scenario		12,662,111	11,915,291	11,373,706	11,675,204	12,223,093	12,753,090	13,203,781	12,627,219	11,894,902	11,376,212	11,675,379	12,221,836	12,750,916	13,201,028	12,626,147	11,894,042
	TOTAL		**5,459,776**	**4,728,986**	**4,198,141**	**4,506,835**	**5,059,545**	**5,592,773**	**6,045,628**	**5,470,516**	**4,739,171**	**4,221,131**	**4,520,734**	**5,067,484**	**5,596,760**	**6,047,002**	**5,472,209**	**4,740,163**

Year:		hectares	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
2,000	Baseline	17,000	715,377	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376
	Project 1 - MAI 35	6,076	473,009	599,325	734,260	800,537	830,599	376,379	360,779	472,995	599,315	734,253	800,533	830,596	376,377	360,778	472,994	599,315	734,253
	Project 2 - MAI 15	10,924	560,904	674,012	793,744	863,505	853,724	462,521	458,556	560,891	674,003	793,738	863,501	853,721	462,520	458,555	560,890	674,003	793,738
	TOTAL		**318,537**	**557,961**	**812,628**	**948,666**	**968,947**	**123,525**	**103,960**	**318,510**	**557,943**	**812,616**	**948,658**	**968,941**	**123,521**	**103,957**	**318,509**	**557,942**	**812,615**
2,001	Baseline	17,000	715,377	715,377	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376
	Project 1 - MAI 35	6,177	366,798	480,872	609,287	746,465	813,844	844,406	382,636	366,777	480,858	609,278	746,459	813,840	844,403	382,634	366,775	480,857	609,277
	Project 2 - MAI 15	10,823	454,336	555,718	667,781	786,406	855,521	845,831	458,245	454,317	555,705	667,772	786,400	855,517	845,828	458,243	454,315	555,704	667,771
	TOTAL		**105,757**	**321,214**	**561,691**	**817,494**	**953,989**	**974,860**	**125,505**	**105,717**	**321,187**	**561,673**	**817,482**	**953,981**	**974,855**	**125,501**	**105,715**	**321,185**	**561,672**
2,002	Baseline	17,000	715,378	715,377	715,377	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376
	Project 1 - MAI 35	5,890	364,888	349,755	458,529	580,978	711,782	776,031	805,172	364,857	349,735	458,516	580,969	711,776	776,027	805,169	364,856	349,734	458,515
	Project 2 - MAI 15	11,110	470,427	466,384	570,455	685,489	807,259	878,207	868,260	470,397	466,364	570,441	685,479	807,253	878,203	868,257	470,395	466,363	570,440
	TOTAL		**119,937**	**100,763**	**313,608**	**551,090**	**803,665**	**938,862**	**958,056**	**119,878**	**100,723**	**313,581**	**551,072**	**803,653**	**938,854**	**958,051**	**119,874**	**100,721**	**313,579**
2,003	Baseline	17,000	715,378	715,378	715,377	715,377	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376
	Project 1 - MAI 35	7,639	1,044,322	473,239	453,613	594,687	753,496	923,142	1,006,469	1,044,263	473,200	453,587	594,669	753,484	923,134	1,006,463	1,044,260	473,197	453,585
	Project 2 - MAI 15	9,361	731,612	396,370	392,963	480,651	577,575	680,176	739,955	731,574	396,344	392,946	480,639	577,567	680,171	739,952	731,571	396,342	392,945
	TOTAL		**1,060,555**	**154,231**	**131,200**	**359,961**	**615,695**	**887,941**	**1,031,047**	**1,060,461**	**154,168**	**131,157**	**359,932**	**615,676**	**887,928**	**1,031,039**	**1,060,455**	**154,164**	**131,155**
2,004	Baseline	17,000	715,380	715,378	715,378	715,377	715,377	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376
	Project 1 - MAI 35	7,116	937,643	972,823	440,839	422,557	553,972	701,908	859,939	937,561	972,768	440,802	422,532	553,956	701,897	859,932	937,556	972,765	440,800
	Project 2 - MAI 15	9,884	781,356	772,487	418,515	414,918	507,505	609,844	718,177	781,296	772,447	418,488	414,900	507,492	609,836	718,172	781,293	772,444	418,486
	TOTAL		**1,003,620**	**1,029,932**	**143,976**	**122,098**	**346,100**	**596,376**	**862,740**	**1,003,481**	**1,029,839**	**143,914**	**122,057**	**346,072**	**596,357**	**862,728**	**1,003,473**	**1,029,833**	**143,910**
2,005	Baseline	17,000	715,381	715,380	715,378	715,378	715,377	715,377	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376
	Project 1 - MAI 35	6,159	744,395	811,543	841,992	381,552	365,729	479,471	607,512	744,290	811,473	841,945	381,521	365,708	479,456	607,502	744,283	811,468	841,942
	Project 2 - MAI 15	10,841	787,812	857,010	847,282	459,037	455,092	556,643	668,891	787,714	856,944	847,237	459,007	455,072	556,629	668,882	787,708	856,940	847,235
	TOTAL		**816,826**	**953,174**	**973,895**	**125,212**	**105,444**	**320,737**	**561,027**	**816,627**	**953,040**	**973,806**	**125,152**	**105,404**	**320,710**	**561,009**	**816,615**	**953,032**	**973,801**
2,006	Baseline	17,000	715,384	715,381	715,380	715,378	715,378	715,377	715,377	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376
	Project 1 - MAI 35	3,669	361,997	443,446	483,447	501,586	227,296	217,870	285,627	361,903	443,384	483,405	501,558	227,277	217,857	285,619	361,897	443,380	483,403
	Project 2 - MAI 15	13,331	822,705	968,760	1,053,851	1,041,888	564,470	559,619	684,494	822,525	968,638	1,053,770	1,041,834	564,434	559,595	684,478	822,514	968,631	1,053,765
	TOTAL		**469,318**	**696,824**	**821,919**	**828,096**	**76,388**	**62,112**	**254,745**	**469,051**	**696,646**	**821,799**	**828,016**	**76,335**	**62,076**	**254,721**	**469,035**	**696,635**	**821,792**
2,007	Baseline	17,000	715,388	715,384	715,381	715,380	715,378	715,378	715,377	715,377	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376
	Project 1 - MAI 35	3,030	235,997	298,951	366,215	399,249	414,229	187,710	179,925	235,882	298,873	366,163	399,215	414,206	187,694	179,915	235,875	298,869	366,160
	Project 2 - MAI 15	13,970	717,587	862,140	1,015,195	1,104,366	1,091,829	591,527	586,444	717,305	861,951	1,015,069	1,104,281	1,091,773	591,489	586,418	717,287	861,940	1,015,061
	TOTAL		**238,197**	**445,707**	**666,029**	**788,235**	**790,680**	**63,859**	**50,992**	**237,810**	**445,448**	**665,855**	**788,119**	**790,602**	**63,807**	**50,957**	**237,786**	**445,432**	**665,845**
2,008	Baseline	17,000	715,394	715,388	715,384	715,381	715,380	715,378	715,378	715,377	715,377	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376
	Project 1 - MAI 35	2,569	152,712	200,091	253,467	310,497	338,505	351,206	159,151	152,550	199,994	253,401	310,453	338,476	351,186	159,137	152,542	199,988	253,397
	Project 2 - MAI 15	14,431	606,274	741,267	890,590	1,048,696	1,140,809	1,127,859	611,047	605,796	740,975	890,395	1,048,565	1,140,721	1,127,800	611,007	605,769	740,957	890,383
	TOTAL		**43,592**	**225,971**	**428,673**	**643,812**	**763,935**	**763,687**	**54,820**	**42,969**	**225,592**	**428,420**	**643,642**	**763,821**	**763,611**	**54,769**	**42,935**	**225,569**	**428,404**
2,009	Baseline	17,000	715,403	715,394	715,388	715,384	715,381	715,380	715,378	715,378	715,377	715,377	715,376	715,376	715,376	715,376	715,376	715,376	715,376
	Project 1 - MAI 35	2,088	129,339	124,119	162,628	206,010	252,362	275,126	285,449	129,352	123,988	162,548	205,956	252,326	275,102	285,433	129,342	123,981	162,543

	Project 2 - MAI 15	14,912	631,406	626,482	765,974	920,275	1,083,650	1,178,833	1,165,452	631,414	625,988	765,673	920,073	1,083,515	1,178,742	1,165,391	631,373	625,960	765,654
	TOTAL		**45,343**	**35,207**	**213,214**	**410,900**	**620,631**	**738,580**	**735,522**	**45,389**	**34,599**	**212,844**	**410,652**	**620,465**	**738,469**	**735,448**	**45,339**	**34,565**	**212,822**
	TOTALS:	**ha**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**	**2045**	**2046**	**2047**
	TOTAL Baseline	170,000	7,153,839	7,153,813	7,153,795	7,153,783	7,153,775	7,153,770	7,153,766	7,153,764	7,153,762	7,153,761	7,153,761	7,153,760	7,153,760	7,153,759	7,153,759	7,153,759	7,153,759
	Subtotal Project 1 - MAI 35	50,413	4,811,100	4,754,165	4,804,277	4,944,118	5,261,815	5,133,248	4,932,659	4,810,431	4,753,587	4,803,899	4,943,865	5,261,644	5,133,134	4,932,582	4,810,380	4,753,553	4,803,876
	Subtotal Project 2 - MAI 15	119,587	6,564,420	6,920,630	7,416,351	7,805,229	7,937,434	7,491,061	6,959,522	6,563,226	6,919,359	7,415,529	7,804,678	7,937,065	7,490,813	6,959,356	6,563,115	6,919,285	7,415,479
	TOTAL Project scenario		11,375,520	11,674,795	12,220,628	12,749,348	13,199,249	12,624,309	11,892,180	11,373,658	11,672,947	12,219,427	12,748,543	13,198,710	12,623,947	11,891,938	11,373,495	11,672,838	12,219,354
	TOTAL		**4,221,681**	**4,520,983**	**5,066,833**	**5,595,565**	**6,045,474**	**5,470,539**	**4,738,414**	**4,219,894**	**4,519,184**	**5,065,666**	**5,594,783**	**6,044,950**	**5,470,188**	**4,738,179**	**4,219,736**	**4,519,079**	**5,065,595**

Year:		hectares	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63
2,000	Baseline	17,000	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376
	Project 1 - MAI 35	6,076	800,533	830,596	376,377	360,778	472,994	599,315	734,253	800,533	830,596	376,377	360,778	472,994	599,315	734,253	800,533	830,596
	Project 2 - MAI 15	10,924	863,500	853,721	462,519	458,555	560,890	674,003	793,738	863,500	853,721	462,519	458,555	560,890	674,003	793,738	863,500	853,721
	TOTAL		**948,657**	**968,941**	**123,521**	**103,957**	**318,509**	**557,942**	**812,615**	**948,657**	**968,941**	**123,521**	**103,957**	**318,509**	**557,942**	**812,615**	**948,657**	**968,941**
2,001	Baseline	17,000	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376
	Project 1 - MAI 35	6,177	746,458	813,840	844,403	382,634	366,775	480,857	609,277	746,458	813,840	844,403	382,634	366,775	480,857	609,277	746,458	813,840
	Project 2 - MAI 15	10,823	786,399	855,517	845,828	458,243	454,315	555,704	667,771	786,399	855,517	845,828	458,243	454,315	555,704	667,771	786,399	855,517
	TOTAL		**817,482**	**953,981**	**974,854**	**125,501**	**105,715**	**321,185**	**561,672**	**817,482**	**953,981**	**974,854**	**125,501**	**105,715**	**321,185**	**561,672**	**817,482**	**953,981**
2,002	Baseline	17,000	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376
	Project 1 - MAI 35	5,890	580,968	711,776	776,027	805,169	364,856	349,734	458,515	580,968	711,776	776,027	805,169	364,856	349,734	458,515	580,968	711,776
	Project 2 - MAI 15	11,110	685,479	807,253	878,203	868,257	470,395	466,363	570,440	685,479	807,253	878,203	868,257	470,395	466,363	570,440	685,479	807,253
	TOTAL		**551,071**	**803,653**	**938,854**	**958,051**	**119,874**	**100,721**	**313,579**	**551,071**	**803,653**	**938,854**	**958,051**	**119,874**	**100,721**	**313,579**	**551,071**	**803,653**
2,003	Baseline	17,000	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376
	Project 1 - MAI 35	7,639	594,668	753,483	923,133	1,006,463	1,044,259	473,197	453,585	594,668	753,483	923,133	1,006,463	1,044,259	473,197	453,585	594,668	753,483
	Project 2 - MAI 15	9,361	480,638	577,567	680,170	739,951	731,571	396,342	392,945	480,638	577,567	680,170	739,951	731,571	396,342	392,945	480,638	577,567
	TOTAL		**359,931**	**615,674**	**887,928**	**1,031,038**	**1,060,455**	**154,164**	**131,155**	**359,931**	**615,674**	**887,928**	**1,031,038**	**1,060,455**	**154,164**	**131,155**	**359,931**	**615,674**
2,004	Baseline	17,000	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376
	Project 1 - MAI 35	7,116	422,531	553,955	701,897	859,931	937,556	972,765	440,800	422,531	553,955	701,897	859,931	937,556	972,765	440,800	422,531	553,954
	Project 2 - MAI 15	9,884	414,899	507,492	609,836	718,172	781,292	772,444	418,486	414,899	507,492	609,836	718,172	781,292	772,444	418,486	414,899	507,492
	TOTAL		**122,054**	**346,070**	**596,356**	**862,727**	**1,003,473**	**1,029,833**	**143,910**	**122,054**	**346,070**	**596,356**	**862,727**	**1,003,473**	**1,029,833**	**143,910**	**122,054**	**346,070**
2,005	Baseline	17,000	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376
	Project 1 - MAI 35	6,159	381,519	365,707	479,456	607,502	744,283	811,468	841,942	381,519	365,706	479,456	607,502	744,283	811,468	841,942	381,519	365,706
	Project 2 - MAI 15	10,841	459,005	455,071	556,629	668,882	787,707	856,940	847,235	459,005	455,071	556,629	668,882	787,707	856,940	847,235	459,005	455,071
	TOTAL		**125,148**	**105,402**	**320,708**	**561,007**	**816,614**	**953,032**	**973,801**	**125,148**	**105,401**	**320,708**	**561,007**	**816,614**	**953,032**	**973,801**	**125,148**	**105,401**
2,006	Baseline	17,000	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376
	Project 1 - MAI 35	3,669	501,556	227,276	217,856	285,618	361,897	443,379	483,403	501,556	227,276	217,856	285,618	361,897	443,379	483,403	501,556	227,276
	Project 2 - MAI 15	13,331	1,041,83	564,431	559,593	684,477	822,513	968,631	1,053,76	1,041,83	564,431	559,593	684,477	822,513	968,631	1,053,76	1,041,83	564,431

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	TOTAL		**828,011**	**76,331**	**62,074**	**254,719**	**469,034**	**696,634**	**821,791**	**828,011**	**76,331**	**62,074**	**254,719**	**469,034**	**696,634**	**821,791**	**828,011**	**76,331**
2,007	Baseline	17,000	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376
	Project 1 - MAI 35	3,030	399,212	414,204	187,693	179,914	235,874	298,868	366,160	399,212	414,204	187,693	179,914	235,874	298,868	366,160	399,212	414,204
	Project 2 - MAI 15	13,970	1,104,275	1,091,769	591,486	586,417	717,286	861,939	1,015,060	1,104,275	1,091,769	591,486	586,416	717,286	861,939	1,015,060	1,104,275	1,091,769
	TOTAL		**788,112**	**790,598**	**63,804**	**50,955**	**237,785**	**445,431**	**665,844**	**788,112**	**790,597**	**63,803**	**50,955**	**237,785**	**445,431**	**665,844**	**788,112**	**790,597**
2,008	Baseline	17,000	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376
	Project 1 - MAI 35	2,569	310,450	338,474	351,185	159,137	152,541	199,987	253,397	310,450	338,474	351,185	159,136	152,541	199,987	253,397	310,450	338,474
	Project 2 - MAI 15	14,431	1,048,557	1,140,716	1,127,797	611,005	605,768	740,956	890,382	1,048,557	1,140,715	1,127,796	611,005	605,768	740,956	890,382	1,048,557	1,140,715
	TOTAL		**643,632**	**763,814**	**763,606**	**54,766**	**42,933**	**225,568**	**428,403**	**643,631**	**763,814**	**763,606**	**54,765**	**42,933**	**225,568**	**428,403**	**643,631**	**763,814**
2,009	Baseline	17,000	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376	715,376
	Project 1 - MAI 35	2,088	205,953	252,324	275,101	285,432	129,341	123,980	162,543	205,953	252,324	275,101	285,432	129,341	123,980	162,543	205,953	252,324
	Project 2 - MAI 15	14,912	920,060	1,083,507	1,178,737	1,165,387	631,370	625,959	765,653	920,060	1,083,506	1,178,737	1,165,387	631,370	625,959	765,653	920,060	1,083,506
	TOTAL		**410,637**	**620,455**	**738,462**	**735,443**	**45,336**	**34,563**	**212,820**	**410,636**	**620,454**	**738,461**	**735,443**	**45,335**	**34,563**	**212,820**	**410,636**	**620,454**
	TOTALS:	**ha**	**2048**	**2049**	**2050**	**2051**	**2052**	**2053**	**2054**	**2055**	**2056**	**2057**	**2058**	**2059**	**2060**	**2061**	**2062**	**2063**
	TOTAL Baseline	170,000	7,153,759	7,153,759	7,153,759	7,153,759	7,153,759	7,153,759	7,153,759	7,153,759	7,153,759	7,153,759	7,153,759	7,153,759	7,153,759	7,153,759	7,153,759	7,153,759
	Subtotal Project 1 - MAI 35	50,413	4,943,849	5,261,634	5,133,127	4,932,578	4,810,377	4,753,551	4,803,874	4,943,848	5,261,633	5,133,127	4,932,577	4,810,377	4,753,551	4,803,874	4,943,848	5,261,633
	Subtotal Project 2 - MAI 15	119,587	7,804,645	7,937,043	7,490,798	6,959,346	6,563,109	6,919,280	7,415,476	7,804,643	7,937,042	7,490,797	6,959,345	6,563,108	6,919,280	7,415,475	7,804,643	7,937,042
	TOTAL Project scenario		12,748,494	13,198,677	12,623,926	11,891,924	11,373,486	11,672,831	12,219,350	12,748,491	13,198,675	12,623,924	11,891,923	11,373,485	11,672,831	12,219,350	12,748,491	13,198,675
	TOTAL		**5,594,735**	**6,044,918**	**5,470,166**	**4,738,165**	**4,219,726**	**4,519,072**	**5,065,591**	**5,594,732**	**6,044,916**	**5,470,165**	**4,738,164**	**4,219,726**	**4,519,072**	**5,065,591**	**5,594,732**	**6,044,916**

5. Total carbon sequestered due to FORESTRY activities

Figure 3 above shows the net carbon sequestration over the project lifetime for the whole project area (based on the activities described earlier). This is represented again below in Figure 4, but this time only showing the net carbon offset.

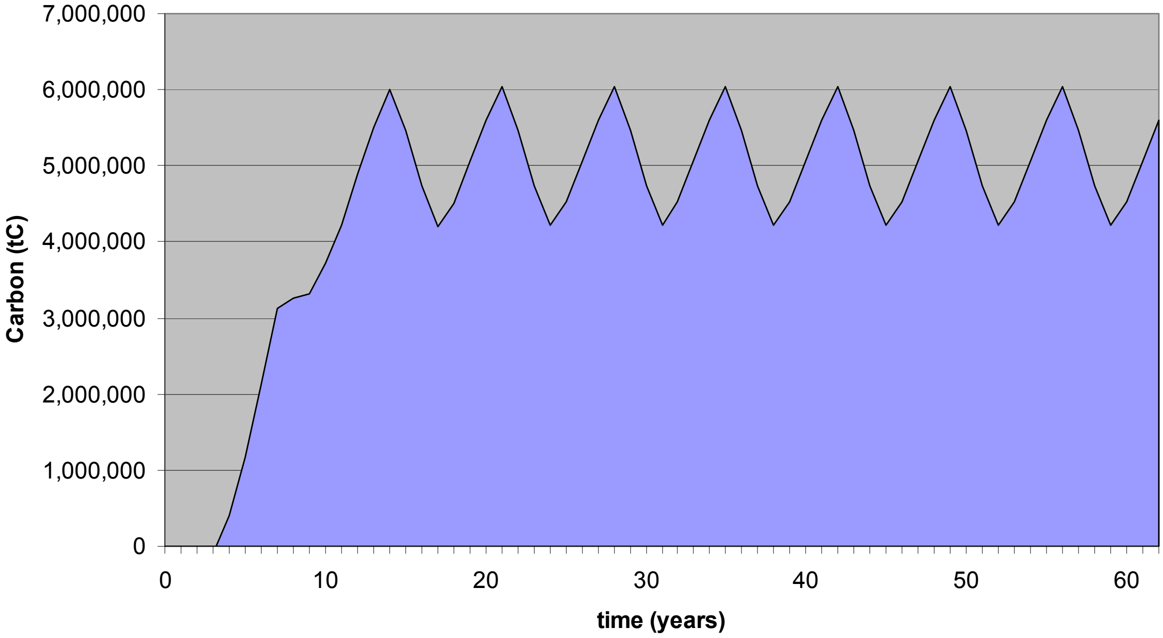

Figure 4: Total net carbon sequestered over the whole project area.

6. Date used

6.1 Data for the project scenario simulations

Carbon Pool	Model Input	Data Required (to be filled in)	Notes / Assumptions / Comments
BASELINE SPECIFICATIONS	species	*Eucalyptus sp.*	
	rotation age (yrs)	7 years	All Eucalyptus planted by the project are grown on rotations of 3 x 7 years = 21 years (the first being planted and the second two regenerating from coppice). The model assumes identical data for the 3 stages, and therefore assumes a rotation length of 7 years.
	stand area (ha)	varies	Varies according to planting plan for project – based n data provided by the project. For the sake of the modelling this area is assumed to be net of roadside margins, fire breaks, wayleaves (pylons) etc.
	other factors		The stands are assumed to be homogenous, with the same management specifications applying to the whole stand.
STEMS	existing volume (m^3/ha)	0	Due to it being new plantation establishment existing biomass will be zero as planted seedling biomass is assumed to be negligible. It is assumed that the land use prior to year zero of the baseline is the last year of a previous rotation – which will have been clear-cut.
	annual growth increments (m^3/ha/yr)	MAI: 35 15 0-1 yrs: 8 2 1-2 yrs: 16 8 2-5 yrs: 61 26 5-6 yrs: 30 15 6-7 yrs: 8 2	Based on the assumption that there are two growth rates – MAI of 35 and 15 (see text). This was then extrapolated to produce a sigmoidal curve, producing the growth rates shown here. Growth figures are net of mortality.
	commercial thinnings yields (m^3/ha) & timings (yrs)	100% harvest (yr 7) till end year 21 No other thinnings. 105 m^3/ha for MAI 15, and 245 m^3/ha for MAI 35	Commercial thinnings refer to any harvest operation where the wood is removed from site for allocation to processing or other uses. The yields removed for final harvest are based on the MAI and rotation length.
	non-commercial thinnings volumes (m^3/ha) & timings (yrs)	none	Non-commercial thinnings refer to any thinning where the woody residue is left on site. No non-commercial thinnings are carried out.

	mortality rates by volume (m^3/ha/yr)	0-1 yrs = 5% 2-7 yrs = 1%	Wilson, 1998 Mortality assumed to be highest in the first two years of growth.
	% crown & root which are coarse	0.777	Based on ESL field data from Eucalyptus plantations in Brazil. Similar to assumptions used by Wilson, 1998 (0.8 was used).
	logging damage	None	No logging or harvesting damages was taken into account.
	litterfall rates (%crown volume)	0.1 (10%)	Based on ESL field data from Eucalyptus plantations in Brazil. Similar to other data used e.g. Wilson, C. 1998 (9 and 13 %).
	crown biomass expansion factor (cBEF)	1.174	Based on field measured data for Eucalyptus in Brazil (Sampaio, *et al*). Similar to ESL data on Eucalyptus in Brazil (1.088).
	root:shoot ratio	0.485	Based on project documents: Sampaio, *et al*; Althoff *et al*.
	wood density (t/m^3)	0.48 (MAI 35) 0.55 (MAI 15)	Calculated as a weighted average of the species planted by the project (based on project data).
	biomass to C conversion factor (tC/t)	0.4716 (stems) 0.4896 (crowns) 0.468 (roots)	Based on project documents: Althoff *et al*.
OTHER VEGETATION	existing biomass (t/ha)	0	No other vegetation will exist on the site.
COARSE NECROMASS	existing volume (t/ha)	22 m^3/ha	Based on project documents, Althoff *et al*., Based on 10.516 tC in litter, split 50:50 between coarse and fine matter.
	rate of decay (%vol/yr)	0.33	Based on ESL field data from *Eucalyptus* plantations in Brazil.
	wood density (t/m^3)	0.5	ESL assumption.
	biomass to C conversion factor (tC/t)	0.48	Based on project documents: Sampaio, *et al*; Althoff *et al*.
FINE NECROMASS	existing volume (t/ha)	22 m^3/ha	Based on project documents, Althoff *et al*., Based on 10.516 tC in litter, split 50:50 between coarse and fine matter.
	rate of decay (%vol/yr)	1 (100%)	Fine necromass turnover assumed to be very rapid.

	wood density (t/m^3)	0.5	Assumed to be the same as for coarse matter.
	biomass to C conversion factor (tC/t)	0.48	Based on project documents: Sampaio, *et al*; Althoff *et al*.
SOIL	existing carbon (tC/ha)	28.989 tC/ha	Based on project documents, Althoff *et al*, for measurements made in the top 40cm. Due to lack of additional data, soil carbon is assumed to remain static over time.
WOOD PRODUCTS (WPs)	allocations of commercial thinnings (%)	100% charcoal	
	allocations of waste (%)		All waste is assumed to be burnt.
	recovery rates of WPs (%)	70%	70 % of harvest in final product, with a lifetime of 1 year.

6.2. Data for the baseline scenario simulations

Carbon Pool	Model Input	Data Required (to be filled in)	Notes / Assumptions / Comments
BASELINE SPECIFICATIONS	species	*Eucalyptus sp.*	A range of species are grown in the area including: *E.citriodora, E.cloeziana, E.camaldulensis, E.urophylla, E.grandis.*
	rotation age (yrs)	7 years	All Eucalyptus planted by the project are grown on rotations of 3 x 7 years = 21 years (the first being planted and the second two regenerating from coppice). The model assumes identical data for the 3 stages, and therefore assumes a rotation length of 7 years.
	stand area (ha)	17,000	For the sake of the modelling this area is assumed to be net of roadside margins, fire breaks, wayleaves (pylons) etc.
	other factors		The stands are assumed to be homogenous, with the same management specifications applying to the whole stand.
STEMS	existing volume (m^3/ha)	0	Due to it being new plantation establishment existing biomass will be zero as planted seedling biomass is assumed to be negligible. It is assumed that the land use prior to year zero of the baseline is the last year of a previous rotation – which will have been clear-cut.
	annual growth increments (m^3/ha/yr)	15 m^3/ha/yr	Due to the absence of more specific data, growth was assumed to be linear, with annual increments of 15 m^3/ha/yr.

	commercial thinnings yields (m^3/ha) & timings (yrs)	100% harvest (yr 7) till end year 21 No other thinnings. 105 m^3/ha	Commercial thinnings refer to any harvest operation where the wood is removed from site for allocation to processing or other uses. The yields removed for final harvest are based on the MAI and rotation length. For this baseline it is assumed that following the full 21 years of a 3 X 7 year cycle, no further planting will occur (see text for explanation), after final harvest it is assumed to be left to grassland.
	non-commercial thinnings volumes (m^3/ha) & timings (yrs)	none	Non-commercial thinnings refer to any thinning where the woody residue is left on site. No non-commercial thinnings are carried out.
	mortality rates by volume (m^3/ha/yr)	0-1 yrs = 5% 2-7 yrs = 1%	Wilson, 1998 Mortality assumed to be highest in the first two years of growth.
	% crown & root which are coarse	0.777	Based on ESL field data from Eucalyptus plantations in Brazil. Similar to assumptions used by Wilson, 1998 (0.8 was used).
	logging damage	None	No logging or harvesting damages was taken into account.
	litterfall rates (%crown volume)	0.1 (10%)	Based on ESL field data from Eucalyptus plantations in Brazil. Similar to other data used e.g. Wilson, C. 1998 (9 and 13 %).
	crown biomass expansion factor (cBEF)	1.174	Based on field measured data for Eucalyptus in Brazil (Sampaio, *et al*). Similar to ESL data on Eucalyptus in Brazil (1.088).
	root:shoot ratio	0.485	Based on project documents: Sampaio, *et al*; Althoff *et al*.
	wood density (t/m^3)	0.55	Calculated as a weighted average of the species planted by the project (based on project data).
	biomass to C conversion factor (tC/t)	0.4716 (stems) 0.4896 (crowns) 0.468 (roots)	Based on project documents: Althoff *et al*.
OTHER VEGETATION	existing biomass (t/ha)	0	The first years of the baseline assumes the continuation of *Eucalyptus* plantations, which tend to have very little other vegetation due to weeding practices. This pool was assumed to be negligible and therefore a value of zero was used.
	annual growth increments (t/ha/yr)	Year 0-21 = 0 Year 22-26 = 2 Year 26 onwards = 0	No growth assumed whilst area is under *Eucalyptus* plantations. Growth of grassland assumed for 5 years, to a maximum of 6.3 tonnes of carbon, after which it is assumed to be stable over time (ESL assumption).

	commercial thinnings yields (m^3/ha) & timings (yrs)	0	No commercial or non-commercial thinnings are assumed to take place during the baseline.
	root:shoot ratio	0.26	ESL assumption
	volume to biomass conversion factor (%)	0.35	ESL assumption
	biomass to C conversion factor (tC/t)	0.5	IPCC (1997)
COARSE NECROMASS	existing volume (t/ha)	22 m^3/ha	Based on project documents, Althoff *et al.*, Based on 10.516 tC in litter, split 50:50 between coarse and fine matter.
	rate of decay (%vol/yr)	0.33	Based on ESL field data from Eucalyptus plantations in Brazil.
	wood density (t/m^3)	0.5	ESL assumption.
	biomass to C conversion factor (tC/t)	0.48	Based on project documents: Sampaio, *et al*; Althoff *et al*.
FINE NECROMASS	existing volume (t/ha)	22 m^3/ha	Based on project documents, Althoff *et al.*, Based on 10.516 tC in litter, split 50:50 between coarse and fine matter.
	rate of decay (%vol/yr)	1 (100%)	Fine necromass turnover assumed to be very rapid.
	wood density (t/m^3)	0.5	Assumed to be the same as for coarse matter.
	biomass to C conversion factor (tC/t)	0.48	Based on project documents: Sampaio, *et al*; Althoff *et al*.
SOIL	existing carbon (tC/ha)	28.989 tC/ha	Based on project documents, Althoff *et al*, for measurements made in the top 40cm. Due to lack of additional data, soil carbon is assumed to remain static over time.

WOOD PRODUCTS (WPs)	allocations of commercial thinnings (%)	100% charcoal	
	allocations of waste (%)		All waste is assumed to be burnt.
	recovery rates of WPs (%)	70%	70 % of harvest in final product, with a lifetime of 1 year.

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Annex 4

MONITORING PLAN

As in part D of this document.