MONITORING REPORT

Version 1.0

Mondi Business Paper Richards Bay

Mondi Richards Bay Biomass Project
CDM Registration Reference No. 0966

Monitoring Period: 1st October 2005 to 31st March 2007

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July 2007
Compiled by: C Terblanche

LIST OF FIGURES

LIST OF TABLES

1. EXECUTIVE SUMMARY

Project Participant:	Mondi Business Paper, Richards Bay
CDM Registration No:	0966
Date of Registration:	20 May 2007
Project:	Fuel switch from coal to biomass waste
Primary Fuel Used:	Biomass
Date of Commissioning of phase 1:	1st February 2004
Monitoring Period:	1st October 2005 to 31st March 2007 (both days inclusive)
Report compiled:	C Terblanche

Operating details during Monitoring Period

Biomass utilized from facilities (previously landfilled):	35,204 t	(Refer to Table 3)
Biomass utilized from plantations:	0 t	(Refer to Table 3)
Additional bark (from the operation) utilized:	60,638 t	(Refer to Figure 19)
CERs generated over the 18 months:	153,080 t CO_2e	(Figure 22)

2. INTRODUCTION

The objective of the Monitoring Report is to demonstrate the calculations and results of the emission reductions achieved by the project activity. The report also contains information pertaining to the procedures for data collection, monitoring and auditing applied by Mondi Richards Bay (hereafter referred to as Mondi or the project participant) in order to determine emission reductions achieved by the project activity. The monitoring plan is compiled in accordance with the registered PDD[1] (version 06, 5 February 2007), in which the principles of the approved methodology "Fuel switch from fossil fuels to biomass residues in boilers for heat generation" (referenced as AM0036/Version 01, 29 September 2006) are applied.

3. STATUS OF THE PROJECT ACTIVITY

The first phase of the Richards Bay Fuel Switching Project (hereafter referred to as the project or project activity) was implemented in November 2004. The scope of the first phase was the implementation of some equipment to test whether the co-fired boiler can burn high amounts of biomass waste without compromising production capacity. The second phase of the project was implemented in September 2005 and included the implementation of biomass waste handling equipment in the wood yard. Furthermore, research and trials have been conducted during the second phase to establish the resource and technical requirements in the plantations (people and equipment) if the project activity was to be implemented. The third and final phase of the project involves implementation of biomass waste management system in the plantations around Richards Bay. The project has a fixed crediting period over 10 years, starting on the 1st of October 2005.

3.1. Project Location

Project Site:	Richards Bay (refer to Figure 2)
Municipality:	City of uMhlathuze
Region:	KwaZulu Natal
Country:	South Africa

Geographical Location: Richards Bay is located on the north east coast of South Africa.
The project activity is located at the Mondi Business Paper operation in Richards Bay, a harbour and industrial town that is situated approximately 180 km north of Durban on the East Coast of South Africa. It has good road and rail connections, and is located only a few kilometers from the Richards Bay harbour. Figure 1 indicates the location of the project activity. There are a number of wood

[1] Project Design Document

chipping facilities located in the Richards Bay area. These facilities chip wood received from plantations for export purposes (see Figure 23.)

Figure 1: Location of the Mondi Richards Bay biomass Project activity

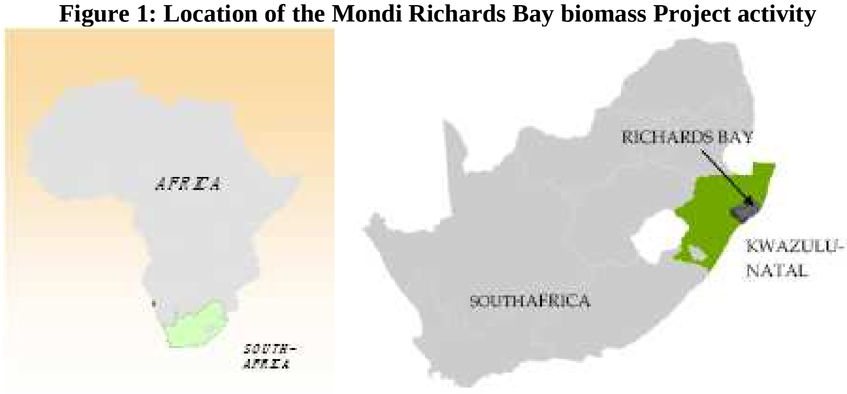

Figure 2: Richards Bay operation

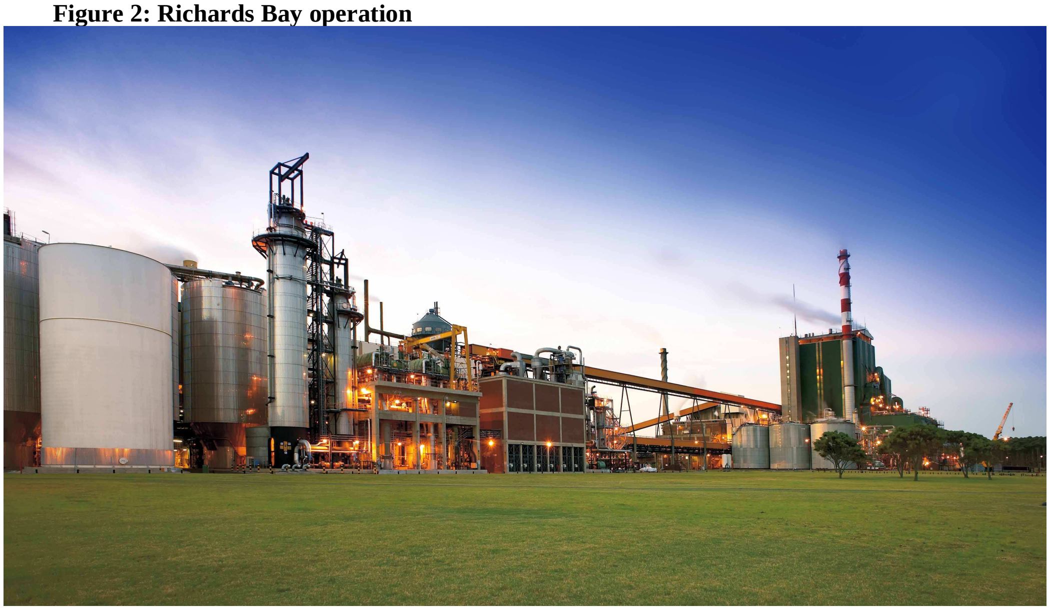

Figure 3: Example of a chipping facility near the vicinity of the Mondi operation

3.2. Project Boundary

The project boundary includes the following elements:

1. The co-fired biomass boiler at Mondi;
2. New equipment in the wood yard implemented to handle the additional waste biomass fuel used during the project activity;
3. Vehicle transport (trucks mostly) of the biomass waste from facilities and plantations to the Mondi operation;
4. Methane generation from landfill of waste biomass and plantation waste left for decay in the absence of the project activity.

3.3. Project equipment

This project involved modifications to the biomass feed system and to the fly ash handling system on the boiler:

1. Installation of a new Saalasti Crush Size 1212 Bark Shredder in the Wood yard to effectively shred all the hardwood slivers, logs and planks that currently clog up and damage the primary biomass feed system.
2. Installation of a secondary biomass feed system to tie into the primary feed system and a smaller Saalasti Crush Size 0609 Bark Shredder to handle the imported biomass.

3. Upgrade of the fly ash conveyors on the power boiler to handle the ash that will be generated. The Saalasti Crush Size 1212 Shredder is designed to process hardwood slivers, logs and planks. The crusher improves the operation of the feed screws substantially.

4. MONITORING METHODOLOGY AND MONITORING PLAN

For determining the emission reductions of the project, methodology AM0036 is applied. The calculations as described by AM0036 are done by means of a spreadsheet (*Richards Bay emission reductions calculations verification 1.xls*) in which the relevant monitoring parameters are entered into and the emission reductions are calculated automatically. The spreadsheet contains several worksheets used to determine the baseline and project activity emissions. Table 1 provides a layout of the worksheets in the spreadsheet with a description of the information contained in each worksheet.

Table 1: Description of worksheet information contained in spreadsheet "Richards Bay emission reductions calculations verification 1

Worksheet name	Description of information contained in the worksheet
I1 Coal NCV data	Net calorific value of coal as received from the coal supplier
I2 NCVs	Summarized NCV data for coal and waste biomass used in the baseline and the project activity
I3 Moisture contents	Table B: Moisture contents for bark, chipping waste and plantation waste biomass
I4 Transport info	Information relevant to the calculation of transport emissions
I5 Information	Parameter values used in baseline and project activity (Year 1 and Year 2) calculations
T1 Baseline Summary:	Table 1: Summary of the baseline emissions
T2 Project activity Summary:	Table 2: Summary of project activity emissions
T3 Total Summary:	Table 3: Summary of emissions for baseline, project activity and leakage
T4&5 Transport summary	Table 4 provides aggregated transport emissions per supplying facility and Table 5 is a total summary of transport emissions per year
T6 Heat emissions	Table 6: Baseline emissions from coal burning in boiler (purpose heat generation)
T7&8: Historical biomass heat	Historical data (2001 to 2003) for coal and bark waste used in the boiler
T 9 Heat generated from biomass	Table 9 provides information on the heat generated from biomass residues as a result of the project activity
T10 BE total biomass decay	Table 10 provides a summary of the total waste biomass decay emissions in the baseline
T11 BE biomass anaerobic info:	Table 11 provides the factors used in calculating baseline methane emissions from waste biomass landfilled calculated in Table 11b
T11b BE biomass anaer calcs:	Worksheet provides the calculations for anaerobic emissions from biomass

Worksheet name	Description of information contained in the worksheet
T12 BE plantation decay:	Table 12 provides the baseline emissions from natural decay of plantation biomass
T13 Electricity:	Table 13 provides electricity information
T14 PA Biomass combustion:	Table 14 provides the direct emissions for biomass combustion in project activity
T15 Biomass quantities info	Tables provide information on the quantities of biomass burned in tons and GJ
T16 Sum Biomass quantities:	Table 16 provides a summary of the biomass quantities utilised in project activity
T17 Wood yard equipment	
T18 Enthalpy	Table 18 contains the enthalpy calculations for the boiler
T19 Additional bark from WY	Calculations to determine the additional amount of bark originating from the Wood yard, half of which would be landfilled (conservatively).

4.1. Data available at validation

The information reflected in Table 2[2] was determined from data available prior to validation. The calculations and resulting values applied in the baseline were validated and most of these values are fixed for the duration of the project activity.

Table 2: Data available for determining baseline emissions

Parameter	Data unit	Description	Value applied in baseline calculations	Comment
$\eta_{boiler,FF}$	%	The energy efficiency of the boiler using fossil fuels to generate heat	PDD baseline: 85.3 Baseline emissions from the boiler prior to verification: 68.6 2001: 68.6 2002: 68.6	The boiler efficiency was determined by an independent consultant according to US EPA Method 3a. The PDD (Table B6.2) described that for the purpose of determining the baseline and forecasted emissions, the design efficiency would be used, and that the true boiler efficiency would be determined once prior to verification. This true boiler efficiency is used to determine the real emission reductions and as no major modifications were done to increase boiler efficiency during the past five years, the measured efficiency is used to determine the baseline emissions from burning coal in the boiler during the 3 baseline years.
$HG_{biomass, 2003}$ $HG_{biomass, 2002}$ $HG_{biomass, 2001}$	GJ	Historical annual heat generation from firing biomass residues in boilers at the project site from 2001 to 2003	2001: 751,986 2002: 784,602 2003: 770,301	Refer to Table 34 in PDD and Table 9 in Excel spreadsheet. Case B as described in AM0036 page 12 is applicable to calculate $HG_{PJ,biomass,y}$
$BF_{bark, historic, 2001}$ $BF_{bark, historic, 2002}$ $BF_{bark, historic, 2003}$	Dry ton/a	The annual net quantity of bark fired in the boiler during the most recent three years prior to project implementation.	2001: 41,777 2002: 43,589 2003: 42,795	These figures represent the historic bark that was burned in the boiler and were determined as part of establishing the baseline. The information was validated and the figures are fixed for the duration of the project activity. Refer to Table 31: Historical biomass and coal consumption, Column B in PDD.
$FC_{coal,2001}$ $FC_{coal,2002}$ $FC_{coal,2003}$	Ton/a	Quantity of coal fired in the boiler at the project site during the historic years: 2001, 2002, 2003	2001: 32,951 2002: 46,864 2003: 48,287	These figures represent the historic amount of coal that was burned in the boiler and were determined as part of establishing the baseline. The information was validated and the figures are fixed for the duration of the project activity. Refer to Table 31: Historical biomass and coal consumption in the PDD and Worksheet T7&8 in the spreadsheet. The

[2] Compiled from information in Section B.6.2 in the PDD version 06, 5 February 2007.

Parameter	Data unit	Description	Value applied in baseline calculations	Comment
				information is noted once at project start for the three years prior to project activity implementation. Refer to Table 34: Parameters to be calculated in PDD
$EF_{CO2, coal,2001-2003}$	Kg CO_2/GJ	CO_2 emission factor for coal displaced by biomass residues	92.7	Appendix B as referenced in Calculation tools for greenhouse gas emissions for Pulp and Paper Industry, 2001. http://www.ncasi.org/support/downloads/Detail.aspx?id=4 Tools - GHG Calc Tools for Pulp and Paper Mills - Spreadsheet Version 1.1
MC_b	%	Moisture content of the biomass (bark) burned during the years 2001 to 2003.	50	This figure is used to determine the amount of bark burned in the baseline years. See Fig 5 in PDD.

4.2. Monitoring data collected for calculating project activity emissions and emission reductions

Table 3: Data available at validation but monitored during the project activity as part of the monitoring plan

Parameter	Data unit	Description	Value applied	Comment
$\eta_{boiler,FF}$	%	The energy efficiency of the boiler using fossil fuels to generate heat	Year 1: 68.6% Year 2: 68.8%	The efficiency was conducted by an independent consultant using US EPA Method 3a. Report is available.
$HG_{biomass,\ 2003}$ $HG_{biomass,\ 2002}$ $HG_{biomass,\ 2001}$	GJ	Historical annual heat generation from firing biomass residues in boilers at the project site from 2001 to 2003	2001: 710,209 2002: 741,013 2003: 727,507	Refer to Table 34 in PDD
$BF_{bark,\ year\ 1}$ $BF_{bark,\ year\ 2}$	Wet ton/a	The annual quantity of waste biomass fired in the boiler during year 1 and year 2 (6 months).	Year 1: 46,439 Year 2 (6 months): 13,965	The total amount of additional waste biomass (compared to the baseline figure) burned during the project activity. The biomass waste is measured by the weighbridge and the additional amount of bark burned from the operation is calculated.
k_i	$Years^{-1}$	Decay rate for the biomass waste	0.035	Default value: Refer to Figure 4: Decay rates for waste.
DOC_i	%	Fraction of degradable organic carbon (by weight) in the biomass waste	50	Default percentage of dry waste Refer to Figure 5: Degradable organic carbon of waste IPCC 2006 Guidelines for National Greenhouse Gas Inventories
MCF		Methane correction factor	1	Refer to Figure 6: Methane correction Factor from IPCC 2006 Guidelines for National Greenhouse Gas Inventories
DOCf		Fraction of degradable organic carbon (DOC) that can decompose	0.5	Recommended default value from IPCC 2006 Guidelines for National Greenhouse Gas Inventories (Volume 5, page 3.13)
F		Fraction of methane in the SWDS gas (volume fraction)	0.5	Recommended default value from IPCC 2006 Guidelines for National Greenhouse Gas Inventories (Volume 5, page 3.15)
OX		Oxidation factor (reflecting the amount of methane from SWDS that is oxidized in the soil or other material	0	Recommended default value from IPCC 2006 Guidelines for National Greenhouse Gas Inventories (Volume 5, Table 3.2) The landfill site is managed, but not covered with soil or compost.

Parameter	Data unit	Description	Value applied	Comment
		covering the waste)		
❸		Model correction factor to account for model uncertainties	Baseline: 0.95 Year 1: 1 Year 2: 1	All the default values used in the first order decay model are conservative figures, therefore the model correction factor is taken as 1. The 2006 1st order decay model does not suggest a model correction factor.
$EF_{coal,CO2,y}$	t CO_2e/GJ	CO_2 emission factor of the coal	94600 kgCO_2/TJ	Recommended default value from IPCC 2006 Guidelines for National Greenhouse Gas Inventories (Volume 2, Table 2.3)
MC_c	%	Moisture content of biomass waste from chipping facilities	Baseline: 32% Year 1: 32% Year 2: 26%	Year 2: Mondi Laboratory data according to Tappi method: T 258 om-85 The moisture content of biomass residue reaches equilibrium after exposure to ambient air and therefore, once equilibrium has been reached the moisture fluctuation over time is negligible (refer to). The biomass residues used in this project activity are envisaged to include bark, chipping residues and plantation residues. Moisture content differs for different types of biomass residues (plantation residues, chipping residues and bark) and will therefore be separately analysed. Mean values will be calculated at least annually to account for variation in moisture from 2007 onwards. For year 1 the published data is used for wood 6 to 12 weeks after felling (Figure 12). This approach is conservative as the wood chips moisture content will be lower (smaller surface area).
MC_b	%	Moisture content of bark	Baseline: 50% Year 1: 50% Year 2: 43%	Mondi Laboratory data according to Tappi method: T 258 om-85. For year 1 the moisture content of 50% is used from literature. This is the conservative approach as the moisture content of the bark will be less than fresh bark from trees that have just been felled.
$EC_{PJ,y}$	MWh	On-site electricity consumption attributable to the project activity during the year	Year 1: 2173 Year 2 (6 months): 891	Mondi electricity consumption meter at the wood yard for the crusher. Continually monitored and aggregated annually for the calculations. The monitor could only be installed in the beginning of 2007 and therefore, the conservative approach will be taken in that it is assumed the equipment functions to its full capacity at maximum load for all hours that it is in operation. The hours that the equipment are in operation are monitored and recorded by the operation's process information system (PI).

Parameter	Data unit	Description	Value applied		Comment
$FC_{coal,year\ 1}$ $FC_{coal,year\ 2}$	Tons	Quantity of coal fired in the co-fired boiler at the project site during the year	2001: 32,951 2002: 46,864 2003: 48,287 Year 1: 19,246 Year 2 (6 months): 7,003		Continually measured and captured in the Process Information (PI) database. Continually monitored and aggregated annually for the calculations
$EF_{grid,y}$	tCO_2/MWh	Weighted average CO_2 emissions for electricity	Year 1: 0.978 Year 2: 0.978		Eskom publicly reported for the year 2005 that for every kWh it produced, 0.978 kg of CO_2 was emitted (Eskom Annual Report 2006). http://www.eskom.co.za/annreport06/tables2.htm For 2006 Eskom reported 0.978.
$TL_{c,silvacel}$ $TL_{c,ctc}$ $TL_{c,shincel}$ $TL_{c,kwambo}$ $TL_{c,nseleni}$ $TL_{c,portent}$ $TL_{c,RBay}$	Tons	Average truck load of the trucks used for transportation of biomass waste from biomass waste supplier facilities	**Year 1**	**Year 2**	Information from Mondi weighbridge at the operation or transport contractor information or information supplied by supplier of biomass waste, whichever is applicable. Monthly averages will be compared before aggregating towards an annual value. Refer to Table C in worksheet Transport info.
			Silvacel 12.9	9.4	
			CTC: 11.3	11.6	
			Shincel: 10.9	7.6	
			Kwambo: 12	-	
			Nseleni: 11.7	11.4	
			Portnet: 18	9.24	
			Peniquick: 9	-	
$AVD_{silvacel}$ AVD_{ctc} $AVD_{shincel}$ $AVD_{portent}$ AVD_{kwambo} $AVD_{nseleni}$ AVD_{rbay} AVD_{pc}	Kilometers	Average return trip distance between biomass fuel supply sites and the project site	Silvacel: 12.4 CTC: 11 Shincel: 24.4 Kwambo: 64 Nseleni: 30		Distances traveled by trucks from all supply sources were recorded, which makes it possible to determine the transport emissions related to biomass waste transport from each supply site. The transport emissions are small in comparison to other emissions from the project activity.

Parameter	Data unit	Description	Value applied	Comment
			Portnet: 15.6 Peniquick 74	
NCV_{coal}	GJ/ton	Net calorific value of coal	Baseline: 27 Year 1: 26.93[3] Year 2: 27.22[4]	An average is calculated every six months from the information supplied by the coal supplier. The two yearly figures are aggregated for use in the calculations if done over a yearly period. Supplier confirmed that the method of analysis is consistent with ISO 1928. The coal supplier runs two Round Robins with two independent laboratories Viz.Yanka Laboratories (+/- 26 local labs.) & Coal & Mineral Technologies, (+/- 50 international labs.)
NCV_b	GJ/ton of dry matter	Net calorific value of bark residues	Baseline: 18 Year 1: 18 Year 2: 17.75	Published information (Papermaking Science and Technology) for NCV was used for year 1 and measured information from the laboratory was used for year 2.
NCV_c	GJ/ton of dry matter	Net calorific value of biomass residues from chipping facilities	Baseline: 19 Year 1: 19 Year 2: 18.9	Published information (Papermaking Science and Technology) for NCV was used for baseline calculations and year 1 and measured information from the laboratory was used for year 2.
$EF_{CH4,BF}$	$kgCO_2$/TJ	Methane emission factor for combustion of biomass in the boilers	15 kg/TJ biomass fuel converted to 21.55 kg/TJ (see comment).	Values are based on the 2006 IPCC Guidelines, Volume 2, Chapter 2, Table 2.2 to 2.6. A conservativeness factor of 1.37 is applied to the CH_4 emission factor of 15kg/TJ (Table 1-16 on Page 1.54) of the Reference Manual of 1996. Revised IPCC Guidelines, giving a revised CH_4 emission factor of 21.55 kg/TJ used in the calculation.
$EF_{Burning, CH4,y}$	tCH_4/t biomass waste (dry)	CH_4 emission factor for the uncontrolled burning of plantation biomass	6.1 g/kg dry matter 0.0061 t CH_4/t dry biomass used	2006 IPCC Guidelines, Volume 4, Table 2.5, default for biofuel burning
$EF_{CO2,LE}$	tCO_2/GJ	CO_2 emission factor of the most carbon intensive fuel used in the country	NA	Not applicable as leakage is ruled out for the period under verification.
L1	tons	Quantity of biomass residues		For chipping facilities, surveys will be conducted annually with the main

[3] Table A in worksheet NCVs in spreadsheet “Richards Bay emission reductions calculations verification 1”
[4] Table A in worksheet NCVs in spreadsheet “Richards Bay emission reductions calculations verification 1”

Parameter	Data unit	Description	Value applied	Comment
Leakage related to biomass residues surplus		that are utilized (e.g. for energy generation or as feedstock) in the defined geographical region		objective to establish whether feasible alternative markets for residue use as energy have emerged during the year under consideration. To reduce uncertainty in the outcome of the survey, all chipping facilities will be covered. On registration, Mondi investigated and evaluated the option of contracting this function out to and independent party. For the time being, the workload is still of such nature that it can be handled internally by Mondi staff. This situation will be re-evaluated prior to the next verification.
L2 Leakage related to the biomass residue market	-	Quantity of available biomass residues in the region		For chipping facilities, surveys will be conducted annually to demonstrate that biomass residue suppliers were not able to supply/sell to an alternative user during the year under consideration. On registration, Mondi investigated and evaluated the option of contracting this function out to and independent party. For the time being, the workload is still of such nature that it can be handled internally by Mondi staff. This situation will be re-evaluated prior to the next verification.
L3 Leakage related to biomass residue consumers	-	Availability of a surplus of biomass residue (which can not be sold or utilized) at the ultimate supplier to the project (or, in case of L4, the former user of the biomass residue) and a representative sample of other suppliers in the defined geographical region.		The city of uMhlathuze was contacted to obtain confirmation that no new industries or consumers of biomass waste (the type that is utilized in the project activity) in the area has established. Confirmation from the municipality was received that no new industries have been established since October 2005.
F		Fraction of methane captured at the SWDS and flared, combusted or used in another manner	0	Written confirmation from the operator of the solid waste disposal site was received which stated that methane flaring is not done (refer to Figure 9: Correspondence from landfill site).
BFx	tons	Total amount of waste	Year 1: 18,092	Collate weighbridge data of waste originating from chipping facilities.

Parameter	Data unit	Description	Value applied	Comment
		prevented from disposal in each year	Year 2 (6 mnths): 12,013	The total aggregated figures for year 1 and year 2 are reflected in Worksheet T16:Sum Biomass quantities in Spreadsheet "Richards Bay emission reduction calculations verification 1.xls"
$FC_{TR,I,y}$	Liters per kilometer	Fuel consumption of fuel type (diesel)	0.5	The consumption figure 1.9 km per liter was obtained from the transport company.
NCV_{diesel}	TJ/Gigagram	Default Net calorific value for diesel	43 (Or 43 x 10^{-6} TJ/kg)	2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2: Energy, Chapter 1, Table 1.2, page 18
EF_{diesel}	Kg/TJ	Default CO_2 emission factor for diesel	74100	2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2: Energy, Chapter 1, Table 1.4, page 23
EF_{diesel}	Kg/km G/km	CO_2 emission factor calculated from IPCC information and local consumption figures for diesel	1.417 739	This value for the emission factor is calculated as described in Section 7.1. Cross check: CO_2 emissions per liter of diesel from a Table adapted from Kinsky, R. Thermodynamics - advanced applications is equal to 2.85 kg CO_2/liter diesel. Another cross check: A BULK MODEL OF EMISSIONS FROM SOUTH AFRICAN DIESEL COMMERCIAL VEHICLES, Energy Research Institute (ERI), University of Cape Town http://www.erc.uct.ac.za/publications/NACA.PDF. Refer to information in Figure 10.
Diesel density	g/cm^3 @ 20^{o}C	Diesel density	0.845	Engen Diesel Material Safety Data Sheet, 27 Jan 2006 http://www.engen.co.za/home/server/products_and_services/safety_data/
Global warming potential of CH_4	tCO_2/tCH_4	GWP	21	IPCC Emission Guidelines 1996

Parameter	Data unit	Description	Value applied	Comment
Softwood processed during the year	t	Tons softwood processed in the process	Year 1: 460,547 Year 2: 183,831	The amount of softwood processed is used as a check against the total amount of bark processed on site. Measured on-site by the weighbridge for every truck of wood entering the Mondi operation. According to literature (and experience at the operation), approximately 10% of the wood processed is biomass waste. This information is used to compare the range of the bark calculated with the bark generated (theoretically). If the figures prove to be vastly different, then investigation must be initiated.

*1 TJ = 10^6 MJ

(1 MJ = 1/3.6 kWh) therefore 1 TJ = 10^6/3.6 kWh = 277 777 kWh = 277.8 MWh

So: 21.55 kg/TJ = 21.55/277.8 kg/MWh = 0.077 kg/MWh = 0.00007758 tonne/MWh

Figure 4: Decay rates for waste: IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Table 3.3)

TABLE 3.3
RECOMMENDED DEFAULT METHANE GENERATION RATE (k) VALUES UNDER TIER 1
(Derived from k values obtained in experimental measurements, calculated by models, or used in greenhouse gas inventories and other studies)

Type of Waste		Climate Zone*							
		Boreal and Temperate (MAT ≤ 20°C)				Tropical[1] (MAT > 20°C)			
		Dry (MAP/PET < 1)		Wet (MAP/PET > 1)		Dry (MAP < 1000 mm)		Moist and Wet (MAP ≥ 1000 mm)	
		Default	Range[2]	Default	Range[2]	Default	Range[2]	Default	Range[2]
Slowly degrading waste	Paper/textiles waste	0.04	0.03[3,5] – 0.05[3,4]	0.06	0.05 – 0.07[3,5]	0.045	0.04 – 0.06	0.07	0.06 – 0.085
	Wood/ straw waste	0.02	0.01[3,4] – 0.03[6,7]	0.03	0.02 – 0.04	0.025	0.02 – 0.04	0.035	0.03 – 0.05
Moderately degrading waste	Other (non – food) organic putrescible/ Garden and park waste	0.05	0.04 – 0.06	0.1	0.06 – 0.1[8]	0.065	0.05 – 0.08	0.17	0.15 – 0.2
Rapidly degrading waste	Food waste/Sewage sludge	0.06	0.05 – 0.08	0.185[4]	0.1[3,4] – 0.2[9]	0.085	0.07 – 0.1	0.4	0.17 – 0.7[10]
Bulk Waste		0.05	0.04 – 0.06	0.09	0.08[8] – 0.1	0.065	0.05 – 0.08	0.17	0.15[11] – 0.2

Figure 5: Degradable organic carbon of waste IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Tables 2.4 and 2.5)

Waste type *j*	DOC_j (% wet waste)	DOC_j (% dry waste)
Wood and wood products	43	50
Pulp, paper and cardboard (other than sludge)	40	44
Food, food waste, beverages and tobacco (other than sludge)	15	38
Textiles	24	30
Garden, yard and park waste	20	49
Glass, plastic, metal, other inert waste	0	0

Figure 6: Methane correction Factor from IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Tables 3.1)

TABLE 3.1
SWDS CLASSIFICATION AND METHANE CORRECTION FACTORS (MCF)

Type of Site	Methane Correction Factor (MCF) Default Values
Managed – anaerobic [1]	1.0
Managed – semi-aerobic [2]	0.5
Unmanaged [3] – deep (>5 m waste) and /or high water table	0.8
Unmanaged [4] – shallow (<5 m waste)	0.4
Uncategorised SWDS [5]	0.6

[1] **Anaerobic managed solid waste disposal sites**: These must have controlled placement of waste (i.e., waste directed to specific deposition areas, a degree of control of scavenging and a degree of control of fires) and will include at least one of the following: (i) cover material; (ii) mechanical compacting; or (iii) levelling of the waste.

[2] **Semi-aerobic managed solid waste disposal sites**: These must have controlled placement of waste and will include all of the following structures for introducing air to waste layer: (i) permeable cover material; (ii) leachate drainage system; (iii) regulating pondage; and (iv) gas ventilation system.

[3] **Unmanaged solid waste disposal sites – deep and/or with high water table**: All SWDS not meeting the criteria of managed SWDS and which have depths of greater than or equal to 5 metres and/or high water table at near ground level. Latter situation corresponds to filling inland water, such as pond, river or wetland, by waste.

[4] **Unmanaged shallow solid waste disposal sites**; All SWDS not meeting the criteria of managed SWDS and which have depths of less than 5 metres.

[5] **Uncategorised solid waste disposal sites**: Only if countries cannot categorise their SWDS into above four categories of managed and unmanaged SWDS, the MCF for this category can be used.

Sources: IPCC (2000); Matsufuji *et al.* (1996)

Figure 7: Oxidation factor from from IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Tables 3.2)

TABLE 3.2
OXIDATION FACTOR (OX) FOR SWDS

Type of Site	Oxidation Factor (OX) Default Values
Managed [1], unmanaged and uncategorised SWDS	0
Managed covered with CH_4 oxidising material [2]	0.1

[1] Managed but not covered with aerated material

[2] Examples: soil, compost

Figure 8: IPCC Volume 4, Table 2.5

TABLE 2.5
EMISSION FACTORS (g kg^{-1} DRY MATTER BURNT) FOR VARIOUS TYPES OF BURNING. VALUES ARE MEANS ± SD AND ARE BASED ON THE COMPREHENSIVE REVIEW BY ANDREAE AND MERLET (2001)
(To be used as quantity 'G_{ef}' in Equation 2.27)

Category	CO_2	CO	CH_4	N_2O	NO_X
Savanna and grassland	1613 ± 95	65 ± 20	2.3 ± 0.9	0.21 ± 0.10	3.9 ± 2.4
Agricultural residues	1515 ± 177	92 ± 84	2.7	0.07	2.5 ± 1.0
Tropical forest	1580 ± 90	104 ± 20	6.8 ± 2.0	0.20	1.6 ± 0.7
Extra tropical forest	1569 ± 131	107 ± 37	4.7 ± 1.9	0.26 ±0.07	3.0 ± 1.4
Biofuel burning	1550 ± 95	78 ± 31	6.1 ± 2.2	0.06	1.1 ± 0.6

Note: The "extra tropical forest' category includes all other forest types.

Note: For combustion of non-woody biomass in Grassland and Cropland, CO_2 emissions do not need to be estimated and reported, because it is assumed that annual CO_2 removals (through growth) and emissions (whether by decay or fire) by biomass are in balance (see earlier discussion on synchrony in Section 2.4.

Figure 9: Correspondence from landfill site

From: Chris Robinson [mailto:ChrisRob@telkomsa.net]
Sent: Friday, July 20, 2007 9:19 AM
To: Von Solms Sibs
Subject: RE: SOLID WASTE SITE AT EMPANGENI
Importance: High

Good day Von,

Yes, your comment that no methane flaring currently takes place on site is correct as per our telephonic conversation.

The current cell, which is part of the new development, is only 4 years old and will not yield sufficient methane volumes to warrant any form of extraction. This factor will however be monitored and the necessary actions taken in accordance with the Minimum requirements, when the need arises.

Regards,

Chris Robinson
Millennium Waste Management
Landfill Site Manager

Millennium Waste Management
Uthungulu Landfill Site
Empangeni
Cell: 082 494 8962
Ph: 035 772 4720
Fax: 035 772 4926
E-Mail: ChrisRob@telkomsa.net

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Table 4: Data from literature used for cross-checking purposes

Parameter		Units	Source of information
Net Calorific Value – Bark (dry)	NCV_b	18 MJ/dry kg	Mondi laboratory, IPCC guidelines
Net Calorific Value – bark (wet – 50% moisture)	NCV_b	7.975 MJ/kg	Published local data (Figure 11: Table with properties for bark)
Net Calorific Value – Sawdust	$NCV_{sawdust}$	20 MJ/dry kg	Mondi laboratory, IPCC guidelines
Net Calorific Value - Plantation Waste	NCV_p	18 MJ/dry kg	Mondi laboratory, IPCC guidelines where applicable
Default net calorific value Oven, dry wood[5]		20 MJ/kg	Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (Table 1-13 on Page 1.45 of the Reference Manual)
Design efficiency of biomass-fired boiler	$\varepsilon_{boiler\ Biomass}$	83.7%	Boiler supplier information
Design efficiency of coal fired boiler	$\varepsilon_{boiler,\ FF}$	85.3%	Boiler supplier information

Figure 10: Estimated emission factors for diesel vehicles (1998)

Table 8: Estimated Emission Factors for Diesel Commercial Vehicles (1998)

Vehicle	Emission Factors (g/km)					
Type	HCn	CO	NOx	SO2	CO2	PM
LCV	0.10	1.14	1.47	0.51	237	0.25
MCV	0.86	2.41	6.18	1.02	473	0.47
HCV	1.05	3.82	13.04	1.66	805	0.68
M&HCV	1.01	3.54	11.68	1.54	739	0.64
All CV's	0.48	2.14	5.70	0.94	446	0.41

[5] Can be used for reference purposes and quality control of data

Figure 11: Bark moisture content and bark calorific value information

Table 15. Properties of pulp & paper residue

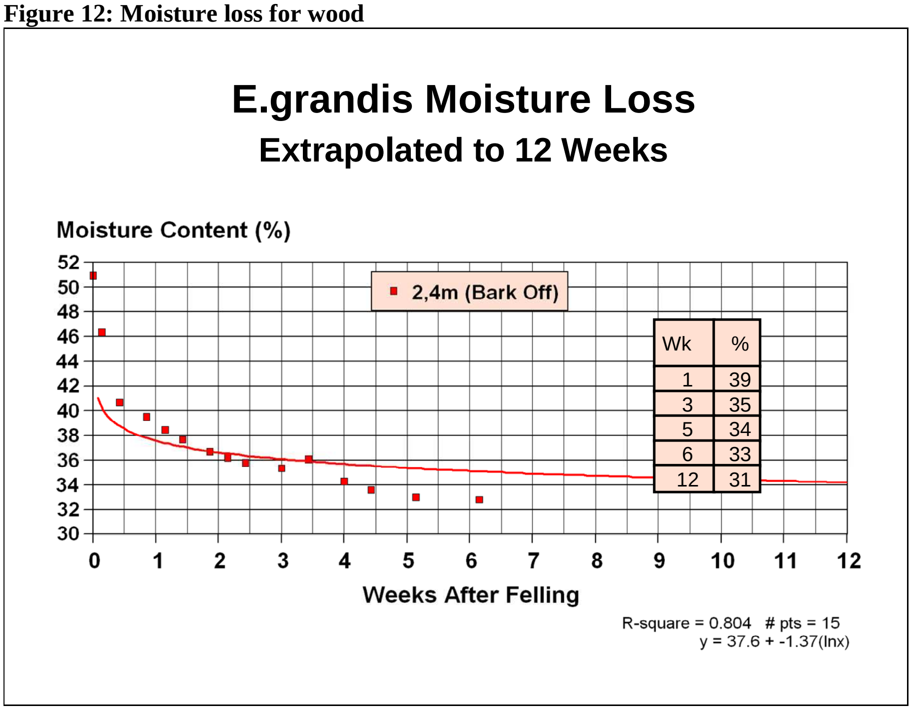
	Mass	Fibre	Moisture	Ash	NCV	Energy
	1000 t	%	%	%	MJ/t	TWh
Black Liq-	5206	40.00	50.00	10.00	6243	9.03
Sludge	234	37.50	50.00	12.50	5777	0.38
Bark	345	48.00	50.00	2.00	7975	0.76
Total	5785	40.38	50.00	9.62	6328	10.17

The net calorific values (NCV) are based on estimated gross calorific values (GCV) of fibre in black liquor and sludge of 20 000 (hydrogen 6.1%) MJ/t and a gross calorific value (GCV) of the fibre in bark of 20 431 MJ/t (hydrogen 5.80%) (www.vt.tuwien.ac.at/biobib).

The amount of biomass on a provincial basis is given in Table 16. There is no reason to believe that the properties of the biomass should be significantly different from province to province and again they are kept the same for the different provinces.

Source of information: Department of Minerals and Energy: Assessment of Commercially Exploitable Biomass Resources: Bagasse, Wood & Sawmill Waste and Pulp, in South Africa, Capacity Building in Energy Efficiency and Renewable Energy, Report No. – 2.3.4 - 29

Figure 12: Moisture loss for wood



5. MONITORING PLAN

Mondi Business Paper South Africa runs a full Total Quality Management (TQA) system inclusive of all requirements of ISO9001:2000 and ISO14001:1994. All QC/QA controls are documented in the TQM system. The following aspects are addressed in general and for the Biomass project in particular:

- Management Responsibility is included in the ISO 14001 System.
- Document Control: Including the format of documents, distribution and authority – D-AADC.001.
- Testing both in terms of Laboratory and Instrument analysis (Test frequencies, Methods and Reporting) – Included in R-EVCR.001.
- Calibration of Equipment (Frequencies, Methods and Reporting) – Included in R-WIEN.001.
- Corrective and Preventative Actions – D-AACA.001. Daily Meetings are held, on normal working days, to discuss Product or Environmental quality-related problems ex the various processes, and to formulate Corrective Action plans. [6]These Meetings are inter alia:-
  -Section and Departmental
  -Operations Meeting
  -Ad Hoc Meeting between Business Unit Managers and the General Manager.

Unresolved problems are referred to the meeting at the next level up for a decision. Weekly and Monthly Management Meetings are held at which problems are identified, discussed, and Corrective Action formulated, if necessary. These meetings are inter alia:-
-Monthly Product Quality Review Meeting
-Monthly Section and Departmental Meetings (to discuss quality related Projects)
-Monthly Management Meeting
-Ad Hoc Meetings as circumstances dictate

During the period of verification, no significant problems were experienced. The operation experienced intermittent down-time due to shortcomings of the bark conveying system, a common problem with bark handling systems. Most of these difficulties have been designed out.

Meetings can be cancelled or postponed, by the relevant Chairman, if unusual circumstances prevail. The daily Laboratory Analysis Report, Quality Trend Graphs and Data, Technical Data Sheets and the other Quality Records are used to identify deviations from Product or Environmental Quality Targets or aims which require corrective action, and for evaluating compliance with Product Quality Standards and Environmental Legislation and Regulations. Control of Corrective Action takes place by means of referring back to minutes of meetings, checking outstanding work lists (to ensure that work requests relating to improving quality deviations are done) and by inspection of subsequent results and records to ascertain whether the Corrective Action was successful.

- Internal Audits as per D-AAQA.001. For the Biomass project, specific audits are scheduled. All elements of the Quality System shall be audited on a regular basis at a frequency of at least *once a year*. The frequency of auditing any particular element of the system may be increased at the discretion of the Head: Quality Systems if he has any reason to doubt the effectiveness of its operation. The Head: Quality Systems shall, at the beginning of each year, produce a program of internal audits (Internal Audit Schedule) for the ensuing year and monitor progress against this schedule. The audits are performed by the Head: Quality Systems or a suitably trained nominee, on his behalf. In all cases the auditor shall be independent of the area being audited. The Initiator of the documents being audited shall be the auditee. The results of the audit are recorded on the Internal Audit Check and any non

[6] This information is copied from formal TQM documents and are accurate at the time of this document being issued. The system is reviewed on a regular basis and changes to these documents may occur, but will not impact materially on the project monitoring control.

compliance on the Corrective Action Request - CAR form. Periodically, but at least once a year, the Head: Quality Systems shall prepare a summary of the audit reports. This shall be the basis of Management Review.

Where possible, the data originating from the Richards Bay operation is monitored with on-line monitoring equipment and recorded by an electronic Process Information (PI) system. The transport company collects the waste biomass quantities from supply sources, and submits this data on a monthly basis to Mondi Richards Bay. Quality control measures are included for example, upon receipt of data on quantity biomass waste receive, Mondi Richards Bay will review the data. In case significant deviations are noticed in the data provided by the transport company, investigations will be lodged to confirm the information or determine and correct the cause.

Table 5: Detailed description of monitoring plan

PARAMETER MONITORED	DEFINITION OF PARAMETER	SOURCE OF INFORMATION	MONITORING METHOD	MONITORING FREQUENCY	RESPONSIBLE PERSON	INFORMATION ON UNCERTAINTY AND CALIBRATION	CORRECTIVE ACTION
1. $\eta_{Boiler, FF}$	The energy efficiency of the boiler	The data is available to use option 1. For validation purposes the manufacturer's information (85.3%) was used. It was expected that this efficiency is higher than the true efficiency, as the boiler is 22 years old. The measured efficiency is closer to 70% (68.6%). The true efficiency will be determined once prior verification according to an international acceptable standard and will be used in calculations.	Literature : supplier information; EPA method	Once a year or if major modifications are done to increase the efficiency.	Energy Manager	Method for determining efficiency is an international recognised standard.	*See Note regarding corrective action

PARAMETER MONITORED	DEFINITION OF PARAMETER	SOURCE OF INFORMATION	MONITORING METHOD	MONITORING FREQUENCY	RESPONSIBLE PERSON	INFORMATION ON UNCERTAINTY AND CALIBRATION	CORRECTIVE ACTION
2. Softwood processed during the year y[7]	Quantity of softwood processed during the year y (wet tons)	Measured on-site by the weighbridge for every truck of wood entering the Mondi operation	Instruments: Mondi weighbridge.	Continuously, and aggregated annually	Business unit manager wood yard	Calibration procedure described in WIPU003. According to this procedure the calibration certificate received from the calibrator has to be traceable to national standard.	*See Note regarding corrective action
3. $BF_{c,y}$ (wet)	Quantity of wet biomass residue from chipping facilities used as fuel in the project plant during the year y	Measured on-site by the weighbridge as biomass residue enters the Mondi operational site.	Instruments: Mondi weighbridge or supplied by transport company.	Continuously, and aggregated annually	Business unit manager for energy	Calibration procedure described in internal ISO 9001 document WIPU003.	*See Note regarding corrective action
4. $BF_{p,y}$ (wet)	Quantity of wet biomass residue from plantations used as fuel in the project plant during the year y	Measured on-site by the weighbridge as biomass residue is transported to the project site.	Instruments: Mondi weighbridge or supplied by transport company.	Continuously, and aggregated annually	Business unit manager for energy	Calibration procedure described in internal ISO 9001 document WIPU003.	*See Note regarding corrective action
5. MC_p	Moisture content of plantation biomass residues	Mondi Laboratory cross checked with published national data	Tappi method: T 258 om-85	Monthly from when plantation residues are received.	Laboratory manager	Calibration procedure described in internal ISO 9001 document TSIM002.	*See Note regarding corrective action

[7] Used to cross check the amount of additional bark from the operation utilized during year y

PARAMETER MONITORED	DEFINITION OF PARAMETER	SOURCE OF INFORMATION	MONITORING METHOD	MONITORING FREQUENCY	RESPONSIBLE PERSON	INFORMATION ON UNCERTAINTY AND CALIBRATION	CORRECTIVE ACTION
6. MC_c	Moisture content of chipping plant residues	Mondi Laboratory cross checked with published national data	Tappi method: T 258 om-85	Once every 6 months.	Laboratory manager	The 12 month average for moisture content will be used to account for variation in moisture from 2007. For 2006 the average moisture content from results obtained during 2005 and 2006.	*See Note regarding corrective action
7. MC_b	Moisture content of bark	Mondi Laboratory cross checked with published national data.	Tappi method: T 258 om-85	Once every 6 months.	Laboratory manager		*See Note regarding corrective action
8. $EC_{PJ,y}$	On-site electricity consumption attributable to the project activity during the year *y*	Mondi electricity consumption meters at the wood yard	Instruments: Tranducer implemented on the crusher, electricity consumption sent to PI system. Alternatively, design capacity will be used to calculate the electricity used over the period for which the crusher was in operation. This is the conservative approach.	Continually measured and aggregated yearly	Business unit manager for energy	Variability over 10% on a monthly basis for electricity consumption for the crusher will be investigated. Because a conservative approach is taken by assuming operational time of 95% for all equipment other than the biggest electricity consumer (crusher) which is monitored, uncertainty in the exact operational time and power consumed for the small electricity consumers is accounted for. Applying the conservative approach will result in the overestimation of emissions associated with electricity consumption rather that underestimation.	
9. $FC_{i,y}$	Quantity of coal	On-site measurements	Instruments:	Continually	Business unit		*See Note

PARAMETER MONITORED	DEFINITION OF PARAMETER	SOURCE OF INFORMATION	MONITORING METHOD	MONITORING FREQUENCY	RESPONSIBLE PERSON	INFORMATION ON UNCERTAINTY AND CALIBRATION	CORRECTIVE ACTION
	fired in the co-fired boiler at the project site during the year *y*		weight meter located before the coal bunker	monitored and data aggregated yearly	manager for energy		regarding corrective action
$TL_{k,y}$	Average truck load of the trucks used for transportation of biomass for the year y	Measured on-site by the weighbridge	Instruments: Mondi weighbridge	Monitored per truckload	Head: Quality control	Calibration procedure described in internal ISO 9001 document WIPU003.	*See Note regarding corrective action
AVD_y	Average return trip distance between biomass fuel supply sites and the Mondi site for the year y	Information supplied by the transport company	Information compiled in datasheets;	Continuously, aggregated yearly	Head: Quality control		*See Note regarding corrective action
NCV_i	Net calorific value of coal	Data supplied by coal supplier with each batch of coal supplied to the Mondi operation	Coal supplier uses **"ISO 1928".** Supplier will be contacted every six months to confirm that the method of analysis is consistent with ISO 1928.	Every six months, and aggregated for use in the calculations	Head: Quality control	(1) Datasheets supplied by coal supplier. (2) Confirmation note from coal supplier that ISO 1928 is used to determine NCV.	*See Note regarding corrective action
NCV_p	Net calorific value of biomass residues from	Measured data or literature information (conservative	Standard bomb calorie meter procedure	Every six months	Mondi laboratory manager		*See Note regarding corrective action

PARAMETER MONITORED	DEFINITION OF PARAMETER	SOURCE OF INFORMATION	MONITORING METHOD	MONITORING FREQUENCY	RESPONSIBLE PERSON	INFORMATION ON UNCERTAINTY AND CALIBRATION	CORRECTIVE ACTION
	plantations	approach)					
NCV_b	Ne calorific value of bark residues	Measured data or literature information (conservative approach)	Standard bomb calorie meter procedure	Every six months	Mondi laboratory manager		*See Note regarding corrective action
NCV_c	Net calorific value of biomass residues from chipping facilities	Measured data or literature information (conservative approach)	Standard bomb calorie meter procedure	Every six months	Mondi laboratory manager		*See Note regarding corrective action
$EF_{kmCO2,y}$	Average CO_2 emission factor for transportation of biomass with trucks	Calculated and cross check with literature - (Table adapted from Kinsky, R. Thermodynamics – advanced applications), IPCC database, national data if available.	Literature search	Annually	Head: Quality control		*See Note regarding corrective action
$EF_{CH4,BF}$	Methane emission factor for combustion of biomass in the boilers	Literature, IPCC database, national data if available	Literature search	Annually review if updated values are available	Head: Quality control	Audit to be conducted prior to yearly verification	Recalculate the emissions for the year applicable.

PARAMETER MONITORED	DEFINITION OF PARAMETER	SOURCE OF INFORMATION	MONITORING METHOD	MONITORING FREQUENCY	RESPONSIBLE PERSON	INFORMATION ON UNCERTAINTY AND CALIBRATION	CORRECTIVE ACTION
$EF_{CO2, FF,i}$	CO_2 emission factor for coal displaced by biomass residues for the year y	Latest IPCC default figures if local data is not available	Literature search	Annually review if updated values are available	Head: Quality control	Audit to be conducted prior to yearly verification	Recalculate the emissions for the year applicable.
k_i	Decay rate for the waste type *j*	IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Table 3.3)	Literature search	Annually review if updated values are available	Head: Quality control	Audit to be conducted prior to yearly verification	Recalculate the emissions for the year applicable.
DOC_i	Fraction of degradable organic carbon (by weight) in the waste type *j*	IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Tables 2.4 and 2.5)	Literature search	Annually review if updated values are available	Head: Quality control	Audit to be conducted prior to yearly verification	Recalculate the emissions for the year applicable.
MCF	Methane correction factor	IPCC 2006 Guidelines for National Greenhouse Gas Inventories	Literature search	Annually review if updated values are available	Head: Quality control	Audit to be conducted prior to yearly verification	Recalculate the emissions for the year applicable.
DOC_f	Fraction of degradable organic carbon (DOC) that can decompose	IPCC 2006 Guidelines for National Greenhouse Gas Inventories	Literature search	Annually review if updated values are available	Head: Quality control	Audit to be conducted prior to yearly verification	Recalculate the emissions for the year applicable.
F	Fraction of methane in the SWDS gas	IPCC 2006 Guidelines for National Greenhouse Gas	Literature search	Annually review if updated values are	Head: Quality control	Audit to be conducted prior to yearly verification	Recalculate the emissions for the year

PARAMETER MONITORED	DEFINITION OF PARAMETER	SOURCE OF INFORMATION	MONITORING METHOD	MONITORING FREQUENCY	RESPONSIBLE PERSON	INFORMATION ON UNCERTAINTY AND CALIBRATION	CORRECTIVE ACTION
	(volume fraction)	Inventories		available			applicable.
OX	Oxidation factor (reflecting the amount of methane from solid waste disposal site that is oxidized in the soil or other material covering the waste)	IPCC 2006 Guidelines for National Greenhouse Gas Inventories	Literature search	Annually review if updated values are available	Head: Quality control	Audit to be conducted prior to yearly verification	Recalculate the emissions for the year applicable.
❸	Model correction factor to account for model uncertainties	IPCC 2006 Guidelines for National Greenhouse Gas Inventories	Literature search	Annually review if updated values are available	Head: Quality control	Application of this factor takes account of the uncertainty in the factors and calculations. Audit to be conducted prior to yearly verification	Recalculate the emissions for the year applicable.

*Note regarding corrective action: If any corrective action must be taken for any parameter, it will be the responsibility of the Energy manager and the Quality control manager to implement and document

6 BASELINE EMISSIONS

6.1 Baseline emissions from coal combustion in the boiler for heat generation ($BE_{HG,y}$)

Case B as described in AM0036 page 12 is applicable to calculate the heat generated with incremental biomass residues used as a result of the project activity during the year *y* (GJ/yr)[8] $HG_{PJ,biomass,y}$. For case B, only the use of biomass residues over and above historical levels are attributed to the CDM project activity.

The Richards Bay operation followed the approach in option 1 as described in AM0036 to calculate the biomass residue use in the absence of the project activity. The boiler efficiency was measured. For the purpose of calculations done in the PDD (and validation), the design efficiency of the boiler was used in calculating the baseline emissions[9]. Prior to the first verification, the boiler efficiency was determined once according to an internationally accepted standard method (EPA). The measured efficiency is used in the monitoring report (and spreadsheet) to determine the baseline emissions and project activity emissions for the period under verification. The operation did not do any major boiler efficiency investigations or modifications to improve the boiler efficiency during the past five years.

<u>Comment: project activity emissions compared to baseline emissions from the co-fired boiler</u>

CO_2 emissions from coal burned in the boiler occur in the baseline. The baseline scenario also includes the possible case where 100% of the heat is generated from coal. With investment in the project activity, the heat is produced mostly from biomass waste. HG_{PJ} (additional biomass heat used in the project activity (GJ/yr) is determined by formula and is based on the heat produced from the biomass in the project activity (in GJ/yr) compared to how much heat the operation produced from biomass over the most recent three years prior to implementation of the project activity (2003 to 2005). The associated CO_2 emissions from an equivalent amount of coal (amount of coal equal to the heat quantity) are determined. Emission reductions are calculated against the baseline which is based on historical information. If ever there is a situation where the operation fires more coal than in the baseline for some operational reasons, the formula delivers a negative HG_{PJ}, which indicates an increase and not a reduction in CO_2 emissions. This scenario will be reflected in the calculations as a net emissions increase and will be highlighted as such during verification.

Calculating the heat generated from biomass waste

The next section describes the methodology presented in Figure 13, the calculation for generating heat from biomass waste.

Figure 13: Heat generated from biomass waste in the baseline and project activity

Heat Generated from Biomass residues as a result of the project activity

		Step 1				Step 2		Step 3				
		A	B	C	D	E	F	G	H	I	J	K
		Heat generated with biomass from chipping facilities	Heat generated with biomass from plantations	Heat generated with total bark form mill operations	Total heat generated with biomass	Net heat generated from biomass in baseline	Increased heat generation in the project activity	Total heat generated in boiler	Net heat generated in boiler prior to project implementation	Ratio	Increased heat generation in the project activity	Increased heat generation in the project plant
					D = A+B+C		F = D - max{E}			I = E/H	J = D - G x max{I}	min [J,F]
		GJ	GJ	GJ	GJ	GJ	GJ	GJ	GJ		GJ	GJ
		$HG_{PJ,c,y}$	$HG_{PJ,p,y}$	$HG_{PJ,b,y}$	$HG_{PJ,biomass,total,y}$	$HG_{biomass,historic,3y}$	$HG_{PJ,biomass,y}$	$HG_{PJ,total,y}$	$HG_{total,historic,n}$		$Q_{biomass,total} - Q_{total} \times MAX\left\{\frac{Q_{biomass,historic,3y}}{Q_{total,historic,3y}}\right\}$	$HG_{PJ,biomass,y}$
Year												
2001	-3					751,986			1,641,663	0.46		
2002	-2					784,602			2,049,930	0.38		
2003	-1					770,301			2,074,050	0.37		
Year 1	1	233,747	0	1,326,229	1,559,976		775,374	1,963,085			660,758	**660,758**
Year 2 (6 months)	2	167,110	0	544,424	711,533		319,232	767,476			359,981	**319,232**

8 This generated heat displaces the heat generated by coal in the boiler in the absence of the project activity.

9 Described in the PDD and validated

Description of calculations:

Column D (Total heat generated with total amount of biomass waste utilized in the operation): The total of columns A to C as calculated from dry biomass quantities multiplied by the associated NCV's.

Column E (Net heat generated from biomass waste in the baseline):

$$HG_{biomass,historic,2003} = \sum_k BF_{k,2003} \cdot NCV_{k,2003}$$

$$HG_{biomass,historic,2003} = BF_{bark,2003} \cdot NCV_{bark} + BF_{chipping\ facilities,2003} \cdot NCV_{chipping\ facilities} + BF_{plantations,2003} \cdot NCV_{plantations}$$

$$HG_{biomass,historic,2003} = 42795 \times 18 \quad + 0 \times 18 + 0 \times 18$$

$$HG_{biomass,historic,2003} = 770{,}301\,GJ$$

The same calculation procedure is followed for 2001 and 2002 to obtain the results in Figure 14. The heat generated figures in the PDD are slightly different, because the NCV used in the PDD for baseline purposes was 17MJ/kg. Literature describes the NCV for bark as 18 MJ/kg – the higher NCV was used in the calculations for verification.

Figure 14: Historical heat generated from biomass waste and coal

Historical Heat generated from biomass and coal

	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6
	A	B	C	D	E	F
	Quantity of wet biomass burnt	Quantity of dry biomass burnt	Historical Heat generated from biomass	Quantity of coal burnt	Historical Heat generated from coal	Historical annual total heat generation
	Moisture content (MC) = 50%		NCV biomass = 18MJ/dry ton		NCV coal = 27 MJ/ton	
		B = A x MC	C=B x $NCV_{biomass}$	$FC_{i,n}$	E=D x NCV_{coal}	F = C + E
	tons	tons	GJ	tons	GJ	GJ
Year						
(n-1) 2003	85589	42795	770301	48287	1303749	2074050
(n-2) 2002	87178	43589	784602	46864	1265328	2049930
(n-3) 2001	83554	41777	751986	32951	889677	1641663
Average		42720	768963	42701	1152918	1921881

Column F (Increased heat generation in project activity): For year 1, the baseline heat generated in the boiler is calculated as:

$$HG_{PJ,biomass,1} = HG_{PJ,biomass,total,1} - MAX\{HG_{biomass,historic,2003}; HG_{biomass,historic,2002}; HG_{biomass,historic,2001}\}$$

$$HG_{PJ,biomass,1} = 1{,}559{,}9769 - MAX\{751{,}986 ; 784{,}602 ; 770{,}301\}$$

$$HG_{PJ,biomass,1} = 775{,}374\,GJ$$

The same procedure is used to determine the increased heat generated in the boiler for year 2 for a period of 6 months.

Column G (Total heat generated in boiler prior to project implementation): Calculated in the enthalpy worksheet in spreadsheet (Richards Bay emission reductions calculations verification 1.xls).

Column H (Net heat generated in boiler prior to project implementation): Calculated from heat historically generated from coal and waste biomass (bark) in the boiler. Heat generated calculated from quantity of coal/biomass multiplied by the relevant NCV. Refer to Figure 14 above.

Column I
The historical fraction of heat generation with biomass residues can be determined based on the quantities of bark and coal used historically in the boiler(s) at the project site by:

$$\frac{HG_{biomass,historic,n}}{HG_{total,historic,n}} = \frac{\sum BF_{bark,n} \cdot NCV_{bzrk}}{\sum BF_{bark,n} \cdot NCV_{bark} + \sum FC_{coal,n} \cdot NCV_{coal}}$$

For n-3 (refer to Column I): $\frac{HG_{biomass,historic,2001}}{HG_{total,historic,2001}} = \frac{41,777 \times 18}{41,777 \times 18 + 32,951 \times 27} = 0.46$

For n-2 (refer to Column I): $\frac{HG_{biomass,historic,2002}}{HG_{total,historic,2002}} = \frac{43,589 \times 18}{43,589 \times 18 + 46,864 \times 27} = 0.38$

For n-1 (refer to Column I): $\frac{HG_{biomass,historic,2003}}{HG_{total,historic,2003}} = \frac{42,795 \times 18}{42,795 \times 18 + 48,287 \times 27} = 0.37$

Column J
The difference between the total quantity of heat generated from biomass residues in the year 1 ($HG_{PJ,biomass,total,1}$) and the total heat generation during the year 1 ($HG_{PJ,total,1}$) multiplied with the highest historical fraction of heat generation with biomass residues from the most recent three years, as follows (Equation 4 in PDD):

$$HG_{PJ,biomass,1} = 1,559,976 - 1,963,085 \cdot MAX\{0.46;0.38;0.37\}$$

$$HG_{PJ,biomass,1} = 660,758 \quad GJ$$

Column K
The heat generated for year 1 is therefore:

$$HG_{PJ,biomass,1} = MIN\{775,374;660,758\}$$

$$HG_{PJ,biomass,1} = 660,758\, GJ$$

The same procedure is used to calculate the heat generated for year 2 for a 6 month period. This energy value represents the amount of energy as coal that would be burned in the absence of the project activity. To determine the emissions in the baseline from coal combustion the calculation steps as illustrated in Figure 15 are done.

Figure 15: Baseline emissions for coal combustion in the boiler

Baseline emissions from fossil fuel combustion for heat generation in boiler

	Step 1	Step 2		Step 3
	A	B	C	D
	Heat generated with biomass residues as a result of the project activity ($HG_{PJ,biomass,y}$)	CO_2 emission factor for bituminous coal based on LHV	Average net efficiency of heat generation in the boiler(s) when fired with fossil fuels $\eta_{boiler,FF}$	Baseline emissions from fossil fuel combustion for heat generation in the boiler
				D = (A x B) / C
	GJ	t CO_2/GJ	%	$BE_{HG,y} = \frac{HG_{PJ,biomass,y} \times EF_{FF,CO2,i}}{\eta_{boiler,FF}}$
Year				
1	660,758	0.0946	69	91,119
2 (6 months)	319,232	0.0946	69	44,022
Step 4: Total baseline emissions from heat generation (tonnes)				**135,142**

6.2 Baseline emissions due to uncontrolled burning or decay of the biomass residues ($BE_{BF,y}$)

Only the use of biomass residues over and above the historical use levels are attributed to the CDM project activity and are consequently considered for determining the baseline emissions due to the decay of plantation waste. The reason is that biomass residues have already been used for heat generation at the project site prior to the implementation of the project activity and the most plausible baseline scenario is that heat will continue to be generated partly with fossil fuels and partly with biomass residues.

The types of biomass residues differ in the baseline scenario, therefore, the total biomass decay emissions in the baseline scenario consist of emissions from two methodologies:
1) *Uncontrolled burning or aerobic decay of the biomass residues* and
2) *Anaerobic decay of the biomass residues*

$$BE_{BF,y} = BE_{Biomass,burning,y} + BE_{Biomass,anaerobic,y}$$

6.2.1. Plantation biomass residues

The baseline scenario for the use of the plantation biomass residues is that the biomass residues will be left to decay under mainly aerobic conditions. Baseline emissions are calculated for natural decay, and as per the methodology, the emissions are calculated assuming that the biomass residues would be burnt in an uncontrolled manner.

During the verification period, no plantation biomass was collected or transported to the operation. Therefore, for the period that is verified, the calculations result in zero emissions from plantation waste.

Figure 16: Baseline emissions from plantation waste biomass

Baseline emissions from natural decay of plantation biomass	Step 1			Step 2
	A	B	C	D
	Net quantity of dry plantation waste fired in the project activity	CH_4 emission factor for the uncontrolled burning of biomass	Global warming potential for methane	Emissions from natural decay of biomass
		0.0061 t CH_4/t dry biomass used	21	**D = A x B x C**
	$BF_{p,project\ plant,y}$	$EF_{Burning,\ CH4\ y}$	GWP	$BE_{Biomass,\ burning,\ y}$
	Tonne	t CH_4/t dry matter		ton CO2 equiv.
Year				
1	0	0.0061	21	0
2	0	0.0061	21	0

6.2.2. Chipping biomass residues (decay of the biomass residues)

The amount of methane that would be generated each year in the baseline scenario (BE_{BF}) was calculated for each year with a multi-phase model. The model is based on a first order decay equation. The results are indicated in Worksheet T11b BE biomass anaerobic.

Figure 17 reflects the total biomass decay emissions in the baseline for the first two years of the project activity. The total baseline emissions associated with biomass decay are simply the sum of 6.2.1 and 6.2.2 (Refer to Worksheet T10 BE total biomass decay in the spreadsheet).

6.2.3. Total baseline emissions

Total baseline emissions are the total baseline emissions from coal combustion for heat generation in the boiler plus the baseline emissions due to decay of plantation residues and decay of the chipping facility residues/waste. Figure 18 shows the total baseline emissions for the first two years of the project activity.

Figure 17: Summary of total biomass waste decay emissions in the baseline

Summary: Total biomass decay emissions in the baseline	Step 1	Step 2	Step 3
	A	B	C
	Emissions from natural decay of biomass	Emissions from biomass under anaerobic conditions	**Total emissions from waste biomass decay in the baseline**
			C = A + B
	$BE_{Biomass,\ burning,\ y}$	$BE_{Biomass,\ anaerobic,\ y}$	$BE_{BF,y}$
	ton CO_2 equiv.	ton CO_2 equiv.	ton CO_2 equiv.
Year			
1	0	4,866	4,866
2 (6 months)	0	7,056	7,056
	Step 4: Total CO2 emissions		**11,923**

Figure 18: Summary of baseline emissions for the project activity

Summary: Baseline emissions

	Step 1	Step 2	Step 3
	A	B	D
	Emissions from heat generation	Emissions due to methane generation from managed or unmanaged landfill and plantations	**Total baseline emissions**
	$BE_{HG,y}$	$BE_{BF,y}$	BE
	ton CO_2 equiv.	ton CO_2 equiv.	ton CO_2 equiv.
Year			
1	97,965	4,866	102,831
2 (6 months)	46,826	7,056	53,882
		Step 4: CO_2 emissions	**156,713**

Figure 19: Biomass quantities utilised as part of the project activity

Biomass quantities utilised in project activity (wet tons)

	Biomass previously to landfill									
	CTC	SHINCEL	SILVACEL	NSELENI	KWAMBO	PENICUIK	PORTNET	TOTAL biomass prev to landfill	WOOD YARD (additional)	TOTAL biomass from external sources
	wet tons	wet tons	wet tons	wet tons	wet tons	wet tons	wet tons	wet tons	wet tons	wet tons
Year										
1	2437	1798	13347	476	3240	126	510	21934	46439	21934
2	5288	1095	5288	1256	0	-	343	13270	14199	13270
3										
Totals								**35204**	**60638**	

Table 6: Data collection for Baseline emissions

Parameter	Data unit	Description	Year 1	Year 2	Comments
Steam flow	Kg/s	Steam produced by the boiler	15.8	12.9	
Steam temperature	Deg C	Steam temperature	470	470	
Steam pressure	MPa		8.1	8.1	
Feed water flow	Kg/s		15	15	
Feed water temperature	Deg C		115	115	
Condensate return flow	Kg/s	Condensate return is fed back into the feed water. Therefore the figures are zero.	0	0	Data is either measured or design information is used as a conservative approach.
Condensate temperature	Deg C	Condensate return is fed back into the feed water. Therefore the figures are zero.	0	0	
Boiler blow down flow	Kg/s		0.169	0.14	
Boiler blow down temperature	Deg C		298	298	

7 PROJECT ACTIVITY EMISSIONS

7.1 Transport emissions

For the first 18 months of the project, all biomass imported to the operation was transported by one transport company.

Emissions are calculated on the basis of distance traveled and the average truckload (TL) of biomass transported from nearby chipping facilities and plantations. Diesel-fuelled trucks will mostly be used for transportation. The average return trip distance traveled from (for example) SilvaCel was provided by the transport company. The average truckload for biomass from each facility is determined over the period for which the verification is done. By applying equation 14 in the PDD, the transport emissions are determined.

Equations determining the CO_2 emissions associated with transport in the methodology use the CO_2 emission factor in unit kilogram per TJ. 2006 IPCC information for CO_2 emission factors are given in kg per TJ fuel consumed. The emission factor in kg per kilometer traveled is therefore calculated from information provided by IPCC and local information for diesel.

The CO_2 emission factor per kilometer traveled is determined from the energy of the fuel consumed, the fuel density (kg per liter) and calorific value (TJ per kg) and the specific fuel consumption (liter per kilometer). Please refer to the Spreadsheet, worksheet I4 Transport info. The diesel density was obtained from Engen material safety data sheets.

Illustration of CO_2 emission factor (year 1) for transport (kg CO_2 per km)

$$EF_{km,CO2,1} = NCV_{diesel}\left(\frac{TJ}{kg}\right)\times Diesel\ \ density\left(\frac{kg}{l}\right) \times Consumption\left(\frac{liter}{km}\right)\times EF_{IPCC}\left(\frac{kg}{TJ}\right)$$

$$EF_{km,CO2,1} = 4.3E^{-5}\left(\frac{TJ}{kg}\right)\times 0.845\left(\frac{kg}{l}\right) \times 0.53\left(\frac{liter}{km}\right)\times 74100\left(\frac{kg}{TJ}\right)$$

$$EF_{km,CO2,1} = 1.42\left(\frac{kg}{TJ}\right)$$

Figure 20 represents a summary of the total transport emissions associated with the project activity. It can be concluded that the transport emissions are small in comparison with other emissions of the project. This is mainly because the waste biomass are not transported over long distances.

Figure 20: Total transport emissions associated with the project activity

Summary of direct Emissions from Transportation in the project activity

Year	Chipping facilities	Plantations	Other	Total CO_2 emissions from transport activities [PET]
1	14.7	0	1.4	16
2 (6 months)	10.6	0	0.0	11

Total CO_2 emissions from transport in the project activity 27

7.2 CH_4 emissions from biomass combustion

Biomass that is combusted in a boiler emits a small amount of methane emissions.

IPCC default CH_4 emission factor value is applied in calculations. In order to reflect the uncertainty of the CH_4 emission factor and for the purpose of providing conservative estimates of emission reductions, a conservativeness factor must be applied in the calculation. The conservativeness factor depends on the uncertainty range of the estimate for the CH_4 emission factor. The assumed uncertainty for wood waste is 300% and the associated conservativeness factor is therefore chosen as 1.3743. This factor is multiplied with the estimate for the CH_4 emission factor. The CH_4 emission factor of 21.55kg/TJ is used in calculations (Refer to worksheet T14 PA Biomass combustion).

As indicated in the PDD[10], only the additional quantities of biomass and fossil fuels will be considered to calculate the project emissions. The additional biomass is the biomass that is related to the implementation of the CDM project activity.

For illustration, the calculation of methane emissions from biomass combustion for year 1 is demonstrated from equation 16 in the PDD[11], based on additional tonnes of biomass fired in the co-fired boiler for year 1:

Additional biomass waste from nearby facilities (previously landfilled) for year 1: 21,144 dry tons

$$PE_{CH4,BF,1} = 19\left(\frac{GJ}{tonne}\right) \times 21{,}934\left(\frac{tonne}{year}\right) \times \frac{21.55}{10^6}\left(\frac{tonneCH4}{GJ}\right)$$

$$PE_{CH4,BF,1} = 8.6\ tonneCH_4$$

Additional bark from the operation for year 1: 40,709 dry tons

$$PE_{CH4,BF,5} = 18\left(\frac{GJ}{tonne}\right) \times 46{,}439\left(\frac{tonne}{year}\right) \times \frac{21.55}{10^6}\left(\frac{tonneCH4}{GJ}\right)$$

$$PE_{CH4,BF,5} = 19\ tonne\ CH_4$$

7.3 Emissions from imported electricity

The total annual electricity consumption is less than 15 GWh (less than 2.5GWh) for the biomass residues equipment. Therefore, the average grid CO_2e emission factor for the South African grid can be used in calculations to determine indirect CO_2 emissions from the net import of electricity to the wood yard associated with the project activity.

The monitor on the crusher could only be installed in 2007. The approach (as described below) to determine emissions is the conservative approach. The equipment operated 300 hours during the first year and 123 during the second year.

The conservative approach is taken when determining the electricity consumption for equipment installed in the wood yard as a result of the project activity. The Richards Bay operation runs 350 days per year, allowing for an annual maintenance shut of two weeks for all equipment. The equipment related to handling biomass is not critical production related equipment (i.e. this

[10] Under section B6.1.2.3 CH4 emissions from combustion of biomass residues in the boiler(s)
[11] Equation 16 in AM0036

equipment does not impact directly on the final saleable product volumes) and therefore, this equipment typically does not operate a full 350 days per year. It is assumed (conservatively) that the crusher was running at full design capacity (load) for all the hours that it operated. This approach is conservative, as indirect emissions from electricity consumption will be over-estimated, because the equipment will not operate at full load for all hours.

From equation 15 in the PDD[12] based on an on-site consumption of electricity for the new equipment in the project activity (2222 MWh) **in year 1**:

$$PE_{CO2,EC,5} = 2222 \times 0.978$$

$$PE_{CO2.EC.5} = 2173 \quad ton\ CO_2$$

7.4 CO_2 emissions from on-site fossil fuel combustion

According to the methodology, this fossil fuel refers to the quantity of coal that is combusted at the project site for purposes other than heat generation as a result of the project activity during the year y.

$FC_{on\text{-}site,i,y}$ does not include the coal co-fired in the boiler but will include all other fossil fuel consumption at the project site that is attributable to the project activity. The only fossil fuel consumed as a result of the project activity is from on-site transportation of biomass residues. The transport on-site is insignificant compared to the transport occurring off-site (the distances of the wood yard facility is about 400m). Therefore, for this project activity $PE_{CO2,FF,y}$ will mainly be zero.

7.5 Total CO_2 emissions from the project activity

Table 2 in worksheet T2 Project Activity Summary provides a summary of the total emissions from the project activity.

Figure 21: Project emissions

Summary: Projected Project Activity emissions

	Step 1	Step 2	Step 3		Step 4
	A	B	C	D	E
	CO_2 emissions from transport of the biomass to the project plant	CO_2 equivalent emissions from the onsite consumption of electricity	CH_4 emissions from the combustion of biomass	$GWP_{CH4} = 21$	**Total CO_2 emissions [PEy]**
	$PE_{CO2,TR,y}$	$PE_{CO2,EC,y}$	$PE_{CH4,BF,y}$	$D = C \times GWP_{CH4}$	$E = A + B + D$
	ton CO_2 equiv.	ton CO_2 equiv.	ton CH_4	ton CO_2 equiv.	ton CO_2 equiv.
Year					
1	16	2,173	18	380	2,570
2 (6 months)	11	891	8	162	1,064
				Step 5: Total Project Activity CO_2 emissions	**3,633**

[12] Equation 12 in AM0036

8 LEAKAGE

The main source of potential leakage is that the project diverts biomass from other users and thereby increases fossil fuel use in the surrounding area. This project utilizes biomass *residues* and therefore, changes in carbon stocks in the LULUCF[13] sector are expected to be insignificant.

No leakage was anticipated as a result of the project activity. The project does not quantify any leakage effect related to biomass availability, because there is enough biomass available to satisfy all the requirements of different consumers. This is principally guaranteed by the provision of Mondi's own biomass, and especially, by additional biomass sources from thinning, pruning and harvesting operations of the plantation industry.

Utilization of the biomass residues does not result in increased fossil fuel consumption elsewhere. To this effect, the suppliers of biomass waste were contacted (as described in leakage parameters L1 to L4) and it was confirmed that:

- Suppliers of the biomass residues do not have a feasible alternative market for their biomass residues.
- At plantation sites from which biomass residues will be supplied, the biomass residues are not collected or utilized (e.g. as energy carrier, fertilizer or feedstock), but is left for decay prior to the implementation of the project activity. This practice will continue in the absence of the CDM project activity, because of the extent of logistics involved in collecting and transporting the biomass waste for any other use.

It is clear that the use of the biomass residues does not result in increased fossil fuel consumption elsewhere.

9 TOTAL EMISSION REDUCTIONS

The total emission reductions are demonstrated in the following figure:

Figure 22: Total emission reductions for 18 months

Summary of emissions: Baseline, Project Activity and Leakage

	Step 1				Step 2
	A	B	C	D	E
	Estimation of projected project activity emissions	Projected baseline emissions for natural decay of biomass in plantations and landfill	Baseline emissions from fossil fuel combustion for heat generation in the boiler	Estimation of projected leakage emissions	Estimation of projected emission reductions
	PE_y	$BE_{BF,y}$	$BE_{HG,y}$	LEy	ER_y
					D = B + C - A - D
	ton CO_2 equiv.	ton CO_2 equiv.		ton CO_2 equiv.	ton CO_2 equiv.
Year					
1	2,570	4,866	97,965	0	100,262
2 (6 months)	1,064	7,056	46,826	0	52,818
				Step 3: Total CO2 emission reductions	**153,080**

[13] Land use and land use change

10 SUSTAINABLE DEVELOPMENT AND ENVIRONMENTAL IMPACT

The project contributes to sustainable development in South Africa in a number of ways:

- The use of renewable energy is in line with the targets set by the national government (Department of Minerals and Energy) to increase the use of biomass as energy source in South Africa[14].
- The boiler emissions comply with relevant legislation (the relevant legislation is mainly related to air quality[15]).
- Introduction of the hogging equipment provides South Africa with the opportunity to gain access to a technology that has not been used in the region on this scale before. Opportunity to transfer knowledge and experience gained at the Richards Bay operation will benefit a wider range of industry in South Africa.
- The project activity is introducing a new idea - the collection of a variety of plantation residue and utilisation of this residue for energy purposes. Once the plantation phase is implemented successfully, the knowledge and experience can be transferred to other regions in South Africa.
- Energy efficiency improvement and the use of renewable energy reduce the use of fossil fuels, contributing to the sustainable use of natural resources.

10.1 Environmental Impact of the project activity

1. The use of biomass residue rather than coal as a fuel has local environmental benefits in that there is a reduction in the emissions of SO_2 and NOx, thereby improving the local air quality in Richards Bay.
2. Furthermore, the project accomplishes an additional greenhouse (GHG) reduction benefit derived from a reduced disposal of biomass residue to landfill, that results in less methane emissions from landfill in the Richards Bay area.
3. The project reduces methane emissions that are formed in plantations as a result of natural decay of plantation residues.
4. There is a reduction of solid waste to landfill in the local area as a result of the project.
5. Implementation of the final phase of the project (collecting plantation residue from plantations) will provide the opportunity to employ approximately 40 people, ranging from unskilled to semiskilled and skilled. Also, a small increase in employment will occur during the construction and commissioning phases of the equipment, and in the supply of the additional transport needs. This will occur specifically in the small to medium sized enterprises (SMME).

[14] White Paper on Renewable Energy (2003): http://www.dme.gov.za/energy/renewable.stm, October 2006

[15] The boiler emissions comply with existing air quality permit requirements. Permit: Registration in terms of the Atmospheric Pollution Prevention Act, Act 45 of 1965, 1382/4. 16 February 2004

Figure 23: Example of a nearby chipping facility