35 MW Bagasse Based Cogeneration Project

By

Mumias Sugar Company Limited (MSCL)

UNFCCC Clean Development Mechanism
Project Design Document

Version 13, 28th January 13

CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-PDD)
Version 03 - in effect as of: 28 July 2006

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Annexes

SECTION A. General description of project activity

A.1 Title of the project activity:

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“35 MW Bagasse Based Cogeneration Project” by Mumias Sugar Company Limited (MSCL)
Version 13
Date of document: 28/01/ 2013.

A.2. Description of the project activity:

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The objective of the project is to satisfy the ever increasing demand for electricity in Kenya with a clean alternative to the more fossil-fuel based electricity component of the Kenyan national grid. The project will generate 35 MW of electricity with 10 MW internal consumption[1] by the factory and 25 MW export to the national grid.

The proposed Clean Development Mechanism (CDM) project, (35 MW Bagasse Based Cogeneration Project by Mumias Sugar Company Limited), is a power capacity expansion project involving the generation of electricity using sugarcane bagasse on site and consisting of the following activities:

- Interim installation of a 5 MVA transformer on the power export line to the Kenya Power & Lighting Company (KPLC) to facilitate 24 hour-a-day transportation of 2 MW up to commissioning (not included in the emission reduction calculations)[2].
- Installation of 1 new 170 t/hr high pressure (87 barg) steam boiler at MSC Limited.
- Installation of a 34.2 MW condensing extraction turbine alternator at MSC Limited.
- Decommissioning of four 22 t/h and two 55t/h bagasse fired steam boilers.

The technology to be employed for the Mumias Cogeneration Project will be based on conventional steam power cycle involving direct combustion of biomass (bagasse) in a boiler to raise steam, which is then expanded through a condensing extraction turbine to generate electricity. Some of the steam generated will be used in the sugar plant processes and equipment, while the power generated will be used internally by the company and the excess (25 MW) will be exported to the national grid. With the implementation of this project, the power house will consist of 2 boilers and 4 turbo alternators as shown on Table 1.B below. The new 25 MW turbine and the existing 7 MW will always be run while the existing two 2.5 MW turbines will be run only on need basis as determined by the internal power demand to ensure the 25 MW export to the national grid. A total effective generation capacity of the new configuration is assumed to be 35 MW due to the age and current performance of the two 2.5 MW turbines.

[1] The internal consumption is based on historical internal power consumption by the company over the last 3 years. 10 MW is conservatively on the high side, but the average lies between 8 MW to 9 MW. The internal consumption is measured using energy metres and calculated based on the generation data. (See Table 2).

[2] CERS from this path are not considered because they are generated before the project is registered as a CDM project. Installation of the transformer is and temporary measure and is necessary to facilitate the continuous export of 2 MW to the national grid during the project construction period. Currently, capacity exists to generate the 2 MW which cannot be exported on a continuous 24 hour basis due to limitations of the existing transformer. The transformer will be replaced by a bigger one that can take the 25 MW export. The cost of installing the interim transformer and the new 25 MVA transformer is to be borne by Mumias Sugar Company.

By retaining the two 2.5 MW turbines, Mumias Sugar Company Limited will ensure capacity to generate at least 35 MW. The 1.25 MW and 1.75 MW turbines will be decommissioned during the project. The present cogeneration configuration at Mumias Sugar Company is shown in Table 1.A below.

Table 1.A: EXISTING BOILERS AND TURBINE GENERATORS AT MSC

Boilers[3]					Installed Turbine Generators			
Steam Capacity (T/hr)	**Number of Units**	**Pressure (Barg)**	**Steam Temp (^oC)**	**Age* (Years)**	**Installed Configuration (MW)**	**Number of Units**	**Total Capacity (MW)**	**Age* (Years)**
110	1	21	380	10	7[4]	1	7	10
55	2	21	380	27	2.5	2	5	15
22	4	21	283	33	1.25	1	1.25	22
					1.75	1	1.75	22
308	**7**					**5**	**15[5]**	

* Although the design life of these boilers and turbines are 10-15 years, most of these boilers have been operated way above this due to absence of incentives to upgrade or replace.

Table 1.B: PROPOSED BOILERS AND TURBINE GENERATORS AT MSC

Boilers					Installed Turbine Generators			
Steam Capacity (T/hr)	**Number of Units**	**Pressure (Barg)**	**Steam Temp (^{o} C)**	**Age (Years)**	**Proposed Configuration (MW)**	**Number of Units**	**Total Capacity (MW)**	**Age (Years)**
110[6]	1	21	380	10	7	1	7	10
170	1	87	525	New	34.2	1	34.2	New
280	**2**					**2**	**41.2[7]**	

Table 2: POWER GENERATION AND CONSUMTION TRENDS IN MUMIAS (MWh)

Year				
Turbo Alternators	56,505.70	62,702.37	65,172.77	**184,380.84**
Diesel Alternators	142.47	68.14	421.81	**632.42**
KPLC Import	2,922.36	1,579.40	1,758.70	**6,260.46**
KPLC Export			4,591.54	
Total				**191,273.72**
Yearly Average Consumption				**63,757.91**
Year Average Power (MW) over 300 days (7,200 hrs)				

[3] All the existing boilers are bagasse fired.

[4] This back pressure turbine generator is the only reliable generator at MSC currently.

[5] Effective capacity is 13.6 MW due to the inefficiency of the existing old turbines.

[6] This boiler is to be retained

[7] Effective capacity is taken as 35 MW because of the age and current performance of the two 2.5 MW turbines.

Immediately after commissioning of the project, MSC will start a second project phase involving energy efficiency improvement where all the current steam turbine drives in the factory will be replaced by electric motors and the old 110 t/hr retained steam boilers will be refurbished and economisers fitted. This is expected to result in another 20 MW export of power to the national grid[8]. The sugar factory operates for 300 days (11 months and 1 week) with 2 days of maintenance shutdown each month. The annual maintenance shut down is conducted during the long rainy season (March to May). The annual maintenance is carried out over a 3 week period, when cane deliveries are low but when there is plenty of hydroelectric power since the dams are usually full then. The proposed project, which is planned to operate for at least the same number of days as the sugar mill but could run for a longer time, depending on bagasse availability after the sugar factory shutdown therefore, complements the existing renewable component of the grid during the dry season when the proportion of the fossil fuel-based thermal power in the grid generally increases. All bagasse generated will be used to produce steam and generate power, even when the sugar factory is down.

Mumias Sugar Company Limited crushed 2,443,298.62 tonnes of cane in 2005/2006 and is expected to crush similar quantities in 2006/2007 based on the quantities crushed so far and the projections for the remaining months of the year. Of the total cane crushed in 2005/2006, existing data indicate that 37% is bagasse yield which is equivalent to 938,227.00 tonnes of bagasse (see Table 3 below). The same data shows that for each tonne of sugarcane crushed, 0.27 tonnes of bagasse is used to produce process energy (steam and electricity[9]). The amount of bagasse generated is calculated from the cane equation:

Cane + Water = Mixed Juice + Bagasse.

This leaves a surplus of 244,329.00 tonnes of bagasse for the period 2005/2006, and it is this amount which is transported by company trucks and dumped (see Plates 1 to 8 below) in the plantations to decompose with significant methane emissions. Usually the bagasse is dumped in areas where soil has been excavated for road maintenance and covered with soil or are spread in areas where sugar cane is not grown within the nucleus plantation. Once a dumpsite is filled, a new dumpsite is created and there are no fixed dumpsites. The heights of the dumping also vary from site to site and there are some above 5metres height while others are below.

Table 3: SUGARCANE CRUSHING AND BAGASSE UTILISATION TRENDS (TONNES) FOR THE LAST 3 YEARS (2003 TO 2006)

Year	Sugarcane Crushed	Wet Bagasse Produced	Wet Bagasse Utilised	Wet Bagasse Dumped
2003/4	2290427	857994	602039	255955
2004/5	2339954	881695	626640	255055
2005/6	2443299	938227	693898	244329
Total	**7073680**	**2677916**	**1922577**	**755339**
Average 3 yr	2357893	892638	640859	251780

[8] This second phase of the project will be the subject of another PDD.

[9] The quantity of bagasse combusted in the boilers in the baseline is determined by using the standard cane equation, MSC laboratory analysis results, sucrose and mass balance together with plant test runs and measurement of bagasse dumped.

The following plates (1 to 8) show sampled actual bagasse dumpsites used by MSC. Some of the sites are excavated sites with up to 10 meter depths while some are on the ground level. This spread is however random and there is no system used in deciding where to dump. Aerobic decomposition and/or uncontrolled burning conditions have therefore been assumed for determination of the methane abated by the proposed project.

PLATE 1 TO 8 SHOWING TRANSPORTATION AND DUMPING SITES OF BAGASSE


Plate 1

Plate 2


Plate 3

Plate 4


Plate 5 Plate 6


Plate 7 Plate 8

The project will therefore reduce GHG emissions directly from the following sources:

- Displacing grid electricity with GHG-neutral biomass (bagasse) electricity generation. This component of the project activity is expected to achieve GHG emission reductions of **1245652 t CO_2e** over the 10 year period (2008-2018).
- Methane abatement through avoidance of dumping of bagasse and instead using it to generate electricity which is expected to achieve GHG emission reductions of **50262 tCO_2e** over the 10 year period.

The overall GHG emission reductions expected from the project is therefore **1295914 tCO_2e** over the period (2008-2018).

The project will play an important role on the country's economic development, as more power will be available for use to offset the deficit of power supply in the country. The provision of renewable electricity is a major factor contributing to sustainable development. Rural electrification which could result from this project would have far reaching impacts on livelihoods in the rural community where the factory is located and where more jobs would be created.

The Kenyan grid generally is in a deficit situation, especially during the dry periods when thermal plants are used to fill in, with some power rationing as was the case in 2000, 2004/5 and expected in 2006[10] *(See Annex 3: Baseline Information)*. A more stable, renewable and local supply of electricity should permit displacement of carbon-intensive power generation and/or expansion which is not only adversely affecting the environmental but also expensive and slows down overall economic growth in Kenya. The energy sources for the country would be more diversified and secured by the domestic energy supply.

In addition, the project will save the country significant foreign exchange that would have been used for the importation of fossil fuels for the thermal plants which are used to address marginal power shortfalls. The savings can then be channeled to other more useful economic activities leading to economic growth of the country. The project will make positive contribution to the country's implementation of its energy strategy which aims to reduce energy from thermal sources and increase energy from renewable sources.

The country now relies on hydro and fossil fuel based electricity, which are sometimes affected by rainfall patterns and erratic fuel price fluctuations, respectively and the project will stabilize the supply of renewable energy during dry seasons and irrespective of fossil fuel prices (See Annex 3).

The creation of a more viable agricultural sector is crucial to the development of the Kenyan economy and the maintenance of livelihoods where over 70% of the population lives in the rural areas AND agriculture is the main source of employment. Agriculture also contributes significantly to the country's GDP. The CDM project will provide sustainable benefits through the diversification of revenue streams where the farmer will not only be producing sugar cane for sugar production and get sucrose content compensation, but also electricity and CERs which will be able to attract a fibre content compensation[11] for the farmer.

The environmental benefits do not only include GHG emission reductions, but also reduced steam generation with higher efficiency resulting in twice the amount of power generated. The project design will also eliminate the occasional current release of ash and related-carbon particles into River Nzoia which supports many local livelihoods in the area. The elimination of particulate matter in the boiler exhaust, which will be fitted with an electrostatic precipitator under the project, will result in improved air quality in the area.

The implementation of the project will offer local people skills in high pressure cogeneration technology and will act as a clean technology demonstration for the other local sugar companies[12].

[10] In August 2006, Kenya commissioned a 100 MW fossil-fuel based thermal plant in Nairobi to offset the deficit being created as a result of low water levels in the main hydro-electricity dam under a contract with Aggreko. This has significantly reduced the hydro component of the total electricity to the grid with a corresponding increase in thermal component.

[11] Fibre content compensation is the additional payment made to the farmer per tonne of cane delivered based on the fibre content of the cane. Currently, farmers are paid based on the sucrose content of the cane only.

[12] Currently, all the sugar companies in Kenya use low pressure (21 barg maximum) cogeneration technology

The sale of the CER generated by the project will boost the financial viability of the project.[13] The company will therefore be able to pay farmers even earlier and better prices. This will enable the company to continue providing sustainable development to the rural economy and the country as a whole.

A.3. Project participants:

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Table 4: Project Participants

Please list project participants and Party(ies) involved and provide contact information in Annex 1. Information shall be in indicated using the following tabular format.		
Name of Party involved (*) ((host) indicates a host Party)	**Private and/or public entity(ies) project participants (*) (as applicable)**	**Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)**
Kenya (host)	Mumias Sugar Company Limited	No
Japan	Japan Carbon Finance Limited	No

Host Country: The host country is Kenya and the Designated National Authority is the National Environment Management Authority (NEMA). The Government of Kenya ratified the Kyoto Protocol in February 2006.

Project Sponsor: Mumias Sugar Company (MSC) Limited is the Project Sponsor and operator of the project. MSCL is a public liability company listed in the Nairobi Stock Exchange since 2001. MSC is funding the registration process.

Purchasing Party: The Japan Carbon Fund (JCF) is purchasing the Emission Reductions (ERs) arising from the Project Activity. In addition, some of the CDM transaction costs (PIN and PDD preparation, validation) have been funded by JFC.

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

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A.4.1.1. Host Party(ies):

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Kenya

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

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Western Province

[13] The Kenya Power and Lighting Company, which is the national power purchaser and distributor pays less per kilowatt hour for energy generated from renewable sources as compared to power from thermal sources.

A.4.1.3. City/Town/Community etc:

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Butere – Mumias District

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

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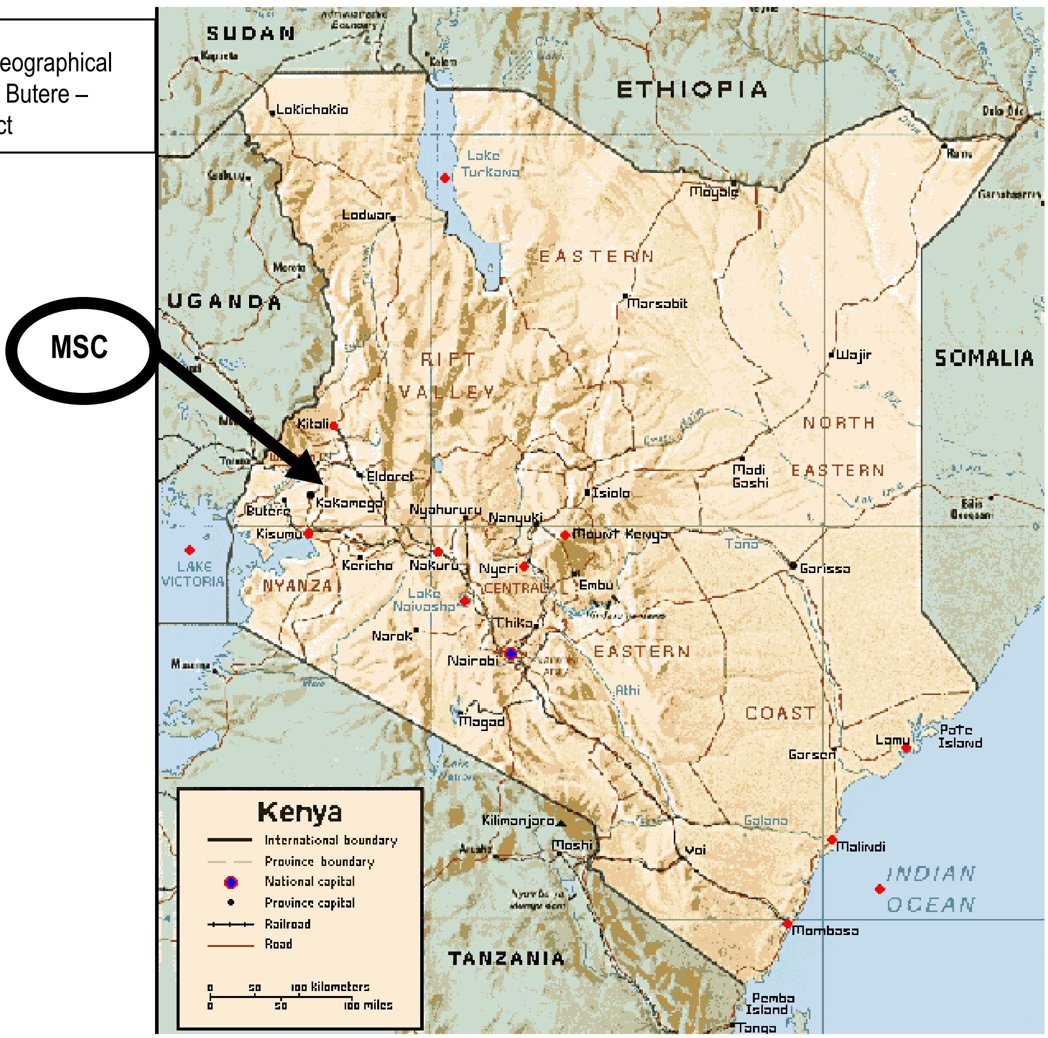
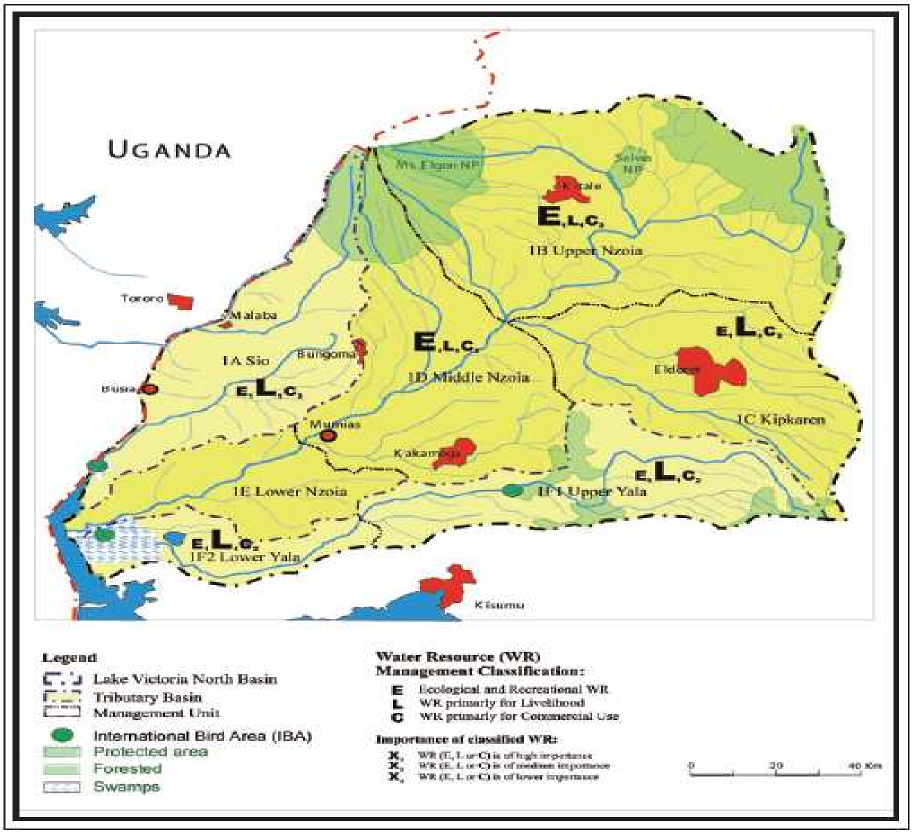
The company is located in Butere-Mumias District (350 km from Nairobi) along the Kakamega Bungoma Road, 38 kilometres west of Kakamega town and 23 kilometres south of Bungoma town at the Busia Junction on plot No. FR/257/12 with a total area of 4,295 hectares (See Figures 1A and 1B below).

The exact location of the sugar factory is $0^{0}21.792'N34^{0}30.25'E$.

Figure 1 A: Geographical position of the Butere – Mumias District





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

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Electricity generation by renewable sources

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

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The cogeneration project activity is based on conventional steam power cycle involving direct combustion of biomass (bagasse) in a boiler to raise steam, which is then expanded through a turbine to generate electricity. The plant comprises of a new 170 t/hr at 87 barg and 525 ^{0}C in combination with the existing 110 t/hr low pressure (21 barg) steam boiler (See Tables 1A and 1B above). The new configuration consists of 4 turbines (one new double condensing extraction turbine of 34.2 MW MW in combination with the existing 7 MW and two 2.5 MW back pressure turbines). The new 34.2 MW turbine and the existing 7 MW will always be run while the existing two 2.5 MW turbines will be run only on need basis as determined by the internal power demand to ensure the required export to the national grid. A total effective generation capacity of the new configuration is assumed to be 35 MW due to the age and current performance of the two 2.5 MW turbines. The steam extracted from the turbines is used in the sugar production processes.

The tender for the Engineering and Construction has been awarded to **Avant Garde Engineers and Consultants (P) Limited of India** and the construction of the project is expected to start by June 2007.

Requests for quotations for the supply of the boiler and turbine alternator has being sent out to companies in France, USA, India, Japan, China, Czech Republic, United Kingdom and South Africa. Other accessories for the project will be sourced world wide. The project is expected to be commissioned around mid 2008.

The steam cycle plant will be located within the factory where the exhaust from the steam turbine is recovered and used for meeting industrial process steam and heat needs. The technology combines heat and power (cogeneration) systems with greater levels of energy services per unit of biomass (bagasse) consumed than systems that generate power only. For Mumias Sugar Company, steam recovery will not be of much value as the factory will not need additional steam for efficiency improvement[14], instead, the project is aimed at utilizing excess bagasse which is not utilized (dumped in the nucleus estate) at the moment, and boiler efficiency improvement to generate electricity which will be exported to the national electricity grid.

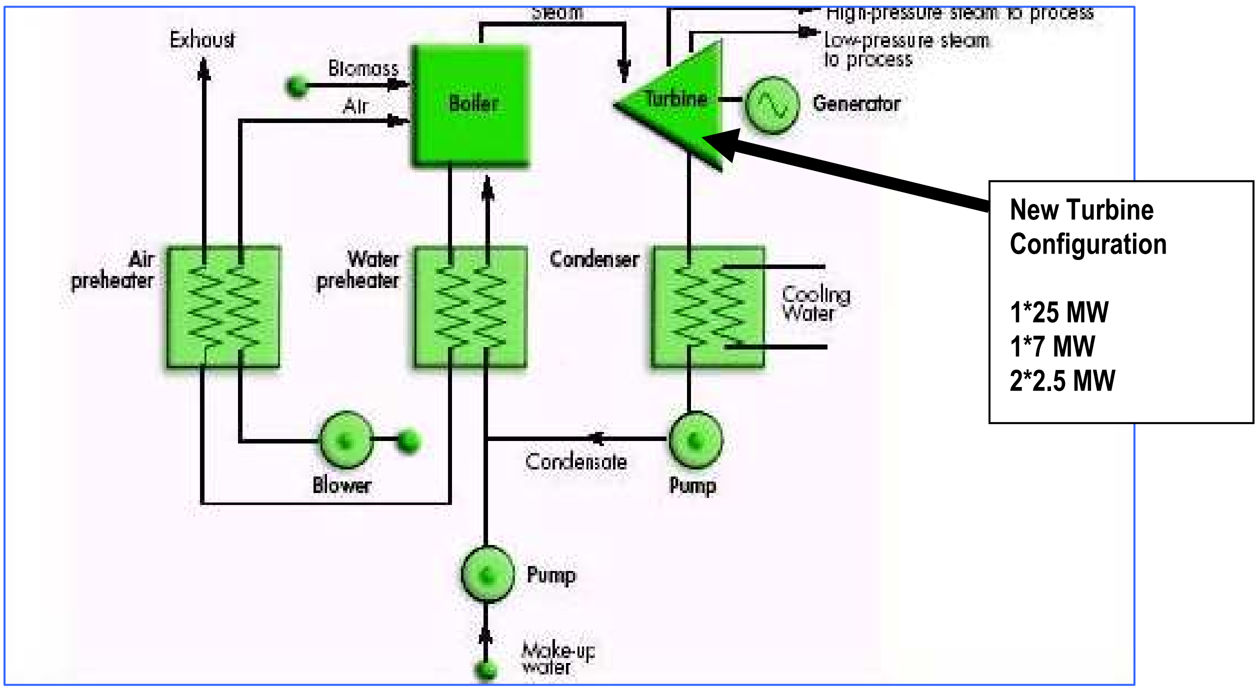

Figure 2: SCHEMATIC DIAGRAM OF A BIOMASS-FIRED STEAM-RANKINE CYCLE FOR COGENERATION USING A CONDENSING EXTRACTION STEAM TURBINE

The technology involves generation of high pressure steam from pressurized water, with the resulting steam expanding to drive a turbo-generator, and then condensing back to water for partial or full recycling to the boiler. A heat exchanger is used to recover heat from flue gases to preheat combustion air, and a deaerator is used to remove dissolved oxygen from water before it enters the boiler.

[14] Implementation of the CDM project will not lead to increased cane processing capacity. As such, the steam requirements for cane processing will not increase from the average current levels. Although there will be an increase in steam generation, the steam will only be used for electricity production purposes. Therefore, CERs from heat production has not been considered in this PDD.

An electrostatic precipitator is installed to remove the particulate matter in the boiler flue gases while a dry ash extraction system is used to remove the ash generated from the combustion. This is an improvement from the current wet ash system which results in some of the carbon and other compounds in the ash being discharged into the Nzoia River. The ash is usually used for soil condition and pH correction in the plantations.

The technology used is safe, environmentally friendly and proven. However, the application of very high pressure (87 barg) and temperature (525^{0}C) in the sugar industry is not only new in Kenya but also in the whole East African Region and currently, there is no sugar company in Kenya or East Africa that is using the high steam pressure technology to generate electricity for export to the grid.. The successful completion of this project activity is likely to contribute to the adoption of similar cogeneration technologies by firms in the sugar and other industry sectors in Kenya.

Currently, MSC staff have experience operating 21barg pressure, 380^{0}C temperature boilers but will require training on the operation and maintenance of the 87barg pressure, 525^{0}C temperature boiler. The training schedule will be developed during project construction. In addition, the staff to be trained and the training needs will be identified at that point. Initially, an international maintenance contract will be issued to a competent firm to assist and advise on the required maintenance and how it is to be done as part of the training program.

A.4.4 Estimated amount of emission reductions over the chosen crediting period:

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Table 5: ESTIMATED ANNUAL EMISSION REDUCTIONS

Please indicate the chosen crediting period and provide the total estimation of emission reductions as well as annual estimates for the chosen crediting period. Information on the emission reductions shal indicated using the following tabular format.

Years	**Annual estimation of emission reduction in tonnes of CO_2 e**
2008	32478
2009	129627
2010	129627
2011	129627
2012	129627
2013	129627
2014	129627
2015	129627
2016	129627
2017	129627
2018	96795
Total estimated reductions (tonnes of CO_2 e)	**1,295,914**
Total number of crediting years	10
Annual average over the crediting perioc estimated reductions (tonnes of CO_2 e)	129591

A.4.5. Public funding of the project activity:

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There will be no public funding for the proposed project. Mumias Sugar Company Limited (MSC) is a limited liability company in Kenya which has been listed in the Nairobi Stock Exchange since late 2001. The company is funding this project through equity and commercial loans. All the CDM project transaction costs have been funded by Japan Carbon Finance.

SECTION B. Application of a baseline and monitoring methodology

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

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Grid-connected electricity generation from biomass residues. The applicable methodology is the Consolidated Baseline Methodology for Grid-connected Electricity Generation from Biomass Residues-ACM0006; Version 04; of the Approved Baseline and Monitoring Methodologies.

The monitoring methodology is applied in reference to approved monitoring methodology ACM0002; Version 6 (Approved Consolidated Baseline Methodology for Grid-connected Electricity Generation from Renewable Sources) which is the baseline methodology applied to this project.

The methodology applied also draws upon the Tool for the Demonstration and Assessment of Additionality; Version 03.

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

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This methodology is applicable to grid-connected and biomass residue fired electricity generation project activities, including cogeneration plants. The project activity may include:

- The installation of a new biomass residue fired power generation plant, at a site which currently no power generation occurs (**Greenfield power projects**);
- The installation of a new biomass residue fired power generation unit, which replaces or is operated next to existing power generation capacity fired with either fossil fuels or the same type of biomass residue as in the project plant (**power capacity expansion projects**);
- The improvement of energy efficiency of an existing power generation plant (**energy efficiency improvement projects**), e.g. by retrofitting the existing plant or by installing a new plant that replaces the existing plant;
- The replacement of fossil fuels by biomass residues in an existing power plant (**fuel switch projects**).

Specifically, the project activity involves the installation of a new cogeneration unit, which is operated next to existing bagasse power generation units. The existing units are only fired with bagasse and continue to operate in the same manner after installation of the new power unit which will also be bagasse fired. Therefore the MSC cogeneration project is a **power capacity expansion project**.

The power generated by the project plant would in the absence of the project activity be generated mostly in power plants in the grid and to a small extent be generated in the existing power plants within the sugar factory. The biomass would in the absence of the project activity partly be used for heat generation in boilers at the project site and, in addition, partly be used in the existing power plant and surplus be dumped or left to decay under both aerobic and anaerobic conditions, depending on the dumpsite or with some burning in an uncontrolled manner without utilizing it for energy purposes (see plate 1 to 8 above).

Even though some of the bagasse heaps are higher than 5 meters and anaerobic decomposition would be applicable, due to the randomness of the occurrence and for conservativeness, aerobic conditions have been assumed in the calculations of CERs.

In view of the aforesaid, under ACM0006 version 4, scenario 16 therefore applies and this methodology is applicable to this project.

ACM0006 version 4 lists five conditions of applicability for applying the methodology to project activities. The conditions and how they are fully met by this project are listed below.

1. No other biomass types other than biomass residues (bagasse) are used in the project plant, and these biomass residues are the predominant fuel used in the project plant. Bagasse will be the predominant fuel in the proposed project. Currently Mumias Sugar mill produces an average of 892639 tonnes of bagasse annually. Out of this, an average of 640859 tonnes is used for steam production while the remaining 251780 tonnes on average are dumped in the company nucleus estate (see Table 3 above). Some 5-10 tonnes fossil fuel will be used for start ups annually. To calculate the project emissions, a conservative amount of 10 tonnes per year of fossil fuel has been assumed.
2. For projects that use biomass residues from a production process such as the production of sugar, the implementation of the project shall not result in an increase of the processing capacity of raw input, in this case sugarcane processed which will be averagely 2357893 tonnes per year before and after the project. The implementation will not result in any other substantial changes in the process. With the implementation of the project, some boilers will be decommissioned (see table 1A and 1B above) at the same time a new boiler will be installed. This will lead to increased bagasse consumption for steam production. Once the project is implemented, the project will utilize all the bagasse generated. Based on the above, the implementation of the project will not increase the processing capacity of the sugar mill or sugarcane production in the area.
3. The bagasse used by the project will not be stored for more than one year. Of the total 892639 tonnes of bagasse produced annually, about 640859 tonnes is fed into the boilers for steam and power production. Since the bagasse production exceeds use, the surplus 251780 tonnes per year is dumped in the nucleus estate (see table 3 above). After implementation of the project, the new boiler will be able to consume all the bagasse generated and there will be no storage.
4. No significant energy quantities, including from transportation of the bagasse, are required to prepare the bagasse residues for fuel combustion. The bagasse comes out of the diffusers dry enough to be used directly in the boilers. There is no significant transportation as the bagasse boiler will be sited within the sugar mill.

Therefore, the methodology ACM0006 version 4 used is applicable for the proposed project activity.

B.3. Description of the sources and gases included in the project boundary

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The electricity will be generated at 11KV in the new system and transmitted via a transformer into the national grid system. The interim 5MVA transformer which is already installed will be replaced with a 25 MVA transformer. The national grid was chosen as the project boundary because Kenya has only one grid system and the GHG resources included are listed in the following Table 6.

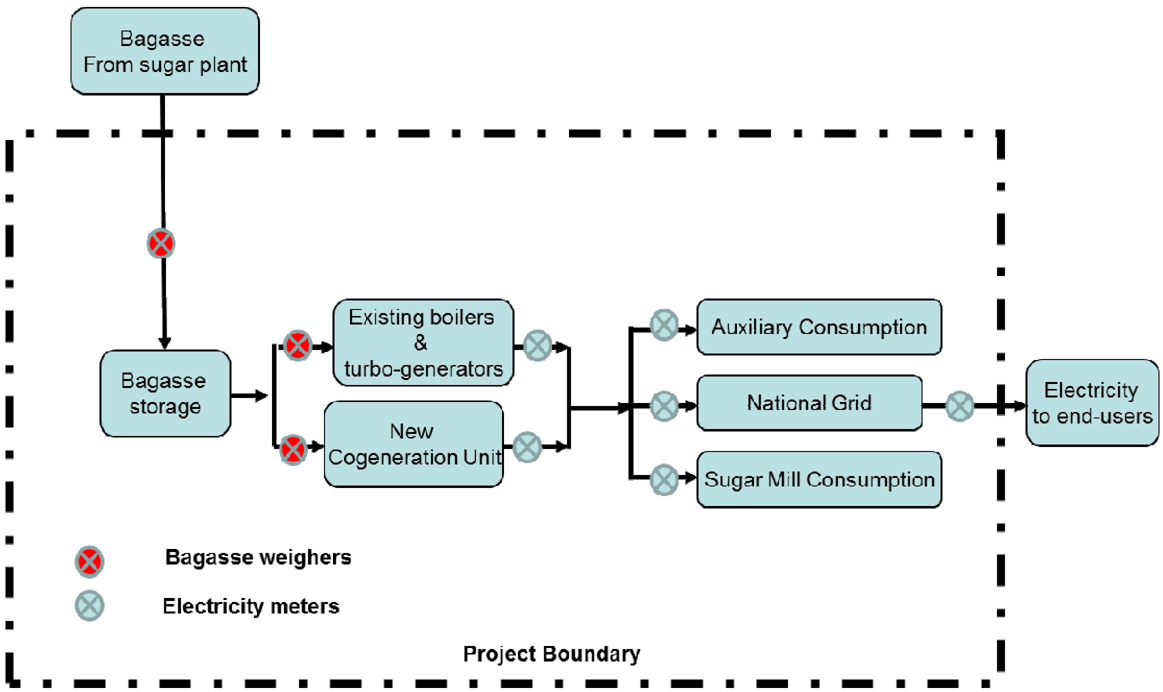
Table 6: OVERVIEW OF EMISSION SOURCES INCLUDED OR EXCLUDED IN THE/ FROM THE PROJECT BOUNDARY

	Source	Gas	Included?	Justification / Explanation
Baseline	Grid electricity generation	CO_2	Included	Main emission source.
		CH_4	Excluded	Excluded for simplification. This is conservative
		N_2O	Excluded	Excluded for simplification. This is conservative
	Heat generation	CO_2	Included	Main emission source
		CH_4	Excluded	Excluded for simplification. This is conservative
		N_2O	Excluded	Excluded for simplification. This is conservative
	Uncontrolled burning or decay of surplus biomass	CO_2	Excluded	It is assumed that CO_2 emissions from surplus residues do not lead to changes of carbon pools in the LULUCF sector.
		CH_4	Included	Emission source from decay (Refer also Plates 1-8 above).
		N_2O	Excluded	Excluded for simplification. This is conservative
Project Activity	Combustion of biomass in the boilers for electricity and heat generation	CO_2	Excluded	It is assumed that CO_2 emissions from surplus residues do not lead to changes of carbon pools in the LULUCF sector.
		CH_4	Included	Included. Combustion of biomass in boilers releases methane in the process.
		N_2O	Excluded	Excluded for simplification. This is conservative
	Off-site transportation of biomass residues	CO_2	Excluded	Excluded for simplification. This emission source is assumed to be very small since there is no off-site transportation.
		CH_4	Excluded	Excluded for simplification. This emission source is assumed to be very small.
		N_2O	Excluded	Excluded for simplification. This emission source is assumed to be very small.
	On-site fossil fuel consumption due to project activity	CO_2	Included	May be an important emission source
		CH_4	Excluded	Excluded for simplification. This emissions source is assumed to be very small
		N_2O	Excluded	Excluded for simplification. This emissions source is assumed to be very small
	Biomass storage	CO_2	Excluded	That CO_2 emission from surplus residues do not lead to changes of carbon pools in the LULUCF sector.
		CH_4	Excluded	Excluded for simplification. Biomass is stored for less than one year, this emission is assumed to be very small
		N_2O	Excluded	Excluded for simplification. This emissions source is assumed to be very small

The **spatial extent** of the project boundary encompasses the following:

- The power plant at the project site
- The means for transportation of bagasse if this was the case. For the MSC project, both the power plant and the sugar mill where the bagasse is produced are on the same site and transportation is therefore negligible.
- The national grid system where all power plants are connected physically to the electricity system that the CDM project power plant is connected to.
- The dump sites where the bagasse residues from MSC would have been left for decay or dumped. This is applicable because the bagasse would in the absence of the project activity be dumped or left to decay on the sites.

The project boundary is shown pictorially below.



Project Boundary

B.4. Description of how the baseline scenario is identified and description of the identified baseline scenario:

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The methodology lists all of the alternatives(s) for power generation, heat generation, and the use of biomass. The determination of the baseline scenario requires that the most conservative baseline is considered.

The starting date of the proposed project was June 2006 and the completion of the project is June 2008. Therefore, its crediting period will not start before the registration of the project activity.

For power generation, the realistic and credible alternatives may include, inter alia:

P1: The proposed project activity not undertaken as a CDM project activity, P2: The proposed project activity (installation of a power plant), fired with the same type of biomass but with a lower efficiency of electrical generation (e.g. an efficiency that is common practice in the relevant industry sector),

P3: The generation of power in an existing plant, on-site or nearby the project site, using only fossil fuels

P4: The generation of power in existing and/or new grid-connected power plants,

P5: The continuation of power generation in an existing power plant, fired with the same type of biomass as (co-fired in the project activity, and implementation of the project activity, not undertaken as a CDM project activity, at the end of the lifetime of the existing plant,

P6: The continuation of power generation in an existing power plant, fired with the same type of biomass as (co-fired in the project activity and, at the end of the lifetime of the existing plant, replacement of that plant by a similar new plant.

The new power plant is not a replacement of the existing power generating plants and is additional to the power plants using bagasse. Baselines P5 and P6 are therefore ruled out. P3 may be ruled out as setting up a similar fossil fuel power plant to supply the grid is not feasible given the core business of MSC and the scale of the plant. P1 is not a credible baseline as without registration of the project as a CDM it would not occur, as demonstrated in section B3. P2 is not a credible baseline as this represents the status quo and there is no additional electricity requirement for the plant. The credible power baseline is therefore P4 which entails the generation of power in existing and/or new grid-connected power plants.

The proposed project activity is the cogeneration of power and heat, so the most plausible baseline scenario for the generation of heat must be defined even though, emissions reductions for heat generation will not be claimed. For heat generation, realistic and credible alternative(s) may include, inter alia:

H1: The proposed project activity not undertaken as a CDM project activity,
H2: The proposed project activity (installation of a cogeneration power plant), fired with the same type of biomass but with a different efficiency of heat generation**.** (e.g. an efficiency that is common practice in the relevant industry sector),
H3: The generation of heat in an existing cogeneration plant, on-site or nearby the project site, using only fossil fuels,
H4: The generation of heat in boilers using the same type of biomass residues,
H5: The continuation of heat generation in an existing cogeneration plant, fired with the same type of biomass as in the project activity, and implementation of the project activity, not undertaken as a CDM project activity, at the end of the lifetime of the existing plant,
H6: The generation of heat in boilers using fossil fuels,
H7: The use of heat from external sources, such as district heat,
H8: Other heat generation technologies (e.g. heat pumps or solar energy).

The project is located next to the sugar factory, which is energy sufficient, and H3, H6, H7 and H8 are not credible. H1 is not a credible baseline since it would not occur without CDM as demonstrated in section B3. H2 is not a credible baseline as the factory is currently self sufficient on heat energy and there would be no need for a lower efficiency plant. The generation of heat in boilers using the same type of biomass residues, H4 is the heat baseline.

For the use of biomass, the realistic and credible alternative(s) may include, inter alia:
B1: The biomass residues are dumped or left to decay under mainly aerobic conditions. This applies, for example, to dumping and decay of biomass residues on fields.
B2: The biomass residues are dumped or left to decay under clearly anaerobic conditions. This applies, for example, to deep landfills with more than 5 meters. This does not apply to biomass residues that are stock-piled or left to decay on fields.
B3: The biomass residues are burnt in an uncontrolled manner without utilizing it for energy purposes.
B4: The biomass residues are used for heat and/or electricity generation at the project site
B5: The biomass residues are used for power generation, including cogeneration, in other existing or new grid-connected power plants
B6: The biomass residues are used for heat generation in other existing or new boilers at other sites
B7: The biomass residues are used for other energy purposes, such as the generation of biofuels
B8: The biomass residues are used for non-energy purposes, e.g. as fertilizer or as feedstock in processes (e.g. in the pulp and paper industry)

From the alternatives, we rule out B4, B5 B6, B7 and B8 since the biomass is not used in any way but dumped to decay or burnt in an uncontrolled manner without utilising it for energy purposes. In view of the aforesaid, baselines B1, B2 and B3 are most credible. However, B2 is included as a credible baseline since some of the bagasse is dumped in deep excavated arrears within the plantations (See plate 1-8 above). However, for conservativeness, this baseline has not been used for calculating emission reductions.

From the analysis above, the scenario that results from P4, H4 and B1 is scenario 16. The baseline is therefore that the existing power plant would continue to operate and provide electricity and steam to the adjacent sugar plant. The extra biomass residues is dumped or left to decay or burned in an uncontrolled manner without utilizing it for energy purposes.

The above credible baseline options are consistent with mandatory and regulatory requirements.

B.5. 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 (assessment and demonstration of additionality):

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The proposed Mumias Sugar Cogeneration Project is additional and the demonstration of how the project is additional and not the baseline scenario in accordance with the selected baseline methodology is applied in reference to Application of Tools for the Demonstration and Assessment of Additionality Version 3, which is the latest version of the tool. While the tool has been used to evaluate the project below, a separate demonstration and analysis of additionality is attached together with other supporting documents.

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

In absence of the proposed project, reasonable and credible alternatives that are in accordance with current laws and regulations include:

1. The proposed project activity not undertaken as a CDM project activity,
2. Installation of a power plant fired with the same type of biomass but with a lower efficiency of electrical generation (e.g. an efficiency that is common practice in the relevant industry sector),
3. Generation of power in an existing plant, on-site or nearby the project site, using only fossil fuels
4. Generation of power in existing and/or new grid-connected power plants,
5. Continuation of power generation in an existing power plant, fired with the same type of biomass as (co-fired in the project activity, and implementation of the project activity, not undertaken as a CDM project activity, at the end of the lifetime of the existing plant,
6. Continuation of power generation in an existing power plant, fired with the same type of biomass as (co-fired in the project activity and, at the end of the lifetime of the existing plant, replacement of that plant by a similar new plant.

As discussed in B4, the only realistic and feasible alternative is alternative 4). All the above alternatives are consistent with mandatory and regulatory requirements.

Step 2. Investment Analysis

As allowed by the Tools for the Demonstration and Assessment of Additionality Version 3, Step 3 (Barrier Analysis has been used below and this option, Investment Analysis, has been forgone). .

Step 3. Barrier analysis

Sub-step 3a. Identify barriers that would prevent the implementation of type of the proposed CDM project activity:

Neither small scale nor large scale cogeneration program in sugar-alcohol sector has occurred yet in the country, due to several barriers, mainly economic, political and institutional, such as:

a) Investment barriers

This project is to be implemented in an industry that is still to a large extent being controlled by the government and therefore perceived as inefficient in terms of management (Ref attached documents "Cogen and LCD Discussion Draft" and "Kenya Sugar Industry 2005"). In addition, most of the sugar companies have been making losses successively over the years and only started making some profits in 2003 after the new political dispensation (Kenya Sugar Board Report 2005). Currently two out of the seven sugar companies are actually under receivership because they cannot pay their debts. The industry relies so much on rain for cane growth and the reliability and sufficiency of this has of late been very erratic and therefore prolonged drought reduces the supply of sugarcane and increases the incidences of fires, leading to a reduction in bagasse available for power generation and sugar production. Viewed against this background, most investors or financiers would be reluctant to invest or extend credit facilities to such a project because of the perceived higher risk associated with the weather uncertainty as well as political interference. The CDM funds would make it more attractive for the investors and financiers since a better return on investment would be realised.

Furthermore, most of the local investors and financial institutions do not have any experience in financing this kind of a project as none exists in the country at the moment and therefore the banks do not have all the tools and information to critically analyze the viability of such a project to warrant them extend a loan facility to the project. If this project is to be considered for funding in any case, getting guarantors would be very difficult because of the risk and huge capital outlay required. Equally, the interest rate charged would be higher than the prevailing interest rate to factor in the risk element, but with the injection of CDM funds, the revenue realised would help make the project financially feasible despite the high interest rates charged.

There is also a barrier arising from the fact that still the government does not have a comprehensive policy on price that KPLC is to pay on power from cogeneration sources and this has made it difficult to have strict and precise projection on sales revenue and profits, this fact can also deter investors and financiers. The pricing aspect has made cogeneration projects not to be pursued by most sugar companies in the country as KPLC tends to offer a lower price for cogenerated power than from fossil fuel sources on the assumption that production costs are low. Recently, the Government ordered Kenya Electricity Generating Company (KenGen) not to charge KPLC the earlier agreed rates as it was felt this would destabilise KPLC's commercial recovery (Refer the Electricity Regulatory Commission website, www.erb.go.ke/downloads). This has scared the potential investors and financiers. The CDM funds would be used to improve the return on investment and make the project worth implementation despite the perceived risks

b) Technological barriers,

Technological barriers represent a very important issue for increasing bagasse cogeneration in Kenya. Despite the fact that Rankine-cycle is a well known technology, the cogeneration units operate with low-efficiency and are not competitive comparing to other generation options.

In this way, there is a tricky issue about technology and economic value for such technology. Although this technology is well developed, the economic value for its application is not present for projects on the scale similar to the sugar mills in Kenya.

Studies reveal that the great majority of the sugar mills in Kenya still rely on inefficient technology, such as on 21 bar pressure boilers. Moreover, when there is a necessity to change equipments it is usual not to consider purchasing high efficiency boilers due to conservativeness, lack of knowledge or even lack of interest to generate surplus steam for electricity sales purposes as electricity sales have not been considered attractive to investors. There is no sugar company in Kenya that generates steam at more than 21barg today and other than Mumias Sugar Company which occasionally has been able to export 2 MW of electricity, all the other companies are net power importers. All the sugar companies were designed to consume as much bagasse as possible so as to minimise bagasse disposal costs. High pressure cogeneration technology, which is also more expensive, was therefore not required as this would significantly improve the bagasse utilisation efficiency. With the CDM funds, and despite the perceived associated risks, the project becomes more commercially attractive and the more costly high pressure cogeneration technology becomes more affordable.

It is difficult to convince the KPLC (local power distributor) that the energy to be acquired, which is generated during the harvest season, is sufficiently reliable to be accounted in the distributor's planning. Traditionally, KPLC is used to hydro electricity which faces similar risks like rain fed sugarcane growing in case of rain failure. However, KPLC does not review the risks the same way and has been averse to entering into long term contract with cogenerators. This has also discouraged previous investments in the sugar industry. With improved revenue flows as a result of CDM funds, MSC can undertake this project with lower financial risks on their part than would have otherwise been the case.

This is a new technology in the local sugar industry and therefore initially there would be inadequate trained manpower to operate it and Mumias Sugar Company will have to spend some time and resources to train personnel with right skills to operate the technology. It would also be difficult to find repair and maintenance services for the machines and even spare parts would have to be sourced from abroad at least for the first years of operation. The project manager has been sourced from India as no local expertise was available. CDM funds can be used to finance some of the critical training and skills development.

c) Barriers due to prevailing practice

All sugar industries in Kenya were built in sixties and seventies. The practice then was to design them in such a way that more bagasse will be burnt in the boilers in order to minimize the amount of bagasse available for dumping. Since then, the trend has been the same and any sugar company being proposed does not incorporate power generation for export as product among the first but only sugar is considered.

Because of these trends, the practice in the sugar industry has remained the same and this is considered a barrier to the implementation of the project. By implementing this project, which has been significantly made possible with consideration for CDM funds, MSC and KPLC have had to develop a Power Purchase Agreement and set precedence for future similar projects. Also, it was for an agreement to be reached on the power pricing having in mind the CDM funds. This agreement would have been more difficult to come to since MSC would have asked for a higher tariff than KPLC is willing to pay for the power it buys a situation which would have delayed the implementation of the project.

d) Other barriers

Institutional and Political Barriers

From the sugar mill point of view, the great majority of sugar mills do not consider investment in cogeneration (for electricity sale) as a priority. The sector "even in the new political context, does not seem to have motivation to invest in a process that it sees with mistrust and no guarantees that the product will have a safe market in the future". Moreover, "the sugar mills are essentially managed by the government, which hurdles the association with external financial agents" that would allow the sector to be more competitive and diversifying its investment. From the point of view of the economic agents, the excessive level of guarantees required to finance the projects is a common barrier to achieving a financial feasibility stage.

Other barriers have more to do with the lack of adequate commercial contractual agreements from the energy buyer, KPLC (i.e. bankable long-term contracts and payment guarantee mechanisms for non-credit worthy local public-sector and private customers) making it much more difficult to obtain long-term financing from a commercial bank and/or a development bank. Some other financing barriers occur simply due to prohibitively high transaction costs, which include the bureaucracy to secure the environmental license and electricity generation license. CDM funds can help finance some of these activities and facilitate the implementation process. At the same time, the government has had to liberalise power generation partially due to pressures from organisations such as MSC. This has resulted in changing the legal framework to facilitate cogeneration.

Cultural Barrier

Due to the nature of the business in the sugar industry the marketing approach is narrowly focused on commodity type of transaction. Therefore, the electricity transaction based on long-term contract (Power Purchase Agreement) represents a significant breakthrough in their business model. In this case, the electricity transaction has to represent a safe investment opportunity from both economical and social environmental perspective for convincing the sugar mills to invest in. MSC has therefore had to overcome several huddles during the negotiations of the Power Purchase Agreement.

Sub-step 3 b. Show that the identified barriers would not prevent the implementation of at least one of the alternatives (except the proposed project activity):

The core objective of the company when it was started was to process sugar for the local market. In the process of achieving its mandate, it was to help increase the economic status of its out growers and their dependants as well as the country's economy. This was to be achieved through buying of sugarcane from the local farmers. Since these sugar factories were located in the sugar belt zone, sugarcane therefore became the only cash crop for farmers in the area.

In addition, production of sugar from sugarcane was considered the only option for sugarcane use. That is why; the sugar mill was not designed to produce other additional products like alcohol or electricity. Therefore, the alternative to this project of continuing with sugar production without any expansion programme or replacing old equipment with one similar to what is existing (P2 or P6) and the above mentioned barriers will not impede the mill from performing its core activities which is sugar processing. The generation of power in the existing or new grid-connected power plants using fossil fuel would also not be affected by any of the identified barriers above.

Step 4. Common practice analysis

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

All sugar factories in the country were constructed in the sixties, seventies and eighties when the technology used was not as advanced like today. They were equipped with designs to generate steam and electricity for internal use only. Others rely entirely on power from the national grid for steam generation and day to day operations of the mill.

Cogeneration is therefore totally new and even if the mills were to cogenerate, the capacities of their boilers are not enough to generate sufficient steam to be used for electricity generation, also the installed turbines cannot generate sufficient power needed for all operations of the mill and auxiliary services. The MSCP will be the first of this kind and its success will be adopted for any future sugar mills to be developed

The prevailing practice in the sugar sector is sugar processing and the surplus bagasse generated is ferried and dumped in the nucleus estates where it is either burned or left to decompose.

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

This project activity type is not considered a widely spread activity in Kenya because it is a new venture in all existing sugar mills in the country. Mumias Sugar Company is the first and only sugar mill in the country producing electricity for sale to the national grid. This is because the installed capacity of the boilers and turbines is able to produce 5.5 MW over what the factory needs for internal use, even though it can only export 2.2 MW over 18 hours each day due to transformer constraints. There are no other similar activities being developed as CDM project in the country nor are there any commercial cogeneration projects for electricity generation for sale in the country.

The MSC Cogeneration project is therefore addition in view of the aforesaid. While the CDM funds can not help overcome political and some institutional barriers, the CDM opportunity, especially the funds provides strong motivation for the project developers to lobby for and carry out the campaigns required to convince the government to make the necessary political and institution changes.

B.6 Emission reductions:

B.6.1. Explanation of methodological choices:

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The baseline methodology is applied in reference to approved consolidated baseline methodology ACM0006 Version 4 (Approved Consolidated Baseline Methodology for Grid-connected Electricity Generation from Biomass Residues) which is the baseline methodology applied to this project.

The applicable combination of types of baseline scenarios is 16 which deals with power capacity expansion projects with P4 & P6 (Power Scenario) and B1 & B3[15] (Biomass Scenario) and H4. This scenario is applicable for the proposed project as it involves the installation of a new cogeneration unit operated next to the existing biomass power generation unit fired with biomass and the existing unit will continue to operate in the same manner after installation of the new power unit. The biomass residues (bagasse) would in the absence of the project activity be used for heat generation in boilers at the project site and in addition, be used in the existing power plant, while the surplus will be dumped or left to decay in aerobic conditions or burnt in an uncontrolled manner without utilizing it for energy purposes.

The proposed plant is grid connected and electricity supplied from the project activity to the grid would be expected to displace part of existing and planned generation in the grid, about 33% of which is fossil fuel-based. Prior to the project implementation, the biomass has been used in boilers for heat generation and in power plants for electricity generation and the project activity involves the use of additional biomass (bagasse) quantities that would in the absence of the project activity be dumped, left to decay or burned in an uncontrolled manner. The heat to be generated by the project plant would have been, in the absence of the project activity, generated in the existing boilers fired with the biomass that is used in the project plant.

In accordance with ACM0006; Version 4, and since Scenario 16 applies to this project, the emission factor for displacement of electricity ($EF_{electricity, y}$) corresponds to the grid emission factor ($EF_{grid, y}$).

Since the power generation capacity of the project plant is more than 15 MW, $EF_{grid, y}$ is calculated as a combined margin (CM), consisting of the combination of operating margin (OM) and build margin (BM) factors according to ACM002; Version 6. Calculations for this combined margin have been based on data from an official source (Electricity Regulatory Commission, website, www.erb.go.ke/downloads).

[15] Scenario B1 & B3 applies because some of the bagasse to be fired in the new project plant would in the absence of the project activity be dumped or left to decay in aerobic condition or burned in an uncontrolled manner without utilizing it for energy purposes.

ACM0002; Version 6 suggests the following optional methods to calculate the Operating Margin emission factor(s), $EF_{OM,\ y}$:

(a) Simple OM, or
(b) Simple adjusted OM, or
(c) Dispatch Data Analysis OM, or
(d) Average OM.

In accordance with ACM0002; Ver 6, Dispatch Data Analysis is the first methodological choice. Since adequate dispatch data is available, this method has been chosen to calculate $EF_{OM,\ y}$.

The Operating Margin emission factor $EF_{OM,,}$ will therefore be updated annually ex-post for the year in which actual project generation and associated emissions reductions occur.

The baseline calculation for the PDD, however is based on ex-ante data vintage using the most recent year (2005/2006).

Calculation of Dispatch Data Operating Margin, $EF_{OM,.Dispatch,y}$

$EF_{OM,.DispatchData,y} = E_{OM,.,y} / EG_y$ ***(6)*** $EF_{OM,.,y} = \sum_h EG_h * EF_{DD,h}$ ***(7)*** $EF_{DD,h} = (\sum_{i,n} F_{i,n,h} * COEF_{i,,n}) / \sum_n GEN_{n,h}$ ***(8)*** $COEF_{i,\ n} = NCV_i * EF_{CO2,i} * OXID_i$ ***(3)***	Where: EG_y is the generation of the project (in MWh) in year y $E_{OM,.,y}$ are the emissions (tCO_2) associated with the operating margin, EG_h is the generation of the project (in MWh) in each hour h, $EF_{DD,h}$ is the hourly generation weighted average emission per electricity unit (tCO_2/MWh) of the set of power plants (n) in the top 10% of grid system dispatch order during hour h, $F_{i,n,h}$ is the amount of fuel i (in a mass or volume unit) consumed by relevant power sources n in hour(s) h, $COEF_{i,j\ y}$ is the CO_2 emission coefficient of fuel i (tCO_2/tonne of the fuel), taking into account the carbon content of the fuels used by relevant power sources j and the percent oxidation of the fuel in year(s) y, $GEN_{n,h}$ is the amount power (MWh) that is dispatched from all plants n in the system during each hour h that the project activity is operating NCV_i is the net calorific value (energy content) per tonne of fuel i, $OXID_i$ is the oxidation factor of the fuel i, $EF_{CO2,i}$ is the CO_2 emission factor per unit of energy of fuel i (tCO_2/GJ).

Calculation of Build Margin

ACM0002 Version 6 gives two options for calculating BM emission factor. Option 2 has been chosen. The Built Margin emission factor $EF_{BM,,}$ will therefore be updated annually ex-post for the year in which actual project generation and associated emissions reductions occur.

Build Margin emission factor ($EF_{BM,y}$) calculation for the PDD, however, has been carried out using ex-ante calculations based on the most recent information available on the plants already built for a sample group *m*. The sample group *m* consists of 5 power plants that have been built most recently.

Calculation of Build Margin Emission Factor ($EF_{BM,y}$)

$EF_{BM,y} = (\sum_{i,m} F_{i,m,y} * COEF_{i,m}) / \sum_{m} GEN_{m,y}$ ***(9)***	Where: $F_{i,m,y}$, $COEF_{i,m}$ and $GEN_{m,y}$ are analogous to the variables described for the Dispatch Data OM method above for plants *m*.

Calculation of Baseline Emission Factor

The Baseline Emission Factor (EF_y) is calculated as the weighted average of the dispatch data operating margin emission factor and build margin emission factor as follows:

$$EF_y = W_{OM}.EF_{Dispatch,\ OM,y} + W_{BM}.EF_{BM,y} \qquad \textbf{\textit{(10)}}$$

Where the weights W_{OM} and W_{BM} are the default values of 50% and 50%, respectively, as per ACM0002, Version 06 guidelines.

Calculation of Baseline Emissions Due to Displacement of Electricity

Emission reductions due to the displacement of electricity are calculated by multiplying the net quantity of increased electricity generated with biomass residues (bagasse) as a result of the project activity (EG_y) with the CO_2 baseline emission factor for the electricity displaced due to the project ($EF_{electricity,y}$):

$$ER_{electricity,\ y} = EG_y * EF_{electricity,\ y} \qquad \textbf{(8)}$$

Where:

$ER_{electricity,y}$ =	Emission reductions due to displacement of electricity during the year *y* (tCO_2/yr)
EG_y =	Net quantity of increased electricity generation as a result of the project activity (incremental to baseline generation) during the year *y* (MWh)
$EF_{electricity,y}$ =	CO_2 emission factor for the electricity displaced due to the project activity during the year *y* (tCO_2/MWh)

For scenarios 16, EG_y corresponds to the lower value between (a) the net quantity of electricity generated in the new power unit that is installed as part of the project activity ($EG_{project\ plant,y}$) and (b) the difference between the total net electricity generation from firing the same type(s) of biomass residues at the project site ($EG_{total,y}$) and the historical generation of the existing power unit(s) ($EG_{historic,3yr}$), based on the three most recent years, as follows:

Determination of Net Quantity of Increased Electricity Generation (EG_y)

$$EG_y = MIN\left\{\begin{array}{l} EG_{project\ plant,\ y} \\ EG_{total,\ y} - \dfrac{EG_{historical,\ 3yr}}{3} \end{array}\right\} \quad \textbf{(12)}$$	Where: EG_y = Net quantity of increased electricity generation as a result of the project activity (incremental to baseline generation) during the year *y* (MWh/yr) $EG_{project\ plant,y}$ = Net quantity of electricity generated in the project plant during the year *y* (MWh/yr) $EG_{total,y}$ = Net quantity of electricity generated in all power units at the project site, generated from firing the same type(s) of biomass residues as in the project plant, including the new power unit installed as part of the project activity and any previously existing units, during the year *y* (MWh/yr) $EG_{historic,3yr}$ = Net quantity of electricity generated during the most recent three years in all power plants at the project site, generated from firing the same type(s) of biomass residues as used in the project plant (MWh)

Emission reductions or increases due to displacement of heat

The proposed project will not lead to increase in capacity production of the sugar mill from the present capacity. Therefore, there will be no increase or decrease in emission related to heat generation.

Baseline emissions due to natural decay or uncontrolled burning of anthropogenic sources of biomass

Since in the absence of the project, excess bagasse would have been ferried and dumped in the nucleus estates where it would have been burned in an uncontrolled manner or left to decay in aerobic conditions, the project proponents have accounted for associated emissions from methane abated by the project in the baseline calculations. The most common practice by Mumias Company with regard to management of dumped bagasse is to leave the bagasse to decay naturally. As bagasse undergoes decomposition, it releases methane in the process.

The baseline emissions due to natural decay or uncontrolled burning of bagasse, $BE_{Biomass,y}$ are determined in two steps according to ACM0006, Version 4, page 37

Step 1 is the determination of the quantity of bagasse (only one type of biomass is used) used as a result of the project activity ($BF_{PJ,k,,y}$).

In the case of Scenario 16, ACM0006 (version 04) specifies that the biomass would in the absence of the project activity be:

a) used for heat generation in boilers at the project site and,
b) dumped or left to decay or burnt in an uncontrolled manner without utilizing it for energy purposes.

According to ACM006; version 04 (page 39), and for Scenario 16, $BF_{PJ,k,,y}$ should be determined taking into account the specific circumstances. The determination should ensure that only the increamental increase in the use of bagasse due to the project activity is taken into account.

Under the situation of MSC, either all the bagasse previously dumped are used as a result of the project (i.e. $BF_{PJ,k,,y}$ = historically dumped bagasse)[16] or the increamental bagasse used is the difference between the total quantity of bagasse used in all the plants and the quantity of bagasse used as fuel in all installations (power plants, boilers, etc) at the project site during the most recent three years prior to the implementation of the project activity (i.e. $BF_{PJ,k,,y} = BF_{all\ plants,,k,,y} - BF_{historical,,k,3yr}$)

The incremental use of biomass residues as a result of the project activity is therefore calculated as follow:

	Where:	
$BF_{PJ,k,,y} = \text{MIN}\left\{ \begin{array}{l} (\text{BF}_{k\ damped,\ historical\ 3y})\mathbf{/3} \\ \text{BF}_{all\ plants,,k,,y} - (\text{BF}_{historical,,k,3yr})\mathbf{/3} \end{array} \right\}$	$BF_{PJ,k,,y}$	Incremental quantity of biomass residue type *k* used as a result of the project activity in the project plant during the year *y* (tons of dry matter)
	$BF_{k\ damped,\ historical\ 3y}$	Quantity of biomass residue type *k* dumped during the most recent three years prior to the implementation of the project activity (tons of dry matter)
	$BF_{all\ plants,,k,,y}$	Quantity of biomass residue type *k* combusted in all power plants at the project site during the year *y* (tons of dry matter)
	$BF_{historical,,k,3yr}$	Quantity of biomass residue type *k* used as fuel in all installations (power plants, boilers, etc) at the project site during the most recent three years prior to the implementation of the project activity (tons of dry matter)

[16] This is the situation assumed for the ex-ante calculation of $BF_{PJ,k,y}$

	Prior to the project, excess bagasse was dumped in the plantations using hired trucks. The bagasse for dumping was therefore determined by weighing the trucks before and after loading. $BF_{k\ damped,\ historical\ 3y}$ was therefore determined for the period 2003 to 2006. The total bagasse produced was determed using the cane equation, sucrose balance and lab analysis results. $BF_{historical,,k,3yr..}$ was determined as the difference between total bagasse generated and bagsse damped. Periodically this amount burnt is also checked against an energy balance on all the existing plants since all steam quantities, temperatures and pressures are monitored for each boiler. For ex-post determination of $BF_{PJ,k,y}$, the bagasse to each of the plant will be measured using a weight meter and thus $BF_{all\ plants,,k,,y}$ will be determined. The value so determined will be cross checked by a mass and energy balance based on opening and closing stocks, and the quantity and quality of steam generated for each year.

The bagasse produced from the sugar mill is directly fed to the boilers though a chain conveyor and the excess is stored. The amount of bagasse to each of the plants would be monitored directly through weight meters. One of the weight meters would be calibrated to give the amount of bagasse being burnt in the project activity. Also on an annual basis, the quantity of electricity (and heat) generated would be used to check the measured amount of bagasse burnt in the project activity. Such cross checks would be in the form of annual mass and energy balance. The mass balance would be on the basis of the measured quantity of sugar cane crushed, water added, mixed juice and bagasse produced and the energy balance would be on the basis of steam quantity and quality generated from each plant. In this way, the requirement of measuring bagasse consumed in the project plant will be met.

Step 2 is the estimation of methane emissions, consistent with the baseline scenario for the use of biomass residues, i.e. Baseline emissions are calculated by multiplying the quantity of biomass residues that would not be used in the absence of the project activity with the net calorific value and an appropriate emission factor, as follows:

$BE_{Biomass,\ y} = GWP_{CH\ 4} * BF_{PJ,k,,y} * NCV_k * EF_{burning,CH4k,y}$ ***(22f)***	Where: $BE_{Biomass,y}$	 are the baseline emissions due to natural decay or burning of anthropogenic sources of biomass *k* during the year *y* (tCO_2 /yr)
	GWP_{CH4}	is the Global Warming Potential for methane valid for the relevant commitment period (tCO2e/tCH4),
	$BF_{PJ,k,,y}$	Incremental quantity of biomass residue type *k* used as

	a result of the project activity in the project plant during the year y (tons of dry matter or liter), NCV_k Net calorific value of the biomass residue type k (GJ/ton of dry matter or GJ/liter), $EF_{burning, CH4,k,y}$ CH4 emission factor for uncontrolled burning of the biomass residue type k during the year y (tCH4/GJ). The CH_4 emission factor of 0.0027 tCH_4/T was used as provided for in ACM006 Ver.4, page 40 guidelines with uncertainty band of 40% resulting in a conservative factor of 0.89 (ACM006 Ver.4, Table 5). This uncertainty factor choice has been influenced by the consideration that nearly 50% of the bagasse dumped go into the excavated sites with depths greater than 5 meters and therefore decompose under anaerobic conditions. However, in this calculation aerobic conditions have been assumed for all bagasse dumped due to the difficulty of determining the exact quantities that decompose under the two possible conditions. We therefore have a very high certainty of higher CH_4 generation in the baseline conditions than assumed in this condition.

Mumias Sugar Company Limited crushed 2,443,298.62 tonnes of cane in 2005/2006 and is expected to crush similar quantities in 2006/2007 based on the quantities already crushed and the projections for the remaining months of the year at the time of PDD preparation.

Mumias Sugar Company Limited weighs all the incoming sugar cane using an electronic weigh bridge that is connected to the computerised data processing system. The cane measurement is used to calculate processing yields and to pay cane farmers.

The process water is also measured using an electronic flow meter which feeds the process control and data collection computerised module. The total amount of water into the process is therefore determined.

On the output side, the amount of the mixed juice coming from the diffuser is also measured by a flow metre connected to the computerised process control system. Therefore the amount of mixed juice is measured and known.

The company has found the calculation method accurate enough for carrying out the sucrose balance and determining the extraction efficiency, checking the payment to the cane farmers and checking the bagasse produced against the steam produced and baggasse dumped.

The amount of bagasse generated is calculated from the cane equation:

Cane + (Water+Steam) = Mixed Juice + Bagasse.

Over the years, Mumias Sugar Company, together with the other sugar companies in the region, have perfected this method of determining the bagasse production, which they find very reliable enough to use as the basis for the sucrose balance.

Based on the above equation and previous test runs, the company has established over the years that the average bagasse yield is about 37% of the total cane crushed by weight. The yield data which is regularly monitored and reported, as this forms a basis for compensating cane farmers, confirms this fact.

The existing data shows that on average, over a 3 year period (2003 to 2006), 2,357,893 tons of cane was crushed, and the total bagasse production was tonnes 892,639 (37%). (see Table 1 below). The same data shows that for each tonne of sugarcane crushed, 0.27 tonnes of bagasse is used to produce process energy (steam and electricity). This has been established though test runs by weighing the surplus bagasse which was dumped in the plantations and the transporters had to be paid based on weight and distance transported. Furthermore, data exists to confirm the amount of bagasse burnt in the boilers based on the efficiency, net caloric value of the bagasse, the boiler efficiencies and steam generation using the following equation (which is the basis for the energy balance for each verification period) for each boiler in operation in year y;

$Q_y = B_{Fk, boiler, y} \,.\, NCV_k \,.\, \varepsilon_{heat, boiler, y}$

Where,

Q_y is the quantity of heat energy in the total steam generated in year y by the boiler, in GJ as determined from the team tables for the quantity and quality of steam generated.
$B_{Fk, boiler, y}$ is the quantity of bagasse burnt in the boiler in year y (tons of dry matter)
NCV_k is the net calorific value of the bagasse (GJ/ton of dry matter)
$\varepsilon_{heat, boiler, y}$ is the heat energy efficiency of the bagasse fired boilers in operation during year y

Therefore, using this 3 year average data the surplus bagasse available for dumping before the project implementation was 251,780 tonnes per year. This amount of bagasse was transported by hired trucks and dumped as described above. The bagasse has previously been dumped in the plantations to decompose with significant methane emissions. Usually the bagasse is dumped in areas where soil has been excavated for road maintenance and covered with soil or are spread in areas where sugar cane is not grown within the nucleus plantation. Once a dumpsite is filled, a new dumpsite is created and there are no fixed dumpsites. The heights of the dumping also vary from site to site and there are some above 5 meters height while others are below.

For conservativeness, aerobic decomposition of the bagasse has been assumed while in reality, at least 50% of the bagasse decomposes under typically anaerobic conditions.

Table 1: SUGARCANE AND BAGASSE PRODUCTION AND UTILISATION TRENDS (TONNES) FOR THE LAST 3 YEARS

Year	Sugarcane Crushed	Wet Bagasse Produced	Wet Bagasse Utilised	Wet Bagasse Dumped
2003/4	2290427	857994	602039	255955
2004/5	2339954	881695	626640	255055
2005/6	2443299	938227	693898	244329
Total	**7073680**	**2677916**	**1922577**	**755339**
Average 3 yr	**2,357,893**	**892,638**	**640,859**	**251,780**

The yield data and the data in Table 1 above was obtained from Mumias Sugar Company Ltd offices. However, most of it is also available from the Kenya Sugar Board Website; http://www.kenyasugar.co.ke/statistics.html

The calculated baggasse amounts are checked by alternative calculations using mass and energy balances. The energy balances are based on the quantity and quality of steam produced from each plant (which are all measure with flowmeters, pressure and temperature gauges) as explained above. The mass balance is based on the stock movements during each verification period, including stock balances at the start and end of each such period.

For more details please refer to the Excel spread sheet; MSC Assumptions attached.

Project Emissions

Project emissions include CO_2 emissions from fossil fuel use during boiler start ups and CH_4 emissions from the combustion of biomass ($PE_{Biomass,CH4,y}$) in the boilers. Equations (2 and 7) specified in ACM0006 version 4 will be used in calculating project emissions. Equation (7) is included because methane emissions from combustion of biomass are part of the project boundary.

Biomass transportation: The proposed project will be located next to the existing sugar mill. Bagasse will beefed into the boilers using a conveyer belt. As such, there will be no bagasse transportation, therefore $PET_y = 0$

CO_2 emission from own electricity consumption: Currently Mumias Sugar mill generates enough power for own consumption. Upon successful implementation of the project, and even though there might be a slight change in auxiliary electricity consumption, the overall own consumption baseline does not change significantly as a result of the project. Emissions from this source will be zero ($PE_{EC,Y} = 0$) because, electricity being utilized is from renewable sources.

Co-firing: Generation of heat and steam for power production will be done using biomass (bagasse) only. Co-firing using fossil fuels will only done during boiler start ups and small amount of fossil fuels are used. For the last three years, the company used about 10 tonnes of fossil fuels to start boilers after shutdown. In the absence of the proposed project, heat will be generated from the existing boilers. In addition, upon successful implementation of the CDM project, heat will be generated from the existing boilers and the proposed project will not lead to increase in heat demand, since the production capacity of the mill will not change.

Calculation of the project emissions (PE_y)

$PE_y = PET_y + PEFF_{,y,} + PE_{EC,y} + (GWP_{CH4} * PE_{Biomass,CH4,y})$ ***(2)*** $PEFF_y = \Sigma_i (FF_{project\ plant\ i\ y} + FF_{project\ site\ i\ y}) * NCV_i * COEF_i$ ***(6)***	Where: PE_y are the project emissions during the year *y* in ton of CO_2 GWP_{CH4} is the Global Warming Potential for methane valid for the relevant commitment period, $PE_{Biomass,CH4,y}$ are the CH_4 emissions from the combustion of biomass during the year *y* (tCH_4/yr) PET_y are project emissions from transportation of

$PE_{Biomass\ CH4.y} = EF_{CH4.BF} * \Sigma\ BF_{k,y} * NCV_k$ **(7)**	biomass *i* $PEFF_{,y}$ are the CO_2 emissions during the year *y* due to fossil fuels co-fired by the generation facility in tons of CO_2 $PE_{EC,Y}$ CO_2 emissions during the year *y* due to electricity consumption at the project site that is attributable to the project activity (tCO_2/yr)

Since the project will introduce more thermally efficient equipment and operations, and because the bagasse boiler is located on the same site as the existing mill, there will be no emissions from own electricity consumption and from transport of the biomass and the above equation therefore, can be summarised as:

$PE_y = PEFF_{,y} + (GWP_{CH4} * PE_{Biomass,CH\ 4,\ y})$ $PEFF_y = \Sigma_i\ (FF_{project\ plant\ i\ y} + FF_{project\ site\ i\ y}) * NCV_i * COEF_i$ and $PE_{Biomass\ CH4.y} = EF_{CH4.BF} * \Sigma\ BF_{k,y} * NCV_k$	Where: $FF_{project\ plant,i,y}$ Quantity of fossil fuel type *i* combusted in the biomass residue fired power plant during the year *y* (mass or volume unit per year) $FF_{project\ site,i,y}$ Quantity of fossil fuel type *i* combusted at the project site for other purposes that are attributable to the project activity during the year *y* (mass or volume unit per year) NCV_i Net calorific value of fossil fuel type *i* (GJ / mass or volume unit) $EF_{CO2,FF,}i$ CO_2 emission factor for fossil fuel type *i* (tCO_2/GJ) $BF_{k,y}$ Quantity of dry biomass residue type *k* combusted in the project plant during the year *y* (tons of dry matter) NCV_k Net calorific value of the dry biomass residue type *k* (GJ/ton of dry matter or GJ/liter) $EF_{CH4,BF}$ CH_4 emission factor for the combustion of biomass residues in the project plant (tCH_4/GJ) The CH_4 emission factor of 0.0000411tCH_4/GJ was used as provided for in ACM0006 version 4, page 23 guidelines with uncertainty of greater than 100% resulting in a conservative factor of 1.37 (ACM0006 Ver.4, Table 3 & 4).

Leakage

The biomass residues used in the proposed project will not result in increase in fossil fuel consumption elsewhere as demonstrated below.

L_1 Mumias sugar gets its sugarcane supply from the surrounding farmers (out growers) and from its nucleus estate. The surrounding farmers cannot sell sugarcane to a different company located outside the Mumias zone due to the contracts mutually signed. This is meant to ensure that each sugar company has a steady supply of sugarcane. Bagasse generated by Mumias is more than what they use for steam generation. The surplus bagasse (see table 3 above) is ferried by company truck and dumped in the nucleus estate (see Plates 1 to 8) above. This is the trend which has been going on and it is expected to continue in the absence of the proposed CDM project. For the past 35 years since the company was started, the excess bagasse has been dumped in the company nucleus estate and no alternative market has emerged for the bagasse. Because of the above contractual and statutory guidelines, the plant will have enough bagasse for use and there will be no transportation of bagasse from other sources to the plant.

L_2 The proposed project is located in the western part of the country. The region comprises one of the sugar growing zones in the country. About 4 sugar companies are located in the region and the bagasse they produce is partly used for internal steam generation. However, not all the bagasse is utilized and a large proportion of it is dumped or left to decay without utilizing it for energy purposes. Mumias Sugar Company also generates a lot of bagasse than what used. The surplus is dumped and with implementation of the project, the dumped bagasse will be used for power generation.

L_3 The proposed project will use bagasse which is generated from milling sugarcane. Sugar cane used in the sugar is sourced from the company nucleus estate and from surrounding farmers who sell their cane to the sugar mill for sugar production. Therefore the project will not buy biomass from any other supplier for power generation and there will be no leakage associated with transportation of biomass to the project.

Mumias Cogeneration Project Emission Reductions

The project activity mainly reduces CO_2 emissions through substitution of power and heat generation with fossil fuels by energy generation with biomass. The emission reduction ER_y by the project activity during a given year *y* is the difference between the emission reductions through substitution of electricity generation with fossil fuels ($ER_{electricity,y}$), the emission reductions through substitution of heat generation with fossil fuels ($ER_{heat,y}$), project emissions (PE_y), emissions due to leakage (L_y) and, where this emission source is included in the project boundary and relevant, baseline emissions due to the natural decay or burning of anthropogenic sources of biomass ($BE_{biomass,y}$), as follows, using equation (1) as specified by ACM0006 version 4.

Therefore, emission reductions for the project activity (ER_y) will be calculated as follows:

$ER_y = ER_{heat,y} + ER_{electricity,y} + BE_{biomass,y} - PE_y - L_y$ ***(1)***	Where:	
	ER_y	are the emissions reductions of the project activity during the year y (tCO_2/yr),
	$ER_{electricity,y}$	are the emission reductions due to displacement of electricity during the year y (tCO_2/yr),
	$ER_{heat,y}$	are the emission reductions due to displacement of heat during the year y (tCO_2/yr),
	$BE_{biomass,y}$	are the baseline emissions due to natural decay or burning of anthropogenic sources of biomass during the year y (tCO_2e/yr)
	PE_y	are the project emissions during the year y (tCO_2/yr)
	L_y	are the leakage emissions during the year y (tCO_2/yr).

Due to explanation above, emissions from biomass transportation and heat generation is negligible and therefore, the above equation can be summarised as:

$ER_y = ER_{electricity,y} + BE_{biomass,y} - PE_y$

B.6.2. Data and parameters that are available at validation:

Data / Parameter:	**GWP_{CH4}**
Data unit:	tCO_2e/tCH_4
Description:	Global warming potential for CH_4
Source of data used:	IPCC
Value applied	21
Measurement procedures (if any):	21 for the first commitment period. Shall be updated according to any future COP/MOP decisions.
Any comment:	

Data / Parameter:	**$EG_{historic,3y}$**
Data unit:	MWh
Description:	Net quantity of electricity generated during the most recent three years in all power plants at the project site, generated from firing the same type(s) of biomass residues as in the project plant
Source of data used:	On site measurement and generation records
Value applied	184,381
Measurement procedures (if any):	Electricity generated is measured using energy meters and validated by calculation using the generation data. The meters used in the power house are moving disc type on MSC panels
Any comment:	Applicable to scenarios 16

Data / Parameter:	**Moisture content of biomass residues used historically**
Data unit:	% Water content
Description:	Moisture content of each biomass residue type *k*
Value applied	50
Source of data used:	On-site measurements
Measurement procedures (if any):	Weekly laboratory analysis of the bagasse
Any comment:	Biomass determination is by calculation so this parameter is required

Data / Parameter:	**$BF_{historic,k,3y}$**
Data unit:	tons of dry matter
Description:	Quantity of biomass residue type *k* used as fuel in all installations (power plants, boilers, etc) at the project site during the most recent three years prior to the implementation of the project activity
Source of data used:	On site measurements and plant operation records
Value applied	320,420
Measurement procedures (if any):	From existing annual bagasse calculations, adjust for the moisture content in order to determine the quantity of dry biomass.

Any comment:	Applicable to scenarios 16

Data / Parameter:	$BF_{k\ dumped,\ historical\ 3y}$
Data unit:	tons of dry matter
Description:	Quantity of biomass residue type *k* dumped during the most recent three years prior to the implementation of the project activity (tons of dry matter)
Source of data used:	On site measurements and plant operation records
Value applied	125,890
Measurement procedures (if any):	From existing annual bagasse calculations, adjust for the moisture content in order to determine the quantity of dry biomass.
Any comment:	Applicable to scenarios 16

All the data and parameters used to calculate actual emission reductions will be monitored ex-post. Data and parameters for ex-ante estimations are included in appropriate Tables in section B.6.3 below.

B.6.3 Ex-ante calculation of emission reductions:

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The Dispatch Data Analysis OM is the option selected to calculate the OM emission factor. For estimation of the emission reductions, recent historical data have been used using the formulae provided in ACM0006 as given below. The baseline emission factor (EF_y) is calculated as a combined margin (CM), consisting of the combination of Dispatch Data Operating Margin and Build Margin (BM) factors.

All the calculated figures given below are derived from excel sheet accompanying this PDD.

Calculation of Dispatch Data Operating Margin

EG_y	***(12)***	190,329
$EF_{OM,.,y} = \sum_h EG_h * EF_{DD,h}$	*(7)*	166,743
$\mathbf{EF_{OM,.Dispatch,y} = E_{OM,.,y} / EG_y}$	***(6)***	**0.8761**

Calculation of Build Margin

$BM_{BM,y}$ = weighted average of emissions by recent 5 recent capacity additions.

$$EF_{BM,y} = \sum F_{i,m,y} * COEF_{i,m} / \sum GEN_{m,y} \qquad \textbf{\textit{(9)}}$$

Build Margin	
$\sum_m GEN_{m,y}$	3,063,557,900
$\sum_{i,m} F_{i,m,y} * COEF_{i,m}$	1,326,117,814
$\mathbf{EF_{BM,y} = (\sum_{i,m} F_{i,m,y} * COEF_{i,m}) / \sum_m GEN_{m,y}}$	**0.4329**

Calculation of Baseline Emission Factor

$EF_y = W_{OM}.EF_{OM,y} + W_{BM}.EF_{BM,y}$ ***(10)***

Where the weights W_{AOM} and W_{BM} are 50% and 50% respectively.

Calculation of Baseline Emission Factor	
W_{OM}	0.5
$EF_{Dispatch\ Data\ OM,y}$	0.8761
W_{BM}	0.5
$EF_{BM,y}$	0.4329
$\mathbf{EF_y} = W_{OM}.EF_{Dispatch\ Data\ OM,y} + W_{BM}.EF_{BM,y}$	**0.6545 (tCO_2e/MWh)**

Calculation of Baseline Emissions due to Displacement of Electricity

$BE_{electricity,y} = EF_{electricity\ ,y} * EG_{,y}$ ***(8)***

$ER_{\ electricity,y} = EG_y * EF_{\ electricity\ ,y}$	
$EF_{electricity,,y}$	0.6545
$EG_{,y}$	190,329 (MWh)
$BE_{electricity,y}$ (tCO_2 e/year)	**124,565 (tCO2e/yr)**

Baseline emissions due to natural decay or uncontrolled burning of anthropogenic sources of biomass

Since in the absence of the project, excess bagasse will have been ferried and dumped in the nucleus estates where it will have been set on fire and burned in an uncontrolled manner or left to decay, the project proponents have decided to account associated emissions from methane abetted by the project in the baseline calculations.

$BE_{Biomass,\ y} = GWP_{CH\ 4} * BF_{p,j,k,\ y} * NCV_k * EF_{burning,CH4,k,y}$ ***(22f)***

$GWP_{CH\ 4}$	21
$BF_{p,j,k,,y}$	125,890 tonnes
$NCV_k * EF_{burning,CH4,k,y}$	0.0027 tCH_4/TJ
Conservative factor	0.89
*Default CH_4 emission factor= NCV_k*$EF_{\ burning,CH4,k,y}$ ($t\ CH_4/t$)	0.002403 (tCH_4/GJ)
$BE_{Biomass,\ y}$	**6,353 (tCO_2e/yr)**

Project Emissions

Project emissions include CO_2 emissions from this project are limited only to CH_4 emissions from the combustion of biomass ($PE_{Biomass,CH4,y}$) in the boilers and use of fossil fuels for boiler start ups.

$PE_y = PEFF_y + GWP_{CH\ 4} * PE_{Biomass,CH\ 4,\ y}$ ***(2)***

$PE_{Biomass,CH\,4,\,y} = EF_{CH\,4,BF} * \Sigma\ BF_{k,y}, * NCV_k$ ***(7)***

$PEFF_y = \Sigma_i\ (FF_{project\ plant\ i\ y} + FF_{project\ plant\ i\ y}) * NCV_i * COEF_i$ *(6)*

Therefore:

$PEy = PEFF_y + GWP_{CH\,4} * PE_{Biomass,CH\,4,\,y}$ ***(2)***

$GWP_{CH\,4}$	21
$BF_{k,y}$	125,890 tonnes
NCV_k	11.6 (GJ/tonne)
$EF_{CH4,BF}$	41.1 (kg CH_4/TJ)
Conservative factor	1.37
$PE_{Biomass,CH\,4,\,y}$	**1,260** (tCH_4/GJ)

$\Sigma_i FF_{project\ plant\ i\ y}$	10 tonnes
$\Sigma_i FF_{project\ site\ i\ y}$	0.0 tonnes
NCV_i	40.19 (GJ/tonne)
$COEF_i$	0.08
$PEFF_{,y}$	**30.78 (tCO_2/year)**

Therefore,

$PE_y = PE_{Biomass,CH\,4,\,y} + PEFF_{,y}$
$= 1260 + 30.78$
$=$ **1,291 tCO_2e/year**

Mumias Cogeneration Project Emission Reductions

The project activity mainly reduces CO_2 emissions through substitution of power and heat generation with fossil fuels by energy generation with biomass. The emission reduction ER_y by the project activity during a given year *y* is the difference between the emission reductions through substitution of electricity generation with fossil fuels ($ER_{electricity,y}$), the emission reductions through substitution of heat generation with fossil fuels ($ER_{heat,y}$), project emissions (PE_y), emissions due to leakage (L_y) and, where this emission source is included in the project boundary and relevant, baseline emissions due to the natural decay or burning of anthropogenic sources of biomass ($BE_{biomass,y}$), as follows:

$ER_y = ER_{heat,\,y} + ER_{electricity,\,y} + BE_{biomass,\,y} - (PEFF_y + PE_{Biomass,CH\,4,\,y}) - L_y$ ***(1)***

The above formulae will be simplified to $ER_y = ER_{electricity,\,y} + BE_{biomass,\,y} - PE_y$ because heat will not be displaced as well as there will be no leakage from the project.

$BE_{electricity,y}$	**124,565** (tCO_2e/yr)
$BE_{Biomass,\,y}$	**6,353** (tCO_2e/yr)

PE_y	**1,291** (tCO_2e/yr)
$ER_y = ER_{electricity,y} + BE_{biomass,y} - PE_y$	**129,627 (tCO_2e/yr)**

B.6.4 Summary of the ex-ante estimation of emission reductions:

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Table 10: Ex-ante Emission Reductions

Year	Estimation of project activity emissions (tonnes of CO_2 e)	Estimation of Baseline emissions (tonnes of CO_2 e)	Estimation of Leakage (tonnes of CO_2 e)	Estimation of overall emission Reductions (tonnes of CO_2 e)
2008	369	32847	0	32478
2009	1291	130918	0	129627
2010	1291	130918	0	129627
2011	1291	130918	0	129627
2012	1291	130918	0	129627
2013	1291	130918	0	129627
2014	1291	130918	0	129627
2015	1291	130918	0	129627
2016	1291	130918	0	129627
2017	1291	130918	0	129627
2018	873	97668	0	96795
Total (tCO_2 e)	**12863**	**1308777**	**0**	**1295914**

B.7 Application of the monitoring methodology and description of the monitoring plan:

B.7.1 Data and parameters monitored:

Data / Parameter:	**$BF_{s,y}$**
Data unit:	tons of sugarcane
Description:	Amount of sugarcane, crushed by the sugar mill in year y
Value applied	2,357,893
Source of data to be used:	On-site measurement
Measurement procedures (if any):	Sugarcane used by the mill is received from the out grower farmers and from the company's nucleus estate. The cane is delivered in trucks and the cane is received and weighed in the receiving bridge. The amount of cane received is then recorded in the presence of the owner of the cane. The figure is then used for the processing of the payment for cane deliveries. The same figures will be used for calculation of the cane delivered and crushed by the sugar mill per year.
QA/QC procedures to be applied:	Cross-check the amount of sugar cane crushed against sugar and power produced (bagasse indicator) and the expected calculated yields on a monthly basis.
Any comment:	100% of the data will be monitored.

Data / Parameter:	**Moisture content of the biomass residues**
Data unit:	% Water content
Description:	Moisture content of each biomass residue type *k* (bagasse)
Value applied	50
Source of data to be used:	On-site analysis of the bagasse produced
Measurement procedures (if any):	On a regular basis (daily), representative samples of the bagasse generated are taken and analysed for moisture content.
Monitoring frequency	Continuously, mean values are calculated at least annually
QA/QC procedures to be applied:	Application of internationally approved test and analysis methods and appropriate calibration of test equipment.
Any comment:	This is applicable because there is no pre-treatment of the bagasse generated

Data / Parameter:	**BF** $_{k,,y}$
Data unit:	tons of dry matter
Description:	Quantity of biomass residue type *k* (bagasse) combusted in the project plant (only new) during the year *y*
Value applied	125,889 (ex-ante determination assumes equals to historically dumped bagasse).
Source of data to be used:	On-site measurement
Measurement procedures (if any):	A weight meter to be used to measure bagasse to the project plant. Adjust for the moisture content in order to determine the quantity of dry bagasse. The quantity shall be crosschecked with the quantity electricity (and heat) generated). There will be no fuel purchases.
Monitoring frequency	Continuously, prepare annually an energy balance
QA/QC procedures to be applied:	Cross-check the measurement with an annual energy balance that is based on stock changes, stocks at start and end of verification period, and production..
Any comment:	The bagasse quantity is on dry basis. There are no fuel purchases.

Data / Parameter:	**BF** $_{\text{all plants}, k,,y}$
Data unit:	tons of dry matter
Description:	Quantity of biomass residue type *k* combusted in all power plants (existing and new) at the project site during the year *y* (tons of dry matter)
Value applied	446,319
Source of data to be used:	On-site measurement
Measurement procedures (if any):	Use weight meters. Adjust for the moisture content in order to determine the quantity of dry bagasse. The quantity shall be crosschecked with the quantity heat generated using an energy balance. At the srat and end of every verification period, bagsse stocks and stock movements are monitored. Bagasse quantity also cross checked aginst calculated quantity based on bagasse yield as fraction of sugar cane. There will be no fuel purchases
Monitoring frequency	Continuously, aggregated at least annually.
QA/QC procedures to be applied:	Cross-check the measurement with an annual energy balance that is based on stock changes and production only since there are no purchases.
Any comment:	The bagasse quantity is on dry basis.

Data / Parameter:	**BF** $_{PJ,k,,y}$
Data unit:	tonnes of dry matter
Description:	Incremental quantity of biomass residue type *k* (bagasse) used as a result of the project activity in the project plant during the year *y*
Value applied	125,890
Source of data to be used:	On-site Calculation
Measurement procedures (if any):	Taken as bagasse historically dumped; $BF_{k\ dumped,\ historical\ 3y,}$ for ex-ante determination. This also the same as bagasse burnt in the project plant; BF $_{k,,y,}$) since it is assumed that all excess bagasse is burnt for ex-ante determination. Ex-post determination of BF $_{PJ,k,,y}$ will be calculated from the minimum of either the historical bagasse dumped ($BF_{k\ dumped,\ historical\ 3y,)}$ or the difference between all the bagasse burnt and the historical bagasse burnt (i.e. $BF_{all\ plants,,k,,y}$ –($BF_{historical,,k,3yr}$)/3).
Monitoring frequency	Calculated annually
QA/QC procedures to be applied:	Cross-check the calculation with an annual energy balance that is based on stock changes and production..
Any comment:	100% of the data will be monitored

Data / Parameter:	$\mathbf{EF_{CH4,BF}}$
Data unit:	tCH_4/GJ
Description:	Methane (CH_4) emission factor for the combustion of biomass residues in the project plant
Value applied	41.1
Source of data to be used:	Default values, as provided in Table 3 of ACM0006 Version 4
Measurement procedures (if any):	Shall be updated according to any future IPCC guidelines
Monitoring frequency	Referring to IPCC guidelines
QA/QC procedures to be applied:	At least once a year, verify that the default values used are in agreement with the latest IPCC default values.
Any comment:	Application of a conservative factor shall be applied, as specified in the baseline methodology of ACM006 Ver. 4.

Data / Parameter:	$\mathbf{FF_{project\ site,i,y}}$
Data unit:	Tonnes per year
Description:	Quantity of fossil fuel type *i* combusted at the project site for other purposes that are attributable to the project activity during the year *y*
Value applied	10
Source of data:	On-site volume measurements and mass conversions using density measurements with data reconciliation from fuel storage (stores requisitions)
Measurement procedures (if any):	Use of volume meters.
Monitoring frequency:	Continuously
QA/QC procedures:	Cross-checking the measurements using stock reconciliations with an annual

	energy balance that is based on used quantities and stock changes.
Any comment:	Fossil fuels are to be used only during boiler start ups.

Data / Parameter:	$\varepsilon_{heat, boiler, y}$
Data unit:	Fraction
Description:	is the heat energy efficiency of the bagasse fired boilers in operation during year y
Value applied	To be determined for each verification period for use in the energy balance for each boiler in operation during the period
Source of data:	On-site measurements
Measurement procedures (if any):	Use the direct method (dividing the net heat generation by the energy content of the fuels fired during a representative time period)
Monitoring frequency:	Continuously
QA/QC procedures:	Cross-checking the measurements with manufacturers data and previously determined data.
Any comment:	To be determined for each boiler in operation during the verification period.

Data / Parameter:	$EG_{project\ plant,y}$
Data unit:	MWh/yr
Description:	Net quantity of electricity generated in the project plant during the year y
Value applied	190,329
Source of data:	On-site measurements.
Measurement procedures (if any):	The net quantity of electricity generated is metered using energy metres (moving disc type on MSC panels) and reconciled with generation data and power export invoices to the KPLC.
Monitoring frequency:	Continuously
QA/QC procedures:	The consistency of metered net electricity generation should be cross-checked with receipts from electricity sales. Meter calibration status to be continuously monitored.
Any comment:	KPLC is also metering the export power from their side using their own meters and this will provide a further check on the accuracy of the electricity sold.

Data / Parameter:	$EG_{total,y}$
Data unit:	MWh/yr
Description:	Net quantity of electricity generated in all power units at the project site, generated from firing the same type of biomass residues as in the project plant, including the new power unit installed as part of the project activity and any previously existing units, during the year *y*
Value applied	252,000
Source of data to be used:	The quantity of electricity generated from each turbine is individually metered using energy metres (moving disc type on MSC panels). The net amount is then calculated as the sum total.
Measurement procedures (if any):	The net quantity of electricity generated is metered using energy metres (moving disc type on MSC panels) and reconciled with generation data and power export and internal power consumption.
Monitoring frequency:	Continuously

QA/QC procedures to be applied:	The consistency of metered net electricity generation should be cross-checked with receipts from electricity sales, generation data and internal consumption.
Any comment:	Internal consumption will have to be metered in order to cross-check this parameter.

Data / Parameter:	$\mathbf{EF_{CO2,FF\mathit{i}}}$
Data unit:	tCO_2e/GJ
Description:	CO2 emission factor for fossil fuel type *i*
Value applied	3.078
Source of data used:	IPCC default emission factors
Measurement procedures (if any):	From the latest IPCC tables. Review the appropriateness of the data annually
Monitoring frequency:	Annually
QA/QC procedures to be applied:	Check consistency of the IPCC default values. If the values differ significantly from previous IPCC default values, verify data.
Any comment:	This parameter to be verified annually

Data / Parameter:	$\mathbf{E_{OM,\,y}}$
Data unit:	tCO_2e
Description:	Emissions associated with the operating margin calculated from the hourly dispatch data for a set of power plants in the top 10% of grid system dispatch order as calculated from equation (7)
Value applied	166,743
Source of data to be used:	Calculated based using ACM0002, version 6, and the dispatch data obtained from KPLC and the latest IPCC emission coefficients ($\mathbf{EF_{\mathit{i}}}$) on annual basis.
Measurement procedures (if any):	Using an Excel spreadsheet, $\mathbf{E_{OM,\,y}}$ is calculated from the annual dispatch data, and from the Approved Specific Fuel Consumption for the Thermal Plants (Readily available from http://www.erb.go.ke/retail-tariff.pdf), the total fuel consumed in the thermal plants ($\mathbf{E_{OM,\,y}}$) as per equation (7)
Monitoring frequency:	Annually
QA/QC procedures to be applied:	Spread sheet used in the validated PDD ex ante calculations to be used. Dispatch data capture is automatic and used to pay energy suppliers, therefore very credible.
Any comment:	The annual dispatch data is available from KPLC on request.

Data / Parameter:	$\mathbf{EG_{,\,y}}$
Data unit:	MWh
Description:	The generation of the project in year y
Value applied	190,329
Source of data to be used:	Calculated from the Dispatch Data for the preceding year
Measurement procedures (if any):	Using an Excel spreadsheet, the generation of the project in year y ($\mathbf{EG_y}$) is calculated from the annual dispatch data obtained from KPLC annually
Monitoring frequency:	Annually
QA/QC procedures to be applied:	Spread sheet used in the validated PDD ex ante calculations to be used. ERB website data used is authoritative. Dispatch data capture is automatic and used to pay energy suppliers, therefore very credible.

Any comment:	The dispatch data is available from KPLC anytime on request but for monitoring, the data will be requested for annually.

Data / Parameter:	**$EF_{OM, y}$**
Data unit:	tCO_2e/MWh
Description:	Operating Margin Emission Factor
Value applied	0.8761
Source of data to be used:	Calculated using ACM0002, version 6, $EG_{, y}$ and $E_{OM, y}$
Measurement procedures (if any):	Using an Excel spreadsheet $EF_{OM, y}$ is calculated from $EG_{, y}$ and $E_{OM, y}$ using formula (6)
Monitoring frequency:	Annually
QA/QC procedures to be applied:	Spread sheet used in the validated PDD ex ante calculations to be used. Dispatch data capture is automatic and used to pay energy suppliers, therefore very credible.
Any comment:	The annual dispatch data is available from KPLC on request.

Data / Parameter:	**$EF_{BM, y}$**
Data unit:	tCO_2e/MWh
Description:	Build Margin Emission Factor
Value applied	0.4329
Source of data to be used:	Calculated using ACM0002, version 6, equation (9)
Measurement procedures (if any):	Using an Excel spreadsheet $EF_{BM, y}$ is calculated dispatch data (MWh) to identify from either the most recent 5 plant additions or 20% of the system generation that have been built most recently, whichever is higher.
Monitoring frequency:	Annually
QA/QC procedures to be applied:	Spread sheet used in the validated PDD ex ante calculations to be used. Dispatch data capture is automatic and used to pay energy suppliers, therefore very credible.
Any comment:	The annual dispatch data is available from KPLC on request.

Data / Parameter:	**NCV_i**
Data unit:	GJ / tonne
Description:	Net calorific value of the fossil fuel type *i*
Value applied	40.19
Source of data to be used:	IPCC 2006 volume 2, Chapter 1, Table 1.2 default net calorific values. The values are conservative. The IPCC default values were chosen because there are no national data or conducting measuring in the project site will not be possible due to lack of technology
Measurement procedures (if any):	Shall be updated according to any future IPCC guidelines
Monitoring frequency:	Appropriateness of the data will be reviewed annually.
QA/QC procedures to be applied:	Annual referencing with IPCC guidelines
Any comment:	

Data / Parameter:	**NCV_k**
Data unit:	GJ/ton of dry matter (bagasse)
Description:	Net calorific value of dry biomass residue type *k* (bagasse)
Value applied	11.6
Source of data to be used:	IPCC 2006 volume 2, chapter 1, Table 1.2 default net calorific values. The values are conservative.
Measurement procedures (if any):	Shall be updated according to the latest IPCC guidelines at the time.
Monitoring frequency:	Annual review and referencing with latest IPCC default values
QA/QC procedures to be applied:	Check the consistency with default values by the IPCC.
Any comment:	

Data / Parameter:	**$EF_{burning,CH4,k,y}$**
Data unit:	tCH_4/GJ
Description:	Methane (CH_4) emission factor for uncontrolled burning of the biomass residue type *k* (bagasse) during the year *y*
Value applied	0.002403
Source of data to be used:	Referenced to IPCC default values as outlined in the ACM0006 version 4
Measurement procedures (if any):	Shall be updated according to any future IPCC guidelines
Monitoring frequency:	Annual review of default values
QA/QC procedures to be applied:	Annual monitoring of the IPCC default values, and cross-checking with the project values.
Any comment:	Conservative factor shall be applied, as specified in the baseline methodology.

Data / Parameter:	**$EC_{PJ,y}$**
Data unit:	MWh
Description:	On-site electricity consumption attributable to the project activity during the year *y*
Value applied	0
Source of data to be used:	On-site measurements using energy meters
Measurement procedures (if any):	Use electricity meters. The quantity shall be cross-checked with electricity purchase receipts
Monitoring frequency:	Continuously, aggregated monthly
QA/QC procedures to be applied:	Cross-check measurement results with invoices for purchased electricity.
Any comment:	All metres meters used by MSC are calibrated by Kenya Bureau of Standards at appropriate intervals while the KPLC owned metres, maintained and calibrated by KPLC

Data / Parameter:	**$EF_{grid,y}$**
Data unit:	tCO_2/MWh
Description:	CO2 emission factor for grid electricity during the year *y*

Value applied	0.6545
Source of data to be used:	Use the latest approved version of ACM0002 to calculate the grid emission factor using ex-post data vintage
Measurement procedures (if any):	
Monitoring frequency:	Updated annually, consistent with guidance in ACM0002.
QA/QC procedures to be applied:	Application of procedures in ACM0002
Any comment:	All data and parameters to determine the grid electricity emission factor, as required by ACM0002, shall be included in the monitoring plan.

B.7.2 Description of the monitoring plan:

>>
Refer Annex 4 below for a detailed explanation of the monitoring plan.

B.8 Date of completion of the application of the baseline study and monitoring methodology and the name of the responsible person(s)/entity(ies)

>>
14/09/2006

The Environmental Cost Management (ECM) Centre Limited, which is the technical adviser on CDM project design and documentation of this project, is responsible for the application of the baseline and monitoring methodology to the project activity. The Environmental Cost Management (ECM) Centre Limited is not a project participant.

Organization:	Environmental Cost Management (ECM) Centre Limited
P.O. Box:	10135
Building:	KP Flats #7
City:	Nairobi
State/Region:	Nairobi
Postfix/ZIP:	00100
Country:	Kenya
Telephone:	254-3001661, 254-20-2712999, 254-0734947882, 254-0720828621
FAX:	254202712999
E-Mail:	ecm@ecmcentre.com
URL:	www.ecmcentre.com
Represented by:	Tom Owino Oduol
Title:	Executive Director
Salutation:	Mr.
Last Name:	Oduol
Middle Name:	Owino
First Name:	Tom
Department:	N/A
Mobile:	254-0733619841, 254-0720788032
Direct FAX:	254-20-271299
Direct tel:	254-3001661

Personal E-Mail:	towino@ecmcentre.com

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:

>>
01/06/2006

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

>>
20 years (240 months)

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:

>>
N/A

C.2.1.2. Length of the first crediting period:

>>
N/A

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

>>
01/10/2008

C.2.2.2. Length:

>>
10 years (120 months)

SECTION D. Environmental impacts

>>

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

>>

The Environmental Impact Assessment (EIA) for the proposed CDM project was carried out in September 2006 and submitted to the National Environment Management Authority (NEMA)[17] as required by law. The report was prepared following the laid down guidelines by NEMA. The report was reviewed by NEMA and a licence was issued to the project. The licence was issued after NEMA was satisfied that the proposed project will not have adverse environmental impacts and all necessary mitigation measures will be put in place to mitigate any impact which might arise.

The Environmental Impact Assessment report is annexed to the PDD.

D.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:

>>

The proposed cogeneration project will not cause significant environmental impacts during construction and operation.

SECTION E. Stakeholders' comments

>>

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

>>

A stakeholder meeting involving central and local government agencies, local NGOs community representatives, cane farmers, cane transporters, power purchaser, project proponents and all members of the District Environmental Committee was convened at Mumias Sugar Company Guest House. The project proponents lead by Head of Factory outlined all the details of the proposed project in a step by step manner. He explained all the likely impacts of the project, and the proposed mitigation measures for the identified potential negative impacts after which, the stakeholders were requested for comments and feedback.

The stakeholders were given forms/questionnaires and checklists designed by the EIA Expert for further comments in case there were additional issues they wanted to raise in writing and confidentially. The proceedings of the meeting were minutes and distributed to stakeholders for further comment and feedback. The minutes are annexed to this PDD.

[17] www.nema.co.ke

E.2. Summary of the comments received:

>>

The comments have been annexed to the PDD as minutes of the stakeholders meeting. Generally, the meeting agreed that the project had substantial benefits to the country and community and should proceed. However, they wanted more community benefits from the projects such as affirmative and preferential employment of the community members in the project, better pay to sugar cane farmers and provision of some of the electricity generated to the local community, especially markets and shopping centres.

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

>>

The company has reviewed the comments and is looking into the modalities of appropriately compensating farmers for the fibre. The company will also give preference to the local community members during employment of unskilled labour for the project. Some of the comments such as power distribution to local community and shopping centres are outside the jurisdiction of the company. This was explained to the stakeholders but has also been brought to the attention of the Kenya Power and Lighting Company, who is the only licensed and authorised distributor of power in Kenya.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	MUMIAS SUGAR COMPANY LIMITED
P.O. Box:	PRIVATE BAG,MUMIAS KENYA
Building:	-
City:	-
State/Region:	KENYA
Postfix/ZIP:	Private Bag
Country:	KENYA
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FAX:	+254-56-641087/641234
E-Mail:	ekidero@mumias-sugar.com
URL:	-
Represented by:	EVANS KIDERO
Title:	MANAGING DIRECTOR
Salutation:	DR.
Last Name:	-
Middle Name:	KIDERO
First Name:	EVANS
Department:	Managing Director
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Direct FAX:	
Direct tel:	-
Personal E-Mail:	ekidero@mumias-sugar.com

Organization:	JAPAN CARBON FINANCE LTD
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State/Region:	JAPAN
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Country:	JAPAN
Telephone:	+81352128870
FAX:	+81352128886
E-Mail:	ke026@jcarbon.co.jp
URL:	-
Represented by:	Mr. Joichi Kimura
Title:	Director General
Salutation:	Mr
Last Name:	Joichi
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First Name:	Kimura
Department:	-
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Direct FAX:	+81352128886
Direct tel:	+81352128870
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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

This project will not benefit from any public funding

Annex 3

BASELINE INFORMATION

General

The Kenyan electricity system has one grid system which serves the entire country. All generating companies feed their power to this grid which is owned by the Kenya power and Lighting Company (KPLC) the sole distribution company. However, not all parts are served by this grid since some are served by isolated fossil fuel generators owned by KPLC.

The Kenyan electricity system comprises of around 1155.0MW of installed capacity, with an effective capacity of 1,066.9MW. For example in 2004/2005, Kenya Power and Lighting Company purchased 5,347.7 GWh from power producers, and out of this 53.6% was from hydro sources, 25.1% from petro-thermal sources, 19.4% was from geo-thermal sources, 0.01% was from wind sources and 1.9% was imported. The proportion of the fossil fuel based thermal component increases substantially during dry seasons and it is this portion that will be significantly replaced because cogeneration electricity is available during the dry season while the mills normally shut down during the rainy season, when hydroelectricity happens to be readily available.

Power rationing often accompanies any shortfall. To avoid this, a 100 MW fossil-based thermal plant has recently been installed and commissioned.

Besides, the feature of electricity generation from bagasse during the dry months when the hydroelectricity (the most important type of electricity in Kenya) is stressed provides complementary energy and makes the bagasse cogeneration electricity attractive to the whole country, in general, and to the potential purchasers in particular.

Approved methodologies ACM0006 version 4 requires project proponents to account for “all generating sources serving the system”. In that way, when applying one of these methodologies, project proponents in Kenya searched for all power plants serving the Kenyan electricity system. www.kplc.co.ke.

Clarification on how Kenyan grid emissions factor has been determined

Kenya has only one national electricity grid. The proposed plant is therefore to export electricity to the Kenyan national grid. The electricity generated from the project would therefore be expected to displace part of existing and planned generation in the grid, which is a mixture of renewable and fossil fuel-based sources.

In accordance with ACM0006; Version 4, and since Scenario 16 applies to this project as explained in the PDD, the emission factor for displacement of electricity ($EF_{electricity, y}$) corresponds to the grid emission factor ($EF_{grid, y}$).

Since the power generation capacity of the project plant is more than 15 MW, $EF_{grid, y}$ is calculated as a combined margin (CM), consisting of the combination of operating margin (OM) and build margin (BM) factors according to ACM002; Version 6.

Using the equation below, the dispatch data analysis operating margin CO_2 emission factor in year y (t CO_2/MWh) was calculated as follows:

$$EF_{grid,\ OM\text{-}DD,y} = (\sum_h EG_{PJ,h}.EF_{EL,DD,h}) / EG_{PJ,h}$$

Where

$EF_{grid,\ OM\text{-}DD,y}$ = Dispatch data analysis operating margin CO_2 emission factor in year *y* (tCO_2/MWh)

$EG_{PJ,h}$ = Electricity displaced by the project activity in hour *h* of year y (MWh). The 2005/2006 hourly dispatch data used to calculate this parameter was obtained from the Kenya Power and Lighting Company Limited Annual report, www.kplc.co.ke (the only electricity buyer and distributor in the country). These integrated total electricity production figures were cross checked with the total power generated during the same 2005/2006 period as provided by the Electricity Regulatory Board[18], www.erb.go.ke/downloads, and were found to agree. See the attached Excel spreadsheet (Sheet 2005-2006 EMO, y).

$EF_{EL,DD,h}$ = CO_2 emission factor for power units in the top of the dispatch order in hour *h* in year *y* (tCO_2/MWh). This factor was calculated based on the energy efficiency of the power plants and the type of fuel used as provided by the Electricity Regulatory Board, www.erb.go.ke/downloads, for purposes of Power Purchase Agreement and Tariff negotiations. This data is available freely from the Electricity Regulatory Board website, www.erb.go.ke/downloads. The following equation was used:

From the Table 1 below:

Total Power into the National Grid (MWh)-2002/03 to 2005/6 (3 yrs):	16,003,780.0
Total Power from 7 most recent plants (MWh):	4,926,000.0
Total CO_2 Emissions from 7 most recent plants (tonnes):	1,639,121.5

Note: 7 most recent plants used since Kipevu Steam Plant was decommissioned in 2004/5 and 2 Nairob South Diesel Plants commissioned at the same time

[18] The Electricity Regulatory Board has since changed its name and role to Energy Regulatory Commission (ERC), http://www.erc.go.ke/downloads.htm

TABLE 1: EMISSIONS FROM INSTALLED POWER PLANTS

Thermal Plants	Approved [19]Specific Fuel Consumption (Kg/KWh)	Power Supplied in 2005/6 (GWh)	Power Supplied in 2004/5 (GWh)	Power Supplied in 2003/4 (GWh)	Total Power for 3 yrs (MWh)	Total Fuel Consumption (Tonne)2005/6	Total Fuel Consumption (Tonne)2004/5	Total Fuel Consumption (Tonne)2003/4	Total Fuel for 3 yrs (tonnes)	CO_2 Emissions (tonnes)	Year Plant Installed
Kipevu Diesel Plant (TPC)- heavy fuel oil	0.219	570.0	508.0	200.0	1,278,000.0	124.8	111.3	43.8	279.9	861,553.1	2001
Kipevu Diesel Plant (KenGen)-heavy fuel oil	0.21	399.0	330.0	279.0	1,008,000.0	83.8	69.3	58.6	211.7	651,608.8	1999
Kipevu Gas Turbine (KenGen)-jet kerosene	0.3	194.0	97.0	4.0	295,000.0	58.2	29.1	1.2	88.5	279,332.8	1987
Kipevu Steam Plant (KenGen)-heavy fuel oil	0.335	0.0	48.0	56.0	104,000.0	0.0	16.1	18.8	34.8	107,247.0	1999
Nairobi South Gas Turbine- diesel oil	0.41	18.0	3.1	0.0	21,080.0	7.4	1.3	0.0	8.6	27,460.0	1973
Nairobi South Diesel Plant-Niigata (Iberafrica)-fuel oil	0.229	212.2	170.0	125.0	507,160.0	48.6	38.9	28.6	116.1	357,509.5	1998
Nairobi South Diesel Plant-Wartsila (Iberafrica)-fuel oil	0.223	195.8	160.0	115.0	470,840.0	43.7	35.7	25.6	105.0	323,210.4	1998
Aggreko industrial diesel(2006)	0.23	30.0	0.0	0.0	30,000.0	6.9	0.0	0.0	6.9	21,922.8	2006
Olkaria II (Geothermal Plant)	0	562.0	**549.0**	417.0	1,528,000.0	0.0	0.0	0.0	0.0	0.0	2003
Olkaria I (Geothermal Plant)	0	324.0	**371.0**	266.0	961,000.0	0.0	0.0	0.0	0.0	0.0	1985
Mumias	0	9.0	**0.0**	0.0	9,000.0	0.0	0.0	0.0	0.0	0.0	
Orpower4	0	117.0	**115.0**	105.0	337,000.0	0.0	0.0	0.0	0.0	0.0	
Hydro	0	3,034.0	2,869.0	3,259.0	9,162,000.0	0.0	0.0	0.0	0.0	0.0	
Wind	0	0.4	0.4	0.4	1,200.0	0.0	0.0	0.0	0.0	0.0	
Imports	0	15.4	99.0	177.1	291,500.0	0.0	0.0	0.0	0.0	0.0	
Total		**5,680.8**	**5,319.5**	**5,003.5**	**16,003,780.0**	**373.4**	**301.6**	**176.6**	**851.6**	**2,629,844.4**	

[19] Already Plant efficiency factored in by the Electricity Regulatory Commission (formally Electricity Regulatory Board)

$EF_{EL, DD, h}$ = $(\sum_n EG_{,n,h} \cdot EF_{EL,n,y}) / \sum_n EG_{n,h}$

Where

$EG_{n,h}$ = Net quantity of electricity generated and delivered to the grid by power unit *n* in hour *h* (MWh). The net amounts of electricity generated and delivered by the power units were obtained from the Electricity Regulatory Commission (formerly Electricity Regulatory Board, www.erb.go.ke/downloads0 as shown in the Table 1 above.

$EF_{EL,n,y}$ = CO_2 emission factor for power unit *n* in year *y* (tonnes CO_2/MWh). These were calculated from the fuel emission factors from the IPCCC tables and the approved specific fuel consumption provided by the Electricity Regulatory Commission, www.erb.go.ke/downloads, (See Table 2 below).

n = Power units in the top of the dispatch. The grid system dispatch order and the dispatch data, both from the Kenya Power and Lighting Company Limited were analysed and the power units in the top dispatch were identified as per the guidelines in ACM0002, ver 6.

h = Hours in the year *y* in which the project activity is displacing grid electricity. This has been taken as 72,000 hrs. (i.e. 300 days a year, 24 hrs a day).

TABLE 2: CARBON DIOXIDE EMISSIONS COEFFICIENT (COEFi) CALCULATION

	Diesel	**Jet Kerosene**	**Heavy Fuel Oil**
Net calorific value of fuel used (Terajoules/10^3 tonnes)- $NCV_{i,y\,i}$	43.33	44.59	40.19
Molecular weight ratio of CO_2 to C (44/12)	3.67	3.67	3.67
Carbon emission factor per unit of energy (tonne C/Terajoules)	20.20	19.5	21.1
Carbon dioxide emission factor per unit of energy (t CO_2/TJ)	74.07	71.50	77.37
Oxidation factor for fuel used (%)	0.99	0.99	0.99
CO_2 Emission Coeffient, $COEF_i = NCV_i * EFCO_{2,i} * OXID_i$	**3,177.2**	**3,156.3**	**3,078.3**

The operating margin emission factor was then calculated as follows (See attached spreadsheet):

EFOM, Dispartch,y = EOM,y / EGY	**2005-2006**
EG_y	190,329
$E_{OM,y} = EG_h * EF_{DD,h}$	166,743
$EF_{OM,.Dispatch,y} = E_{OM,y} / EG_Y$	0.8761
$EF_{OM,Dispatch,y}$ (tCO_2/MWh)	**0.8761**

The data used to calculate EG_y is as given in the Table 3 below and the attached Excel spread sheet (Historical Power data), . The equation used is:

$$EG_y = \text{MIN}\{EG_{project\ plant,\ y} \text{ or } EG_{total,\ y} - EG_{historical,\ 3yr}/3\}$$

Where

EG_y =Net quantity of increased electricity generation as a result of the project activity (incremental to baseline generation) during the most recent year *y* (MWh/yr)

$EG_{project\ plant,y}$ =Net quantity of electricity generated in the project plant during the year *y* (MWh/yr)
$EG_{total,y}$ =Net quantity of electricity generated in all power units at the project site, generated from firing the same type(s) of biomass residues as in the project plant, including the new power unit installed as part of the project activity and any previously existing units, during the year *y* (MWh/yr)
$EG_{historic,3yr}$ =Net quantity of electricity generated during the most three recent year in all power plants at the project site, generated from firing the same type(s) of biomass residues as used in the project plant (MWh)

Table 3: Determination of EG_y

MSC Energy Data (MWh)			
Year	**2005**	**2004**	**2003**
Turbo alternators	65,172.77	62,702.37	56,505.70
Diesel Alternators	421.81	68.14	142.47
KPLC import	1,758.70	1,579.40	2,922.36
KPLC Export	4,591.54		
Years Total	**67,353.28**	**64,349.91**	**59,570.53**
Average Power from Biomass	**61,460.28**		

Baseline Generation	**2005**	**2004**	**2003**
Turbo alternators	65,172.77	62,702.37	56,505.70
Diesel Alternators	421.81	68.14	142.47
Total	**65,594.58**	**62,770.51**	**56,648.17**
3 Yr average	**61,671.09**		

From the application the equation, the following results were obtained (Refer Excel Spread sheet):

EG_y = MIN {$EG_{project\ plant,\ y}$ or $EG_{total,\ y}$ - $EG_{historical,\ 3yr}$ /3}

$EG_{project\ plant,\ y}$	=	190,329
$EG_{total,\ y}$	=	252,000
$EG_{historical,\ 1yr}$	=	61,460
$EG_{total,\ y}$ - $EG_{historical,\ 3yr}$ /3	=	190,540

The determination of the built margin emission factor was as follows (Excel spread sheet, EOM, y):

$EF_{BM,y}$ (tCO2/MWh)	**(January-June)**	**(July - December)**	**Total**
∑ F i,m,y * COEFi,m; tonnes of CO_2	682,346,853.67	643770960	**1,326,117,813.52**
∑GEN $_{m,y}$ (MWh); power supplied from 5 recent additions	1,526,914,640.00	1536643260	**3,063,557,900.00**
$EF_{BM,y} = \sum F_{i,m,y} * COEF_{i,m} / \sum GEN_{m,y}$ (tCO2/MWh)	0.4329		

Notes:

Emissions and power supplied from the 5 most recent power plants were calculated using the 2005/2006 hourly dispatch data from the Kenya power and lighting Company. This data has already been provided to the DOE last year.

5 most recent plants in calculation of the Build Margin were identified from Table 1 above since it was established that the set of additions that comprised 20% was less (Data from Electricity Regulatory Board)

Power Supplied in 2005/6 in GWh were obtained from the Kenya Power and Lighting Company Limited (Annual report)

Carbon Emission Factor (tons Carbon per Terrajoule of power) based on *IPCC Reference Manual, 2006.*

In summary, the following sets of information and sources were used and availed to the DOE:

Type of information	Source	website	Availability
Hourly Dispatch Data (2003-2006)	Kenya Power and Lighting Company	www.kplc.co.ke	On request only
Dispatch Order	Kenya Power and Lighting Company	www.kplc.co.ke	On request only
Grid Connected Power Plants and their ages	Kenya Power and Lighting Company Electricity Regulatory Board	www.kplc.co.ke www.erb.go.ke/	On request only Publicly available from website
Annual Power Generation by Each Grid Connected Plant (2003-2006)	Kenya Power and Lighting Company Electricity Regulatory Board	www.kplc.co.ke www.erb.go.ke/	Annual Report Publicly available from website
Approved Specific Fuel Consumption (Kg/KWh), and Approved Fuels and Plant Efficiencies	Electricity Regulatory Board	www.erb.go.ke/	Publicly available from website
Fuel Emission Factors	IPCC		
Weightings for combined margin calculations	Default from ACM 0002		
Historical Power Generation and consumption by Mumias Sugar company	Kenya Power and Lighting Company Electricity Regulatory Board Mumias Sugar Company	www.kplc.co.ke www.erb.go.ke/	Annual Report Publicly available from website

Annex 4

MONITORING INFORMATION

MSC is an ISO-9001 certified company, and maintains all production/purchase/sales records as per audit guidelines. MSC has procedures in place for operation and maintenance of the plant machinery, equipment and instruments and data on maintenance & calibration of the equipment. The equipment used for the cogeneration project would also be maintained and controlled through the ISO 9001 certified system. The ISO 9001 certified quality management system will provide a basis of the monitoring plan for the project.

The following are the details of the monitoring plan:

1. Requirements for Monitoring

The proposed project developer must maintain credible, transparent and adequate data measurement, collection, estimation, and tracking systems in order to enable verification of the Emission Reduction Units.

Emission reduction will be realized through the use of a renewable source of electricity thereby avoiding the use of fossil fuel, and from methane abatement resulting from avoidance of bagasse dumping. The following parameters are therefore the most important data that need monitoring

- The grid-connected power generation and the baseline emission factor.
- The amount of bagasse whose dumping has been avoided (incremental consumption), and the aerobic decomposition and uncontrolled burning baseline emission factor.
- The grid emission coefficient, calculated from dispatch data and fuel consumption.

The structure for monitoring this project activity will basically consist of recording data on the amount of electricity generated in the project plant, amount of electricity consumed by all processes in MSC and amount of electricity exported to the national grid. To monitor the grid emission coefficient, the annual dispatch data from the Kenya Power and Lighting Company will be collected on an annual basis. This data will then be used to calculate the energy generated in the grid and also the total emissions from the grid. To calculate the total annual emissions from the grid, data on the Approved Specific Fuel Consumption of the set of power plants in the top 10% of the grid system dispatch order for a specified time. The default IPCC fuel emission coefficients are also required to calculate the grid emission coefficient and will be monitored on an annual basis.

There are three operations that the project operators must perform in order to ensure data consistency.

2. Responsibility for Monitoring

Mumias Sugar Company Limited is both the project owner and developer and is therefore responsible for monitoring.

The Managing Director is the overall responsible person for the operation and monitoring of the Co-generation Plant. Specifically, the Head of Factory who is accountable to the Managing Director is responsible for all the monitoring activities within the plant. Under the Head of Factory, the Production Manager, the Mechanical Engineer and the Electrical Engineer will be further assigned more specific duties with regard to monitoring of the project. As is currently the case, the Electrical Engineer will be responsible for monitoring all the metered electricity, including their calibration status and overall accuracy. The Production Manager will continue to monitor the Sugarcane processed, bagasse produced and bagasse burnt in the boilers.

The Head of Factory will also be responsible for collecting the annual dispatch data from KPLC, the Approved Specific Fuel Consumption data for the fossil fuel power plants in the grid and for verifying the applicable fuel type emission factors each year. The Head of Factory will be responsible and accountable for the generation of Emission Reductions, including the ERPA fulfillment, monitoring, record keeping, computation of Emission Reductions and verification activities.

The Marketing Manager, who is also responsible for corporate affairs and public relations will develop and monitor the fulfillment of the social aspects of the project.

Through the existing ISO 9001:2000 management systems already in practice, internal audits and management reviews will be conducted to ensure compliance with the established and documented systems for monitoring, recording, maintaining and, if necessary, improving the data. This responsibility will continue to be implemented by the appointed Quality Management Representative.

In case of staff during the project crediting period, appropriate training will be provided to the new staff in order to ensure adequate competence to carry out the required monitoring. One of the staff will be specifically trained to use the spreadsheet for calculating the grid emission factor.

3. Meters Installation and Bagasse Weight Measurement

Two meters will be installed on the power export line (one on the Mumias Sugar Company (MSC) side will be the Back Up Meter while the other on the Kenya Power and Lighting Company (KPLC) side will be the Main Meter. The Back Up Meter will be owned, operated and maintained by MSC while the Main Meter will be owned, operated and maintained by KPLC. The two systems will be readable remotely and will also record the cumulative generation. Both MSC and KPLC will have the right to read the two meters.

Power generation, import, export, auxiliary consumption & fuel consumption will be recorded daily and will be verified and approved by Head of Factory. These records will be sent to CDM office for review reconciliation, verification and archiving.

The amount of Sugarcane crushed, and quantity of sugar produced are currently monitored as part of the data used to pay Sugarcane farmers and monitor sugar yields. This data will continue to be monitored by MSC as the existing system is adequate and even meets the existing legal requirements. MSC owns, operates and maintains the weighing equipment. Bagasse yields will be calculated as is currently the case, although the moisture content will be regularly monitored to ensure efficient boiler operation and to calculate the dry bagasse weight.

To determine the amount of total and incremental bagasse combusted in the boilers, weight measuring meters will be installed for both boilers (existing and project). The amount of bagasse burnt in each of the boilers will be determined through the direct measurement. The total bagasse combusted is determined through summing up the bagasse burnt in each of the boilers. For quality assurance and on an annual basis, the bagasse stock movements are monitored together with the bagasse stocks at the beginning and end of each verification period. Mass and energy balances are then prepared around each boiler. This is further cross checked with the total bagasse production as determined from the established bagasse yield as a fraction of sugar cane crushed.

The mass balance would be on the basis of the measured quantity of sugar cane crushed, water added, mixed juice and excess bagasse and energy balance would be on the basis of steam quality and quantity generated .

4. Calibration of Meters

MSC carries out calibration of its exiting meters and weighing machines at planned intervals and in accordance with predetermined procedures. The calibrations, as carried out, meet both the ISO 9001:2000 and the Weights and Measures Act requirements. Appropriate calibration records are maintained.

Specifically, the MSC energy meters shall be tested and calibrated by Kenya Bureau of Standards each year. KPLC meters are calibrated by KPLC.

5. Monitoring

Reference should be made to section B.7.1 for the data to be monitored.

5.1.1. **Monitoring of Grid Connected Electricity Generated by the Proposed Project**

Grid connected electricity generated by the proposed project will be monitored through metering equipment at the transformer substation (interconnection facility connecting the plant to the grid). The data can also be monitored from the on-site control centre using a computer system. A detailed monitoring procedure of grid-connected electricity generated by the proposed project will be established in accordance with the Grid Connection Agreement.

The meter reading will be easily accessible for the DOE and calibration records will be maintained for verification.

Total electricity generated by the cogeneration plant will be recorded at the project site on the MSC panel. The generation data will be recorded on a continuous basis by energy metres. Generation data readings will be done at each end of every 8 hour shift and recorded in a manual log book. Exported electricity readings will also be done at midnight of every month end and recorded. Metre reading will be done by KPLC staff in presence of MSC officials.

Power generation, export and auxiliary consumption will be recorded at the plant on MSC panels and KPLC panels simultaneously from the installed meters. However, for applying monthly bill to MSC the meter readings will be taken at midnight of every month end by KPLC officials in presence MSC officials and readings will be jointly certified.

The following log sheets will be maintained for the critical equipment of the plant and readings are recorded on day to day basis (at the end of each every 8 hour shift):

- Turbine log
- Boiler log
- Electrical log

The monthly readings of the calibrated meter equipment must be recorded in an electronic spreadsheet. Mumias Sugar Company Electrical Engineer will visit the cogeneration plant and along with KPLC staff to take meter readings at midnight of the end of the month. The meter readings will be from the main KPLC meter at the KPLC panel at the interface point with the National Grid but it will be checked against the ‘’check meter’’ at the substation. Mumias Company in turn checks the meter readings with their own meters situated on the MSC control panel in the turbine of the power plant.

Moreover, according to the law, the metering equipment shall be periodically calibrated to comply with the regulations for independent power producers connected to the National Grid. MSC metres will be calibrated annually by Kenya Bureau of Standards while metres used by KPLC are calibrated by KPLC following their calibration schedule.

Sales receipt, power generation data as well as sugarcane and bagasse quantities must be archived for double checking the data. In case of inconsistency, these are the data to be used. The archived documents will be kept in hard and soft copies for a minimum of 12 years from the start of the crediting period.

Yearly calculation of the amount of bagasse used to generate electricity for sale to the National Grid. The calculations will be done by Electrical Engineer.

5.1.2. **Monitoring of Bagasse Burnt and the Direct Emissions**

Direct on-site emissions arise from combustion of bagasse in the boilers. These emissions mainly comprise CO_2 and CH_4. However, it is assumed that CO2 emissions from surplus bagasse do not lead to changes of carbon pools in the LULUCF sector. Emissions from CH_4 are considered and will be monitored. Data will be recorded each day in the boiler log book regarding the amount of bagasse combusted in the boilers. This data will them be used for calculation of the amount of emission generated from burning bagasse in the boilers. In addition, laboratory analysis of the moisture content of bagasse used in the boilers will be conducted not less than once per week.

Fossil fuels used for boiler start ups will be monitored at each use. Data will be kept in the stores when the fuel is requisitioned and tallied at the end of the month and year to establish the total amount of fuel used.

The following is the procedure used to monitor the bagasse quantity at the plant site:

1. Monitoring of Bagasse Consumption and Steam Generation on continuous basis

   Step1: The quantity of bagasse consumed in each of the two boilers (existing and project) is continuously monitored though continuous measurement.
   Step 2: The actual quantity of steam generated is measured using steam flow meter, pressure and temperature gauges for each of the 2 boilers.
   Step3 **-** The quantity of bagasse consumed in each boiler is then estimated by dividing the total amount of steam generated by the steam raising[20]

2. Cross checking and Verification of Bagasse Consumption on monthly basis

   Step 1 **-**The total bagasse generated in the sugar manufacturing facility is based on the total cane crushed and percent amount of bagasse in cane. The actual amount of cane sent for the crushing is weighed on a weigh bridge and the per cent bagasse per unit of cane is measured in the laboratory, and with reference to previous test run results, the total quantity of bagasse produced is determined. This is cross checked with the total bagasse calculated from the energy balance covering all the boilers and the mass balance based on the stock movements and the verification perid opening and closing stocks.
   Step 2 **-**The bagasse consumed in the boilers is measured as above.
   Step 3 **-**The total bagasse consumed so calculated is then cross checked with the value obtained by continuous monitoring procedure.
   Step 4: The incremental bagasse is the determined as the smaller of either the historical 3 year average bagasse dumped over the prior 3 years or the difference between the total bagasse burnt and the historical 3 year average of the bagasse burnt over the prior 3 years.

5.2. Dispatch Data Analysis and Merit Order Monitoring

As mentioned 5.1.1 above, the Electrical Engineer will be assigned specific duties with regard to monitoring of the project. He will be responsible for monitoring all the metered electricity, including their calibration status and overall accuracy. In addition, he will be assigned the role of liaising with Kenya Power and Lighting Company Limited official in collecting dispatch data and grid merit order data which will be used in recalculating the operating margin emission factor and build margin emission factor. Dispatch data and merit order data collected will be analysed as indicated in the relevant Consolidated baseline methodology for grid-connected electricity generation from renewable sources (ACM0002).

5.3. Quality Assurance and Control

[20] The steam raising is the steam generated in tons per ton of bagasse. The value is based on steam raising tests conducted at the factory several times. The data is available at the factory for verification. In the steam raising test, a known quantity of bagasse is fired in the boiler and the quantity of steam generated is monitored through steam flow meter. The value obtained from dividing the steam generated by the quantity of bagasse fired is the steam raising.

The quality assurance and control procedures for recording, maintaining and archiving data shall be improved as part of this CDM project and continual improvement of the ISIO 9001-certified quality management system. This is an ongoing process, which will be ensured through the need to verify the emission reductions on an annual basis in accordance to this PDD and Baseline Methodology for Grid-connected Electricity Generation from Biomass Residues- ACM0006; Version 04; of the Approved Baseline and Monitoring Methodologies.

6. Start Ups

During the Sugar Mill start ups, the project may use small quantities of fossil fuels. In such a case, the quantity of the fossil fuels used shall be recorded in detail, as is currently the case, and leakage emission shall be calculated in a transparent and accurate way and in accordance to the Approved Baseline and Monitoring Methodology, ACM0006; Version 04.

7. Data Management System

The data management system provides information on record keeping of the data collected during monitoring. Record keeping is the most important exercise in relation to the monitoring process. Without accurate and efficient data, the emission reduction from the proposed project cannot be verified.

Overall responsibility for monitoring of the Green House Gas emission reduction will rest with the Head of Factory who is also responsible for the project. The PDD sets out the procedures for tracking information from the primary source to the end data calculations, in paper document format. If the data is from the internet, the website shall always be provided. Also, the credibility and reliability of the data and information have been confirmed by the CDM project developer, or other qualified person. It is the responsibility of the Head of Factory to provide any additional necessary data and information for validation and verification requirement of the DOE.

Physical documentation such as paper-based maps, diagrams and reports will be collated in a central place with the monitoring plan. In order to facilitate reference, monitoring results will be indexed. All paper based information will be stored by the Head of Factory, or his appointee, and at least one additional copy will be maintained.

The person assigned the day-to-day responsibility for information management system for emission reduction monitoring shall be appropriately qualified.

8. Verification and Monitoring Results

The verification of the monitoring results of the project is a mandatory requirement for all CDM projects. The main objective of the verification is to independently verify that the project has realized the emission reductions as reported and projected in the PDD. It is expected that the verification will be done annually.

The main verification activities are:

- The signing of the verification contract between MSC and the DOE and abiding by the time framework set by the Executive Board for carrying out verification activities while taking into account the buyer’s schedule. MSC will make arrangements for verification and will appropriately prepare for the audit and verification process.
- Completion of the necessary information by MSC for verification by the DOE before and during verification activities.
- Full cooperation of the DOE by MSC and the instruction of staff and management to be available for interviews and honest response to all questions raised by the DOE.
- Resolution of any requirements raised by the DOE that are deemed unreasonable by MSC. This shall be done by consulting the CDM project developer or other qualified entity and should this fail, a rewritten rejection letter shall be provided to the DOE with justifications. If no agreement is reached, the matter shall be referred to the CDM Executive Board or UNFCCC for arbitration.
- The proposed project has designated the Head of Factory as the responsible person for the monitoring and verification process and shall act as the focal point for DOE.

Annex 5

SUMMARY OF POST REGISTRATION CHANGES

The Project has been installed and commissioned as planned and as described in the Project Design Document (PDD)**- Reference :** http://cdm.unfccc.int (Number 1404) – except for the following changes:

Permanent Changes

The following is the only permanent post registration change that has occurred since registration of the project activity:

i. A 34.2 MW turbine has been installed instead of the originally planned 25 MW turbine. Since the project had been originally designed and registered as a large scale project, this change is not considered material to either the integrity or additionality of the emission reductions claimed.

This change would not impact the additionality of the project since:

- It represents the same technology but with a bigger turbo-generator than the registered project.
- It has no additional component or extension of technology.
- The project is not multiple-site.
- The investment analysis was not used for proof of additionality of the project but barrier analysis was used instead and project was first of its kind.
- The circumstances of the project have not changed and the additionality arguments still do apply.

The following is a summary of the changes and their impacts.

Impacts	Changes
	A 34.2 MW turbine has been installed instead of the originally planned 25 MW turbine
a) The applicability and application of the applied methodology under which project was registered	Since the project is registered as a large scale project, this change has no impact on applicability and application of the methodology
b) Compliance of the monitoring plan with the applied methodology	This change has no impact on compliance of the monitoring methodology
c) Level of accuracy and completeness in the monitoring of the project activity	This change has no impact on the level of accuracy and completeness in the monitoring of the project activity
d) The additionality of the project activity	The additionality of the project activity is not impacted by this change since barrier analysis was applied and the registered project is large scale and remains so even with this change.
e) The scale of the project	The scale of the project is not impacted by this change since the registered project activity is large scale and remains so even with this change.