# 35 MW Bagasse Based Cogeneration Project

# by

# Mumias Sugar Company Limited (MSCL)

## UNFCCC Clean Development Mechanism
## Project Design Document

**VER 03.1, 13 November 06**

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

## CONTENTS

SECTION A.   General description of project activity

A.1      Title of the project activity:
>>
**"35 MW Bagasse Based Cogeneration Project"** by Mumias Sugar Company Limited (MSCL)

Version 03.1

Date of document: 13/11/ 2006.

A.2.      Description of the project activity:
>>
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 150 t/hr high pressure (87 barg) steam boiler at Mumias Sugar Company Limited.
- Installation of a 25 MW condensing extraction turbine alternator at Mumias Sugar Company 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 turbo alternator 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 2 years.

[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 necessary to facilitate the continuous export of 2 MW to the national grid. 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.

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] | | | | | Turbine Generators | | |
|---|---|---|---|---|---|---|---|
| Steam Capacity (t/hr) | Number of Units | Pressure (Barg) | Steam Temperature (°C) | Age (Years) | Installed Capacity (MW) | Number of Units | Age (Years) |
| 110 | 1 | 21 | 380 | 10 | 7[4] | 1 | 10 |
| 55 | 2 | 21 | 380 | 27 | 2.5 | 2 | 15 |
| 22 | 4 | 21 | 283 | 33 | 1.25 | 1 | 22 |
| | | | | | 1.75 | 1 | 22 |
| **308** | **7** | | | | **15**[5] | **5** | |

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

| Boilers | | | | | Turbine Generators | | |
|---|---|---|---|---|---|---|---|
| Steam Capacity (t/hr) | Number of Units | Pressure (Barg) | Steam Temperature (°C) | Age (Years) | Capacity (MW) | Number of Units | Age (Years) |
| 110[6] | 1 | 21 | 380 | 10 | 7 | 1 | 10 |
| | | | | | 2.5 | 2 | 15 |
| 150 | 1 | 87 | 525 | New | 25 | 1 | New |
| **260** | **2** | | | | **37**[7] | **4** | |

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 2,400,000 tonnes of cane in 2005 and is expected to crush similar quantities in 2006 based on the quantities crushed so far and the projections for the remaining months of the year. Of the total cane crushed, existing data indicate that 37% is bagasse yield which is equivalent to 888,000 tonnes of bagasse. 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).

---

[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

[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.

This leaves a surplus of 240,000 tonnes of bagasse (10% of total cane crushed), and it is this amount which is transported by company trucks and 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.The project will therefore reduce GHG emissions directly from the following sources:

- Displacing grid electricity with GHG-neutral biomass electricity generation. This component of the project activity is expected to achieve GHG emission reductions of **872,863.08 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 **82,352.40 $tCO_2e$** over the 10 year period.

The overall GHG emission reductions expected from the project is therefore **955,215.68 $tCO_2e$** 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[8] *(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).

---

[8] 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.

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 where 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[9] 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[10].

The sale of the CER generated by the project will boost the financial viability of the project.[11] 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: |
|---|---|

>>
**Table 2: 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 |

---

[9] 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.

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

[11] 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.** | **Technical description of the project activity:** |
|---|---|

| | **A.4.1. Location of the project activity:** |
|---|---|

>>

| | **A.4.1.1.** | **Host Party(ies):** |
|---|---|---|

>>

Kenya

| | **A.4.1.2.** | **Region/State/Province etc.:** |
|---|---|---|

>>

Western Province

| | **A.4.1.3.** | **City/Town/Community etc:** |
|---|---|---|

>>

Butere – Mumias District

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

>>

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 Figure 1 below).



**Figure 1**: Geographical position of the Butere – Mumias District
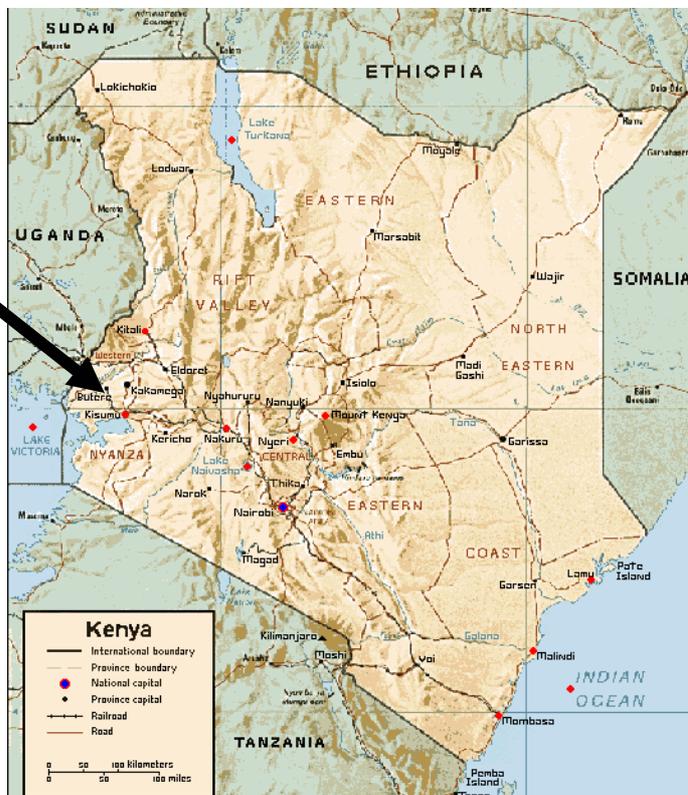
| A.4.2.  Category(ies) of project activity: |
| --- |

\>\>

Electricity generation by renewable sources

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

\>\>

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 150 t/hr at 87 barg and 525 $^0$C in combination with the existing 110 t/hr low pressure (21 barg) steam boiler. The new configuration consists of 4 turbines (one new double extraction-condensing turbine of 25 MW in combination with the existing 7 MW and two 2.5 MW back pressure turbines). The steam extracted from the turbines is used in the sugar production processes.

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, 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.
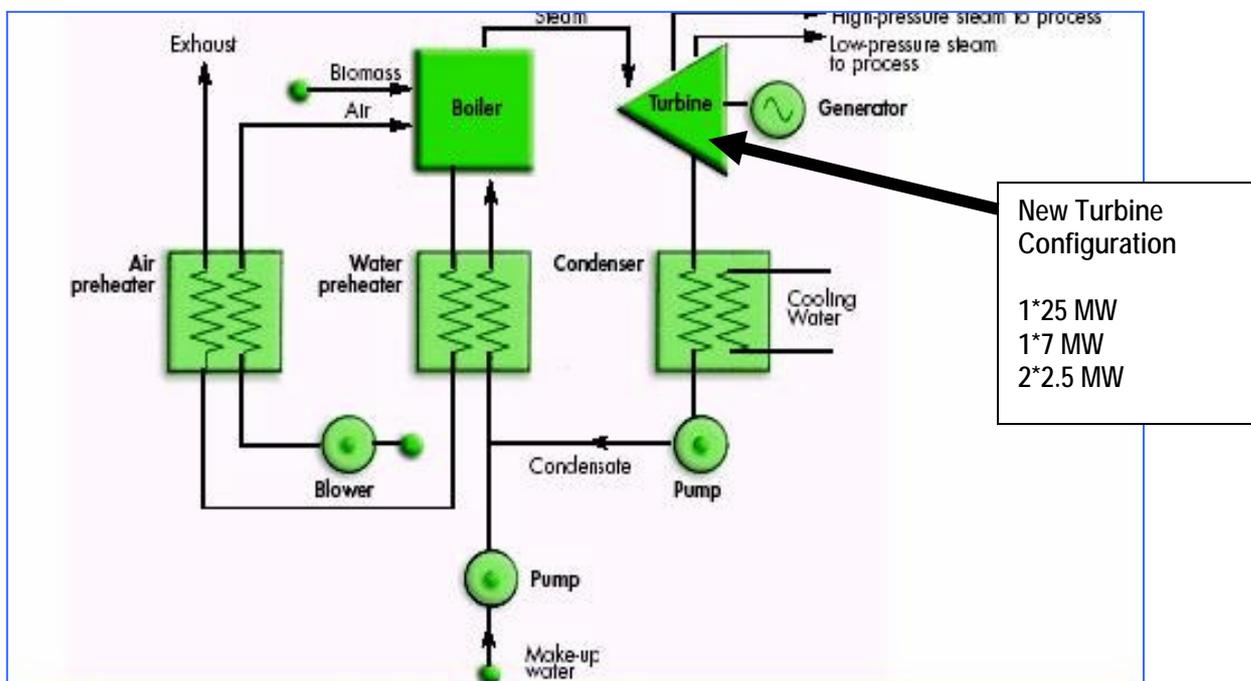


**Figure 2:** *Schematic diagram of a biomass-fired steam-Rankine cycle for cogeneration using a condensing extraction steam turbine*

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. 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. 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, 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.

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

>>

**Table 3: 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 shall be indicated using the following tabular format. | |
| --- | --- |
| **Years** | **Annual estimation of emission reductions in tonnes of CO2 e** |
| 2008 | 24,182.35 |
| 2009 | 95,521.57 |
| 2010 | 95,521.57 |
| 2011 | 95,521.57 |
| 2012 | 95,521.57 |
| 2013 | 95,521.57 |
| 2014 | 95,521.57 |
| 2015 | 95,521.57 |
| 2016 | 95,521.57 |
| 2017 | 95,521.57 |
| 2018 | 71,339.22 |
| **Total estimated reductions** (tonnes of CO2 e) | **955,215.68** |
| **Total number of crediting years** | 10 |
| **Annual average over the crediting period of estimated reductions** (tonnes of CO2 e) | 95,521.57 |

| A.4.5. Public funding of the project activity: |
| --- |

>>

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 <u>approved baseline and monitoring methodology</u> applied to the <u>project activity</u>:**

>>

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 02.

**B.2     Justification of the choice of the methodology and why it is applicable to the <u>project activity:</u>**

>>

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.

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 partly be dumped or left to decay mainly under aerobic conditions or with some burning in an uncontrolled manner without utilizing it for energy purposes.

In view of the aforesaid, Scenario 16 B1and B3 and P4 and P6 therefore apply and this methodology is applicable to this project specifically due to the fact that:

▪   The bagasse is produced and consumed in the same facility and will be fed into the boilers by a conveyor belt. There will be no transportation or modification of bagasse prior to use in the boilers and no significant energy quantities will be required to prepare the bagasse. The proposed project is within the existing sugar factory.
▪   The project would never be implemented by the public sector, as well as it would not be easy to implement in the absence of CDM, as shown in the additionality chapter following.
▪   There will be no increase on the bagasse production due to the project activity itself. Instead, the project is implemented to utilize excess bagasse which is currently dumped and sometimes incinerated in the company's nucleus zones/estates.
▪   The project will utilize excess bagasse which is currently ferried by company trucks and dumped in the nucleus estate/zones of the company thereby avoiding emission of methane which is produced by bagasse during decomposition.

- There will be no bagasse storage for more than one year at the site as the project is designed to utilize all the excess bagasse. Also the milling capacity of the sugar mill will not change from the current production levels since the sugar mill will continue to operate for 300 days a year during the sugar production cycle.
- The project will use only bagasse to generate electricity for sale to the national grid and fossil fuels or any other type of biomass residues will not be used.

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

\>\>

**Table 4: Overview of emission sources included or excluded in the from the project boundary**

| | Source | Gas | Included? | Justification / Explanation |
|---|---|---|---|---|
| **Baseline** | Fuel oil used in 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 |
| | 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 |
| | | $N_2O$ | Excluded | Excluded for simplification. This is conservative |
| | 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. |
| | | $CH_4$ | Excluded | Excluded for simplification. This is conservative |
| | | $N_2O$ | 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 |
| | Biomass storage | $CO_2$ | Excluded | It is assumed that $CO_2$ emissions from surplus residues do not lead to changes of carbon pools in the LULUCF sector. |
| | | $CH_4$ | Excluded | Excluded for simplification. Since biomass is stored for not longer 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 |
| | On-site fossil fuel consumption due to project activity | $CO_2$ | Excluded | Excluded for simplification. This emissions source is assumed to be very small |
| | | $CH_4$ | 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 |

---

**B.4**. **Description of how the** <u>baseline scenario</u> **is identified and description of the identified baseline scenario:**

>>

In the baseline scenario, burning of bagasse for the generation of heat and power is a practice already established at Mumias Sugar Company. Due to constrains (inadequate policy framework, poor pricing, inadequate funding, inadequate technical knowledge, experience and skills) that limit the access of independent power producers (IPPs) to the electricity utilities market, there has been no incentive for sugar companies to operate in a more energy efficient way and the focus has been to maintain inefficient boilers so as to burn (dispose of) as much bagasse as possible in order to minimise bagasse dumping which is costly. Further, due to the policy framework, pricing, statutory requirements that allow only KPLC to buy and distribute power from IPPs and other limitations on the sale of electricity, sugar factories in Kenya have been unable to exploit all the bagasse produced during sugarcane processing to produce sugar. These constraints continue to negatively impact bagasse based cogeneration of electricity in Kenya. (Refer attached document "Cogeneration and LCP Discussion Draft").

While every tonne of cane crushed produces 0.37 tonnes of bagasse, only 0.27 tonnes of the bagasse produced is required for steam and power to process the same quantity of cane (from existing actual historical company data). The excess bagasse, estimated at 240,000 tonnes per year based on the 2005 and 2006 actual figures, has been treated as waste and dumped in the plantations at a cost of US\$.2.6 million (Kshs 179.2 million) per year. This has resulted in the emission of the greenhouse gas, methane.

The baseline for methane abatement is therefore based on the excess bagasse that would be dumped into the plantations after burning as much as possible in the boilers to generate electricity and the steam for the factory processes.

The baseline emissions due to methane decay/uncontrolled burning has been calculated using:

The Baseline Emissions of Biomass i in year y, $BE_{Biomass\ i,\ y} = GWP_{CH4} * \Sigma BF_{p,j\ k,y} * NCV_k * EF_{burning,CH4,k,y}$. **(22f)** since the bagasse could have been burned in an uncontrolled manner or decayed in aerobic condition in the absence of the project activity in reference to (Scenario 16) of ACM0006 Vers 4.

To determine the methane emissions factor from natural decaying of biomass i, $EF_{burning,CH4k,y}$, the default emissions factor of 0.0027 t $CH_4$/t and the maximum conservativeness of 0.73 because the uncertainty is deemed to be greater than 100% resulting to an emission factor of 0.001971 t $CH_4$/t. the conservativeness factor of 0.73 (Table 5 of ACM0006/Version 04) was chosen because more accurate data is not available. The amount of bagasse that would have otherwise been dumped in the absence of the project activity, which is now used in the boiler, $\Sigma BF_{p,j,k,,y}$ has been used.

The methane emissions from the combustion of bagasse have been determined using:

$$PE_y = GWP_{CH4} * PE_{Biomass,CH4k,y}. \hspace{3cm} (2)$$

These emissions have been netted off the baseline emissions due to methane decay in order to determine the emission reductions due to methane abatement. For the calculation of methane emission factor due to bagasse burning, the default emissions factor of 0.03 t/TJ with a conservativeness factor of 1.37 (Table 3 and Table 4 of ACM0006/Version 04) have been assumed resulting to an emission factor of 0.0000411t $CH_4$/GJ.

The following table presents the key information and data used to determine the baseline scenario for methane abatement.

**Table 5: Values Used to Determine the Baseline Scenarios for Methane Abatement**

| ID number | Data type | Value | Unit | Data Source |
|---|---|---|---|---|
| 1. GWP $_{CH4}$ | Global warming potential | 21 | Factor | IPCC 1995, Table 4 |
| 2. CH$_4$ | Default emission factor (combustion of biomass $i$, in boilers) | 0.03 | t/TJ | Table 3 ACM0006 Version 4 |
| 3. EF $_{CH4}$ | Methane emission factor (combustion of biomass $i$.) | 0.0000411 | tCH$_4$/GJ | Calculated |
| 4. Σ BF $_{s,y}$ | Amount of sugarcane s, crushed by the sugar mill in year $y$ | 2,400,000.00 | tonnes | Measured |
| 5. Σ BF $_{i,y}$ | Amount of biomass $i$, used/burned in boilers in year $y$. | 240,000.00 | tonnes | Calculated |
| 6. NCV $_i$ | Net calorific value of biomass $i$, | 8.2 | gigajoules/ tonnes | IPCC Reference Manual, 1996, Chapter 1, Table 1-13 |
| 7. Σ BF $_{i,y}$ | Amount of biomass $i$, not dumped in year $y$. | 240,000.00 | tonnes | Calculated |
| 8. CH$_4$ | Default emission factor (natural decay of biomass $i$.) | 0.0027 | tCH$_4$/T | 2006 IPCC Volume 4 Table 2.5 |
| 9. EF $_{CH4}$ | Methane emission factor (natural decaying of biomass $i$.) | 0.001971 | t/T | Calculated |
| 10. PE $_{b,y}$ | Project emissions from combustion of bagasse $i$. | 1,698.58 | tCO$_2$/t | Calculated |
| 11. BE $_{Biomass\,i,\,y}$ | Project emissions from natural decay or uncontrolled burning of bagasse $i$ for year y | 9,050.83 | tCO$_2$/t | Calculated |
| 12. CH$_4$ emission conservativeness factor | Conservativeness factor for natural decay of biomass | 0.73 | Factor | ACM0006 Version 04, Table 5. Conservativeness factors |
| 13. CH$_4$ emission conservativeness factor | Conservativeness factor for combustion of biomass | 1.37 | Factor | ACM0006 Version 04, Table 4. Conservativeness factors |

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.

While Mumias Sugar Company has been able to generate surplus power, it has not been able to sell all the surplus power to the national grid, because of export line capacity limitations and lack of adequate financial incentives from the Kenya Power and Lighting Company, the sole purchaser of electric power in Kenya. Mumias export has therefore been limited to not more than 2 MW for a continuous period not exceeding 18 hour per day. During shutdowns or startups, the company has either generated power from a diesel generator or purchased it from the grid.

The installed power situation and supplied power in the period 2004/200 as at June 2005 are shown in Tables 6A and 6B below.

**Table 6A: Installed and Effective Electric Power Capacities in Kenya (MW) For 2004/2005**

| Ownership | Type | Installed Capacity (MW) | | | Energy Supplied (GWH) | % Energy Supplied |
| | | Nominal | Effective | % Installed Capacity | | |
|---|---|---|---|---|---|---|
| KenGen | Hydro | 677.3 | 660.4 | 61.9 | 2,869.0 | 53.6 |
| | Petro-thermal | 214.2 | 143.4 | 13.4 | 491.0 | 9.2 |
| | Geo-thermal | 115.0 | 115.0 | 10.8 | 920.0 | 17.2 |
| | Wind | 0.4 | 0.4 | 0.04 | 0.4 | 0.01 |
| IPP | Petro- Thermal | 130.0 | 130.0 | 12.2 | 842.0 | 15.7 |
| | Geo-Thermal | 13.0 | 13.0 | 1.2 | 115.0 | 2.2 |
| Imports | UETCL | - | - | | 99.0 | 1.9 |
| | TANESCO | - | - | | 0.3 | 0.01 |
| GOK-REP[12] | Petro-Thermal | 5.1 | 4.6 | 0.4 | 11.0 | 0.2 |
| | **TOTAL** | **1,155.0** | **1,066.8** | **100.0** | **5,347.7** | **100.0** |

**Table 6B: Type Distribution of the Installed Effective Power and Supplied Electric Energy in Kenya (MWh) For 2004/2005**

| Type | % Effective  Installed Capacity | % Energy Supplied |
|---|---|---|
| Hydro | 61.9 | 53.6 |
| Geothermal | 12.0 | 19.4 |
| Wind | 0.04 | 0.01 |
| Imports | 0.0 | 1.9 |
| Petro-Thermal | 26.1 | 25.1 |
| **Totals** | **100.0** | **100.0** |

The generation system which is significantly hydro, is usually stressed during the dry months when the water levels in the dams are low and there is either rationing or fossil fuel-based thermal generation. Since the sugar companies usually shutdown for maintenance during the rainy season (March to May) and operate during the dry season, the cogeneration will complement the Kenyan grid in a positive way by replacing the thermal plants or avoiding rationing. However, and for conservativeness in the baseline scenario, it is assumed that the co generated 25 MW export will replace the typical mix in the grid and not just the thermal plants.

The emission reduction baseline for the 25 MW export therefore is based on the emission factor of the national grid mix calculated from the power generation mix over the period 1999 to 2006 (Annexes 3, Table 3). It should be noted however, that in August 2006, Kenya commissioned another 100 MW thermal plant which has not been considered in the baseline scenario.

Based on the above, Scenario 16 (Baseline scenario P4 & P6 for power, and B1 &B3 for biomass) of approved consolidated baseline methodology for grid-connected electricity generation from biomass residues ACM0006 version 3 applies to the Mumias Cogeneration Project.

---

[12] The GoK REP means the Government of Kenya's rural electrification programme and is off-grid.

Heat generation and use has not been considered in the baseline since it does not significantly change before and after the project activity. This is because the amount of cane crushed and processed and the related steam equipment has not changed as a result of the project.

The baseline scenario set out in this PDD is that the Business As Usual (BAU) practice will continue where the sugar mill will use small portion of bagasse for generation of electricity and steam for internal use and sale of 2 MW to the grid for 18 hours per day. In the absence of this project therefore the grid emissions will continue to increase or remain the same depending on the mix. In addition, the power generated by the project plant would in the absence of the project activity be generated by power plants in the grid. The bagasse would in the absence of the project activity be used for heat and steam generation in boilers at the project site. And the surplus bagasse be ferried by company trucks and be dumped or left to decay or burned in an uncontrolled manner without utilizing it for energy purposes in the company nucleus estate.

From the foregoing, the baselines emissions for electricity generation have been calculated based on the Combined Margin method which uses the weighted average of the Average Operating Margin and Built Margin calculated as below using equation 2, 3, 9 and 10 specified in ACM0002 Vers 6 which is referenced from ACM006 Vers 4:

Average Operating Margin, EFOM, average, y = $\sum F_{i,j,y} * COEF_{i,j} / \sum EG_{baseline, y}$[13] *(2)*

Build Margin, $EFBM,y = \sum F_{i,m,y} * COEF_{i,m} / \sum GEN_{m,y}$ *(9)*

Emission Factor for the Grid for year y, $EF_y = W_{AOM}.EF_{AOM,y} + W_{BM}.EF_{BM,y}.$ *(10)*

The weights, $W_{AOM}$ and $W_{BM}$ have been taken as 0.25 and 0.75, respectively due to the following reasons:
- The project has a disproportionately high output during on-peak periods and therefore a greater BM weight is recommended (Reference ACM0002 Vers 6, *Guidance on Selecting Alternative Weights*). The seasonal on peak period in Kenya is during the dry season when the dams, and therefore, the hydro power generation is low. This is the period when the project will be at its peak generation since the annual shutdown is during the rainy seasons.
- The project output is more predictable since the bagasse production is directly linked to cane processing which historically has been very stable.
- The project is being implemented under suppressed demand situation in Kenya (Reference *"Cogen & LCPD Discussion Draft"* by David Yuko).

The following table presents the key information and data used to determine the baseline scenario for electricity generation.

---

[13] The plant emission factors used for calculation of the average operating and build margin emission factors were obtained from **IPCC Reference Manual 1996;** Chapter 1, Table 1-1

Table 7: Values Used to Determine the Baseline Emission for Electricity Generation

| ID number | Data type | Value | Unit | Data Source |
|---|---|---|---|---|
| 14. $EG_y$ | Electricity supplied to the grid by the project. | Obtained throughout project lifetime | MWh | Readings of the energy metering connected to the grid and receipt of sales invoices |
| 15. $EF_y$ | $CO_2$ Emission factor of the Grid. | 0.485 | tCO2e/MWh | Calculated |
| 16. $EF_{AOM,y}$ | $CO_2$ Average Operating Margin Emission factor of the grid. | 0.194 | tCO2e/MWh | Calculated |
| 17. $EF_{BM,y}$ | CO2 Build Margin Emission factor of the grid. | 0.582 | tCO2e/MWh | Calculated |
| 18. $\sum F_{i.j.y}$ | Amount of fuel $i$ consumed by relevant power sources $j$ in year(s) $y$. | 2,042.9 | tonnes | Calculated (See Annex 3, Table 1) |
| 19. $\sum F_{i.m.y}$ | Amount of fuel $i$ consumed by 7 most recent addition power sources m in year(s) $y$. | 1,692.1 | tonnes | Calculated (See Annex 3, Table 2) |
| 20.$\sum EG$ baseline, y. | Electricity delivered to the grid including low-cost/must-run | 32,544,380.00 | MWh | KPLC records |
| 21.$\sum GEN_{m,y.}$ | Electricity delivered by 7 most recent additions $m$ to the grid by excluding low-cost/ must-run | 8,953,000.00 | MWh | KPLC records |
| 22. $COEF_{i.j}$ | $CO_2$ emission coefficient of fuel $i$ used by relevant power sources $j$. | 3,177.2(diesel) 3,078.3(Fuel oil) 3,156.3 (Jet Kerosene) | tCO2/t | Calculated |
| 23. $NCV_{i.j.}$ | Net calorific value for fuel type $i$, used power sources $j$. | 43.33 (diesel) 40.19(Fuel oil) 44.59(Jet Kerosene) | Terajoules/$10^3$ tonne | IPCC reference manual, 1996, Chapter 1, Table 1-3 |
| 24. $EF_{CO2.i,j.}$ | $CO_2$ emission factor of fuel type $i$, used by power sources $j$. | 74.07 (diesel) 77.37 (Fuel oil) 71.50(Jet Kerosene) | Tonne C/Terajoules | Calculated |
| 25. $OXID_{i,j}$ | Oxidation factor of fuel type $i$, used by power sources $j$. | 0.99 (diesel, Fuel oil, &Jet Kerosene) | Fraction | IPCC reference manual, 1996, Chapter 1, Table 1-6 |
| 26. $COEF_{i.m}$ | $CO_2$ emission coefficient of fuel $i$ used by 5 relevant new additions power sources $m$. | 3,177.2(diesel) 3,078.3(Fuel oil) 3,156.3 (Jet Kerosene) | tCO2/t | Calculated |
| 27. $NCV_{I,m}$ | Net calorific value for fuel type $i$, used by power sources m. | 43.33 (diesel) 40.19(Fuel oil) 44.59(Jet Kerosene) | Terajoules/$10^3$ tonne | IPCC reference manual, 1996, Chapter 1, Table 1-3 |
| 28. $EF_{CO2.i,m}$ | CO2 emission factor of fuel type i, used by power sources m. | 74.07 (diesel) 77.37 (Fuel oil) 71.50(Jet Kerosene) | Tonne C/Terajoules | Calculated |

| 29. OXID $_{i,m}$ | Oxidation factor of fuel type $i$, used by power sources $m$. | 0.99 | Fraction | IPCC reference manual, 1996, Chapter 1, Table 1-6 |
|---|---|---|---|---|
| 30. W $_{AOM}$ | Weighted average operating margin | 0.25 | Fraction | Determined according to the guidance given in the methodology ACM0002, Vers 6 |
| 31. W $_{BM}$ | Weighted build margin | 0.75 | Fraction | Determined according to the guidance given in the methodology ACM0002, Vers 6 |

**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):**

>>
The proposed Mumias Sugar Cogeneration Project is additional and the demonstration of how the project is additional and nor 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 2).

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

**Sub-step 1a. Define alternatives to the project activity:**
a)  The first alternative to the implementation of the project is for Mumias Sugar Company to continue selling 2 MW (for 18 hrs per day) of electricity to the national grid which it started late last year (2005) after negotiation with KPLC, and focus on its core activity of production of sugar without any future expansion of the power generation, without giving any regard to revenues which will accrue from power sales and carbon credits.

To increase their profits, the company will rely on its workforce and improve in production efficiencies and reduce costs of operations at the same time urge the government to restrict cheap imports which affects the local sugar markets.

b)  The second option is to expand the cogeneration plant by installing extra boilers with high efficiency and generators to generate the 35 MW of power for sale to the national grid and utilize the excess bagasse which is otherwise disposed off in the nucleus estates at a cost of U$3.68 per tonne. The project would however be taken up not as a CDM project.

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

All the alternative options are consisted with the laws and regulation governing sugar companies and the sugar sector as well as industrial activities.

**Step 3. Barrier analysis**

**Sub-step 3a. Identify barriers that would prevent the implementation of type of the proposed 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 "Cogen and LCD Discussion Draft"). 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 can affect sugar cane supply and thus bagasse availability. 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.

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.

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 not to charge KPLC the earlier agreed rates as it was felt this would destabilise KPLC commercial recovery.

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. 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.

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.

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.

c) **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.

d) **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.

There are also questions regarding the managerial capacity of the companies that comprise the Kenyan sugarcane industry. Apart from MSC, the companies have in many cases demonstrated the will to undertake investments in new technologies, but without sufficient financial and entrepreneurial capacity to complete such projects.

**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 is to continue with sugar production without any expansion programme and the above mentioned barriers will not impede the mill from performing its core activities which is sugar processing.

**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.

**Step 5. Impact of CDM registration**

The approval and registration of the MSCP-CDM will go along way overcoming some of the barriers mentioned above i.e. technological, economic, institutional and political, common practice, cultural, and investment barriers. However, economic barriers will form the backbone as it will bring in additional revenues for the company. The revenues generated will be used by the company in achieving its financial obligation, thereby making it more profitable. This will give farmers a motivation to increase cane production. This way, the company will have sufficient bagasse to generate electricity.

The project will prevent bagasse dumping in the nucleus estates. This alone will prevent large quantities of methane and carbon dioxide from being emitted into the atmosphere, leading to reduction of impacts of climate change.

Smooth implementation and operation of the project will act as a case study/pilot project in the country. This way, more people who have been misjudging the Kyoto protocol and the Clean Development Mechanism will start to get involved and implement renewable energy projects in the country. This will enable financial institutions which had over estimated the risk will understand the sector and start financing CDM projects in the country without charging high interest rates for the loans advanced.

| B.6 | Emission reductions: |
|-----|----------------------|

| | B.6.1. | Explanation of methodological choices: |
|--|--------|----------------------------------------|

>>
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[14] (Biomass Scenario) without considerations for heat generation. 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 would in the absence of the project activity be partly be used in the existing power plant and the excess biomass be dumped or left to decay in aerobic conditions.

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, 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 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.

---

[14] Scenario B1 & B3 applies because the 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 suggested following methods to calculate the Operating Margin emission factor(s) (EFOM,y):
(a) Simple OM, or
(b) Simple adjusted OM, or
(c) Dispatch Data Analysis OM, or
(d) Average OM.

As per the approved methodology ACM0002 vers 6, dispatch data analysis should be the first methodological choice. However due to lack of data availability 'Dispatch Data Analysis' is not selected for the project activity.

The Simple Adjusted OM and Average OM methods are applicable to project activities connected to the project electricity system (grid) where the low-cost/must run resources constitute more than 50% of the total grid generation. 'Simple OM' method is applicable to project activity connected to the project electricity system (grid) where the low-cost/must run resources constitute less than 50% of the total grid generation in 1) average of the five most recent years, or 2) based on long-term normal for hydroelectricity production.

The project activity supplies power to Kenyan Grid; the low-cost/must run resources contribute more than 50% of total power in the grid hence 'Simple OM' option is not applicable. Simple Adjusted OM however requires dispatch data, which is not available.

The baseline emission factor (EFy) is therefore calculated as a combined margin (CM), consisting of the combination of average operating margin (AOM) and build margin (BM) factors. The average OM emission factors for Mumias Cogeneration Project would be calculated using ex-ante data vintages for seven years from year 1999/2000 to 2005/2006[15]. Ex-ante was chosen because of the availability of adequate data.

---

[15] The calculation for Average Emission Factor has been calculated using data from the past 7 year s due to the fact that, power generation in the last years has seen some power plant being decommissioned, and using a 3 year data vintages will skew the result. Kipevu Steam Power plant and Westmont were shut down in 2004/2005. A 1000 MW Diesel Generator was installed CDM 2005/2006 by Aggrekko.

**Calculation of Average Operating Margin**

| | |
|---|---|
| $EF_{AOM,y} = \sum F_{i,j,y} * COEF_{i,j} / \sum EG_{Baseline, k, y}$ **(2)** <br><br><br><br><br><br><br><br><br><br> $COEF_i = NCV_i \cdot EF_{CO2,i} \cdot OXID_i$ | Where: <br> $F_{i,j,y}$    is the amount of fuel $i$ (diesel) in a mass or volume unit consumed by relevant power sources $j$ in year(s) $y$, <br> $J$    refers to the power sources delivering electricity to the grid, not including low-operating cost and must-run power plants, and including imports to the grid, <br> $K$    refers to the power sources delivering electricity to the grid, including low-operating cost and must-run power plants, and including imports to the grid, <br> $COEF_{i,j y}$    is the $CO_2$ emission coefficient of fuel $i$ (t$CO_2$ / mass or volume unit 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) $y$, and <br> $EG_{baseline, y}$ is the electricity (MWh) delivered to the grid by source $k$. <br> $NCV_i$    is the net calorific value (energy content) per mass or volume unit of a fuel $i$, <br> $OXID_i$    is the oxidation factor of the fuel <br> $EF_{CO2,i}$    is the $CO_2$ emission factor per unit of energy of the fuel $i$. |

**Calculation of Build Margin**

Build Margin emission factor $EF_{BMy}$ is done using ex-ante calculations based on the most recent information available on the plants already built for a sample group $m$ at the time of PDD submission.

$BM_{yr}$ = weighted average of emissions by recent 6 recent capacity additions.

Calculation of Build Margin emission factor ($EF_{BM,y}$)

| | |
|---|---|
| $EF_{BM,y} = \sum F_{i,m,y} * COEF_{i,m} / \sum GEN_{m,y}$ **(9)** | Where: <br> $F_{i,m,y}$, $COEF_{i,m}$ and $GEN_{m,y}$ are analogous to the variables described for the Average OM method above for plants $m$. |

**Calculation of Baseline Emission Factor**

$EF_y = W_{OM}.EF_{AOM,y} + W_{BM}.EF_{BM,y}$

Where the weights $W_{AOM}$ and $W_{BM}$ are 25% and 75% respectively. The weight of 75% for the BM margin was chosen because Kenya at the moment has suppressed demand that is expected to persist for more than half of the first crediting period (based on previous trends) across a significant number of hours per year, available power plant are likely to be operated fully regardless of the CDM project. In addition, Mumias Sugar Cogeneration Project will operate on-peak season and be closed for maintenance during off-peak season (rain season) when cane deliveries by farmers is low. The electric power from this project is more predictable because the cane harvesting and the number of days the sugar plant operates are known.

### Calculation of Baseline Emissions due to Displacement of Electricity

Equation (8) will be used to calculate emission reductions due to displacement of fossil fuel-based electricity during the year (ER *electricity,y*) by the project activity. The calculation procedure will be as follows:

| | |
|---|---|
| $BE_{electricity,y} = EF_{electricity,y} * EG_{baseline,y}$ *(8)* | Where:<br>$BE_{electricity,y}$   are baseline emissions due to displacement of electricity during the year y in tonnes of $CO_2$<br>$EG_{baseline,y}$   is the net quantity of electricity generated in the bagasse based cogeneration plant due to the project activity during year y.<br>$EF_{electricity,y}$   is the $CO_2$ baseline emission factor for the electricity displaced due to the project activity. |

### 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 in aerobic conditions, the project proponents have decided to account 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. $BE_{Biomass,y}$ will be calculated using Equation (22f) in accordance with the ACM0006, Version 4.

| | |
|---|---|
| $BE_{Biomass,y} = GWP_{CH4} * \Sigma BF_{pj,k,y} * NCV_k \cdot EF_{burning,CH4k,y}$ *(22f)* | Where:<br>$BE_{Biomass,y}$   are the baseline emissions due to natural decay or burning of anthropogenic sources of biomass $k$ during the year $y$ in tons of $CO_2$ equivalents,<br>$GWP_{CH4}$   is the Global Warming Potential for methane valid for the relevant commitment period,<br>$BF_{k,y}$   is the quantity of biomass type $k$ (bagasse) not dumped by the project plant during the year $y$ in a volume or mass unit,<br>$NCV_k$   is the net calorific value of the biomass type $k$ in terajoules (TJ) per mass or volume of biomass,<br>$EF_{burning,CH4,k,y}$ is the $CH_4$ emission factor for uncontrolled burning of the biomass type $k$ in tons $CH_4$ per TJ.<br><br>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 of greater than 100% resulting in a conservative factor of 0.73 (ACM006 Ver.4, Table 5). |

## Project Emissions

Project emissions include $CO_2$ emissions for the project are limited only to $CH_4$ 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 is part of the project boundary.

| | Where: |
|---|---|
| $PE_y = PET_y + PEFF_{CO2,y,} + PE_{EG,y} + GWPCH_4 \cdot PE_{Biomass,CH4,y}$ **(2)** | $PE_y$      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. |
| | $PET_y$      are project emissions from transportation of biomass i |
| | $PEFT_{CO2,y}$      are the CO2 emissions during the year y due to fossil fuels co-fired by the generation facility in tons of CO2 |
| $PE_{Biomass,CH4,y} = EF_{CH4} \cdot \Sigma BF, \cdot NCV_k$ **(7)** | $PE_{EG,Y}$      CO2 emissions during the year y due to electricity consumption at the project site that is attributable to the project activity (tCO2/yr) |
| | $BF_{k,,y}$      is the quantity of biomass type k (bagasse) used as fuel in the project plant during the year y in a volume or mass unit |
| | $NCV_k$      is the net calorific value of the biomass type k in terajoules (TJ) per mass or volume of biomass, |
| Since there will be no transport of the biomass and use of fossil fuels for co-firing the project Plant, | $EF_{CH4}$      CH4 emission factor for the combustion of biomass in the project plant tons $CH_4$ per GJ. |
| $PE_y = GWPCH_4 * PE_{Biomass,CH4,y}$ | The CH4 emission factor of 0.0000411tCH4/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). |

## 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 (ERy) will be calculated as follows:

| | |
|---|---|
| $ER_y = ER_{heat, y} + ER_{electricity, y} + BE_{biomass, y} - PE_y - L_y$ **(1)** <br><br><br><br><br><br> Since there will be no leakage from the project and there will be no change in heat usage, The above formulae can be simplified as: <br><br> $ERy = ER_{electricity, y} + BE_{biomass, y} - PE_y$ | Where: <br> $ER_y$     are the emissions reductions of the project activity during the year y in tons of $CO_2$, <br> $ER_{electricity,y}$     are the emission reductions due to displacement of electricity during the year y in tons of $CO_2$, <br> $ER_{heat,y}$     are the emission reductions due to displacement of heat during the year y in tons of $CO_2$, <br> $BE_{biomass,y}$     are the baseline emissions due to natural decay or burning of anthropogenic sources of biomass during the year y in tons of $CO_2$ equivalents, <br> $PE_y$     are the project emissions during the year y in tons of $CO_2$, and <br> $L_y$     are the leakage emissions during the year y in tons of $CO_2$. |

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

*Copy this table for each data and parameter)*

| Data / Parameter: | $EF_v$ |
|---|---|
| Data unit: | tCO2e/MWh |
| Description: | $CO_2$ Emission factor of the Grid |
| Source of data used: | Calculated |
| Value applied: | 0.485 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | All the data used for calculations are based on the previous data from Kenya Power and Lighting Company. |
| Any comment: | Kenya Power and Lighting Company does not have emission factors and the figure therefore had to be calculated. |

| Data / Parameter: | $EF_{AOM,y}$ |
|---|---|
| Data unit: | tCO2e/MWh |
| Description: | $CO_2$ Average Operating Margin Emission factor of the grid. |
| Source of data used: | Calculated |
| Value applied: | 0.194 |
| Justification of the choice of data or description of measurement methods | The data was chosen and used in accordance to UNFCCC guidelines and formula for calculating emission factors for the grid |

| | |
|---|---|
| and procedures actually applied : | |
| Any comment: | This value will remain constant during the crediting period |

| | |
|---|---|
| **Data / Parameter:** | **EF $_{BM,y}$** |
| Data unit: | tCO$_2$e/MWh |
| Description: | CO$_2$ Build Margin Emission factor of the grid. |
| Source of data used: | Calculated |
| Value applied: | 0.582 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | The data was chosen and used in accordance to the formula for calculating emission factors for the grid |
| Any comment: | This can change in cases of new additions of power sources to the grid. Because of ex ante calculations, it will remain constant in the crediting period |

| | |
|---|---|
| **Data / Parameter:** | **∑F $_{i.j.y}$** |
| Data unit: | Tonnes |
| Description: | Amount of fuel i (diesel) consumed by relevant power sources j in years y. |
| Source of data used: | Calculated |
| Value applied: | 2,042.9 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | This data unit is used in calculation of the average operating margin for the grid emissions. The amount of fuel is gotten from tariff figures of Electricity Regulatory Board. The tariff figures are used in the calculation of fuel adjustment for the electricity billing in the country. The adjustment tariff reflects on the amount of fuel consumed by the relevant power plants |
| Any comment: | This is a constant figure and the value will not change during the crediting period |

| | |
|---|---|
| **Data / Parameter:** | ∑F i. m. y |
| Data unit: | Tonnes |
| Description: | Amount of fuel i (diesel) consumed by 6 most recent addition power sources m in year(s) y. |
| Source of data used: | Calculated |
| Value applied: | 1,692.1 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | This data unit is used in calculation of the build margin for the grid emissions. The amount of fuel is gotten from tariff figures of Electricity Regulatory Board. The tariff figures are used in the calculation of fuel adjustment for the electricity billing in the country. The adjustment tariff reflects on the amount of fuel consumed by the relevant power plants |
| Any comment: | This is a constant value which will not change during the crediting period |

| | |
|---|---|
| **Data / Parameter:** | **∑EG $_{baseline, y.}$** |

| | |
|---|---|
| Data unit: | MWh |
| Description: | Electricity delivered to the grid including low-cost/must-run |
| Source of data used: | KPLC records |
| Value applied: | 32,544,380.00 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | The data is crucial in calculating the baseline electricity generation and usage in the country. The measurement figures were obtained from the Kenya Power and Lighting Company annual figures which outlines the electricity generation and consumption in the whole country |
| Any comment: | This amount is projected to increase once the hydro plant under construction is commissioned. |

| | |
|---|---|
| **Data / Parameter:** | **$\sum$GEN $_{m, y.}$** |
| Data unit: | MWh |
| Description: | Electricity delivered by 6 most recent additions m to the grid by excluding low-cost/ must-run |
| Source of data used: | KPLC records |
| Value applied: | 8,953,000.00 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | Data used in calculation of build margin. The data was chosen following the formula given in the approved consolidated methodology. |
| Any comment: | Fossil fuel generation power sources may decrease or increase depending on the climatic conditions experienced at any particular time. This is because Kenyan generation sources are dominated by hydro plants. |

| | |
|---|---|
| **Data / Parameter:** | COEF i. J |
| Data unit: | $tCO_2/t$ |
| Description: | $CO_2$ emission coefficient of fuel i used by relevant power sources j. |
| Source of data used: | Calculated |
| Value applied: | 3,177.2(diesel), 3,078.3(Fuel oil), 3,156.3 (Jet Kerosene) |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | Data used in the calculation of build margin. The data source is from the IPCC reference manual tables |
| Any comment: | This data is calculated based on each fuel source |

| | |
|---|---|
| **Data / Parameter:** | **NCV $_{i. j.}$** |
| Data unit: | Terajoules/$10^3$ tonne |
| Description: | Net calorific value for fuel type i, used power sources j. |

| Source of data used: | IPCC reference manual, 1996, Chapter 1, Table 1-3 |
|---|---|
| Value applied: | 43.33 (diesel), 40.19(Fuel oil), 44.59(Jet Kerosene) |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | Data used in the calculation of average operating margin. The data source is from the IPCC reference manual tables |
| Any comment: | This data will remain the same |

| Data / Parameter: | $EF_{CO2.i,j.}$ |
|---|---|
| Data unit: | Tonne C/Terajoules |
| Description: | $CO_2$ emission factor of fuel type i, used by power sources j. |
| Source of data used: | Calculated |
| Value applied: | 74.07 (diesel), 77.37 (Fuel oil), 71.50(Jet Kerosene) |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | Data sourced from IPCC reference manual and used based on the formula of the approved consolidated methodology. |
| Any comment: | This data will remain the same |

| Data / Parameter: | $OXID_{i,j}$ |
|---|---|
| Data unit: | Factor |
| Description: | Oxidation factor of fuel type i, used by power sources j. |
| Source of data used: | IPCC reference manual, 1996, Chapter 1, Table 1-6 |
| Value applied: | 0.99 (Diesel, Jet kerosene & Fuel oil) |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | Data gotten from IPCC reference manual tables and the data was chosen based on the formula given in the approved methodology |
| Any comment: | This data will remain the same |

| Data / Parameter: | $COEF_{i,m}$ |
|---|---|
| Data unit: | tCO2 |
| Description: | $CO_2$ emission coefficient of fuel i used by 6 relevant new additions power sources m. |
| Source of data used: | Calculated |
| Value applied: | 3,177.2(diesel),  3,078.3(Fuel oil), 3,156.3 (Jet Kerosene) |
| Justification of the choice of data or description of measurement methods and procedures actually | Data sourced from IPCC reference manual and used based on the formula of the approved consolidated methodology. |

| applied : | |
|---|---|
| Any comment: | This data will remain the same |

| Data / Parameter: | $NCV_{I,m}$ |
|---|---|
| Data unit: | Terajoules/$10^3$ tonne |
| Description: | Net calorific value for fuel type i, used by power sources m. |
| Source of data used: | IPCC reference manual, 1996, Chapter 1, Table 1-3 |
| Value applied: | 43.33 (diesel), 40.19(Fuel oil), 44.59(Jet Kerosene) |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | Data sourced from IPCC reference manual and used based on the formula of the approved consolidated methodology. |
| Any comment: | This data will remain the same |

| Data / Parameter: | $EF_{CO2,i,m}$ |
|---|---|
| Data unit: | Tonne C/Terajoules |
| Description: | $CO_2$ emission factor of fuel type i, used by power sources m. |
| Source of data used: | Calculated |
| Value applied: | 74.07 (diesel), 77.37 (Fuel oil), 71.50(Jet Kerosene) |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | The data unit is calculated by following IPCC reference manual guidelines and the consolidated approved methodology. |
| Any comment: | This data will remain the same |

| Data / Parameter: | $OXID_{i,m}$ |
|---|---|
| Data unit: | Factor |
| Description: | Oxidation factor of fuel type i, used by power sources m. |
| Source of data used: | IPCC reference manual, 1996, Chapter 1, table 1-6 |
| Value applied: | 0.99 (Diesel, Jet kerosene & Fuel oil) |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | Data gotten from IPCC reference manual tables and the data was chosen based on the formula given in the approved methodology |
| Any comment: | This data will remain the same |

| Data / Parameter: | $W_{AOM}$ |
|---|---|
| Data unit: | Factor |
| Description: | Weighted average operating margin |
| Source of data used: | Determined according to the guidance given in the methodology ACM0002 version 6 guidelines |

| Value applied: | 0.25 |
|---|---|
| Justification of the choice of data or description of measurement methods and procedures actually applied : | The project has a disproportionately high output during on-peak periods, its output is more predictable since the bagasse production is directly linked to cane processing which historically has been very stable and it is being implemented under suppressed demand situation in Kenya. |
| Any comment: | This data will remain the same for the crediting period |

| **Data / Parameter:** | $W_{BM}$ |
|---|---|
| Data unit: | Factor |
| Description: | Weighted build margin |
| Source of data used: | Determined according to the guidance given in the methodology ACM0002 version 6 guidelines |
| Value applied: | 0.75 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | The project has a disproportionately high output during on-peak periods, its output is more predictable since the bagasse production is directly linked to cane processing which historically has been very stable and it is being implemented under suppressed demand situation in Kenya. |
| Any comment: | This data will remain the same for the crediting period |

| **Data / Parameter:** | $GWP_{CH4}$ |
|---|---|
| Data unit: | Factor |
| Description: | Global warming potential |
| Source of data used: | IPCC 1995, Table 4 |
| Value applied: | 21 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | Data gotten from IPCC reference manual tables and the data was chosen based on the formula given in the approved methodology |
| Any comment: | This data will remain the same for the crediting period |

| **Data / Parameter:** | $CH_4$ |
|---|---|
| Data unit: | Kg $CH_4$/TJ |
| Description: | Default emission factor (combustion of biomass $k$, in boilers) |
| Source of data used: | ACM0006 Version 4, page 23 |
| Value applied: | 30 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | Most conservative value |

| Any comment: | This data will remain the same |
|---|---|

| Data / Parameter: | EF $_{CH_4}$ |
|---|---|
| Data unit: | tCH$_4$/GJ |
| Description: | Methane emission factor (combustion of biomass *k*.) |
| Source of data used: | Calculated |
| Value applied: | 0.0000411 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | Most conservative value. Obtained from ACM0006 Version 4, page 23, Table 3 and Table 4. |
| Any comment: | This data will remain the same |

| Data / Parameter: | NCV $_k$ |
|---|---|
| Data unit: | Gigajoules/ tonnes |
| Description: | Net calorific value of biomass *k*, |
| Source of data used: | IPCC reference manual, 1996, Chapter 1, Table 1-13 |
| Value applied: | 8.2 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | This figure was calculated from the guidelines of IPCC reference manual tables. The data type was chosen so as to calculated the emission reduction from methane abatement |
| Any comment: | This data will remain the same |

| Data / Parameter: | CH$_4$ |
|---|---|
| Data unit: | tCH$_4$/GJ |
| Description: | Default emission factor (natural decay of biomass *k*.) |
| Source of data used: | ACM0006 version 4, page 40 |
| Value applied: | 0.0027 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | Most conservative value |
| Any comment: | This data will remain the same |

| Data / Parameter: | EF $_{CH_4}$ |
|---|---|
| Data unit: | tCH$_4$/GJ |
| Description: | Methane emission factor (natural decaying of biomass *k*.) |
| Source of data used: | Calculated in accordance with guidelines given in ACM0006 Version 4 page 40 |
| Value applied: | 0.001971 |
| Justification of the | Most conservative value |

| | |
|---|---|
| choice of data or description of measurement methods and procedures actually applied : | |
| Any comment: | This data will remain the same |

| Data / Parameter: | CH$_4$ emission conservativeness factor |
|---|---|
| Data unit: | Factor |
| Description: | Conservativeness factor for natural decay of biomass |
| Source of data used: | Determined according to table 5 in the guidance in the methodology ACM006 version 04 |
| Value applied: | 0.73 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | The data unit was chosen from the approved consolidated methodology formula for the calculation of methane abetment. The unit was taken from the tables given in the methodology. |
| Any comment: | This data will remain the same |

| Data / Parameter: | CH$_4$ emission conservativeness factor |
|---|---|
| Data unit: | Factor |
| Description: | Conservativeness factor for combustion of biomass |
| Source of data used: | Determined according to table 4 in the guidance in the methodology ACM006 version 04 |
| Value applied: | 1.37 |
| Justification of the choice of data or description of measurement methods and procedures actually applied : | The data unit was chosen from the approved consolidated methodology formula for the calculation of methane abatement. The unit was taken from the tables given in the methodology. |
| Any comment: | This data will remain the same |

**B.6.3    Ex-ante calculation of emission reductions:**
>>

The baseline emission factor (EFy) is calculated as a combined margin (CM), consisting of the combination of average operating margin (AOM) and build margin (BM) factors. Average Operating Margin was chosen to calculate the Operating Margin (OM) for the electricity baseline emission factor because the preferable choice (c) Dispatch Data Analysis OM would face the barrier of data availability. Also the low cost/must run resources in Kenya constitute more than 50% of the grid generation. The average OM emission factors for Mumias Cogeneration Project would be calculated using ex-ante data vintages for seven years from year 1999/2000 to 2005/2006. Ex-ante was chosen because of the availability of adequate data.

**Calculation of Average Operating Margin**

$$EF_{AOM,y} = \sum F_{i,j,y} * COEF_{i,j} / \sum EG_{Baseline, K, y} \qquad (2)$$

The $CO_2$ emission coefficient $COEF_i$ is obtained as

$$COEF_i = NCV_i \cdot EF_{CO2,i} \cdot OXID_i \qquad (3)$$

| Average Operating Margin | |
|---|---|
| $\sum F_{i,j,y} * COEF_i$ $(tCO_2)$ | 6,317,328.50 |
| $EG_{baselinej,y}$ $(MWh)$ | 32,544,380.00 |
| **EF $_{AOM,y=}$** | **0.194 tCO$_2$e/Mwh)** |

**Calculation of Build Margin**

$BM_{yr}$ = weighted average of emissions by recent 5 recent capacity additions.

Calculation of Build Margin emission factor ($EF_{BM,y}$)

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

Where $Fi,m,y$, $COEFi,m$ and $GENm,y$ are analogous to the variables described for the Average OM method above for plants $m$.

| Build Margin | |
|---|---|
| $\sum F_{i,m,y} * COEF_{i,m}$ (tCO$_2$) | 5,209,396.99 |
| $\sum GEN_{m,y}$ (MWh) | 8,953,000.00 |
| **EF$_{BM,y}$** =$\sum F_{i,m,y} * COEF_{i,m} / \sum GEN_{m,y}$ | **0.582 tCO$_2$e/Mwh)** |

## Calculation of Baseline Emission Factor

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

Where the weights $W_{AOM}$ and $W_{BM}$ are 25% and 75% respectively.

| Calculation of Baseline Emission Factor | |
|---|---|
| $W_{AOM}$ | 0.25 |
| $EF_{AOM,y}$ | 0.194 |
| $W_{BM}$ | 0.75 |
| $EF_{BM,y}$ | 0.582 |
| **$EF_y = W_{AOM}.EF_{AOM,y} + W_{BM}.EF_{BM,y}$** | **0.485 (tCO$_2$e/Kwh)** |

## Calculation of Baseline Emissions due to Displacement of Electricity

$$BE_{electricity,y} = EF_{electricity,y}.\; EG_{baseline,y} \qquad (8)$$

| $BE_{electricity,y} = EF_{electricity,y}.EG_y$ | |
|---|---|
| $EF_{electricity,y}$ | 0.485 |
| $EG_{baseline,y}$ | 180,000 (MWh) |
| **$BE_{electricity,y}$ (tCO$_2$ equivalent)** | **87,286.31 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.

$$BE_{Biomass,y} = GWP_{CH4} \cdot \Sigma BF_{p,j,k,y} \cdot NCV_k \cdot EF_{burning,CH4,k,y} \qquad (22f)$$

| $GWP_{CH4}$ | 21 |
|---|---|
| $BF_{p,j,k,y}$ | 240,000.00 tonnes |
| $NCV_k * EF_{burning,CH4,k,y}$ | 0.0027 tCH$_4$/TJ |
| Conservative factor | 0.73 |
| Biomass methane emission factor | 0.001971 (tCH$_4$/GJ) |

$BE_{Biomass,y} = 21* 240,000.00* 0.001971$
$\qquad\qquad = $ **9,933.84** tCO$_2$e/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.

$$PEy = GWPCH_4 \cdot PE_{Biomass,CH_4, y} \tag{2}$$

$$PE_{Biomass,CH_4, y} = EF_{CH_4,BF} \cdot \Sigma BF_{k,y}, \cdot NCV_k \tag{7}$$

Therefore:

$$PEy = GWPCH_4 \cdot PE_{Biomass,CH_4, y} \tag{2}$$

| | |
|---|---|
| $GWP_{CH_4}$ | 21 |
| $BF_{k,y}$ | 240,000.00 tonnes |
| $NCV_k$ | 8.2 (tCH$_4$/GJ) |
| $EF_{CH4,BF}$ | 30 (kg CH$_4$/TJ) |
| *Conservative factor* | 1.37 |
| *Biomass methane emission factor* | 0.0000411 (tCH$_4$/GJ) |

$$= 21*240,000.00*8.2* 0.0000411$$

$$= \mathbf{1,698.58} \text{ tCO}_2\text{e/yr}$$

## 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 *ERy* by the project activity during a given year *y* is the difference between the emission reductions through substitution of electricity generation with fossil fuels (*ERelectricity,y*), the emission reductions through substitution of heat generation with fossil fuels (*ERheat,y*), project emissions (*PEy*), emissions due to leakage (*Ly*) 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 (*BEbiomass,y*), as follows:

$$ER_y = ER_{heat, y} + ER_{electricity, y} + BE_{biomass, y} - PE_y - L_y \tag{1}$$

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

| | |
|---|---|
| $BE_{electricity,y}$ | 87,286.31 (tCO2e/yr) |
| $BE_{Biomass, y}$ | 9,933.84 (tCO$_2$e/yr) |
| PEy | 1, 698.58 (tCO$_2$e/yr) |
| **ERy = $ER_{electricity, y} + BE_{biomass, y} - PE_y$** | **95,521.57 (tCO2e/yr)** |

**B.6.4    Summary of the ex-ante estimation of emission reductions:**
>>
**Table 8: Ex-ante Emission Reductions**

| Year | Estimation of project activity emissions (tonnes of CO2 e) | Estimation of baseline emissions (tonnes of CO2 e) | Estimation of Leakage (tonnes of CO2 e) | Estimation of overall emission Reductions (tonnes of CO2 e) |
|---|---|---|---|---|
| 2008 | 486.93 | 24, 669.28 | 0 | 24,182.35 |
| 2009 | 1, 698.58 | 97,220.15 | 0 | 95,521.57 |
| 2010 | 1, 698.58 | 97,220.15 | 0 | 95,521.57 |
| 2011 | 1, 698.58 | 97,220.15 | 0 | 95,521.57 |
| 2012 | 1, 698.58 | 97,220.15 | 0 | 95,521.57 |
| 2013 | 1, 698.58 | 97,220.15 | 0 | 95,521.57 |
| 2014 | 1, 698.58 | 97,220.15 | 0 | 95,521.57 |
| 2015 | 1, 698.58 | 97,220.15 | 0 | 95,521.57 |
| 2016 | 1, 698.58 | 97,220.15 | 0 | 95,521.57 |
| 2017 | 1, 698.58 | 97,220.15 | 0 | 95,521.57 |
| 2018 | 1,211.65 | 72,550.87 | 0 | 71,339.22 |
| **Total (tCO$_2$ e)** | **16,985.81** | **972,201.48** | **0** | **955,215.68** |

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

**B.7.1    Data and parameters monitored:**

*(Copy this table for each data and parameter)*

| Data / Parameter: | $\Sigma BF_{s,y}$ |
|---|---|
| Data unit: | tonnes |
| Description: | Amount of sugarcane s, crushed by the sugar mill in year y |
| Source of data to be used: | Measured |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | 2,400, 000 (10% of the total sugarcane supplied to the factory |
| Description of measurement methods and procedures to be applied: | Sugarcane used by the mill is received from the out growers 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 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 owners/farmers. The figures from this end will be used for calculation of the cane delivered and crushed by the sugar mill per year. |
| QA/QC procedures to be applied: | A system will be established to monitor the amount of bagasse combusted in the project site by measuring the quantity combusted on a weekly basis. Such on-site measurements will be cross-checked with an annual energy balance based on sugarcane inflows and bagasse generation. Uncertainty level of data: Low. |

| Any comment: | 100% of the data will be monitored |
|---|---|

| Data / Parameter: | $\Sigma BF_{k,,y}$ |
|---|---|
| Data unit: | tonnes |
| Description: | Amount of biomass (bagasse) $k$, used/burned in boilers in year y. |
| Source of data to be used: | Calculated |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | 240,000 |
| Description of measurement methods and procedures to be applied: | Sugarcane supplied to the mill is crushed and used for sugar production. Bagasse generation from sugarcane received is 37% of the total weight of cane crushed. For each tonne of bagasse produced, 27% will be burned in the boilers to produce steam for sugar production process. To get the quantities burned in the boilers, the Chief Engineer will compile the data of cane received and use the percentage of bagasse generation to calculate the total amount of bagasse used in the boilers. The above amount of bagasse are currently being dumped, but the project will utilise this quantities during its operation |
| QA/QC procedures to be applied: | A system will be established to monitor the amount of bagasse combusted in the project site by measuring the quantity combusted on a weekly basis. Such on-site measurements will be cross-checked with an annual energy balance based on sugarcane inflows and bagasse generation. Uncertainty level of data: Low. |
| Any comment: | 100% of the data will be monitored |

| Data / Parameter: | $\Sigma BF_{k,,y}$ |
|---|---|
| Data unit: | Tonnes |
| Description: | Amount of biomass $k$, not dumped in year $y$. |
| Source of data to be used: | Measured and calculated |
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | 240,000 |
| Description of measurement methods and procedures to be applied: | The amount of bagasse burned in the boilers will be equal the amount of bagasse not dumped. The figures arrived at in the calculation of bagasse used in the boilers will be the amount of bagasse not dumped |
| QA/QC procedures to be applied: | All the equipment used for measuring will be calibrated yearly following guidelines set out by ISO 9001 system and verified by the Kenya Bureau of Standards. |
| Any comment: | This is the amount of bagasse which will have been dumped in the nucleus estate in the absence of the project. |

| Data / Parameter: | $EG_y$ |
|---|---|
| Data unit: | Mwh |
| Description: | Electricity delivered to the grid by the project |
| Source of data to be used: | From Mumias power production records |

| | |
|---|---|
| Value of data applied for the purpose of calculating expected emission reductions in section B.5 | 180,000 |
| Description of measurement methods and procedures to be applied: | Calculated based on production records and export records to the national grid |
| QA/QC procedures to be applied: | Level of uncertainty of data will depend on accuracy of export reporting from both KPLC and Mumias |
| Any comment: | |

**B.7.2    Description of the monitoring plan:**

>>

The structure for monitoring this project activity will basically consist of registering the amount of energy sold to the grid (EGy). There are two operations that the project operators must perform in order to ensure data consistency.

1.  The monthly readings of the calibrated meter equipment must be recorded in an electronic spreadsheet. On 1st of very month, Mumias Sugar Company Chief Engineer will visit the cogeneration plant and along with KPLC officer to take meter readings. The meter readings will be from the main meter at the interface point with the National Grid but it will be checked against the ''check meter'' at the substation. Mumias Company may in turn check the meter readings with their own meters situated on the 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.
2.  Sales receipt 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.
3.  Yearly calculation of the amount of bagasse used to generate electricity for sale to the National Grid. The calculations will be done by Chief Engineer.

**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. ECM Centre Limited is not a project participant.

| 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: |
|---|

&gt;&gt;

01/06/2006

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

&gt;&gt;

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: |
|---|

&gt;&gt;

N/A

| C.2.1.2. Length of the first crediting period: |
|---|

&gt;&gt;

N/A

| C.2.2. Fixed crediting period: |
|---|

| C.2.2.1. Starting date: |
|---|

&gt;&gt;

01/10/2008

| C.2.2.2. Length: |
|---|

&gt;&gt;

10 years (120 months)

| SECTION D. Environmental impacts |
|---|

&gt;&gt;

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

&gt;&gt;

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 during which the proponents presented the details of the project, including impacts. The stakeholders were then requested for comments and feedback

The proceedings of the meeting were minutes and distributed to stakeholders for further comment 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 minutes are annexed to this PDD.

**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 action in 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 is still reviewing the comments and a decision will soon be made on those comments that the company has control over. 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 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: | |
| Country: | KENYA |
| Telephone: | +254-56-641620/1 |
| FAX: | +254-56-641087/641234 |
| E-Mail: | |
| URL: | |
| Represented by: | EVANS KIDERO |
| Title: | MANAGING DIRECTOR |
| Salutation: | DR. |
| Last Name: | |
| Middle Name: | KIDERO |
| First Name: | EVANS |
| Department: | |
| Mobile: | +254-722-203891/2/3/4/5 |
| Direct FAX: | |
| Direct tel: | |
| Personal E-Mail: | ekidero@mumias-sugar.com |

| | |
|---|---|
| Organization: | JAPAN CARBON FINANCE LTD |
| P.O. Box: | 102-0073 |
| Building: | |
| City: | TOKYO |
| State/Region: | JAPAN |
| Postfix/ZIP: | |
| Country: | JAPAN |
| Telephone: | +81352128870 |
| FAX: | +81352128886 |
| E-Mail: | |
| URL: | |
| Represented by: | |
| Title: | DEAL MANAGER |
| Salutation: | MR |
| Last Name: | OGIHARA |
| Middle Name: | |
| First Name: | HIROSHI |
| Department: | |
| Mobile: | |
| Direct FAX: | |
| Direct tel: | |
| Personal E-Mail: | h-ogihara@jcarbon.co.jp |

## Annex 2

### INFORMATION REGARDING PUBLIC FUNDING

This project will not benefit from any public funding

## Annex 3

### BASELINE INFORMATION

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 3 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. However, information regarding power dispatch for power stations is not available; instead only power sold to KPLC in GWh per year is freely available.

In that regard, calculation of the emission factor for the grid used Average Operating Margin for thermal plants which are connected to the national grid.

## BASELINE DATA

**Table 1: Calculation of Total Fuel Consumption of Kenya Thermal Power Plants (2005/6)**

| Power Plants | Approved Specific Fuel Consumption (Kg/KWh) | Total Power Supplied (1999- 2005/6) (GWh) | Total Fuel Consumption (1999- 2005/6) (Tonnes) |
|---|---|---|---|
| Kipevu Diesel Plant (TPC)- heavy fuel oil | 0.22 | 2,308,000.0 | 505.5 |
| Kipevu Diesel Plant (KenGen)-heavy fuel oil | 0.21 | 2,262,000.0 | 475.0 |
| Kipevu Gas Turbine (KenGen)-jet kerosene | 0.3 | 1,050,000.0 | 315.0 |
| Kipevu Steam Plant (KenGen)-heavy fuel oil | 0.34 | 606,000.0 | 203.0 |
| Nairobi South Gas Turbine-Fiat (KenGen)-diesel oil | 0.41 | 87,280.0 | 35.8 |
| Nairobi South Diesel Plant-Niigata (Iberafrica)-fuel oil | 0.23 | 1,145,160.0 | 262.2 |
| Nairobi South Diesel Plant-Wartsila (Iberafrica)-fuel oil | 0.22 | 1,073,840.0 | 239.5 |
| Aggreko - industrial diesel (2005/06) | 0.23 | 30,000.0 | 6.9 |
| Olkaria II (Geothermal Plant) | 0 | 1,528,000.0 | 0.0 |
| Olkaria I (Geothermal Plant) | 0 | 2,336,000.0 | 0.0 |
| Mumias | 0 | 9,000.0 | 0.0 |
| Orpower4 | 0 | 640,000.0 | 0.0 |
| Hydro | 0 | 18,444,000.0 | 0.0 |
| Wind | 0 | 1,700.0 | 0.0 |
| Imports | 0 | 1,023,400.0 | 0.0 |
| **Total** | | **32,544,380.0** | **2,042.9** |

**Table 2: Calculation of Fuel Consumed by 7 Most Recent Plants Additions in Kenya (1999/2006)**

| 7 Most Recent Plants | Approved Specific Fuel Consumption (Kg/KWh) | Total Power Supplied (1999- 2005/6) (GWh) | Total Fuel Consumption (1999- 2005/6) (Tonnes) |
|---|---|---|---|
| Kipevu Diesel Plant (TPC)-heavy fuel oil | 0.22 | 2,308,000 | 505.5 |
| Kipevu Diesel Plant (KenGen)-heavy fuel oil | 0.21 | 2,262,000 | 475.0 |
| Kipevu Steam Plant (KenGen)-heavy fuel oil | 0.34 | 606,000 | 203.0 |
| Nairobi South Diesel Plant-Niigata (Iberafrica)-fuel oil | 0.23 | 1,145,160 | 262.2 |
| Nairobi South Diesel Plant-Wartsila (Iberafrica)-fuel oil | 0.22 | 1,073,840 | 239.5 |
| Aggreko - industrial diesel (2005/06) | 0.23 | 30,000 | 6.9 |
| Olkaria II (Geothermal Plant) | 0 | 1,528,000 | 0.0 |
| **Total** | | **8,953,000** | **1692.1** |

*Source: Retail Tariffs Review Policy 2005 and KPLC Annual Report 2004/2005 and Additional Informtion from KPLC*

**Table 3: Kenya Electricity Generation Plants Supplying Power to KPLC from 1999/2000 to 2005/2006**

| COMPANY | Capacity (MW) as at 30.06.2006 | | UNIITS IN GWh | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Installed | Effective | 1999/ 2000 | 2000/ 2001 | 2001/ 2002 | 2002/ 2003 | 2003/ 2004 | 2004/ 2005 | 2005/ 2006 |
| **KenGen Hydro** | | | | | | | | | |
| Tana | 14.4 | 13.4 | 63 | 71 | 76 | 65 | 65 | 59 | 56 |
| Wanjii | 7.4 | 7.4 | 46 | 47 | 52 | 51 | 34 | 21 | 22 |
| Kamburu | 94.2 | 88.0 | 247 | 181 | 330 | 470 | 470 | 381 | 399 |
| Gitaru | 225.0 | 216.0 | 734 | 364 | 665 | 945 | 938 | 757 | 795 |
| Kindaruma | 40.0 | 40.0 | 157 | 81 | 162 | 224 | 221 | 170 | 190 |
| Small stations | 6.3 | 5.6 | 19 | 20 | 23 | 25 | 28 | 23 | 20 |
| Masinga | 40.0 | 40.0 | 142 | 28 | 127 | 206 | 230 | 169 | 170 |
| Kiambere | 144.0 | 144.0 | 813 | 292 | 703 | 999 | 1010 | 814 | 862 |
| Turkwel | 106.0 | 106.0 | 214 | 240 | 264 | 136 | 263 | 475 | 520 |
| **KenGen Hydro Total** | **677.3** | **660.4** | **2435** | **1,325** | **2,402** | **3,120** | **3,259** | **2,869** | **3,034** |
| **KenGen Thermal** | | | | | | | | | |
| Kipevu steam | 63.0 | 60.0 | 199 | 126 | 94 | 83 | 56 | 48 | 0 |
| Kipevu diesel | 73.5 | 70.0 | 393 | 449 | 268 | 144 | 279 | 330 | 399 |
| Fiat-Nairobi South | 13.5 | 10.0 | 30 | 35 | 1 | 0.2 | -0.02 | 3.1 | 18 |
| Kipevu Gas Turbine | 60.0 | 60.0 | 384 | 274 | 77 | 20 | 4 | 97 | 194 |
| Garissa & Lamu | 4.2 | 3.4 | 10 | 10 | 11 | 12 | 13 | 13 | 15 |
| **Total** | **214.2** | **143.4** | **1015** | **894** | **451** | **260** | **352** | **491** | **626** |
| **KenGen Geothermal** | | | | | | | | | |
| Olkaria I | 45.0 | 45.0 | 381 | 340 | 377 | 277 | 266 | 371 | 324 |
| Olkaria II | 70.0 | 70.0 | 0 | 0 | 0 | 0 | 417 | 549 | 562 |
| **KenGen Geothermal Total** | **115.0** | **115.0** | **381** | **340** | **377** | **277** | **682** | **920** | **886** |
| **KenGen Wind** | | | | | | | | | |
| Ngong | 0.4 | 0.4 | 0.1 | 0.1 | 0.0 | 0.3 | 0.4 | 0.4 | 0.4 |
| **Government of Kenya Thermal** | | | | | | | | | |
| REP Stations | 5.1 | 4.6 | 10 | 10 | 10 | 10 | 10 | 11 | 11 |
| **Independent Power Producers Thermal** | | | | | | | | | |
| Iberafrica | 56.0 | 56.0 | 294 | 348 | 348 | 251 | 240 | 330 | 408 |
| Westmont[16] | 0.0 | 0.0 | 169 | 277 | 149 | 29 | 15 | 3 | 0 |
| Tsavo | 74.0 | 74.0 | 0 | 7 | 550 | 473 | 200 | 508 | 570 |
| Mumias | 0.0 | 0.0 | 0 | 6 | 1.0 | 0 | 0 | 0 | 9 |
| **IPP Thermal Total** | **130.0** | **130.0** | **463** | **463** | **638** | **753** | **455** | **842** | **968** |

---

[16] Westmont was retired in August 2004 upon expiry of its contract with KPLC

**Table 3: Kenya Electricity Generation Plants Supplying Power to KPLC from 1999/2000 to 2005/2006** *(Continued)*

| Independent Power Producers Geothermal | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| OrPower4 | 13.0 | 13.0 | 2 | 89 | 103 | 109 | 105 | 115 | 117 |
| **Emergency Power Producers** | | | | | | | | |
| Aggreko | 0 | 0 | 0 | 303 | 0 | 0 | 0 | 0 | 30 |
| Coming | 0 | 0 | 0 | 174 | 0 | 0 | 0 | 0 | 0 |
| Deutz | 0 | 0 | 0 | 111 | 0 | 0 | 0 | 0 | 0 |
| **EPP Total** | **0** | **0** | **0** | **587** | **0** | **0** | **0** | **0** | **30** |
| **Imports** | | | | | | | | |
| UETCL | 0 | 0 | 140 | 198 | 172 | 222 | 177 | 99 | 15 |
| TANESCO | 0 | 0 | 0 | 0 | 0.0 | 0 | 0 | 0.3 | 0.4 |
| **Total Imports** | **0** | **0** | **140** | **197.8** | **172.0** | **221.7** | **177.1** | **99** | **15.4** |
| **TOTAL ENERGY PURCHASED** | **1,155.0** | **1,066.9** | **4637** | **4,461** | **4,081** | **4,564** | **5,035** | **5,347** | **5,697** |

**Source:** Kenya Power and Lighting Company Limited Annual Report 2004/2005 and Additional Informtion from KPLC – www.kplc.co.ke

**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.

At MSC, there are a number of departments including operation, maintenance, purchase, stores, finance, accounts, laboratory and others. Each department is headed by one Department Head supported by assistants and support staff such as operators. The overall responsibility of the department functioning is with the respective department heads. Maintenance sections include mechanical, electrical and instrumentation departments. These are responsible for the overall upkeep of plant machinery and instruments.

A cogeneration project team will be constituted with participation from Operation, Maintenance, Purchase & Stores, Quality, Sales & Marketing, and finance. This team will first be trained on CDM concepts and then they will be given the responsibility of collecting & maintaining data. This team will meet periodically (Proposed period of 3 months) to review CDM project activity and also to check data collected to estimate emissions reduction. One person dedicated to CDM related activity will be appointed. This person would be responsible for gathering data from all relevant functions, and to keep records of the same. This person will report to CDM project team.

MSC shall adopt the following procedures to assure the completeness and correctness of the data needed to be monitored for CDM project activity.

A CDM project team would be constituted with participation from relevant departments. People would be trained on CDM concept and monitoring plan. This team will be responsible for data collection and archiving. This team will meet periodically to review CDM project activity, check data collected, emissions reduced etc. On a monthly basis, the monitoring reports will be checked and discussed by the senior CDM team members/managers. In case of any irregularity observed by any of the CDM team members, it is brought to the attention concerned person for necessary actions. Further these reports are forwarded to the management on a monthly basis.

Specific responsibility will be assigned to all staff concerned as pertains to the monitoring of the project. The responsibilities will include compliance with the CDM monitoring plan, ensuring completeness and reliability of data, including instrumentation as well as measurement integrity and daily and monthly report generation.

This template shall not be altered. It shall be completed without modifying/adding headings or logo, format or font.

The training of the CDM team and plant personnel will be carried out on CDM principles, CDM activities, monitoring of data and record keeping through a planned schedule made in advance and a record of various training programmes undertaken would be kept for verification.

Plant data shall be collected on operation under the supervision of the assigned supervisory staff and record would be kept in daily logs.

MSC is an ISO-9001 certified company and it has procedures well defined for the calibration of instruments. A log of calibration records is maintained. Instrumentation department in the company is responsible for the upkeep of instruments in the plant. The reliability of the meters will be checked by testing the meters on a regular basis and at least once a year. Documents pertaining to testing of meters shall be maintained.

The frequency for data monitoring shall be as per the monitoring details in Section D of this PDD.

The maintenance department shall be responsible for the proper functioning of the equipments/ instruments and shall inform the concerned department for corrective action if found not operating as required. Corrective action shall be taken by the concerned department and a report on corrective action taken shall be maintained as done time to time along with the details of problems rectified.

The CDM team will have the overall responsibility of checking data for its completeness and correctness. The data collected from daily logs will be forwarded to the central registry after verification from respective departments.

CDM audits shall be carried out to check the correctness of procedures and data monitored by the internal auditing team entrusted for the work. Report on internal audits done, faults found and corrective action taken shall be maintained and kept for external auditing.

The project activity does not result in any unidentified activity that can result in substantial emissions from the project activity. No need for emergency preparedness in data monitoring is visualized.

After verification of the data and due diligence on correctness an annual report on monitoring and estimations shall be maintained by the CDM team and record to this effect shall be maintained for verification.