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

CONTENTS

Annexes

SECTION A. General description of project activity

A.1 Title of the project activity:

Optimisation of Kiambere Hydro Power Project
Version 10
14/9/2012

A.2. Description of the project activity:

The objective of the Optimisation of Kiambere Hydro Power Project is to rehabilitate the Kiambere Power Plant that includes the upgrade of the turbines with new efficient runners at the existing Kiambere power plant. The existing (2 x 72 MW) turbines will be replaced with (2 x 84.5 MW) turbines with new efficient runners. Thus, the upgrade will increase the plant's generation capacity by 25 MW from its existing capacity of 144 MW. However, of this additional 25 MW, at present only 20 MW is the contracted capacity to be supplied to the Kenyan grid.

From 2003-2008, the existing 144 MW capacity has supplied on average annual electricity amounting to 917.4 GWh to the Kenyan grid. The additional contracted capacity of 20 MW will supply an estimated annual incremental power of 75.0 GWh[1] to the Kenyan grid. Hence, with this additional contracted capacity, the total electricity supply to the grid from the Kiambere power plant will be 992.4 GWh per year.

The project activity will result in greenhouse gas (GHG) emission reductions by displacing fossil fuel-based electricity generation in the Kenyan grid with clean hydropower. Emission reductions associated with the project activity will be determined based on the additional 20 MW of contracted capacity. However, the emission reductions will be adjusted if Kengen will be able to get the increase in contracted capacity with the Kenyan grid in the future.

Contribution of Project Activity to Sustainable Development

The project will contribute to national sustainable development through the following:

Sustainable clean energy: The provision of renewable clean hydroelectricity is a major factor contributing to sustainable development in Kenya through improved environmental quality, positive health impacts and increased productivity. Also, increased power availability will create more opportunities for expanded rural electrification with far reaching impacts on job creation and improved livelihoods in the rural areas.

[1] This value has been adjusted taking into account the standard deviation of the annual average historical net electricity generation delivered to the grid by the existing facility that was operated at the project site prior to the implementation of the project activity.

Decreased dependence on fossil fuels: Hydropower generation has been a major component of Kenya's energy strategy. 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. With the project assisting the country to facilitate utilization of renewable energy resources such as hydropower, Kenya's dependence on imported crude petroleum can be reduced significantly. (Petroleum accounts for 20-25% of the national import bill.[2]) This may result in considerable foreign exchange savings that can be committed to other economic activities.

Assistance in community programs: While the sale of the CERs generated by the project will boost production of clean energy in the country, it will also assist poor rural communities in the project area through implementing community programs funded by carbon revenues. Since the emission reductions due to the project activity will be purchased by the CDCF (Community Development Carbon Fund), part of the carbon revenues will be earmarked for implementing a community benefits plan.

A.3. Project participants:

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)	Kenya Electricity Generating Company Ltd. (KenGen)	No
The Netherlands	International Bank for Reconstruction and Development as Trustee of the Community Development Carbon Fund (CDCF).	Yes
The Netherlands	Netherlands' Ministry of Infraestructure and the Environment (IenM)	Yes
(*) In accordance with the CDM modalities and procedures, at the time of making the CDM-PDD public at the stage of validation, a Party involved may or may not have provided its approval. At the time of requesting registration, the approval by the Party(ies) involved is required.		
Note: *When the PDD is filled in support of a proposed new methodology (forms CDM-NBM and CDM-NMM)*, at least the host Party (ies) and any known project participants (e.g. those proposing a new methodology) shall be identified.		

Host Country: The host country is Kenya and the Designated National Authority is the National Environment Management Authority (NEMA). The Government of Kenya acceded to the Kyoto Protocol in February 25, 2005.

[2] http://en.wikipedia.org/wiki/Economy_of_Kenya

Project Sponsor: The state-owned Kenya Electricity Generating Company Ltd. (KenGen) is the project sponsor and handles the generation of electricity.[3] Established in 1997 under the name of Kenya Power Company, KenGen is currently producing about 80 percent of electricity consumed in the country. Its various sources of power generation range from hydro, geothermal, thermal and wind. Hydro is the leading source, accounting for over 70 percent of KenGen's installed capacity.

Purchasing Party: The Community Development Carbon Fund (CDCF) is purchasing the emission reductions (ERs) arising from the project activity. The CDCF is a public/private fund initiated by the World Bank in collaboration with the International Emissions Trading Association (IETA) and the United Nations Climate Change Secretariat, to provide carbon finance to projects in developing countries. The CDCF invests contributions made by governments and companies in projects designed to produce ERs fully consistent with the Kyoto Protocol, aimed at mitigating climate change. The first tranche of the CDCF has been operational since July 2003. With a capitalization of US$128.6 million, the fund was closed to further subscription as of January 15, 2005.

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.:

Eastern Province

A.4.1.3. City/Town/Community etc:

Mbeere District

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

The Kiambere Hydro Power Project is located in Eastern Province, downstream of Kindaruma Power station, along the Tana cascade.

The project activity is located at Latitude 0° 38' 24" S (-0.6400) and Longitude 37° 54' 36" E (+37.9100). The Kiambere power station is the last of the five hydropower stations on the Tana River (see Figure 1).

[3] Meanwhile, the Kenya Power and Lighting Company Ltd. (KPLC) is the one responsible for the transmission, distribution and retail of electricity throughout the country.

Figure 1: General location of the Kiambere hydropower project

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

The project falls into:
Sectoral scope 1: Energy industries (renewable-/ non-renewable sources)

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

Kiambere is the last Dam on the Tana river and was commissioned in 1988. The underground powerhouse that accommodates the existing 144 MW plant is situated 4 km away from the saddle dam where the intake structure is located. The water conveyance is by a 6 m diameter headrace. The existing 144 MW plant, consisting of (2 x 72 MW) units, has supplied on average annual electricity of about 917.4 GWh to the Kenyan grid from 2003 to 2008.

It is a well-known fact that, in general, the cavitation problems are frequent for Francis turbines. Kengen has been successfully dealing this as part of the regular maintenance practice and with the help of spare runner they have in the plant and maintaining the high availability factor of the units in the plant. Because cavitation is a very predictable thing and has no impact on the safety on the operation of the plant, Kengen would have

continued operation of units without modifying the runners as business as usual. However, Kengen realized the opportunity that exists to increase the output of the plant in parallel to reducing cavitation with the help of modern runner designs.

The Rehabilitation of the Power Plant, which will include the upgrading of the turbines with new runners, will increase the plant's generation capacity by 25 MW in the Kiambere Power Station. This upgrade is beyond routine maintenance and will take a much longer time (six months) than the usual maintenance (one month).

The details for the rehabilitation include the following:

- To replace the whole turbine with a more efficient, powerful and cavitations-free runner (installed capacity with new runner of 84.5 MW x 2 sets instead of existing 72 MW x 2 sets)
- To replace head cover, guide vanes, bottom ring
- To install new electronic governor and adoption to the existing hydraulic parts of governor
- To install new excitation system
- To install additional power cable to carry the extra power

This modification will deliver an estimated incremental annual electricity of 75.0 GWh to the Kenyan grid based on the additional 20 MW contracted capacity. Therefore, the total electricity generation for export to the grid from the power plant will be about 992.4 GWh per year.

The project activity is the replacement of components of the existing machines in Kiambere Power Station. It does not involve construction of a new dam or associated reservoir since it is merely a replacement of components of the existing machines in the power station.

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

Year	**Annual estimation of emissions reductions in tonnes of CO_2e**
Nov 2012- Dec 2012[a]	6,867
Jan 2013– Dec 2013	41,204
Jan 2014– Dec 2014	41,204
Jan 2015– Dec 2015	41,204
Jan 2016– Dec 2016	41,204
Jan 2017– Dec 2017	41,204
Jan 2018– Dec 2018	41,204
Jan 2019– Dec 2019	41,204
Jan 2020– Dec 2020	41,204
Jan 2021– Dec 2021	41,204
Jan 2012 – Sept 2022[b]	34,337
Total estimated reductions (tonnes of CO2e)	412,040

Total number of crediting years	10 years
Annual average over the crediting period of estimated reductions (tonnes of CO2e)	41,204

[a] Estimated for three months, [b] Estimated for 9 months

A.4.5. Public funding of the project activity:

The public funding involve in this CDM project activity does not make use of Official Development Assistance (ODA), nor result in the diversion of such ODA.

SECTION B. Application of a baseline and monitoring methodology

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

Approved consolidated baseline and monitoring methodology ACM0002/Version 13.0.0: "Consolidated baseline methodology for grid-connected electricity generation from renewable sources"

This methodology also refers to the latest approved version of the following tools:

- Tool to calculate the emission factor for an electricity system, Version 02.2.1
- Tool for the demonstration and assessment of additionality, Version 06.1.0
- Combined tool to identify the baseline scenario and demonstrate additionality, Version 04.0.0
- Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion, Version 02

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

The project will be a grid-connected hydro power generation activity and meets all the conditions stated in the approved methodology ACM0002/Version 13.0.0. These conditions are:

- The project activity is the replacement of units of a hydro power plant (with a run-of-river reservoir) that supplies electricity to the grid.[4]
- The project activity is implemented in an existing single reservoir, with no change in the volume of reservoir.[5]
- The existing plant started commercial operation prior to the start of a minimum historical reference period of five years, used for the calculation of baseline emissions and defined in the baseline emission section[6]
- Five years of historical data are available, without any capacity addition or replacement being undertaken between the start of this five-year historical period and the implementation of the project activity.[7]

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[4] Source: Norplan, Final efficiency tests, Nov 2010

[5] Source: Voith Siemens, Initial Proposal for Optimisation of Kiambere, 2005.

[6] Source: KPLC, Annual account, 2009

- The electricity grid (the Kenyan grid) has clearly identified geographic and system boundaries and information on the characteristics of this grid is available.[8]
- The project will not be an activity that involves switching from fossil fuels to renewable energy at the project site.[9]
- The most plausible baseline scenario, as a result of the identification of baseline scenario, is the continuation of the current situation, i.e. to use the power generation equipment that was already in use prior to the implementation of the project activity and undertaking business as usual maintenance. (Refer to Section B.4). This has been established, as per the methodology guidance, using the combined tool to identify the baseline scenario and demonstrate additionality, Version 04.0.

The incremental electricity resulted from the proposed project activity will be supplied to the Kenyan national grid and substitute the grid electricity. Therefore, following the methodology guidance, the tool to calculate the emission factor for an electricity system (Version 2.2.1) is applied in the PDD to estimate the operating margin, build margin and combine margin CO2 emission factors. Similarly, following the methodology guidance, in order to calculate project emissions out of use of any fossil fuel in emergency generators in the plant, the Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion, Version 02 has been applied.

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

>>In accordance with ACM0002/Version 13.0.0, the only greenhouse gas accounted for in the calculation of the emission reductions is CO2.

	Source	Gas	Included	Justification / Explanation
Baseline	CO_2 emissions from fossil fuel fired power plants connected to the Kenyan grid that would be displaced due to project activity.	CO2	Yes	Included as per the ACM0002 methodology
		CH4	No	Excluded as per ACM0002. This is a minor emission source.
		N2O	No	Excluded as per ACM0002. This is a minor emission source.
Project Activity	CH_4 emissions not applicable: project activity is a replacement of equipment of an existing hydropower plant, with no change in volume of reservoir due to project.	CO2	No	Excluded. The project activity is a zero-emission project activity.
		CH4	No	Excluded. The project activity is a zero-emission project activity.
		N2O	No	Excluded. The project activity is a zero-emission project activity.

[7] Ibid.

[8] Source: KPLC

[9] Source: Voith Siemens, Initial Proposal for Optimisation of Kiambere, 2005.

	CO_2 emissions from fossil fuel consumption in diesel generators used for emergency back-up	CO2	No	Neglected as per ACM 0002, Ver 13.0.0.
		CH4	No	Excluded as per ACM0002. This is a minor emission source.
		N2O	No	Excluded as per ACM0002. This is a minor emission source.

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

The project activity is the replacement of equipments of the existing grid-connected Kiambere hydropower plant. According to ACM0002, if the project activity is a replacement or retrofit of an existing grid-connected electricity generation facility, the baseline scenario needs to be identified using the step-wise procedure mentioned below:

Step 1: Identification of alternative scenarios
This Step serves to identify all alternative scenarios to the proposed CDM project activity(s) which can be the baseline scenario:

Step 1a: Define alternative scenarios to the proposed CDM project activity
Under this, identify all alternative scenarios that (a) are available to the project participants, (b) cannot be implemented in parallel to the proposed project activity, and (c) provide the same output as the proposed CDM project activity.
Accordingly, the alternatives considered as per Step 1a and prescribed in the methodology are as follows:

P1 The project activity not implemented as a CDM project;

P2 The continuation of the current situation i.e. to use all power generation equipment that was already in use prior to the implementation of the project activity and undertaking business as usual maintenance. The additional power generated under the project would be generated in existing and new grid-connected power plants in the electricity system;

P3 All other plausible and credible alternatives to the project activity that provide an increase in the power generated at the site, which are technically feasible to implement.

Out of above listed alternatives, the following are only available for the project developer:

P1 The project activity not implemented as a CDM project

As explained in detail in Section B.5, the project would not be implemented without CDM revenue consideration and hence this option is not considered.

P2 The continuation of the current situation and generation of equivalent electricity from the grid

This is the most plausible option available to the project entity considering remaining life of the equipments and current maintenance practices in the plant. In the absence of CDM revenue, the project would have continued operation in its present form and equivalent level of electricity generation would have generated from the grid.

P3 All other plausible and credible alternatives to the project activity that provide an increase in the power generated at the site, which are technically feasible to implement

There are no other technically feasible implementation measures available for increasing power generation without making changes to:

- Reservoir capacity
- Water Passage
- Civil Structure

And making these changes is not technically and economically feasible and hence this is not a credible alternative available to the project developer.

Considering the above, the only alternative is the continuation of the current situation with the generation of equivalent electricity from the grid.

Step 1b: Consistency with mandatory applicable laws and regulations

The one remaining alternative i.e. the continuation of the current situation is in consistent with applicable laws and regulations and there are no mandatory laws and regulations in the country.

Step 2: Barrier Analysis

As per the combined tool, as there is only one alternative available to the project developer, the baseline scenario for the project activity is the continuation of the current situation and generation of equivalent electricity from the grid.

Step 2a: Identify barriers that would prevent the implementation of alternative scenarios

There are no barriers identified that would prevent the implementation of the identified alternative i.e. continuation of the current situation.

Step 2b: Eliminate alternative scenarios which are prevented by the identified barriers

As there are no barriers identified that would prevent the implementation of the identified alternative i.e. continuation of the current situation, the baseline scenario would be the same.

Thus in accordance with the guidance stated in the approved methodology ACM0002/Version13.0.0, the baseline scenario is the continuation of the operation of the existing plant.

The spatial extent of the project boundary includes the project power plant and all power plants connected physically to the Kenyan grid.

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 following steps from the "Tool for the demonstration and assessment of additionality" (Version 06.1.0) will be completed in this section:

Step 1: Identification of alternatives to the project activity consistent with mandatory laws and regulations
Step 2: Investment analysis
Step 3: Barriers analysis
Step 4: Common practice analysis

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

Define realistic and credible alternatives to the project activity through the following steps:

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

There are two identified realistic and credible alternatives available to the project participants that provide outputs or services comparable with the proposed CDM project activity:

1) The proposed project activity undertaken without being registered as a CDM project activity
2) Continuation of the current situation (no project activity or other alternatives undertaken)

Sub-step 1b. Consistency with mandatory laws and regulations:

The main electricity energy laws in Kenya are the Electric Power Act No.11 of 1997 and the Energy Act No.12 of 2006. The Electric Power Act is primarily directed at large-scale conventional power technologies (including thermal, geothermal and hydro). The Energy Act brings under its purview the development and use of renewable energy technologies – including biomass, solar, wind, small hydropower, biogas, etc.

Both the project activity and the above alternatives are in compliance with all regulations under these Acts (though they are not mandatory).

Step 2. Investment Analysis

This step is to determine whether the proposed project activity is not:

(a) The most economically or financially attractive; or
(b) Economically or financially feasible, without the revenue from the sale of certified emission reductions (CERs).

Sub-step 2a: Determine appropriate analysis method

Option III Benchmark Analysis will be used. The Government of Kenya issued guidelines on the minimum required rate of return for all government projects.

Sub-step 2b: Option III. Apply benchmark analysis

The relevant financial indicator was chosen as the IRR. This is a post-tax project IRR benchmark

The benchmark will be derived from Government of Kenya bond rates[10]. Kenyan treasury bonds are considered as suitable indicators. Treasury bills and bonds are auctioned by the government, for which the latest results gave averages of 8.488% and 8.972% for 91-day and 182- day bills, respectively. The bond rates are 8.75% (2 years), 9.5% (5 years), 10.75% (10 years), 12.5% (15 years) and 13.75% (20 years). For the purpose of deriving the benchmark, the Government of Kenya issued guidelines of 15% will be used[11].

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

The following data was used in calculating the project IRR.

Item	**Value**	**Unit**	**Source**
Increase in generation capacity during flooding period	20	MW	Norplan_Optimistation of Kiambere Power Plant_Sept 2003 (p.ii)
Flooding period	120	day	Norplan_Optimistation of Kiambere Power Plant_Sept 2003 (Assumptions)
Load factor	100	%	Assumed 100% for conservativeness
Increase in electricity export amount	57.6	GWh/year	please see below the justification for this figure
Initial	7.581146	Million	Voith Siemens_ Kiambere Project initial proposal_November

[10] http://www.centralbank.go.ke/ - Key Financial Indicators

[11] Circular Number 27/2003 from the ministry of Finance

investment costs		Euro	2005
Capital replacements	2 (year number 10) 2 (year number 25)	Million USD	Kengen
Electricity tariff	1.76	Ksh/kWh	Kengen/KPLC_PPA_April 1, 2005
Variable O&M costs/yr	0.0102	Ksh/kwh	Historical values. Kengen
Depreciation	25	years	Expected lifetime of the project
Tax rate	30%		http://www.doingbusiness.org/reports/thematic-reports/~/media/FPDKM/Doing%20Business/Documents/Special-Reports/DB07-Paying-Taxes.pdf
Ksh/USD exchange rate	75.2954	Ksh/USD	Oanda. 2005 average
Euro/USD exchange rate	0.8371	Euro/USD	Oanda. 2005 average

Based on the above, even with the higher than the expected incremental output of 57.6 GWh/yr, the project IRR, which is post-tax project IRR, for Kiambere Optimisation Project was calculated to be 9.20%. Given that the benchmark shown in Sub-step 2b is 15%, the project's IRR clearly demonstrates that the project is not feasible for KenGen on commercial basis.

Sub-step 2d: Sensitivity analysis

In order to understand the impact of the key input parameters on IRR, a sensitivity analysis has also been carried out as per the guidance of the Tool for various scenarios. The key parameters, viz. Investment Cost, variable O&M Costs, power generation and electricity have been changed.

The sensitivity analysis to determine effect on the IRR was done using the following scenarios:

Item	**Effect on IRR**
Decreasing investment cost by 10%	Increase to 10.48%
Decreasing variable O&M cost by 10%	Increase to 9.21%
Increasing electricity tariff by 10%	Increase to 10.51%
Increasing electricity generation by 10%	Increase to 10.50%

In addition, attempts were made to identify the variation required in key parameters in order to cross the benchmark value and evaluated the possibility for each parameter selected for analysis to vary to that level. The table below shows the variation required for each selected parameter in order to make project IRR cross the benchmark value:

Parameter	**Variation required**	**Commentary on possibility for the parameter to vary to the level required**
Investment cost	-35%	It is very unlikely that there is a possibility for reduction in investment costs since decision making. Considering that the project activity is already commissioned, comparing the actual final costs with the costs estimated during the decision making reveals an increase in investment costs by USD 7 million i.e. a total of US$ 16 million in comparison to US$ 9.06 million considered for the analysis.
Variable O&M cost	-	Even considering zero variable O&M costs, the IRR of the project is way below the benchmark value and hence this variation is of no significance for its analysis.
Electricity generation	+47%	The expected generation from the project activity is already considered using 100% plant load factor and it cannot go beyond 100% and hence operating plant at 147% plant load factor is technically infeasible and hence this scenario is very unlikely to occur.
Electricity tariff	+47%	As the tariff for the project activity is already fixed in the long term PPA, the applicability of any change in the tariff to the already signed long term PPA is difficult and hence change in the tariff to the level required to cross the benchmark is unrealistic and hence very unlikely. Also, the determination of the tariff rate is primarily at the sole discretion of the Energy Regulatory Commission of the Government of Kenya and hence increase in the tariff by 50% is very difficult as this could increase the retail prices to consumers.

From the above analysis, it is evident that the IRR remains low even with the favorable financial assumptions.

<u>Justification for the ‘incremental generation’ value (i.e. ‘increase in electricity export of 57.60 GWh/year’) estimated during investment analysis</u>

It was estimated that there is a loss of 2 x 7 – 10 MW power due to existing runner design which could not handle excess water available during flood season and also due to problem with inlet cavitation. The new cavitation-free runners (Pressure balanced runners, which are advanced than the one installed) which will be installed as part of the project activity are expected to utilize the excess water available during the 120 days

flooding period and hence reducing water spillage at the same time producing more power. [12]In other words, the project activity with new runners is expected to operate and generate power normally during rest of the period (as in the baseline scenario) but generate additional power of 20 MW for export to the grid during flooding period only, which is considered to be 120 days in a year.

With a 2 x 10 MW recovery of power (as per the contracted capacity to the grid) for 120 days (flood season), the new cavitation-free runners are expected to generate an additional electricity of 57.6 GWh for export to the grid with a plant load factor of 100%. However, as the plant is expected to operate normally at a plant load factor of historical levels (assuming same water availability as in baseline), which is 74.8%[13], the increased generation during that period will be only about 43.1 GWh (i.e., 20 MW * 120 days * 24 hours * 0.748).

Even considering the non-contracted capacity out of up gradation of 2.5 MW more per unit (84.5 MW as against 82 MW), the incremental generation is still well below[14] the 57.6 GWh value used for the financial analysis and hence conservative.

Hence the usage of 57.6 GWh for investment analysis as against 43.1 GWh is very conservative.

Step 4: Common practice analysis

As required under the additionality tool (version 06.1.0), the investment analysis has been supplemented by common practice analysis for its credibility check following guidance as per para 47 of the tool as the project falls under energy efficiency as defined under para 6 of the tool. As per para 47 and following the Guideline on common practice (version 2.0), the common practice analysis shall be demonstrated using the following steps:

Step 1: Calculate applicable output range as +/-50% of the design output or capacity of the proposed project activity.

Capacity of the plant	165	MW			
Applicable range (±50%)	82.5	MW	to	247.5	MW

[12] Reported by Mr. Samson Kimani, Chief Plant Engineer of Kiambere Hydropower Station, KENGEN. (Also see NORPLAN report, *op cit*. p. 1: it was pointed out that upgrading the turbines with new runners will increase output between 2 x 7 MW and 2 x 10 MW while solving the problem of cavitation.)

[13] See tabulation of Kiambere Power Station historical statistics shown in Section B.6.1 of the PDD under Estimation of Baseline Emissions.

[14] With 2 x 84.5MW, power recovery for 120 days (flood season) will be 2 x 12.5 MW or 25MW. Based on plant load factor of historical levels, the incremental generation is 51.84 GWh/year (25MW * 120 days * 24 hours * 0.72 /1000).

Step 2: identify similar projects (both CDM and non-CDM) which fulfill all of the following conditions:
(a) The projects are located in the applicable geographical area;
(b) The projects apply the same measure as the proposed project activity;
(c) The projects use the same energy source/fuel and feedstock as the proposed project activity, if a technology switch measure is implemented by the proposed project activity;
(d) The plants in which the projects are implemented produce goods or services with comparable quality, properties and applications areas (e.g. clinker) as the proposed project plant;
(e) The capacity or output of the projects is within the applicable capacity or output range calculated in Step 1;
(f) The projects started commercial operation before the project design document (CDM-PDD) is published for global stakeholder consultation or before the start date of proposed project activity, whichever is earlier for the proposed project activity.

The geographical area considered for the analysis includes whole country (Kenya) and plants selected for comparison are all electric plants that are connected to the grid and operational before the start date of the project i.e. 24/02/2006. The proposed project activity applies measure (b) according to the Guidelines on Common Practice (Version 2.0) which is Switch of technology with or without change of energy source including energy efficiency improvement as well as use of renewable energies. The energy source used by the project activity is hydro power. All the power plants which produce electricity in Kenya can be considered satisfied the criterion (d) listed above. The applicable capacity range calculated in Step 1 is from 82.5 MW to 247.5 MW.

Table: List of plants in Kenya connected to grid (Source: Grid emission factor excel sheet; KPLC and KENGEN)

Power Plant	Type	Installed capacity (MW)	Commissioning year	Commissioned before the project start date	Capacity within the applicable range i.e. between 82.5 MW and 247.5 MW	CDM (registered or under validation)	Apply the same measure as the proposed project activity	Use the same energy source/fuel as the proposed project activity
AGGREKO Embakasi 6 - Petrothermal	Thermal (AGO)	60	2011	No	No	No	No	No
AGGREKO Embakasi 7- Petrothermal	Thermal (AGO)	30	2011	No	No	No	No	No
AGGREKO Muhoroni- Petrothermal	Thermal (AGO)	30	2011	No	No	No	No	No
Kipevu III	Thermal (HFO)	115	2010	No	Yes	No	No	No
RABAI -	Diesel	90	2009	No	Yes	No	No	No

Power Plant	Type	Installed capacity (MW)	Commissioning year	Commissioned before the project start date	Capacity within the applicable range i.e. between 82.5 MW and 247.5 MW	CDM (registered or under validation)	Apply the same measure as the proposed project activity	Use the same energy source/fuel as the proposed project activity
Petrothermal								
AGGREKO Embakasi 4 - Petrothermal	Thermal (AGO)	40	2009	No	No	No	No	No
AGGREKO Embakasi 5 - Petrothermal	Thermal (AGO)	60	2009	No	No	No	No	No
Mumias	Biomass	35	2008	No	No	Yes	No	No
Sondu Miriu	Hydro	60	2007/08	No	No	No	Yes	Yes
Iberafrica II	Thermal (Diesel)	52.5	2007	No	No	No	No	No
Olkaria II	Geothermal	70	2003	Yes	No	Yes	No	No
Tsavo (IPP)	Thermal (HFO)	74	2001	Yes	No	No	No	No
OrPower (IPP)	Geothermal	13	2000	Yes	No	Yes	No	No
Kipevu I	Thermal (HFO)	75	1999	Yes	No	No	No	No
Iberafrica I	Thermal (Diesel)	56	1997	Yes	No	No	No	No
Ngong Wind	Wind	0.35	1995	Yes	No	No	No	No
Turkwel	Hydro	106	1991	Yes	Yes	No	Yes	Yes
Masinga	Hydro	40	1981	Yes	No	No	Yes	Yes
Olkaria I	Geothermal	45	1981	Yes	No	No	No	No
Gitaru	Hydro	225	1978-2000	Yes	Yes	No	Yes	Yes
Kamburu	Hydro	94.2	1974-76	Yes	Yes	No	Yes	Yes
Kindaruma	Hydro	40	1968	Yes	No	No	Yes	Yes
Wanjii	Hydro	7.4	1952	Yes	No	No	Yes	Yes
Tana	Hydro	14.4	1932-56	Yes	No	Yes	Yes	Yes
Small Hydro (Gogo, Sosiani, Sagana)	Hydro	4.9	1925-58	Yes	No	No	Yes	Yes

Step 3: within the projects identified in Step 2, identify those that are neither registered CDM project activities, project activities submitted for registration, nor project activities undergoing validation. Note their number N_{all}.

Based on above mentioned criteria, the list of power plants that meet all above mentioned conditions is as follows:

Power Plant	Type	Installed capacity (MW)	Commissioning year	Commissioned before the project start date	Capacity within the applicable range i.e. between 82.5 MW and 247.5 MW	CDM (registered or under validation)	Apply the same measure as the propose d project activity	Use the same energy source/fuel as the proposed project activity
Turkwel	Hydro	106	1991	Yes	Yes	No	Yes	Yes
Gitaru	Hydro	225	1978-2000	Yes	Yes	No	Yes	Yes
Kamburu	Hydro	94.2	1974-76	Yes	Yes	No	Yes	Yes

Based on Step 2, the number of power plants that falls in the applicable capacity range is N_{all} = 3.

Applied geography:	Whole country
N_{all}	3

Step 4: within similar projects identified in Step 3, identify those that apply technologies that are different to the technology applied in the proposed project activity. Note their number N_{diff}.

It is noteworthy from the table above that no new hydropower project has been constructed in Kenya over the last 16 years that supply electricity to the national grid.[15] As the table also indicates, the most recent capacity addition took place in 2000 concerning the expansion of the Gitaru hydropower station. Consequently, although hydropower projects may rely on broadly similar technology, these three hydro projects differ from the project activity in the following way:

1) Since year 2000, the energy sector as a whole has been undergoing restructuring and reforms as articulated in the Sessional Paper No.4 of 2004 and the Energy Act No.12 of 2006[16]. Considering this, the regulatory and investment environment under which these three projects implemented were different.
    a. The ownership structure of KenGen was changed in 2006, when the Government of Kenya divested its interest in the company by selling 30% of the shares to the public.[17] This required KenGen to evaluate its investment in projects as a *private investor* on behalf of all of its shareholders (Government and the public), instead as a purely public investor. With this change, KenGen operates on a commercial basis and have private share capital, although the Government is the majority

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[15] Exception is the Sondu Miriu hydropower project which is a proposed CDM activity. It has started operation in year 2007/2008.

[16] http://www.climateinvestmentfunds.org/cif/sites/climateinvestmentfunds.org/files/Kenya%20IP_0.pdf
[17] There are several press releases on this decision of the Government to sell 30% of its KenGen shares. See for example
1) Page 6 of the report at http://www.os.is/gogn/unu-gtp-sc/UNU-GTP-SC-05-30.pdf;
2) http://www.kengen.co.ke/index.php?page=investor&subpage=intro
3) http://www.africanexecutive.com/modules/magazine/articles.php?article=567

shareholder. This investment evaluation environment was different when these three projects were implemented.

b. Second, the prices of relevant input materials for the manufacture of equipment (steel, copper, etc) have increased by more than 30% in recent years making investments in new hydropower projects and new capacity additions more expensive.[18] That means, the cost per MW of investment made for these three hydro projects is less compared to the project activity.

Furthermore, in the context of the measure applied in the proposed CDM project, out of the three hydro projects (Turkwel, Gitaru and Kamburu), none of the plants undergone rehabilitation or retrofitting before the project start date similar to the activities considered for the project activity (and installing efficient technology) and hence different from the project activity. Kiambere is the only optimization activity being undertaken by KenGen, and no upgrade of capacity of hydropower projects was done before 2005. These three hydro projects never undergone changes similar to the project activity before the start of the project activity i.e. no rehabilitation occurred in these projects before and that makes these three projects different from the project activity.

Considering the above, $N_{diff} = 3$

Step 5: calculate factor $F=1-N_{diff}/N_{all}$ representing the share of similar projects (penetration rate of the measure/technology) using a measure/technology similar to the measure/technology used in the proposed project activity that deliver the same output or capacity as the proposed project activity.

Based on outcomes of step 3 and step 4, F = 1 – (3/3) = 0; and $N_{all}-N_{diff} = 0$

Considering above, the proposed project activity is not a common practice within a sector in the applicable geographical area as both of the following conditions are not fulfilled:

(a) the factor F is greater than 0.2, and
(b) $N_{all}-N_{diff}$ is greater than 3.

<u>Start Date and Implementation Timeline:</u>

As indicated in Section C.1 of this document, the starting date of the project activity is on February 24, 2006 when the contract for project construction was signed between KenGen and Voith Siemens Hydro. This starting date of the project activity is before the date of project validation and before 02 Aug 2008. Hence, in accordance with the ”Guidelines on the demonstration and assessment of prior consideration of the CDM**”,** EB 62 Annex 13 (Version 04), serious consideration of CDM and continuation actions taken to secure CDM status is demonstrated in the “Managing Director’s Report” published in the *Kenya Electricity Generating*

[18] For example, a World Bank Project Implementation Support Mission conducted for the Energy Sector Recovery Project on 3-16 May 2006 reported that prices of materials (mainly steel and copper) have recently increased by 31.7% from the date of appraisal. [Reference: Energy Sector Recovery Project (Cr.3958-KE). World Bank Implementation Support Mission, May 3-16, 2006. p.12]

Company Limited Annual Report 2006 (p.23)[19] where in potential for generation of revenues from CDM was considered for the project activity. Consideration of revenue stream from CDM to the project is important for Kengen in order to improve the financial viability of the project as discussed above. Discussion of CDM revenues as part of Managing Director's discussions highlights the serious consideration of importance of role that the revenues from CDM can play for the successful implementation and operation of the project activity.

To demonstrate that continuing and real actions were taken to secure the CDM status for the project, the chronological sequence of events is as follows: The World Bank and KenGen signed the Letter of Intent for the Project on October 6, 2006[20] and subsequently the Emissions Reduction Purchase Agreement (ERPA) on July 30, 2007; and amendment to the ERPA on September 18, 2009.[21] The World Bank and Det Norske Veritas AS (DNV) signed the contract for validation of project on November 30, 2007. DNV conducted a site visit of the project during the period of July 28-31, 2008. Finally, the project was commissioned in March 2009 (Unit 2) and November2009 (Unit 1)[22].

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

Estimation of Project Emissions

Based on ACM0002/Version 13.0.0, the project emissions (PE_y) are equal to zero. The project activity is a replacement of equipments of an existing hydropower plant and does not result in new reservoir or an increase in volume of existing reservoir.

Estimation of Baseline Emissions

The project activity follows the steps provided by the methodology in estimating the baseline emissions. Baseline emissions include only CO_2 emissions from electricity generation in fossil fuel fired power plants in the Kenyan grid that are displaced due to the project activity, calculated using Equations (6), (8) and (9).

(6) $BE_y = EG_{PJ,y} * EF_{grid,CM,y}$ (8) $EG_{PJ,y} = EG_{facility,y} - (EG_{historical} + \sigma_{historical})$; until $DATE_{BaselineRetrofit}$	Where: BE_y Baseline emissions in year *y* (tCO_2/yr) $EG_{PJ,y}$ Quantity of net electricity generation that is produced and fed into the grid as a result of the implementation of the CDM project activity in year *y* (MWh/yr)

[19] Relevant pages of this report were provided to the DOE.

[20] LOI has been provided to the DOE during the validation process

[21] Relevant pages of the Emissions Reduction Purchase Agreement were provided to the validators.

[22] Evidence on the commissioning date has been provided to the DOE during the validation process

and ***(9)*** $EG_{PJ,y} = 0$ ***; on/after*** $DATE_{BaselineRetrofit}$	$EG_{facility,y}$ Quantity of net electricity generation supplied by the project plant to the grid in year *y* (MWh/yr). $EG_{historical}$ Annual average historical net electricity generation delivered to the grid by the existing hydropower plant that was operated at the project site prior to the implementation of the project activity (MWh/yr) $\sigma_{historical}$ Standard deviation of the annual average historical net electricity generation delivered to the grid by the existing hydropower plant that was operated at the project site prior to the implementation of the project activity (MWh/yr) $DATE_{BaselineRetrofit}$ Point in time when the existing equipment would need to be replaced in the absence of the project activity (date) $EF_{grid,CM,y}$ Combined margin CO_2 emission factor for grid connected power generation in year *y* calculated using the latest version of the "Tool to calculate the emission factor for an electricity system".

$EG_{historical}$ is estimated based on the last five years prior to the implementation of the project activity (i.e., from July 2003/June 2004 to July 2007/June 2008)[23].

Calculation of $DATE_{BaselineRetrofit}$ ***for Kiambere Power Station***

As per the methodology, in order to estimate the point in time when the existing equipment would need to be replaced /retrofitted in the absence of the project activity ($DATE_{BaselineRetrofit}$), project participants may take the following approaches into account:

(a) The typical average technical lifetime of the type equipment may be determined and documented, taking into account common practices in the sector and country, e.g. based on industry surveys, statistics, technical literature, etc.

(b) The common practices of the responsible company regarding replacement/retrofitting schedules may be evaluated and documented, e.g. based on historical replacement/retrofitting records for similar equipment.

The following paragraphs further elaborate how the PP has taken the above into account while determining the $DATE_{BaselineRetrofit}$

A) Average technical lifetime of the type equipment in the sector and country

As per the "Approach a)" indicated in the methodology (page 11) while determining the $DATE_{BaselineRetrofit,}$ to account the following: i) life time of plants in Kenya ii) lifetime of the hydro power plants in Africa (as

[23] KenGen's year of operation is defined from the first of July of current year to end of June the following year.

similar techno-economic environment prevails in the region) of comparable size to the Kiambere Power Plant, iii) Typical life of hydro plant that has got similar runner problem, and iv) information from technical literature.

As explained above, since the project activity "Optimisation of Kiambere Hydro Power Project" involves replacement of all main components of the power plant, the selection of the entire plant and its life time of existing hydro power plants in the selected region for determining the common practice in the region are found to be appropriate.

i) Life time of plants in Kenya

There are five power plants that were commissioned during the period 1925-1958 (see Table below), which was decades earlier than the commissioning of units in the Kiambere station (in 1988), and are still running successfully without any future replacement schedules planned.

Table 1: Hydro Power Plants in Kenya with a lifetime higher than 50 years

Name of Hydro Electric Power plant	Commissioning Year	No. of years in operation (till 2010)	Any replacement activities performed?	Remarks
Ndula	1925	85	Normal routine repairs	Oldest Hydro in Kenya
Gogo	1958	52	Generator stator coils were replaced	-
Sosiani	1952	58	Automation of plant done around year 2000	
Mesco	1933	77	Generator replacement in progress	A fault caused breakdown
Sagana	1955	55	Normal routine repairs	Most reliable old plant

Source: Kengen

As KenGen is the sole utility in the country operating all the hydro plants, there are no historical evidences to show the replacement schedule timeline as no plant has undergone such activities (including runner replacement) till date (as evidenced from above table). Based on the above mentioned information, the lifetime of the plants operating in Kenya can conservatively considered as 52 years though this plant is continue to operate till date without any replacement schedule.

ii) Lifetime of plants in Africa of comparable size

The analysis has been done based on the public information available on installed and operational hydro power plants in various countries of Africa (excluding Kenya) and the list of power plants with more than 50 years operational life time till 2010 has been tabulated below:

Table 2: Hydro Power Plants in Africa with a lifetime higher than 50 years

Sr. No	Hydro Station Name	Country	Year of installation	Operational life till year 2010
1	Sennar Power Station	Sudan	1925	85
2	Felou Regional Hydro	Mali	1927	83
3	Kayes Hydro power plant	Mali	1927	83
4	Firestone Power Station	Liberia	1942	68
5	Tis Abay I Power Station	Ethiopia	1953	57
6	Edea Power Station	Cameroon	1953	57
7	Nalubaale Power Station	Uganda	1954	56
8	Kariba South Station	Zambia	1955	50
9	Koka Power Station	Ethiopia	1960	50

Source: Wikipedia

Based on the analysis, it is observed that the hydro plants with a technical life of more than 80 years are still running. This is a very common practice in African countries where capacity and technical expertise required to evaluate such replacements is minimal along with lack of financial resources and hence continue to operate at least 80 years or even more.

Out of these 9 power plants, a more detailed analysis has been conducted to the 4 hydro power plants of similar size:

Plant # 1: Edea Power Station (Cameroon, 204MW, 57 years in operation):

Commissioning date:

Construction – Feb/5/ 1954 (opening ceremony), construction actually took place during 1953. Sources:

- French investment in colonial Cameroon - Martin-René Atangana – 2009 – Library of the congress USA

http://books.google.com/books?id=bYsBSDyFEEgC&pg=PA144&lpg=PA144&dq=edea+dam+construction&source=bl&ots=otP1hLk8y1&sig=AhxlOytKxyTogzsrB4_PxnV2JG0&hl=en&sa=X&ei=owsfT5f3OcGViAe_wtzpDQ&ved=0CE8Q6AEwBg#v=onepage&q=edea%20dam%20construction&f=false

- The aluminum industry in West and Central Africa, WB 2009

Proof that it has been in operation for more than 50 years:

- Hydroworld article (12/15/08) http://www.hydroworld.com/index/display/article-display/8019318576/articles/hrhrw/News/Cameroon_finalizes_deals_to_refurbish_263-MW_Edea_396-MW_Song_Loulou.html
- Hydroworld article (12/15/08) http://www.hydroworld.com/index/display/article-display/4579713799/articles/hrhrw/News/DSD_Noell_supplies_gates_to_refurbish_Cameroons_263-MW_Edea.html
- Allafrica article (4/21/09) http://allafrica.com/stories/201102150700.html

Plant # 2: Nalubaale Power station [originally called Owen Falls Dam] (Uganda, 180 MW, 56 years in operation)

Commissioning date:
Construction date: 1954 (the year when the lake reached its designed altitude). Construction of the dam commenced in 1950 and it was commissioned on 29th April 1954 by Her Majesty the Queen Elizabeth the second. Sources:

- Eskom Uganda http://www.eskom.co.ug/power_stations.php

Proof that it has been in operation for more than 50 years:

- Eskom Uganda http://www.eskom.co.ug/power_stations.php

Plant # 3: Kariba South Station (Zimbabwe, 705 MW, 50 years in operation)

Commissioning date:
Construction: between 1955 and 1959. Source:

- World Commission of Dams and ADB (http://www2.adb.org/water/topics/dams/pdf/cszzmain.pdf)

Proof that it has been in operation for more than 50 years:

- World Commission of Dams and ADB (http://www2.adb.org/water/topics/dams/pdf/cszzmain.pdf)

Plant # 4: Koka Power Station (Ethiopia, 43 MW, 50 years in operation)

Commissioning date:
Commissioning year May/June 1960. Source:

- http://www.norway.org.et/News_and_events/etiopia/Koka-Dam-50-years-with-39-megawatts/

Proof that it has been in operation for more than 50 years:

- http://www.norway.org.et/News_and_events/etiopia/Koka-Dam-50-years-with-39-megawatts/

iii) Typical life of hydro plant that has got similar runner problem

As no information is available on whether the above mentioned plants have experienced similar activities in the plant, the analysis boundary has been further expanded to identify any such plants exist in the World and found one example in India. The details are as follows:

Plant Name: Bhakra Beas Left Bank Power Plant

Capacity: 5 x 106 MW

Operation since: 1962

Have runners faced similar issue as that of Kiambere plant: Yes, they also experienced the cavitation during after 2 years it got commissioned.

When the runners are proposed to be replaced with new: 2012 (the rehab work has just started)

How long runners operated without any operational issues: 49 years (as also evidenced through their high availability factor and plant load factor).

iv) Based on technical literature

Moreover, the economic lifetime of a hydroelectricity generation facility is presumed to be 50 to 60 years.

It is also observed that there are few hydro plants in the world operating for more than 100 years[24]. This also confirmed in some of the technical literature available on the subject[25]. These facts were also confirmed by the recently registered CDM project – "Felou regional hydro project", which is installed in 1927.

[24] Decew Falls 1, St. Catharines, Ontario completed 25 August 1898. Owned by Ontario Power Generation. Four units are still operational. Recognized as an IEEE Milestone in Electrical Engineering & Computing by the IEEE Executive Committee in 2002 (http://en.wikipedia.org/wiki/Hydroelectricity)

Also, Ardnacrusha power station in Ireland, installed in 1929, is 80 years old and is still running (http://en.wikipedia.org/wiki/Ardnacrusha_power_plant)

Haltwood's 108 MW power plant in Pennyslavania has been in operation for the last 100 years (installed in 1910) http://www.renewableenergyworld.com/rea/news/article/2010/07/hydro-hall-of-fame-taking-holtwood-next-into-the-century

[25] Risk in Hydroelectricity Production', Inhaber H, Energy, v3 pp 769-778, 1978

B). Common practices of the responsible company regarding replacement/retrofitting schedules

Following the methodology guidance and as per Option b), the analysis also covers an assessment of the replacement practice of equipments by KENGEN, the sole authority operating hydro plants in Kenya. It is observed that no such practice of retrofitting and replacement has neither been carried out in the past nor have been planned for the future except the proposed CDM project activity. Therefore, this analysis is not considered to be appropriate in the context of determining the $DATE_{BaselineRetrofit}$. However this analysis does provide stronger evidences in support of longer operating life of hydro power plants operated by Kengen, as presented below.

There are five power plants that were commissioned during the period 1925-1958 in Kenya, which were decades earlier than the commissioning of units in the Kiambere station (in 1988), and are still running successfully without any future replacement schedules planned. This is evidenced from the information provided in the table above where it is shown that some units are operating successfully for more than 85 years and no runner replacement was taken place in any of the plants. This is a very common practice in African countries like Kenya where capacity and technical expertise required to evaluate such replacements is minimal along with lack of financial resources and hence continue to operate at least 80 years or even more. These facts along with best maintenance culture justify that it is not a common practice for Kengen to replace or modify the project components.

Also, as evidenced by the regular maintenance practices by Kengen, for example the cavitation problem in the runners can be easily handled with the help of welding the steel elements of the runner with stainless steel rods and would have continued doing this with the help of prevailing elaborate welding procedures to achieve the highest quality repairs. Cavitation repair practices followed by Kengen are consistent with the method documented by US Bureau of Reclamation (http://www.usbr.gov/power/data/fist/fist2_5/vol2-5.pdf), which involves grinding off the damaged material to sound material and building up by welding and then grinding to profile. Special welding rods are used to create a cavitaion resistant overlay. This ensures following best maintenance practices in the industry and meets the requirements under CDM.

To establish the continuation of the existing units through the crediting period selected in absence of the implementation of the project activity, the following information is used:

i. Continued high availability of units

In looking at the remaining lifetime for Kiambere Power station, we have looked at the operational statistics of the power plant for the last 5 years (see table below). 5 The average generation over the years has been fairly constant.

Sustainable Energy-choosing among options, p. 532. http://books.google.com/books?id=AIbLqsJrW-

Kiambere Power station historical statistics (Effective capacity 144 MW)

Year	03 – 04	04 - 05	05 - 06	06 - 07	07 - 08	Mean	Std. dev.
Sent out units (Gwh)	1,010	814	852	973	938	917.4	82.2
Load factor (%)	80.8	72.5	68.3	77.9	74.57	74.8	4.8
Availability (%)	97.0	89.6	96.2	95.5	86.57	93.0	4.6

Source: KENGEN, Annual Reports, various years. Also, KENGEN, Kiambere Annual Plant Operations Report, 2004/2005.

Mean sent out generation is about 917.4 GWh with a standard deviation of about 82.2 GWh. The sent out generation has been basically a function of hydrology as opposed to plant availability. Plant availability has basically been in the range of 93% with a standard deviation of about 4.6%. This implies that due to routine maintenance of the plant, its availability has remained high.

ii. Regular maintenance practices as per the manufacturer guidance

The two units in Kiambere power station have been undergoing regular maintenance as per the manufacture maintenance schedules. This also ensured the continued availability and operation of the units. During the whole operational history of units, there were no major breakdowns that could lead to shut down of plant for more than 2 months. This fact is well reflected in the plant annual availability factors provided in the table above. Rivers flow to its reservoir except outflows of water from upstream power stations. The breakdowns are usually “minor” e.g. failure of electronic cards, leaking generator air coolers etc. The summary of main reasons for the breakdowns/outages of the units so far is as follows:

1. Lack of some spares for governor and excitation systems due to obsolescence.
2. Higher stresses on the machines and associated equipment due to maximum loading of plants as Kenya’s national economy is growing at a high rate about 7% per year causing high power demand growing at a rate of about 8% per year.
3. Repairs of runners due to cavitation and cracking (as it is general for Francis Turbines).[26]
4. Leaking of generator air coolers due to corroded water boxes requiring changing with spare coolers.

QC&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false

[26] NORPLAN report, *op cit*. p.1: Cavitation on the runners is a frequent problem in Francis turbines, in general, as well as other problems related to the mechanical design of the turbine.

From the above it is clear that none of these are related to prolonged age of the plant and hence one can conclude that the health of the units is satisfactory. This also substantiates the argument that these units would have continued to perform well meeting the requirements.

Clearly, KenGen has highly effective maintenance practices in their power plants. The units in the Kiambere power plant have been maintained very well and the result of such well maintained practices is evidenced through high availability of units all the time. This has also been evidenced in the analysis of the NORPLAN report[27], which identifies the following:

- Cavitation is very predictable and has no impact on the safety of operation of the plant
- In general, cavitation problem is frequent in Francis turbines
- Modification of runners is not needed
- High availability of units as a result of good maintenance practices

These facts along with good maintenance culture justify that it is not a common practice for KenGen to replace or modify the project components. KenGen would have continued to operate the plant with existing runner design without any upgrade with continuation of good maintenance practices.

C) Independent report results and expert opinion

Though this is not necessary as per the guidance provided in the methodology, as supplement, the PP has also referred to results of an independent study and sought an expert opinion to demonstrate the remaining life of plant. According to the independent study conducted by Norplan on optimization options available for the project activity, the alternative of continuation of the existing plant with continued best maintenance practices is also considered. As per the report, keeping the spare runner design as same as original runners and using this as a replacement during repair of original runners is an option that permit continuation of the plant operation without change-out operations.

In addition to above, the report also confirms the following:

- Cavitation of the runner is predictable and does not present any threat to the safety of operation. The good maintenance practices by KenGen would have continued, with high availability as demonstrated earlier.
- Kiambere cavitation problem started immediately after commissioning of the plant in 1988. Maintenance practices to address this problem ensured that the machines availability was high. Regular inspections would ensure that problems were addressed in time.

[27] Ibid. p. 1; 2-3.

- With the cavitation defects repaired, the runners would perform as expected as stated in 1 above.

Also, an independent expert opinion confirms the following:

- That the cavitation is very common in type of turbines installed in Kiambere and is not a major concern for continuation of plant operation;
- That the cavitation issue identified in Kiambere can be addressed with the practices that are already in place and followed by Kengen since beginning;
- The runners continue to operate with no performance issues as long as these practices are maintained;

Conclusion

Based on above, it is clear that hydro plants operate more than 50 years and any cavitation issues with turbines can be easily handled following standard industry practices without any immediate need for their replacement. Considering the present lifetime of Kiambere plant (which is 24 years), the plant would operate beyond the crediting period of 10 years without any need for undergoing rehabilitation.

Accordingly it is concluded that the units in the existing Kiambere power station prior to project activity would have continued their operation at least until the end of the crediting period considered i.e. till 2022 and hence the ***DATEBaselineRetrofit*** is considered to be 31/12/2022 on a conservative basis.

Leakage

No leakage emissions are considered as per the approved methodology (ACM0002/Version 13.0.0).
Therefore, emission reductions (ER_y) are calculated as follows based on Equation (11):

(11) $ER_y = BE_y - PE_y$	Where: ER_y Emission reductions in year y (tCO_2/yr) BE_y Baseline emissions in year y (tCO_2/yr) PE_y Project emissions in year y (tCO_2/yr)

Estimation of the CO_2 emission factor of the Kenyan grid ($EF_{grid,CM,y}$)

Following the guidance specified in the "Tool to calculate the emission factor of an electricity system/Version 02.2.1", the Combined Margin CO_2 emission factor ($EF_{grid,CM,y}$) of the Kenyan grid is estimated as the weighted average of the Operating Margin (OM) emission factor and Build Margin (BM) emission factor, using Equations (10), (12), (13), (3) and (14). The weights for calculating the Combined Margin are the default 50% for each of the margins.

The Operating Margin method selected is the Dispatch Data Analysis OM. In terms of vintage of data, Option 1 is selected to estimate the Build Margin *ex-ante*.

The margins calculation is done according to the following steps as indicated in the tool:

Calculation of the Dispatch Data Analysis OM ($EF_{grid,OM-DD,y}$)

$EF_{grid,OM-DD,y}$ is determined based on the grid power units that are actually dispatched at the margin during each hour *h* where the project is displacing grid electricity. The emission factor is calculated as shown below.

(10) $$EF_{grid,OM-DD,y} = \frac{\sum_h EG_{PJ,h} \cdot EF_{EL,DD,h}}{EG_{PJ,y}}$$	Where: $EF_{grid,OM-DD,y}$ Dispatch data analysis operating margin CO_2 emission factor in year *y* (tCO_2/MWh) $EG_{PJ,h}$ Electricity displaced by the project activity in hour *h* of year y (MWh) $EF_{EL,DD,h}$ CO_2 emission factor for grid power units in the top 10% of the dispatch order in hour *h* in year *y* (tCO_2/MWh) $EG_{PJ,y}$ Total electricity displaced by the project activity in year *y* (MWh)
As the hourly fuel consumption data is not available, the hourly emissions factor is calculated based on the energy efficiency of the grid power unit and the fuel type used, as follows: **(12)** $$EF_{EL,DD,h} = \frac{\sum_n EG_{n,h} \times EF_{EL,n,y}}{\sum_n EG_{n,h}}$$	$EF_{EL,DD,h}$ CO_2 emission factor for grid power units in the top 10% of the dispatch order in hour *h* in year *y* (tCO_2/MWh) $EF_{EL,n,y}$ CO2 emission factor of grid power unit n in year y (tCO2/MWh) $EG_{n,h}$ Net electricity generated and delivered to the grid by grid power unit *n* in hour *h* (MWh) ***n*** Grid power units in the top 10% of the dispatch ***h*** Hours in year *y* in which the project activity is displacing grid electricity ***y*** Year in which the project activity is displacing grid electricity
Following the Tool, the $EF_{EL,n,y}$ is calculated using option A1 of the simple OM as data on fuel consumption and electricity generation is	$EF_{EL,n,y}$ CO2 emission factor of power unit n in year y (tCO2/MWh) $FC_{i,n,y}$ Amount of fossil fuel type i consumed by power

available: $$EF_{EL,m,y} = \frac{\sum_i FC_{i,m,y} \cdot NCV_{i,y} \cdot EF_{CO2,i,y}}{EG_{m,y}}$$ ***(2)*** During ex-post calculation of OM, depending on the data availability, the $EF_{EL,n,y}$ can be estimated using various Options (A1 or A2 or A3).	unit n in year y (Mass or volume unit);); this is estimated based on the specific fuel consumption data available for each power plant and the electricity ***$NCV_{i,y}$*** Net calorific value (energy content) of fossil fuel type i in year y (GJ/mass or volume unit) ***$EF_{CO2,i,y}$*** CO2 emission factor of fossil fuel type i in year y (tCO2/GJ) ***$EG_{m,y}$*** Net quantity of electricity generated and delivered to the grid by power unit n in year y (MWh) ***n*** = Grid power units in the top 10% of the dispatch ***i*** All fossil fuel types combusted in power unit m in year y ***y*** The relevant year as per the data vintage chosen in Step 3 (July 2007-June 2008)

As indicated above, ***n*** refers to the set of power units (*n*) falling within the top 10% of the system dispatch. To determine the set of power units (*n*), obtain from a national dispatch center: a) the grid system dispatch order of operation for each grid power unit of the system including power units from which electricity is imported; and b) the amount of power (MWh) that is dispatched from all grid power units in the system during each hour *h* that the project activity is displacing electricity. At each hour *h*, stack each grid power unit's generation using the merit order. The set of grid power units (*n*) consists of those power units at the top of the stack (i.e., having the least merit), whose combined generation comprises 10% of total generation from all power units during that hour (including imports to the extent they are dispatched).

For purposes of estimating the dispatch data analysis OM emission factor (***$EF_{grid,OM-DD,y}$***), data during the year 2011 is used. The methodology requires using the year in which the project activity actually displaces grid electricity. In accordance with this requirement, ***$EF_{grid,OM-DD,y}$*** will be updated annually during monitoring.

Calculation of the ex-ante BM ($EF_{grid,BM,y}$)

The Build Margin emission factor is the generation-weighted average emission factor (tCO_2/MWh) of all power units *m* during the most recent year *y* for which power generation data is available, calculated as shown below:

$$EF_{grid,BM,y} = \frac{\sum_m EG_{m,y} \times EF_{EL,m,y}}{\sum_m EG_{m,y}}$$ ***(13)***	Where: ***$EF_{grid,BM,y}$*** Build margin CO_2 emission factor in year *y* (tCO_2/MWh) ***$EG_{m,y}$*** Net quantity of electricity generated and delivered to the grid by power unit *m* in year *y* (MWh) ***$EF_{EL,m,y}$*** CO_2 emission factor of power unit *m* in year *y* (tCO_2/MWh)

	m Power units included in the build margin ***y*** Most recent historical year for which power generation data is available (2011)
The CO_2 emission factor of each power unit *m* ($EF_{EL,m,y}$) is determined using option A1 of the simple OM and calculated as follows: $$EF_{EL,m,y} = \frac{\sum_i FC_{i,m,y} \cdot NCV_{i,y} \cdot EF_{CO2,i,y}}{EG_{m,y}}$$ ***(2)***	$EF_{EL,m,y}$ CO2 emission factor of power unit m in year y (tCO2/MWh) $FC_{i,m,y}$ Amount of fossil fuel type i consumed by power unit m in year y (Mass or volume unit); this is estimated based on the specific fuel consumption data available for each power plant and the electricity generation data. $NCV_{i,y}$ Net calorific value (energy content) of fossil fuel type i in year y (GJ/mass or volume unit) $EF_{CO2,i,y}$ CO2 emission factor of fossil fuel type i in year y (tCO2/GJ) $EG_{m,y}$ Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh) ***m*** All power units serving the grid in year y except low-cost/must-run power units ***i*** All fossil fuel types combusted in power unit m in year y ***y*** The relevant year as per the data vintage chosen in Step 3(2011)

In accordance with the guidance provided in the Tool (p.14), the sample group of power units *m* used to calculate the build margin consists of the set of power capacity additions in the Kenyan grid that comprise 20% of the grid generation (in MWh) and that have been built most recently. The choice of the sample group of power units *m* is justified below.

List of power units built most recently	Fuel type	Installed capacity (MW)	Commissioning year	Generation (GWh) in 2011
AGGREKO Embakasi 6 - Petrothermal	Thermal (AGO)	60	2011	75,484
AGGREKO Embakasi 7- Petrothermal	Thermal (AGO)	30	2011	27,493
AGGREKO Muhoroni- Petrothermal	Thermal (AGO)	30	2011	17,108
Kipevu III	Thermal (HFO)	115	2010	592,043
RABAI - Petrothermal	Diesel	90	2009	387,529
AGGREKO Embakasi 4 - Petrothermal	Thermal (AGO)	40	2009	164,819
AGGREKO Embakasi 5 - Petrothermal	Thermal (AGO)	60	2009	81,053
Mumias	Biomass	35	2008	79,002
Sondu Miriu	Hydro	60	2007/08	371,494

Total		1,796,029

Total grid generation 2011 (MWh)	7,462,923.85
20% of total grid generation 2011 (MWh)	1,492,584.77
Total generation 5 units built most recently (MWh)	1,099,658.33

Therefore, the sample group of power units m used in BM calculation is group b (Tool, p.14): those power units comprising 20% of system generation in 2011. Following the "Tool to calculate the emission factor for an electricity system." Version 02.1.0 p.14, footnote 7, since the 20% falls on part capacity of the Sondu Miriu unit, this unit has been fully included in the calculation. Therefore, the group of power units m used in the BM calculation includes those in the previous table, which generated 1,796.029 GWh in 2011.

Calculation of the Combined Margin emission factor ($EF_{grid,CM,y}$)

(14) $EF_{grid,CM,y} = EF_{grid,OM,y} \times w_{OM} + EF_{grid,BM,y} \times w_{BM}$	Where: w_{OM} Weighting of operating margin emission factor (%) w_{BM} Weighting of build margin emissions factor (%) The default values of 50%-50% are used for the crediting period.

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

Data / Parameter:	***$EG_{historical}$***
Data unit:	MWh/yr
Description:	Annual average historical net electricity generation delivered to the grid by the existing facility that was operated at the project site prior to the implementation of the project activity
Source of data used:	KPLC (Kenya Power and Lighting Company Ltd.) and KenGen.
Value applied:	917,400
Justification of the choice of data or description of measurement methods and procedures actually applied :	Historical data on electricity sold to the grid over the last five years, from 2003/04 to 2007/08, prior to the implementation of the project activity. Measurements were done using electricity meters. 2003/04: 1,010 GWh; 2004/05: 814 GWh; 2005/06: 852 GWh; 2006/07: 973 GWh; 2007/08: 938 GWh

Any comment:	Measurement procedures are based on electricity meters.

Data / Parameter:	$\sigma_{historical}$
Data unit:	MWh/yr
Description:	Standard deviation of the annual average historical net electricity generation delivered to the grid by the existing facility that was operated at the project site prior to the implementation of the project activity
Source of data used:	Calculated from data used to establish $EG_{historical}$
Value applied:	82,248
Justification of the choice of data or description of measurement methods and procedures actually applied :	Parameter is calculated as the standard deviation of the annual generation data used to calculate $EG_{historical}$ for retrofit or replacement project activities
Any comment:	-

Data / Parameter:	$DATE_{BaselineRetrofit}$
Data unit:	date
Description:	Point in time when the existing equipment would need to be replaced in the absence of the project activity
Source of data used:	KenGen
Value applied:	31/12/2022
Justification of the choice of data or description of measurement methods and procedures actually applied :	As per provisions in ACM0002/Version 13.0.0. See Section B.6.1 on Calculation of $DATE_{BaselineRetrofit}$ for the existing Kiambere plant.
Any comment:	-

Data / Parameter:	$EF_{CO2,n,i,y}$ and $EF_{CO2,m,i,y}$
Data unit:	tCO_2/TJ
Description:	Average CO_2 emission factor of fossil fuel type *i* used in power unit *m* or *n* in year *y*
Source of data to be used:	2006 IPCC Guidelines for National Greenhouse Gas Inventories, Chapter 1 of Vol. 2 (Energy), Table 1.4, p.1.23,
Value applied:	Automotive Gas Oil (AGO): 67.5; Diesel:72.6; Fuel Oil:75.5; and Kerosene: 70.8
Justification of the choice of data or description of measurement methods and procedures actually applied :	Default data from IPCC has been used as Country specific data is not available.
Any comment:	IPCC default values at the lower limit of the uncertainty at a 95% confidence interval

Data / Parameter:	$NCV_{,i,y}$
Data unit:	GJ / ton
Description:	Net calorific value (energy content) of fossil fuel type i in year y (GJ/mass or volume unit)
Source of data to be used:	2006 IPCC Guidelines for National Greenhouse Gas Inventories, Chapter 1 of Vol. 2 (Energy), Table 1.2, p.1.18
Value applied:	Automotive Gas Oil (AGO): 42.5; Diesel: 41.4; Fuel Oil: 39.8; and Kerosene: 42.4
Justification of the choice of data or description of measurement methods and procedures actually applied :	Default data from IPCC has been used as Country specific data is not available.
Any comment:	IPCC default values at the lower limit of the uncertainty at a 95% confidence interval

Data / Parameter:	$EF_{grid,BM,y}$
Data unit:	tCO_2/MWh
Description:	Build Margin CO_2 emission factor in year *y*
Source of data to be used:	KPLC Dispatch Centre and IPCC default factors
Value applied:	0.4665 tCO_2/MWh
Justification of the choice of data or description of measurement methods and procedures actually applied :	Calculated using the latest version of the "Tool to calculate the emission factor for an electricity system." Version 02.2.1
Any comment:	Calculated once ex-ante for the crediting period

B.6.3 Ex-ante calculation of emission reductions:

Project emissions are estimated as follows:

$PE_y = 0$

The project activity is the replacement of equipments of an existing hydropower plant and does not result in new reservoir or an increase in volume of existing reservoir.

Baseline emissions are estimated as follows:

(6) $BE_y = EG_{PJ,y} \cdot EF_{grid,CM,y}$

Where

(8) $EG_{PJ,y} = EG_{facility,y} - (EG_{historical} + \sigma_{historical})$; until $DATE_{BaselineRetrofit}$

and

(9) $EG_{PJ,y} = 0$; on/after $DATE_{BaselineRetrofit}$

$EG_{facility,y}$ is estimated using the historical average load factor to the total capacity. Thus:

$EG_{facility,y}$ = (2x82MW * 8760 * 0.748) = 1,074,607 MWh

$EG_{historical}$ is estimated as the average of historical electricity delivered by the existing facility to the grid during the last five years prior to the implementation of the project activity, as shown below:

Kiambere Power Plant

Year	**Net electricity delivered to grid (GWh)**
2003/04	1,010
2004/05	814
2005/06	852
2006/07	973
2007/08	938
Total	4,587
Average/yr	917.4

The variance (**σ^2**) of the net electricity delivered to grid in the past five years is estimated as follows:

$$\sigma^2 = 1/(n-1) * [\Sigma X^2 - (\Sigma X)^2 / n]$$

$$= 1/4 * [4,235,173 - (4,587)^2 / 5]$$

$$= 6,764.8 GWh^2$$

$$\sigma_{historical} = 82,248 \text{ MWh}$$

$EF_{grid,CM,y}$ is estimated to be equal to **0.5497 tCO_2/MWh** (see Annex 6 for detailed calculation of the CO_2 emission factor of the Kenyan grid).

Therefore,

$$BE_y = [1,074,607 - (917,400 + 82,250) \text{ MWh/yr}] * 0.5497 \text{ tCO}_2\text{/MWh} = \underline{41,204 \text{ tCO}_2\text{/yr}}$$

Because ***PE_y*** is equal to zero, then

(11) $ER_y = BE_y$

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

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Year	Estimation of Project Activity Emissions (tonnes of CO_2e)	Estimation of Baseline emissions (tonnes of CO_2e)	Estimation of Leakage (tonnes of CO_2e)	Estimation of overall emissions reductions (tonnes of CO_2e)
Nov 2012 – Dec 2012[a]	0	6,867	0	6,867
Jan 2013– Dec 2013	0	41,204	0	41,204
Jan 2014– Dec 2014	0	41,204	0	41,204
Jan 2015– Dec 2015	0	41,204	0	41,204
Jan 2016– Dec 2016	0	41,204	0	41,204
Jan 2017– Dec 2017	0	41,204	0	41,204
Jan 2018– Dec 2018	0	41,204	0	41,204
Jan 2019– Dec 2019	0	41,204	0	41,204
Jan 2020– Dec 2020	0	41,204	0	41,204
Jan 2021– Dec 2021	0	41,204	0	41,204
Jan 2022– Oct 2022[b]	0	34,337	0	34,337
Total	**0**	**412,040**	**0**	**412,040**

a Estimated for three months, b Estimated for 9 months

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

All data collected as part of monitoring will be archived electronically and be kept at least for 2 years after the end of the last crediting period. 100% of the data will be monitored if not indicated otherwise in the tables below. All measurements will be conducted with calibrated measurement equipment according to relevant industry standards.

B.7.1 Data and parameters monitored:

Data / Parameter:	$EG_{facility,y}$
Data unit:	MWh/yr
Description:	Quantity of net electricity generation supplied by the project plant/unit to the grid in year *y*
Source of data to be used:	KenGen
Value of data applied for the purpose of calculating expected emission reductions in section B.5	1,074,607 MWh per year (estimated with 74.8% historical average load factor) (2x82MW * 8760 * 0.748) = 1,074,607 MWh
Description of measurement methods and procedures to be	This parameter shall be determined as a difference between (i) quantity of electricity supplied by the project plant/unit to the grid and quantity of electricity delivered to the project plant/unit from the grid.

applied:	Electricity meters are installed complying with industry standards in the country. Measured continuously and recorded on a monthly basis. The following parameters shall be measured: (i) The quantity of electricity supplied by the project plant/unit to the grid; and (ii) The quantity of electricity delivered to the project plant/unit from the grid
QA/QC procedures to be applied:	Electricity supplied by the project activity to the grid will be double checked by receipt of sales.
Any comment:	This data will be monitored. Monitoring frequency will involve hourly measurement and monthly recording.

Data / Parameter:	$EF_{grid,OM-DD,y}$
Data unit:	tCO_2e/MWh
Description:	Dispatch data analysis Operating Margin CO_2 emission factor
Source of data to be used:	KPLC Dispatch Centre and IPCC default factors
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.6330 tCO_2e/MWh
Description of measurement methods and procedures to be applied:	Calculated using the latest version of the “Tool to calculate the emission factor for an electricity system.”
Monitoring frequency	Yearly
QA/QC procedures to be applied:	Calculation should be done after KPLC energy balance to ensure data validity.
Any comment:	-

Data / Parameter:	$EG_{n,h}$ ***and*** $EG_{m,y}$
Data unit:	MWh
Description:	Net electricity generated and delivered to the Kenyan grid by power plant/unit *m* in year *y* or *n* in hour *h*
Source of data to be used:	KenGen and KPLC Dispatch Centre
Value of data applied for the purpose of calculating expected emission reductions in section B.5	See Annex 3.
Description of	Actual net generation and export to the grid by each power unit will be measured

measurement methods and procedures to be applied:	and recorded.
Monitoring frequency:	Hourly for Dispatch data OM; For BM, once *ex-ante* for the first crediting period and once *ex-ante* at start of the second crediting period.
QA/QC procedures to be applied:	Electricity supplied by the power units to the grid will be double checked by receipt of sales.
Any comment:	-

Data / Parameter:	$EG_{PJ,h}$
Data unit:	MWh
Description:	Electricity displaced by the project activity in hour *h* in year *y*
Source of data to be used:	KenGen and KPLC Dispatch Centre
Value of data applied for the purpose of calculating expected emission reductions in section B.5	See Annex 3.
Description of measurement methods and procedures to be applied:	Electricity displaced by the project activity will be measured every hour and recorded.
Monitoring frequency:	Hourly
QA/QC procedures to be applied:	Total electricity displaced by the project activity during the year will be double checked against sales receipts.
Any comment:	-

B.7.2 Description of the monitoring plan:

See Annex 4 for a description of the monitoring plan. In a related issue, detailed project management planning is shown in Annex 5.

The monitoring methodology involves the monitoring of the following:

- Electricity generated and fed into the grid by the proposed CDM project.
- Public data on dispatch of electricity by all power units connected to the Kenyan grid and other relevant information from KPLC.
- Public data on official KPLC report.

Monitored data required for verification and issuance of CERs is to be kept for two years after the end of the crediting period or the last issuance of CERs, whichever occurs later.

Data Processing for ER calculation

Step 1. Calculation of the Operating Margin CO_2 Emission Factor

The diagram below shows the process for calculating the OM emission factor based on dispatch data analysis:

Net Hourly Generation from Optimisation of Kiambere Power Project and other units in the Kenyan grid system
(MWh)

⇩

Analysis of hourly dispatch from all units to determine the top 10% on the margin ("Tool to calculate the emission factor for an electricity system", version 02.1.0 p.14)
(KPLC hourly data)

⇩

Calculation of emission factor of all thermal units included in the top 10% of the dispatch order
(KPLC, KenGen, 2006 IPCC Guidelines, Energy Regulatory Commission)
(tonnes CO_2e/MWh)

⇩

Determination of $EF_{grid,OM-DD,y}$ in year y
(tonnes CO_2e/MWh)

Equations (10), (12), and (3) of the "Tool to calculate the emission factor for an electricity system" version 02.1.0 are used to calculate the $EF_{grid,OM-DD,y}$.

Step 2. Use the Build Margin CO_2 Emission Factor ($EF_{grid, BM, y}$) calculated ex-ante; and once at the beginning of the crediting period

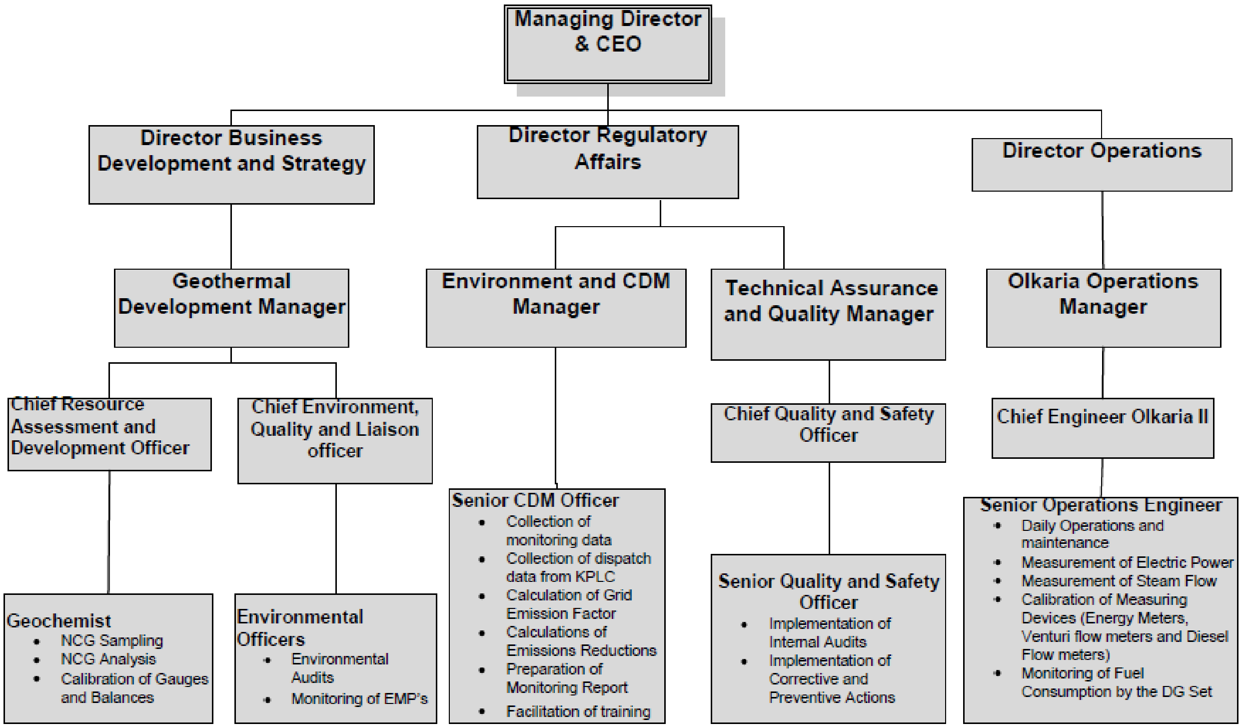
Step 3. Calculation of the Emission Reductions of the Project

Calculation of Combined Margin Emission Factor $EF_{grid,CM,y}$ as the weighted average of $EF_{grid,OM-DD,y}$ and $EF_{grid,BM,y}$ (Equation 13 of the "Tool" with equal weights assigned to OM and BM) (tonnes CO_2e/MWh) ⇩ Electricity generation and delivered to grid (after deducting any imports from grid) by the 'Optimisation of Kiambere Power Project' (KPLC and KenGen) (MWh) ⇩ Calculation of Baseline Emissions of the Project (ACM0002/Version 13.0.0: Equations 6,8,9) (tonnes CO_2e/yr) ⇩ Discount any leakage or project activity emissions, if any (no leakage and project emissions are identified for the Project) (tonnes CO_2e/yr)

Operational and Management structure

The diagram below provides an overview of the general management structure of KenGen as it will directly affect the implementation of the proposed CDM project.

KenGen General Management Structure



KenGen will designate a competent staff who will be in charge of, and accountable for, the generation of ERs – including ERPA supervision, monitoring, record keeping, computation of ERs, audits and verification. In addition, KenGen will ensure that internal training is made available to its operational staff, if needed, to enable them to undertake all the required tasks in executing the CDM project.

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)

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1. Date of completing the final draft of this baseline section: 30/05/2012

2. Name of person/entity determining the baseline: Mr. Pius Kollikho (pkollikho@kengen.co.ke), Manuel Luengo (mluengo@worldbank.org) and Noreen Beg (nbeg@worldbank.org). They are not project participants as listed in Annex 1.

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:

24/02/2006 - This is the date of contract signed between KenGen and the contractor Voith Siemens Hydro.

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

25 years

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

C.2.1. Renewable crediting period

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

Not applicable

C.2.1.2. Length of the first crediting period:

Not applicable

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

01/11/2012 or the date of registration of the project, whichever is later.

C.2.2.2. Length:

10 years

SECTION D. Environmental impacts

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

The project activity entails rehabilitation works that will take place within the confines of the existing power plant. No environmental impact assessment was conducted in accordance with the provisions of the Environmental Coordination and Management Act (EMCA, 1999). The Act does not require EIA when the main project work consists of replacement of mechanical equipment within the plant. Nonetheless, as required by the Act, the Kiambere power station will be subject to annual Environmental Audits under the guidance of the National Environmental Management Authority (NEMA).

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:

No environmental assessment was deemed necessary as explained above. Meanwhile, dam safety is ensured as the station is operated in cascade with other upstream power plants. The addition of the 20MW capacity will have no impact on the dam because all that the project entails is the installation of more efficient machines utilizing the same water channels/penstocks as the existing station.

SECTION E. Stakeholders' comments

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

Stakeholder consultations were carried out to compile and consider comments from the local residents before project implementation. Two stakeholder meetings were held in 2007. The stakeholders were invited by sending letters with one week in advance.

The first stakeholder meeting was held on 10th April 2007 in the Gitaru conference room, attended among others by the community liaison officer and various members of the community. The role of KenGen in clean power generation was highlighted and its efforts in corporate social responsibility (CSR) were emphasized. The CSR committee of KenGen announced a plan to provide assistance to the community in terms of awarding scholarships to five nearby neighborhoods as well as assisting in construction of schools, roads and hospitals as possible component of the community development plan to be associated with implementing the proposed CDM project. The second stakeholder meeting was on 5th December 2007. In this meeting, the CDCF (Community Development Carbon Fund) community benefit plan was discussed in more detail. Participants during the meeting, including liaison officer and HRO training and development officials, agreed to design the community benefit plan by first visiting the projects done by the CSR committee and also based on those projects specifically requested by the local community.

E.2. Summary of the comments received:

Comments received pertain mainly on the provisions of the community benefits plan. (See Section E.3 below.)

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

Based on the needs listed on the stakeholder meeting held on April 10th and December 5th 2007, KenGen and local community leaders agreed on the following items to make up the community benefit plan: providing water to certain parts of the community; constructing six water kiosks at Musumaa sub-location around the Masinga power station; constructing classrooms in primary schools; and building health centers. Financing of the benefit plan would be met through the sale of ERs to the CDCF. [28]

[28] For every ton of ERs in CO_2 equivalent generated by the CDM project and purchased by the CDCF, a dollar is added to the unit price which should be spent on the implementation of the community benefit plan.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	Kenya Electricity Generating Company Ltd (KenGen)
Street/P.O.Box:	Kolobot Road, Parklands; P.O Box 47936-00100
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Department:	Regulatory Affairs
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Direct FAX:	
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Organization:	Netherlands' Ministry of Infraestructure and the Environment (IenM)
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URL:	
Represented by:	Mr. Maas Goote
Title:	
Salutation:	Mr.
Last Name:	Goote
Middle Name:	
First Name:	Maas

Department:	
Mobile:	
Direct FAX:	
Direct tel:	
Personal E-Mail:	

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

There is no Annex I public funding involved in the proposed project. The project does not make use of Official Development Assistance (ODA), nor result in the diversion of such ODA.

Annex 3

BASELINE INFORMATION

Table A3-1 Power plants connected to Kenya national power grid in 2011

Power Plant	*Type*	*Installed capacity (MW)*	*Net generation 2011 (Gwh)*	*% of Total Generation*	*Commissioning year*
Tana	Hydro	14.4	77.535	1.04	1932-56
Wanjii	Hydro	7.4	43.064	0.58	1952
Kamburu	Hydro	94.2	36.114	4.84	1974-76
Gitaru	Hydro	225	722.403	9.68	1978-2000
Kindaruma	Hydro	40	146.083	1.96	1968
Masinga	Hydro	40	155.007	2.08	1981
Kiambere	Hydro	144	758.755	10.17	1988
Small Hydro (Gogo, Sosiani, Sagana)	Hydro	4.9	31.652	0.20	1925-58
Turkwel	Hydro	106	503.734	6.75	1991
Sondu Miriu	Hydro	60	371.494	4.98	2007/08
UETCL Imports	Hydro	-	31.652	0.42	-
Olkaria I	Geothermal	45	232.906	3.12	1981
Olkaria II	Geothermal	70	844.516	11.32	2003
OrPower (IPP)	Geothermal	13	366.702	4.91	2000
Ngong Wind	Wind	0.35	18.694	0.25	1995
Mumias	Biomass	35	79.002	1.06	2008
Total of Hydro, Geothermal, Wind & Biomass		***899.25***	***4,727.554***	***63.35%***	
Rabai	Diesel	90	387.529	5.19	2009
Kipevu I	Thermal (HFO)	75	236.172	3.16	1999
Kipevu III	Thermal (HFO)	115	592.043	7.93	2010
Iberafrica II	Thermal (Diesel)	52.5	383.888	5.14	2007
Iberafrica (IPP)	Thermal (Diesel)	56	381.904	5.12	1997
Aggreko-Embakasi 4	Thermal (AGO)	40	164.820	2.21	2009
Aggreko-Embakasi 5	Thermal (AGO)	60	81.054	1.09	2009
Aggreko Embakasi 6	Thermal (AGO)	60	75.484	1.01	2011
Aggreko Embakasi 7	Thermal (AGO)	30	27.493	0.37	2011
Aggreko Muhoroni	Thermal (AGO)	30	17.108	0.23	2011

Tsavo Power Plant (IPP)Thermal (HFO)	74	387.874	5.20	2001
Total of Thermal	***682.5***	***2,735.370***	***36.65%***	
Total	**1,562.45**	**7,462.924**	**100%**	

Table A3-2 Net calorific values and carbon dioxide emission factors of fossil fuels consumed in the grid

Fossil fuel type	Net calorific value (GJ/ton)	Emission factor (tCO_2/GJ)	Reference
Automotive Gas Oil (AGO)	42.5	0.0675	2006 IPCC Guidelines for National GHG Inventories, Tables 1.2 - 1.4, p.1.18 - 1.24.
Diesel	41.4	0.0726	
Fuel Oil	39.8	0.0755	
Kerosene	42.4	0.0708	

Table A3-3 Power units built most recently

List of power units built most recently	Fuel type	Installed capacity (MW)	Year built [a]	Generation (GWh) in 2011
Aggreko Embakasi 6	AGO	60	2011	75.484
Aggreko Embakasi 7	AGO	30	2011	27.493
Aggreko Muhoroni	AGO	30	2011	17.108
Kipevu III	HFO	115	2010	592.043
Rabai	Diesel	90	2009	387.529
Aggreko-Embakasi 4	AGO	40	2009	164.820
Aggreko-Embakasi 5	AGO	60	2009	81.054
Mumias	Biomass	35	2008	79.002
Sondu Miriu	Hydro	60	2007/2008	371.494
Total				1,796.029

Annex 4
MONITORING INFORMATION

The data and parameters that will be monitored in this project activity are detailed in Section B.7.1. Monitoring will take place from the registration date up to the end of the last crediting period. Since project emissions were not identified in this project activity, and since ACM0002/Version 13.0.0 does not consider emissions due to leakage, there will be no need to monitor the parameters for these cases.

All data collected as part of monitoring will be archived electronically and kept at least for two years after the end of the last crediting period. All measurements will be conducted with calibrated measurement equipment according to relevant industry standards.

The monitoring will occur as follows:

- The quantity of electricity exported to the grid by the project activity will be metered by KenGen and KPLC, and readings of meters will be done jointly by them. Readings will be double checked by receipts of sales each month. In accordance with the approved methodology, hourly measurement and monthly recording will be done. Meters will be subject to a regular maintenance regime to ensure accuracy.

- Specific fuel consumption (and hence the amount of fossil fuel consumption) for each thermal power unit in the grid will be monitored on a yearly basis through the Energy Regulatory Commission

- Net electricity generated and delivered to the grid (determined based on electricity supplied to and from the grid) by each power unit connected to the grid will be measured and recorded. Readings of meters will be done jointly by KPLC and KenGen, and will be crosschecked with receipts of sales. Meters will be regularly maintained to ensure accuracy.

- CO_2 Combined Margin emission factor of the Kenyan grid will be estimated based on KPLC hourly dispatch data, on specific fuel consumption (and hence the amount of fossil fuel consumption) for each thermal power unit in the grid and electricity delivered to grid by each power unit. Accuracy of data reporting by KPLC and KenGen will be monitored through consistency in meter readings and sales receipts.

Monitoring plan for the Kenyan grid is discussed in further details below:

Kenya's interconnected grid system (IGS) is coordinated by the Kenya Power and Lighting Company Ltd (KPLC). KPLC is the sole distribution and transmission company in Kenya.

KPLC programs the dispatch of the power units by strict economic priority, considering the river flows, water availability, and the operational cost of the thermal units and the filling of the hourly load curve of the demand. The outcome is the hourly generation program for each power unit and the hourly marginal cost of the whole system (that cost represents the highest operational cost of the power units generating in each hour). KPLC must coordinate in real time the dispatch at minimum cost of the power units according to the monthly, weekly, and daily programs.

KPLC keeps daily and monthly reports of the actual operation of the IGS, including half hourly generation data for each power unit.

KenGen will be responsible for managing the monitoring of data and parameters required in updating the CO2 emission factor of the Kenyan grid.

A. Dispatch Data Analysis OM

The dispatch data analysis OM emission factor ($EF_{grid,OM-DD,y}$) is determined based on the grid power units that are actually dispatched at the margin during each hour *h* where the project is displacing grid electricity. This approach requires annual monitoring of $EF_{grid,OM-DD,y}$.

For each hour *h* where the project plant is displacing grid electricity, the following data and parameters will be monitored:

1. The dispatch order of all grid-connected power plants (including imports). The actual dispatch of all power units in the interconnected grid system and dispatch priority list of the units are collected from the KPLC Dispatch Centre which keeps electronic version of the half hourly dispatch data. This information is sent to KenGen designated staff daily.

2. The total grid electricity demand. This information is collected by the KPLC centre.

3. The quantity of electricity displaced by the project activity. The hourly net generation of the project plant is obtained from the metering system of the plant, but is also available from KPLC Dispatch Centre. This information is compiled by KPLC as for all other plants in the IGS. With this data, KPLC provides half hourly report of the system dispatch and hourly data is obtained by summing half hourly generation data.

4. Plants that are in top of the dispatch. KPLC Dispatch Centre collects information on the dispatch priority order of the power units in the IGS on half hourly basis. Also, based on this information, KPLC produces every month a dispatch merit order list of the power units in the IGS according to their marginal operation costs.

5. The quantity of electricity generation of plants that are in top of the dispatch. This information pertains to electricity generated and delivered to the grid by grid power unit *n* in hour *h*. This information is collected by the KPLC centre.

6. Types and quantities of fossil fuel consumption of plants that are in top of the dispatch. This information is used to calculate the hourly emission factor of plants in the top of the dispatch, and is collected by KenGen.

7. CO2 emission factor of fossil fuel type. Data source: IPCC default values at the lower limit of the uncertainty at a 95% confidence interval as provided in Table 1.4 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories.

B. Build Margin

In calculating the Build Margin emission factor ($EF_{grid,BM,y}$), Option 1 is chosen. Option 1 does not require monitoring the Build Margin emission factor during the crediting period.

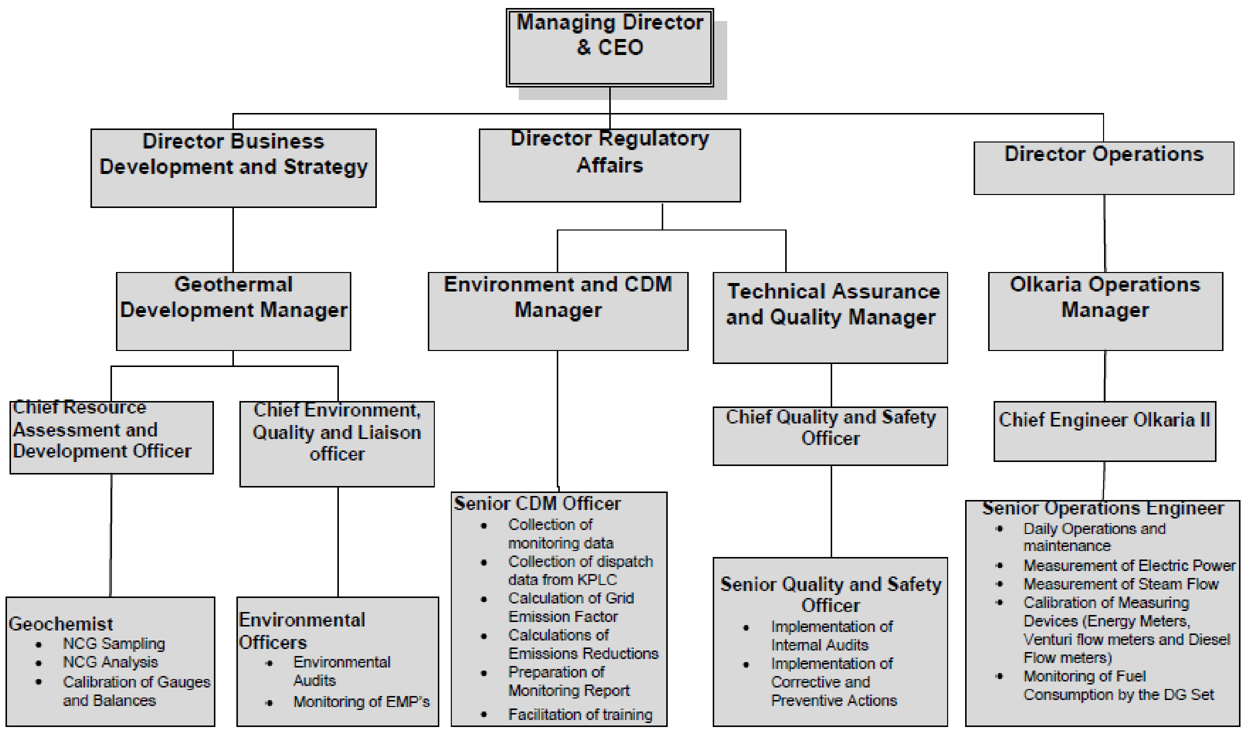
In the case of the proposed project, the crediting period covers a fixed 10-year period. Therefore, under Option 1, the $EF_{grid,BM,y}$ will be calculated once *ex-ante* for the fixed crediting period.

All generation data is obtained from KPLC Dispatch Centre. All power units in the system can be arranged chronologically with commissioning dates that are available from KenGen or KPLC annual reports.

Annex 5
PROJECT MANAGEMENT PLANNING

The diagram below provides an overview of the general management structure of KenGen as it will directly affect the implementation of the proposed CDM project.

KenGen General Management Structure



KenGen will designate competent staff who will be in charge of, and accountable for, the generation of ERs – including ERPA supervision, monitoring, record keeping, computation of ERs, audits and verification. In addition, KenGen will ensure that internal training is made available to its operational staff, if needed, to enable them to undertake all the required tasks in executing the CDM project.

Table A5-1 CDM Monitoring System Procedures

Procedure name	Description	Scope

Procedures identified for training of monitoring personnel	This procedure outlines the steps to ensure that staff will acquire adequate training to collect and archive complete and accurate data necessary for CDM monitoring.	KenGen is ISO 9001 certified for all their plants in Kenya. Procedures for training have been incorporated as part of ISO 9001.
CDM data and record keeping arrangements	This procedure provides details of the site data and record keeping arrangements. The arrangements ensure that complete and accurate records are retained within the quality control system.	All data and records should be managed following this procedure. Staff are responsible for ensuring that any data or records are dealt with according to this procedure. Data and records will be stored and archived according to this procedure.
Data collection	This procedure describes how to collect data for all of the monitored variables in the PDD.	This procedure will outline the steps to collect the data from the electricity meter.
CDM data quality control and quality assurance	This procedure covers all measured and/or calculated variables.	Data and records will be checked prior to being stored and archived. Data from the project will be checked to identify possible errors or omissions. All records will be checked for completeness.
Equipment maintenance	This procedure outlines the steps to provide regular maintenance to the electricity meters and steam flows meters.	This procedure should be followed by all staff involved in checking and maintaining the on site meters
Equipment calibration	This procedure details the process of organising and managing the calibration of measuring and monitoring equipment.	The calibration of the electricity meters will be conducted by a suitable company according to the AMM standards. The relevant Engineer in charge is responsible for organising the calibration and ensuring that records are retained.
Internal audits of GHG project compliance with operational requirements	This procedure details the internal audits for compliance with operational requirements.	An internal quality audit team is available within KenGen and this will be tasked to include the audit of the GHG project compliance. KenGen has ISO 9001 certification and will be extending this to include the proposed project.
Project performance reviews before data is submitted for verification, internally or externally	This procedure is for project performance reviews before data is submitted for verification, internally or externally.	The KenGen internal quality audit team will be tasked with the review of data before submission for verification.

Corrective action to provide for more accurate future monitoring and reporting	This procedure details the corrective action in order to provide for more accurate future monitoring and reporting.	Any requirement for more accurate reporting will be identified by the quality audit team and will be discussed and resolved by the entire management team.
Corrective Actions	Details how corrective actions of errors will be taken care of, if necessary.	Any corrections in the source data are marked, and the type of correction is documented in the spreadsheet. The original source data are stored next to the corrected data.

Table A5-2 Operational procedures and responsibilities for monitoring and quality assurance of emissions reductions from the project activity
(E = responsible for executing data collection, R = responsible for overseeing and assuring quality, I = to be informed)

Task	Technicians	Engineer in charge	Project developer’s head office
Collect Data	E	R	N/A
Enter data into Spreadsheet	N/A	R	N/A
Make monthly and annual reports	N/A	E	E/R
Archive data & reports	N/A	R	N/A
Calibration/ Maintenance	I/E	R	I