Project design document form
(Version 11.0)

Complete this form in accordance with the instructions attached at the end of this form.

BASIC INFORMATION	
Title of the project activity	Olkaria II Geothermal Expansion Project
Scale of the project activity	☒ Large-scale ☐ Small-scale
Version number of the PDD	Version 12
Completion date of the PDD	11/08/2020
Project participants	• **Kenya:** Kenya Electricity Generating Company Ltd. (KenGen) • **Netherlands:** Netherlands' Ministry of Infrastructure and the Environment (IenM) • **Germany:** KfW • **Austria:** Kommunalkredit Public Consulting GmbH • **Denmark:** Maersk Olie og Gas A/S, DONG Energy Slag and service A/S; Nordjysk Ethandel A/S, Danish Ministry of Climate, Energy and Building, /Danish Energy Agency; Aalborg Portland A/S • **Sweden:** Goteborg Energi AB • **Italy:** Government of Italy-Ministry for the Environment, Land and Sea • **Finland:** Ruukki Metals Oy • **Spain:** Kingdom of Spain- Ministry of Agriculture, Food and Environment & Ministry of Economy and Competitiveness;EDP Energias de Portugal, S.A.; Endesa Generacion, S.A., Gas Natural SDG S.A. • **Japan:** Idemitsu Kosan Co.,Ltd.; The Okinawa Electric Power Co., Inc. • **Norway:** Statoil ASA; Statkraft Carbon Invest AS • **Switzerland:** Schweizeriscbe Ruckversicherungsgesellschafts AG (Swiss RE) • **Luxembourg:** Ministry for Sustainable Development and Infrastructure **Bilateral and Multilateral Funds**: Managing Company - International Bank for Reconstruction and Development (IBRD) as Trustee of the Community Development Carbon Fund (CDCF)

Host Party	Kenya
Applied methodologies and standardized baselines	ACM0002 Version 19 Grid-connected electricity generation from renewable sources
Sectoral scopes	1. Energy industries (renewable sources)
Estimated amount of annual average GHG emission reductions	78,640 tCO_2e

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

>>
The objective of Olkaria II Geothermal Expansion Project is to increase the capacity of the existing Olkaria II Geothermal Power Plant by adding a third generating unit of 35MW. This addition resulted in an average annual generation of 276GWh which was exported to the Kenyan grid.

The Kenya Electricity Generating Company (KenGen) currently owns and operates the two geothermal power stations, Olkaria I and Olkaria II. Olkaria I (three units commissioned between 1981 and 1985) has an installed capacity of 45 MW, although its steam gathering capacity could produce up to 70 MW. Olkaria II has an installed capacity of 70 MW (2 x 35MW) and its steam gathering capacity could produce approximately 98 MW. Therefore, the estimated steam surplus between the two steam fields is roughly 53 MW. To make use of this surplus steam, KenGen added a third generating unit (Unit 3) of 35 MW at Olkaria II.

The project results in greenhouse gas (GHG) emission reductions by displacing fossil fuel-based electricity generation in the Kenyan grid with clean geothermal power.

The project activity covers the installation of a dry/flash steam geothermal power plant. The project boundary covers the power generation equipment, steam well, and national grid of Kenya, i.e. all power plants/units connected physically to the electrical system. The baseline is CO2 emissions from electricity generation in fossil fuel fired power plants in the national grid of Kenya, which is displaced due to the project activity.

The total emission reductions during the 2nd crediting period are 550,482 tCO2e, with an annual average of 78,640 tCO_2e.

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 energy 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.

Decreased dependence on fossil fuels: Kenya is the first African country to tap geothermal power. Significant geothermal potential exists in the country's Great Rift Valley which could easily double the entire grid capacity of the East Africa region, but exploration is costly. Nonetheless, 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 geothermal power, Kenya's dependence on imported crude petroleum can be reduced significantly. (Petroleum accounts for 20-25% of the national import bill.[1]) 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.

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

A.2. Location of project activity

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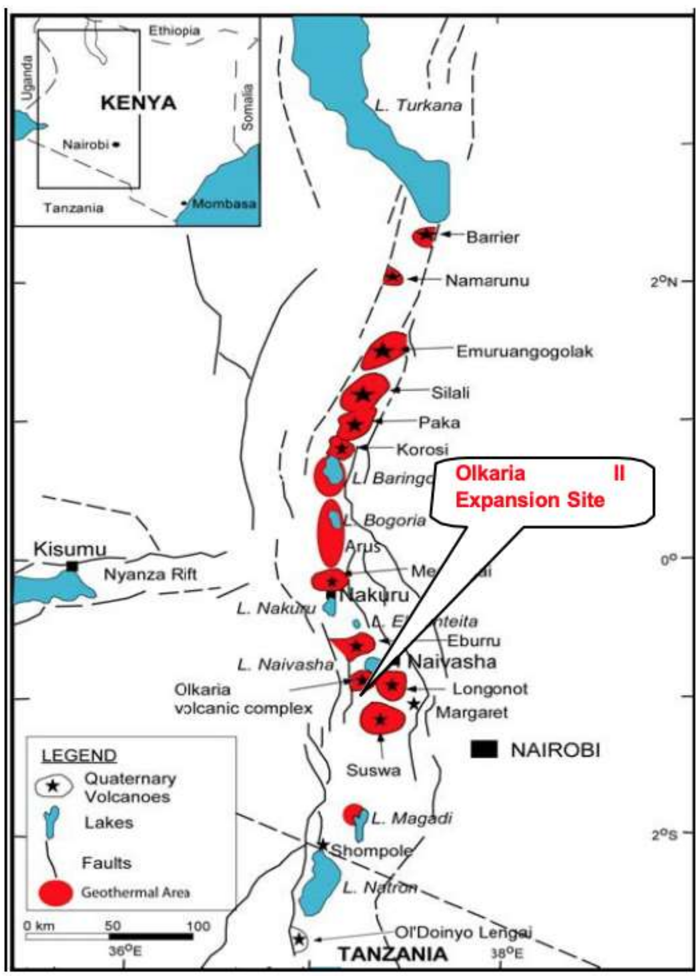
The Olkaria site is located in the Hell's Gate National Park, approximately 132km northwest of Nairobi by road, near Naivasha Town. The GPS coordinates of the facility are -0.8642, 36.2991. The Olkaria geothermal field is located 6 km to the south of Lake Naivasha in Kenya's Rift Valley Province and occupies a circular area of roughly 80km².

Olkaria II is approximately 3km north of Olkaria I power station and was commissioned in September 2003[2] with two generating units. Olkaria II field covers an area of approximately 12km² and is situated in the northeast quadrant of Olkaria geothermal field.

Figure 1. General Location of the Olkaria II Geothermal Expansion Project



A.3. Technologies/measures

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[2] Commissioning report for Olkaria II Unit 1&2.pdf

The existing Olkaria II power station has been extended to accommodate an additional steam turbine/generator (Unit 3) and auxiliaries and its subsequent interconnection to Unit 1and Unit 2. At the power station, the steam will run a steam turbine/alternator before exhausting into a direct contact condenser. The steam condenses and the condensate is pumped by hot well pumps to forced draught cooling towers from where it flows by gravity back to the condenser.

The project activity involved installation of a dry/flash steam geothermal power plant with no less than 94% availability factor[3] and a lifetime of 25 years. The technical specifications of the turbine/generator and auxiliaries are as contained in the Olkaria II Unit 3 contract document[4]. The turbine/generator has a rated capacity of 35.MW, with a speed of 3000rpm and steam pressure of 4.8 bara. The generator rating and characteristics shall comply with the requirements of all relevant parts of IEC 60034-1 except where modified by specifications. The generator shall be of cylindrical rotor type and cooled by means of closed circuit cooling. The closed circuit cooling medium shall be air, and heat shall be transferred from the primary coolant to circulating water by means of suitable coolers complying with IEC 60034. The turbine generator shall have a Normal Continuous Rating (NCR) of at least 32.5 MWe (net). The turbine shall conform to I.E.C Publication 45.

The condensing system shall be of the low-level direct contact type with a gas cooling zone incorporated in the body of the condenser. The extraction unit shall be of the hybrid type with standby second stage steam ejector, and with barometrically drained inter and after condensers.

The new plant was installed next to the two existing units. The three units share the same steam header and use an existing switch gear. However, to be able to accommodate the transmission switchgear for the new turbine/alternator unit, the existing switchyard was augmented.

Generation is at 11kv, stepped up to 220kv before being transmitted to Nairobi North substation and further to Dandora substation. There is also an interconnection between Olkaria II and Olkaria I through a 132kv line.

Interconnections between Olkaria I and Olkaria II steam fields will have to be accomplished to be able to harvest the surplus steam. The surplus steam shall be gathered into a common steam line and piped to the power station. Further modifications shall be carried out in the steam fields for the hot and cold brine re-injections into designated re-injection wells.

At Olkaria II Power station, the additional third unit will be installed at an open bay next to the power station (see photo below).

Olkaria II Power Station

[3] Olkaria I & II PPA Extract.pdf

[4] Olkaria II Unit 3 Extension Geothermal Power Project – Contract for Power Plant, Switch Yard and Steam field, August 2007.

Unit 3 will generate on average about 276 GWh per year which will be sold to the Kenyan grid.

A.4. Parties and project participants

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Kenya (host)	Kenya Electricity Generating Company Ltd. (KenGen)	No
Netherlands	Netherlands' Ministry of Infrastructure and the Environment (IenM)	Yes
Austria	Kommunalkredit Public Consulting GmbH	No
Denmark	Maersk Olie og Gas A/S, DONG Naturgas A/S; Nordjysk Ethandel A/S, Danish Ministry of Climate, Energy and Building, /Danish Energy Agency; Aallborg Portland A/S	Yes
Spain	Kingdom of Spain- Ministry of Agriculture, Food and Environment & Ministry of Economy and Competitiveness; EDP Energias de Portugal, S.A.;Endesa Generacion, S.A., Gas Natural SDG S.A.	Yes
Germany	KfW	No
Luxembourg	Ministry for Sustainable Development and Infrastructure	Yes
Finland	Ruukki Metals Oy	No
Switzerland	Schweizeriscbe Ruckversicherungsgesellschafts AG (Swiss RE)	No
Japan	Idemitsu Kosan Co.,Ltd.; The Okinawa Electric Power Co., Inc.	No
Italy	Government of Italy - Ministry for the Environment, Land and Sea	Yes
Sweden	Goteborg Energi AB	No
Norway	Statoil ASA ; Statkraft Carbon Invest AS	No

A.5. Public funding of project activity

No public funding from Annex I Parties is used for the proposed project. The Community Development Carbon Fund is not an Official Development Assistance (ODA). Therefore, the project does not make use of ODA, nor result in the diversion of such ODA.

A.6. History of project activity

>>
The proposed CDM project activity is neither registered as a CDM project activity nor included as a CPA in a registered CDM PoA.

The proposed CDM project activity is not a project activity that has been deregistered.

The proposed CDM project activity is **not** a CPA that has been excluded from a registered CDM PoA.

A registered CDM project activity or a CPA under a registered PoA whose crediting period has or has not expired does **not** exist in the same geographical location as the proposed CDM project activity.

A.7. Debundling

>>
Not Applicable

SECTION B. Application of methodologies and standardized baselines

B.1. References to methodologies and standardized baselines

>>
Approved consolidated baseline and monitoring methodology ACM0002/Version 19: Grid-connected electricity generation from renewable sources.[5]

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

- TOOL07: Tool to calculate the emission factor for an electricity system/Version 7[6]
- TOOL01: Tool for the demonstration and assessment of additionality/Version 7[7]
- TOOL11: Assessment the validity of the original/current baseline and to update of the baseline at the renewal of a crediting period/Version 3[8]
- TOOL03: Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion/Version 3[9]

B.2. Applicability of methodologies and standardized baselines

>>
The project will be a grid-connected geothermal power generation activity and meets all the conditions stated in the approved methodology ACM0002/Version19. These conditions are:

- The project activity is the capacity addition of a new generating unit to an existing geothermal power plant that supplies electricity to the grid.
- Five years of historical electricity generation data are available, without any capacity addition or retrofit being undertaken between the start of this five-year historical period and the implementation of the project activity.
- The electricity grid (the Kenyan grid) has clearly identified geographic and system boundaries and information on the characteristics of this grid is available.

[5] https://cdm.unfccc.int/methodologies/DB/VJI9AX539D9MLOPXN2AY9UR1N4IYGD
[6] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v7.0.pdf
[7] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-01-v7.0.0.pdf
[8] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-11-v1.pdf/history_view
[9] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-03-v3.pdf

- The project will not be an activity that involves switching from fossil fuels to renewable energy at the project site.
- As the project activity covers a capacity addition, the most plausible baseline scenario is the continuation of the current situation, e.g. use of the power generation equipment already installed and in use prior to the project activity.

B.3. Project boundary, sources and greenhouse gases (GHGs)

>>

	Source	GHG	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	CO_2	Yes	Included as per the ACM00002 methodology
		CH_4	No	Excluded as per ACM0002. This is a minor emission source.
		N_2O	No	Excluded as per ACM0002. This is a minor emission source.
Project activity	Fugitive emissions of CH_4 and CO_2 from non- condensable gases contained in geothermal steam	CH_4	Yes	Included as per the ACM00002 methodology
		N_2O	No	Excluded as per ACM0002. This is a minor emission source.
		CO_2	Yes	Included as per the ACM00002 methodology

B.4. Establishment and description of baseline scenario

>>

The project activity is the capacity addition of a new grid-connected renewable power unit to an existing geothermal plant. Thus, in accordance with the guidance stated in the approved methodology ACM0002 under section 5.2.2. The baseline scenario is the following:

In the absence of the CDM project activity, the existing Olkaria II facility would continue to supply electricity to the grid at historical levels, until the time at which the generation facility would likely be replaced or retrofitted (DATEBaselineRetrofit), and electricity delivered to the grid by the added capacity would have otherwise been generated by the operation of grid-connected power plants and by the addition of new generation sources, as reflected in the combined margin (CM) calculations described in "TOOL07: Tool to calculate the emission factor for an electricity system. From that point of time onwards, the baseline scenario is assumed to correspond to the project activity, and no emission reductions are assumed to occur."

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

As per ACM0002/Version 19, TOOL11: *Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period* should be followed at renewable of the crediting period to assess the continued validity of the baseline and to update the baseline.

Step 1.1 Assess compliance of the current baseline with relevant mandatory national and/or sectoral policies

The current baseline complies with all relevant mandatory national and sectoral policies. Since registration of the Project Activity, the host country has put new energy policies in place, such as the Least Cost Power Development Plant in 2011[10] and a new National Energy Policy in 2018[11].

[10] https://renewableenergy.go.ke/downloads/studies/LCPDP-2011-2030-Study.pdf

While the Least Cost Power Development Plan cites geothermal power as a least-cost choice technology, there is no effect on the baseline at the time of registration of the project activity as a result of the plan or the 2018 policy. There are no new policies since validation of the project activity that prevent the current baseline.

Step 1.2 Assess the impact of circumstances

The baseline scenario at the time of validation of the project activity was the continuation of the current practice without any investment. Since the validation of the project activity, there have been no major changes in the market characteristics in the power industry in Kenya. The dominant sources of power, hydro power for baseload and diesel generators for margin power are the same. While there has been some addition of renewable sources of energy, such as renewable biomass and wind energy, the grid mix is largely the same, as well as the cost of electricity.

In 2012 the cost of electricity in Kenya most between 16 and 20 KES/KWh, while in 2019 the price has moved between 22 and 24 KES/KWh from January through August of 2019.[12] This is in line with inflation in Kenya meaning the real cost of electricity since registration has remained the same, as 16 KES in 2012 is roughly 22 KES in 2019.[13]

Step 1.3 Assess whether the continuation of use of current baseline equipment(s) or an investment is the most likely scenario for the crediting period for which renewal is requested.

The renewal of the crediting period would extend the project activity through 03/12/2024. The equipment assessed in the baseline that would continue to be used was commissioned in 2003.[14] The certified lifetime of the equipment is longer than 01/01/2025 and exceeds the renewed crediting period. The lifetime has been extended beyond the original lifetime at the time of registration due to delays in commissioning and longer than expected equipment lifetime prior to installation/commissioning.

Step 1.4 Assessment of the validity of data and parameters

The global warming potential of methane valid for the relevant commitment period was updated from 21 to 25 in the ex ante parameter section.

The Build Margin CO_2 emission factor in year y was updated to reflect the composition of the national grid at the time of renewal of the crediting period.

As Step 1.4 requires updating data and ex ante parameters, as per Step 2.2 the data and baseline parameters have been updated, as per below.

B.5. Demonstration of additionality

>>

The following steps from the “Tool for the demonstration and assessment of additionality” (Version 05.2) will be completed in this section:

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[11] https://kplc.co.ke/img/full/BL4PdOqKtxFT_National%20Energy%20Policy%20October%20%202018.pdf

[12] https://stima.regulusweb.com/

[13] https://fxtop.com/en/inflation-calculator.php?A=16&C1=KES&INDICE=KECPI022009&DD1=31&MM1=12&YYYY1=2012&DD2=01&MM2=01&YYYY2=2019&btnOK=Compute+actual+value

[14] https://www.climateinvestmentfunds.org/sites/cif_enc/files/meeting-documents/srep_field_trip_on_geothermal_development_in_kenya_march2012_0.pdf

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 mandatory regulations under these Acts.

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 as stipulated by the "Tool for the demonstration and assessment of additionality", Version 05.2. The IRR will be calculated as project IRR.

The benchmark will be derived from Government of Kenya bond rates.[15] 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.

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

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

The following data was used in calculating the project IRR.

Item	Value
Costs of equipment and plant (initial investment cost) (million US$)	90.2
Project life (years)	25
Electricity tariff (US cent/kwh)	6.106
Electricity export amount (GWh/year)	276
Revenues and Expenses	
Electricity sales (million US$)	16.82
O&M costs/yr (million US$)	1.99
Project IRR (%)	**12.2**

Based on the above, the project IRR for Olkaria II Geothermal Expansion Project was calculated to be 12.2%. 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

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

Item	Effect on IRR
Decreasing EPC (engineering, procurement, construction) cost by 18%	Increase to 15%
Decreasing running cost by 98%	Increase to 14%
Increasing electricity tariff by 23%	Increase to 15%
Increasing plant load factor to 100%	Increase to 12.4%

It is evident that the IRR remains low even with the favorable financial assumptions.

Step 3. Barrier Analysis

This step is used to determine whether the proposed project activity faces barriers that:
(a) Prevent the implementation of this type of proposed project activity; and
(b) Do not prevent the implementation of at least one of the alternatives.

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

Establish that there are realistic and credible barriers that would prevent the implementation of the proposed project activity from being carried out if the project activity was not registered as a CDM activity. These barriers include:

Investment barriers

Country risk for Kenya has been considered very high by investors. Until quite recently main rating companies such as Moodys, Fitch, and Standard & Poor's have not even provided sovereign credit rating for Kenya[16]. Although Standard & Poor's assigned 'B+' long-term foreign currency and 'BB-' long-term local currency sovereign credit ratings to Kenya on 8th September 2006 for the first time, it also indicated that such ratings were constrained by low levels of economic development and by a

[16] Moodys (go to "Sovereign") - registration required: http://www.moodys.com/cust/default.asp?den=1 Fitch: http://www.fitchibca.com/corporate/sectors/issuers_list_corp.cfm?sector_flag=5&marketsector=1&detail= Standard & Poor's (go to "Sovereign risks rating since 1975"): http://www2.standardandpoors.com/servlet/Satellite?vqt=SOVEREIGN+RATINGs+history+&pagename=sp%2FPage%2FSiteSearchResultsPg&search=site&b=10&r=1&s=&ig=&i=&f=null&l=ENG&submit.x=4&submit.y=4

vulnerability to exogenous shocks due to deteriorating terms-of-trade and governance scandals[17]. In this circumstance, access to commercial loans for project investments becomes extremely difficult. Also, a recent United Nations world investment report indicated that Kenya's ability to attract foreign direct investment is limited[18].

Meanwhile, Kenya does not have strong domestic financial institution for long-term borrowing. This has resulted in most project proponents looking for loans in the international capital markets, which usually offer more attractive rates and longer terms. However, as mentioned above, access to the international capital market is limited due to the high-perceived risk of the country. The CDM can assist the project activity in mitigating the adverse effects of such investment barriers.

Over the past years, there has been very little investment in geothermal power projects in the country due to associated huge capital requirements. In fact, as discussed in Step 4a below, there have only been three geothermal projects in the country, due partly to huge costs and risks associated with geothermal exploration. The latest geothermal power plant built in Kenya is Olkaria II (Units 1&2) which started delivering electricity to the national grid in 2003.[19] The proposed Olkaria II Unit 3 expansion project is financed in part through a long-term concessional credit from the International Development Association (IDA) to the Government of Kenya (see Annex 2). IDA is a part of the World Bank that lends to the poorest countries in the world on concessional terms.[20]

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

Based on the barriers analysis, the first alternative scenario (i.e. the proposed project activity undertaken without being registered as a CDM project activity) is not viable. Its implementation will be prevented by the barriers discussed above. Meanwhile, the identified barriers of the project activity will not prevent the implementation of the second alternative since it involves the continuation of the current situation.

Step 4: Common practice analysis

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

In order to test whether a credible claim can be made that there are real, prohibitive barriers to development of projects such as the proposed Olkaria II Geothermal Expansion Project, it is noteworthy that only three geothermal power stations have been constructed in Kenya despite the existence of great potential for geothermal development in the country's Rift Valley Region. (Part of the reason is the fact that geothermal exploration is very costly and risky.)[21] All these three geothermal power plants supply electricity to the Kenyan grid.

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[17] Standard & Poors http://www2.standardandpoors.com/portal/site/sp/en/us/page.siteselection/site_selection/0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0.html

[18] UNCTAD (United Nations Conference on Trade and Development) World Investment Report 2006 http://www.unctad.org/en/docs/wir2006_en.pdf

[19] Initial planning and design for Olkaria II Units 1&2 started in the late 1980s, but due to difficulty of securing funding, the implementation of project did not progress until 1997 when loans became available from the World Bank, EIB and Kreditansalt fur Wiederaufbrau (KfW). A second problem arose when a financial crisis within the Government of Kenya developed as a result of the extended drought that had affected the country from 1998 through 2000. Because the Government's share of the contract payments could not be met, contractors' work slowed down and the schedule could not be maintained. The problem was resolved in 2002. [Reference: KenGen (December 2004). Olkaria II Geothermal Power Project Completion Report.

[20] http://web.worldbank.org/WBSITE/EXTERNAL/EXTABOUTUS/IDA/0,,contentMDK:21206704~pagePK:51236175~piPK:437394~theSitePK:73154,00.html

[21] http://mobile.alertnet.org/thenews/newsdesk/L22135111.htm

Geothermal Power Plants	Installed Capacity (MW)	Commissioning Year
Olkaria I (KenGen)	45	1981
OrPower4 (IPP)	13	2000
Olkaria II Units 1&2 (KenGen)	70	2003

OrPower4 is an independent power producer that was granted a contract to supply electricity to KPLC. Its power purchase agreement (PPA) with KPLC comprises payment of a higher tariff for the electricity delivered to grid, as compared to KenGen. This is because the tariff also includes a royalty, a capacity charge, and a bonus if the generation exceeds annual target output. KenGen contracts with KPLC for the Olkaria projects do not include such payments.

The conditions upon which decisions to implement the earlier projects were based are different compared to more recent situations affecting the implementation of the proposed project activity. First of all, 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.[22] This required KenGen to formulate 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. Second, the prices of relevant input materials for the manufacture of equipment (steel, copper etc) have increased considerably over the years making investments in geothermal projects more expensive.[23] Third, there has been a consolidation in the equipment supply side, with the established equipment manufacturers are now mainly in Japan (Mitsubishi, Fuji and Toshiba). This results in decreased competition and higher equipment prices.[24]

[22] There are several press releases on this decision of the Government to sell 30% of its KenGen shares. See for example http://www.theinvestornetwork.net/index.php?option=com_content&task=view&id=43&Itemid=71

[23] A World Bank Project Implementation Support Mission conducted for the Energy Sector Recovery Project on 3-16 May 2006 reports that the cost estimate for the third unit of the Olkaria II geothermal power plant has increased by 31.7% over the appraisal estimate due to increase in material (mainly steel and cooper) prices (p.12). A more recent article, Business Daily Africa, March 18, 2008, reported that the cost of Olkaria II project has shot up by $5 million due to surge in prices of building materials like steel. http://www.bdafrica.com/index.php?option=com_content&task=view&id=6497&Itemid=5810

[24] Energy Sector Recovery Project (Cr.3958-KE), World Bank Implementation Support Mission, May 3-16, 2006, p. 16.

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

Further to the foregoing discussion, the table below shows the relative importance of thermal power sources in the Kenyan grid. Aggreko power plants, comprising altogether an installed capacity of 150MW, are the newest thermal-based addition to the grid. They started exporting power to the grid in 2006-08. Before that, a 74MW heavy fuel oil plant was built by an Independent Power Producer in 2001. Meanwhile, it should be noted that no new hydropower plant has been constructed in Kenya over the last 16 years that supply electricity to the national grid.[25]

This suggests that geothermal power plants are not a common activity in the more recent years.

Power Plants	Installed Capacity (MW)	Percent of Total Installed Capacity
Hydro	675[a]	51
Geothermal	128	9
Wind	0.35	0
Biomass	35	3
Thermal	491.5	37
Total	1,329.85	100

[a] Excluded from the table is the 60MW Sondu Miriu hydropower plant which started operations in 2007/08. This was a proposed CDM project which had been published on the UNFCCC website for global stakeholder consultation as part of the project's validation process.

As indicated in Section C.1 of this document, the starting date of the project activity is on August 20, 2007 when the contract for the installation of Unit 3 in Olkaria II was signed between KenGen and Mitsubishi. This starting date of the project activity is prior to the date of project validation. In accordance with EB-41 guidance, serious consideration of CDM is demonstrated by the following evidence: (a) on July 3, 2006 KenGen submitted to the Carbon Finance Unit of the World Bank the Project Idea Note pertaining to the proposed project activity; and (b) an initial review of the draft PDD was conducted by the DOE who then issued a review statement on November 11, 2006.[26] The World Bank and KenGen signed the Emissions Reduction Purchase Agreement for the project on November 14, 2006.

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

[26] Copies of documents pertaining to the starting date of the project activity and as evidence of serious consideration of CDM are provided to the validators.

B.6. Estimation of emission reductions

B.6.1. Explanation of methodological choices

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Estimation of Project Emissions

Based on ACM0002/Version 19, project emissions are to include fugitive emissions of carbon dioxide and methane due to release of non-condensable gases from produced steam as well as carbon dioxide emissions resulting from combustion of fossil fuels related to the operation of the geothermal plant. Project emissions are calculated using Equations (1), (2), and (3) (see ACM0002/Version 19, p. 13 and 14).

(1) $PE_y = PE_{FF,y} + PE_{GP,y} + PE_{HP,y}$ $PE_{FF,y}$ is equal to 0.[a] $PE_{HP,y}$ is equal to 0 as no hydro projects are implemented.	Where **PE_y** Project emissions in year y (t CO_2e/yr) **$PE_{FF,y}$** Project emissions from fuel consumption in year y (t CO_2e/yr) **$PE_{GP,y}$** Project emissions from the operation of dry, flash steam or binary geothermal power plants in year y (t CO_2e/yr) **$PE_{HP,y}$.** Project emissions from water reservoirs of hydro power plants in year y (t CO_2e/yr)

[a] Explained in Section B.6.3 of this document.

With

(2) $PE_{GP,y} = PE_{dry\ or\ flash\ steam,y} + PE_{binary,y}$ $PE_{binary,y}$ is equal to 0.[b]	Where **$PE_{GP,y}$** Project emissions from the operation of dry, flash steam or binary geothermal power plants in year y (t CO_2e/yr) **$PE_{dry\ or\ flash\ steam,y}$** Project emissions from the operation of dry steam or flash steam geothermal power plants due to release of non-condensable gases in year y (t CO_2e/yr) **$PE_{binary,y}$.** Project emissions from the operation of binary geothermal power plants due to physical leakage of non-condensable gases and working fluid in year y (t CO_2e/yr)

[b] This technology is not used by the project.

With

(3) $PE_{dry\ or\ flash\ steam,y} = (w_{steam,CO2,y} + w_{steam,CH4,y} \times GWP_{CH4}) \times M_{Steam,y}$	Where **$PE_{dry\ or\ flash\ steam,y}$** Project emissions from the operation of dry steam or flash steam geothermal power plants due to release of non-condensable gases in year y (t CO_2e/yr) **$w_{steam,CO2,y}$** Average mass fraction of CO_2 in the produced steam in year y (t CO_2e/ t steam) **$w_{steam,CH4,y}$** Average mass fraction of CH_4 in the produced steam in year y (t CH_4e/ t steam) **GWP_{CH4}** Global warming potential of CH_4 valid for the relevant commitment period (tCO_2e/t CH_4) **$M_{steam,y}$** Quantity of steam produced in year y (t steam/yr)

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 that are displaced due to the project activity, calculated using Equations (11), (14) and (15) (ACM0002/Version 19).

(11) $BE_y = EG_{PJ,y} \cdot EF_{grid,CM,y}$ Option 1 chosen to determine $EG_{PJ,y}$. ***(14)*** $EG_{PJ,y} = EG_{facility,y} - (EG_{historical} + \sigma_{historical})$; until $DATE_{BaselineRetrofit}$ and ***(15)*** $EG_{PJ,y} = 0$; on/after $DATE_{BaselineRetrofit}$	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) $EG_{facility,y}$ Quantity of net electricity generation supplied by the project plant/unit to the grid in year *y* (MWh/yr) $EG_{historical}$ Annual average historical net electricity generation delivered to the grid by the existing renewable energy 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 renewable energy 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."

As per definition of $\boldsymbol{EG_{facility,y}}$, a separate metering of electricity fed into the grid by the added power unit(s) is not necessary under paragraph 46 of ACM0002/Version 19.

As per paragraph 52 option (a) of the methodology, $\boldsymbol{EG_{historical}}$ is estimated based on the five last calendar years prior to the implementation of the project activity.

A. $\boldsymbol{DATE_{BaselineRetrofit}}$ is the typical average technical lifetime of the existing turbines. The equipment is certified for 200,000 hours of continuous operation. Assuming continuous operation throughout the year of 365 days, this covers 8760 hours per year (365 days x 24 hours per day). The resulting maximum lifetime is 22.8 years (200,000 hours divided by 8760 hours per year). While continuous operation is already a conservative estimate of the lifetime, the resulting 22.8-year life has been rounded down to 22 years to assure a conservative estimate. This is 22.8 years from start of operation on 30/09/2003[27].[28] Therefore, the parameter $DATE_{BaselineRetrofit}$ is 29/09/2025.

The lifetime of the existing turbines was determined as per TOOL10 option a) which allows use of manufacturer specifications, if the following conditions are met:

1. Manufacturer information on the equipment lifetime is available;
2. Project participants can demonstrate the equipment has been operated and maintained as per the manufacturer specifications;
3. There is no periodic replacement schedule or scheduled replacement practices; and
4. The equipment has no design flaw or defect and did not have an industrial accident causing equipment to be unable to operate at performance levels.

The criteria above have all been met. The manufacturer specified lifetime is 200,00 hours of continuous operation.

In accordance with ACM0002/Version 19, no other leakage emissions are considered for the project activity.

Emission reductions ($\boldsymbol{ER_y}$) are calculated as follows based on Equation (17):

(17) $\boldsymbol{ER_y = BE_y - PE_y}$	Where: $\boldsymbol{ER_y}$ Emission reductions in year y (tCO_2/yr) $\boldsymbol{BE_y}$ Baseline emissions in year y (tCO_2/yr) $\boldsymbol{PE_y}$ Project emissions in year y (tCO_2/yr)

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

Following the guidance specified in the TOOL07: Tool to calculate the emission factor for an electricity system/Version 7, the Combined Margin CO_2 emission factor ($\boldsymbol{EF_{grid,CM,y}}$) 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 (12), (10), (12), (3) and (13). 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 tools methodology:

[27] Commissioning report for Olkaria II Unit 1&2.pdf

[28] The remaining lifetime is estimated by the project sponsor from the date of writing the PDD. See *Olkaria II technical life2.pdf* for evidence of lifetime.

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

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

(12) $EF_{grid,OM-DD,y} = (\Sigma\ EG_{PJ,h} \cdot EF_{EL,DD,h}) / EG_{PJ,y\ h}$	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 of the dispatch order in hour h in year y (tCO_2/MWh)
(13) $EF_{EL,DD,h} = (\Sigma\ FC_{i,n,h.} \cdot NCV_{i,y} \cdot EF_{CO2,i,y}) / \Sigma\ EG_{n,h}$	$EG_{PJ,y}$ Total electricity displaced by the project activity in year y (MWh) $FC_{i,n,h}$ Amount of fossil fuel type i consumed by power unit n in hour h (mass or volume unit) $NCV_{i,y}$ Net calorific value (energy content) of fossil fuel type i in year y (GJ/mass or volume) $EF_{CO2,i,y}$ CO_2 emission factor of fossil fuel type i in year y (tCO_2/GJ) $EG_{n,h}$ Electricity generated and delivered to the grid by power unit n in hour h (MWh) ***n*** 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

Above, ***n*** refers to the set of power units (n) falling within the top 10% of the system dispatch a per paragraph 69 (a) of the Tool. To determine the set of power units (n), obtain from a national dispatch center: a) the grid system dispatch order of operation for each 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 power units in the system during each hour h that the project activity is displacing electricity. At each hour h, stack each power unit's generation using the merit order. The set of 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 2018 is used[29]. 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 ($EF_{grid,BM,y}$)

[29] Hourly electricity consumption per plant provided by Kenya Power and Lighting Company (KPLC)

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:

(15) $EF_{grid,BM,y} = (\sum_m EG_{m,y} \cdot EF_{EL,m,y}) / \sum_m EG_{m,y}$ The CO_2 emission factor of each power unit *m* ($EF_{EL,m,y}$) is determined using Option A1 and calculated as follows: **(4)** $EF_{EL,m,y} = (\sum_i FC_{i,m,y} \cdot NCV_{i,y} \cdot EF_{CO2,i,y}) / EG_{m,y}$	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) $FC_{i,m,y}$ Amount of fossil fuel type *i* consumed by power unit *m* in year *y* (mass

	or volume unit) $NCV_{i,y}$ Net calorific value (energy content) of fossil fuel type *i* in year *y* (GJ/mass or volume) $EF_{CO2,i,y}$ CO_2 emission factor of fossil fuel type *i* in year *y* (tCO_2/GJ) ***m*** Power units included in the build margin ***y*** Most recent historical year for which power generation data is available (January 2018-December 2018).

In accordance with the guidance provided in the TOOL 07, 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 at least 20% of the grid generation (in MWh), excluding CDM projects, and that have been built most recently. The choice of the sample group of power units *m* is justified below.

The sample group covering at least 20% of grid generation, excluding CDM projects is shown in the excel sheet provided to determine the grid emission factor.[30]

The updated value for the new crediting period ($EF_{grid,BM,2018}$) is 0.2906 tCO_2e/MWh.[31]

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

$$(16)\ EF_{grid,CM,y} = EF_{grid,OM,y} \cdot W_{OM} + EF_{grid,BM,y} * W_{BM}$$

Where:

W_{OM} Weighting of operating margin emission factor (%)
W_{BM} Weighting of build margin emissions factor (%)

The default values of 25%-75% are used for the second crediting period.

B.6.2. Data and parameters fixed ex ante

Data/Parameter	GWP_{CH4}
Unit	tCO_2/tCH_4
Description	Global warming potential of methane valid for the relevant commitment period.
Source of data	IPCC
Value(s) applied	Default value for the second commitment period = 25 tCO_2/tCH_4
Choice of data or Measurement methods and procedures	-
Purpose of data	Calculation of baseline emissions
Additional comment	-

[30] GEF Olkaria II 2018_V2.xlsx

[31] GEF Olkaria II 2018_V2.xlsx

Data/Parameter	***$EG_{historical}$***
Unit	MWh/yr
Description	Annual average historical net electricity generation delivered to the grid by the existing renewable energy plant that was operated at the project site prior to the implementation of the project activity
Source of data	KenGen Annual Reports[32]
Value(s) applied	549,800
Choice of data or Measurement methods and procedures	Historical data on electricity delivered to the grid over the last five years, from 2004/05 to 2008/09, prior to implementation of the project activity: 2004/05: 549 GWh; 2005/06: 562GWh; 2006/07: 540GWh; 2007/08: 563GWh; 2008/09: 535GWh.
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data/Parameter	***$\sigma_{historical}$***
Unit	MWh/yr
Description	Standard deviation of the annual average historical net electricity generation delivered to the grid by the existing renewable energy plant that was operated at the project site prior to the implementation of the project activity
Source of data	Calculated from data used to establish ***$EG_{historical}$***
Value(s) applied	12,637.25
Choice of data or Measurement methods and procedures	Parameter was calculated as the standard deviation of the annual generation data used to calculate ***$EG_{historical}$*** for retrofit or replacement project activities.
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data/Parameter	***$DATE_{BaselineRetrofit}$***
Unit	year
Description	Point in time when the existing equipment would need to be replaced in the absence of the project activity
Source of data	KenGen
Value(s) applied	29/09/2025
Choice of data or Measurement methods and procedures	The date is 22 years from the commissioning date of 30/09/2003. The operational lifetime of 22.8 years was rounded down to 22 years.
Purpose of data	Calculation of baseline emissions
Additional comment	-

[32] KenGen Annual Report 2008

Data/Parameter	***$EF_{grid,BM,y}$***
Unit	tCO_2/MWh
Description	Build Margin CO_2 emission factor in year *y*
Source of data	KPLC Dispatch Centre and IPCC default factors
Value(s) applied	0.2906 tCO_2/MWh
Choice of data or Measurement methods and procedures	Calculated using the latest version of the TOOL07: Tool to calculate the emission factor for an electricity system.
Purpose of data	Calculation of baseline emissions
Additional comment	Calculated *ex-ante* for the first crediting period, and again once *ex-ante* at the start of the second crediting period.

B.6.3. Ex ante calculation of emission reductions

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Project emissions are estimated as follows:

$$PE_y = PE_{FF,y} + PE_{GP,y}$$

Where:

$$PE_{GP,y} = (W_{steam,CO2,y} + W_{steam,CH4,y} \cdot GWP_{CH4}) \cdot M_{steam,y}$$

Calculation of fugitive emissions from non-condensable gases (NCG): The NCG composition of the wells on-site was studied by the Kenya Electricity Generating Company Ltd (KenGen) during the normal monitoring. The latest monitoring results are from 15 production wells which supply steam to Olkaria II power station:

Studies were made of wells OW701, OW-705, OW-706, OW-709, OW-710, OW-713, OW-714, OW-715, OW-716, OW-720, OW-721, OW-725, OW-726, OW-727, and OW-728 to determine the percentage of NCGs in the produced steam and the composition of those NCGs. The average readings of the fifteen wells is used to estimate project emissions, but monitored data of the steam coming from all producing wells will be used ex-post. Detailed data is indicated in the table below:

Determination of Wsteam,CO_2 and Wsteam,CH_4			
Fraction (%) of NCG's in the produced steam=		0.00353	
source: KenGen Steam Monitoring report			
Fraction of CO_2 in gas composition of NCG (%)		Fraction of CH_4 in gas composition of produced steam (%):	
source: KenGen Steam Monitoring report			
OW701	89.52	OW701	0.00044
OW-705	93.76	OW-705	0.00000
OW-706	89.95	OW-706	0.00040
OW-709	91.83	OW-709	0.00028
OW-710	95.46	OW-710	0.00011
OW-713	90.53	OW-713	0.00007
OW-714	93.68	OW-714	0.00005
OW-715	94.504	OW-715	0.00100

OW-716	92.631	OW-716	0.00020
OW-720	92.8756	OW-720	0.00010
OW-721	91.48	OW-721	0.00000
OW-725	94.953	OW-725	0.00020
OW-726,	90.032	OW-726,	0.00020
OW-727	94.31	OW-727	0.00044
OW-728	93.452	OW-728	0.00000
Average	92.59766%	Average	0.00027%
Wsteam,CO_2	0.3268697%	Wsteam,CH_4	0.00009531%

Annual quantity of steam produced (Msteam,y in t/year)	2,070,000
Fraction of CO2 in produced steam (Wsteam,CO_2)	0.3268697%
Fraction of CH4 in produced steam (Wsteam,CH_4)	0.00009531%
Emissions of CO_2 (tons)	6,766.2028
Emissions of CH_4 (tons)	1.972917
GWP of CH_4	25
Emissions from CH4 (tCO_2e)	49.32
$PE_{GP,y}$ (tCO_{2e} /year)	6,815.53

$PE_{FF,y} = 0$

The amount of diesel combusted to operate the Olkaria II power plant with Units 1 and 2 will remain the same even after Unit 3 is installed. Thus this equation is assigned a zero value.

Therefore, $PE_y = PE_{GP,y} + PE_{FF,y}$ = **6,816 tCO_2/yr** as shown below:

$PE_{GP,y}$ = [(6,766.2028/2,070,000) + ((1.972917/2,070,000) * 25))] * 2,070,000 tons/yr

= 6,816 tCO2e per year

Baseline emissions are estimated as follows:

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

Where:

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

$EG_{PJ,y} = 0$; **on/after** $DATE_{BaselineRetrofit}$

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

Year	**Net electricity delivered to grid (GWh)**
2004/05	549
2005/06	562
2006/07	540
2007/08	563

2008/09	535
Average/year	549.8
Total	2,749

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

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

$= 1/4 * [1,512,039 - (2,749)^2 / 5]$

= 159.7 GWh

Therefore,

$\sigma_{historical}$ **= 12.63725 GWh**

$EG_{facility,y}$ is estimated as the sum of net electricity delivered to the grid by existing and added power units. For the existing Units 1 and 2, the average historical value over the last five years is used (549,800 MWh/yr) and for Unit 3, the value used is 276,000 MWh/yr. Thus,

$EG_{facility,y}$ = 825,800 **MWh/yr**

Therefore,

(8) $EG_{PJ,y}$ = 825,800 - (549,800 + 12,637.25)

= **263,362.75 MWh/yr**

(6) BE_y = 263,362.75 MWh/yr * 0.3245 tCO_2/MWh

= 85,455.94 **tCO_2/yr**

The project's emission reductions are estimated as follows:

$ER_y = BE_y - PE_y$ **= (85,455.94 – 6,815.53 tCO_2/yr) = 78,640 tCO_2/yr**

B.6.4. Summary of ex ante estimates of emission reductions

Year	Baseline emissions (t CO_2e)	Project emissions (t CO_2e)	Leakage (t CO_2e)	Emission reductions (t CO_2e)
04/12/2017 to 31/12/2018[a]	92,011	7,338	0	84,673
01/01/2019 to 31/12/2019	85,456	6,816	0	78,640
01/01/2020 to 31/12/2020	85,456	6,816	0	78,640
01/01/2021 to 31/12/2021	85,456	6,816	0	78,640

01/01/2022 to 31/12/2022	85,456	6,816	0	78,640
01/01/2023 to 31/12/2023	85,456	6,816	0	78,640
01/01/2024 to 03/12/2024[b]	78,900	6,293	0	72,607
Total	598,192	47,709	0	550,482
Total number of crediting years	7			
Annual average over the crediting period	85,456	6,816	0	78,640

[a] Entries for this row are estimated for 393 days.
[b] Entries for this row are estimated for 337 days.

B.7. Monitoring plan

B.7.1. Data and parameters to be monitored

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 and as such the values provided are estimates. All measurements will be conducted with calibrated measurement equipment according to relevant industry standards.

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	KenGen
Value(s) applied	825,800[33]
Measurement methods and procedures	Electricity meters are installed complying with industry standards in the country.
Monitoring frequency	The installed meters are of 0.2 accuracy and accuracy tests are performed once in 2 years as per the requirements of the PPA.
QA/QC procedures	Total electricity supplied by the project activity and existing units to the grid will be cross-checked with receipt of sales.
Purpose of data	Calculation of baseline emissions
Additional comment	This data will be monitored continuously. 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	KPLC Dispatch Centre and IPCC default factors from 2018. This is the most recently available data.

[33] Projection of Emission Reductions for Crediting Period Renewal_13.12.2019.xls

Value(s) applied	0.4262 tCO_2e/MWh
Measurement methods and procedures	Calculated using the latest version of the “Tool to calculate the emission factor for an electricity system.”
Monitoring frequency	Yearly
QA/QC procedures	Calculation should be done after KPLC energy balance to ensure data validity.
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data/Parameter	$FC_{i,n,h}$ **and** $FC_{i,m,y}$
Data unit	Mass or volume
Description	Amount of fossil fuel type *i* consumed by power unit *n* in hour *h* or by power unit *m* in year *y*.
Source of data	KPLC (dispatching centre, who gets electricity generation i.e. kWh data from KenGen, who owns majority of generation power plants and IPPs) and Energy Regulatory Commission, a regulatory agency who regulates the electricity sector and tariffs, compiles specific fuel consumption data (ton/kWh) based on annual fuel consumption data received from generators.
Value(s) applied	See *GEF Olkaria II 2018 Updated_Renewal of crediting period for Olkaria II.xlsx*
Measurement methods and procedures	This will be calculated based on the specific fuel consumption (ton/MWh) data provided by the Energy Regulatory Commission for each power plant on annual basis.
Monitoring frequency	Annually 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	-
Purpose of data	Calculation of baseline emissions
Additional comment	Applicable in the following cases: (a) Calculation of power unit emission factor $EF_{EL,m,y}$ as per equation (3), “Tool to calculate the emission factor for an electricity system.” (b) Calculation of the hourly emission factor of plants in the top of the dispatch as per equation (9), “Tool to calculate the emission factor for an electricity system.”

Data/Parameter	$NCV_{i,y}$
Data unit	TJ/mass or volume
Description	Net calorific value (energy content) of fossil fuel type *i* in year *y*
Source of data	2006 IPCC Guidelines for National Greenhouse Gas Inventories, Table 1.2, p.1.18-1.19
Value(s) applied	Automotive Gas Oil (AGO): 42.5 TJ/10^3 tons; Diesel: 41.4 TJ/10^3 tons; Fuel Oil: 39.8 TJ/10^3 tons; and Kerosene: 42.2 TJ/10^3 tons Default values at the lower limit of the 95% confidence intervals have been used.
Measurement methods and procedures	-
Monitoring frequency	Annually 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	Internal validation check should be performed contrasting historical data for existing plants and their fuels.
Purpose of data	Calculation of baseline emissions
Additional comment	Applicable in the following cases: (a) Calculation of power unit emission factors $EF_{EL,m,y}$ as per equation (3), "Tool to calculate the emission factor for an electricity system" (b) Calculation of the hourly emission factor of plants in the top of the dispatch as per equation (9), "Tool to calculate the emission factor for an electricity system"

Data/Parameter	$\boldsymbol{EF_{CO2,i,y}}$ **and** $\boldsymbol{EF_{CO2,m,i,y}}$
Data unit	tCO_2/TJ
Description	CO_2 emission factor of fossil fuel type *i* in year *y*
Source of data	2006 IPCC Guidelines for National Greenhouse Gas Inventories, Table 1.4, p.1.23
Value(s) applied	Automotive Gas Oil (AGO): 67.5; Diesel:72.6; Fuel Oil: 75.5; and Kerosene: 70.8 Default values at the lower limit of the 95% confidence intervals have been used.
Measurement methods and procedures	-
Monitoring frequency	Annually 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	-
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data/Parameter	$\boldsymbol{EG_{n,h}}$ ***and*** $\boldsymbol{EG_{m,y}}$
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	KenGen and KPLC Dispatch Centre[34]
Value(s) applied	See worksheet ER Olkaria II Renewal.xlsx
Measurement methods and procedures	Actual net generation and export to the grid by each power unit will be measured 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	Electricity supplied by the power units to the grid will be double checked by receipt of sales.
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data/Parameter	$\boldsymbol{EG_{PJ,h}}$
Data unit	MWh

[34] ER Olkaria II_Renewal.xlsx

Description	Electricity displaced by the project activity in hour *h* in year *y*
Source of data	KenGen and KPLC Dispatch Centre[35]
Value(s) applied	263,362.75
Measurement methods and procedures	Electricity displaced by the project activity will be measured every hour and recorded.
Monitoring frequency	Hourly
QA/QC procedures	Total electricity displaced by the project activity during the year will be double checked against sales receipts.
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data/Parameter	$W_{steam,CO2,y}$
Data unit	tCO_2/t steam
Description	Average mass fraction of carbon dioxide in the produced steam in year *y*
Source of data	Measured by KenGen
Value(s) applied	0.0032687
Measurement methods and procedures	NCGs in geothermal reservoirs usually consist mainly of CO_2 and H_2S. They also contain a small quantity of hydrocarbons, including predominantly CH_4. In geothermal power projects, NCGs flow with the steam into the power plant. A small proportion of the CO_2 is converted to carbonate/bicarbonate in the cooling water circuit. In addition, parts of the NCGs are reinjected into the geothermal reservoir. However, as a conservative approach, this methodology assumes that all NCGs entering the power plant are discharged to atmosphere via the cooling tower. NCG sampling should be carried out in production wells and at the steam field-power plant interface using ASTM Standard Practice E1675 for Sampling 2-Phase Geothermal Fluid for Purposes of Chemical Analysis (as applicable to sampling single phase steam only). The CO_2 and CH_4 sampling and analysis procedure consists of collecting NCG samples from the main steam line with glass flasks, filled with sodium hydroxide solution and additional chemicals to prevent oxidation. Hydrogen sulphide (H_2S) and carbon dioxide (CO_2) dissolve in the solvent while the residual compounds remain in their gaseous phase. The gas portion is then analyzed using gas chromatography to determine the content of the residuals including CH_4. All alkanes concentrations are reported in terms of methane.
Monitoring frequency	At least every 3 months and more frequently, if necessary
QA/QC procedures	The equipment used for analysis is self-calibrating. Calibration test runs are conducted before samples are analysed.
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data/Parameter	$W_{steam,CH4,y}$
Data unit	tCH_4/t steam
Description	Average mass fraction of methane in the produced steam in year *y*

[35] ER Olkaria II_Renewal.xlsx

Source of data	Measured by KenGen
Value(s) applied	0.000000953
Measurement methods and procedures	NCGs in geothermal reservoirs usually consist mainly of CO_2 and H_2S. They also contain a small quantity of hydrocarcons, including predominantly CH_4. In geothermal power projects, NCGs flow with the steam into the power plant. A small proportion of the CO_2 is converted to carbonate/bicarbonate in the cooling water circuit. In addition, parts of the NCGs are reinjected into the geothermal reservoir. However, as a conservative approach, this methodology assumes that all NCGs entering the power plant are discharged to atmosphere via the cooling tower. NCG sampling should be carried out in production wells and at the steam field-power plant interface using ASTM Standard Practice E1675 for Sampling 2-Phase Geothermal Fluid for Purposes of Chemical Analysis (as applicable to sampling single phase steam only). The CO_2 and CH_4 sampling and analysis procedure consists of collecting NCG samples from the main steam line with glass flasks, filled with sodium hydroxide solution and additional chemicals to prevent oxidation. Hydrogen sulphide (H_2S) and carbon dioxide (CO_2) dissolve in the solvent while the residual compounds remain in their gaseous phase. The gas portion is then analyzed using gas chromatography to determine the content of the residuals including CH_4. All alkanes concentrations are reported in terms of methane.
Monitoring frequency	At least every 3 months and more frequently, if necessary
QA/QC procedures	The equipment used for analysis is self-calibrating. Calibration test runs are done before samples are analysed
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data/Parameter	$M_{steam,y}$
Data unit	t steam/yr
Description	Quantity of steam produced during the year *y*
Source of data	Steam monitoring records at site[36]
Value(s) applied	2,070,000
Measurement methods and procedures	The steam quantity discharged from the geothermal wells should be measured with a venture flow meter (or other equipment with at least the same accuracy). Measurement of temperature and pressure upstream of the venture meter is required to define the steam properties. The calculation of steam quantities should be conducted on a continuous basis and should be based on international standards. The measurement results should be summarized transparently in regular production reports. Cumulative steam from the main meter and auxiliary meter ae recorded and used to calculate steam consumption.
Monitoring frequency	Daily
QA/QC procedures	Data is read continuously and logged daily. Data will be entered into CDM monitoring workbook every day and will be checked for consistency when entered. Meters will be maintained and periodically verified according to manufacturer specifications to ensure accurate readings; they will be recalibrated within the schedule recommended by the manufacturer.
Purpose of data	Calculation of baseline emissions
Additional comment	-

[36] Olkaria II steam consumption summary 2017.xls

Data/Parameter	***$FC_{i,j,y}$***
Data unit	Mass or volume unit per year (e.g. ton/yr or m^3/yr)
Description	Quantity of fuel type i combusted in the project plant in process j during the year y
Source of data	Quantity of fuel type i combusted in process j during year y
Value(s) applied	0 (based on past records)
Measurement methods and procedures	On-site measurements will be carried out using fuel meters connected to Units 1 and 2 to determine if the operation of Unit 3 has not resulted in any increase in the consumption of diesel due to the project activity.
Monitoring frequency	Monthly
QA/QC procedures	The recorded monthly fuel consumption quantities will be cross-checked with available purchase invoices from the financial records, as well as by an annual energy balance based on purchased quantities and stock changes.
Purpose of data	Calculation of baseline emissions
Additional comment	This parameter is used to calculate the project emission out of combustion of any fossil fuel $FC_{i,j,y}$ in the plant during the year and multiplying this with $NCV_{i,y}$ and $EF_{CO2,i,y}$ following the Option B of the “Tool to calculate project or leakage CO_2 emissions from fossil fuel consumption” Version 3.

B.7.2. Sampling plan

>>
N/A

B.7.3. Other elements of 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.

Data Processing for ER calculation

Step 1. Calculation of 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 Olkaria II Geothermal Expansion 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 TOOL7, p.12)
(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)
(tonnes CO_2e/MWh)

↓

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

Equations (12) and (13) of TOOL 7 are used to calculate the $\boldsymbol{EF_{grid,OM\text{-}DD,y}}$.

Step 2 - Calculation of the Build Margin CO_2 Emission Factor

The next diagram shows the process for calculating the BM emission factor:

Dispatch of all power units of the Kenyan grid
(MWh)

↓

Determination of 20% of electricity generated from most recently built power units
(set of *m* power units following "Tool to calculate the emission factor for an electricity system", p.12)
(MWh)

↓

Calculation of emission factors of the *m* power units for most recent historical year with power generation data available
(KPLC, KenGen, 2006IPCC Guidelines)
(tonnes CO_2e/MWh)

↓

Determination of $\boldsymbol{EF_{grid,BM,y}}$ in year *y*
(tonnes CO_2e/MWh)

Equations (15) and (4) of TOOL 7 are used to calculate the $\boldsymbol{EF_{grid,BM,y}}$.

Step 3 – Calculation of the Project Emission Reductions

Calculation of Combined Margin Emission Factor $\boldsymbol{EF_{grid,CM,y}}$ as the weighted average of $\boldsymbol{EF_{grid,OM\text{-}DD,y}}$ and $\boldsymbol{EF_{grid,BM,y}}$ (Equation 13 of the "Tool" with equal weights assigned to OM and BM)
(tonnes CO_2e/MWh)

↓

Electricity generation and delivered to grid by the 'Olkaria II Geothermal Expansion Project'
(KPLC and KenGen)
(MWh)

↓

Calculation of Baseline Emissions of the Project (ACM0002/Version 19) (tonnes CO_2e/yr)

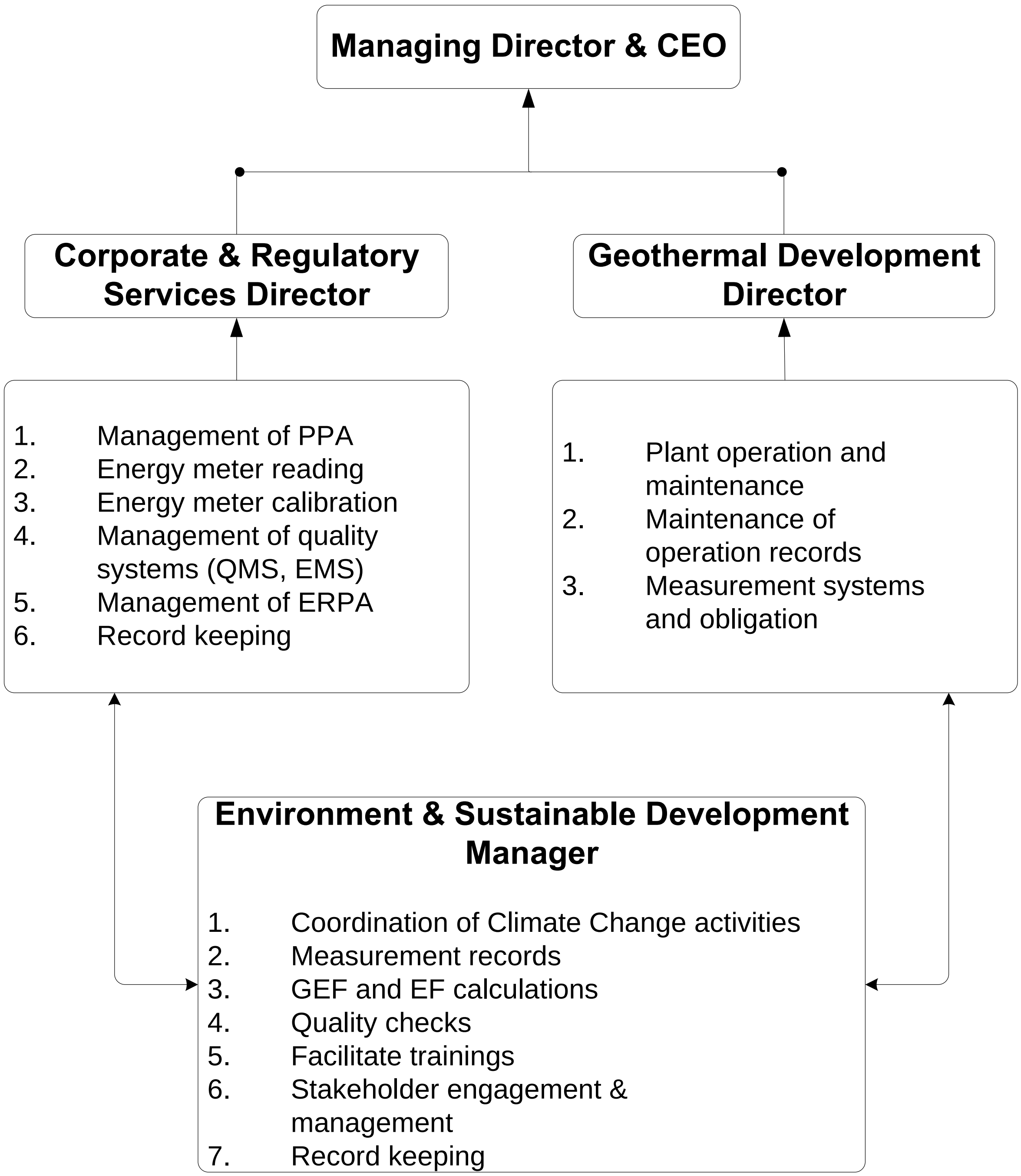
↓

Discount any leakage or project activity emissions, if any (no leakage emissions were considered as per the approved methodology) (tonnes CO_2e/yr)

<u>Operational and Management structure</u>

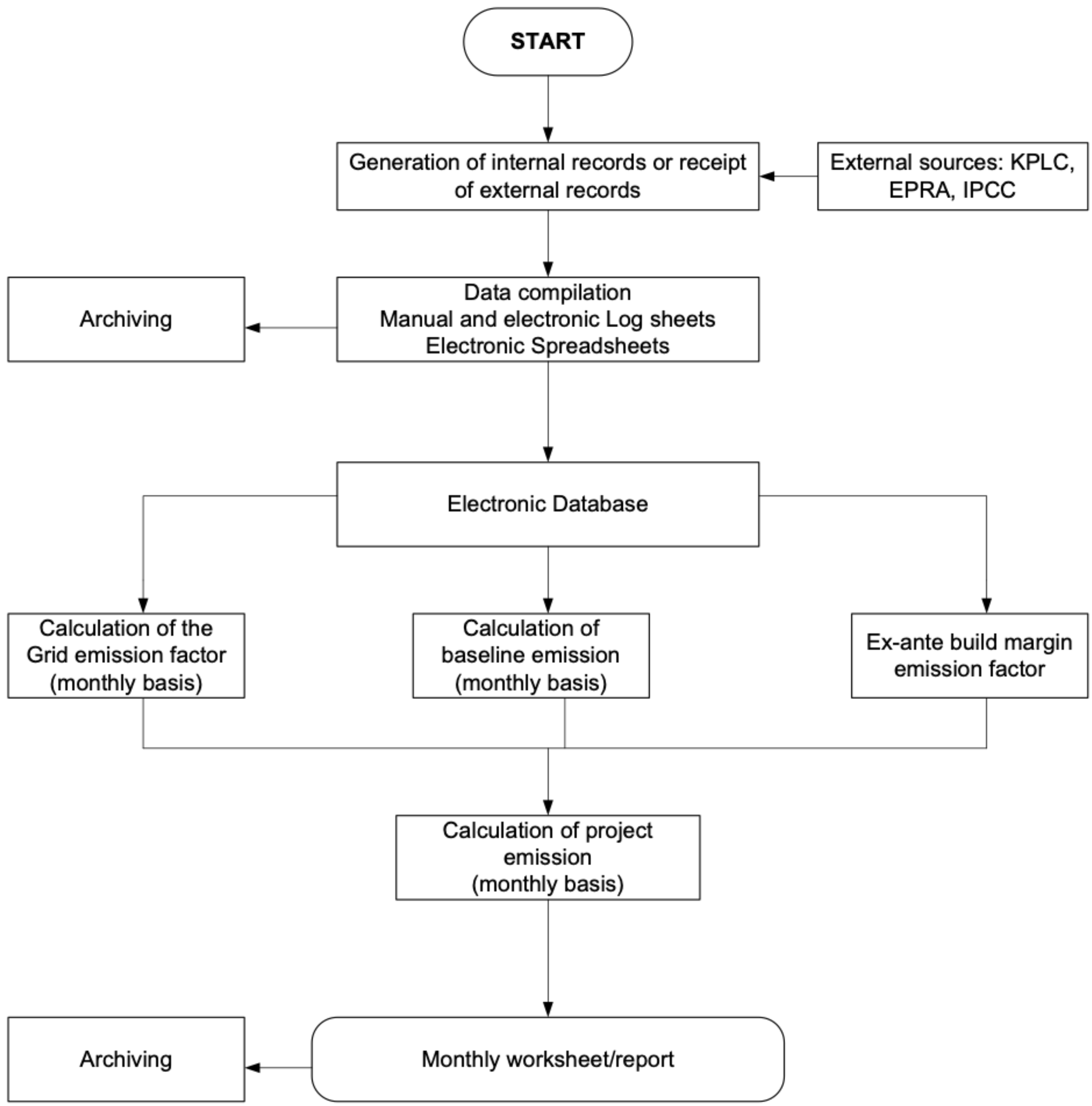
The diagram below provides an overview of the general management structure of KenGen as it will directly affect the implementation of the proposed CDM project.

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.

Below is a graph showing the flow of data during operation and monitoring of the project.


START
Generation of internal records or receipt of external records
External sources: KPLC, EPRA, IPCC
Archiving
Data compilation
Manual and electronic Log sheets
Electronic Spreadsheets
Electronic Database
Calculation of the Grid emission factor (monthly basis)
Calculation of baseline emission (monthly basis)
Ex-ante build margin emission factor
Calculation of project emission (monthly basis)
Archiving
Monthly worksheet/report

SECTION C. Start date, crediting period type and duration

C.1. Start date of project activity

>>
20/08/2007 This is the date of contract signed between KenGen and Mitsubishi for the installation of Unit 3.

C.2. Expected operational lifetime of project activity

>>
25 years

C.3. Crediting period of project activity

C.3.1. Type of crediting period

>>
Renewable crediting period – 7 years X 3

The project activity is currently in the 2nd crediting period.

C.3.2. Start date of crediting period

>>
04/12/2017 after expiry of the previous crediting period.

C.3.3. Duration of crediting period

>>
7 years

SECTION D. Environmental impacts

D.1. Analysis of environmental impacts

>>
In April 2004, KenGen approached GIBB Africa Ltd. to undertake a study to address the environmental and social impacts of a third unit at Olkaria II.[37] Its findings were reported in *Environmental Impact Assessment for Olkaria II Third Unit Extension Project, Environmental Project Report*. GIBB Africa Ltd, 2005.[38]

D.2. Environmental impact assessment

>>
The above-cited report noted that the main issue of concern would be the increased emissions of hydrogen sulphide (H_2S) that would result from the construction of the third unit at Olkaria II. Nonetheless,

---

[37] An environmental and social impact assessment was carried out for the development of the entire Olkaria geothermal field in 1993 and a mitigation plan was developed and implemented under the World Bank-financed Energy Sector Reform and Power Development Project, approved on 30th June 2004. The Environmental Management Plan for this project has been satisfactorily implemented.

[38] The EIA was approved by the National Environment Management Authority (NEMA) and a project implementation license was issued on February 6, 2006.

the report also pointed out that the cumulative levels of H_2S after the commissioning of Unit 3 are expected to be acceptable because Olkaria II has a superior dispersion of air emissions through its cooling towers. (In fact, H_2S monitoring data indicate no significant change in cumulative H_2S levels in immediate areas outside the Olkaria II plant boundary due to its operation.[39]) Continued monitoring of cumulative H_2S levels at Olkaria II would be required to ensure that emission levels remain acceptable after Unit 3 starts its operation.

Other concerns include dust emissions and high noise levels during construction of Unit 3. Although noise levels exceeding recommended levels are possible during the operation of the plant, they would be addressed through mitigation and monitoring. Meanwhile, the EIA report suggested that the installation of Unit 3 at Olkaria II would not result in any significant water abstraction from Lake Naivasha, nor it would affect the lake's hydrology or water quality. In addition, the proposed project would not affect the wetlands in the project area because the brine and condensate that would be generated from Unit 3 would be disposed through deep well re- injection, as currently done in Olkaria II.

KenGen has the technical capacity and a good record of implementing environmental mitigation and monitoring. A World Bank website on best practice on mitigating geothermal environmental impacts had commented favorably on KenGen's compliance with environmental laws and regulations both at the national and international levels. KenGen established in 1985 an environmental unit which has been responsible for monitoring environmental impacts, erosion control, sites rehabilitation, and pollution control. The website further noted that KenGen has retained the services of a Geothermal Board of Consultants which includes an environmental expert who routinely evaluates and reviews the progress made by KenGen staff in aspects of environmental monitoring and mitigation.

The project is not expected to have any transboundary environmental impacts.

[39] An environmental audit done in late 2005 found that H S emissions are within acceptable levels. KenGen established impact stations both in Olkaria I and Olkaria II to monitor H_2S emissions. Monitoring in Olkaria II is done continuously.

SECTION E. Local stakeholder consultation

E.1. Modalities for local stakeholder consultation

>>

Since dissatisfaction was voiced by the local Maasai communities in 2001 about lack of job opportunities and access to health and education benefits at Olkaria, KenGen has appointed a full- time Social Development Officer, Ms. Beatrice Kipngók. Ms. Kipngók is part of a Corporate Social Responsibility Team, which includes the Manager and three other staff members of the Olkaria Power Facility. They hold regular meetings with local stakeholders, including residents from the nearby Maiella area, the flower farmers' associations, Lake Naivasha Tourism Group, Kenya Wildlife Service, and the adjacent Kedong Ranch.

The World Bank community benefits specialist met with the local Maasai communities and local school teachers, accompanied by KenGen officials including the Social Development Officer in October 2006.

E.2. Summary of comments received

>>

The complaints made in 2001were repeated during a stakeholders' meeting in 2003. They were again raised in October 2006 when a meeting was held pertaining directly to the proposed project and was attended by the World Bank community benefits specialist. The schoolteachers requested more classroom facilities (e.g. buildings and school equipment), and possibly a better access road from rural schools' location to nearby towns. The Maasai expressed the need for better access to water for them and their livestock.

E.3. Consideration of comments received

>>

KenGen has already been providing support and assistance to the Maasai communities around Olkaria. For instance, KenGen has provided four water points to the Maasai communities in collaboration with the Oserian flower farm. During medical emergencies KenGen provides transportation to hospital in Naivasha; and it also transports local Maasais for inoculation programs. Transport is likewise provided by KenGen every Saturday for the Maasai communities to go shopping in Naivasha. Maasai children are encouraged to attend the Mvuke Primary School (built in 1983 by KenGen for children of its staff, but open to the public) and transport is provided for them to do so.

Concerning job opportunities, hiring for employment has been based on applicants' qualifications for skilled positions. After the 1995 retrenchment, there has been little employment opportunities in the plant, and it was this time when KenGen decided to contract out non-core business (security and cleaning services) to private companies. While KenGen has no influence on the hiring policy of the private companies, they nonetheless hired Maasais as regular workers and for ad-hoc casual jobs.

Nevertheless, it is still the case that the communities near the plant have inadequate facilities for social services. A comprehensive community benefits plan has been designed by the Corporate Social Responsibility Team. Financing of the community benefits plan would be met through the sale of ERs to the CDCF.[40] This plan covers the provision of water pipelines and access points in isolated areas, along with supporting infrastructure: schools, dispensaries, and access roads. It has been finalized and will be monitored on a continuing basis by the project verifiers and local NGOs.

SECTION F. Approval and authorization

>>

[40] 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 benefits plan.

The letters of approval from Parties for the project activity were available at the time of submitting the PDD to the validating DOE.

Each Project Participant of the project activity is authorized by at least one Party involved in the project activity as evidenced by their respective Letters of Approval.

Appendix 1. Contact information of project participants

Organization name	Kenya Electricity Generating Company Ltd (KenGen)
Country	Kenya
Address	Kolobot Road, P.O Box 47936-00100 Stima Plaza Nairobi
Telephone	254-20-3666000
Fax	254-20-3745250
E-mail	sngure@kengen.co.ke
Website	http://www.kengen.co.ke
Contact person	Simon Ngure

Organization name	International Bank for Reconstruction and Development (IBRD) as Trustee of the Community Development Carbon Fund (CDCF)[41]
Country	USA
Address	1818 H Street, NW Washington DC
Telephone	202 458 5051
Fax	1 202 522 7432
E-mail	IBRD-carbonfinance@worldbank.org
Website	www.carbonfinance.org
Contact person	Mr. Jose Andreu

Organization name	Netherlands' Ministry of Infrastructure and the Environment (IenM)
Country	The Netherlands
Address	Plesmanweg 1-6 , P.O. Box 20901 The Hague
Telephone	31-70-456.6470
Fax	+31-70-456-7550
E-mail	ferry.vanhagen©minienm.nl
Website	
Contact person	Mr. Ferry van Hagen

Organization name	KfW
Country	Germany
Address	Palmengartenstrasse 5-9 Frankfurt
Telephone	+49 69 74314218
Fax	+ 49 69 7431 4775
E-mail	curboncredits(ii)k(W. de
Website	
Contact person	Karin Mulder

Organization name	KommunalKredit Public Consulting GmbH
Country	Austria
Address	Tuerkenstrasse 9 Vienna

[41] Bilateral and Multilateral Fund- Managing Company.

Telephone	43-1-31631-240
Fax	43-1-31631-104
E-mail	A.amerstorfer@kommunalkredit.at
Website	
Contact person	Ms. Alexandra Amerstorfer

Organization name	Maersk Olie og Gas AS
Country	Denmark
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Fax	+45 3363 3849
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Website	
Contact person	Torben Norgard

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Fax	
E-mail	gagre@dongenergy.dk
Website	
Contact person	Mr. Gavin Arthur Green

Organization name	Nordjysk Elhandel A/S
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Fax	99 39 59 99
E-mail	blr@neas.dk
Website	
Contact person	Bo Lynge Rydahl

Organization name	Danish Ministry of Climate, Energy and Building/Danish Energy Agency
Country	Denmark
Address	Amaliegade 44, DK 1256 Kobenhavn K Kobenhavn
Telephone	+47 33 92 67 37
Fax	+45 33 11 47 43
E-mail	
Website	
Contact person	Mr. Frederick Schmidt

Organization name	Aalborg Portland A/S
Country	
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Telephone	+45 9933 7760

Fax	
E-mail	
Website	
Contact person	Mr. Soeren Holm Christesen

Organization name	Goteborg Energi AB
Country	Sweden
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Fax	+46 31 626006
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Website	
Contact person	Lotta Brandstrom

Organization name	Ministry for Environment, Land and Sea
Country	Italy
Address	Via Cristoforo Colombia 44 Rome
Telephone	+390657222146
Fax	+39 06 57226173
E-mail	Clini.corrado@minambiente.i
Website	
Contact person	Corrado Clini

Organization name	Ruukki Metals Oy
Country	Finland
Address	Suolakivenkatu 1, P.O. Box 138 Helsinki
Telephone	+358 20 592 9217
Fax	+358 20 592 9293
E-mail	toni.hemminki@ruukki.com
Website	
Contact person	Toni Hemminki

Organization name	Kingdom of Spain - Ministry of the Agriculture, Food and Environment and Ministry of Economy and Competitiveness
Country	Spain
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Telephone	3491 583 7659
Fax	3491 583 5211
E-mail	and@marm.es
Website	
Contact person	Susana Magro Andrade

Organization name	EDP - Energias de Portugal, S.A
Country	Portugal
Address	Praça Marques de Pombal 13-2°, Lisboa

Telephone	+35121001 7231
Fax	+351 21 001 7220
E-mail	henrique.loboferreira@edp.pt
Website	
Contact person	HENRIQUE LOBO FERREIRA

Organization name	Endesa Generacion, S.A
Country	Spain
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Fax	+34 91 2131 052
E-mail	david.corregidor@endesa.es
Website	34-91-2131052
Contact person	Mr. David Corregidor Sanz

Organization name	Gas Natural SDG, S.A.
Country	Spain
Address	Avda. San Luis 77, 2A, Madrid
Telephone	+34) 91 589 30 38
Fax	+34) 91 567 7309
E-mail	rmsanZ@gasnatural.com
Website	
Contact person	Rosa M Sanz Garcia

Organization name	Idemitsu Kosan Co., Ltd
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Fax	81-3-3213-9410
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Website	
Contact person	Mr. Shoichi Idemitsu

Organization name	The Okinawa Electric Power Corporation, Incorporated
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Website	
Contact person	Mr. Hirotaka Yamashiro

Organization name	Statkraft Carbon Invest AS
Country	Norway
Address	Pb 200 Lilleaker Oslo
Telephone	+47 24 06 78 91 // +47 24 06 70 00
Fax	+47 24 06 70 01
E-mail	
Website	
Contact person	Anne Bolle

Organization name	Statoil ASA
Country	Norway
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Telephone	+47 93 05 02 91
Fax	+47 51 99 00 50
E-mail	
Website	
Contact person	Thomas B. Egeland

Organization name	Schweizerische Ruckversicherungs-gesllsschaft AG (Swiss Re)
Country	Switzerland
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Telephone	+41 43 285 4349
Fax	+41 43 282 3640
E-mail	Vincent_Eckert@swissre.com
Website	
Contact person	Mr. Vincent Eckert

Organization name	Ministry of Sustainable Development and Infrastructure
Country	Luxembourg
Address	3, rue de la Congregation
Telephone	+ 352-2247-82687
Fax	+352-220-673
E-mail	Raoul.Wirtz@fi.etat.lu
Website	
Contact person	Raoul Wirtz

Appendix 2. Affirmation 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.

The project is financed through the following loans:

- European Investment Bank (EIB) USD 41 Million
- International Development Association (IDA) USD 27.6Million
- AfD € 20 Million (not yet concluded)

The conditions are as follows:

- EIB, Grace period 5YRS, Interest LIBOR + 1.95% or floating, Repayment period 20YRS
- IDA Grace period 5YRS, Interest 4.5%, Repayment period 15YRS

The World Bank IDA loan is a concessional credit made to the Government of Kenya (GoK) which was on-lent by GoK to kenGen on the terms cited above.[23]

Appendix 3. Applicability of methodologies and standardized baselines

See *GEF Olkaria II 2018 Updated_Renewal of crediting period for Olkaria II.xlsx* for details on the grid emission factor calculation.

Appendix 4. Further background information on ex ante calculation of emission reductions

The data and parameters that will be monitored in this project activity are detailed in Section B.7.1. Monitoring will take place from year 2009 up to the end of the last crediting period. Leakage parameters will not be monitored since the approved methodology does not consider emissions due to leakage.

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:

- Total net electricity generation exported to the grid by the project activity (Unit 3) and by the existing Units 1 and 2 will be metered by KenGen and KPLC, and readings of meters will be done jointly by them. Readings will be cross-checked with 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.

  The quantity of electricity fed into the grid by Units 1, 2 and 3 will be monitored and recorded. In accordance with ACM0002/Version 19, separate metering of electricity exported from the three power units is not necessary under Option 1.

- The average mass fraction of carbon dioxide in the produced steam will be measured and monitored by KenGen at least every 3 months. The sampling procedure and method of analysis to use are in accordance with the procedures required by the approved methodology.

- The average mass fraction of methane in the produced steam will be measured and monitored by KenGen at least every 3 months. The sampling procedure and method of analysis to use are in accordance with the procedures required by the approved methodology.

- Quantity of steam produced during the year in the production wells will be measured daily using a venture flow meter. Measurements will be recorded regularly in production reports.

- Quantity of diesel (and other fossil fuels) combusted in the Olkaria II power facility will be measured continuously. On-site measurements will be carried out using fuel meters connected to Units 1 and 2 to determine if the operation of Unit 3 has not resulted in any increase in the consumption of diesel due to project activity. The consistency of measurements will be cross-checked with purchased fuel invoices, as well as by an annual energy balance based on purchased quantities and stock changes.

- Consumption of fossil fuels will be monitored using fuel meters installed in the fuel supply to each thermal power unit connected to the Kenyan grid.

- Net calorific value of fossil fuels will be based on the IPCC Guidelines while internal validation check of plant performance will be done annually.

- CO_2 emission factors of fossil fuels will be monitored yearly based on the IPCC Guidelines.

- Net electricity generated and delivered to 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 KenGen fossil fuel consumption data 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:

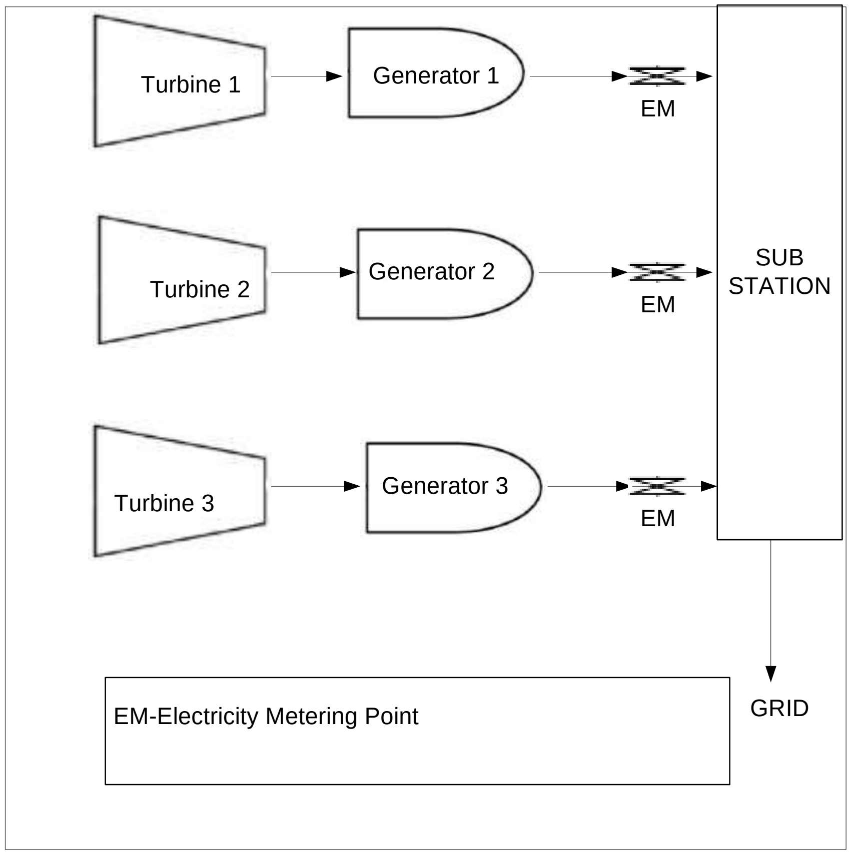
Kenya's interconnected grid system (IGS) is coordinated by the Kenya Power and Lighting Company Ltd (KPLC). KPLC is the sole distribution and transmission company in Kenya.

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.

Below is a line diagram of the monitoring points showing the location of the electrical meters (EM) relative to the other project activity equipment.



Each of the metering points has electricity meters; one main and a backup. The backup meter is maintained by the power off taker-Kenya Power.

A. Dispatch Data Analysis OM

The dispatch data analysis OM emission factor ($EF_{grid,OM-DD,y}$) is determined based on the power units that are actually dispatched at the margin during each hour *h* where the project is displacing 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 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. Net calorific value of each fossil fuel type. Data source: IPCC default values at the lower limit of the uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories. This parameter will be monitored annually.

8. CO_2 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. This parameter will be monitored annually.

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 7 years x 3. Following the guidance provided in TOOL 7 Tool to calculate the emission factor for an electricity system, for the first crediting period, the $EF_{grid,BM,y}$ is estimated *ex-ante* based on the most recent information available on units already built for a sample group *m* at the time of CDM-PDD submission to the DOE for validation. For the second crediting period, the Build Margin emission factor will be updated based on the most recent information available on units already built at the time of submission of the request for renewal of the crediting period to the DOE. The third crediting period will use the one calculated for the second crediting period.

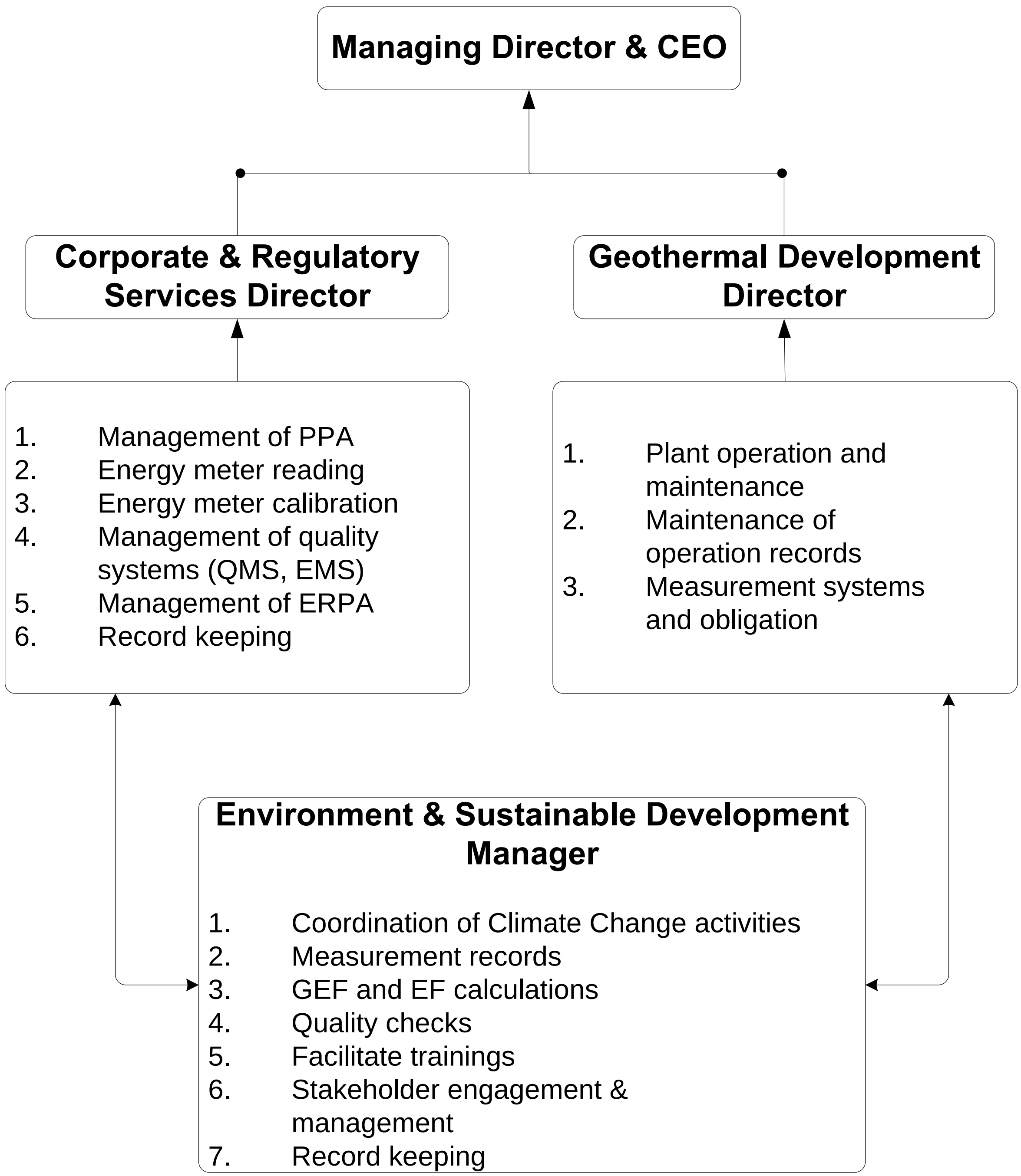
Therefore, under Option 1, the $EF_{grid,BM,y}$ will be calculated once *ex-ante* for the first crediting period and again once *ex-ante* at the start of the second crediting period.

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.

Appendix 5. Further background information on monitoring plan

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, steam flow meters, and sample steam for NCG analysis.
CDM data quality control and quality	This procedure covers all measured and/or calculated	Data and records will be checked prior to being stored and archived.

assurance	variables.	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 onsite 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 Scientist/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	Field Technicians	Scientist/ Engineer in charge	Project developer's head office	Steam Analysis Lab
Collect Data	E	R	N/A	E
Enter data into Spreadsheet	N/A	R	N/A	N/A
Make monthly and annual reports	N/A	E	E/R	N/A
Archive data	N/A	R	N/A	N/A

& reports				
Calibration/ Maintenance	I/E	R	I	E

Appendix 6. Summary report of comments received from local stakeholders

NA

Appendix 7. Summary of post-registration changes

The following corrections have been made to the Project Activity and submitted along with a renewal of the crediting period:

Correction of monitored parameter $EG_{facility,y}$ to reflect parameter description in the updated version of methodology used by the Project Activity.

Correction of monitored parameter $M_{steam,y}$, to reflect parameter correct measurement methods and procedures of the monitored parameter.

Correction of ex ante parameter $Date_{BaselineRetrofit}$ in order to reflect the correct lifetime of the equipment based on manufacturer certification of operational hours of the equipment. The parameter was however erroneously indicated as 2022 instead of 2025, considering the commissioning date of 2003 for the existing plant.

Correction of the PDD template to Version 11 as required when undertaking post-registration changes and/or renewal of the crediting period.

Correction of the management structure, monitoring points and monitoring procedure graphics. The organization structure has changed with creation of a division in charge of Geothermal Development that was not in place at the time of registration, at registration the plant operations was under Operations Division which is no longer the case. The function in charge of CDM monitoring activities has also be clarified with details of specific activities. Lastly Regulatory Affairs Division has been renamed to Corporate and Regulatory Services Division. This was not the case in the previous version of the PDD.

Reference Number: PRC-3773-002
Approval Date: 15/12/2017

The following temporary deviation was approved from 01/02/2014 - 31/05/2014 (inclusive of both days):

The parameter FCi,j,y was unable to be monitored from 01/02/2014 - 31/05/2014 as detailed in the monitoring plan. The highest possible value diesel consumption value was applied during this time period to ensure a conservative estimate of any resulting emission reductions.

Reference Number: PRC-3773-001
Approval Date: 15/12/2017

The following correction was made:

As per the *"Tool to calculate the emission factor for an electricity system"* version 04.0, for parameters NCVi,y and EFCO2,i,y the IPCC default values at the lower limit of uncertainty at a 95 per cent confidence interval should be used. The PDD and the spreadsheet calculations have been updated on 14 October 2014 to incorporate NCVi,y and EFCO2,i,y IPCC default values at the lower limit of uncertainty at a 95 per cent confidence interval. Since parameters NCVi,y and EFCO2,i,y are also used to calculate the emission factor, the EFBM and EFOM have been updated, resulting in a decrease in the annual ERs from 149,632 to 140,682.

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Document information

Version	*Date*	*Description*
11.0	31 May 2019	Revision to: • Ensure consistency with version 02.0 of the "CDM project standard for project activities" (CDM-EB93-A04-STAN); • Make editorial improvements.
10.1	28 June 2017	Revision to make editorial improvement.
10.0	7 June 2017	Revision to: • Improve consistency with the "CDM project standard for project activities" and with the PoA-DD and CPA-DD forms; • Make editorial improvement.
09.0	24 May 2017	Revision to: • Ensure consistency with the "CDM project standard for project activities" (CDM-EB93-A04-STAN) (version 01.0); • Incorporate the "Project design document form for small-scale CDM project activities" (CDM-SSC-PDD-FORM); • Make editorial improvement.
08.0	22 July 2016	EB 90, Annex 1 Revision to include provisions related to automatically additional project activities.
07.0	15 April 2016	Revision to ensure consistency with the "Standard: Applicability of sectoral scopes" (CDM-EB88-A04-STAN) (version 01.0).
06.0	9 March 2015	Revision to: • Include provisions related to statement on erroneous inclusion of a CPA; • Include provisions related to delayed submission of a monitoring plan; • Provisions related to local stakeholder consultation; • Provisions related to the Host Party; • Make editorial improvement.

Version	*Date*	*Description*
05.0	25 June 2014	Revision to: • Include the Attachment: Instructions for filling out the project design document form for CDM project activities (these instructions supersede the "Guidelines for completing the project design document form" (Version 01.0)); • Include provisions related to standardized baselines; • Add contact information on a responsible person(s)/ entity(ies) for the application of the methodology (ies) to the project activity in B.7.4 and Appendix 1; • Change the reference number from F-CDM-PDD to CDM-PDD-FORM; • Make editorial improvement.
04.1	11 April 2012	Editorial revision to change version 02 line in history box from Annex 06 to Annex 06b.
04.0	13 March 2012	Revision required to ensure consistency with the “Guidelines for completing the project design document form for CDM project activities” (EB 66, Annex 8).
03.0	26 July 2006	EB 25, Annex 15
02.0	14 June 2004	EB 14, Annex 06b
01.0	03 August 2002	EB 05, Paragraph 12 Initial adoption.

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