

Research and Development Plan for New Climate Technology Cooperation Project in 2023

Strengthening Waste Management Policymaking in Uganda in Response to Climate Change

[Proposal for Greenhous Gas Reduction at Kiteezi Landfill]

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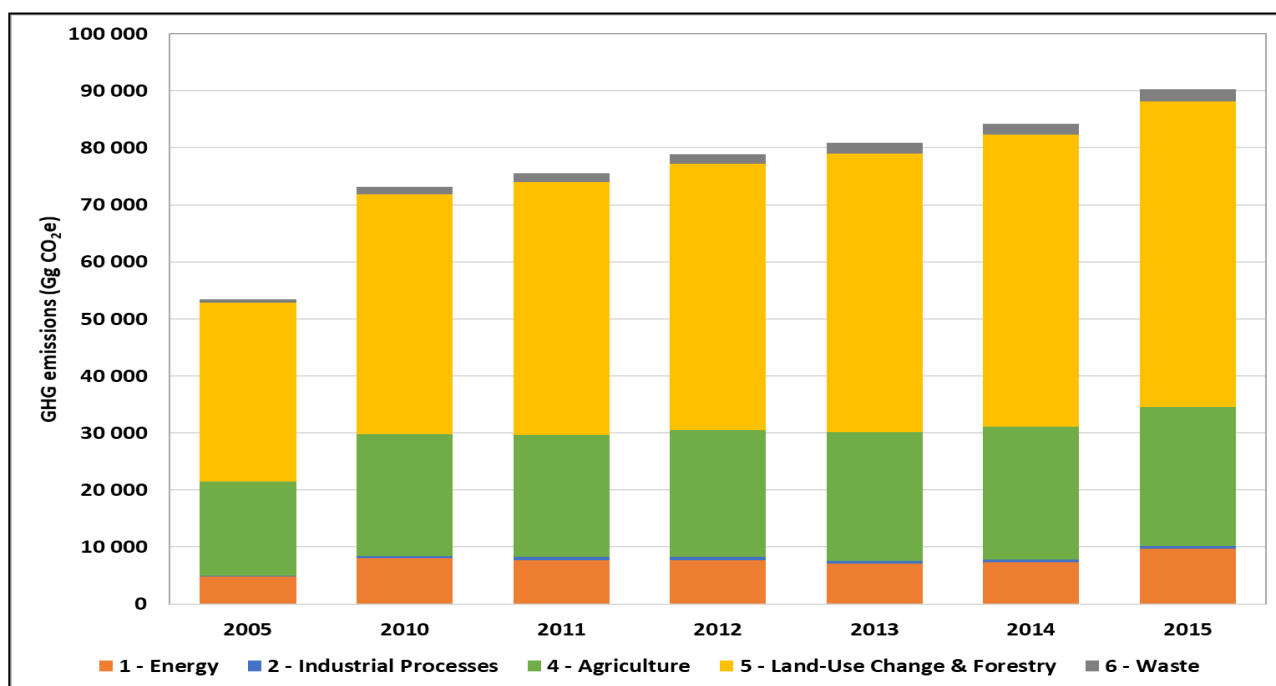
Proposal for Greenhouse Gas Reduction at Kiteezi Landfill

A.1. Purpose and general description of project activity

The objective of the project is to capture and flare the landfill gas (LFG) generated from the Kiteezi landfill site. This project is aimed at reducing atmospheric emissions of methane, a greenhouse gas (GHG) which contributes to global warming and climate change. Apparently, the central business parts of the city are serviced with daily sweeping and cleaning, but outside these areas such services are not provided. At times, the poorer parts of the city and the industrial areas show extreme littering. Littering and the near absence of city cleaning appear to be the most important waste problem in Kampala City. Litter is all around, even in the wealthier areas of the city.

The amount of waste produced in Uganda is rapidly increasing, owing to a growing population, rapid urbanization, the growth of the middle class, and shifting spending habits and lifestyles. In the updated Nationally Determined Contribution (NDC), Uganda presents an ambitious economy-wide mitigation target in 2030 of 24.7% reduction below the Business As Usual (BAU).

However, Uganda's GHG emissions have slowly increased from 53.4 MtCO_{2e} in 2005 to 90.1 MtCO_{2e} in 2015 (Figure). The emissions are projected to increase to 148.8 MtCO_{2e} by 2030 and rise to 235.7 MtCO_{2e} by 2050.



<Figure> Sectoral trends in GHG emissions for Uganda (Updated Nationally Determined Contribution, 2022)

The Ugandan government is implementing the agenda of its overarching Uganda Vision 2040 as well as its Second National Development Plan (NDP III) intending to reduce carbon emissions, achieving low-carbon goals, and ensuring sustainable development.

According to the National Urban Solid Waste Management Policy (NUSWMP), the Greater Kampala Metropolitan Area (GKMA) produced 3,206 tons of solid waste per day as of 2015. It is expected to reach 4,739 tons by 2030. However, only one landfill site, the Kiteezi landfill site, serves the entirety of the GKMA. This facility has far exceeded its design capacity, and moreover does not treat leachate due to obsolete, broken, or otherwise inoperable treatment equipment.

Although the 35-acre Kiteezi landfill site receives around 1,200 tons of waste daily, reusable solid waste is not separated from the general waste flows, and is left to mix with the waste materials already buried on site. Nor does the landfill site have a sanitary drainage system, contributing considerably to soil and water pollution in the surrounding environment. Furthermore, the landfill site has no facilities to properly manage carbon dioxide and methane emissions, which are released into the atmosphere unprocessed.

This landfill site is managed as open dumpsites, posing a high risk to environment and public health. For instance, because the dumpsites do not make use of leachate protection barriers, the sites pose a potential risk of groundwater contamination. Moreover, the lifespan of these dumpsites is estimated to elapse in roughly 2~4 years under the existing scenario.

This project presents the key activities that are identified to stop uncontrolled dumping, open burning and improving the final treatment and disposal in the city. The project activities involve the capture of methane to produce electricity for the on-site needs. GHG emission reductions will result from the efficient combustion of otherwise flared LFG, in the power generation, leachate evaporation, and flaring equipment.

The project involves methane destruction through burning and combustion in engines, while generating energy that will be used internally in the landfill. Other activities also include a gas extraction system, equipment for gas burning, a gas pre-treatment plant and gas reception engines, as well as the engines for burning the Landfill Gas (LFG) generated in dumping zones.

The extraction system comprises a set of closed wells interconnected through a system of pipes inside the landfill, that allows to extract the LFG and carry it to a central collector that connects with the burning system. Vacuum pumps or blowers will be connected to the collection system for active gas extraction.

Environmental Benefits

The implementation of a CDM project at the Kiteezi landfill will contribute positively to climate change, as the emission of greenhouse gases emission will be reduced. Methane (CH₄) is the main GHG generated at the landfill, and combustion of such gas yields carbon dioxide (CO₂) which is less harmful (being methane 25 times as dangerous as carbon dioxide in terms of climate change); other compounds destroyed by flaring include ammonia.

Social Benefits

The burning of the LFG will not only contribute to climate change mitigation but also to the health and life quality of the surrounding communities in the project's area of influence. During the project's lifetime, the CDM/SDM project activity should lead to alleviation of poverty by generating additional employment and contribution to provision of basic amenities to the people and hence leading to improvement in quality of life of, at least, the people within the community in which the project is sited.

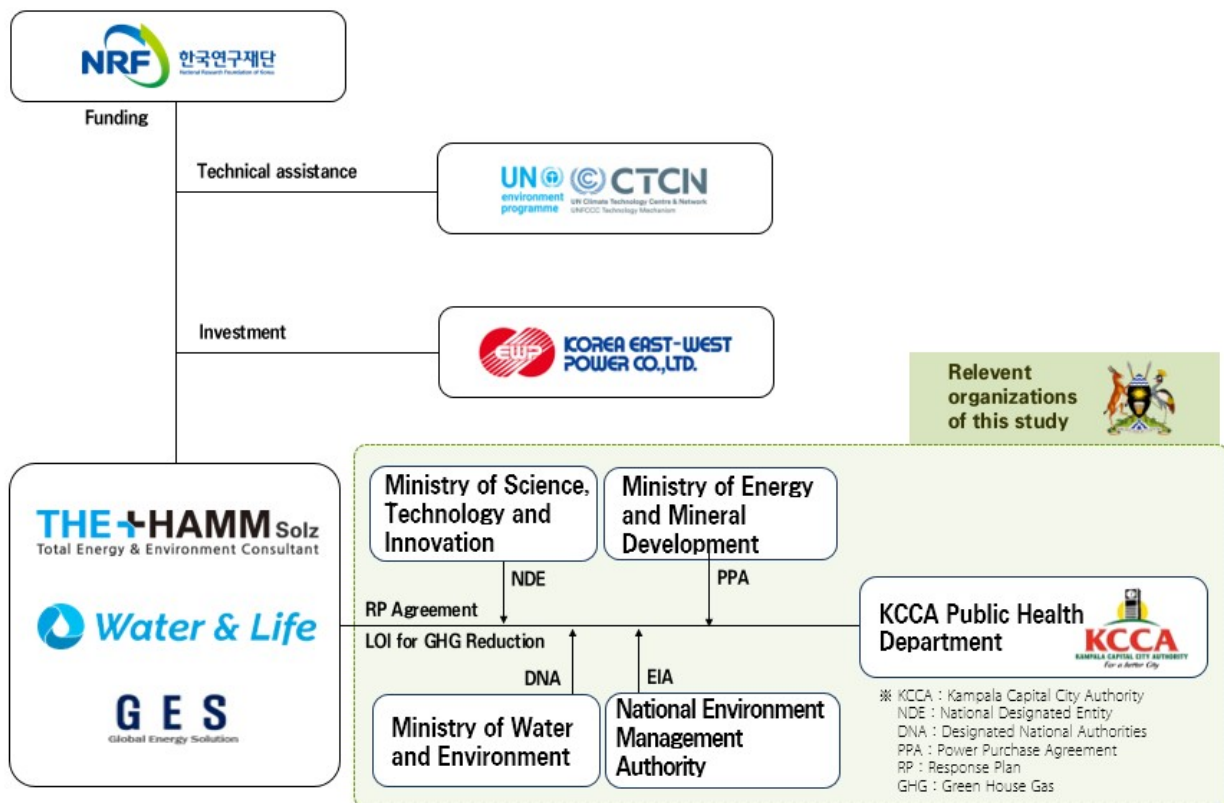
Sustainable Benefits of the Project Activity

Flaring of the collected LFG does not only destroy methane but will also destroy volatile organic compounds in the LFG. The project will further result in reduced air pollution, reduced odour nuisances, improved health and safety conditions for nearby residents, and reduction of the risk of fire and explosion at the landfill site.

- Contribute to establish better practices over the local natural resources, as many open dumps are still a common practice and waste disposal habits are incautious

- Prove the use of a new technology and demonstrate the viability of LFG capture and flare project, while increasing demand for local labour
- Encourage local supply of equipment and other components for the construction and operation of the LFG plant, increasing local know-how
- Generate local jobs both for low-skilled and skilled workers
- Improve air quality in the area and local health conditions for inhabitants
- Environmental and sanitary impacts associated with the emissions of methane and other organic compounds will be prevented
- The capture and flaring of landfill gas will avoid emissions of methane and other gases such as hydrogen sulphide (H₂S), mercaptans and other odorous compounds, which leads to a cleaner environment in the surrounding area to the landfill
- Odorous gas emissions affect public health and quality of life. Bad odours can cause local health problems
- Capture and flaring of landfill gas will reduce explosion and fire risks.

A.2. Implementing organization and stakeholders



A.3. Location of project activity

A.3.1. Host Party

The Republic of Uganda

A.3.2. City/Town/Community etc.

Kampala Capital City

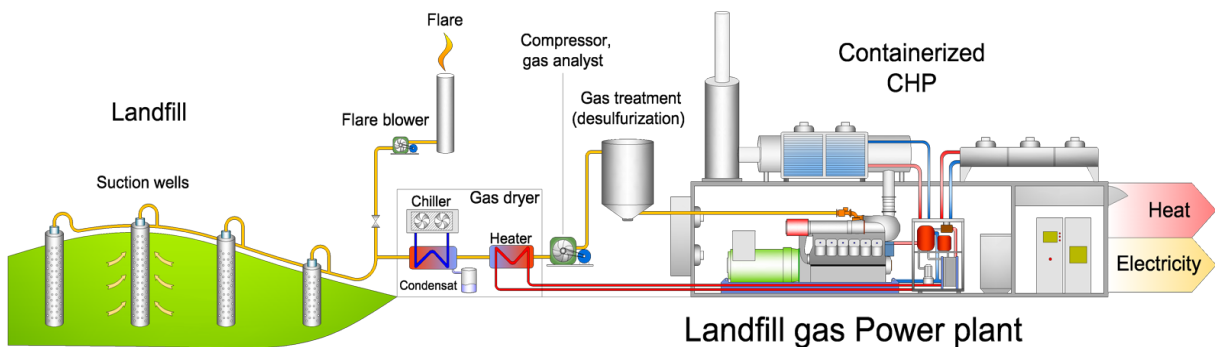
A.3.3. Location

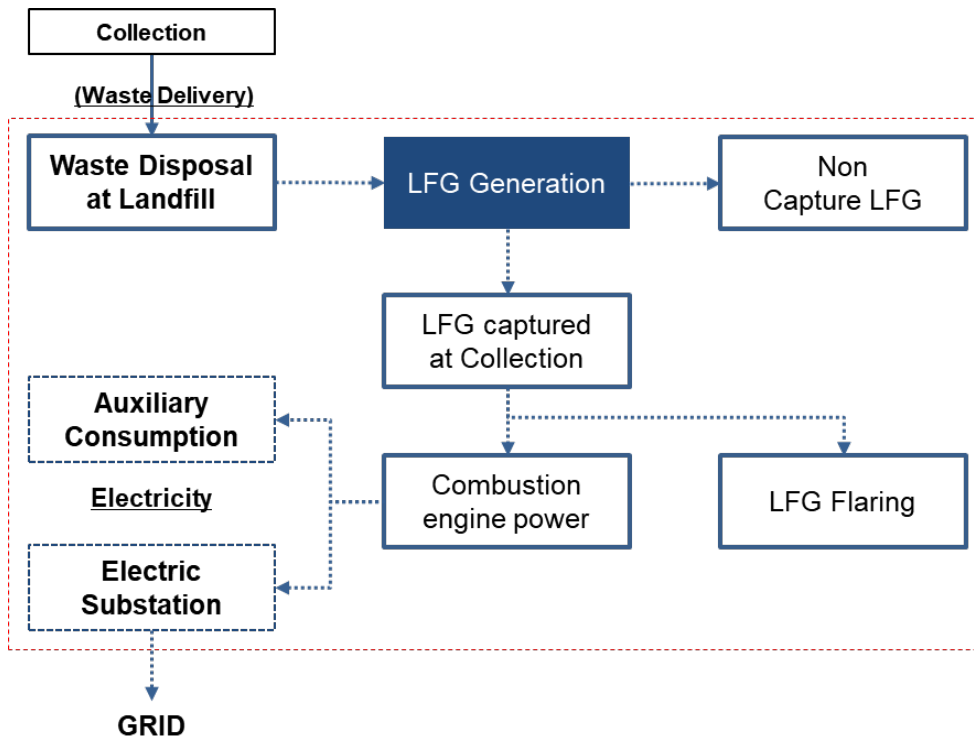
Kampala City



A.4. Landfill gas power generation technology

1. Securing greenhouse gas emissions rights by capturing and refining landfill gas and using it as power generation fuel
2. Facilities are divided into processes that collect landfill gas and cogeneration facilities that utilize purified landfill gas.
3. Landfill gas is stored in a CSV (Condensate Separate Vessel) tank through a collection facility, and moisture and hydrogen sulfide are removed through a purification facility.
4. Refined gas is fed into a combined heat and power (CHP) plant as fuel, and the final byproducts are waste heat and electricity.





A.4.1. Ex ante calculation of emission reductions

Emission Reduction

1. Baseline Emissions

1.1 Landfill Methane Recovery

The following table summarizes the calculation for the variable part of the equation and the emissions from solid waste disposal site ($BE_{CH_4,SWDS,y}$) for every year in the crediting period, please refer to the project's spreadsheet for more details.

Year	$BE_{CH_4,SWDS,y}$ (tCO ₂ e)	$F_{CH_4,BL,y}$ (tCH ₄ /yr)	Total LFG generation (Nm ³ /a)	Total captured LFG (Nm ³ /a)	Total captured LFG (Nm ³ /hr)
2026	289,593	0	28,889,916	14,444,958	1,649
2027	279,632	0	27,896,259	13,948,129	1,592
2028	270,014	0	26,936,779	13,468,389	1,537
2029	260,727	0	26,010,299	13,005,150	1,485
2030	251,760	0	25,115,686	12,557,843	1,434
2031	243,100	0	24,251,842	12,125,921	1,384
2032	234,739	0	23,417,710	11,708,855	1,337
2033	226,665	0	22,612,268	11,306,134	1,291
2034	218,869	0	21,834,528	10,917,264	1,246
2035	211,341	0	21,083,539	10,541,769	1,203

1.2. Grid connected to renewable electricity generation

Baseline emissions from electricity generation are given for the following equation, which multiplies the effective generation of energy generated by the project for the emission factor of 0.137 tCO₂e/MWh taken.

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

Year	BE _{CH₄,S} WDS,y (tCO ₂ e)	Total LFG generation (Nm ³ /a)	Total captured LFG (Nm ³ /a)	Total captured LFG (Nm ³ /hr)	Unit installed (kW)	Flaring LFG (Nm ³ /hr)	Net quantity of electricity produced (MWh)
2026	289,593	28,889,916	14,444,958	1,649	1,500	890	11,169
2027	279,632	27,896,259	13,948,129	1,592	1,500	834	11,169
2028	270,014	26,936,779	13,468,389	1,537	1,500	779	11,169
2029	260,727	26,010,299	13,005,150	1,485	1,500	726	11,169
2030	251,760	25,115,686	12,557,843	1,434	1,500	675	11,169
2031	243,100	24,251,842	12,125,921	1,384	1,500	625	11,169
2032	234,739	23,417,710	11,708,855	1,337	1,500	578	11,169
2033	226,665	22,612,268	11,306,134	1,291	1,500	532	11,169
2034	218,869	21,834,528	10,917,264	1,246	1,500	488	11,169
2035	211,341	21,083,539	10,541,769	1,203	1,500	445	11,169

1.3. Baseline Emissions

Year	BE _{CH₄,SWDS} , y (tCO ₂ e)	Estimation of F _{CH₄,PJ,Y} (tCH ₄)	Estimatio n of F _{CH₄,BL,y} (tCH ₄)	stimation of EC _{BL,y} (MWh)	Estimation of BE _{EC,y} (tCO ₂ e)	Estimatio n of BE _{CH₄,y} (tCO ₂ e)	Estimatio n of baseline emissions (tCO ₂ e)
2026	289,593	5,171	0	11,169	1,530	130,317	130,317
2027	279,632	4,993	0	11,169	1,530	125,834	125,834
2028	270,014	4,822	0	11,169	1,530	121,506	121,506
2029	260,727	4,656	0	11,169	1,530	117,327	117,327
2030	251,760	4,496	0	11,169	1,530	113,292	113,292
2031	243,100	4,341	0	11,169	1,530	109,395	109,395
2032	234,739	4,192	0	11,169	1,530	105,633	105,633
2033	226,665	4,048	0	11,169	1,530	101,999	101,999
2034	218,869	3,908	0	11,169	1,530	98,491	98,491
2035	211,341	3,774	0	11,169	1,530	95,104	95,104

2. Project Emissions

2.2 Grid connected to renewable electricity generation

Project emissions from electricity consumption are determined as per the procedures described in the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”, “AMS-I.D.: Grid connected renewable electricity generation”

$$PE_{Power,y} = PE_{EC,y} = \sum EC_{PJ,j,y} \times EF_{EL,j,y} \times (1 + TDL_{j,y})$$

	Estimation of EC _{PJ,y} (MWh)	EF _{grid} (MWh/tCO _{2e})	Estimation of PE _{EC,y} (tCO _{2e})
	Monthly consumed elcetricity x 12m		PE _{EC,y} = EC _{PJ,y} *EF _{EL,grid,y}
2026	2,000	0.137	274
2027	2,000	0.137	274
2028	2,000	0.137	274
2029	2,000	0.137	274
2030	2,000	0.137	274
2031	2,000	0.137	274
2032	2,000	0.137	274
2033	2,000	0.137	274
2034	2,000	0.137	274
2035	2,000	0.137	274

A.4.2. 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})
Year 1	130,317	274	0	130,043
Year 2	125,834	274	0	125,560
Year 3	121,506	274	0	121,232
Year 4	117,327	274	0	117,053
Year 5	113,292	274	0	113,018
Year 6	109,395	274	0	109,121
Year 7	105,633	274	0	105,359
Year 8	101,999	274	0	101,725
Year 9	98,491	274	0	98,217
Year 10	95,104	274	0	94,830
Total	1,118,899	2,740	0	1,116,159
Total number of crediting years	10 years			
Annual average over the crediting period	111,890	274	0	111,615

A.5. Future schedule

Items	3	6	9	12	15	18	21	24	27	30	~
1. F/S	█										
2. Design & PCP, PIN etc.			█								
3. PPA approval						█					
4. FDI approval							█				
5. GHG reduction registration				█							
6. installation (10 mos)								█			
7. O&M (15 years)											█

Attachment. Introduction of GHG Reduction Technology