GOVERNMENT OF UGANDA

MINISTRY OF WATER AND ENVIRONMENT
CLIMATE CHANGE UNIT (CCU)

Proposal for:
Nationally Appropriate Mitigation Action NAMA Seeking Support for Implementation

Integrated Bio-Wastewater Treatment for agro-process wastewater

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DESCRIPTION OF MITIGATION ACTION

1.1 Objective of NAMA

The main objective of the National Appropriate Mitigation Action (NAMA) for integrated bio-wastewater treatment for agro-process waste water in Uganda is to reduce greenhouse gas emissions associated with wastewater treatment for agro-processing factories and facilities in Uganda. The agro-processing facilities targeted by the NAMA include fish processing factories, livestock slaughterhouses, tanneries and fresh fruit and wine processing plants, and other facilities that generate large volumes of bio-or-agro-process wastewater including breweries, beverage companies, urban markets, schools, flower firms, hides and skins processing plants, mini-sewage treatment facilities.

The NAMA also seeks to increase efficiency and value addition prospects for wastewater treatment of agro-processing firms by establishing an integrated wastewater treatment process using both an anaerobic and aerobic digester with sequencing batch reactor. From the two processes, greenhouse gases (GHGs) especially methane will be capture in the form of biogas and using a generator converted for electricity, and/or used directly for cooking, and lighting where the volumes of biogas generated are small. Also, the process will lead to generation of large volumes of bio-slurry, which can be used for producing bio-fertilizers, while the treated wastewater can be re-used in some of the targeted facility.

1.2 Sector

The focus sector is waste management, based on the Working Group III to the Fourth Assessment Report of the intergovernmental panel on climate change (IPCC). In Uganda waste management is regulated by the Ministry of Water and Environment (MWE) and the specific local government authorities where the facilities are located. The national authorities in the MWE specifically the Directorate of Water Resources Management, under the water (waste discharge) regulation S.I 152-4, and together with the National Environment Management Authority (NEMA) under the National Environment (Standards for Discharge of Effluent into Water or on Land) Regulations, provide a regulatory platform for enforcing regulations on wastewater discharge.

A substantial volume of waste water is produced in Uganda. Wastewater generated has been estimated at 7.62million m^3/year with nearly half from Kampala City alone (Kayizzi et al. 2012). Several facilities and factories have been issued with permits allowing them to discharge treated wastewater. A key condition attached to wastewater discharge permits is installation of a wastewater treatment plant. Out of 101 wastewater discharge permit holders, 73 had treatment facilities. The percentage represents only those companies that are permitted to discharge effluents into environment. In depth assessment of the effluent quality in the receiving waters indicates that there is generally low compliance to effluent standards Compliance to waste water discharge permit conditions stands at 48% (MWE-SPR 2013). Some of the biggest dischargers for example NWSC facilities, sugar manufacturing companies, leather tanning industries, some beverage companies etc., do not meet National Standards for wastewater Discharge onto/into land and water. The overall compliance to permit conditions was 60% (MWE-SPR 2013).

Several other facilities that should be regulated for effluent discharge do not have a permit, which further reduces the efficiency of the regulatory process. Currently the National Water and Sewerage Corporation[1]

[1] NWSC is a utility parastatal 100% owned by The Government of Uganda. The mandate of the Corporation is to operate and provide water and sewerage services in areas entrusted to it, on a sound, commercial and viable basis.

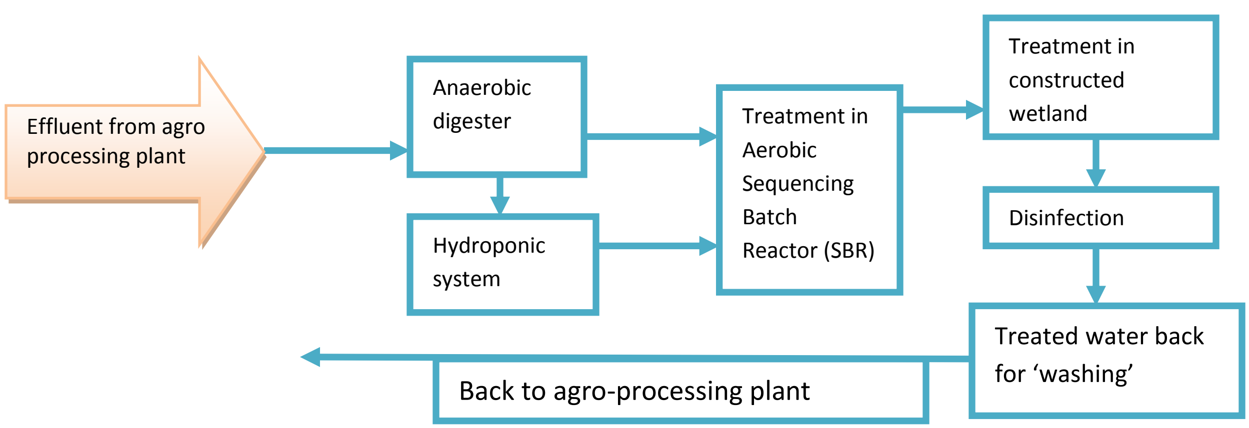
(NWSC) is developing a Clean Development Mechanism (CDM)especially focusing on the sewage treatment processes in Kampala City. NWSC's efforts to develop a CDM project whereas significant are unlikely to address challenge of wastewater management in the country. This is because the current plants and technology used by NWSC are old, even though this can be addressed in the CDM project for the Kampala NWSC systems. The NWSC's has a coverage of only 10% of Kampala's Central Business District and 22 towns in Uganda (NWSC website 2013), means that the effort required to achieve high levels of wastewater treatment and GHG mitigation is greater than what can be addressed by the NWSC CDM project in the medium to long-term. Furthermore, discussions held with the MWE/CCU (Ntabadde M. pers. comm. CDM office MWE/CCU, 2013) showed that independent and low emissions from wastewater treatment, lack of a clear value chain and the large geographical area make the integrated wastewater treatment processes more suitable for a NAMA than a CDM project. Moreover, there is a higher national priority to address the problem of poorly or untreated treated wastewater discharge in urban areas given the extent of pollution, especially in Lake Victoria basin (Odada et al. 2004; NEMA 2010; MWE-DWRM 2010; MWE-SPR 2012;2013).

1.3 Type of action

The integrated wastewater treatment technology proposed for the NAMA comprises of anaerobic and aerobic sequencing batch reactors (SBRs) set up in series to treat high-strength agro-process wastewater onsite. The overall percentage removal of chemical oxygen demand (COD), and faecal coliforms in the integrated anaerobic and aerobic SBR system in pre-treated water versus treated water was quite high compared to available literature (Odong et al. 2013). Therefore, anaerobic and aerobic SBRs have good potential for treating abattoir wastewater highly recalcitrant in organic pollutants and faecal coliforms.

The process flow for is illustrated in Figure 1 and it shows that the technology for the NAMA involves of using anaerobic bio-conversion of agro-process wastes to produce biogas energy and nutrient-rich slurry. The aerobic oxidation of anaerobic digestate leads to a reduction in organic and nutrient loading in the wastewater and generate nutrient-rich sludge, use of effluent from anaerobic digester and aerobic SBRs for hydroponic systems and finally polishing of this effluent in constructed wetlands to achieve sustainable waste treatment and environmental clean-up.

Figure 1: Process flow diagram showing innovation pathway and value addition to agro-process wastewater treatment



Source: Njau et al. 2011

On initial discharge, wastewaters can contain high levels of inorganic pollutants which can be easily biodegradable, while the impact load on the ecosystem in Total Suspended Solids (TSS), Biochemical Oxygen Demand (BOD), or Chemical Oxygen Demand (COD), is in tens of thousands mg/l. The initial phase of this NAMA focuses on the livestock slaughterhouses and fish processing plants in Kampala, and Kampala, Jinja and Entebbe, respectively. As shown in Table 1, 11 of the 18 factories in Kampala, Jinja and Entebbe release 0.974 million m^3/year (Gumisiriza et al. 2009). The nature of fish processing wastewater suggests that they have high BOD together with inorganic compounds from detergents and disinfectants from the factories. The wastewater if not sufficiently treated lead to lake eutrophication and changes in species composition (Muyodi 2004).

Table 1: Fish processing industries and wastewater generation in Uganda

Number of factories	Urban centre	No. of factories per urban centre	Operating factories	Surveyed factories	Waste water generated m^3/year
18	Entebbe	4	3	3	252,000
	Kampala	6	5	5	423,000
	Jinja	4	3	3	298,800
	Masaka	3	3	0*	na
	Busia	1	1	0*	na

* analysis for the report relied on data for Entebbe, Kampala and Jinja
Source: Gumisiriza et al (2009)

An assessment of the effluent from the fish processing plants found that the wastewater generated was high strength with a total COD of 12,400 mg/l and solid content of 5,580 mg/l (Gumisiriza 2009). The wastewater also contained 61/60 mg/l of lipids and 61 mg/l of protein. The nitrogen content was 20 mg/l, phosphorus 340 mg/l or organic nitrogen and 61 mg/l of ammonia nitrogen.

Table 2: Characteristics of Nile Perch Processing wastewater

Parameter	Magnitude
Ph	6.9 ± 0.9
EC(μ)	1,10 ± 500
Solid content	
Total solid	5,580 ± 790
Volatile solids	95.4 ± 2.5
Suspended solids	4,500 ± 640
Volatile SS (% of SS)	95.6 ± 3.8
Organic content	
Organic carbon (%)	52.5 ± 6.4
Organic nitrogen (mg/l)	340 ± 50
Protein (mg/l)	2,020 ± 290
Total (COD) mg/l	12,400 ± 140
Lipids (mg/l)	6,160 ± 140
Total sugars (mg/l)	0 ± 0
Nutrient level (mg/l)	
Ammonium nitrogen	61 ± 21
Reactive phosphorous	9.2 ± 2.4
Total phosphorous	20 ± 6

Source: Gumisiriza et al. (2009)

For the three main abattoirs that feed the Kampala capital market (Agriterra 2012), the volume of wastewater produced is estimated at 800 m^3/day (Table 3) equivalent to 0.3million m^3/year (Njau et al. 2011; pers. Comm. Kyambadde J. 2013). Whereas only three abattoirs have been included in this study a number of modern slaughter houses have been planned, but so far none of these plans have resulted in an operational modern abattoir. Also, there are a number of facilities where animals are slaughtered at farm, village markets, town slaughter slabs and urban slaughter houses that are not accessible at the time of study (Agriterra 2011). Therefore the NAMA focused on the three slaughter houses.

The estimated average daily throughput of animals was estimated to range between 600-1,000 animals per day, predominantly cattle but also includes goats and sheep. The estimated volume of water use is 400 m^3/day (Mbabazi and Ahmed 2012; Njau et al. 2011; pers. Comm. Kyambadde J. 2013). The major abattoir control about 50% of all slaughterhouse activity with the rest shared out by the two abattoirs. There is considerable activity from abattoirs outside Kampala City whose data has not been documented in available literature.

Table 3: Abattoirs in Kampala City animals throughput & volume of wastewater generated per day

Abattoir	Daily throughput (animals)	Estimated average wastewater capacity
City abattoir Ltd. Kampala	250-300	200 m^3/day
UMI Ltd Kampala	30-100	50 m^3/day
Nsooba slaughter house Ltd Kampala	150-200	150 m^3/day
Total	430-600	400 m^3/day

Adapted from: Agriterra 2012; Njau et al. 2011; pers. Comm. Kyambadde J. 2013

Experimental characteristics for slaughterhouses based on international standards indicate an organic content of 5,817mg/litre of COD, 2,543 mg/litre of BOD and 2,247 mg/litre of TSS (Brazrafshan et al. 2012). The specific estimates for Uganda are characterized based on percentages and therefore an international default has been used until clear estimates can be found.

Table 4: Characteristics of experimental slaughter house wastewater

Parameter	Raw wastewater mean $\pm$ SD
Total COD (mg/l)	5,817 $\pm$ 473
Total BOD	2,543 $\pm$ 363
Total suspended Solids	3,247 $\pm$ 845
pH	7.3 $\pm$ 0.72

Source: Brazrafshan et al. (2012)

2. NATIONAL IMPLEMENTING AGENCY

2.1 Core implementing agencies

The NAMA will be implemented by a several government agencies under the leadership of the Directorate of Water Resources Management (DWRM) of the Ministry of Water and Environment. The other agencies that will be involved are the Department of Fisheries Resources and the Directorate of Animal Resources (DAR) at the Ministry of Agriculture Animal Industry and Fisheries (MAAIF), the National Environment Management Authority (NEMA), and the urban authorities under whose jurisdiction the factories that discharge wastewater are located. The DWRM will provide leadership even where wastewater is discharged into the ground without clear consequences on surface or ground water resources.

2.2 Private sector and public limited companies

The success of the NAMA will rely on participation of companies that discharge wastewater into natural ecosystems. Up to 101 firms hold wastewater discharge permits and many more unregulated discharge wastewater (i.e. without permits). The current regulation is based on waste discharge permit and meeting the set standard for wastewater to be discharged into natural systems. There is no specific requirement that the companies need to use an integrated wastewater treatment process. Therefore the choice of using NAMA technology will be based on whether or not it makes economic or financial sense for companies and the information and awareness created and additional policy incentives accompanying the technology. Therefore, cooperation of private sector will be at the centre of whether or not the NAMA will be implemented.

3. EXPECTED TIMEFRAME FOR IMPLEMENTATION OF NAMA

The wastewater treatment process NAMA is designed to be in line with strategic plans for the public agencies and urban areas. Strategic plans for government agencies and urban areas usually span 10 years. This will allow for increasing the NAMA technology facilities from zero[2] to 50 units over the course of 10 years. The proposed activities are shown in Table 5. The initial phase will work with the 14 facilities (abattoirs and fish factories) whose wastewater discharges are clear and the facilities are willing to participate in the NAMA. The second phase will expand the NAMA technology by another 16 factories to 30 integrated wastewater treatment process units, and then an additional 20 facilities in third phase.

Table 5: Proposed work plan for implementing NAMA

	Timeline in years									
	1	2	3	4	5	6	7	8	9	10
Completion of technical feasibility and financial feasibility studies										
Install wastewater treatment technology infrastructure for initial 14 projects (11 fish factories and 3 slaughterhouses)										
Marketing and sell of emissions reductions										
Marketing and sell of value added products (bio-fertilizer, biogas, and/or electricity, recyclable effluent water)										
Scale-up project from 14 to 30 factories										
Install wastewater treatment technology infrastructure for 16 factories										
Marketing and sell of emissions reductions										
Marketing and sell of value added products (bio-fertilizer, biogas, and/or electricity, recyclable effluent water)										
Scale-up project from 30 to 50 factories										
Install wastewater treatment technology infrastructure for 20 factories										
Marketing and sell of emissions reductions										
Marketing and sell of value added products (bio-fertilizer, biogas, and/or electricity, recyclable effluent water)										
Conduct annual & biennial MRV reporting and monitoring and evaluation										

[2] Although one facility is being piloted at the Kampala City Abattoir under a research study conducted by Makerere University from which the NAMA technology is drawn (Njau et al. 2011)

4. CURRENCY & FULL & INCREMENTAL COST OF IMPLEMENTATION

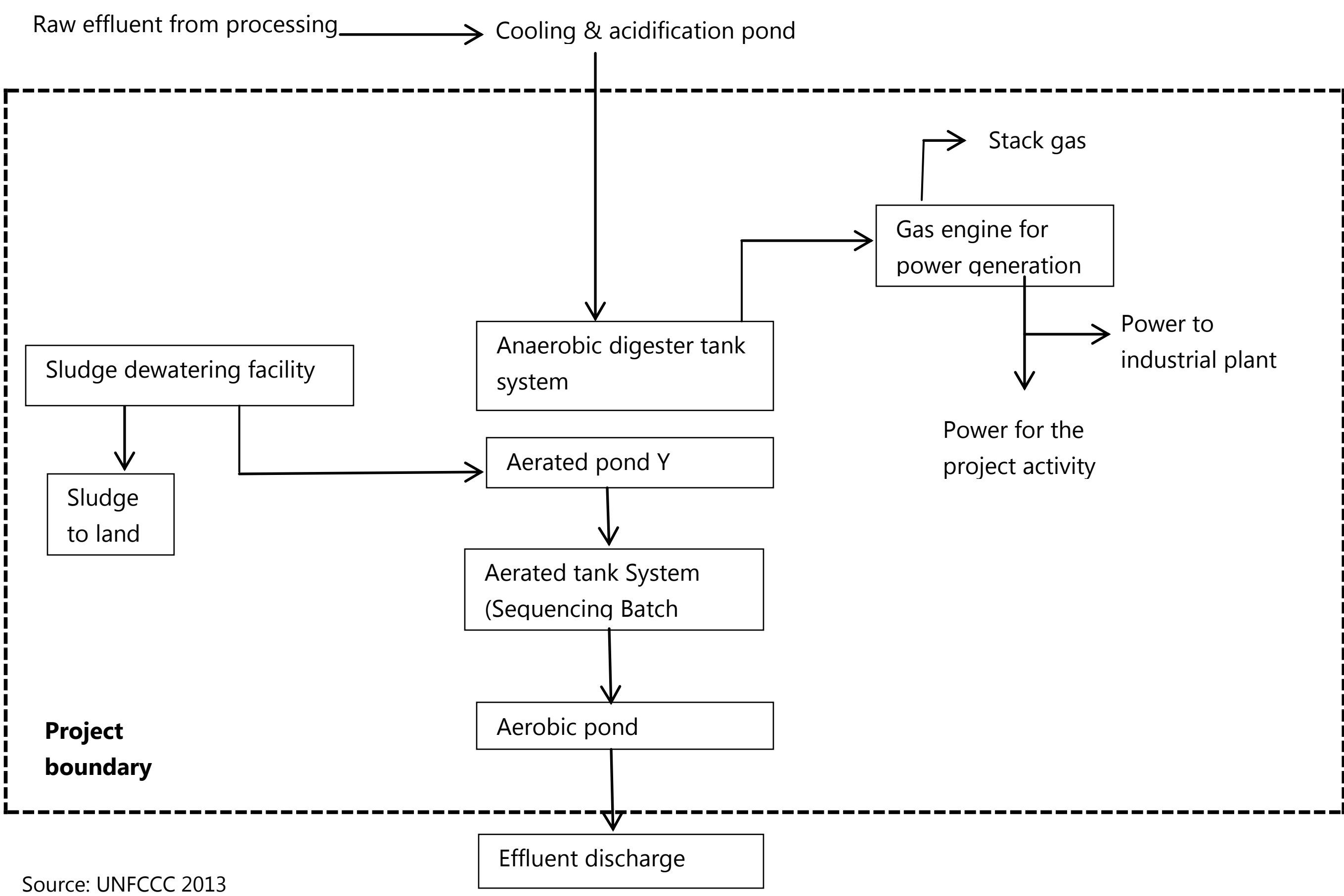
4.1 Used currency

The currency used for making estimates is the United States Dollar ($), while the Ugandan currency is Uganda shillings (UGX). The $ is preferred over the UGX because of the ease of interpretation because of the external support sought for implementing the project. However, because the project has a component for private sector and government agencies who will likely incur costs in both UGX and $, the quoted rate used will be referred to as $1 for UGX 2,500 (BoU [3]2013)

4.2 Estimated cost of implementation of NAMA

The cost of setting up the technology and operational costs were extracted from the proposed process for effluent treatment has been further illustrated (Figure 2) based on a project design document submitted for a methane recovery and utilization system for Kunak Oil Palm Mill in Sabah Malaysia (UNFCCC 2013).

Figure 2: Illustrated Methane recovery and utilization system similar to that proposed for NAMA



Source: UNFCCC 2013

The total cost setting up and operating a single unit of the integrated wastewater treatment facility was estimated at $17.58/m^3 of wastewater treated, while the 10-year present value of investment and

[3] Bank of Uganda (BOU) October 2013 International Exchange Rates for Uganda Shilling, http://www.bou.or.ug

operational costs for the integrated wastewater treatment plant is $44.7/m^3. Therefore the investment and operational costs in first year will be $22.33 million per year for the 14 factories (in Entebbe, Jinja and Kampala). The fixed investment in and installation of equipment at $13.2/m^3 and represent the largest costs (28%). Operational costs including salaries, testing and calibration, repairs and consumables constitute the remaining 72% mostly because they are variable costs incurred over the 10 year timeline. The operational costs could be recoverable if the facilities are operated with value added activities associated with bio-fertilizer and biogas (Njau et al. 2010).

Table 6: Estimated costs for implementing

Parameter	**Value US$/m3 per year**	**Present Value US$/m^3 for a 10 year timeline**
Capital cost inclusive of: engineering, procurement & construction of anaerobic digester system & biogas engines for power generation, plus aerobic digester with SBR	13.2	13.2
Operation & maintenance costs:		
Salary & Administration	1.02	10.2
Monitoring, testing and calibration	1.02	6.85
Parts & repair	1.02	7.58
Consumables	1.32	9.61
Total technology costs	**17.58**	**47.44**
Estimated MRV costs		
MRV costs (10% of technology cost)	1.76	5.73
Feasibility studies, information & awareness (5% of cost)	0.88	0.88
Sub-total	**2.64**	**6.61**

Source: UNFCCC 2013; Kyambadde (Makerere University Dept. Biochemistry) pers. Comm. (2013)

The cost for conducting feasibility studies and MRV costs are calculated as a percentage of the technology investment and operational costs. These estimated are done on the basis of discussions with contractors engaged in installation of similar technologies, as well as the Climate Change Unit (CCU) of the Ministry of Water and Environment (MWE). About 10% of the value of the technology would be estimated cost of implementing routine MRVs, while 5% of the cost of the technology would go to feasibility studies, present value of $2.64/m^3 in the first year and $6.61/m^3 over the ten year period. The viability of the technology investments should show that facilities can recover their investment and operational costs if they are to use this technology. Therefore, the external investment support needed should go towards conducting feasibility studies and implementing MRV; that is $6.61/m^3. This cost will be revised upwards as the technology is scaled-up to include more factories and facilities.

4.3 Incremental cost of implementation

The incremental cost of implementation will be determined by the volume of the wastewater that is treated by the technology. The estimates in Table 6 above are based on estimates conducted for 11 fish factories and three livestock slaughterhouses where the annual volume of wastewater was estimated at 1.27 millionm^3 (See Tables 7). Since the estimates are based on the volume of wastewater handled, there will differences in the viability of different factories. The viability of technology for different facilities will be based on the potential emissions reductions that can be achieved as well as volume of bio-fertilizer and biogas that can potential be produced and used in subsequent generation of electricity or direct use for lighting and cooking. Therefore, the feasibility (and viability) of establishing the integrated wastewater treatment facility will be a pre-requisite for factories and facilities that will be part of the NAMA.

6. SUPPORT REQUIRED TO IMPLEMENT THE MITIGATION ACTION

6.1 Financial support

There are three areas of financial support for implementing the NAMA. The first is to support the regulatory and national implementing agencies to undertake MRV actions as well as build capacity including hiring and maintaining staff to undertake information and awareness and MRV actions. The target agencies are the Directorate for Water Resources Management (DWRM), National Environment Management Authority (NEMA) and the Climate Change Unit (CCU) in the Ministry of Water and Environment, as well as urban authorities where the factories are located. The other agencies are Department of Fisheries Resources, Directorate of Animal Resources in the Ministry of Agriculture Animal Industry and Fisheries.

Therefore for the purposes of MRV a financial support of $7.3 million would be required

Table 7 above showed the required investment in the technology and operational costs. It is believed that the technology can financially viable if the appropriate actions are undertaken first to choose the appropriate size of installation need and to create a value chain that utilizes the by-products of the wastewater treatment process. Nonetheless, the initial investment at the scale of $17.6/m^3$ for the 14 factories that release 1.27 million m^3 of waste water is $22.33 million in the first year. This is equivalent to an average investment of $1.3million per facility in the first year and annual operational costs of about $200,000 for the next nine years. For many facilities the initial investment may be slightly higher than their available investment budget for a waste treatment facility even though the resources can be recovered. Whereas large companies such as East African/Uganda breweries (EABL/UBL) invested as much as $2.4 million in setting up wastewater treatment plant, with similar investments by Nile Breweries and Century Bottling Company (coca cola), many other industry players do not have adequate resources to make upfront investments in wastewater treatment. Through consultations, however, for a pilot facility set up at Kampala City abattoir, some private stakeholders can meet up to 50% of the proposed $1.3 million if they can be supported with accredit facility to cover the remaining 50% of the investment. The investors would then be willing to repay the credit extended over a 10 year period. A further consideration is that the credit facility may only be feasible with a 6% annual rate of interest (UNFCCC 2013).

Therefore for the first 16 pilot facilities (one pilot facility has already been set up) a credit facility of $10.52 million would be required.

The third area is addressed under Technological support.

6.2 Technological Support

In order to scaling-up technology to reach factories and facilities that discharge large volumes of wastewater, including the pilot 14 facilities, feasibility studies, viability assessment as well as investment in building technological support and installation capacity will be required. The present facility set-up by Makerere University at Kampala City Abattoir has shown the need for investment in supporting the technology team to train technicians to install equipment as well as produce several units of the technology for use by the increasing number of factories.

Specific technological support will also needed by the implementing public agencies, as well as Makerere University to training officers in charge of monitoring, reporting and verification. The support will extend to equipment for recording data and database systems, as well as information technology network for sharing information and analyses within themselves as well as with the UNFCCC NAMA Registry and potential supporters to the NAMA.

The proposed financial support required for this component is $1.12 million for the first 14 units. The cost would increase as more facilities are added. The economies of scale of having many facilities participate in this process means that if the budget proposed were doubled to $2.24 million it would be adequate for up to 50 facilities envisaged over the 10-years of the NAMA.

6.3 Capacity Building

The capacity building support proposed is in five key areas, listed as follows:

(i) Establishing appropriate institutional arrangements linking public actors and private sector, based on current regulatory arrangements to ensure that an adequate volume of emissions reductions, sustainable development and other co-benefits are achieved.
(ii) Capacity for undertaking feasibility and viability studies, these may be through identifying national and international experts to support government agencies and private sector.
(iii) Capacity building in the use of the proposed technology as well as accompanying equipment for monitoring and reporting purposes.
(iv) Capacity building for setting up monitoring, reporting and verification facilities especially for the implementing government agencies. These include data bases and analytical and reporting approaches.
(v) Support in establishing financing mechanisms and governance structures within existing financial arrangements of government and private sector.

7. OUTCOMES OF NAMAS

7.1 Estimated Emission Reductions

Total methane emissions from the fish factories and slaughterhouses wastewater was estimated based on formulars developed from the 2006 IPCC Guidelines for National Inventories (IPCC 2006). The formula is illustrated as follows (See Attachment I for details):

Total CH_4 Emissions (WM) = $\sum_i(TOW_i \times EF_i - MR_i)$

Where:
WM = total CH4 emissions from wastewater in kg CH4/yr
TOW = organic waste for wastewater type in a year, kgBOD/yr (domestic) & kgCOD/yr (industrial stream)
EFi = emission factor for wastewater type in kgCH4/y/kgDC
MRi =total amount of methane recovered or flared for wastewater type in kg CH4. (default value =0)

The total methane emissions, from agro-process wastewater treatment estimated at 14,358 tCO_2e/year for effluent from 11 fish factories and three abattoirs in Kampala City (Table 7). About of the 88% of the emissions calculated were for effluent from fish factories given the large volumes of wastewater produced. The volume of wastewater for abattoirs will increase considerably when additional activities outside Kampala city have been included, during up-scaling phases. Up to 98% of methane emissions generated during waste treatment can be captured at the anaerobic stage of the integrated wastewater treatment process (Yi et al. 2009). Therefore, emissions reductions proposed are achievable with the available technology and mitigation actions.

From current emissions up to 98% emissions reductions can be achieved with the integrated wastewater treatment process (Yi et al. 2009). Therefore, under the business as usual scenario all the emissions indicated in Table 7 are released to the atmosphere, Under the NAMA scenario up to 98% emissions reductions are achieved.

Table 7: Estimated methane emissions from waste water in tonnes of carbon dioxide equivalent

Source of emissions	Volume of wastewater (million m^3/year)	Methane emissions (tonnes/ year)	Methane emissions in tCO_2e/year
Fish factories	0.97	600.85	12,618
abattoirs	0.30	82.85	1,740
Total	**1.27**	**683.7**	**14,358**

The 14 factories mentioned in this report do not represent the major wastewater discharging facilities. Many of these facilities such as breweries and beverage companies, tanning factories, flower firms and sugar processing companies have not been considered yet due to the lack of data. The 14 facilities represent a very small component of potential emissions reductions that can be achieved from the sector. It is envisaged that the scaling-up process will cover the larger wastewater discharging facilities as well.

Indicators of Implementation

Since 2010, the MWE-DWRM waste water discharged monitoring comprises three vital parameters, i.e. Total Suspended Solids (TSS), five-day Biological Oxygen Demand (BODs) and Chemical Oxygen Demand (COD). Therefore, the key indicators that will lead to the estimation of greenhouse gas emissions are:

- Tons of methane emissions reductions achieved calculated based on
- The Biological Oxygen Demand (BODs); and
- Chemical Oxygen Demand (COD) of the wastewater as influent as well as effluent from the wastewater treatment facility
- Percentage of methane gas capture as biogas and fully utilized or converted (carbon dioxide and water)

Other indicators include:

- Number of facilities that have set up the integrated wastewater treatment process;
- Number of facilities that have integrated a component of GHG emissions reductions in their wastewater treatment facility;
- Amount of electricity generated from biogas and/or quantity of lighting units and cooking units using captured biogas (measured in terms of magnitude of alternative displaced);
- Volume of bio-fertilizer generated and value generated in the market; and
- Volume of treated wastewater re-used and value saved per facility.

7.2 Other relevant information, Local Sustainable Development

WasteWater from Kampala City, especially via the Nakivubo Channel, is the most important cause of pollution to the Murchison Bay area of L. Victoria, the main abstraction point for water used for Kampala City and much of central Uganda. Other areas surrounding L. Victoria have reported similar pollution. The main contaminations are organic substances from agro-industry, sewerage and storm flow. A major concern, alongside pollution, destruction of biodiversity, in the lake, is the high levels of GHG released from the waste water. Whereas specific estimates are unknown, globally wastewater contributes 3% to GHG emissions. In the case of Uganda, waste water GHG mitigation technology would have considerable leverage in reducing GHG emissions, minimising a major pollution problem, and reducing pressure on L. Victoria and its biodiversity while also saving the livelihoods of over one million Ugandans dependent on L. Victoria. Concern over pollution in L. Victoria extends from local and national concerns to the regional and international levels. They are under consideration at the Lake Victoria Basin Commission (for the countries in the L. Victoria basin), the East African community and the Nile Basin, and Lake Victoria Environment Management Programme. The potential for improving livelihoods of fisher folk, renewable energy, production of bio fertilisers from the bioslurry and safeguarding the lake represent sustainable development benefits in line with the National Development Plan where agriculture and agro-industry are primary drivers of the economy

Therefore, the NAMA will seek, as part of the monitoring process, to establish contribution to reduction of pollution load on water systems in Uganda, especially the L. Victoria basin. The assessments will be made based on monitoring of wastewater discharge points, for agro-process industry associated with project. The proposed outcome is a reduction in pollution load, from agro-processing factories, on surface water systems in Uganda, especially the L. Victoria basin.

8. LINKS TO NATIONAL POLICIES AND OTHER NAMAS

NAMAs submitted to the registry may have been formulated in the context of other initiatives, such as national or sectoral policies or programs. These links should be made explicit.

8.1 Relevant National Policies

Guidance for management for use as well as the legal and regulatory framework for water resources and wastewater management fall under several regulations policies and laws, outlined below. Leadership over management of water resources falls under the Ministry of Water and Environment (MWE) Directorate of Water Resources Management (DWRM). However, regulatory support is also drawn from the National Environment Management Authority (NEMA) and other sector laws, policies and regulaitons as delineated below.

The key Regulations include:
The legal framework for control water depletion and pollution as well as mitigation of climate change impacts under the Water Act, Cap 152, as well as the National Environment Act Cap 153, comprise the following regulations:

The Water (waste discharge) regulations S.I. 152-4
The Water Resources Regulations, No. 33/1998
The National Environment (Waste Management) Regulations of 1999
The National Environment (Standards for Discharge of Effluent into Water or on Land) Regulations 1999,
Under the National Environment Act, key regulations include:
The Environmental Impact Assessment Regulations 1998;

Policies for Key policy documents include:
The National Water Policy 1999
The National Environment Management Policy, 1994
The National Trade Policy, 2006
The National Health Policy, 1999
National Policy on Injection Safety and Health Care Waste Management, 2004
National Oil and Gas Policy, 2008
The Environment Health Policy
The National Wetland Policy
The National Fisheries Policy, 2004

The laws include:
The Constitution of the Republic of Uganda
The National Environment Act Cap 153,
The Water Act Cap 152
The Local Government Act Cap 243
The Public Health Act, Cap. 281
The Agricultural Chemicals (Control) Act, No.1 of 2006

9. ATTACHMENTS

Attachment 1: Methodology for CH_4 emissions from Industrial wastewater treatment

	Total CH_4 Emissions (WM) = $\sum_i(TOW_i \times EF_i - MR_i)$ Where: WM = total CH4 emissions from wastewater in kg CH4/yr TOW = total organic waste for wastewater type in a year, kg BOD/yr (domestic) and kgCOD/yr (industrial stream) EFi = emission factor for wastewater type in kgCH4/y/kgDC MRi =total amount of methane recovered or flared for wastewater type in kg CH4.(default value =0) TOW_{ind} (kg COD/yr) = W x O x D_{ind} x (I –DS_{ind}) Where : TOW_{ind} = total industrial organic wastewater in kg COD/yr W = wastewater consumed in m^3/tonne of product O = total output by industry in tonnes/yr D_{ind} = industrial degradable organic component in kg COD/m^3 wastewater DS_{ind} = fraction industrial degradable organic component removed as sludge (default value)
	EF_i = B_o x (WS-MCF) Where: EF_i = Emission factor (kg CH_4/kg DC) for the wastewater type B_o = maximum methane producing capacity (kg CH_4/kg DC) for wastewater type (default value = 0.25 kg CH_4/kg DC WS = fraction of wastewater treated using the wastewater handling method MCF =methane conversion factor for each wastewater system (default =0.8)
	IPCC 2006
	Methods because of data gaps and low level of certainty in data. Default parameters used as advised by IPCC 1996

Attachment II: Institutions

Ministry of Water and Environment
Permanent Secretary: Mr. David O. O. Obong

Directorate of Water Resources Management
Contacts: Dr. Callist Tindimugaya

Climate Change Unit
Contacts: Mr. Paul Isabirye, Mr. Chebet Maikut

National Environment Management Authority
Contacts: Dr. Tom Okia Okurut; Ms. Christine Akello; Mr. Ronald Kaggwa

Ministry of Agriculture Animal Industry and Fisheries
Directorate of Animal Resources
Director Animal Resources: Dr. Nicholas Kauta

Directorate of Crop Resources
Director Crop Resources - Mr. Okaasai Opolot

Department of Fisheries Resources
Acting Commissioner - Lovelock Wadanya

UNDP
Low-Emissions Capacity Building Project
Project Manager – Ms. Martha Bbossa

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