PROGRAMME DESIGN DOCUMENT FORM FOR
SMALL-SCALE CDM PROGRAMMES OF ACTIVITIES (F-CDM-SSC-PoA-DD)
Version 02.0

PROGRAMME OF ACTIVITIES DESIGN DOCUMENT (PoA-DD)

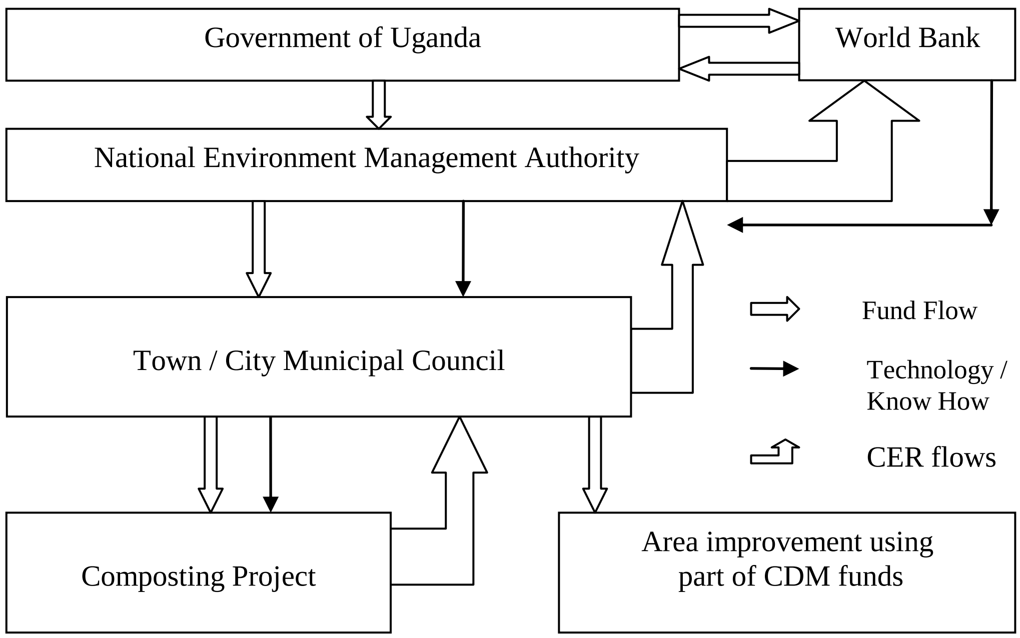
PART I. Programme of activities (PoA)

SECTION A. General description of PoA
A.1. Title of the PoA

Uganda Municipal Waste Compost Programme.
Version 1.8
Date : ~~2009-06-24~~ 12/05/2014

A.2. Purpose and general description of the PoA

Uganda has 75 urban centres as per 2002 Census (Uganda Population and Housing Census 2002). Urban population has been increasing at over 3.8 % per annum in Uganda. As per Census, 2002 2.9 million people live in towns and municipalities accounting for 12 % of the total population. One of the significant environmental concerns of the growing urban areas has been the management of municipal solid wastes (MSW). So far as disposal of MSW is concerned, the common practice in Uganda is to dispose the wastes in landfills (controlled dumpsites). Many of the landfills/Controlled dump sites are located adjacent to wetlands. The wetlands thus get contaminated by the leachate generated from the landfills due to heavy rainfalls. These landfills also generate and emit significant amount of methane to the atmosphere. It is proposed to recover the organic matter from municipal solid waste as compost and avoid methane emission through a "Municipal Waste Compost Programme" with the support of CDM. As multiple towns and cities are expected to participate in this programme, a Programme of Activity CDM is being proposed. The goal of the program is to avoid methane emissions from Municipal waste landfills by undertaking composting of the wastes and using the organic matter in wastes as humus for soil conditioning and plant growth. The Operating and implementing framework for the Programme is depicted in the flowchart below:



The Government of Uganda has taken a Loan from the World Bank under the "Environment Management and Capacity Building Project-II" and intends to use part of this loan to improve municipal solid waste management in cities and municipalities through the proposed municipal waste compost program. The program aims to promote composting as an alternative means of solid waste processing and disposal in Uganda.

The National Environment Management Authority (NEMA) is the nodal agency which would support the municipalities in setting up of composting facilities, providing of the technical know how and monitoring the implementation and operation of the individual compost plants. Municipal waste composting is a new concept in Uganda and the World Bank is supporting the transfer of appropriate technology through NEMA. Extensive work has already been carried out including the planning and detailed design of the composting facilities. NEMA would provide technical and financial support to the municipalities to set up and operate the facilities. The municipalities would either set up and operate the facilities themselves through their own staff or contract it out to the private sector. The facilities would sustain on the revenues generated from sale of compost and the revenues generated from the sale of emission reductions.

The Composting projects would be implemented by the individual municipalities. Each of these compost projects is considered a CDM Programme Activity (CPA). The Municipalities would transfer their CER rights to the NEMA in lieu of the investments received for the CPA. The NEMA would sell the CERs to the Community Development Carbon Fund (CDCF) of the World Bank. The co-operation agreement signed between the municipalities and NEMA would have provisions for sharing of financial benefits accruing from the sale of emission reductions. The NEMA would be the Coordinating/Managing Entity (C/ME)1 for all the CPAs under the Programme of Activities (POA).

At present the technical requirement as well as the common practice for municipal solid waste disposal in Uganda is landfills, and there are no specific requirements for capturing and flaring the landfill gas from landfills. As a result, significant amount of methane is emitted to the atmosphere. Methane emissions to the atmosphere from the landfills will be avoided through implementation of the waste composting program. Organic matters from the waste will be recovered through composting. The entire program is voluntary in nature both for NEMA and the municipalities, as there are no specific regulations that mandate waste composting as the only means of solid waste disposal in the country.

A.3. CMEs and participants of PoA

National Environmental Management Authority (NEMA) would be the Coordinating/Managing Entity (C/ME)[1] for the CPAs under this Programme of Activity (POA).

The C/ME shall be a project participant authorized by all participating host country DNAs involved and identified in the modalities of communication as the entity which communicates with the Executive Board, including on matters relating to the distribution of CERs.

A.4. Party(ies)

Name of Party involved (host) indicates a host Party	Private and/or public entity(ies) project participants (as applicable)	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Government of Netherlands	International Bank for Reconstruction and Development as the Trustee of the Community Development Carbon Fund (CDCF) (Multilateral Fund)	Yes
Government of Uganda	National Environmental Management Authority (Public Entity)	No

A.5. Physical/ Geographical boundary of the PoA

The Programme of activities would be implemented in several urban local bodies of Uganda. Uganda is located in Africa and is a landlocked country with borders with Kenya, Sudan, Rwanda and Tanzania. The Map of Africa showing location of Uganda and a map of Uganda showing the municipalities where the program of activities would be implemented in the initial phase are provided below.

The urban local bodies are spread across Uganda and the locations of the major ones on the Uganda Map are shown below. The boundaries of the Programme of Activity would be national boundaries of Uganda. This is because the proposed program of activity deals with waste management, which is governed by the same set of rules and regulations for the whole country. The location would be within the existing 56

districts of the country or any new districts that may be constituted in future. The urban area shall be classified as a town council, urban local body or city.

A.6. Technologies/measures

Solid waste management, an important responsibility of the town/municipal councils in Uganda, is increasingly becoming a major concern across all the urban local authorities. At present there is no municipal waste composting activity in practice in the country. This PoA would support the

municipalities to set up such facilities. The Programme would also generate local employment and help the country develop in an environmentally friendly and sustainable way.

The urban areas of the country typically have three divisions: a well developed town centre, an agro processing industrial area and an area with predominantly rural character. The waste being disposed per capita for the towns as a whole has been assessed at about 0.4 to 0.9 kg [2]. The actual per capita waste generation is higher in designated urban areas which have rural character, as agriculture wastes such as banana stems are also disposed off in municipal waste systems. Many of the waste components like paper, cloth etc. are recycled and disposed off to private channels directly from the home. The major waste reaching the collection system is organic in nature. Banana locally called *matooke* is a staple diet and leads to a large waste generation from the unused parts like stem and skin. The inorganics include sand, silt, ash, glass, metal and plastic. The waste is disposed at the partially managed dumpsites which are typically about 5-10 m deep. The National Environment Management Authority has prescribed that waste in the landfills should be covered and this is being put into practice. The National Environment Management Authority prescribes controlled tipping of waste with soil cover as the minimum standard for waste disposal.

The aerobic composting process produces a saleable compost product from a waste material that would otherwise have been placed in a landfill and generated large quantities of methane and other noxious gases, as well as leachate that seeps into and pollutes ground and surface waters at the landfill sites.

In Uganda the town/ municipal councils are taking efforts to collect the waste generated and transport it to identified waste disposal sites. Uganda being an agrarian and less developed country over 80 % of the waste is organic in nature. This programme would support setting up of composting plants (CPAs) in the municipalities to undertake aerobic composting of the waste to stabilize the waste and minimize local pollution and completely eliminate the production of methane. The reduction in methane generation proposed in this Programme qualifies for generation of certified emission reductions. Each of the town / municipal council may handle from about 50 T of waste per day up to 200 tons of waste per day with typical number being about 70 tons per day. Typical waste handled per annum would be about 25550 tons per annum. About 5000 tons of compost would be generated per annum resulting in average of 8370 ton of emission reduction per year for the first 7 year crediting period.

A.7. Public funding of PoA

The Program of Activity will be partly financed through the IDA Credit to Uganda for the project “Environment Management and Capacity Building Project-II”. The DOE will be provided with the evidence that the same IDA money is not being used for purchasing emission reductions.

SECTION B. Demonstration of additionality and development of eligibility criteria

B.1. Demonstration of additionality for PoA

The present practice for municipal waste disposal in Uganda is controlled tip type landfills. The typical landfills have a depth of 5-10 m. In larger cities these are deeper. Further with regard to the landfills, there are no specific requirements pertaining to capturing and flaring of landfill gas (LFG). Composting of solid waste is new to Uganda. It is evident from the fact that Uganda does not have any composting plants that use municipal solid waste as the input.. There is also no regulation that requires the municipalities to follow composting as the only option for processing the municipal solid wastes. The Municipalities are not obligated to set up composting plants. The proposed PoA, which lays down a framework for promoting composting of MSW in several municipalities is a voluntary action.

[2] Page 9, Study on solid waste management options in Africa, African Development Bank, July 2002.

The technology (for solid waste composting) is new for the country. Uganda has significant agriculture diversity. Although the soils have generally been rich in organic matter, in recent times the need for adding organic matter to soils is being observed. Acceptability of the municipal waste compost has not been tested and the market for the same is uncertain. The municipalities of Uganda are extremely resource constrained and most of their budgets are not funded through local taxes but funded by the state. There are very limited funds to undertake upgradation of the solid waste facilities. Solid waste composting is thus not and would not become a natural choice for the municipalities in Uganda.

Assessment and demonstration of additionality of a typical CPA

The latest version of the "Tool for the demonstration and assessment of additionality" (Version 05.2) is used to demonstrate the additionality of a typical CPA.

Step 1. Identification of alternatives to the Programme activity consistent with current laws and Regulations

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

The CDM Programme activity involves composting of municipal solid waste. The following were initially considered as possible alternatives to composting wastes in Uganda.

1. The Programme activity, composting, not implemented as a CDM Programme;
2. Disposal of the waste at a landfill where landfill gas captured is flared;
3. Biomethanation of the waste and use of the methane for heat or electricity.
4. Disposal of the waste on a landfill without the capture of landfill gas (business as usual).

Some of above options, particularly options 2 and 3, are either not considered technically feasible in the context of Uganda or are technologically advanced and expensive to be able to be absorbed realistically by the municipalities in Uganda, and were thus eliminated without any further evaluation.

Alternative 2, although considered initially, was dropped from further evaluation on the ground that most of the municipalities in Uganda are small in size and would not justify investments for landfill gas collection and flaring, particularly as this is not a requirement in Uganda.

Similarly, Alternative 3 involving bio-methanation was initially considered as one of the options due to the high organic content of wastes in Uganda. Biomethanation of municipal waste is a new technology, very costly with the initial investment costs at 3-5 times the composting alternative. The local technological competence required to absorb the technology is also very high. The municipalities where these Programmes have to be adopted do not have the ability to absorb this investment or high technology and the alternative is not considered feasible. Alternative 3 was therefore dropped from further consideration.

The report on "Promoting Solid Waste Composting in Uganda", which forms the basis of developing this PoA, examined various other options for disposing solid wastes in Uganda. The report refers to the study "Solid Waste Management Options for Africa" by African Development Bank and concludes that alternatives 2 and 3 defined above are not viable for the municipalities in Uganda. (refer to section 2.3 of the report). Therefore these options have not been considered for further evaluation in the PDD.

Thus the plausible alternatives that were considered for further evaluation are:

Alternative 1: The Programme activity, composting, not implemented as a CDM Programme;

Alternative 4: Disposal of the waste on a landfill without the capture of landfill gas (Continuation of current practice)

Sub-Step 1b. Consistency with mandatory laws and regulations

The two plausible alternatives defined in the Sub-Step 1a, which merited further consideration are fully consistent with the mandatory laws and regulations of Uganda. Thus the two options have been subject to both investment analysis and barrier analysis to demonstrate the additionality of the Programme activity. The same analyses would be used to justify the additionality of each CPA.

Step – 2

Investment analysis

Sub-Step 2a : Determine appropriate analysis method

Production of compost using solid waste as the input raw material is presently not being practised in Uganda. Although there is potential for sale of municipal compost in Uganda, the program is designed with expectation that the compost market would develop as the program gets implemented. To this effect, additional budgetary and financial provisions are being made for the implementation of the program. The Investment Comparison Analysis is used to compare the alternatives.

Sub Step – 2b : Investment Comparison Analysis

The Net Present Value (NPV) of the investments is chosen as the relevant financial indicator for comparing the two options. This is done as the present practice of landfilling operation has only costs while the composting operations have both costs and revenues. The financial analysis (carried out for a typical operation involving 70 TPD of wastes) shows that the current practice of disposing wastes in the landfills is the least cost alternative. Without the CDM revenues, the composting operations have a negative return and composting becomes viable only with the CDM revenues.

	Option Considered		
	Continuation of Current Practice	Composting without CDM	Composting with CDM
Description of the Options	Disposal of MSW at Landfills/Controlled Dump Sites without LFG Capture and Flare	Processing of waste in the compost plant followed by landfilling of rejects without considering the CDM benefits	Processing of waste in the compost plant followed by landfilling of rejects considering the CDM benefits
Quantity of waste handled (TPD)	70	70	70
Capital Investments (US$)	-	421,344	421,344
Operating Costs	16,004	47,525	47,525

(US$/Year)			
NPV (US$)	- 237,529	-$433,835	$787,634

A typical CPA is thus proved to be additional based on the investment analysis. It is also established that investment in a compost plant can yield positive returns only with carbon revenues. A summary of the key assumptions pertaining to the investment analysis of the composting option are presented below.

Capital Investment for Composting: A total investment of US$ 421,344 is assumed for a 70 TPD compost plant in the financial analysis. This assumption matches closely with the capital investments estimates contained in the document "Promoting Solid Waste Composting in Uganda", which forms the basis of this Program. The average capital investment for a typical 70 TPD plant is mentioned to be US$ 440,722 in the program document. It is further assumed that the vehicles and equipments will depreciate completely over a period of 7 years. Therefore, new investments in equipments have been considered in the 8th year of operation of the plant. The justification for assuming the above depreciation and the need for re-investment in equipments is provided below.

The depreciation rates for vehicles & earthmoving equipment is 35% (Schedule 6) on written down method, as per the provisions of the Income Tax Rules in Uganda. The residual values of the earth moving equipments (similar in nature to the equipment used in the project) after the end of 7 years turns out to be 2.63 % of initial asset value when the above depreciation rate is applied. However a residual value of zero after the end of 7 years is considered in the financial analysis, taking into account some specific aspects of the activity of collecting and composting of municipal solid waste involving higher wear and tear of the equipments as further described below.

- The collection of municipal solid waste is a demanding activity for the engines of vehicles involving continuous start-stop cycles due to the characteristics of the urban collection.
- One of the main problems in composting and waste handling machinery is the inevitable erosion of its components and parts due to their exposure in any type of work, specific environmental conditions and in constant contact with all kinds of materials. The frequent wear of diverse pieces entails a significant reduction in equipment life.
- Solid wastes in developing countries like Uganda contain a high amount of present organic matter, and are constantly under degradation resulting in various forms of leachate and acids that affect the equipments
- Life of the equipments also depends heavily on how they are used. The construction industry is a traditional industry and skilled operators are already available who are fully familiar with operating procedures of earth moving operations compared to composting operations, where getting skilled operators is expected to remain a challenge , as it is anew activity that is being introduced in Ugandan intensive operation plan, involving maximum usage of the available equipments, has been designed by the Project Participant for vehicles and equipment, which would reduce the useful life of the equipments. Calculations for few equipments are presented below for demonstration purpose, as described below:

Equipment	**Number**	**Use pattern**	**Situation after 7 years**
Tractor with Front end loader and attachments	1	8 hours/day x 365 days x 7 years	20,440 working hours

Waste Sieving	3	4 hours/day x 365 days x 7 years	10,220 working hours
Truck (Transport of waste)	1	17 trips/day x 15* km/trips x 365 days x 7 years	651,525 km
Truck (Transport of compost)	1	2 trips/day x 100 km/trips x 365 days x 7 years	511,000 km

*Average distance to plants.

Taking into consideration the conditions of use of such equipment (climatological constraints, intensive use, conditions of infrastructures, etc) it can be concluded that the estimated residual value of zero is appropriate in attention of the situation at the end of defined period of useful life.
In addition to the above arguments, the impact of 2.63% residual value of equipments after the end of 7 years has been studied to be small and negligible in the financial analysis. In the hypothetical case of extending the useful life of equipment to 15 years (which is unrealistic), NPV would change from USD -433.855 to USD -345.520.

Production of Compost : The production of compost is taken at 22 % of the waste handled to estimate the quantity of compost which can be sold potentially. This is a conservative estimate as international experience shows that compost production is in the range of about 15 -22 %.

Price of Compost : The price of compost in the first year is taken at Ush 23400 (USD 13 /ton) based on the affordability of the market segment and observed market price of farmyard manure locally. An annual increase of 5 % is considered. As there is no organized market for compost in Uganda, the price of sewage sludge, which is sold and used for the same purpose as what compost would be used for, has been taken as the proxy. As there is no organized market for compost in Uganda, Compost Selling price has been assumed at 13 USD/MT based on the invoices of "sewage sludge" taken as a proxy. In the absence of any organized compost market in Uganda, assuming the price of sewage sludge for compost is considered suitable and reasonable on the following grounds:

- Both products have similar agronomic characteristics, although international experience and published reports indicate that those aspects such as degree of stabilization and granulometry, predictability of the nutrient content and productivity make the sludge option clearly preferred in the market (further explained below).
- The production cycles with low levels of technological intensity, are similar in both products.
- In both cases the raw materials are waste products, and strongly linked to local production and acceptance.

The conservativeness of the price assumption is established by (i) comparing the quality of both the products, (ii) referring to price of compost in other countries in Africa as available in published reports, and (iii) analyzing the farmers' affordability and willingness to pay based on published data from various sources.

Published study[3]: on comparison of productivity arising from application of refuse compost and activated sludge indicates that application of refuse compost leads to lower productivity compared to sludge. Due to the variability of the composition of the input municipal solid waste, the predictability of nutrient

[3] "Comparison of refuse compost and activated sludge for growing vegetables ".M. H. Wong, C. M. Mok and L. M. Chu, Department of Biology, The Chinese University of Hong Kong, Shatin, Hong Kong)

content in refuse compost is expected to be lower than the nutrient content in sludge. Published reports[4] indicate that the predictability of nutrient content of yard waste compost is much lower than the nutrient content of sludge. Given the fact that yard waste has more uniform characteristics than municipal solid waste, predictability of nutrient content of refuse waste can be expected to be even lower than sludge.

A study[5] carried out on the sustainability aspects of municipal solid waste composting in South Africa, reports a price of 4U$D 10-22 per Tone of compost. This report confirmed that, based on the volumes and prices of compost and the operational costs, when sold in bags, compost gave incomes that covered the production costs, but not when sold in bulk, it rendered a lower price. However, it is important to emphasize that South Africa has different socio-economic profile than Uganda, and the market conditions are not exactly the same.

The willingness to pay for compost among the Ugandan Farmers, is analysed based on the information provided in the paper titled "*Economic viability of fertilizer use in Uganda's agriculture*"[6] .The paper examined the viability of fertilizer use in Uganda, using the 2005/06 Uganda National Household Survey data, providing some useful information about the market and the potential willingness to pay of the farmers. According to this article, taking all the sample farmers into consideration, average expenditure on fertilizer was only UGX 700 per hectare (U$D 0.38 per hectare), which was much less than their average expenditure on seed, hired labour or traction power. If a conservative compost use pattern of 5-15 tn/hectare, and a price of U$D 13 per tone are applied, the result is that the cost is between U$D 65-195 per hectare, what means that the price estimate is a conservative value, which is situated in a high-margin in relation to the Ugandan prototype farmer willingness to pay.

Sale of Compost : It is assumed that 30 % of the compost production would be sold from the first year of operation and this would increase annually by 10 % till about 80 % of the compost production is sold. Low sale of compost in the initial years is used in light of the market barriers that compost faces in the developing countries like Uganda. The main uses of compost and market segments are Agriculture and Gardening. Marketing of compost produced from MSW will be a key challenge. This problem is further aggravated by the perception of general public that compost produced from waste is dirty and problematic. More justification for the reasonableness of this assumption is provided below.

The main uses of compost and market segments are Agriculture and Gardening. Some structural aspects in Uganda (and other markets), imply marketing of compost produced from MSW will be a key challenge since currently there is not a market for this product in Uganda. This problem is further aggravated by the perception of general public that the compost produced from waste is dirty and problematic and thus prefers the chemical fertilizers or other alternative products, such as manure or sludge. For example, a majority of existing compost plants in India are facing problems in marketing of compost, which is detailed in document "*Report of the Inter Ministerial task force on Integrated plant Nutrient Management*" (Indian Government)[7] .

Similar experiences are also observed in Africa as documented in the report prepared by the African Development Bank[8].

Common problems in the market for compost

[4] Reference : "Comparing yard waste and sludge compost", by Henry, Charles L., Harrison, Robert B. Publisher
[5] Composting of Municipal Waste in South Africa- sustainability aspects", by Lotten Ekelund and Kristina Nystrom
[6] http://mpra.ub.uni-muenchen.de/19428/
[7] www.bhavanibio.in/Main%20Report%20on%20IPNM.doc
[8] "Solid Waste Management Options for Africa" by African Development Bank

- Less than 10 % of the farmers use fertlizers in Uganda. There is a significant promotion required for promoting use of fertilizer. Use of organic fertilizer is negligible. Considering this a low initial penetration of sale is realistic.
- The compost has a high degree of dispersion on the qualities and confusion regarding technical specifications.
- Lack of information on the materials from which it comes.
- Presence of undesirable substances or products, for example seeds, which constitutes a significant disadvantage for the massive use of compost in industrial plantations such as coffee and tea plantations.
- Because of the lack of characterization of the products and the confusion of qualities and controls, the prices are hardly comparable.

Constraints in the Uganda's agricultural sector: (source PMA[9])

- Very low proportion of farmers (10.2%) having technology awareness.
- Very low access to agricultural inputs (Only 10% of farmers used improved seeds).
- Low level of market access (40% farm households).
- Low level of access to irrigation outreach (29% of 202,000 hectares that are under irrigation).
- Over-dependence on hand hoe cultivation technology and backward agricultural development practices.
- Very small sized farms among the very poor subsistence farmers (less than two acres).
- Low returns to labour (less than one dollar a day), over dependence on hand hoe and backward farming practices.
- Low returns to land (less than 2 acres of landholding).
- Low levels of overall aggregate production and productivity (Low input ‟ low output syndrome)
- Disjointed food marketing with poor infrastructure, poor information flow and small added value (Market disintegration).

The use of fertilizers in Uganda is amongst the lowest in the world. According to the *"Uganda Fertilizer Strategy 2006 Draft Report"* it is estimated that between 1996 and 2000, fertilizer usage was 0.37kg fertilizer nutrients per hectare. This is compared to 4kg/ha in Mozambique, 6kg/ha in Tanzania, Malawi 16kg/ha, Kenya 31.6 kg/ha, South Africa 51kg/ha, USA 105kg/ha and 578 kg/ha in The Netherlands.

In the early 1960s, Ugandan farmers used 2,600 tones of fertilizers per year. This increased to 8,100 tones in the early 1970s. This dropped to almost zero from 1979 to 1984 due to political turmoil in the country. Official fertilizer imports are estimated at 25,000-30,000 tones annually.

The report includes reasons for the low fertilizer usage in Uganda such as the wrong perception that the country's soils do not need replenishment, and the fact that farmers have insufficient knowledge of the advantages of fertilizers and soil enhancers. The report also points to the high prices of fertilizers and the low level of their distribution in rural areas.

Given this scenario and taking into account the difficulties experienced by other markets of compost it can be seen that the forecast of selling 30% of the compost produced along the first year is reasonable

[9] http://www.pma.go.ug/

and commensurate with the reality. The fact that from the 6th year is expected to sell 80% of the compost produced, presents an optimistic scenario that will continue until the end of the life of the project.

Sensitivity Analysis

The sensitivity analysis carried out for different scenarios with variations in capital costs and compost price concludes that the compost plant is not viable without carbon revenues in any of the scenarios. The NPV is negative in all the scenarios. The NPV of investments in a compost plant in the base case without considering carbon revenues is lower (-433,835). Even with the best circumstances (as can be seen in the results of sensitivity analysis presented below), the NPV of investments in a compost plant without considering carbon revenues is lower (-357,337) than the NPV of continuation of current practice (-237,529). Inputs to the sensitivity analysis as well as the results of the sensitivity analysis are presented below.

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Assumptions for Sensitivity Analysis

Sensitivity Analysis w.r.t. Capital Cost			
Description of Scenarios	**% Change**	Values	Units
Base Case	0%	421344	USD
Increase by 5%	5%	442411	USD
Increase by 10%	10%	463478	USD
Decrease by 5%	-5%	400276	USD
Decrease by 10%	-10%	379209	USD
Sensitivity Analysis w.r.t. Price of Compost			
Description of Scenarios	**% Change**	Values	Units
Base Case	0%	13.0	USD/Ton
Increase in compost price in the base year by 5%	5%	13.7	USD/Ton
Increase in compost price in the base year by 10%	10%	14.3	USD/Ton
Decrease in compost price in the base year by 5%	-5%	12.4	USD/Ton
Decrease in compost price in the base year by 10%	-10%	11.7	USD/Ton

Results of Sensitivity Analysis

Parameters	Units	0%	-10%	-5%	+5%	+10%
Capital Cost	USD	-$433,835	-$393,322	-$413,579	-$454,092	-$474,349
Compost Price	USD	-$433,835	-$510,334	-$472,085	-$395,586	-$357,337

The sensitivity analysis concludes that the Programme without CDM is not the least cost option for the municipalities.

Step -3 : Barriers Analysis

Sub-Step 3(a)

Technology barrier

The proposed CDM program would introduce a new technology for processing of solid wastes in Uganda. These technological measures proposed in the program are not practiced in Uganda. The fact that there are no compost plants in Uganda that processes municipal solid waste to produce compost, the technological risks associated with composting operation by the municipalities is considered high. Failure or underperformance the solid waste processing technologies have been widely reported in published reports leading to low acceptance of any such technologies particularly in the developing world like Uganda. Technology appropriate for Uganda is available in the other developing countries but they need to be localised and adapted to Uganda. There is a need for demonstration of the technology at multiple locations to check out its appropriateness and acceptability. Transfer of the technical know how including training of the manpower in Uganda to construct and operate solid waste composting plants puts additional financial burden on the program. The technology requires financial support for its demonstration and success. The proposed program activity intends to achieve this objective with support from CDM.

Barriers due to prevailing practice

Composting is a new idea compared to the prevailing practice of dumping/disposing the municipal wastes in dumpsites/landfills. The prevailing practice is very common in Uganda, as almost of all of the municipal solid waste in Uganda is disposed off in this manner.

Sub Step 3b: How identified barriers would not prevent the alternative scenarios

The only alternative scenario that needs to be analysed here is the continuation of the current practice of disposal of wastes in landfills/dumpsites without LFG capture and flaring. This practice is very common. The present practice of disposing wastes in landfills/dumpsites does not involve any technical sophistication and the municipalities have been following this as a common practice. This does not require any additional technology or investment input. Thus the barriers identified for the Programme activity would not prevent the continuation of the current practice.

Step 4. Common practice analysis

As there are no municipal waste composting plants in Uganda, composting of municipal solid wastes is not a common practice.

Impact of CDM registration

The investment analysis demonstrates that the Programme is not financially viable without the CDM. It is established that investment in a compost plant can yield positive returns only if carbon revenues are included. The returns are always negative in all scenarios without carbon revenues. The barriers analysis shows that there are significant barriers to implementation of the Programme. Thus, CDM registration directly impacts the decisions to implement the Programme activity.

Investments in a compost plant The CDM registration of the Programme, which will be a first of its kind in Uganda and Africa, will also serve as a model for other Programmes and promote the dissemination of sustainable waste management practices.

B.2. Eligibility criteria for inclusion of a CPA in the PoA

1. The CPA would be from a town council, municipal council or city council in Uganda. Only one CPA for each urban local body.
2. The urban local body would have land designated for the compost plant.
3. The urban local body would have signed a cooperation agreement with NEMA to participate in the program, and to transfer the emission reduction rights to NEMA
4. The urban local body shall take responsibility for operating the compost facility and landfill, as per the guidelines and training provided in the program.

Since additionality has been established at the Program level for a typical CPA, it is not required to carry out further additionality analysis for the individual CPAs, provided they fall within the framework of the Program. For this purpose, the following criteria would be used for assessing additionality of CPA:

1. There should not be any existing composting operations of capacity greater than 5 tons of waste handled per day in the urban local body proposing a CPA[10].
2. The common practice for waste disposal in the urban local body area should be disposal of wastes at landfills/dumpsites.
3. The financial analysis[11] of composting operations should prove the Programme to be unviable w/o carbon revenues, if the plant is designed for a different capacity than the standard 70 TPD considered in the program (A variation of 20% in the design capacity is considered reasonable and will not require separate financial analysis).

B.3. Application of methodologies

The following methodologies and tools will be used in the CPAs.

- AMS III F Version 6, Scope 13, EB 41 titled "Avoidance of Methane emissions through controlled biological treatment of biomass"
- "Tools to determine methane emissions avoided from disposal of waste at a solid waste disposal site" version 4.0.

SECTION C. Management system

The municipalities participating in the program are responsible for implementing the solid waste composting activity. Construction of the composting facility, transport of wastes to the composting facility, processing of the waste in the composting facility, selling of compost produced and disposal of rejects from the compost plant etc. are the prime responsibilities of the urban local body that proposes a CPA.

As part of the inclusion of the CPA under the PoA a Cooperation Agreement would be signed by each of the CPA proponent (town council, municipal council or city council) with NEMA. Suitable training

[10] Existence of any unorganised or small scale composting activity at a scale less than 5 TPD capacity will not disqualify a CPA on additionality.

[11] Since a standard design of 70 TPD compost plant has been adopted for the program and the financial analysis carried for the 70 TPD plant has proved that composting is not the least cost option for the municipalities, separate financial analysis will not be required to establish the additionality of the CPAs , unless the CPAs are designed for different sizes (beyond 20% variation).

programs will be conducted for the municipalities proposing a CPA to make them aware of the rules of the CDM and PoA. In addition, the Cooperation Agreement would include specific provisions and declarations that makes CPA proponents acknowledge that they are aware and have agreed that their activity is being subscribed under the PoA. The agreement would also require the proponent of CPA to confirm that they have not previously been a part of any CDM project.

The proposed PoA would be the first PoA for Municipal waste composting in Uganda: this would be confirmed as part of the host country approval letter from the DNA of Uganda. This would avoid the case of the CPA being part of another PoA.

NEMA acting on behalf of the municipalities and/or city/town councils participating in the program shall maintain the data about each of the CPA's and share the same with the IBRD and the DoE as required. The names of the municipalities and/or city/town councils proposing a CPA shall be included in the title of each CPA for easy identification. The record keeping would be both in paper and in electronic format. The record is of two types: the first would be record of the various CPA and their status; the second would be detailed record of each of the CPA. The basic database about the CPA and the monitoring data for each of the CPA is included in Appendix 5.

The purpose of the Monitoring Plan (MP) is to provide a standard by which NEMA will conduct monitoring and verification of the proposed CDM CPA activity. The MP will be in accordance with all relevant rules and regulations of the CDM. The MP forms an integral part of this PDD and will facilitate accurate and consistent monitoring of the Programme's Certified Emission Reductions (CERs). NEMA will use the MP for the duration of the Programme activity and will refine and expand it from time to time, as may be required. A CDM Management Unit has been established within NEMA organizational structure to manage the preparation and implementation phases of the proposed CDM program of activity. During implementation it will be responsible for organizing and supervising all of the monitoring activities required for accurate and timely verification and reporting of the CERs generated.

Specific Objectives of the Monitoring Plan

Specifically, the objectives of the MP are the following:

- Establishing and maintaining a reliable and accurate monitoring system
- Provide guidance for the implementation of necessary measurement and record management operations
- Guidance for meeting CDM requirements for verification and certification

Operational and Monitoring Obligations

The MP will be supported by a CDM Operations and Monitoring Manual which will be prepared before the start of the first crediting period and will be tested during start up of the components of the Programme activity. This will provide an opportunity to correct any deficiencies and further refine the monitoring and recording procedures. It will also provide an opportunity to train laboratory and operating personnel for the strict requirements for accuracy in collecting and recording data for CDM purposes.

Management and Operational Systems

In order to ensure a successful operation of the Programme and the credibility and verifiability of the CERs achieved, the Programme will have a well-defined management and operational system, which will

be documented in the CDM Operations and Monitoring Manual[12]. A system will be put in place for the Programme activity and include the operation and management of the monitoring and record keeping system that is described in the MP.

A CDM Steering Committee will be constituted with Management and Operational structures as listed below

- Management Structure composition: NEMA Executive Director, NEMA Senior legal Counsel, Urban Local Body Mayor, Urban local body Chairperson of Social services committee, Urban local body secretary for Health and Urban local body Secretary for Finance

- Operational/Technical Structure composition: NEMA Deputy Executive Director, NEMA Senior Environment Inspector, NEMA Environment Inspector, NEMA environment Economist, NEMA District Support Officer, Urban local body Town Clerk, Urban local body Health Inspector, Urban local body Engineer, Urban local body Chief Finance Officer and the District Environment Officer.

This Steering Committee will meet periodically to review the CDM program of activity.

- The first line of responsibility for implementing the MP will be the Town Clerk of the individual municipalities. The NEMA will take a leading role in preparing the CDM Programme and obtaining necessary approval for proceeding. The NEMA would have a team of inspectors and monitoring staff to ensure that all monitoring and data recording for the Programme activity meet the requirements for CER verification and certification.

The monitoring plan for the Programme activity is described in detail in Appendix 5 and are not repeated here.

SECTION D. Duration of PoA

D.1. Start date of PoA

31/10/2007, this was the earliest date at which real action of the Programme of Activities begun.

D.2. Length of the PoA

28 years

SECTION E. Environmental impacts

E.1. Level at which environmental analysis is undertaken

[12] The CDM Operations and Monitoring Plan shall be finalized after registration of the PoA in order to embrace the final monitoring plan contained in the registered POADD document..

1. Environmental Analysis is done at PoA level ☐
2. Environmental Analysis is done at SSC-CPA level ✔

The Environmental Analysis would be carried out at the SSC-CPA level, due to the nature of the individual CPA activities and the potential site specific concerns and as applicable under the Uganda law.

An environmental Impact assessment is required for a typical CPA and the same is to be carried for each of the site as per the host party laws and regulations.

E.2. Analysis of the environmental impacts

NEMA is the National Environment Management Agency for Uganda and it has taken all required actions as per Ugandan requirements. Based on the assessment of the operations to be included in the program, the following aspects have been considered in the Programme design.

Environmental or Social Impact	**Proposed Environmental Mitigation and Management Measures**
Composting Plant	
Air emissions and odor control	1. adopt modern composting techniques with a roof for the composting yard to minimize odours and leachate generation 2. good housekeeping and maintenance of equipment 3. regular washing of work areas after completion of daily processing 4. clearing of spilled wastes 5. immediate transport of rejects to landfill 6. control dust with water sprays during the dry season
Control of leachate	1. installation of concrete lined compost pad with leachate drains and sump 2. Reuse the leachate by spraying onto compost windrows. 3. adopt aerobic composting technique with use of compost to control leachate 4. reuse leachate by spraying onto compost windrows
Control compost quality	1. regular monitoring of compost quality parameters 2. regular monitoring of process parameters 3. use modern composting techniques 4. use off-spec compost for agricultural uses 5. develop horticultural uses
Vector control	1. use modern composting techniques 2. good housekeeping and maintenance of equipment 3. pest control program
Worker health and safety	1. health and hygiene training and posters 2. adequate lighting and ventilation 3. provision of personal protection equipment 4. health monitoring
Aesthetics	1. plant tree buffer zone on the boundary of the plant 2. remove waste rejects daily form the plant area and do not allow to accumulate

SECTION F. Local stakeholder comments
F.1. Solicitation of comments from local stakeholders

1. Local stakeholder consultation is done at PoA level ✔
2. Local stakeholder consultation is done at SSC-CPA level ☐

Stakeholder consultations have been undertaken at the PoA level. The details of the consultation at the PoA level included stakeholder consultation at Kampala and at multiple town and municipalities which have shown interest in participation in PoA.

The CPAs are for towns and municipalities so it was required to include their views into the program formulation. As the program also addresses multiple towns and municipalities, country level stakeholders consultations were also undertaken.

The Stakeholder comments have been taken through multiple mechanisms. The process adopted is given below with a chronological outline highlighting the stake holder consultations that have been on-going.

1. In mid- 2005 discussions with several Municipal authorities in Uganda on the same subject. The focus was on solid waste management activities that would benefit from Carbon financing. Composting of municipal solid waste into manure was identified as such an activity. NEMA held initial discussions, to seek interest in the activity, with both district and Municipal leaderships.
   Municipal leaders were invited to NEMA offices for the discussions. Technical data, on solid waste loads and management practices was obtained from a number of Urban local body and Town authorities. A number of municipalities and towns were visited, to asses feasibility and interest in the proposed activity.

2. In November 2005, NEMA staff together with a technical specialist visited a number of towns/Municipalities, to assess the technical feasibility of compositing solid waste at the municipalities, including Kabale Mbarara, Kasese, Jinja , Soroti, Mbale Lira and. Mukono. In each of these towns, discussions were held with the local political leadership (including Mayors, Resident District Commissioners, Local council chairmen and Local councillors), the technical staff (including Town Clerks, Health and sanitation inspectors, waste collection and transportation staff) and nearby residents at some of the proposed compositing sites. A number of issues were discussed including the responsibilities by the several parties to be involved in the compositing activity, the content of MOUs, EIAs to be undertaken for the sites, training, budgetary commitments by the local authorities, awareness in the community and views and opinions of the communities in these towns.
   Further liaisons (correspondences, phone calls, and meetings) continued with the local political and technical leaderships in these municipalities/towns and NEMA staff.

3. In March 2006, NEMA staff with representatives from the World Bank undertook field visits covering a number of municipalities including Fort Portal, Kasese, Kabale and Masaka. The team held discussions with stakeholders including the respective Municipal authorities. This was to acquaint them with more details on the Solid Waste Compositing activity, and to outline the potential responsibilities and commitments of the Programme participants.

   Once again further liaisons continued between NEMA staff and the Municipal authorities. These were aimed at further explaining the Programme, establishing progress and giving guidance to the EIA process especially when the municipalities were delaying on follow-up activities.

Also, at this stage, interactions with various central Government departments were undertaken to create further awareness for the Programme.

4. In November 2006 NEMA staff together with a representative from the World Bank undertook field visits, covering all the selected municipalities, for further consultations. It was possible during these visits to meet at the respective sites local community representatives, the respective EIA consultants. This was in addition to the local political and technical leaders.

5. The respective Consultants who undertook the Environmental Impact Assessment studies met with various stakeholders at each site. View and opinions obtained were included in the submitted EIS reports.

6. As per requirements of the national regulations, review of the submitted EIS reports was a consultative process undertaken by NEMA at site and Kampala. Stakeholder inputs were taken into consideration before approval of the solid waste compositing activities, at each site.

F.2. Summary of comments received

The Programme was welcomed as it would improve cleanliness within the municipalities and the neighbouring townships; create jobs; raise revenue from the sale of manure, and reduce diseases like cholera especially during the rainy season;

The law mandates the Urban Authorities to manage waste but the authorities were constrained by several factors including scarce resources. They highlighted the following problems of waste management within the municipalities:

- lack of equipment, e.g. skips, skip loaders, refuse dumpers;
- budget constraints
- lack of sensitization so no sorting is done by the communities and neither are the skips efficiently used;

The municipalities have designated dumpsites which should be used for the Programme;

The waste generated in the municipalities/ towns was mainly organic nature and can therefore be turned into manure.

The conversion of garbage into manure would generate a stable product thus leading to reduction of emissions. Under the Kyoto Protocol there is a mechanism through the World Bank that pays for emission reduction.

The process of composting should use simple composting technology and be safe.

The responsibilities NEMA under the Programme will be :

- Setting up infrastructure on the site and money has been set aside.
- Trade in the emissions reductions

The responsibilities of the Municipalities/ Town Councils would be:

- Collect and transport the waste to the composting site and undertake composting.
- Providing personnel at the composting site. Training to be provided.

- In the short run sorting of waste will take place on site and in the run households sorting can be encouraged at source.
- Sale the manure produced.
- There was an indication that there are several NGOs in the Town Council which can undertake sensitization of the people.
- Undertaking an EIA.

F.3. Report on consideration of comments received

The very extensive stakeholder consultation has been taken over the last 2 years. The comments received from the stakeholder consultations were incorporated into the design of the program including the implementation arrangements.

SECTION G. Approval and authorization

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

PART II. Generic component project activity (CPA)

SECTION A. General description of a generic CPA

A.1. Purpose and general description of generic CPAs

The urban local body would undertake improvement of its waste collection systems within the municipal area. The wastes collected would be transported to the compost facilities, which in most cases, would be located adjacent to the landfills/ solid waste disposal sites, where the wastes would usually be disposed off in the absence of the program. The incoming waste would be aerobically composted, the compost would be sold, recyclables would be removed and sold, and the rejects from the process would be disposed off at the landfills/disposal sites. The organic components of the waste would not be land filled subsequent to the implementation of the Program of Activities and the potential methane generation from the landfills would be avoided.

Each CPA will be identified by the following : (1) the Urban Local Body it belongs to, (2) the district in which it is located, and the (3) Latitude and Longitude of the location of the compost plant. The following information shall be compiled for each CPA.

Component	Details
Name of the Urban Local Body	
Type (town , municipal, city Council)	
Latitude and Longitude	
District	
Nearest airport	

SECTION B. Application of a baseline and monitoring methodology

B.1. Reference of the approved baseline and monitoring methodology(ies) selected

The following methodologies and tools will be used in the CPAs.

- AMS III F Version 6, Scope 13, EB 41 titled “Avoidance of Methane emissions through controlled biological treatment of biomass”

- “Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site” version 4.0.

The above mentioned methodology and tool are available at the UNFCCC website, at:
http://cdm.unfccc.int/methodologies/DB/7RF5DZ2T6T8F88BMPPHNDOATXD40Y0

B.2. Application of methodology(ies)

AMS III F is applicable for the following reasons:

- The Programme activity involves the following waste treatment option for the fresh waste that in a given year would have otherwise been disposed of in a landfill, namely: a composting process in aerobic conditions;
- The proportions and characteristics of different types of organic waste processed in the Programme activity can be determined, in order to apply a multiphase landfill gas generation model to estimate the quantity of landfill gas that would have been generated in the absence of the Programme activity;
- Waste handling in the baseline scenario shows a continuation of current practice of disposing the waste in a landfill and environmental regulation does not mandate the treatment of the waste using composting;
- The CPA is small scale as the emission reduction of less than 60000 t CO2e reduction and sum of the CPA emissions is less than 15000 t CO2e.

This baseline methodology shall be used in conjunction with the approved monitoring methodology.

B.3. Sources and GHGs

The extent of CPA boundary as per the AMS III F/version 06 would be the following

a. Where the solid waste would have been disposed and methane emission occurs in the absence of the proposed CPA activity,
b. The site of the compost plant, where composting operation takes place.
c. Locations where the compost produced would be applied.
d. The transportation of compost to the use sites.

The gases and sources relevant to the CPA are listed below based on the AMS III F/Version 06 methodology.

Table B3.1. Emissions sources within CPA Boundary that are considered

	Source	Gas		Justification / Explanation
Baseline	Emissions from decomposition of waste at the landfill site	CH_4	Included	The major source of emissions in the baseline
		N_2O	Excluded	N_2O emissions are small compared to CH_4 emissions from landfills. Exclusion of the gas is conservative
		CO_2	Excluded	CO_2 emissions from decomposition of organic waste are not accounted
	Emissions from	CO_2	Excluded	Electricity is not consumed or generated in the

	electricity consumption	N_2O CH_4		baseline scenario
	Emissions from thermal energy generation	CO_2 CH_4 N_2O	Excluded	Thermal energy is not consumed or generated in the baseline scenario
Project Activity	Fossil fuel consumption due to the CPA activity	CO_2	Included	May be an important emission source
		CH_4	Excluded	Excluded for simplification. The emission source is assumed to be very small.
		N_2O	Excluded	Excluded for simplification. The emission source is assumed to be very small.
	Emissions from on-site electricity use	CO_2	Included	May be an important emission source
		CH_4	Excluded	Excluded for simplification. The emission source is assumed to be very small.
		N_2O	Excluded	Excluded for simplification. The emission source is assumed to be very small.
	Direct emissions from the waste treatment process	CO_2	Excluded	CO_2 emissions from decomposition of organic waste are not accounted
		CH_4	Included	Included for composting, run off and residual disposal processes.
		N_2O	Excluded	Excluded as the activity is a small scale.

B.4. Description of baseline scenario

The baseline scenario is identified based on a review of current practices of disposal of wastes in Uganda and an assessment of feasibility and economic attractiveness of other alternatives (as provided in the following section B.5 within the technical and financial capabilities of the municipalities in Uganda.

The four alternatives considered in section B.5 are consistent with the laws and regulations in Uganda. However some of them are either not considered technically feasible in the context of Uganda or are technologically advanced and expensive to be realistically absorbed by the resource constrained municipalities in Uganda. Such options were thus not considered as baseline scenarios. Moreover, implementation of the Programme activity (composting of municipal solid wastes) in Uganda faces several barriers (as discussed in the following section) and is not a financially attractive proposition for the resource constrained municipalities. Therefore, continuation of the current practice, i.e. disposal of wastes in landfills is considered the baseline scenario.

This would mean that the MSW collected by the municipalities would be disposed off at the landfills. Anaerobic degradation of the organic fraction of the MSW in the landfill would generate methane which would be emitted to the atmosphere.

B.5. Demonstration of eligibility for a generic CPA

The projects eligible to be included as a CPA in the proposed shall comply with all the eligibility criteria listed in the PoA-DD as described below.

1- The CPA would be from a town council, municipal council or city council in Uganda. Only one CPA for each urban local body
2- The urban local body would have land designated for the compost plant.
3- The urban local body would have signed a cooperation agreement with NEMA to participate in the program, and to transfer the emission reduction rights to NEMA
4- The urban local body shall take responsibility for operating the compost facility and landfill, as per the guidelines and training provided in the program

Since additionality has been established at the Program level for a typical CPA, it is not required to carry out further additionality analysis for the individual CPAs, provided they fall within the framework of the Program. For this purpose, the following criteria would be used for assessing additionality of CPA:

~~1.~~5. There should not be any existing composting operations of capacity greater than 5 tons of waste handled per day in the urban local body proposing a CPA[13].
~~2.~~6. The common practice for waste disposal in the urban local body area should be disposal of wastes at landfills/dumpsites.
~~3.~~7. The financial analysis[14] of composting operations should prove the Programme to be unviable w/o carbon revenues, if the plant is designed for a different capacity than the standard 70 TPD considered in the program (A variation of 20% in the design capacity is considered reasonable and will not require separate financial analysis).

Additionality of a typical CPA has been demonstrated at the PoA level by following the latest version of the "Tool for the demonstration and assessment of additionality" (Version 05.2)

B.6. Estimation of emission reductions of a generic CPA
B.6.1. Explanation of methodological choices

The emission reductions caused by the proposed composting Programme are calculated according to the approved methodology AMS III F Version 6, Scope 13, EB 41 "Avoidance of Methane production from Biomass Decay through Composting." with "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site Version 4.0".

The methodology has been applied as follows:

Project Emissions (PE_y):

The project emissions in year y for the composting process from equation **(1)** are:

$$PE_y = PE_{y,transport} + PE_{y,power} + PE_{y,comp} ++ PE_{y,\ phy\ leakage} + PE_{y,runoff} + PE_{y,reswaste} \quad (1)$$

1. Project emissions from fuel use in transport of compost:

[13] Existence of any unorganised or small scale composting activity at a scale less than 5 TPD capacity will not disqualify a CPA on additionality.
[14] Since a standard design of 70 TPD compost plant has been adopted for the program and the financial analysis carried for the 70 TPD plant has proved that composting is not the least cost option for the municipalities, separate financial analysis will not be required to establish the additionality of the CPAs , unless the CPAs are designed for different sizes (beyond 20% variation).

$PEy_{,transp}$ = $(Q_y/CT_y) * DAF_w * EF_{co2} + (Q_{y,comp}/CT_{y,comp}) * DAF_{comp} * EF_{co2}$ **(2)**

Where:

Q_y = Quantity of raw waste treated in the year "y" (tonnes)
CT_y = Average truck capacity for waste transportation (tonnes/truck)
DAF_w = Average incremental distance for raw solid waste (km/truck)
EF_{Co2} = CO2 emission factor from fuel use due to transportation (kgCO2 /km)
$Q_{y,comp}$ = Quantity of final compost product produced in the year "y" (tonnes)
$CT_{y,comp}$ = average truck capacity for final compost product transportation (tonnes/truck)
DAF_{comp} average distance for final compost product transportation (km/truck)

2. Project emission from onsite energy use

$PE_{y,power} = PE_{electricity,y} + PE_{fuel,onsite,y}$ **(3)**

$PE_{electricity,y} = MWh_{e,y} * CEF_{elec}$ **(4)**

Where

$MWh_{e,y}$ is the amount of electricity consumed from the grid in the project activity, measured using an electricity meter (MWh).
CEF_{elec} is the carbon emissions factor for electricity generation (tCO_2/MWh). The CEF_{elec} shall be estimated using the weighted average method as per AMS ID ver 13 and the details is given in annex 3. A value of 0.14 is used ex ante for calculation.

$CEF_{elec,y} = \sum EF_m \times EG_{m,y-1} / \sum EG_{m,y-1}$

$EF_m = EF_{m\ ipcc2006} * 3.6 / \eta_m / 1000000$

EF_m = emission factor for fuel m in TCO_2 / MWh.
$EF_{m,ipcc2006}$ = emission factor for the fuel as per IPCC 2006 in kg CO_2 / TJ.
m = fuel type m used for power generation.
η_m = efficiency of fuel taken as per " Tools to calculate the emission factor for an electricity system."
$EG_{m,y-1)}$ = Total energy generated using fuel m in the previous year of year under consideration.

3. Project emission from methane emission from composting operations

Emissions from the composting process are calculated using the following formula.

$PE_{y,comp}$= $Q_y * EF_{composting} * GWP_{CH4}$ **(6)**

4. Project emission from runoff from composting operations

Methane emissions from runoff water is calculated using the following formula.

$PE_{y,runoff}$ = $Q_{y,ww,runoff} * COD_{y,ww,runoff} * B_{o,ww} * MCF_{ww,\ treatment} * UF_b * GWP_{CH4}$ **(7)**

Where,

$Q_{y,ww,runoff}$ = Volume of run off water in year y (m^3)
$COD_{y,ww,runoff}$ =Chemical Oxygen demand of run off water leaving the composting facility in year y (Tonnes/ m^3)
$B_{o,ww}$ Methane producing capacity of waste water taken at IPCC default value of 0.25 kg . kg COD
$MCF_{ww,\ treatment}$ Methane Correction water for waste water treatment plant as per table III F.1 in the methodology III.F/Version 06
UF_b Model correction factor to account for uncertainities default of 1.06
GWP_{CH4} Global Warming Potential (GWP) of methane, valid for the relevant commitment period, taken at 21 for the first commitment period of Kyoto protocol.

5. Project emission from landfill of residual of composting operations

The emissions from landfill of residuals from composting activity $\mathbf{PE_{y,reswaste}}$ are calculated using the equation

$$BE_{CH4,SWDS,y} = \varphi \cdot (1-f) \cdot GWP_{CH4} \cdot (1-OX) \cdot \frac{16}{12} \cdot F \cdot DOC_f \cdot MCF \cdot \sum_{x=1}^{y} \sum_{j} W_{j,x} \cdot DOC_j \cdot e^{-k_j \cdot (y-x)} \cdot \left(1-e^{-k_j}\right)$$

The quantity of waste and the composition of waste in the above equation correspond to the residual waste. Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site (Version 04) is used.

Baseline Emissions:

There is no waste water co composting, no electricity or thermal energy consumed at the site in the absence of the project activity and finally no methane which requires to be captured and combusted. The baseline emissions for the composting activity are calculated using the following equation..

$$BE_y = BE_{CH4,SWDS,y} - (MD_{y,reg} * GWP\_CH_4) + (MEP_{y,ww} * GWP\_CH_4) \qquad \textbf{(8)}$$

where:

BE_y is the baseline emissions in year y (tCO2e)

BECH4,SWDS,y yearly methane generation potential of the solid waste composted by the project during the years "x" from the beginning of the project activity (x=1) up to the year "y" estimated as described in "Tool to determine methane emissions avoided from disposal of waste at solid waste disposal site version 4".

$MEP_{y,ww}$ Methane emission potential in the year *y* of the wastewater co-composted. The value of this term is zero as co-composting of wastewater is not included in the project activity (tonne)

$MD_{reg,y}$ methane emissions that would be captured and destroyed to comply with national or local safety requirement or legal regulations in the year "y" (tCO_2e). In Uganda there is no requirement or regulation to capture and destroy methane and this value is zero and not considered further.

GWP_{CH4} Global Warming Potential (GWP) of methane, valid for the relevant commitment period, taken at 21 for the first commitment period of Kyoto protocol.

Thus the above equation reduces to :

$$BE_y = BE_{CH4,SWDS,y} \quad (9)$$

Where

$$BE_{CH4,SWDS,y} = \varphi \cdot (1-f) \cdot GWP_{CH4} \cdot (1-OX) \cdot \frac{16}{12} \cdot F \cdot DOC_f \cdot MCF \cdot \sum_{x=1}^{y} \sum_{j} W_{j,x} \cdot DOC_j \cdot e^{-k_j \cdot (y-x)} \cdot \left(1-e^{-k_j}\right)$$

where:

φ = Model correction factor (default 0.9) to correct for the model-uncertainties

f = Fraction of methane captured at the SWDS and flared, combusted or used in another manner.

GWP_{CH4} = Global Warming Potential (GWP) of methane, valid for the relevant commitment period

OX = Oxidation factor (reflecting the amount of methane from SWDS that is oxidised in the soil or other material covering the waste).

F = Fraction of methane in the SWDS gas (volume fraction) (0.5)

DOC_j = Fraction of degradable organic carbon (by weight) in the waste type j

MCF = Methane Correction Factor (fraction)

$W_{j,x}$ = Amount of organic waste type j prevented from disposal in the SWDS in the year x (tonnes/year)

DOC_f = Fraction of degradable organic carbon that can decompose

k_j = Decay rate for the waste stream type j

j = Waste type category (index).

x = Year during the crediting period: x runs from the first year of the first crediting period (x=1) to the year y for which avoided emissions are calculated (x=y)

y = Year for which methane emissions are calculated

Where different waste types *j* are prevented from disposal, determine the amount of different waste types ($W_{j,x}$) through sampling and calculate the mean from the samples, as follows:

$$W_{j,x} = W_x \cdot \frac{\sum_{n=1}^{z} p_{n,j,x}}{z} \quad (10)$$

where:

$W_{j,x}$ = Amount of organic waste type j prevented from disposal in the year x (tonnes)

W_x = Total amount of organic waste prevented from disposal in the year x (tonnes/year)

$p_{n,j,x}$ = Weight fraction of the waste type j in the sample n collected during the year x

z = Number of samples taken during the year x

No leakage is considered as there is no equipment being transferred from existing compost facility and the proposed CPAs are completely new facilities.

Provisions regarding the revisions of the CPAs in case the methodology is put on hold or withdrawn.

- If the approved methodology is put on hold or withdrawn, for any reason other than for the purpose of inclusion in a consolidated methodology, no new CPAs shall be included to the PoA.
- If the methodology is subsequently revised or replaced by inclusion in a consolidated methodology, the PoA shall be revised accordingly and the changes shall be validated by a DOE and approved by the Board if new CPAs are to be included. The Board's approval defines a new version of the PoA and the PoA specific CDM-CPA-DD.
- Once changes have been approved by the Board, each new CPA shall use the latest version of the PoA specific CDM-CPA-DD.
- CPAs that were included before the methodology was put on hold, shall apply the latest version of the PoA specific CDM-CPA-DD at the time of the renewal of the crediting period.

Changes required for methodology implementation in 2nd and 3rd crediting periods

The baseline situation will be re-assessed during the renewal of the crediting period. If changes in the regulations with respect to waste disposal practices have resulted in implementation of new compost plants without considering CDM or has resulted in capture and flare of LFG from landfills without considering CDM, then the baseline emissions shall be re-estimated.

The grid emission factor will be revised at the point of renewal of the crediting period of the PoA, and the emission factor will be calculated using the new algorithms published at that moment as per the latest version of the methodology.

At the renewal of the crediting period, the following data should be updated according to default values suggested in the most recently published IPCC Guidelines for National Greenhouse Gas Inventories:
• Oxidation factor (*OX*);
• Fraction of methane in the SWDS gas (*F*);
• Fraction of degradable organic carbon (*DOC*) that can decompose (*DOCf*);
• Methane correction factor (*MCF*);
• Fraction of degradable organic carbon (by weight) in each waste type *j* (*DOCj*);
▪ Decay rate for the waste type j (kj), except for food and garden waste, which has been established to be 1.49.

B.6.2. Data and parameters that are to be reported ex-ante

Data / Parameter	EF_{co2}
Unit	kg CO2/ km
Description	Emission factor for diesel vehicles
Source of data	2006 IPCC Guidelines for National Greenhouse Gas Inventories combined with data from Ugandan references
Value(s) applied	0.545
Choice of data or Measurement methods and procedures	Default CO2 emission factor of diesel used in road transport as per IPCC (2006 IPCC Guidelines for National Greenhouse Gas Inventories) is 74,100 kgCO2/TJ. Calorific Value and density of diesel according to Uganda Energy Balance data is 43.3 GJ/ton, and 0.85 ton/m3 respectively. (Ref: http://www.energyandminerals.go.ug/Energy_Balance_2004(1)%20basic%20data%20and%20assumptios.pdf). The above data results in an emission coefficient of 2.727 kgCO2/litre for diesel. Considering an average efficiency of transport vehicle as 5 km/litre, this translates to an emission factor of 0.545 kgCO2/km.
Purpose of data	Calculation of project emissions
Additional comment	-

Data / Parameter	EF_{Fuel}
Unit	(kg CO2/ litre)
Description	Emission factor for diesel used in construction equipments
Source of data	2006 IPCC Guidelines for National Greenhouse Gas Inventories combined with density of diesel from Ugandan references
Value(s) applied	2.727
Choice of data or Measurement methods and procedures	Default CO2 emission factor of diesel used in construction as per IPCC (2006 IPCC Guidelines for National Greenhouse Gas Inventories) is 74,100 kgCO2/TJ. Calorific Value and density of diesel according to Uganda Energy Balance data is 43.3 GJ/ton, and 0.85 ton/m3 respectively. (Ref: http://www.energyandminerals.go.ug/Energy_Balance_2004(1)%20basic%20data%20and%20assumptios.pdf). The above data results in an emission factor of 2.727 kgCO2/litre for diesel.
Purpose of data	Calculation of project emissions
Additional comment	-

Data / Parameter	**EF_m**
Unit	TCO2/ MWh
Description	Emission factors for different types of fuels used to supply power to the grid
Source of data	2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value(s) applied	Diesel: 0.68 Heavy Fuel Oil: 0.71 Biomass = 0 Hydro = 0
Choice of data or Measurement methods and procedures	Default emission factor for diesel as per IPCC 2006 is 74100 kg CO2 / TJ, η for equipment installed after year 2000 is taken as 39.5 % and calculation of emission factor is done using the formula EF_m * 3.6 / η_m /1000000. Default emission factor for HFO as per IPCC 2006 is 77,400 kg CO2 / TJ, η for equipment installed after year 2000 is taken as 39.5 % and calculation of emission factor is done using the formula EF_m * 3.6 / η_m /1000000.
Purpose of data	Calculation of project emissions
Additional comment	Emission factor for Hydro Power and Biomass based power is zero

Data / Parameter	η_m
Unit	%
Description	Efficiency of power plant.
Source of data	"Tools to calculate the emission factor for an electricity system." Ver 1.1
Value(s) applied	39.5 %
Choice of data or Measurement methods and procedures	Uganda has diesel and heavy fuel oil power plants apart from Hydro and biomass based power. The diesel and heavy fuel oil power plants have been installed in 2005-06 and the efficiency data for plants set up after year 2000 is used.
Purpose of data	Calculation of project emissions
Additional comment	-

Data / Parameter	$EF_{m\ ipcc,2006}$
Unit	Kg CO_2/ TJ
Description	Emission factor for diesel fuel Emission factor for Heavy Fuel Oil (Residual fuel oils)
Source of data	2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value(s) applied	Diesel : 74100 kg CO_2/ TJ Heavy Fuel Oil 77400 kg CO_2/ TJ
Choice of data or Measurement methods and procedures	Default value acceptable as per IPCC 2006.
Purpose of data	Calculation of project emissions
Additional comment	-

Data / Parameter	**$EF_{composting}$**
Unit	Kg CH4/ton waste
Description	Methane emission per ton wet waste composted
Source of data	AMS III F version 06
Value(s) applied	4 kg / ton wet waste
Choice of data or Measurement methods and procedures	Taken as per AMS III F version 06
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data / Parameter	$B_{o,ww}$
Unit	Kg methane / kg COD
Description	Methane producing capacity of waste water.
Source of data	IPCC 2006 default value of 0.25 kg / kg COD
Value(s) applied	0.25
Choice of data or Measurement methods and procedures	Default as recommended in methodology AMS III.F Version 06
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data / Parameter	$MCF_{ww, treatment}$
Unit	Factor
Description	Methane Correction water for waste water treatment plant
Source of data	As per table III F.1
Value(s) applied	0.3
Choice of data or Measurement methods and procedures	The composting process is proposed under a roof. No rain run off is expected. The process management would ensure that no leachate from excess watering is generated. Leachate generated due to moist waste input would be sprayed back onto the older waste windrows. In this context no treatment plant is proposed. In case leachate does get produced and which cannot be sprayed back an aerobic treatment system based on reed bed or similar botanical treatment system would be undertaken without use of power. The number for aerobic treatment poorly managed is adopted.
Purpose of data	Calculation of project emissions
Additional comment	Annually to check if any run off is there.

Data / Parameter	**OX**
Unit	Factor
Description	Oxidation factor
Source of data	Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site version 4.0
Value(s) applied	0
Choice of data or Measurement methods and procedures	*OX* is determined by the following two ways: (1) Conduct a site visit at the solid waste disposal site in order to assess the type of cover of the solid waste disposal site. Use the IPCC 2006 Guidelines for National Greenhouse Gas Inventories for the choice of the value to be applied. (2) Use 0.1 for managed solid waste disposal sites that are covered with oxidizing material such as soil or compost. Use 0 for other types of solid waste disposal sites. Since the landfill in baseline scenario can be considered as a unmanaged landfill with soil cover, the *OX* in this case is 0. The Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site version 4.0 says the OX be taken as 0.
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data / Parameter	**DOC_f**
Unit	Factor
Description	The fraction of DOC that can decompose
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories, and Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site version 4.0
Value(s) applied	0.5
Choice of data or Measurement methods and procedures	Default value
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data / Parameter	**MCF**
Unit	Factor
Description	Methane Correction Factor
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value(s) applied	0.8
Choice of data or Measurement methods and procedures	Use the following values for MCF: • 1.0 for anaerobic managed solid waste disposal sites. These must have controlled placement of waste (i.e., waste directed to specific deposition areas, a degree of control of scavenging and a degree of control of fires) and will include at least one of the following: (i) cover material; (ii) mechanical compacting; or (iii) leveling of the waste. • 0.5 for semi-aerobic managed solid waste disposal sites. These must have controlled placement of waste and will include all of the following structures for introducing air to waste layer: (i) permeable cover material; (ii) leachate drainage system; (iii) regulating pondage; and (iv) gas ventilation system. • 0.8 for unmanaged solid waste disposal sites – deep and/or with high water table. This comprises all SWDS not meeting the criteria of managed SWDS and which have depths of greater than or equal to 5 meters and/or high water table at near ground level. Latter situation corresponds to filling inland water, such as pond, river or wetland, by waste. • 0.4 for unmanaged-shallow solid waste disposal sites. This comprises all SWDS not meeting the criteria of managed SWDS and which have depths of less than 5 metres. The landfill is unmanaged and >5 m depth
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data / Parameter	**DOC_j**
Unit	%
Description	Percent of degradable organic carbon (by weight) in the waste type j
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Tables 2.4 and 2.5)
Value(s) applied	see table below
Choice of data or Measurement methods and procedures	Quantity of waste handled at the facility will be measured on an wet basis. Therefore DOCj values corresponding to the wet waste is used.
Purpose of data	Calculation of baseline emissions
Additional comment	-

Waste Type	**DOC_j (%)**
Wood and wood products	43
Pulp, paper and cardboard (other than sludge)	40
Food, food waste beverages and tobacco (other than sludge)	15
Textiles	24
Garden, yard and park waste	20
Glass, plastic, metal, other inert waste	0

Data / Parameter	**k_j**
Unit	Factor
Description	The decay rate for the waste stream type j
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Table 3.3)
Value(s) applied	see table below
Choice of data or Measurement methods and procedures	MAT for Uganda is 22.6 C MAP for Uganda is 1257 mm
Purpose of data	Calculation of baseline emissions
Additional comment	-

Waste Type		**k_j (%) MAT>20°C MAP>1000 mm**
Slowly degrading	Pulp, paper and cardboard (other than sludge), textiles	0.07
	Wood and wood products	0.035
Moderately degrading	Other (non-food) organic putrescible garden and park waste	0.17
Rapidly degrading	Food, food waste, beverages and tobacco (other than sludge)	0.4

Data / Parameter	**GWP_{CH4}**
Unit	tCO_2e/tCH_4
Description	Global Warming Potential (GWP) of methane, valid for the relevant commitment period
Source of data	Decisions under UNFCCC and the Kyoto protocol (a value of 21 is to be applied for the first commitment period of the Kyoto Protocol)
Value(s) applied	21 for the first KP commitment period 25 for the second KP commitment period
Choice of data or Measurement methods and procedures	
Purpose of data	Calculation of baseline and project emissions
Additional comment	-

B.6.3. Ex-ante calculations of emission reductions

Project Emissions (PE_y):

The project emissions in year y for each CPA will be calculated as below.:

$$PE_y = PE_{y,\,transp} + PE_{y,power} + PE_{y,comp} + PE_{y,\,phy\ leakage} + PE_{y,runoff} + PE_{y,reswaste}$$
(1)

where:

PE_y is the project emissions during the year y (tCO2e)
$PE_{y,transp}$ is the emission due to incremental transportation in the year y (tCO2e)
$PE_{y,power}$ is the emissions from electricity or fossil fuel consumption in the year y (tCO2e).
$PE_{y,comp}$ is methane emissions during composting process in the year y (tCO2e).
$PE_{y,\,phy\ leakage}$ **is** methane emissions from physical leakages of the anaerobic digester in year *y* (tCO_2e). Not considered here as no anaerobic digester is proposed.
$PE_{y,runoff}$ is methane emissions from runoff water in the year y (tCO2e).
$PE_{y,reswaste}$ is methane emissions from anaerobic decay of the residual wastes/products in case they are subjected to anaerobic storage or disposed in a landfill (tCO2e).

Emissions due to incremental transport

Emissions due to incremental transportation is calculated using the formula below.

$$PEy_{,transp} = (Q_y/CT_y) * DAF_w * EF_{co2} + (Q_{y,comp}/CT_{y,comp}) * DAF_{comp} * EF_{co2} \quad (1)$$
Where:

Q_y = Quantity of raw waste treated in the year "y" (tonnes)
CT_y = Average truck capacity for waste transportation (tonnes/truck)
DAF_w = Average incremental distance for raw solid waste (km/truck)
EF_{Co2} = CO2 emission factor from fuel use due to transportation (kgCO2 /km)

$Q_{y,comp}$ = Quantity of final compost product produced in the year "y" (tonnes)
$CT_{y,comp}$ = average truck capacity for final compost product transportation (tonnes/truck)
DAF_{comp} average distance for final compost product transportation (km/truck)

IPCC default values will be used for the net calorific value and CO_2 emission factor for diesel fuel.

The compost plants in the CPAs will be located at the landfill site and no incremental transportation of waste is required and there are no additional emissions due to incremental transport of wastes (DAF_W = 0). Emission associated with transport of compost will be calculated using the general formulae provided above with DAF_w =0.

With DAFw = 0, the equation above reduces to

$$PEy,transp = (Q_{y,comp}/CT_{y,comp}) * DAF_{comp} * EF_{co2} \quad \textbf{(2)}$$

Emission due to electricity or fossil fuel consumption on site.

The composting process involves electricity consumption only for lighting and water pumping. Emissions associated with consumption of electricity and fossil fuel are calculated using the following formulae

$$PE_{y,power} = PE_{electricity,y} + PE_{fuel,onsite,y} \quad \textbf{(3)}$$

$$PE_{electricity,y} = MWh_{e,y} * CEF_{elec} \quad \textbf{(4)}$$

where:

$MWh_{e,y}$ is the amount of electricity consumed from the grid in the project activity, measured using an electricity meter (MWh).
CEF_{elec} is the carbon emissions factor for electricity generation (tCO_2/MWh). The CEF_{elec} shall be estimated annually using the weighted average method as per AMS ID ver 13 and the details is given in annex 3. A value of 0.14 is used ex ante for calculation.

Where

$$CEF_{elec,y} = \sum EF_m \times EG_{m,y-1} / \sum EG_{m,y-1} \quad \textbf{(4.1)}$$

$$EF_m = EF_{m\ ipcc2006} * 3.6/ \eta_m /1000000 \quad \textbf{(4.2)}$$

EF_m = emission factor for fuel m in TCO_2 / MWh.
$EF_{m,ipcc2006}$ = emission factor for the fuel as per IPCC 2006 in kg CO_2 / TJ.
m = fuel type m used for power generation.
η_m = efficiency of fuel taken as per " Tools to calculate the emission factor for an electricity system."
$EG_{m,y-1}$ = Total energy generated using fuel m in the previous year of year under consideration.

The year prior to the year of generation is taken because ex-post option is chosen and the data would be available only 6 months after the year is complete, adopted as per guidance in " Tools to calculate the emission factor for an electricity system."

$$\mathbf{PE_{fuel,onsite,y}} = F_{cons,y} * \mathbf{EF_{fuel}} \quad \mathbf{(5)}$$

On-site fuel is used for front end loaders used for turning waste.

where:
$F_{cons,y}$ is the fuel consumption on site in year y
EF_{fuel} is the CO2 emissions factor of the fuel (tCO2/Kilolitre). Default CO2 emission factor of diesel used in road transport as per IPCC (2006 IPCC Guidelines for National Greenhouse Gas Inventories) is 74,100 kgCO2/TJ. Calorific Value and density of diesel according to Uganda Energy Balance data is 43.3 GJ/ton, and 0.85 ton/m3 respectively. (Ref: http://www.energyandminerals.go.ug/Energy_Balance_2004(1)%20basic%20data%20and%20assumptios.pdf).

Emissions from Composting

Emissions from the composting process is calculated using the following formula.

$$\mathbf{PE_{y,comp}} = Q_y * \mathbf{EF_{composting}} * GWP\_{CH4} \quad \mathbf{(6)}$$

where:

$\mathbf{EF_{composting}}$ is the methane emission factor of composting waste taken at 4 kg methane / ton wet waste

Emissions from runoff water

Methane emissions from runoff water is calculated using the following formula.

$$\mathbf{PE_{y,runoff}} = Q_{y,ww,runoff} * COD_{y,ww,runoff} * B_{o,ww} * MCF_{ww,\ treatment} * UF_b * GWP_{CH4} \quad \mathbf{(7)}$$

where:
$Q_{y,ww,runoff}$ = Volume of run off water in year y (m^3)
$COD_{y,ww,runoff}$ =Chemical Oxygen demand of run off water leaving the composting facility in year y (tonnes / m^3)
$B_{o,ww}$ Methane producing capacity of waste water taken at IPCC default value of 0.25 kg/ kg COD
$MCF_{ww,\ treatment}$ Methane Correction water for waste water treatment plant as per table III F.1 in the methodology III.F/Version 06

UF_b Model correction factor to account for uncertainties default of 1.06

GWP_{CH4} Global Warming Potential (GWP) of methane, valid for the relevant commitment period, taken at 21 for the first commitment period of Kyoto protocol.

Emission from anaerobic storage/disposal of residual waste

The emissions from landfill of residuals from composting activity $\mathbf{PE_{y,reswaste}}$ are calculated using the equation

$$BE_{CH4,SWDS,y} = \varphi \cdot (1-f) \cdot GWP_{CH4} \cdot (1-OX) \cdot \frac{16}{12} \cdot F \cdot DOC_f \cdot MCF \cdot \sum_{x=1}^{y} \sum_{j} W_{j,x} \cdot DOC_j \cdot e^{-k_j \cdot (y-x)} \cdot \left(1-e^{-k_j}\right)$$

The quantity of waste and the composition of waste in the above equation correspond to the residual waste. Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site (Version 04) is used.

Compost and inert materials are the two types of residual wastes expected to be generated in the project activity. Only the inert materials will be disposed off in the landfill once in 3 days, which would not lead to any methane emissions unlike disposal of sludge and compost in the landfill. Compost produced in the plant is not intended to be disposed off in the landfill. If needed, compost may be sold at a low or no price in the initial years when the market is still being developed. Therefore emissions associated with anaerobic storage/disposal of residual waste is mostly not applicable. However provisions have been made to analyse and monitor the type of residual wastes that would be disposed off at the landfill and calculate the emissions if relevant.

Baseline Emissions:

There is no waste water co composting, no electricity or thermal energy consumed at the site in the absence of the project activity and finally no methane which requires to be captured and combusted. The baseline emissions for the composting activity are calculated using the following equation..

$$BE_y = BE_{CH4,SWDS,y} - (MD_{y,reg} * GWP\_CH_4) + (MEP_{y,ww} * GWP\_CH_4) \qquad \textbf{(8)}$$

where:

BE_y is the baseline emissions in year y (tCO2e)

BECH4,SWDS,y yearly methane generation potential of the solid waste composted by the project during the years “x” from the beginning of the project activity (x=1) up to the year “y” estimated as described in “Tool to determine methane emissions avoided from disposal of waste at solid waste disposal site”.

$MEP_{y,ww}$ Methane emission potential in the year *y* of the wastewater co-composted. The value of this term is zero as co-composting of wastewater is not included in the project activity (tonne)

$MD_{reg,y}$ methane emissions that would be captured and destroyed to comply with national or local safety requirement or legal regulations in the year “y” (tCO_2e). In Uganda there is no requirement or regulation to capture and destroy methane and this value is zero and not considered further.

GWP_{CH4} Global Warming Potential (GWP) of methane, valid for the relevant commitment period, taken at 21 for the first commitment period of Kyoto protocol.

Hence:

$BE_y = BE_{CH4,SWDS,y}$ **(9)**

The amount of methane that would in the absence of the project activity be generated from disposal of waste at the solid waste disposal site ($BE_{CH4,SWDS,y}$) is calculated with a multi-phase model. The calculation is based on a first order decay (FOD) model. The model differentiates between the different types of waste j with respectively different decay rates k_j and different fractions of degradable organic carbon (DOC_j). The model calculates the methane generation based on the actual waste streams $W_{j,x}$ disposed in each year x, starting with the first year after the start of the project activity until the until the end of the year y, for which baseline emissions are calculated (years x with x = 1 to x = y).

The amount of methane produced in the year y ($BE_{CH4,SWDS,y}$) is calculated as follows:

$$BE_{CH4,SWDS,y} = \varphi \cdot (1-f) \cdot GWP_{CH4} \cdot (1-OX) \cdot \frac{16}{12} \cdot F \cdot DOC_f \cdot MCF \cdot \sum_{x=1}^{y} \sum_{j} W_{j,x} \cdot DOC_j \cdot e^{-k_j \cdot (y-x)} \cdot \left(1-e^{-k_j}\right)$$

(10)

where:

φ	= Model correction factor (default 0.9) to correct for the model-uncertainties
f	= Fraction of methane captured at the SWDS and flared, combusted or used in another manner.
GWP_{CH4}	= Global Warming Potential (GWP) of methane, valid for the relevant commitment period
OX	= Oxidation factor (reflecting the amount of methane from SWDS that is oxidised in the soil or other material covering the waste).
F	= Fraction of methane in the SWDS gas (volume fraction) (0.5)
DOC_j	= Fraction of degradable organic carbon (by weight) in the waste type j
MCF	= Methane Correction Factor (fraction)
$W_{j,x}$	= Amount of organic waste type j prevented from disposal in the SWDS in the year x (tonnes/year)
DOC_f	= Fraction of degradable organic carbon that can decompose
k_j	= Decay rate for the waste stream type j
j	= Waste type category (index).
x	= Year during the crediting period: x runs from the first year of the first crediting period (x=1) to the year y for which avoided emissions are calculated (x=y)
y	= Year for which methane emissions are calculated

Where different waste types *j* are prevented from disposal, determine the amount of different waste types ($W_{j,x}$) through sampling and calculate the mean from the samples, as follows:

$$W_{j,x} = W_x \cdot \frac{\sum_{n=1}^{z} p_{n,j,x}}{z}$$

(11)

where:

$W_{j,x}$	= Amount of organic waste type j prevented from disposal in the year x (tonnes)
W_x	= Total amount of organic waste prevented from disposal in the year x (tonnes/year)
$p_{n,j,x}$	= Weight fraction of the waste type j in the sample n collected during the year x
z	= Number of samples taken during the year x

Emission Reductions – Composting process:

The following equation will be used to calculate emission reductions for the composting process:

$$ER_y = BE_y - PE_y \quad (12)$$

B.7. Application of the monitoring methodology and description of the monitoring plan
B.7.1. Data and parameters to be monitored by each generic CPA

Data / Parameter	Q_{ycomp}
Unit	Tonnes
Description	Total quantity of compost produced and transported out of the site
Source of data	Compost Production and Sales Register maintained by the operator.
Value(s) applied	To be determined by each CPA
Measurement methods and procedures	The quantity of compost taken out of the compost facility including Sales and free lifting shall be recorded in Compost Production and Sales Register. In case of large volume sales/lifting, the no. of loads by tractors/trucks will be recorded, along with the standard volume of the carriers. To record the small volume sales/lifting, a standard skip/box (of fixed volume) shall be used to estimate the volume sold/lifted. Density of compost shall be measured to convert the volume sold/lifted to weight. The density shall be measured by weighing compost contained in a standard 5 cft. box in a calibrated weighing scale installed at the site. The density shall be measured once in a month and the annual average density shall be used for converting the annual volume of compost transported into weights (tons).
Monitoring frequency	The volume of compost sold/lifted shall be recorded on a daily basis.
QA/QC procedures	The weighing scale is calibrated
Purpose of data	Calculation of project emissions
Additional comments	The volume data will be reported on a monthly basis.

Data / Parameter	$CT_{y,comp}$
Unit	tonnes/truck
Description	Average truck capacity for transportation of compost
Source of data	Outgoing Compost ~~Production and Sales~~ Register maintained by the operator.
Value(s) applied	6
Measurement methods and procedures	Data on no. of trips/loads will be recorded in the Compost Production and Sales Register. The aggregated annual compost sold/lifted ($Q_{y,comp}$) in tons as shall be divided by the number of trips/loads to calculate the average truck capacity (tons/truck).
Monitoring frequency	This will be calculated annually
QA/QC procedures	-
Purpose of data	Calculation of project emissions
Additional comments	Average record taken at the end of the year. The individual records are collected whenever the compost is transported out of the site.

Data / Parameter	DAF_{comp}
Unit	Km
Description	Average distance for compost transportation to end users
Source of data	Outgoing compost registers maintained by the operator.
Value(s) applied	100 km.
Measurement methods and procedures	For each load/trip of compost taken out of the plant, the operator shall record the distance to destination by speaking to the carrier. The total distance will be divided by the total no. of trips to calculate the average distance.
Monitoring frequency	Monitored Daily, and average calculated annually
QA/QC procedures	-
Purpose of data	Calculation of project emissions
Additional comments	This will be calculated annually.

Data / Parameter	$MWh_{e,y}$
Unit	MWh
Description	Amount of electricity consumed from the grid in the project activity[15]
Source of data	Electricity meter and the bills from the power utility
Value(s) applied	2.92. The ex ante calculation has been done based on assumption that electricity use would be limited to lighting. Considering 12 tube lights of 40 W operating for 16 hours per day for 365 days operation the consumption has been estimated to be 2.92 MWh. The actual consumption would be monitored for each CPA.
Measurement methods and procedures	Consumption of electricity recorded by the meter will be the prime source of data. Monthly consumption will be recorded. The electricity bills received from the power utility may be used as an alternative source of data.
Monitoring frequency	Monthly
QA/QC procedures	Electricity consumption recorded at the plant shall be checked with power bills received from the power utility.
Purpose of data	Calculation of project emissions
Additional comments	-

Data / Parameter	$CEF_{electricity,}$
Unit	tCO2e/MWh
Description	CO2 Emission Factor of the grid supplying electricity to the project
Source of data	Calculated as per AMS I D
Value(s) applied	0.14
Measurement methods and procedures	The weighted average method of calculation of emission factor will be used. Data on electricity generated and supplied to the Uganda National Grid from various sources (fuel types) for the previous year will be collected from the UETCL and used for the calculation. Emission factor of 0.68 tCO2/MWh and 0.71 tCO2/MWh shall be used for diesel and HFO based generation respectively. Hydro and biomass based power will have zero emissions. Generation data for the previous year will be used
Monitoring frequency	This will be calculated annually.
QA/QC procedures	-
Purpose of data	Calculation of project emissions
Additional comments	The data used in the calculation is obtained from the Uganda Electricity Regulatory Authority.

[15] For CPA sites that are not connected to the power grid, actual fuel consumption of the facilities will be monitored. Therefore the monitoring of this parameter is not applicable.

Data / Parameter	$EG_{m,y-1}$
Unit	MWh
Description	Total annual electricity generation from Fuel m for the previous year supplied to the grid.
Source of data	Uganda Electricity Transmission Company Limited; the state power transmission company of Uganda which manages the grid and supplies electricity to the projects.
Value(s) applied	Data for 2006-07 has been used for the purpose of calculations Hydro : 1009440 MWh Diesel : 269096 MWh Heavy Fuel Oil : 0 MWh Biomass : 0 MWh
Measurement methods and procedures	Data reported by UETCL shall be used.
Monitoring frequency	This will be calculated annually.
QA/QC procedures	-
Purpose of data	Calculation of project emissions
Additional comments	-

Data / Parameter	F_{cons}
Unit	Litres
Description	Fuel consumption for equipment used in the composting process
Source of data	Fuel Purchase Records as the primary source of data. Information on standard duration of operation of the equipments and the average fuel ratings of the equipments may be used as an alternative method of calculating the fuel consumed in case the equipments are hired and the plant operator does not have access to the fuel purchase data.
Value(s) applied	14600 l/yr
Measurement methods and procedures	Records will be kept for the fuel purchased for the plant. Duration of operation of the equipment and their fuel rating may be used as alternative method. In case the alternative method is used, the calculations shall be made and the fuel consumption data shall be recorded on monthly basis.
Monitoring frequency	Monitored monthly
QA/QC procedures	Copies of the receipts of fuel purchased by the operator.
Purpose of data	Calculation of project emissions
Additional comments	The fuel usage is only for equipment that is operating on-site and does not include fuel usage for trucks that transport the waste to the composting plant or trucks carrying waste rejects to the landfill. This transport would have occurred under the baseline scenario as the composting plant is located at the landfill. Emissions associated with transport of compost are calculated

	separately.

Data / Parameter	**$Q_{y,ww,runoff}$**
Unit	m^3
Description	Volume of run-off water in year y
Source of data	Records of the compost plant
Value(s) applied	0 (No run off from rain is expected as the compost plant is covered. All leachate from the plant would be stored in a storage tank and reused on the windrows.)
Measurement methods and procedures	Leachate accumulated in the tank over a period of 24 hours shall be calculated (on volume basis) with measurements for the area of the tank and the depth of leachate accumulated in the tank using standard free board. For this purpose, the depth from leachate surface to the tank top is measured by freeboards two consecutive days once in a month to determine the daily volume of accumulated leachate and the average leachate generation rate (m3/day) shall be converted to annual leachate generation.
Monitoring frequency	Measurements to be taken two consecutive days once in a month
QA/QC procedures	The records of monthly measurement will be reviewed and signed off by the responsible site manager, and kept on site. Spot checks will be carried out by CME on a quarterly basis.
Purpose of data	Calculation of project emissions
Additional comments	Standard freeboards to be used.

Data / Parameter	**$COD_{y,ww,runoff}$**
Unit	Tonnes / m^3
Description	Chemical Oxygen demand of run-off water leaving the composting facility
Source of data	Waste Characterization Reports
Value(s) applied	0.001621
Measurement methods and procedures	Analytical technique for COD measurement.
Monitoring frequency	Measurements to be taken once in a month and the annual average will be used. The value of 0.001621 Tonnes/m3 (= 1621 g/m3) has been used for the purpose of ex-ante estimation of emission reductions (taken from published references).
QA/QC procedures	Sample given to laboratories recognised by the government.
Purpose of data	Calculation of project emissions
Additional comments	-

Data / Parameter	**f**
Unit	Fraction
Description	Fraction of methane captured at the SWDS and flared, combusted or used in another manner
Source of data	Site visits to solid waste disposal sites in the corresponding municipality hosting the CPA
Value(s) applied	0 (None of the landfills in Uganda are equipped with landfill gas capture and flaring facilities. Landfill gas from the SWDs is neither being captured and flared, nor is being used in another manner. Since capture and flare of LFG is not feasible for smaller landfills f = 0 is being fixed for all the CPAs.)
Measurement methods and procedures	Solid waste disposal sites located in the corresponding municipality hosting the CPA will be visited to check if any of the sites is implementing landfill gas capture and flaring schemes. Information on the fraction of gas being captured and flared will be collected from such facilities. CDM projects will not be considered for this.
Monitoring frequency	To be carried out on an annual basis
QA/QC procedures	-
Purpose of data	Calculation of project emissions
Additional comments	-

Data / Parameter	**W_x**
Unit	Tonnes
Description	Total quantity of organic waste prevented from disposal in year x (tons)
Source of data	Records of incoming waste and measurements at the facility
Value(s) applied	To be determined by each CPA
Measurement methods and procedures	No. of incoming trips made by different types of carriers (trucks/tractors/other carriers) on a daily basis shall be recorded by the operator. For smaller quantity of wastes brought by other means, a standard skip of known volume will be used to quantity the daily inflow of wastes. The aggregated annual volume of waste (m3) shall be converted to weights by using the density of waste, which shall be measured once in a month using standard techniques (weighing a known volume of waste in a weighing balance). The sum of the volume of waste (m3) received in a year shall be multiplied with the average density (kg/m3). The quantity of inerts present in the waste (as reported in the waste composition analysis on % weight basis) shall be deducted to calculate the total quantity of organic waste prevented from disposal (Refer to **$P_{n,j,x}$**). This adjustment for inerts is required to calculate emissions from composting ($PE_{y,comp}$), as inerts do not contribute to methane emissions. For the purpose of calculating baseline emissions (BECH4,SWDS,y), it is not required to do these adjustments because the waste composition of the mixed incoming waste is used in the calculations which automatically considers only the organics present.
Monitoring frequency	Calculated annually from daily records for volume of waste brought in to the compost plant, and monthly records for density and composition analysis of the incoming waste. The volume data will be reported compiled and reported on a monthly basis.
QA/QC procedures	The data recorded may be cross checked with municipal record of waste disposal and payments for the same.
Purpose of data	Calculation of baseline emissions
Additional comments	-

<table>
<tr><td>Data / Parameter</td><td>$P_{n,j,x}$</td></tr>
<tr><td>Unit</td><td>-</td></tr>
<tr><td>Description</td><td>Weight fraction of the waste type j in the incoming waste in sample n</td></tr>
<tr><td>Source of data</td><td>Waste Composition Analysis</td></tr>
<tr><td>Value(s) applied</td><td><table><tr><th>Waste Type</th><th>%</th></tr><tr><td>Wood and wood products</td><td>3.5</td></tr><tr><td>Pulp, paper and cardboard (other than sludge)</td><td>8.0</td></tr><tr><td>Food, food waste beverages and tobacco (other than sludge)</td><td>31.9</td></tr><tr><td>Textiles</td><td>1.8</td></tr><tr><td>Garden, yard and park waste</td><td>36.7</td></tr><tr><td>Glass, plastic, metal, other inert waste</td><td>18.1</td></tr></table></td></tr>
<tr><td>Measurement methods and procedures</td><td>Standard procedures for determining the waste composition shall be used. The composition of incoming waste will be determined by sampling and analysis done by municipality staff that are trained and certified by Makerere University.</td></tr>
<tr><td>Monitoring frequency</td><td>Samples will be taken three times in three months which translates to 12 samples in a year. The average composition will be used in all calculations.</td></tr>
<tr><td>QA/QC procedures</td><td>Paper records will be kept on site, as well as copies of training certificates by Makerere University for staff conducting the sampling. Results will be cross-checked by NEMA staff with those obtained during the same month for previous years.</td></tr>
<tr><td>Purpose of data</td><td>Calculation of baseline emissions</td></tr>
<tr><td>Additional comments</td><td>-</td></tr>
</table>

Data / Parameter	**$W_{x\ residual}$**
Unit	Tonnes
Description	Total quantity of residual organic waste landfilled in year x
Source of data	Compost plant outgoing records
Value(s) applied	0
Measurement methods and procedures	The plant operator will maintain records of the quantity of residual waste taken out of the compost plant to the landfill in terms of no. of trips of tractors/trucks on a daily basis. The standard volume of trucks and tractors will be used to convert the trips to volume of residual wastes transported. The density of residual wastes meant for landfilling shall be measured once in a month and the average density will be used to calculate the aggregated annual volume (m3) to weight. (tons)
Monitoring frequency	Calculated annually from daily records for volume of residual wastes sent to landfill, and monthly records for density and composition analysis.
QA/QC procedures	Operations manual detailing the procedures are available on site, the NEMA officials carry out routine monitoring to verify these records.
Purpose of data	Calculation of project emissions
Additional comments	-

<table>
<tr><td>Data / Parameter</td><td>$P_{n,j,x,residual}$</td></tr>
<tr><td>Unit</td><td>%</td></tr>
<tr><td>Description</td><td>Weight fraction of the waste type j in the residual waste sample n collected</td></tr>
<tr><td>Source of data</td><td>Monthly sampling and analysis of the residual waste stream</td></tr>
<tr><td>Value(s) applied</td><td>
<table>
<tr><th>Waste Type</th><th>%</th></tr>
<tr><td>Wood and wood products</td><td>0.0</td></tr>
<tr><td>Pulp, paper and cardboard (other than sludge)</td><td>0.0</td></tr>
<tr><td>Food, food waste beverages and tobacco (other than sludge)</td><td>0.0</td></tr>
<tr><td>Textiles</td><td>0.0</td></tr>
<tr><td>Garden, yard and park waste</td><td>0.0</td></tr>
<tr><td>Glass, plastic, metal, other inert waste</td><td>100.00</td></tr>
</table>
</td></tr>
<tr><td>Measurement methods and procedures</td><td>Standard procedures for determining the waste composition shall be used. The composition of residual waste will be determined by sampling and analysis performed by trained personnel. Samples will be taken three times in three months. The average composition shall be used in all calculations.</td></tr>
<tr><td>Monitoring frequency</td><td>Composition analysis three times in three months.</td></tr>
<tr><td>QA/QC procedures</td><td>Paper records will be kept on site, as well as copies of training certificates by Makerere University for staff conducting the sampling. Results will be cross-checked by NEMA staff with those obtained during the same month for previous years.</td></tr>
<tr><td>Purpose of data</td><td>Calculation of project emissions</td></tr>
<tr><td>Additional comments</td><td>-</td></tr>
</table>

B.7.2. Description of the monitoring plan for a generic CPA

The purpose of the Monitoring Plan (MP) is to provide a standard by which NEMA will conduct monitoring and verification of the proposed CDM CPA activity. The MP will be in accordance with all relevant rules and regulations of the CDM. The MP forms an integral part of this PDD and will facilitate accurate and consistent monitoring of the Programme's Certified Emission Reductions (CERs). NEMA will use the MP for the duration of the Programme activity and will refine and expand it from time to time, as may be required. A CDM Management Unit has been established within NEMA organizational structure to manage the preparation and implementation phases of the proposed CDM program of activity. During implementation it will be responsible for organizing and supervising all of the monitoring activities required for accurate and timely verification and reporting of the CERs generated.

Specific Objectives of the Monitoring Plan

Specifically, the objectives of the MP are the following:

- Establishing and maintaining a reliable and accurate monitoring system
- Provide guidance for the implementation of necessary measurement and record management operations
- Guidance for meeting CDM requirements for verification and certification

Operational and Monitoring Obligations

The MP will be supported by a CDM Operations and Monitoring Manual which will be prepared before the start of the first crediting period and will be tested during start up of the components of the Programme activity. This will provide an opportunity to correct any deficiencies and further refine the monitoring and recording procedures. It will also provide an opportunity to train laboratory and operating personnel for the strict requirements for accuracy in collecting and recording data for CDM purposes.

Management and Operational Systems

In order to ensure a successful operation of the Programme and the credibility and verifiability of the CERs achieved, the Programme will have a well-defined management and operational system, which will be documented in the CDM Operations and Monitoring Manual[16]. A system will be put in place for the Programme activity and include the operation and management of the monitoring and record keeping system that is described in the MP.

A CDM Steering Committee will be constituted with Management and Operational structures as listed below

- Management Structure composition: NEMA Executive Director, NEMA Senior legal Counsel, Urban Local Body Mayor, Urban local body Chairperson of Social services committee, Urban local body secretary for Health and Urban local body Secretary for Finance

- Operational/Technical Structure composition: NEMA Deputy Executive Director, NEMA Senior Environment Inspector, NEMA Environment Inspector, NEMA environment Economist, NEMA District Support Officer, Urban local body Town Clerk, Urban local body Health Inspector, Urban local body Engineer, Urban local body Chief Finance Officer and the District Environment Officer.

This Steering Committee will meet periodically to review the CDM program of activity.

- The first line of responsibility for implementing the MP will be the Town Clerk of the individual municipalities. The NEMA will take a leading role in preparing the CDM Programme and obtaining necessary approval for proceeding. The NEMA would have a team of inspectors and monitoring staff to ensure that all monitoring and data recording for the Programme activity meet the requirements for CER verification and certification.

The monitoring plan for the Programme activity is described in detail in Annex 4 and are not repeated here.

- - - - -

[16] The CDM Operations and Monitoring Plan shall be finalized after registration of the PoA in order to embrace the final monitoring plan contained in the registered POADD document..

Appendix 1: Contact information on entity/individual responsible for the PoA

Organization	National Environment Management Authority (NEMA)
Street/P.O. Box	Plot 17/19/21 Jinja Road. P.O. Box 222255 Kampala, Uganda
Building	NEMA House
City	Kampala
State/Region	Kampala
Postcode	____
Country	UGANDA
Telephone	+256-41-251064/5/8
Fax	+256-41-257521
E-mail	info@nemaug.org
Website	www.nemaug.org
Contact person	Executive Director
Title	Executive Director
Salutation	Dr.
Last name	Araymanya-Mugisha
Middle name	_______
First name	Henry
Department	Office of The Executive Director
Mobile	(+256) 772 477 556
Direct fax	+256-41-257521
Direct tel.	+256-41-257491
Personal e-mail	haryamanya@nemaug.org

Organization	World Bank Carbon Finance Unit
Street/P.O. Box	1818 H street NW
Building	MC
City	Washington
State/Region	DC
Postcode	20433
Country	USA
Telephone	1202 473 9189
Fax	1202 522 7432
E-mail	IBRD-carbonfinance@worldbank.org
Website	www.carbonfinance.org
Contact person	
Title	Manager, Carbon Finance Unit
Salutation	
Last name	Chassard
Middle name	
First name	Joelle
Department	ENVCF
Mobile	
Direct fax	
Direct tel.	
Personal e-mail	

Organization	DNA of the Netherlands (VROM)
Street/P.O. Box	Rijnstraat 8 30945
Building	
City	The Hague
State/Region	
Postcode	2500 GX
Country	The Netherlands
Telephone	+310703393456
Fax	+310703391306
E-mail	cdm.dna@minvrom.nl
Website	
Contact person	
Title	
Salutation	
Last name	Gerards
Middle name	
First name	Marisa
Department	Directorate of International Environmental Affairs
Mobile	
Direct fax	
Direct tel.	
Personal e-mail	cdm.dna@minvrom.nl

Appendix 2: Affirmation regarding public funding

The Program of Activity will be partly financed through the IDA Credit to Uganda for the project "Environment Management and Capacity Building Project-II". The DOE will be provided with the evidence that the same IDA money is not being used for purchasing emission reductions.

Appendix 3: Application of methodology(ies)

See chapter B.2.

1.

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

BASELINE INFORMATION

A. The Mean annual Precipitation data for Uganda over last 10 years is presented below.

S.NO	Year	Mean annual Rainfall (mm)
1	1996	1589
2	1997	1247
3	1998	1255
4	1999	1411
5	2000	1269
6	2001	1372
7	2002	1181
8	2003	1151
9	2004	1088
10	2005	1010

B. The Mean annual Temperature data for Uganda is presented below.

S.NO	Month	Mean temperature (^oC)
1	January	23.9
2	February	24.1
3	March	22.9
4	April	22.5
5	May	22.2
6	June	22.1
7	July	22.2
8	August	22.0
9	September	22.4
10	October	22.8
11	November	21.8
12	December	22.0
	Annual average	22.6

C. CO2 Emission Factor of the Grid.

The CO2 emission factor of the grid has been calculated using the weighted average method calculation as per the AMS ID using the following formula. This would be done every year and used for calculating project emission due to electricity use.

$CEFelec = \Sigma\, EG_{m,y-1} \times EF_m / \Sigma\, EG_m$

Where

$EG_{m,y-1}$ Expressed in MWh is the energy generated in year prior to consideration by the fuel type m in the National Grid. This data would be obtained from Uganda Electricity Transmission Company Limited.

EF_m Expressed in TCO_2 / MWh is the emission factor of the fuel type m

m type of the fuel used.

Where

EF_m = EF fuel x 3.6 / ηm /1000000

EF fuelm expressed in kg CO_2 / TJ is the default emission factor of the specific fuel value as per IPCC 2006.
EF fuel diesel = 74100 kg CO_2 / TJ
EF fuel heavy fuel oil = 77400 kg CO_2 / TJ

ηm is the efficiency of the fuel generating station and for station set up after 2000 the default value as per IPCC 2006 is 39.5 %

Data used

EG_m This data is sourced from the Uganda Electricity Transmission Company limited. For the ex ante calculation the data for the year 2006-07 is used. Uganda has Hydro and Diesel generation capacity and the same has been used.

EF_m This data has been calculated for diesel and heavt fuel oil below using procedure described above. . The data for Hydro and Biomass is taken as 0 as per IPCC 2006 guidelines.

EF diesel = 0.68
EF heavy fuel oil = 0.71

S.No	**Fuel Source**	**EG_m (MWh)**	**EF_m**	**EG_m x EF_m**	
1	Hydro	1009440	0	0	
2	Diesel	269096	0.68	182985.3	
3	Heavy Fuel Oil	0	0.71	0	
4	Biomass	0	0	0	
	Sum	1278536		182985.3	

CEF elec = $\Sigma EG_m \times EF_m / \Sigma EG_m$ = 0.14

Appendix 5: Further background information on the monitoring plan

Table 5.1: Details of data to be collected in order to monitor emission from Programme activity

ID No.	Data variable	Data Source	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived (electronic/ paper)	For how long is archived data to be kept?	Comment
1.1	F_{Cons}. (Fuel Consumption)	Fuel Purchase Records as the primary source of data.	Kilo litres	Measured or estimated	Monthly	100%	Paper	Crediting period + 2 years	Aggregated monthly & annually. Duration of operation of the equipments and their fuel rating may be used as alternative method.
1.2	$Q_{y,comp}$ (Compost Produced and Transported).	Compost Production and Sales Register.	M3	Estimated	Monthly	100%	Paper	Crediting period + 2 years	Based on records maintained at each facility
1.3	$CT_{y,comp}$ (Average Truck Capacity).	Production and Sales Register	Tons/ Truck	Estimated	Annually	100 %	Paper	Crediting period + 2 years	Averaged annually
1.4	DAF_{comp}	Compost Production and Sales Register.	km	Estimated	Annually	100 %	paper	Crediting period +	Averaged annually

	(Average distance for compost transportation)							2 years	
1.5	MWH_{ey} (Electricity consumed)	Meter Readings at the facility as primary source. The bills from the power utility may also be used as an alternative source.	MWH	Measured or estimated	Monthly	100 %	paper	Crediting period + 2 years	Aggregated annually
1.6	$CEF_{electricity}$ (CO2 emission factor of the grid)	Fuel wise electricity generation data from UETCL combined with fuel specific emission factors specified in the PDD.	tCO2/ MWh	Calculated	Annually	100%	paper	Crediting period + 2 years	Weighted average emission factor calculated for the grid.
1.7	$EG_{m,y-1}$ (Annual electricity generation from fuel type m)	Fuel wise electricity generation data from UETCL for the previous year.	MWh	Measured (by UETCL)	Annually	100%	paper	Crediting period + 2 years	Data reported by UETCL to be used
1.8	$W_{x,residual}$ (Quantity of residual organic waste landfilled)	Records at Compost Plant	M3	Estimated	Monthly	100 %	Paper	Crediting period + 2 years	Calculated using procedures similar to determination of quantity of incoming wastes
1.9	$P_{n,j,x,residual}$ (Weight fraction	Residual Waste Composition Analysis	%	Measured	Monthly	One sample every month	Paper	Crediting period	Measured using procedures similar to composition

	of waste type j in the residual waste)	carried out once in a month						Plus 2 years	analysis of incoming waste
1.10	$Q_{y,ww,runoff}$ (Volume of runoff water)	Records at Compost Plant	M^3	Measured	Monthly	One sample in a month	paper	Crediting period Plus 2 years	
1.11	$COD_{y,ww,runoff}$ (COD of runoff water	COD Test Report	Tonnes/ m^3	Measured	Monthly	One sample every month	paper	Crediting period Plus 2 years	Analysed at government recognised laboratory.

Table 5.2 :Details of data to be collected in order to monitor baseline emission from Programme activity

ID No.	Data variable	Data Source	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived (electronic/ paper)	For how long is archived data to be kept?	Comment
2.1	W_x (Total Quantity of organic waste prevented from disposal)	Incoming Waste Register	M3	Estimated	Monthly	100 %	Paper	Crediting period + 2 years	As the towns are small and managing weighbridge is expensive low cost method is proposed to have vehicle counting and skips (of known capacity) as the basis of estimate.
2.2	$P_{n,j,x}$ (Weight Fraction of waste type j in the incoming	Waste Composition Analysis	%	Measured	Monthly	One sample every month	Paper	Crediting period Plus 2 years	Sampling as per the guidelines provided in the Tool "Tools to determine methane emissions avoided from disposal of wastes at a solid waste

	waste sample)								disposal site" version 04.
2.3	f (Fraction of Methane captured at the SWDS and flared , combusted or used in another manner)	Site Visits to SWDS sites	Fraction	Estimated	Annually	100%	Paper	Crediting period Plus 2 years	To be reported based on observations and discussions with SWDS operators

Table 5.3 : Details of Procedures for data collection

No	Data	Procedure for collection	Physical process and calibration	Alternative data Source
3.1	Fuel Consumption	Fuel purchased for the plant shall be recorded on a monthly basis in the Purchase Register.	The fuel purchased by the operator shall be recorded.	The hours of operations of the turning equipment would be maintained and the fuel consumption per hour stated by manufacturer of equipment shall be used as reference.
3.2	Compost Produced and transported	The no. of trips/loads of compost taken out and the volume per trip will be recorded in the daily log, and the data will be reported on a monthly basis. Density of compost will be measured once in a month. The aggregated annual volume of compost taken out of the plant shall be multiplied with the average density of compost to calculate the quanity of compost transported out of the plant in tons..	The weighing scale to be used for weighing the compost for the purpose of determining the density shall be calibrated. The volume of compost used for the purpose of determining the density shall be measured using a standard 5 cft box. The volume of each types of carriers such as trucks and tractors used for transporting wastes shall be determined at least once by measuring the length breadth and depth of the carrier through a standard tape and kept as reference.	Compost produced can be estimated by applying a factor of 22% to the incoming waste (design parameter) for the purpose of cross checking.
	Average Truck Capacity	Total quantity of compost transported shall be divided by the total no. of trips to calculate the average truck capacity for the purpose of calculating transport related emissions.		Standard capacity of the carriers used for transporting compost can be collected by talking to the drivers of the carriers

3.3	Average distance for compost transportation	The destination and distance of transport for each trip/load of compost shall be recorded. The average distance shall be calculated by dividing the total distance by no. of trips/loads.		A data base of the large buyers could be maintained. As an alternative method, the average distance of transport could be determined by interviewing these large buyers once in a year.
	Electricity consumed	Meter Readings at the facility as primary source.	Meters provided by UETCL are expected to have been calibrated.	The bills from the power utility may also be used as an alternative source.
	CO2 emission factor of the grid	Fuel wise electricity generation data from UETCL combined with fuel specific emission factors specified in the PDD shall be used to calculate the grid emission factor following the weighted average method.	NA	Published emission factors for Ugandan grid by the DNA or any other agency could be used as alternative source of data if available.
	Annual electricity generation from fuel type m	Fuel wise electricity generation data for the previous year shall be collected from UETCL. If available in UETCL's annual report the same should be used. .	NA	NA
3.4	Quantity of residual organic waste landfilled	No. of trips and volume per trip of residual waste will be recorded in the daily log. The data will be compiled and reported on a monthly basis. Density will be measured once a month. The aggregated annual volume will be multiplied with the average density to calculate the quantity of residual organic waste landfilled in tons.	Daily data log will be maintained.	The percentage of inerts present in the waste can be used as a proxy to determine the quantity of residual waste transported to the landfill for the purpose of crosschecking..
3.6	Weight fraction of waste type j in the residual waste	Composition analysis would be carried out for the residual waste three times in three months by trained personnel.	ASTM 5231-92 (reapproved 2003) would be used.	NA
	Volume of runoff	Leachate accumulated in the tank over a	Standard freeboards to be used.	NA

	water	period of 24 hours shall be calculated (on volume basis) with measurements for the area of the tank and the depth of leachate accumulated in the tank using standard free board. For this purpose, the depth from leachate surface to the tank top is measured by freeboards two consecutive days once in a month to determine the daily volume of accumulated leachate and the average leachate generation rate (m3/day) shall be converted to annual leachate generation.		
	COD of runoff water	Analytical technique for COD measurement to be used by a contracted lab. Samples to be taken once in a month.	Only recognised/certified labs to be used.	NA
	Total Quantity of organic waste prevented from disposal	No. of trips and volume of each trip for different waste carriers (trucks/tractors/skips) will be recorded in the daily log. The data will be compiled and reported on a monthly basis. Density of waste shall be measured once in a month. The aggregated annual volume will be multiplied with the average density to calculate the total quantity in tons.	Calibrated weighing scales shall be used for measuring the weight of a given volume of waste for the purpose of calculating the density.	Weights of different types of vehicles with and without waste can be measured once in a year and the no. of trips recorded in the register can be used as an alternative method of calculation.
	Weight Fraction of waste type j in the incoming waste sample	Standard procedures for determining the waste composition shall be used. The composition of incoming waste will be determined by sampling and analysis. Samples will be taken three times in	ASTM 5231-92 (reapproved 2003) would be used.	NA

		three months, which translates to 12 samples in a year. The average composition will be used in all calculations		
	Fraction of Methane captured at the SWDS and flared , combusted or used in another manner	To be reported based on observations and discussions with SWDS operators	NA	Use 0 as the default
3.7	Common Practice Analysis report	New solid waste management projects being taken up in smaller municipalities of Uganda will be tracked to check if methane avoidance projects such as landfills with LFG capture and flare, composting and biomethanation are becoming common without the support of CDM. Otherwise disposal of waste at the landfills without LFG capture will be accepted as the common practice.	NA	Discussion with NEMA that provides environmental clearance to solid waste management projects could provide the required information. District State of Environment reports may be used for data on solid waste management
3.8	Aerobic Condition during Composting	Oxygen availability in the aerated piles will be recorded using standard methods, such as use of oxygen meters as per requirements in the Operational and Monitoring Manual.	Standard acceptable methods will be used.	NA
3.9	Aerobic conditions in compost use	A sample survey of the users to be carried out. A record of the purchasers of compost would be maintained and a random sampling would be done and the use assessed	Based on discussions and observations.	NA

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History of the document

Version	Date	Nature of revision(s)
02.0	EB 66 13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the programme design document form for small-scale CDM programmes of activities" (EB 66, Annex 13).
01	EB33, Annex43 27 July 2007	Initial adoption.
Decision Class: Regulatory **Document Type:** Form **Business Function:** Registration		