Climate MRV for Africa – Phase 2
MRV of Mitigation Actions
Composting of Municipal Solid Waste
Case Study

Lead partner

Project of the European Commission
DG Clima Action

EuropeAid/136245/DH/SER/MULTI

Amr Osama Abdel-Aziz, Assen Gasharov, Mike Bess and Laura Lahti
Team Leader and Key Experts

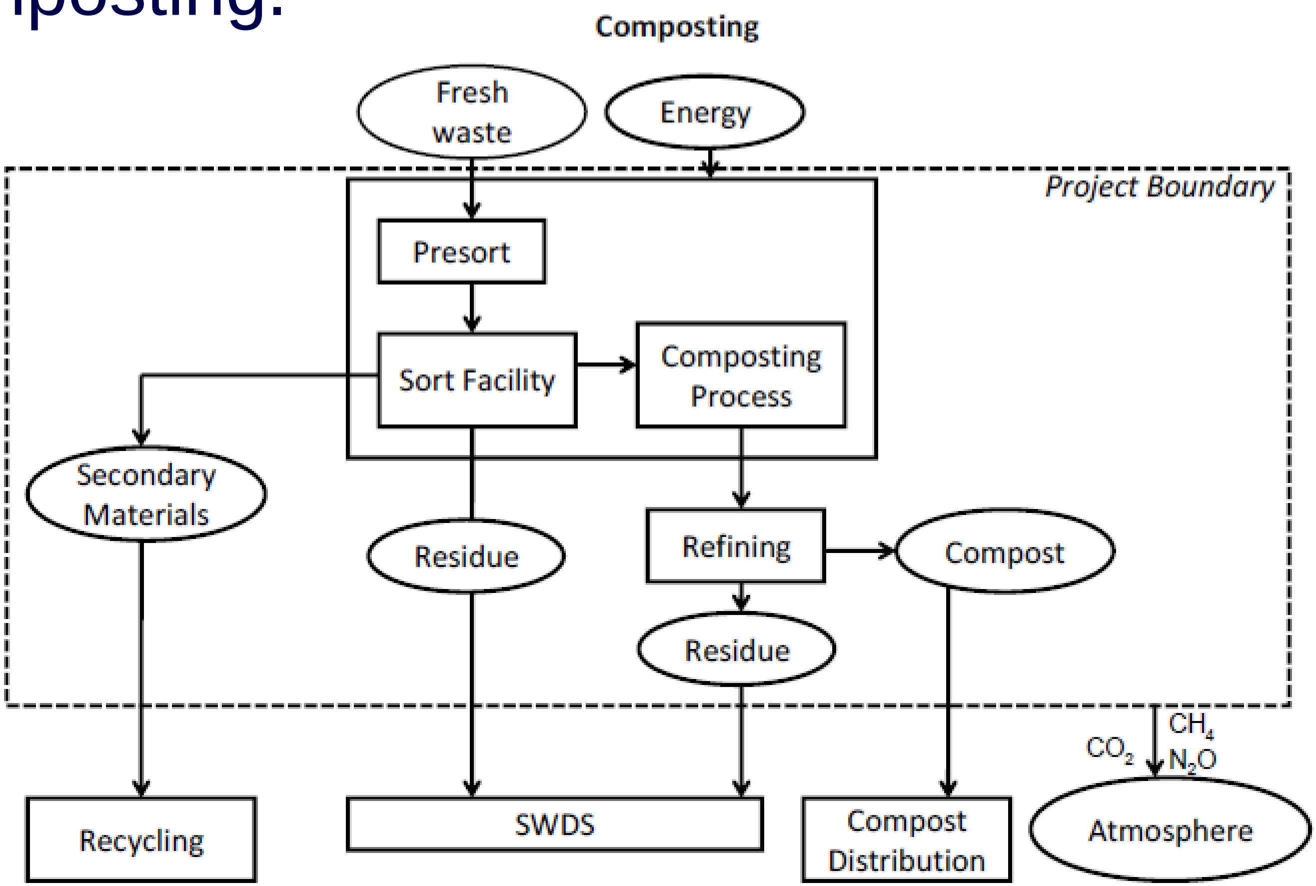
June 2017

Agenda

- Define Mitigation Action
- Co-Benefits of Mitigation Action
- Define the GHG Assessment Boundary
- Baseline Emissions
- Mitigation Action Emissions
- Monitoring Performance over Time

Define Mitigation Action

Controlled biological treatment of biomass or other organic matter through aerobic treatment by composting.



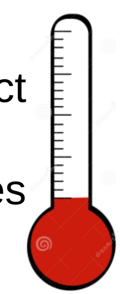
What is Composting?

Breakdown & Composition

Raw organic material → **Oxygen + Microbes** → **Stabilized Compost**

- Soil bacteria
- Fungi
- Actinomycete
- Protozola

Managed by adding O_2 & H_2O



Active Phase
55-70 ° C

Curing Phase
37 ° C

Final Product
ambient air
temperatures

Define Policy/Action

The title of the NAMA	Creating Opportunities for Municipalities to Produce and Operationalise Solid Waste Transformation (COMPOST)
Implementing Partner	Ministry of Urban Development and Housing (MUDH)
Type of policy or action	1) Strengthening the **regulatory** and institutional framework to integrate ISWM and UGI within urban systems; 2) Develop **market-based system** with micro and small enterprises to ensure financial sustainability of compost production; 3) Implementation of NAMA to generate and quantify emission reductions by **building composting facilities**.
Geographical coverage	Adama, Bahir Dar, Bishoftu, Dire Dawa, Hawassa and Mekelle
The status of the policy or action	Funding received & operational
Targeted GHG	CH4
Key performance indicators	• Tons of waste that would have landfilled • (organic fertilizer, reforestation & sustainable fuel wood)

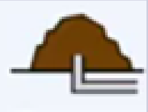
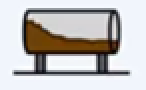
Composting Technology - Selected

Windrow Composting

- The technology selected for solid waste composting is windrow composting.
- Source segregation of organic waste is to be introduced at the household level. - Awareness raising & economic reward program required.
- Once household waste has been sorted, the organic fraction will be collected and used for composting.
- Will build on the lessons learned from a pilot project in Hawassa.

Break down and mix compost
Turning of compost to guarantee air supply

Comparison of Composting Technology

Method	Investment	Maintenance	Space	Time	Labor
Windrow Composting 	○	○	○○○○○	○	○○○○○
Passively Aerated W. 	○○	○○	○○○○○	○○○	○○
Forced Aerated W. 	○○○○	○○○○	○○○○	○	○
In-Vessel Composting 	○○○○○	○○○○○	○○○	○	○○
Bin Composting 	○○○	○○	○○○	○○○○○	○○

Co-benefits of Mitigation Action

Aligns with Ethiopia’s sustainable development strategies:

- Improved waste management and urban greenery;
- Reduction of bad odours from open waste dump sites;
- Increase employment opportunities for low-income and marginalised persons living in urban areas through waste collection and management and operation of nurseries/ forests;
- Increased gender equality through involvement of woman in tree seedling growth in nurseries using compost, transporting seedlings, planting, management of forest plantations and urban agricultural plots;
- Improved food security by utilising the compost for the plantation of vegetation;
- Reinforced decentralisation of governance responsibilities to the local level.

Adverse Impacts

- Relocation of “informal settlers”

Safeguards put in place:

- Loss, salvage and/or transport of affected properties, including original dwellings;
- Business losses derived from dwellings and lands (including crops, livestock);
- Transitional support and relocation assistance; or
- Opportunities to restore, if not improve, livelihoods.

-Other?

Define the GHG Assessment Boundary for Baseline

Assess the significance of potential GHG effects

GHG effect	Likelihood	Relative magnitude	Included?
Reduced emissions from landfills (diversion to composting, AD, and energy recovery)			
CO_2	Very likely	Minor	Excluded
CH_4	Very likely	Major	**Included**
N_2O	Very likely	Minor	Excluded

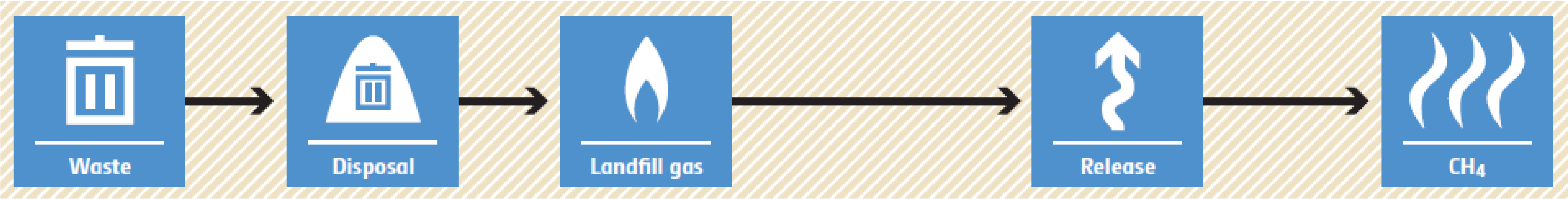
List GHG to be included in Assessment Boundary

GHG effect	GHG sources	GHG sinks	Greenhouse gases
1 Reduced emissions from landfills (diversion to composting, AD, and energy recovery)	Landfills	N/A	CH_4

Baseline Emissions

Baseline Scenario:

Landfill gas from the landfill site is released to the atmosphere



Source: CDM Methodology Booklet ,November 2016

Suppressed demand?

If, it can be demonstrated that waste is being dumped in an uncontrolled manner in human settlement areas under the current practice due to a lack of organized waste collection and disposal system .

Baseline Emissions from SWDS (Ex-Ante & Ex-Post)

Bases on First Order Decay Model, in which waste quantity is subject to exponential decay. The amount of CH4 emitted is proportional to the amount of reactive material.

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

Where:

Parameter	Definition	Value
$BE_{CH4,SWDS,y}$	Baseline emissions of methane from the SWDS in year (t CH4/y)	Calculated

Baseline Emissions from SWDS

Para.	**Definition**	**Value (Default & CS)**
W	Amount of solid waste type disposed in SWDS	Waste in tons
DOCj	Fraction of degradable organic carbon that decomposes for – subject to waste type	0.2-0.43
DOCf	Fraction of degradable organic carbon that decomposes under the specific conditions occurring in the SWDS year - reflects the fact that different types of organic carbons decompose in different rate	0.5
MCF	CH4 Correction Factor - The presence of oxygen varies depended on disposal practices i.e. control, placement and management of waste and the site leading to either aerobic, semi-aerobic or anearobic conditions.	0.71 (0.2-0.8) 0.4 for suppressed demand
k	Decay rate for the waste type, which is a reaction constant and depended on weather conditions (moisture & temperature)	IPCC default values for wet conditions

Baseline Emissions from SWDS

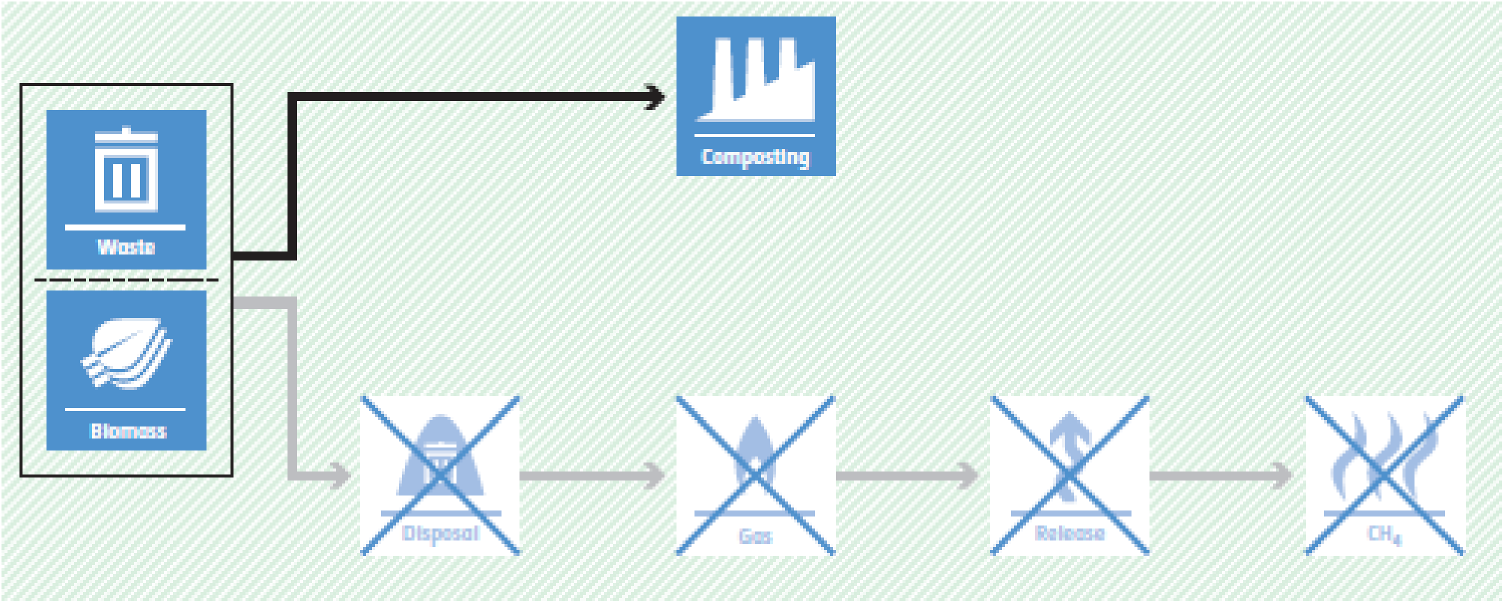
Para.	Definition	Value (Default & CS)
OX	Oxidation factor - reflects the amount of CH_4 from SWDS that is oxidised by methanotrophic micro-organisms in the soil or other material covering the waste.	0
F	Fraction of Methane in Developed SWDS Gas	0.5
φ	Default value for Model Correction factor to account for model uncertainties	0.75 for wet conditions
f	Fraction of methane captured at the SWDS and flared	0
GWP	Methane Global Warming Potential – to convert to CO_2 equivalent	21

Key parameters: Quantity and composition of material (recycled and) composted!

Mitigation Action Emissions

Mitigation Action Scenario

Methane emissions are avoided through composting.



Source: CDM Methodology Booklet ,November 2016

Project Emissions Associated with Composting

$$PE_{COMP,y} = PE_{EC,y} + PE_{FC,y} + PE_{CH4,y} + PE_{N2O,y}$$

Source	GHG	Comment
$PE_{COMP,y}$: Project emissions associated with composting	CO_2	
PE_{ECy}: Emissions from electricity consumption due to the project activity	CO_2	if any
$PE_{FC,y}$: Project emissions from fossil fuel consumption	CO_2	if any
$PE_{CH4,y}$: Project CH_4 emissions from the composting cycle	CH_4	Lack of oxygen during composting process: anaerobic spots in the pile create ideal conditions for methanogenic bacteria to grow.
$PE_{N2O,y}$: Project N_2O emissions from the composting cycle	N_2O	Lack of oxygen and low Ph: during nitrification of ammonia and denitrification of nitrite.

Mitigation Action Emissions

$$PE_{EC,y} = EC_{PJ,y} * EF_{grid,y} * (1+ TDL_y)$$

Parameter	Definition	Value
EC	Quantity of electricity consumed during the project activity	MWh
EF	Ethiopia's National Grid Emission factor	0.399 t CO2/MWh
TDL	Average technical transmission and distribution losses for providing electricity to source	20% (default value)
If electricity consumption unknown use $SEC_{com,default}$ for ex-ante:		
SECcomp,default	Default specific quantity of electricity consume per ton of waste composted - establish country specific values for ex-post.	0.01 MWh/t compost

Mitigation Action Emissions

$$PE_{FC,j} = FC_{i,j} * CO_{EFi}$$

Para.	Definition	Unit
$FC_{i,j}$	the quantity of fuel type i combusted in process j during the year y	mass or volume unit / y
CO_{EFi}	CO2 emission coefficient of fuel type I n year y	tCO2 / mass or volume unit
Or use default emission factor for fossil fuel consumed per ton of waste composted (ex –ante) and establish country specific values:		
$EF_{FC,default}$	Default emission factor for fossil fuel consumed per tonne of waste composted (wet basis)	0.0207 tCO2/t compost

Mitigation Action Emissions

$$PE_{CH4,y} = Q_{,y} * EF_{CH4,y} . GWP_{CH4}$$

Parameter	Definition	Unit
$PE_{CH4,y}$	Project emissions of methane from the composting process in year	t CO2e/ y
$Q_{,y}$	Quantity of waste composted in year	*t / y*
$EF_{CH4,y}$	Emission factor of methane per ton of waste composted valid for year – use default emission for ex-ante and establish CS values	0.002 t CH4 / t compost
GWP_{CH4}	Global Warming Potential of CH4	21 t CO2e / t CH4

Mitigation Action Emissions

$$PE_{N2O,y} = Q_{,y} * EF_{N2O,y} . GWP_{N2O}$$

Parameter	Definition	Unit
$PE_{N2O,y}$	Project emissions ofnitrous oxidefrom the composting process in year	t CO2e/ y
$Q_{,y}$	Quantity of waste composted in year	*t / y*
$EF_{N2O,y}$	Emission factor ofnitrous oxideper ton of waste composted valid for year – use default emission for ex-ante and establish CS values	0.0002 t N2O / t compost
GWP_{N2O}	Global Warming Potential of CH4	310 t CO2e / t N2O

GHG Emission Reductions

$$ER_y = BE_y - PE_y - LE_y$$

Monitoring Over Time

- For accurate estimation of GHG emission reductions, following parameters should be monitored in each composting facility

Parameter
Amount of waste composted
Waste types (fractions)
Amount of compost produced
Amount of electricity used in composting process, if relevant
Amount of fossil fuel used in composting process, if relevant
Update the electricity grid emission factor (t CO2/MWh) of Ethiopia on a regular basis
Methane and nitrous oxide emissions from the composting installation during the composting cycle

Monitoring Over Time - Simplified Option

- Develop country specific emission factors for comporting

Parameter
Amount of waste composted
Waste types (fractions)
Ton of compost produced per ton of waste (t compost/ t waste)
It is further recommended that following parameters are monitored (at some of the sites) to establish country specific default values:
Amount of electricity used in composting process (MWh/ t compost)
Amount of fossil fuel used in composting process (t fuel/ t compost)
Methane and nitrous oxide emissions from the composting installation during the composting cycle (t N_2O/ t compost, t CH_4 / t waste)

Remember to consider different climatic regions and seasons!

Thank you!

Amr Osama Abdel-Aziz, Assen Gasharov, Mike Bess and Laura Lahti