
Calculation of Baseline Emissions for Landfill Project

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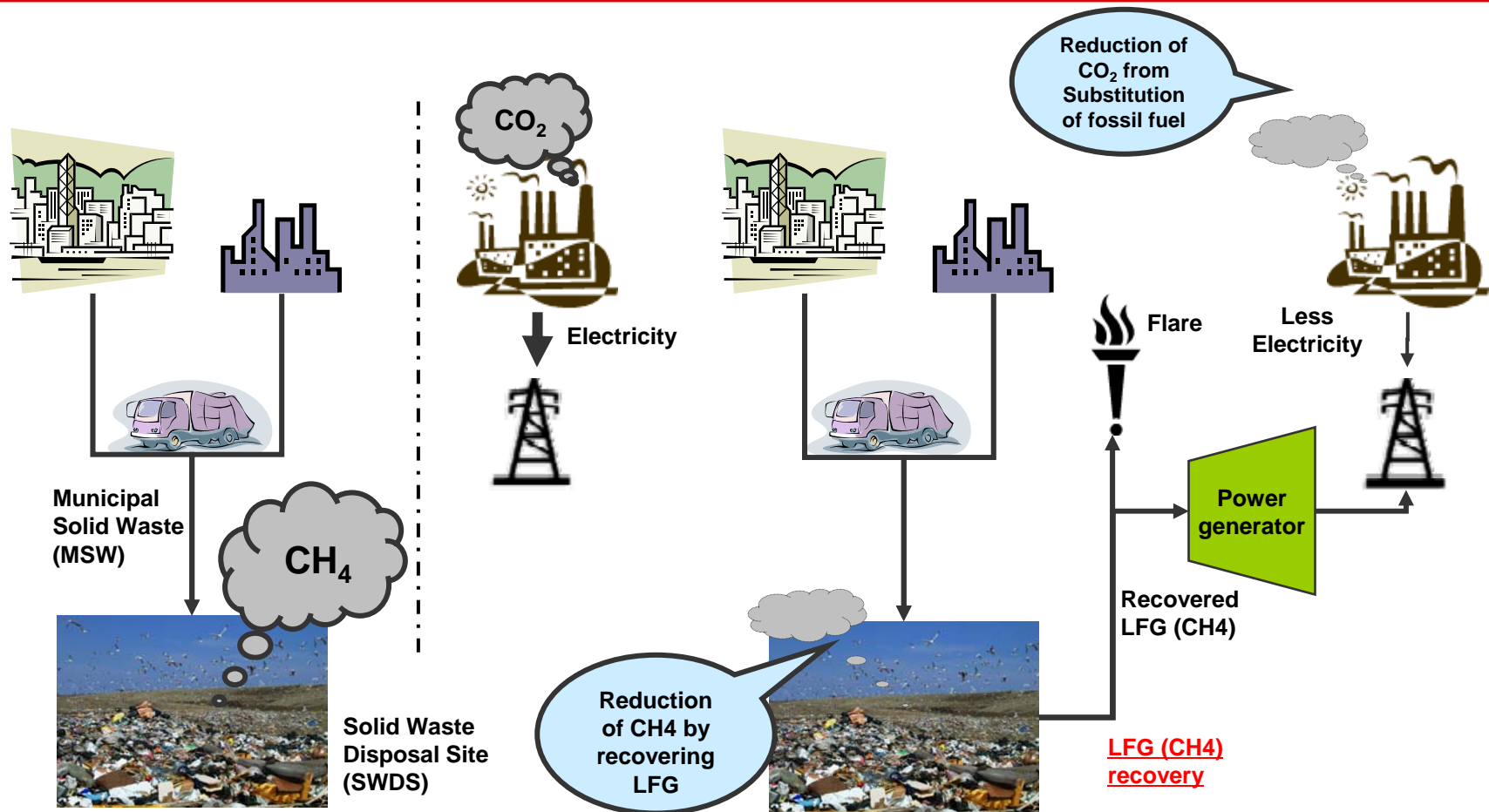
Clean Energy Finance Committee



Mitsubishi UFJ Securities

How does “Landfill project” reduce GHG?

- Recover CH₄ emission in Landfill gas (LFG) (AMS III.G.)
 - Capture and combust methane from landfills used for disposal of residues from human activities including municipal, industrial, and other solid wastes.
 - ground piping system/LFG flaring system in landfill site
- Reduce fossil fuel consumption if supply renewable energy
 - Reduce coal by generating steam from the biogas combustion
 - Reduce diesel oil for in-house power generation by utilizing biogas
 - Reduce power generation of thermal power plant by supplying power to the grid



Without project

With project

Baseline Emissions

$$BE_y = BE_{CH_4,SWDS,y} - MD_{reg,y}$$

$BE_{CH_4,SWDS,y}$ Apply “Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site” to calculate Baseline emissions.

The Tool is based on Multi-phase First Order Decay (FOD) model.

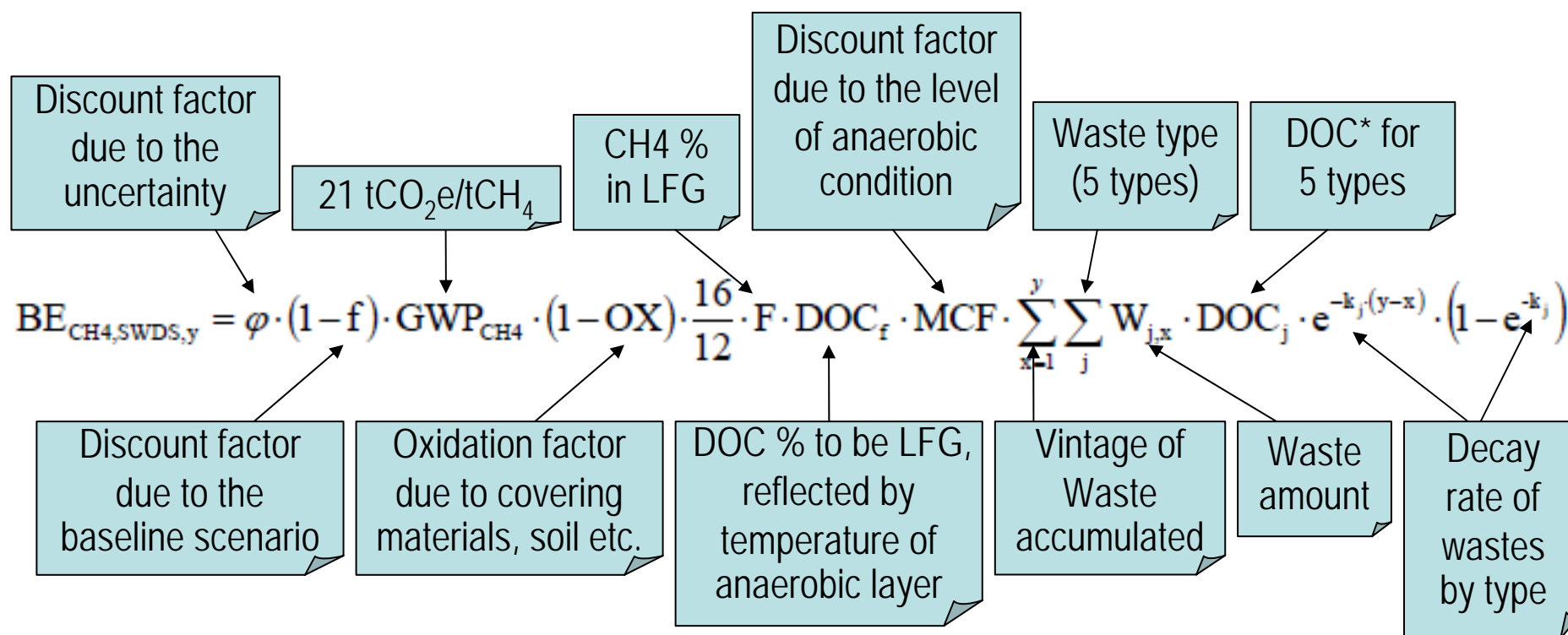
$MD_{reg,y}$ methane emissions that would be captured and destroyed to comply with national or local safety requirement or legal regulations in the year “y” (tCO₂e)

- FOD model

$$BE_{CH_4,SWDS,y} = \varphi \cdot (1-f) \cdot GWP_{CH_4} \cdot (1-OX) \cdot \frac{16}{12} \cdot F \cdot DOC_f \cdot MCF \cdot \sum_{x=1}^y \sum_j W_{j,x} \cdot DOC_j \cdot e^{-k_j(y-x)} \cdot (1 - e^{-k_j})$$

$BE_{CH_4,SWDS,y}$	= Methane emissions avoided during the year y from preventing waste disposal at the solid waste disposal site (SWDS) during the period from the start of the project activity to the end of the year y (tCO ₂ e)
φ	= Model correction factor to account for model uncertainties (0.9)
f	= Fraction of methane captured at the SWDS and flared, combusted or used in another manner
GWP_{CH_4}	= 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_f	= Fraction of degradable organic carbon (DOC) that can decompose
MCF	= Methane correction factor
$W_{j,x}$	= Amount of organic waste type j prevented from disposal in the SWDS in the year x (tons)
DOC_j	= Fraction of degradable organic carbon (by weight) in the waste type j
k_j	= Decay rate for the waste 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

- What is FOD model of the Tool?



* *DOC: Degradable organic carbon*

Unit: t-CO₂e

	inventory year y																				total
waste of year	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	
1	3,211	2,388	1,814	1,409	1,121	912	758	643	555	487	432	388	351	320	293	270	250	232	216	201	16,251
2		3,211	2,388	1,814	1,409	1,121	912	758	643	555	487	432	388	351	320	293	270	250	232	216	16,050
3			3,211	2,388	1,814	1,409	1,121	912	758	643	555	487	432	388	351	320	293	270	250	232	15,834
4				3,211	2,388	1,814	1,409	1,121	912	758	643	555	487	432	388	351	320	293	270	250	15,602
5					3,211	2,388	1,814	1,409	1,121	912	758	643	555	487	432	388	351	320	293	270	15,353
6						3,211	2,388	1,814	1,409	1,121	912	758	643	555	487	432	388	351	320	293	15,083
7							3,211	2,388	1,814	1,409	1,121	912	758	643	555	487	432	388	351	320	14,789
8								3,211	2,388	1,814	1,409	1,121	912	758	643	555	487	432	388	351	14,469
9									3,211	2,388	1,814	1,409	1,121	912	758	643	555	487	432	388	14,118
10										3,211	2,388	1,814	1,409	1,121	912	758	643	555	487	432	13,731
11																					0
12																					0
13																					0
14																					0
total	3,211	5,599	7,413	8,822	9,943	10,855	11,613	12,256	12,812	13,298	10,519	8,519	7,056	5,967	5,140	4,498	3,990	3,578	3,238	2,952	151,281

According to the above spreadsheet,
 - How long had this SWDS collected MSW?
 - When was it closed?

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- DOC_j : Fraction of degradable organic carbon in waste type j

Waste type j	DOC_j (% wet waste)	DOC_j (% dry waste)
Wood and wood products	43	50
Pulp, paper and cardboard (other than sludge)	40	44
Food, food waste, beverages and tobacco (other than sludge)	15	38
Textiles	24	30
Garden, yard and park waste	20	49
Glass, plastic, metal, other inert waste	0	0

- k_j : Decay rate of waste type j

Waste type j		Boreal and Temperate (MAT < 20°C)		Tropical (MAT > 20°C)	
		Dry (MAP/PET < 1)	Wet (MAP/PET > 1)	Dry (MAP < 1000mm)	Wet (MAP > 1000mm)
Slowly degrading	Pulp, paper, cardboard (other than sludge), textiles	0.04	0.06	0.045	0.07
	Wood, wood products and straw	0.02	0.03	0.025	0.035
Moderately degrading	Other (non-food) organic putrescible garden and park waste	0.05	0.10	0.065	0.17
Rapidly degrading	Food, food waste, sewage sludge, beverages and tobacco	0.06	0.185	0.085	0.40

NB: MAT – mean annual temperature, MAP – Mean annual precipitation, PET – potential evapotranspiration. MAP/PET is the ratio between the mean annual precipitation and the potential evapotranspiration.

- **MCF: Methane Correction Factor**

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.

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- W_j : Amount of organic waste type j (1/2)
 - Normally, the following information on waste disposed is not monitored/recorded:
 - Annual amount of waste received,
 - Waste component (food, paper, wood, textile etc.)
 - However, we have to estimate the emission reduction from the information.
 - But, it is not required so accurately as methane avoidance project, since amount of CH_4 to be recovered/flared will have to be monitored
 - Let's use default values of IPCC guidelines!

- W_j: Amount of organic waste type j (2/2)

MSW composition rate by % - Regional defaults

Region	Food	Paper	Wood	Textiles	Other
Asia					
Eastern Asia	26.2	18.8	3.5	3.5	7.4
South-Central Asia	40.3	11.3	7.9	2.5	21.9
South-Eastern Asia	43.5	12.9	9.9	2.7	16.3
Western Asia & Middle East	41.1	18	9.8	2.9	5.4
Africa					
Eastern Europe	30.1	21.8	7.5	4.7	14.6
South America	44.9	17.1	4.7	2.6	13

Region	MSW Generation rate (t/cap/yr)	Fraction of MSW disposed to SWDS	MSW to SWDS
Asia			
Eastern Asia	0.37	0.55	
South-Central Asia	0.21	0.74	
South-Eastern Asia	0.27	0.59	0.159
Africa	0.29	0.69	
Eastern Europe	0.38	0.9	0.342
South America	0.26	0.54	0.140

2006 IPCC Guidelines for National GHG Inventories,
Volume 5: Waste, Chapter 2: Waste Generation, Composition, and Management Data

Project Emissions

- Project activity emissions consist of CO2 emissions related to the power used by the project facilities.
- Emission factors for electricity shall be calculated as described in I.D.

Exercise

Let's calculate...

Project type:

- Landfill gas (LFG) recovery and flaring

The emission reduction activities:

- Recover/Flare CH₄ emission in the LFG

The methodologies to be applied:

- Type III.G. version 05 “*Landfill Methane Recovery*”

- Assumptions for calculation

Project emissions	<p>(i) Emissions from electricity use due to the project activity</p> <ul style="list-style-type: none"> ➤ No electricity is used by the project activity.
Baseline emissions	<p>(i) Methane emission potential</p> <ul style="list-style-type: none"> ➤ The SWDS is categorized as “Unmanaged-shallow solid waste disposal site” ➤ Population whose waste had been disposed at the landfill site: 100,000 ➤ MSW generation rate, fraction of MSW to be disposed to SWDS, MSW composition rate: Regional default determined in IPCC 2006 (<i>see slide “Wj (2/2)”</i>) <p>(ii) Methane emissions that would be captured and destroyed to comply with national or local safety requirement or legal regulations</p> <ul style="list-style-type: none"> ➤ No methane is assumed to be destroyed/combusted (by national or local safety requirement or legal regulations) in the absence of the project.