Training on 2006 IPCC Guidelines for preparing National GHG Inventory: General Reporting and Guidelines

Waste Sector in Philippines

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Organized by the Capacity Building Initiative for Transparency
Global Support Programme (CBIT-GSP)

INTERGOVERNMENTAL PANEL ON climate change

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- Waste Composition Data
- Solid Waste Disposal Sites: Managed
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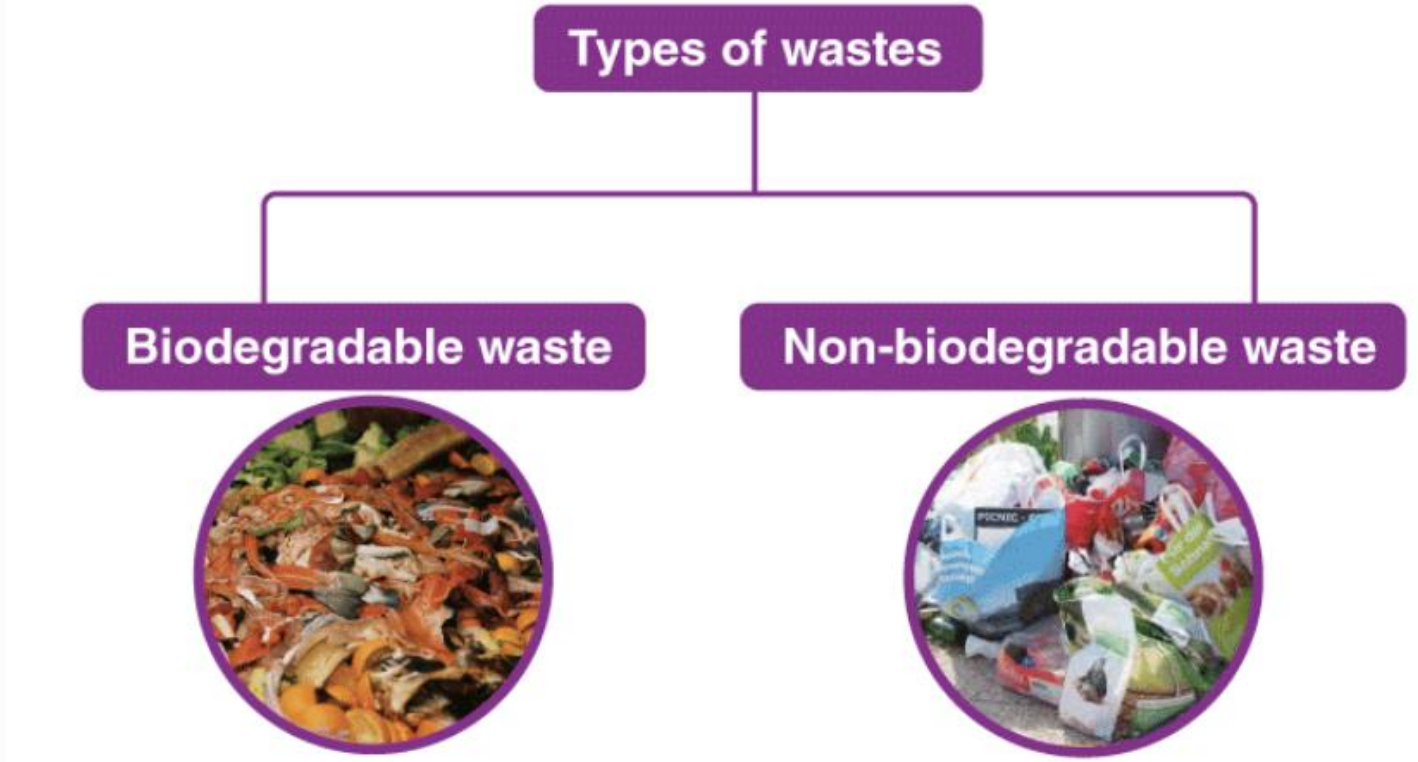
General overview of waste

Definition of waste:

Unwanted and unusable materials and which is regarded as a substance that is unusable.

Normally, waste are in two types.



General Overview of Waste Sector in Philippines

- The Philippines is among the top waste generators in Southeast Asia.
- About 35,580 tons of garbage is generated daily in Philippines.
- According to the latest Solid Waste Management Status Report (2008-2018), the Philippines was estimated to generate **18.05 Million Tons** in 2020.
- Total solid waste generation of the Philippines is expected to reach **23.61M tons** in 2025.

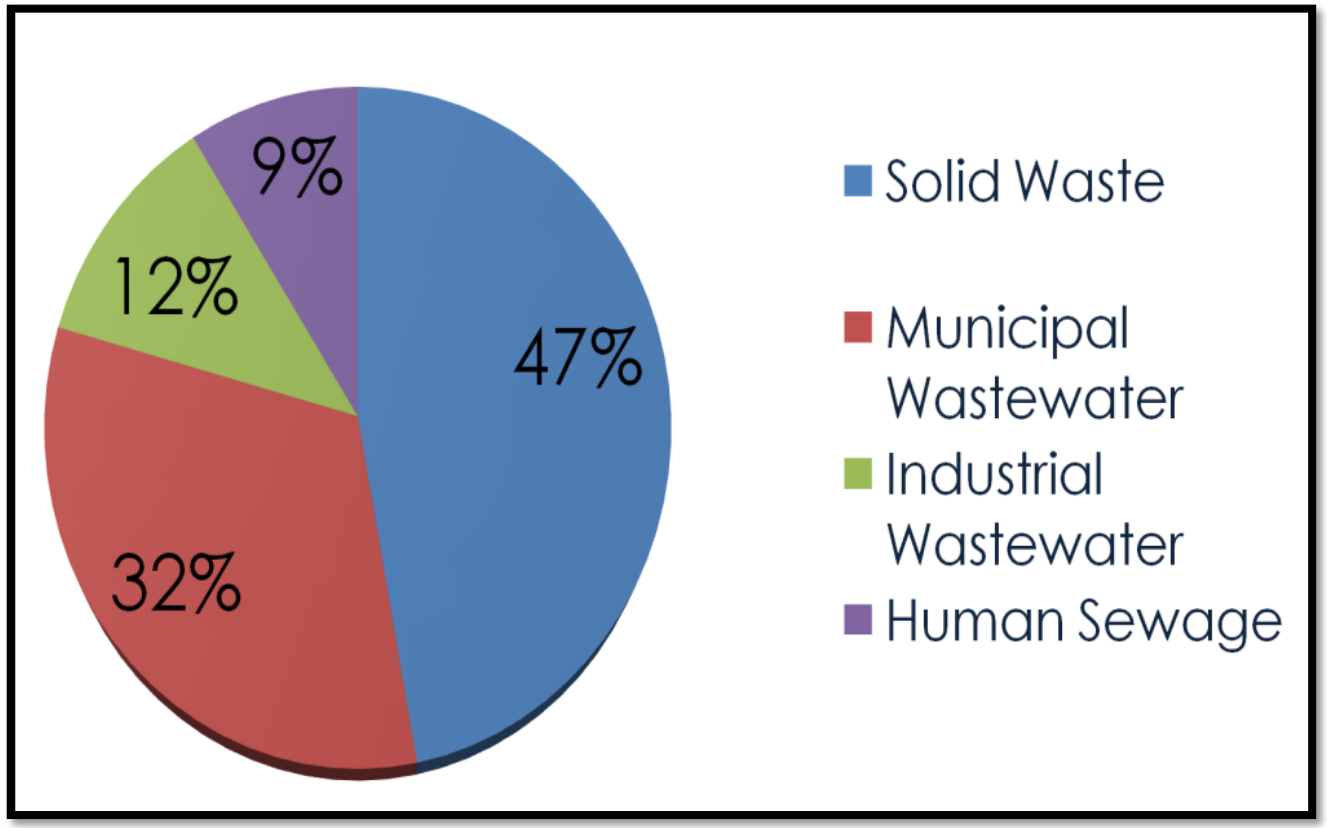
- A person generates around **0.40 kg daily in Philippines.**

- Solid waste management is a challenging issue in Philippines, specially in urban areas like Metro Manila.

- Key problems identified in waste sector are,
  - Improper wastes disposal
  - Inefficient wastes collection
  - Lack of disposal facilities

Greenhouse gas emissions from the waste sector in Philippines in 2000.

- Sources,
  - Solid wastes
  - Industrial and municipal wastewater
  - Human sewage

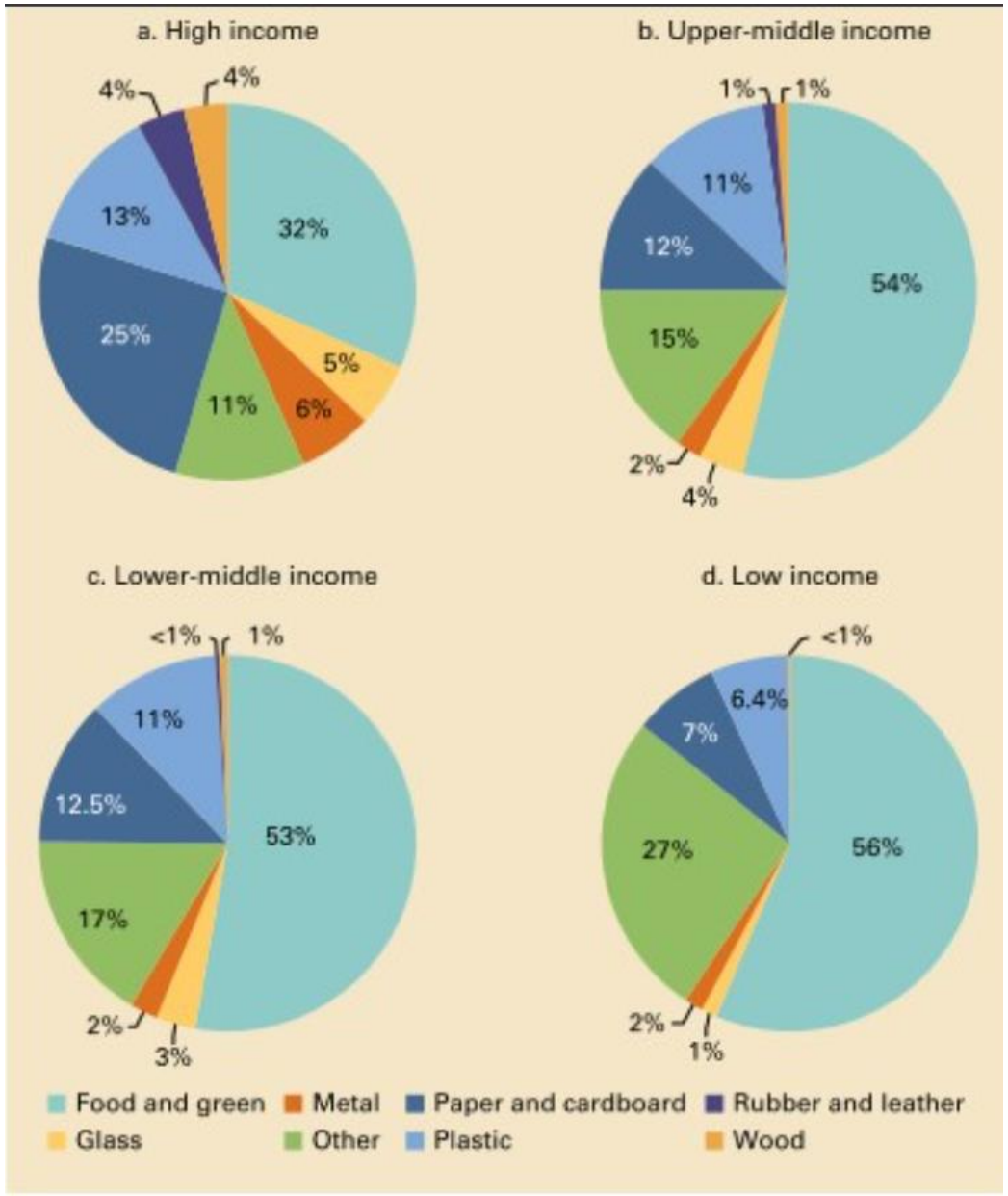


In 2000, the waste sector released 11,556 Gg of CO_2 to the atmosphere.

Approximately 47% of the total emissions come from solid waste which generated 259 Gg of CH_4.

Waste Generation

- The daily waste generation can be affected by changes in lifestyle, urbanization level, and migration patterns.



Waste Generation Cont..

- The Philippines' waste generation continues to rise with the
  - Increase in population
  - Rapid economic growth
  - Industrialization

- The NSWMC calculated that from 37,427.46 tons per day in 2012, the country's waste generation steadily increased to 40,087.45 tons in 2016. (AAG_Philippine Solid Wastes_Nov2017.pdf (senate.gov.ph)

- The World Bank (2012) estimates that solid waste being produced by Philippine cities will go up by 165 percent to 77,776 tons per day from 29,315 tons as a consequence of a projected 47.3-percent hike in urban population by 2025.

Waste Generation of the Philippines by region 2012-2016 (Tons per day)

- Source : [AAG_Philippine Solid Wastes_Nov2017.pdf (senate.gov.ph)]

Region	2012	2013	2014	2015	2016
1	1,709.17	1,739.54	1,769.90	1,800.27	1,830.64
2	1,100.64	1,120.19	1,139.75	1,159.31	1,178.86
3	3,631.99	3,696.52	3,761.05	3,825.58	3,890.12
4a	4,145.52	4,219.18	4,292.83	4,366.49	4,440.15
4b	909.43	925.59	941.74	957.90	974.06
5	1,878.74	1,912.12	1,945.50	1,978.88	2,012.26
6	2,700.14	2,748.11	2,796.09	2,844.06	2,892.04
7	2,605.68	2,651.97	2,698.27	2,744.57	2,790.86
8	1,479.47	1,505.75	1,532.04	1,558.33	1,584.61
9	1,391.95	1,416.68	1,441.41	1,466.15	1,490.88
10	1,693.94	1,724.03	1,754.13	1,784.23	1,814.32
11	1,818.05	1,850.35	1,882.65	1,914.95	1,947.26
12	1,348.20	1,372.15	1,396.10	1,420.06	1,444.01
13	884.69	900.41	916.13	931.85	947.57
CAR	620.64	631.67	642.70	653.72	664.75
NCR	8,601.60	8,754.43	8,907.26	9,060.09	9,212.92
ARMM	907.64	923.76	939.89	956.02	972.14
TOTAL	**37,427.46**	**38,092.46**	**38,757.46**	**39,422.46**	**40,087.45**

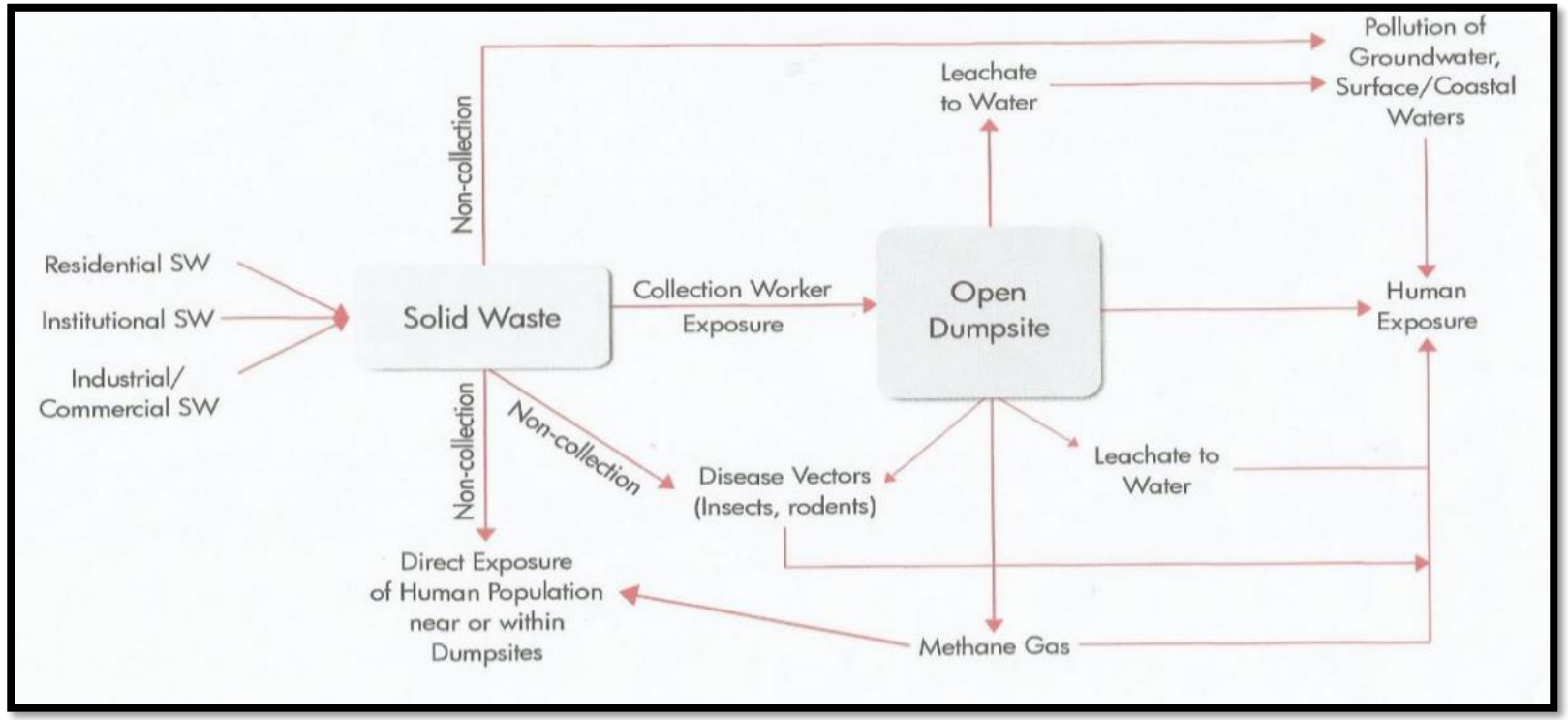
Synthesized waste generation rates in the Philippines, Base Year 2010

- Source : NSWMC 2014

Scope/Coverage	Weighted Average (kg/cap/day)	Difference from National Average (kg)
Philippines (Nationwide)	0.40	0
Metro Manila and HUCs	0.69	+0.29
Other cities and provincial capitals (excl. NCR/HUCs)	0.50	+0.10
Municipalities (excluding cities and some capital towns)	0.31	-0.09

Waste management

Improper waste management can cause significant negative impacts to the environment.



Solid waste exposure pathways (source: 3-Solid-Waste-1.8.pdf)

The implementation of the Philippines Republic Act 9003 – Ecological Solid Waste Management Act of 2000

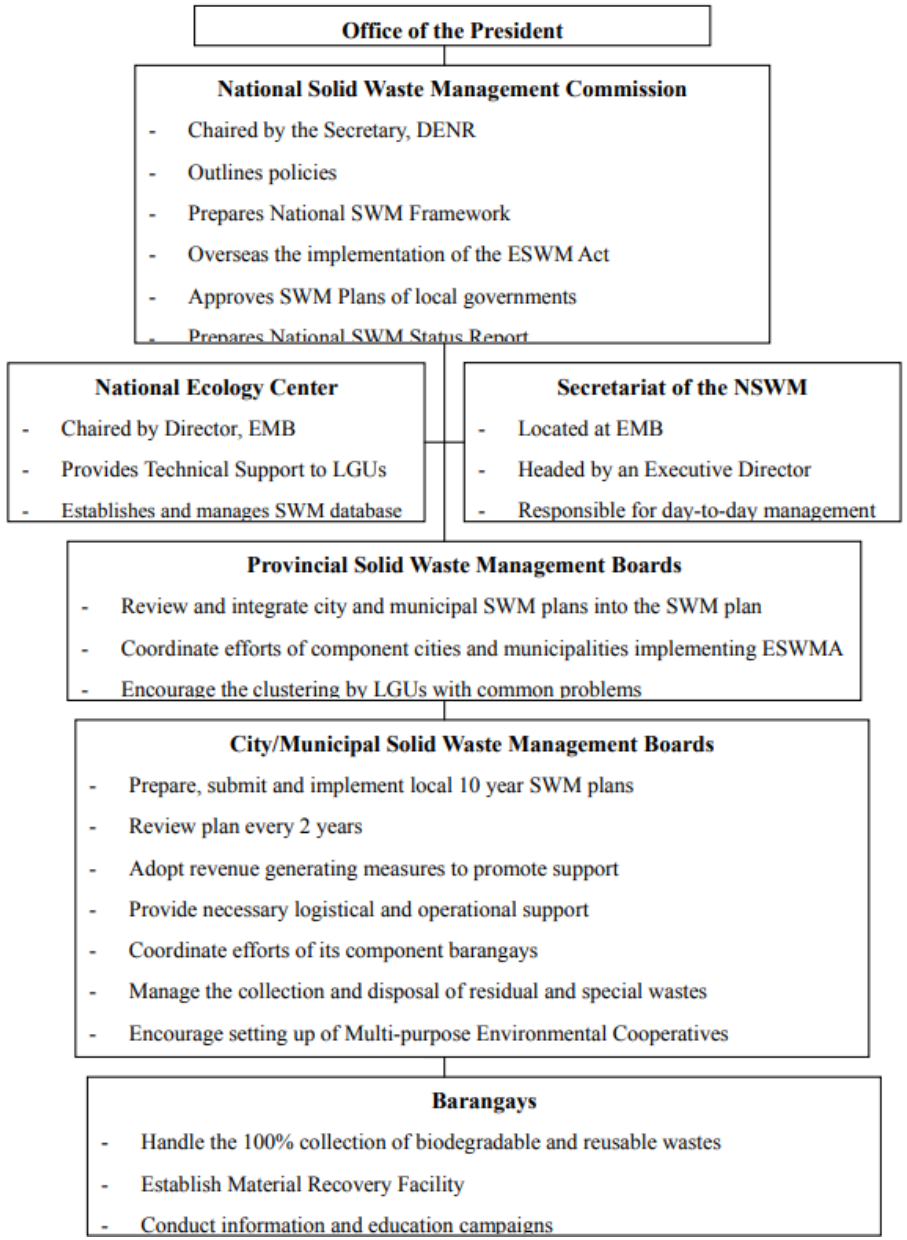
The Philippine government enacted the Republic Act 9003 on 26 January 2001.

It provides the legal framework for the country's systematic, comprehensive and ecological solid waste management program which ensures the protection of public health and environment.

It provides for the necessary institutional mechanisms with the creation of the National Solid Waste Management Commission (NSWMC) which shall oversee the implementation of solid waste management plans and prescribe policies as well as incentives to achieve objectives of the Act.

- The ecological solid waste management (ESWM) policy is based on the management of waste in the following hierarchy,
  - Source reduction (avoidance) and minimization of waste generated at source
  - Reuse, recycling and resource recovery of wastes at the barangay level
  - Efficient collection, proper transfer, and transport of wastes by city/municipality
  - Efficient management of residuals and of final disposal sites and/or any other related technologies for the destruction/reuse of residuals

Institutional Arrangement mandated by the ESWMA



Local Solid Waste Management Plans

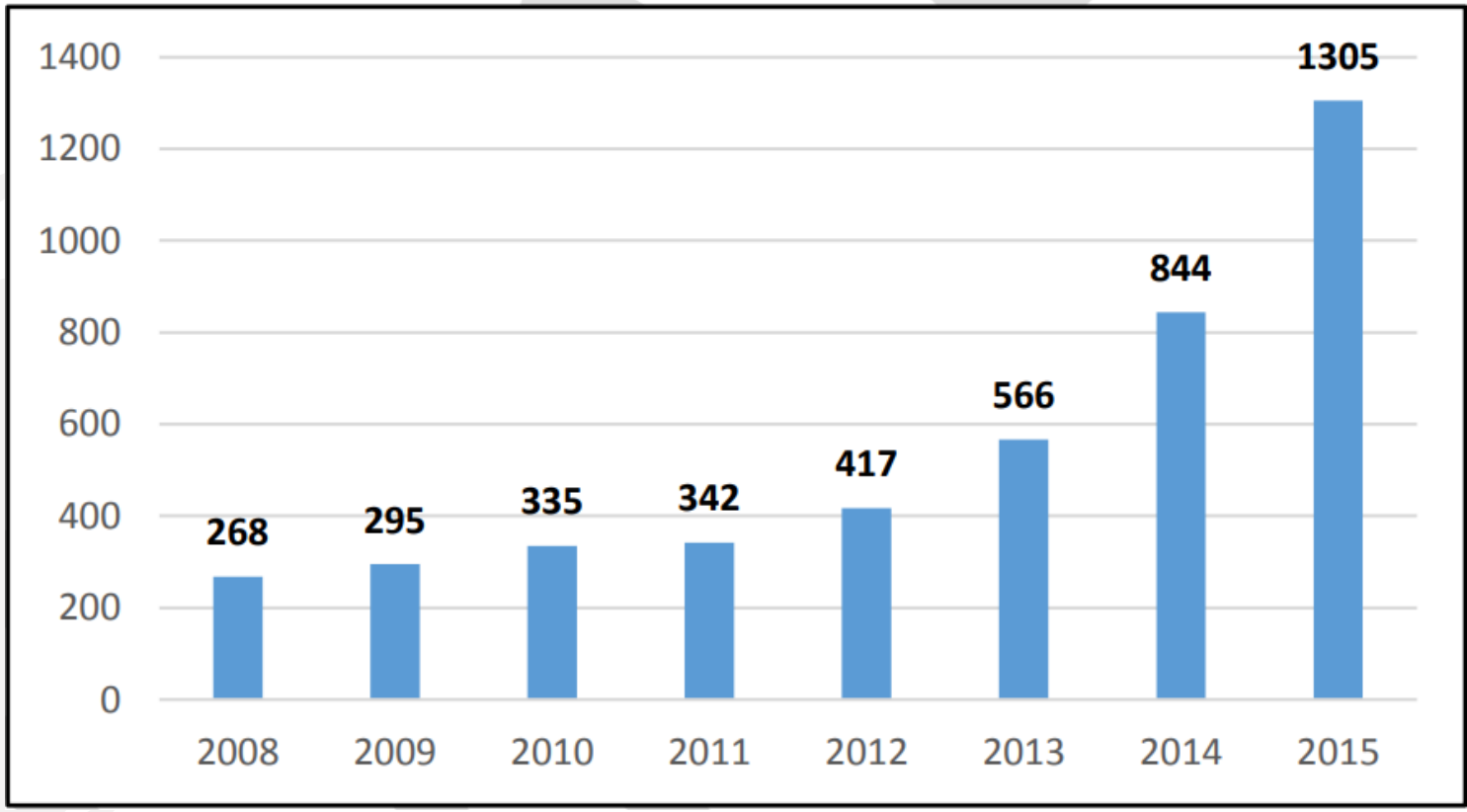
- The Ecological Solid Waste Management Act requires the preparation of 10-year SWM plans by provinces, cities and municipalities consistent with the national SWM Framework.

- The plans are subject to annual review and updating by the provincial, city or municipal SWM boards.

- All plans must be approved by the NSWMC.

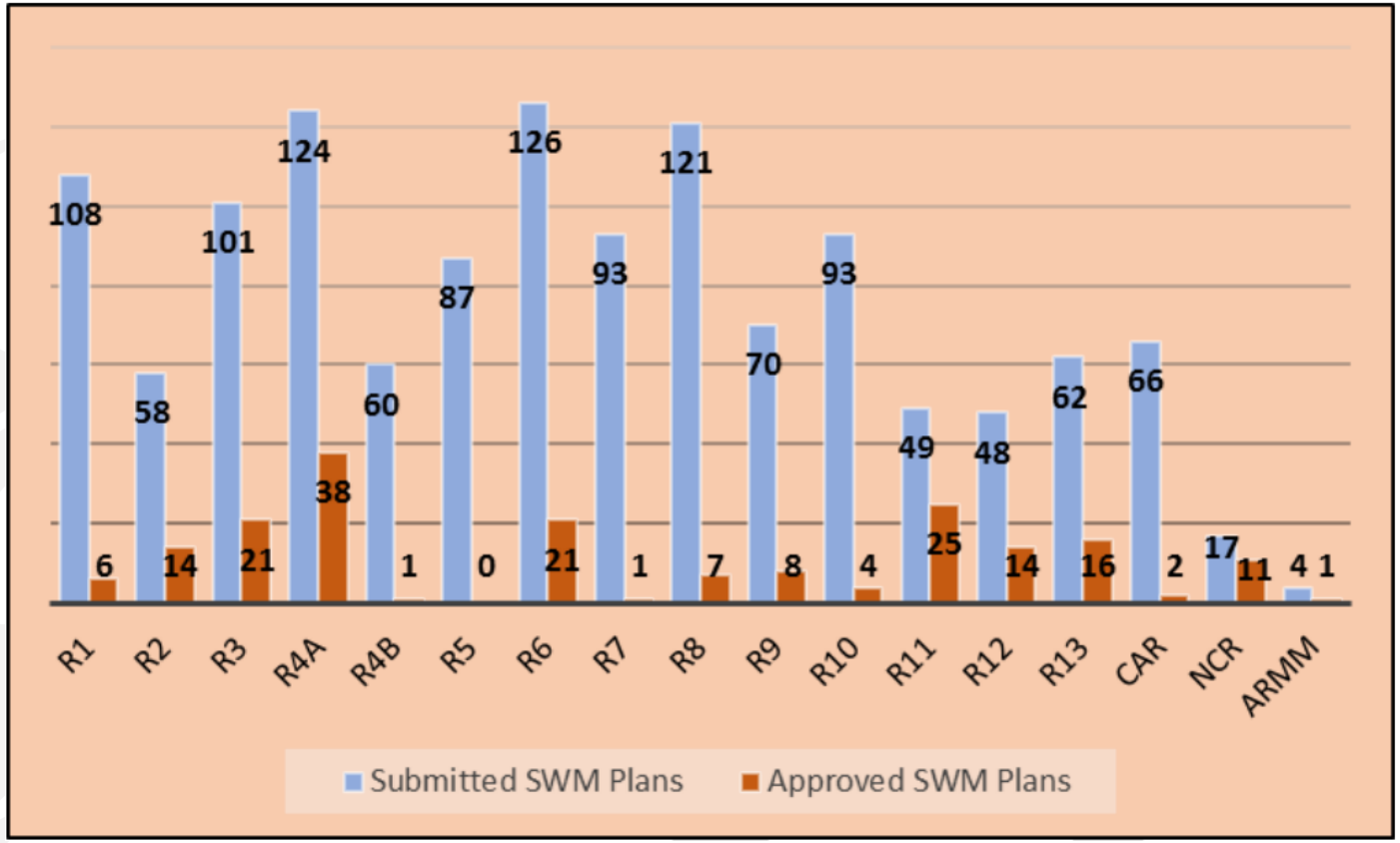
Number of 10-year SWM Plans submitted to NSWMC from 2008 to 2015

- Source: [3-Solid-Waste-1.8.pdf (emb.gov.ph)]



Approved viz-a-viz submitted SWM plans per region, 2015

- Source : [3-Solid-Waste-1.8.pdf (emb.gov.ph)]



Other SWM-related laws and policies in Philippines

- Republic Act No. 6969 (Toxic Substances and Hazardous and Nuclear Waste Act of 1990)
- Republic Act No. 7160 (Local Government Code (LGC) of 1991)
- Republic Act No. 8749 (Clean Air Act of 1999)
- Republic Act No. 9275 (Philippine Clean Water Act of 2004)
- Republic Act No. 9512 (Environmental Awareness and Education Act of 2008)
- Presidential Decree No. 1586 (Environmental Impact Assessment Law)

National policy frameworks that support solid waste management in Philippines

- National Solid Waste Management Framework (NSWMF) (2004)
- National Framework Strategy on Climate Change (NFSCC) - Chapter 8: Mitigation pillar on waste management (2010-2022)
- The Philippine National Solid Waste Management Strategy (NSWMS) (2012-2016)

Waste collection

- Collection is the act of removing solid waste from the source or from a communal storage point.
- It is potentially the most expensive of the functional elements of SWM
- Reasons identified for waste collection inefficiencies in Philippine are:
  - poor labor management and supervision
  - inadequate cooperation from the citizenry with collection schedules and methods
  - inappropriate type and size of collection vehicles
  - long vehicle down times from poor equipment maintenance and repair
  - harsh driving conditions at disposal sites cause vehicle and tire damage

Recovery and Processing

Materials Recovery Facility (MRF)

- The MRF shall be designed to receive, sort, process and store compostable and recyclable material efficiently and in an environmentally sound manner.
- Any resulting residual waste shall be transferred to a proper disposal facility.
- MRFs can be established in schools, malls, and other commercial establishments.

Low-cost MRFs in the Philippines

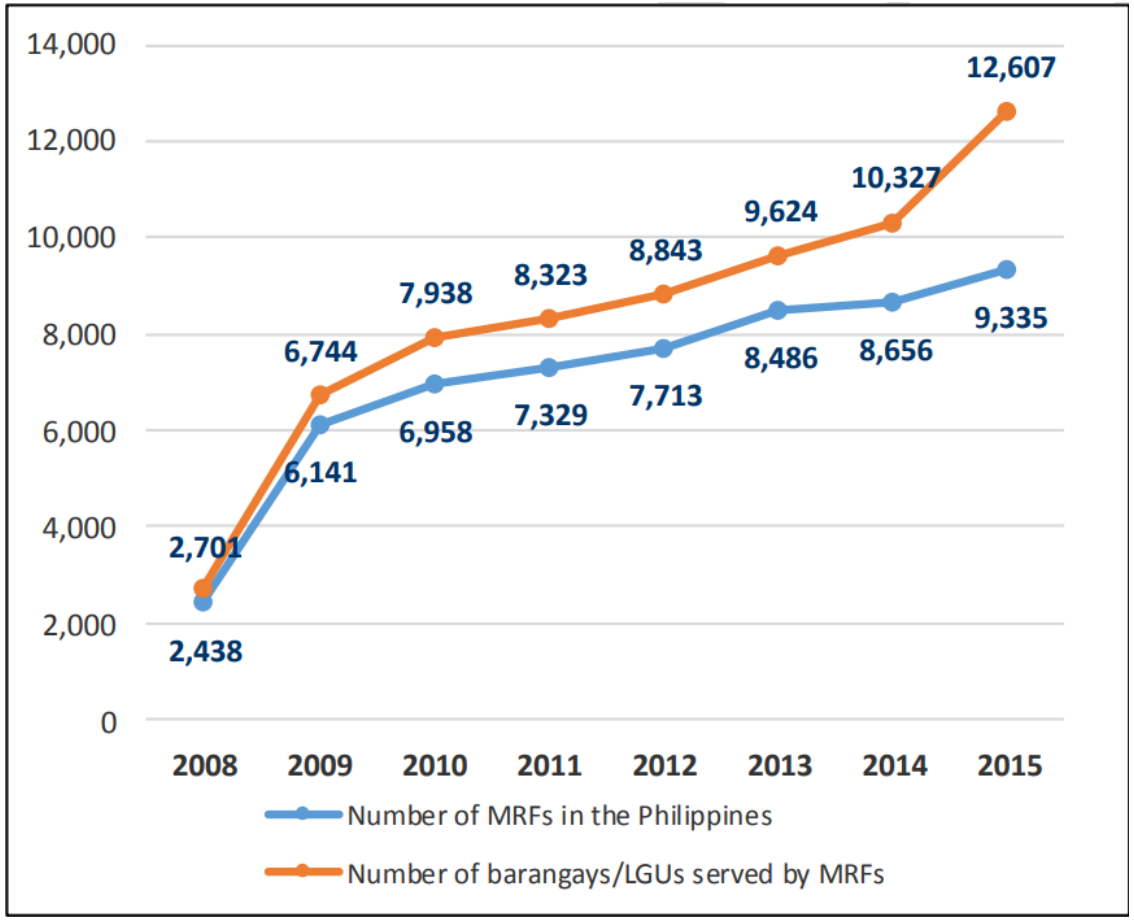
Source : [3-Solid-Waste-1.8.pdf (emb.gov.ph)]

Mobile MRFs


COMMUNITY-BASED ECOLOGICAL SOLID WASTE MANAGEMENT PROGRAMME IN THE PHILIPPINES
(PROJECT ID: 00014472)
Barangay Rosario Mobile MRF
Launching and Turnover
KUBO SA ROSARIO, ROSARIO PASIG CITY
MATERIALS RECOVERY


MAKATI
MATERIAL
RECOVERY
FACILITY

Number of MRFs and the number of barangays served by MRFs from 2008 to 2015



Source :[3-Solid-Waste-1.8.pdf (emb.gov.ph)]

Composting

- In Philippine, typical small-scale composting is done in compost pits, tire towers, coconut shell stack, bottomless bins, clay pots and plastic sacks.

- Large-scale composting is done in windrows (by turning, passive aeration, active aeration and static piles), in-vessel (e.g., agitated beds, composting silos and rotating drum bioreactors), and through vermi or worm composting.

Recycling

Various recycled materials for personal and home use

However, recycling rate in Philippines has been increased with the time.

The below table shows the recycling rates in Metro Manila

Year	Recycling Rate (%)
1997	6
2000	13
2002	25
2006	28
2009	31

Source : 2. Waste Management and the 3Rs in the Philippines from The 3Rs and Poverty Reduction in Developing Countries: Lessons from Implementation of Ecological Solid Waste Management in the Philippines on JSTOR

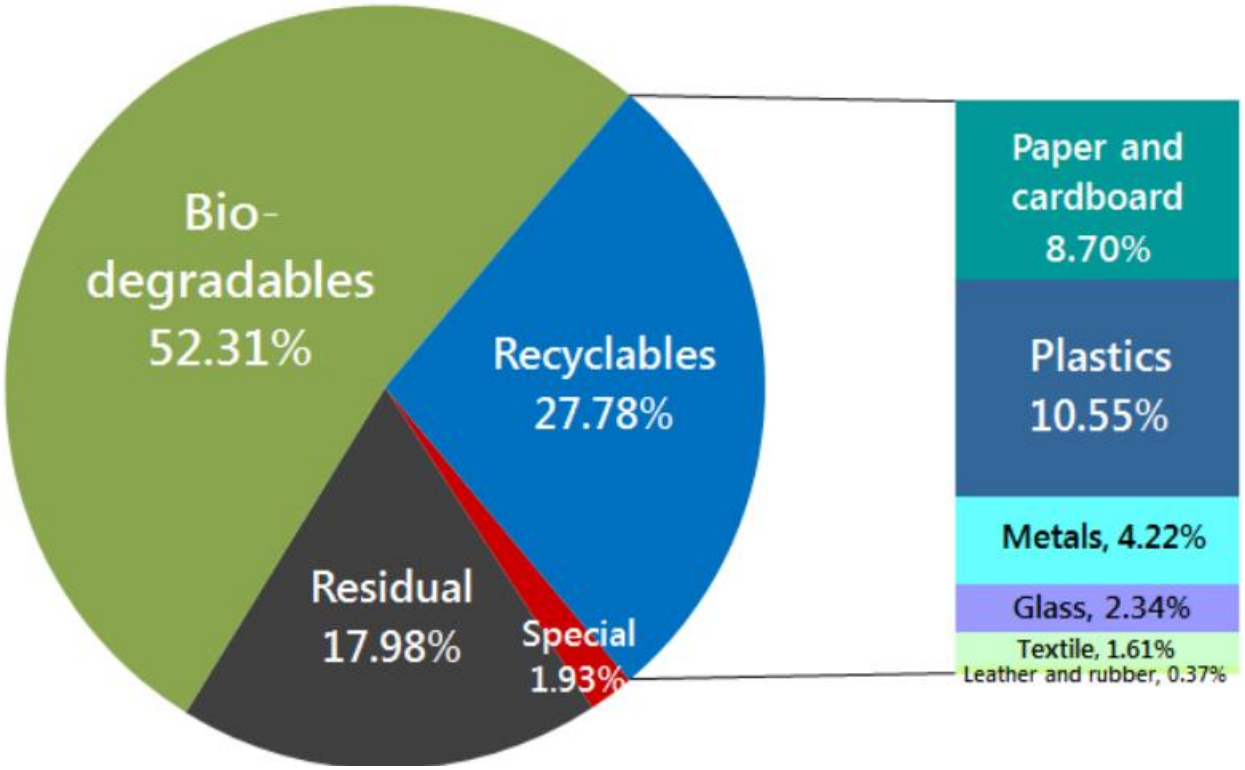
Based on a 2008 study by NSWMC and JICA, primary waste collectors could divert significant number of recyclables from the waste stream as shown in the table below. (unit: kg/capita/day)

- Source: 3-Solid-Waste-1.8.pdf (JICA Study, 2008)

Recyclable Material	Primary Collector	Metro Manila	Metro Cebu	Southern Mindanao
Paper	Street Collectors	3.18	3.59	2.45
	Collection Workers	21.83	1.81	0.62
	Disposal Site Scavengers	22.01	8.21	12.86
Aluminum	Street Collectors	0.76	0.35	0.40
	Collection Workers	0.78	0.13	0.02
	Disposal Site Scavengers	2.50	0.05	1.79
Other Metals	Street Collectors	1.39	5.04	14.76
	Collection Workers	12.35	0.94	0.64
	Disposal Site Scavengers	16.75	6.34	13.75
Plastic	Street Collectors	1.63	3.94	3.50
	Collection Workers	9.79	0.50	0.63
	Disposal Site Scavengers	20.32	4.48	25.00
Glass	Street Collectors	0.85	0.58	6.65
	Collection Workers	6.58	0.26	0.94
	Disposal Site Scavengers	9.96	0.32	49.64

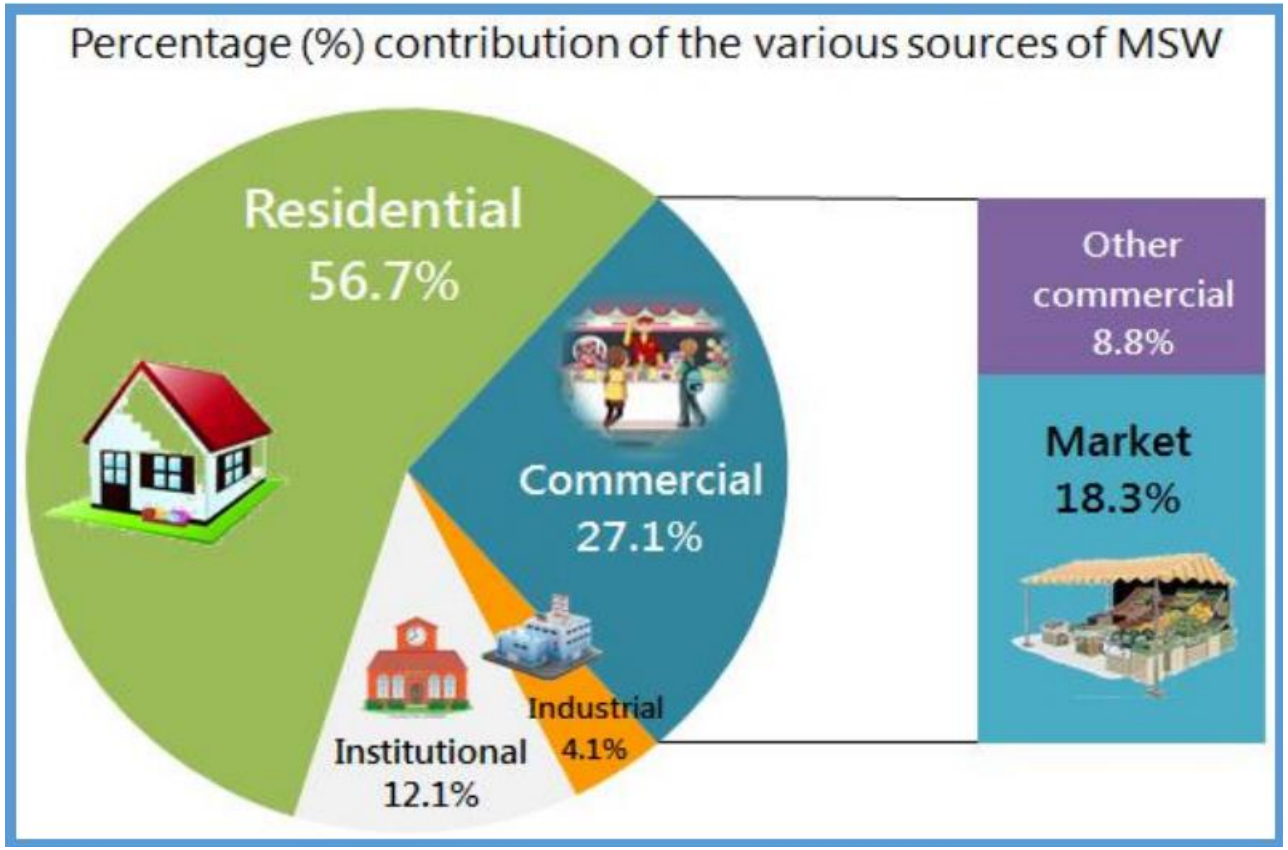
Waste Composition

According to NSWMC, 2014, waste composition of the Philippines can be described as below.

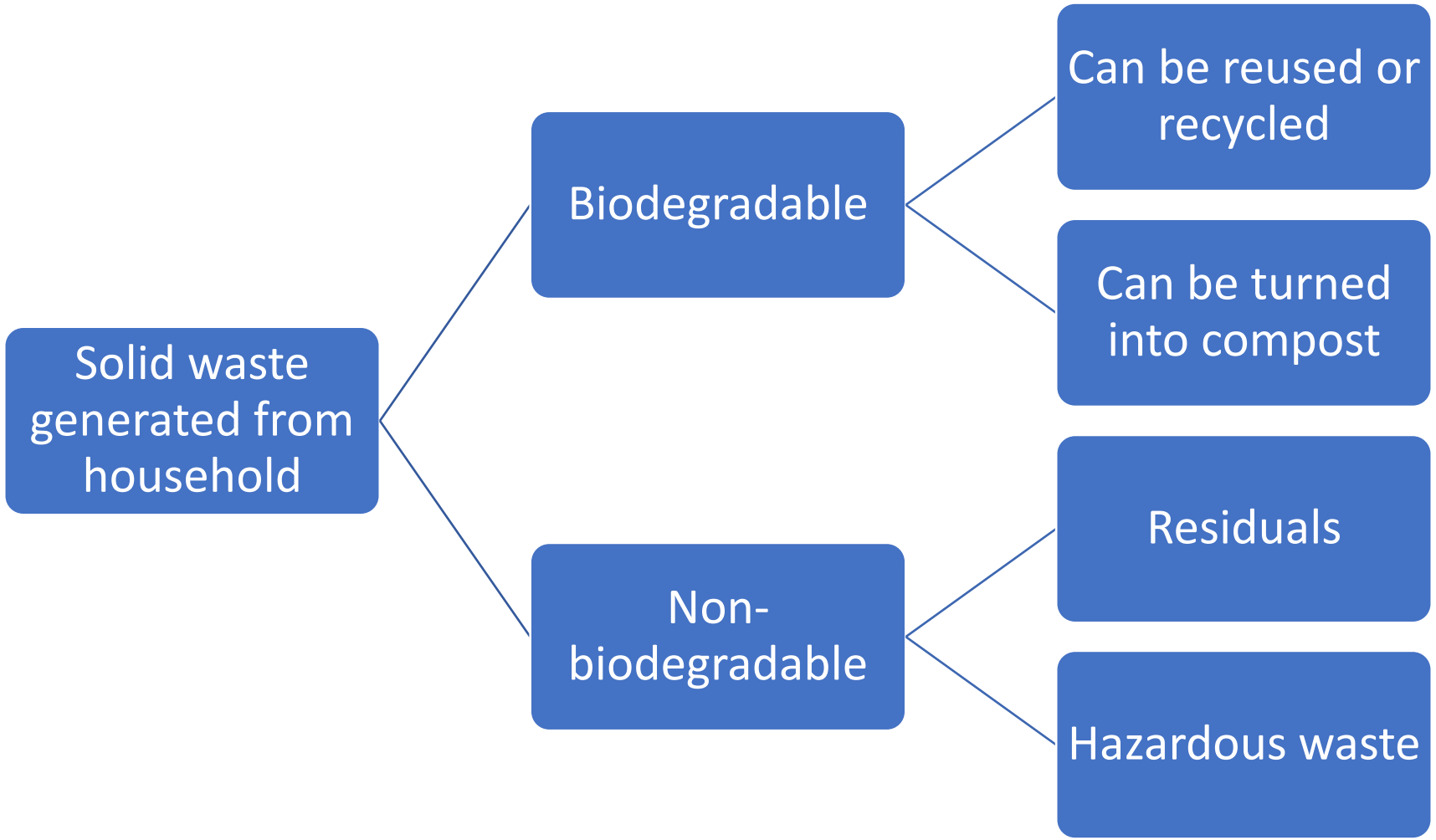


Source : [15 Statistics about Solid Waste Management in the Philippines that Every Filipino should Know (Updated 2022!) - EnP Tinio]

- Most of solid waste that is generated in Philippine, come from **residential sources.**
- These are in the form of **kitchen scraps, yard waste, paper, and plastic.**



Source: [Solid-Wastefinaldraft-12.29.15.pdf (emb.gov.ph)]



Source: https://www.jstage.jst.go.jp/article/jsmcwm/24/0/24_677/_pdf

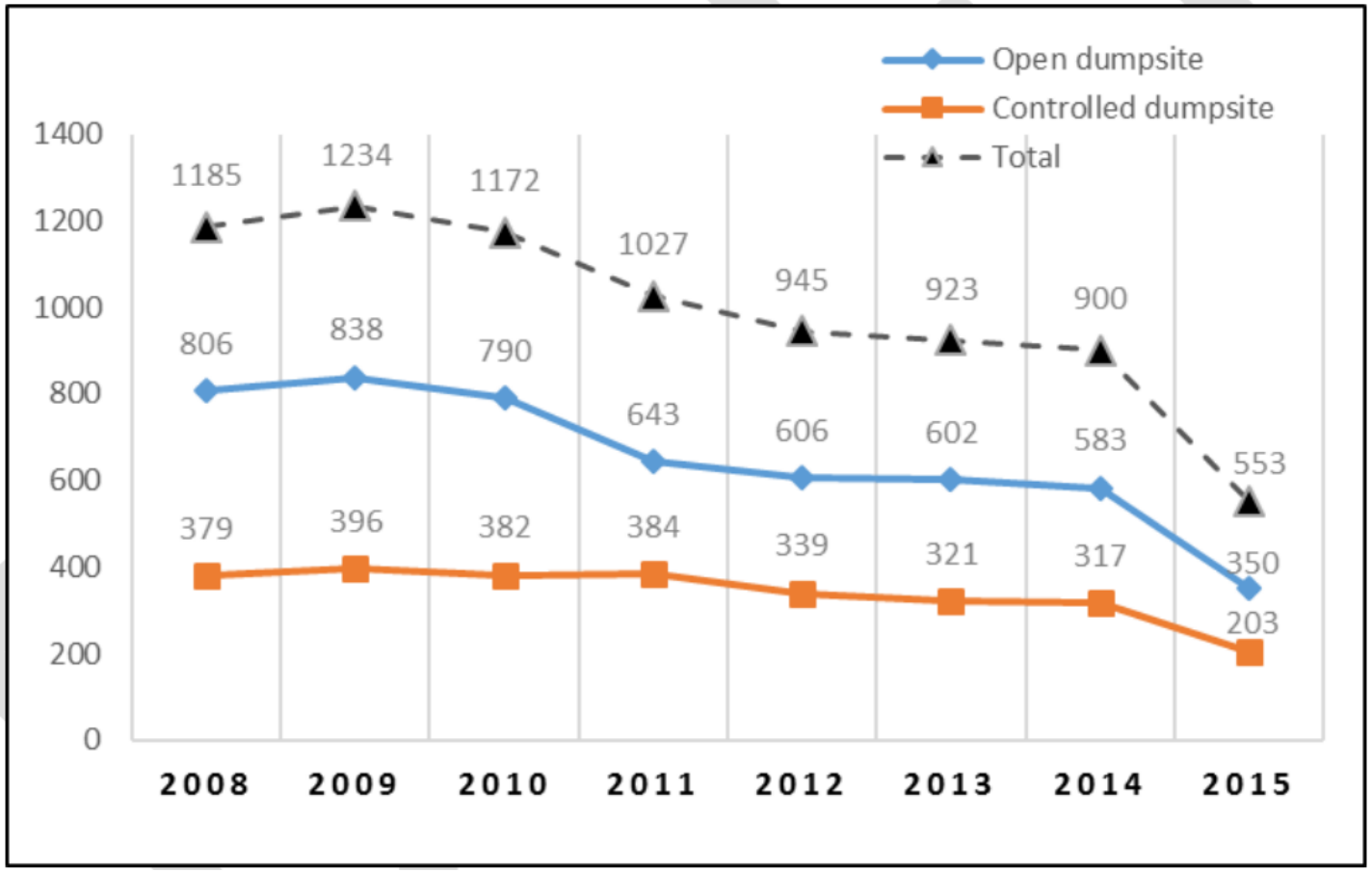
Disposal sites

- Waste disposal refers to the discharge, deposit, dumping, spilling, leaking or placing of any solid waste into or in any land while disposal sites refer to areas where solid waste is finally discharged and deposited.

Open and controlled dumpsites

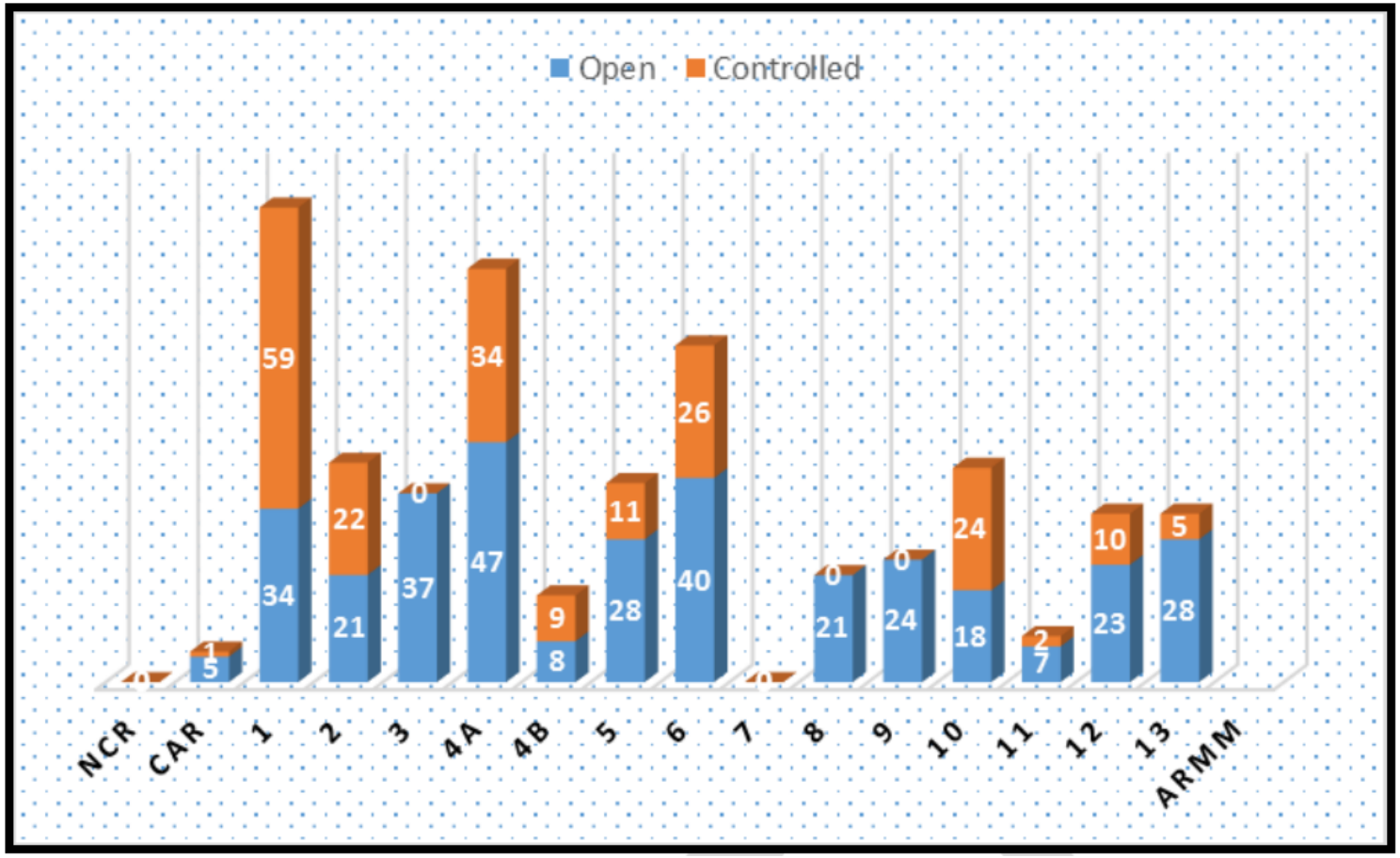
- Number of open dumpsites in the country has decreased by more than half over the past 8 years from 806 in 2008 to 350 in 2015. (3-Solid-Waste-1.8.pdf (emb.gov.ph))

Number of dumpsites existing from 2008 to 2015 in Philippine



Source : [3-Solid-Waste-1.8.pdf (emb.gov.ph)]

Number of open and controlled dumpsites in 2015, per region in Philippine



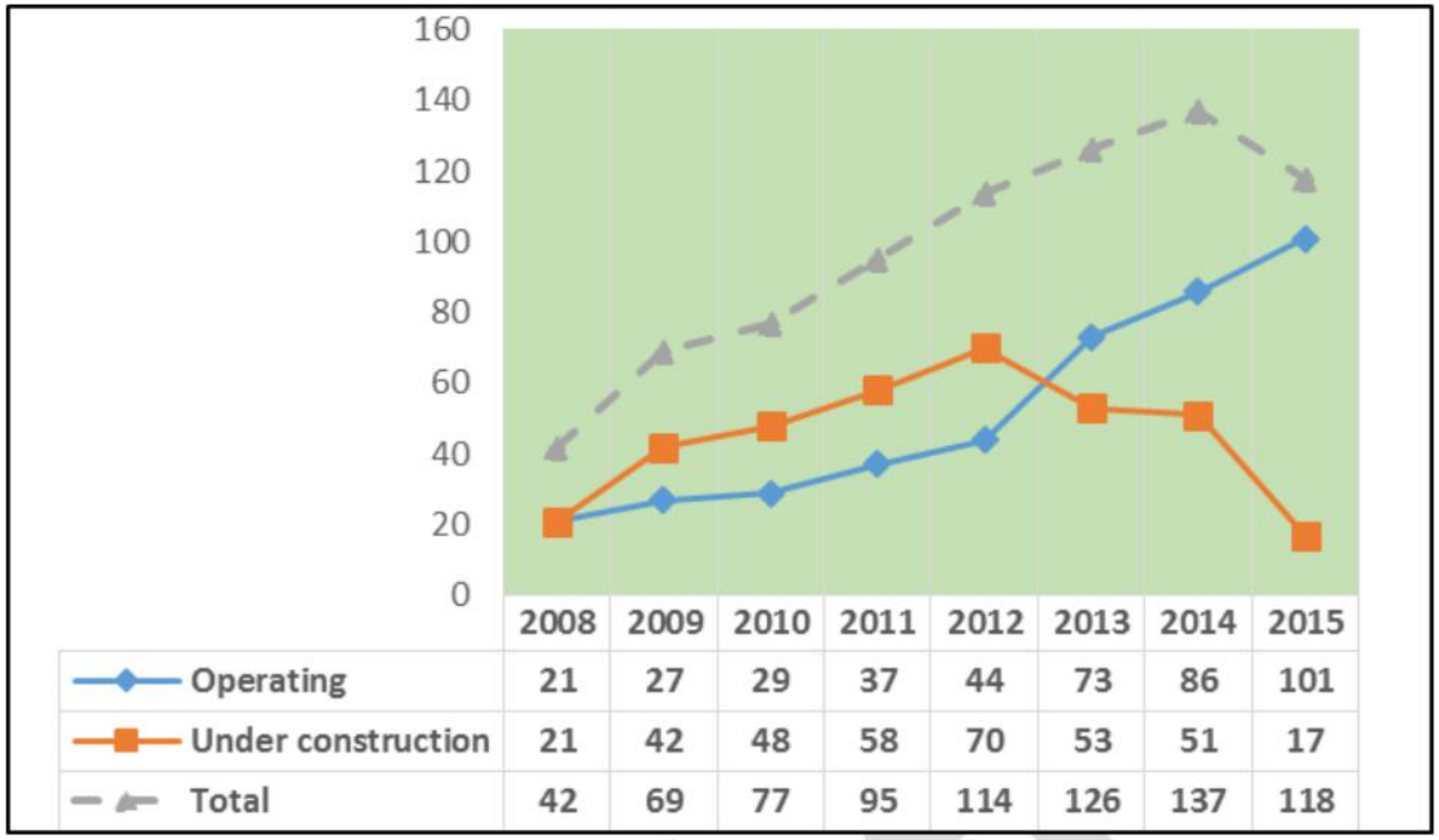
Source : [3-Solid-Waste-1.8.pdf (emb.gov.ph)]

Sanitary landfills

- Prior to 2004, the country had only four sanitary landfills - located in Capas, Tarlac, Inayawan, Cebu City, San Mateo, Rizal and Carmona, Cavite.

- The number of SLFs doubled within a four-year period from 2008 to 2012 but the number more than doubled within a span of three years from 2012 to 2015.

Number of SLFs (operating and under construction) from 2008 to 2015



	2008	2009	2010	2011	2012	2013	2014	2015
Operating	21	27	29	37	44	73	86	101
Under construction	21	42	48	58	70	53	51	17
Total	42	69	77	95	114	126	137	118

Source : 3-Solid-Waste-1.8.pdf (emb.gov.ph) NSWMC

Clustered landfills

- Clustering is an option in which small LGUs can pool their resources into setting up a common solid waste disposal facility.
- It also enables to attain large economies of scale and reduce the cost per unit of solid waste disposal.
- Forms of clustering in the Philippines include private sector-led ventures that offer their landfills where LGUs dispose their residual waste upon payment of tipping fees.

Example for a clustered sanitary landfill in Surallah, South Cotabato

Number of solid waste disposal facilities in the Philippines from 2012 to 2022, by year

- Source : [Philippines: solid waste disposal facilities by type | Statista]

Characteristic	Open dump	Controlled dump	Materials recovery facility	Sanitary landfill	Illegal dumpsites
2012	606	339	7,713	44	-
2013	602	321	8,486	55	-
2014	583	317	8,656	86	-
2015	350	203	9,335	101	-
2016	403	108	9,883	118	-
2017	296	89	10,052	135	-
2018	-	-	10,340	165	353
2019	-	-	10,722	187	331
2020	-	-	11,546	241	233
2021	-	-	11,637	245	-
2022	-	-	11,779	290	-

Incineration of waste

- Waste incineration is the use of high temperature furnaces to combust waste and reduce its volume and mass.
- The process of incineration can be applied for municipal solid waste, hazardous waste, and medical waste.
- In Philippines, pursuant to section 20 of Republic Act No.8749 otherwise known as the “ Philippine Clean Air Act of 1999, incineration for treating municipal, biomedical and hazardous wastes is prohibited due to emitting poisonous and toxic fumes.

Republic of the Philippines
Department of Environment and Natural Resources
Visayas Avenue, Diliman, Quezon City
Tel Nos. (632) 929 66 26 to 29 • (632) 929 62 52
929 66 20 • 929 66 33 to 35
929 70 41 to 43

MEMORANDUM CIRCULAR NO. 2002-05
Series of 2002

"JUL" 12 2002

SUBJECT : **CLARIFICATION ON THE INCINERATOR BAN IN THE PHILIPPINE CLEAN AIR ACT OF 1999 (REPUBLIC ACT NO. 8749)**

Pursuant to Section 20 of Republic Act No. 8749 otherwise known as the "Philippine Clean Air Act of 1999," incineration for treating municipal, bio-medical and hazardous wastes, which process emits poisonous and toxic fumes is prohibited. Further, Section 5t of the same Act defines poisonous and toxic fumes as emissions and fumes which are beyond internationally – accepted standards, including but not limited to World Health Organization (WHO) guideline values.

Further, in a decision of the Supreme Court in the case of the Metro Manila Development Authority (MMDA) versus Jancom Environmental Corporation G.R. No. 147465 dated 30 January 2002, it held in agreement with the ruling of the Court of Appeals on 13 November 2001 that Section 20 of RA 8749 does not prohibit incineration of wastes except those burning processes which emit poisonous and toxic fumes. Quoted hereunder is an excerpt of said decision.

> *"Section 20 does not absolutely prohibit incineration as a mode of waste disposal; rather only those burning processes which emit poisonous and toxic fumes are banned."*

In view of the Supreme Court decision, this Memorandum Circular hereby clarifies that any thermal treatment technology, whether burn or non-burn as defined in DAO 2000-81, that meets the emission standard for stationary sources as listed in Section 19 of RA 8749 and complies with all other relevant provisions of RA 8749 and other applicable laws of the Republic, is allowed to be operated in the country.

However, in the meantime that this office has insufficient capabilities with respect to the monitoring of emission from municipal solid waste incineration, i.e. personnel, equipment, infrastructure, etc., this Memorandum Circular covers only the incineration of toxic and hazardous as well as medical and bio-medical wastes, in view of the limited appropriate disposal techniques and procedures for said wastes. Toxic and hazardous wastes are those defined in RA 6969 while medical and bio-medical wastes are those indicated in RA 8749 and its Implementing Rules and Regulations (DENR Administrative Order No. 2000-81, Series of 2000).

Moreover, incineration of said wastes shall only be allowed in state-of-the-art facilities which are proven to emit minimal air pollutants, the concentrations of which shall meet the standards as provided for in RA 8749 and its Implementing Rules and Regulations.

The Environmental Management Bureau (EMB) shall issue the appropriate technical and procedural guidelines necessary to facilitate implementation of this Circular.

HEHERSON T. ALVAREZ
Secretary

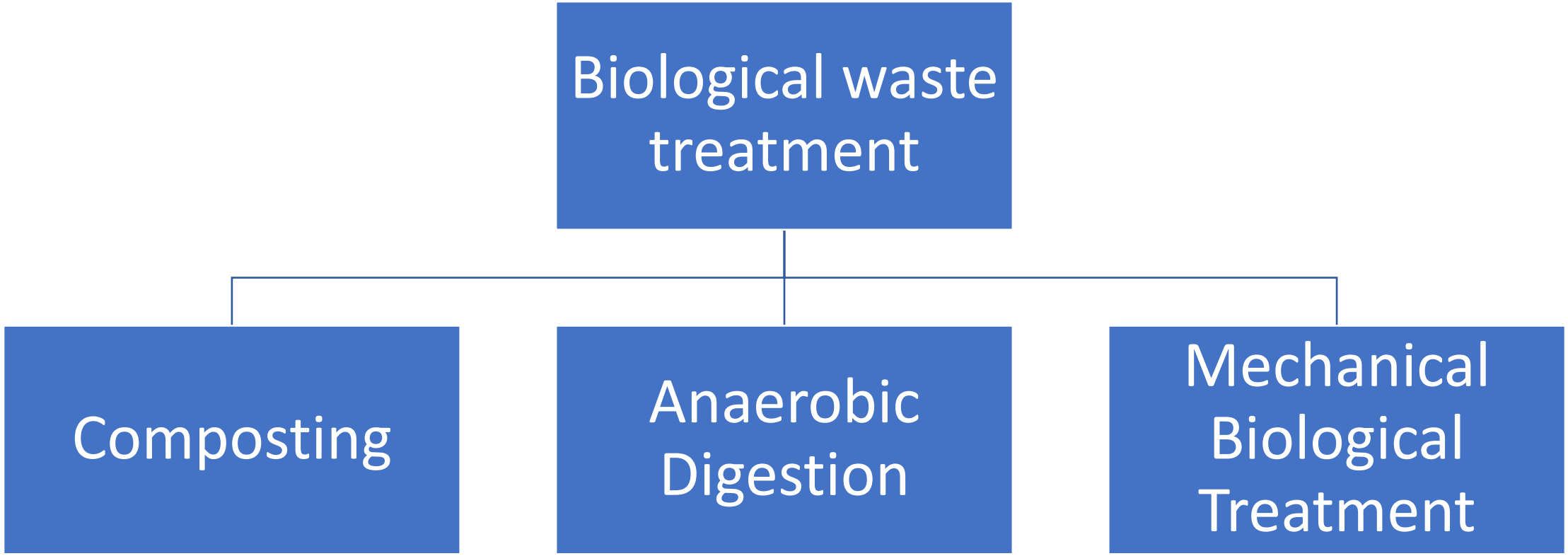
- However, Officials of Cebu City, the country's second biggest metropolis, signed a joint venture for a garbage incinerator to be completed by 2025.

- This is the first large-scale Waste To Energy in the country, after a proposal for a US$423 million facility in Quezon City stalled in 2019.

- But the Philippine Congress and Environment Secretary Climate are called to uphold the ban on waste incineration enshrined in the Philippine Clean Air Act--instead of promoting so-called "waste-to-energy" incineration that is harmful to public health and the environment.

Biological Treatment of waste

- Biological treatment of waste affects the amount and composition of waste that will be deposited.



1. Composting

Aerobic process.

A large fraction of the degradable organic carbon (DOC) in the waste material is converted into carbon dioxide.

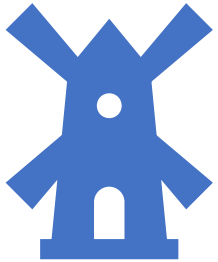
CH_4 is formed in anaerobic sections of the compost, but it is oxidized to a large extent in the aerobic sections of the compost.

Composting can also produce emissions of N_2O.

2.Anaerobic Digestion

Natural decomposition of organic material without oxygen by maintaining the temperature, moisture content and pH close to their optimum values.

Generated CH_4 can be used to produce heat and/or electricity.



N_2O emissions from the process are assumed to be negligible and on the other hand, the data on these emissions are very scarce.

3. Mechanical-biological (MB) treatment

- Becoming popular in Europe.
- The waste material undergoes a series of mechanical and biological operations that aim to reduce the volume of the waste as well as stabilize it to reduce emissions from final disposal.
- The mechanical operations separate the waste material into fractions that will undergo further treatment (composting, anaerobic digestion, combustion, recycling) which may include separation, shredding and crushing of the material.

Status of biological treatment in the Philippines

1. **<u>Bio composters</u>**

- Bio-composters are already available in the country at the barangay level.
- They rapidly convert biomass and organic waste into fertilizer.
- Bio-composters require microbes as catalysts to hasten the conversion of organic waste.

2. Anaerobic Digesters

- Useful for municipalities with high organic waste production.
- This type of organic waste treatment is common in areas where animal manure is processed.

Example : Central Luzon Region of the Philippines

- Anaerobic digesters do not require catalysts to address nutrient imbalances and microbe diversity.
- Anaerobic digesters convert organic waste into biogas that can be collected and used for other activities that require gaseous fuels.

Anaerobic Digester in Wooster, Ohio

Waste Sector

Solid waste disposal

$$DOC = \Sigma_i = (DOC_i * W_i)$$

Where,

DOC = fraction of degradable organic carbon in bulk waste, Gg C/Gg waste

DOC_i = fraction of degradable organic carbon in waste type I

W_i = fraction of waste type i by waste category

Biological Treatment of Solid Waste

CH4 emissions from biological treatment

$$CH_4 \text{ Emissions} = \Sigma_i = (M_i * EF_i) * 10^{-3} - R$$

Where,

CH4 Emissions = total CH4 emissions in inventory year, Gg CH4

M_i = mass of organic waste treated by biological treatment type i, Gg

EF = emission factor for treatment i, g CH4/kg waste treated

i = composting or anaerobic digestion

R = total amount of CH4 recovered in inventory year, Gg CH4

N2O emissions from biological treatment

$$N_2O \text{ Emissions} = \Sigma_i = (M_i * EF_i) * 10^{-3}$$

Where,

N_2O Emissions = total N2O emissions in inventory year, Gg N2O

M_i = mass of organic waste treated by biological treatment type i, Gg

EF = emission factor for treatment i, g N2O/kg waste treated

i = composting or anaerobic digestion

Calculation of National Total Emissions

Wastewater

$$CH_4\ Emissions = \left[\sum_{i,j}\left(U_i \bullet T_{i,j} \bullet EF_j\right)\right](TOW - S) - R$$

Where:

CH_4 Emissions = CH_4 emissions in inventory year, kg CH_4/yr

TOW = total organics in wastewater in inventory year, kg BOD/yr

S = organic component removed as sludge in inventory year, kg BOD/yr

U_i = fraction of population in income group *i* in inventory year, See Table 6.5.

$T_{i,j}$ = degree of utilisation of treatment/discharge pathway or system, *j*, for each income group fraction *i* in inventory year, See Table 6.5.

i = income group: rural, urban high income and urban low income

j = each treatment/discharge pathway or system

EF_j = emission factor, kg CH_4 / kg BOD

R = amount of CH_4 recovered in inventory year, kg CH_4/yr

Total Emission = CH4 Emission x GWP_CH4 + N2O Emission x GWP_N20

N_2O EMISSIONS FROM WASTEWATER EFFLUENT

$$N_2O\ Emissions = N_{EFFLUENT} \bullet EF_{EFFLUENT} \bullet 44/28$$

Where:

N_2O emissions = N_2O emissions in inventory year, kg N_2O/yr

$N_{EFFLUENT}$ = nitrogen in the effluent discharged to aquatic environments, kg N/yr

$EF_{EFFLUENT}$ = emission factor for N_2O emissions from discharged to wastewater, kg N_2O-N/kg N

The factor 44/28 is the conversion of kg N_2O-N into kg N_2O.

TOTAL NITROGEN IN THE EFFLUENT

$$N_{EFFLUENT} = \left(P \bullet Protein \bullet F_{NPR} \bullet F_{NON-CON} \bullet F_{IND-COM}\right) - N_{SLUDGE}$$

Where:

$N_{EFFLUENT}$ = total annual amount of nitrogen in the wastewater effluent, kg N/yr

P = human population

Protein = annual per capita protein consumption, kg/person/yr

F_{NPR} = fraction of nitrogen in protein, default = 0.16, kg N/kg protein

$F_{NON-CON}$ = factor for non-consumed protein added to the wastewater

$F_{IND-COM}$ = factor for industrial and commercial co-discharged protein into the sewer system

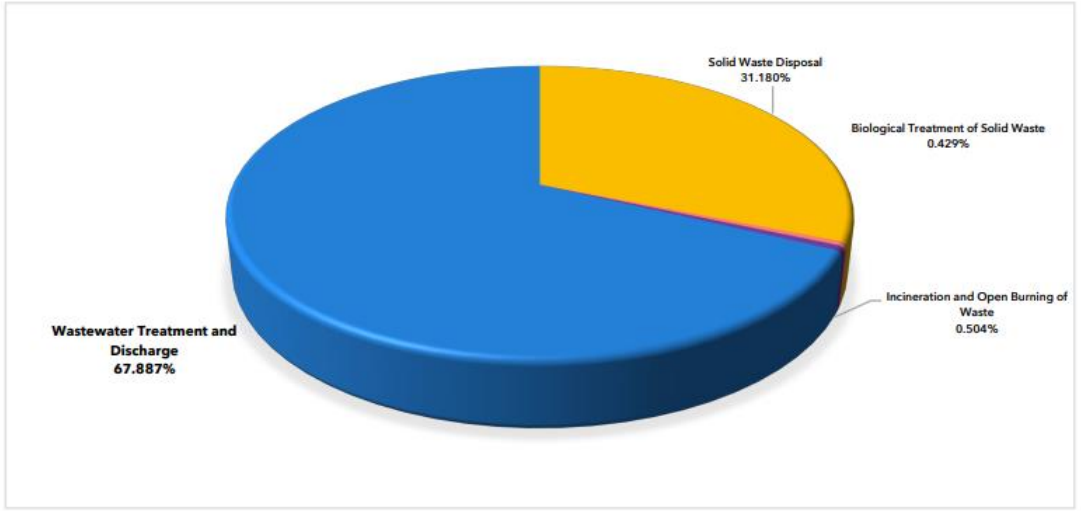
N_{SLUDGE} = nitrogen removed with sludge (default = zero), kg N/yr

Calculation of National Total Emissions

Table 8. Summary of 2010 waste sector emissions, per subsector and per gas (values in Mt CO2e)

	CO_2	CH_4	N_2O	Total
Solid Waste Disposal	-	4.851	-	4.851
Biological Treatment of Solid Waste	-	0.035	0.032	0.067
Incineration and Open Burning of Waste	0.015	0.053	0.011	0.078
Wastewater Treatment and Discharge	-	9.588	0.974	10.562
TOTAL				15.55

Figure 7. Emission shares of waste subsectors, 2010 national GHGI



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