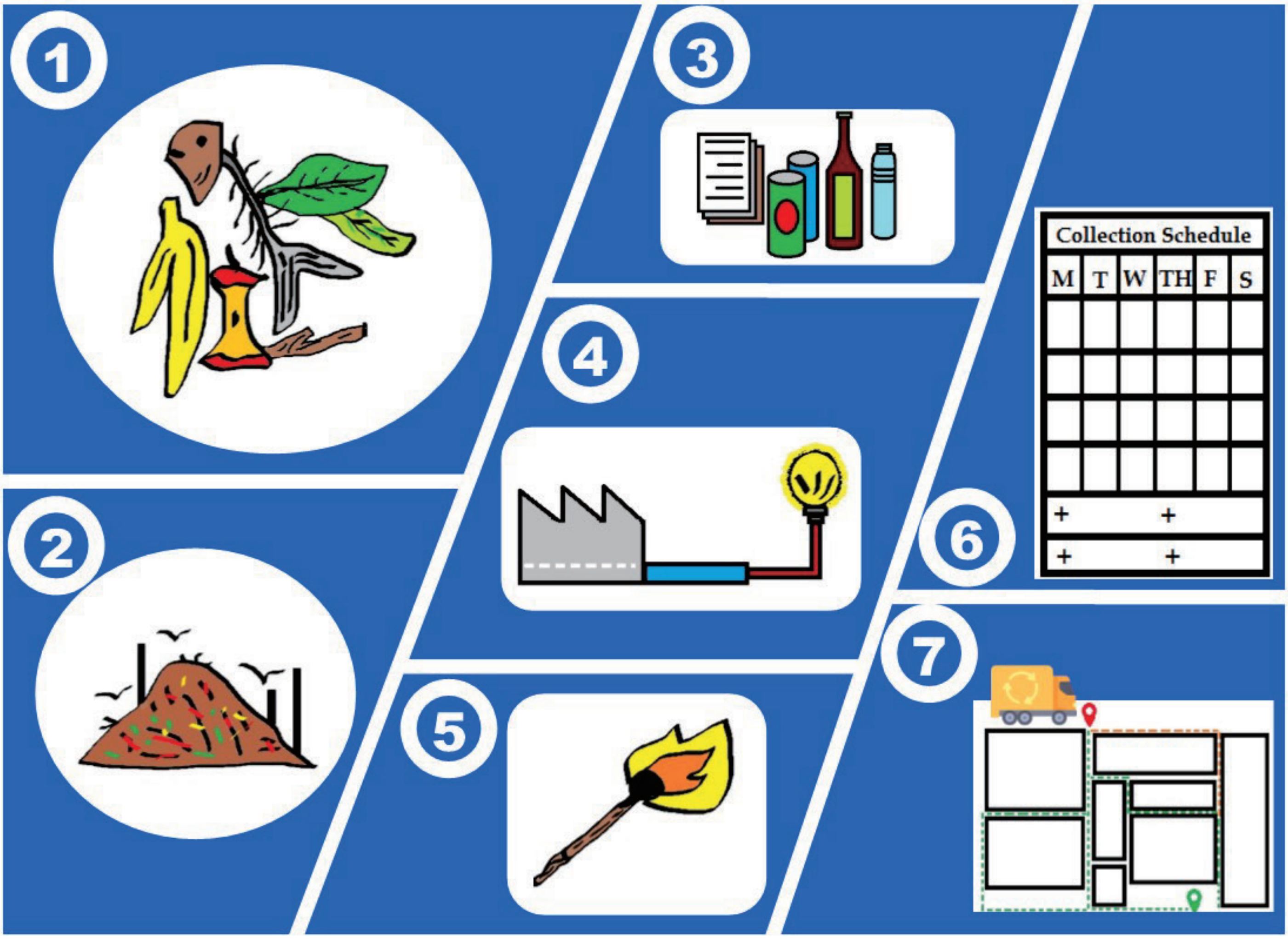
NATIONAL STRATEGY TO REDUCE SHORT-LIVED CLIMATE POLLUTANTS FROM THE MUNICIPAL SOLID WASTE SECTOR IN THE PHILIPPINES



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CLIMATE & CLEAN AIR COALITION TO REDUCE SHORT-LIVED CLIMATE POLLUTANTS

IGES Institute for Global Environmental Strategies

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Disclaimer:

FOREWORD

Even before the Philippines ratified the Paris Agreement on Climate Change in 2017, our country had been very vocal and persistent on the global stage on the urgent need to reduce greenhouse gases (GHGs) in the atmosphere. Why? Because the Philippines is among the countries most vulnerable to the adverse impacts of climate change, although its generation of GHG - the main driver of climate change - has been miniscule, estimated at 0.31 percent of global emissions in 2010 and 0.39 percent in 2015.

Accordingly the Department of Environment and Natural Resources has been safeguarding and building up the capacities of human communities and natural ecosystems to adapt to adversities, particularly the risks of disasters. The DENR has taken the lead in assessing climate change mitigation potentials in three sectors: forestry; industrial processes and product use; and waste generation, which covers both wastewater and municipal solid waste (MSW).

The MSW sector is a primary emitter of methane, which is both a GHG and short-lived climate pollutant (SLCP). Measures have been identified to avoid generating methane by diverting biodegradable wastes away from solid waste disposal sites (SWDS) or to reduce the methane that is already present.

Another SLCP, black carbon, is emitted by the MSW sector during the burning of wastes in backyards and SWDSs, the use of fossil fuels in waste collection and transport, and the operation of machineries in waste management facilities. Managing black carbon not only supports the implementation of the Ecological Solid Waste Management Act of 2000 (Republic Act 9003); it also addresses air pollution and health issues related to particulate matter emissions.

Reducing SLCP emissions is certainly beneficial. For the past years, however, what we have lacked is a coherent strategy that we can implement on a nationwide basis across the MSW sector. This need has now been addressed with the publication of this National Strategy to Reduce SLCPs from the MSW Sector in the Philippines.

For the formulation of the Philippine SLCP strategy, the DENR, as Chair of the National Solid Waste Management Commission, acknowledges the contributions of the different member-agencies and resource persons from local government units, academe, private sector, and experts from the Institute for Global Environmental Strategies and the Climate and the Clean Air Coalition.

Let us take pride in what we have accomplished, because this national SLCP strategy is not only the first of its kind in Asia; its focus on the MSW sector

Mabuhay!

BENNY DIAZ ANTIPORDA

Undersecretary for Solid Waste and Local Government Concerns, DENR

The traditional notion that municipal solid waste (MSW) management is a local or a national issue at the most is refuted by the advent of many concerns that cut through international borders such as marine litter, sustainable production and consumption, and climate change. The National Solid Waste Management Commission (NSWMC) recognizes this and has been proactively identifying and strengthening measures that lead to the successful implementation of Republic Act (RA) 9003 and the Philippines' sustainable development goals.

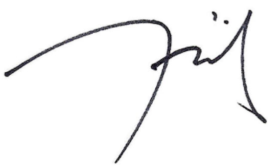
While the MSW sector has a huge potential to reduce greenhouse gas (GHG) emissions, it is also prone to climate shifts as exemplified by prolonged flooding due to refuse-clogged canals or the occasional garbage slides. It is with this realization that in 2012, NSWMC included climate change-relevant measures in its National Solid Waste Management Strategy.

The NSWMC has worked closely with various sectors to identify mechanisms to reduce GHG emissions in line with RA 9003 implementation. The preparation for the country's Intended Nationally Determined Contribution (INDC) heavily focused on methane reduction through the diversion of biodegradables and closure of dumpsites. As private sector representative to NSWMC, I believe that other waste streams such as recyclables or other functional elements such as waste collection and transport should be included in the prioritization as well. The MSW emission quantification tool developed by the Institute for Global Environmental Strategies (IGES) fits this requirement for a more comprehensive, life cycle analysis-based evaluation of baselines and emission reduction potential of measures.

With this tool, the NSWMC's Committee on Climate Change and the invited experts were able to assess the carbon dioxide reduction potential of recycling the paper, plastic, metal and glass fractions from the MSW stream. And aside from methane, black carbon is another short-lived climate pollutant (SLCP) that was brought to light in emission quantification and during the development of the National Strategy to Reduce SLCPs from the MSW Sector in the Philippines. The life cycle approach enabled the MSW sector to examine all the technical aspects of RA 9003 implementation. It also allowed for a better appreciation of sustainable production and consumption as well as public-private partnerships as intricate components of economics and sustainable development.

As the global community finds ways to address the seemingly inevitable shift in the earth's climate, it is recognized that mitigating SLCPs would reduce warming more quickly than addressing other climate pollutants due to its relatively short atmospheric lifetime. The NSWMC, DENR through its Environmental Management Bureau, IGES through the Climate and the Clean Air Coalition-supported MSW Initiative, and various stakeholders, take pride in developing and adopting this national strategy for SLCP reduction. This is a contribution of the Philippines and a concerted product of its MSW sector.

Maraming salamat po!



Commissioner CRISPIAN N. LAO

Vice Chairman

National Solid Waste Management Commission

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ABBREVIATIONS

BAU	Business As Usual
BC	Black Carbon
CCAC	Climate and Clean Air Coalition
CCC	Climate Change Commission
CH_4	Methane
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
DENR	Department of Environment and Natural Resources
DILG	Department of the Interior and Local Government
DRR	Disaster Risk Reduction
EMB	Environmental Management Bureau
EO	Executive Order
EQT	Emission Quantification Tool
ESWM	Ecological Solid Waste Management
FGD	Focus Group Discussion
FS	Feasibility Study
GHG	Greenhouse Gas
GWP	Global Warming Potential
IEC	Information, Education, and Communication
IGES	Institute for Global Environmental Strategies
IPCC	Intergovernmental Panel on Climate Change
kg	kilogram
LGU	Local Government Unit
MERV	Monitoring, Evaluation, Reporting and Verification
MRF	Materials Recovery Facility
MSW	Municipal Solid Waste
N_2O	Nitrous Oxide
NDC	Nationally Determined Contribution
NEDA	National Economic Development Authority
NSWMC	National Solid Waste Management Commission
NSWMS	National Solid Waste Management Strategy
PGHGIMRS	Philippine Greenhouse Gas Inventory Management and Reporting System
PM	Particulate Matter
$PM_{2.5}$	Particulate Matter (fine, 2.5 microns)
PPP	Public-private Partnership
R&D	Research and Development

SLCP	Short-lived Climate Pollutant
SLF	Sanitary Landfill
SNAP	Supporting National Planning for Action
SWDS	Solid Waste Disposal Sites
SWM	Solid Waste Management
SWMD	Solid Waste Management Division
tCO_2e	Tons carbon dioxide equivalent

EXECUTIVE SUMMARY

The National Strategy to Reduce Short-Lived Climate Pollutants from the Municipal Solid Waste Sector in the Philippines was developed through a multi-stakeholder consultation process led by the Department of Environmental and Natural Resources (DENR) through its Environmental Management Bureau's (EMB) Climate Change Division (CCD) and Solid Waste Management Division (SWMD), with guidance from the multi-agency National Solid Waste Management Commission (NSWMC), in coordination with the Climate Change Commission (CCC), and with assistance from the Institute for Global Environmental Strategies (IGES), under its Climate and Clean Air Coalition (CCAC)-supported Municipal Solid Waste (MSW) Initiative.

The Philippines, one of Southeast Asia's fastest growing nations, has always led efforts to adapt to the impacts of anthropogenically driven climate change while at the same time identifying climate-smart strategies to reduce greenhouse gas (GHG) emissions in line with its sustainable development agenda and national policies and programs. All current GHG emissions and other climate forcing agents will affect the rate and magnitude of climate change over the coming decades. The Philippines supported international efforts to reduce GHG emissions by submitting its Intended Nationally Determined Contribution (INDC) in 2015, ratifying the Paris Agreement on Climate Change in 2017, and reviewing the 2018 recalculations in mitigation cost-benefit analysis (CBA) as inputs to the development of the country's Nationally Determined Contribution (NDC).

National attention on short-lived climate pollutants (SLCPs) has been also increasing in recent years. SLCPs are powerful climate forcers that remain in the atmosphere for a much shorter period of time when compared to carbon dioxide (CO_2), yet their potential to warm the atmosphere can be many times greater. Certain SLCPs are also dangerous air pollutants that have harmful effects on people, ecosystems, and agricultural productivity. As a result, the Philippines submitted its Medium Term Plan on SLCP Reduction for 2016-2021 to CCAC.

The two main SLCPs from the municipal solid waste (MSW) sector are methane (CH_4) and black carbon (BC). Due to its relatively short atmospheric lifetime, mitigating BC would reduce warming more quickly than addressing other climate pollutants. Methane has already been discussed in the CBA study in more detail but BC has not yet been explored at the national level in the Philippines. Thus, initial assessments on baseline GHG emissions from CH_4, CO_2 and nitrous oxide (N_2O), as well as BC emissions have been carried out using the emission quantification tool (EQT), which was developed by IGES on behalf of the CCAC initiative [Nirmala and Premakumara, 2018].

The results of the analysis revealed that net GHG (CH_4, CO_2 and N_2O) emissions from the annually generated MSW in the 2010 base year would be around 4.46 million tons carbon dioxide equivalent (tCO_2e)—5.54 million tCO_2e of these are contributed by CH_4 alone whereas recycling efforts contributed to a deduction of around 1.69 million tCO_2e. In addition, the MSW sector released 1,422 tons of BC, or the equivalent of 0.97 million tCO_2e, in 2010. In total, net baseline emissions from GHGs and BC are equivalent to 5.43 million tCO_2e. If SLCPs only (CH_4 and BC) are considered, the total baseline emissions would be equal to 6.50 million tCO_2e, of which about 15% is due to BC.

To identify the key issues and solutions to reduce SLCPs from MSW, the NSWMC formed a core group of experts (CGE) who supported DENR-EMB, stakeholders and experts in a series of focus group discussions (FGDs) and consultations. The finalization of the strategic measures has been made in line with a pre-identified set of guiding principles. Table 1 summarizes information on the seven main strategies agreed upon with corresponding targets by 2025, 2030 and 2040.

Table 1. Main strategies and targets to reduce SLCPs from the Philippine MSW sector

	Main Strategy	Target/Goal (relative to 2010 Baseline)	Targets by			Description of Targets
			2025	*2030*	*2040*	
Strategies that primarily target CH_4 reduction						
1	Implement comprehensive and strategic biodegradable waste management programs.	Increase the diversion of biodegradable waste.	17.9%	24.3%	37.1%	of generated biowaste is composted or digested.
2	Promote gas capture, recovery and/or treatment during operation, and closure and rehabilitation of solid waste disposal sites (SWDS)	Increase the amount of SWDS gas captured and/or utilized.	36%	52%	54%	of generated tons of methane will be captured and flared (with or without energy utilization).
	… including the use of eco-efficient soil cover (EESC) at small SWDS.	Increase the amount of SWDS gas captured through EESC.	31%	50%	50%	of small SWDS captures methane using EESC
Strategies that primarily target BC reduction						
3	Implement comprehensive and strategic recyclables management programs.	Increase the diversion of recyclables.	50%	55%	60%	of the aggregated amount of recyclable fractions is recycled.
4	Adopt alternative technologies, including waste-to-energy, as SWM solution, considering institutional, legal, and technical limits.	Increase the amount of captured biogas and SWDS gas that are utilized for energy generation.	34%	56%	56%	of captured biogas is utilized for energy generation, displacing grid electricity use.
		Increase the percentage of low-economic value waste fractions used for resource and energy recovery.	10%	30%	50%	of segregated, low-economic value waste fractions are utilized for resource and energy recovery.
5	Implement BAT/BEP to prevent and control burning at SWDS.	Reduce the amount of deposited waste that is burned at SWDS.	60%	65%	70%	of the remaining unmanaged SWDS have been closed or rehabilitated, hence, reduced likelihood of burning.
6	Implement BAT/BEP to prevent and control open burning at backyards or communal areas	Reduce the amount of waste burnt at backyards.	30%	50%	70%	reduction in waste burned at backyards relative to 2010 baseline.

	Main Strategy	Target/Goal (relative to 2010 Baseline)	Targets by			Description of Targets
			2025	*2030*	*2040*	
Strategies that primarily target CH_4 reduction						
	… by (among others) increasing waste collection coverage and frequency.	… by decreasing the amount of uncollected waste.	7%	5%	3%	of generated waste remains uncollected.
7	Promote the use of low-polluting waste collection vehicles and optimization of MSW collection routes and transport schemes.	Reduce fuel consumption per ton of waste collected.	3%	5%	10%	reduction in vehicle fuel consumption per ton of waste collected.

Strategies 1 and 2 would primarily provide solutions to reduce CH_4 emissions by avoiding further CH_4 generation and by treating CH_4 that is already being generated at solid waste disposal sites (SWDS) in a more environmentally friendly manner. Baselines and targets were based on the Enhanced CBA Study as of January 2018. For example, the targets set for Strategy 1 adopted the long-term projection of having at least 50 percent (%) of bio-waste composted or digested by 2050. A similar approach was taken into consideration in setting the targets for Strategy 2 but with quantitative validation using the EQT.

The reduction or avoidance in BC emissions is addressed through Strategies 3 to 7. The envisioned recycling targets have been identified by the CGE based on baselines in a Recycling Industry Development Study. Strategy 4 adopted a key element under Subsector Outcome 2 of Chapter 19 of the Philippine Development Plan (PDP) 2017-2022. Targets set for the reduction in burning at SWDS in Strategy 5 were correlated with the closure and rehabilitation of unmanaged SWDS. In addition, Strategy 6 emphasizes the importance of improved waste collection coverage and frequency to discourage backyard burning. While Strategy 7, which deals with reducing vehicular emissions, may be classified as a transport sector strategy, the MSW sector still actively affects whether to use low-polluting waste collection vehicles as well as if MSW collection routes and transport schemes could be optimized.

The identified measures to reduce GHG/SLCP emissions are mostly interlinked and inter-dependent, hence individual reduction strategies have been grouped together into three future mitigation scenarios to evaluate aggregated climate impacts.

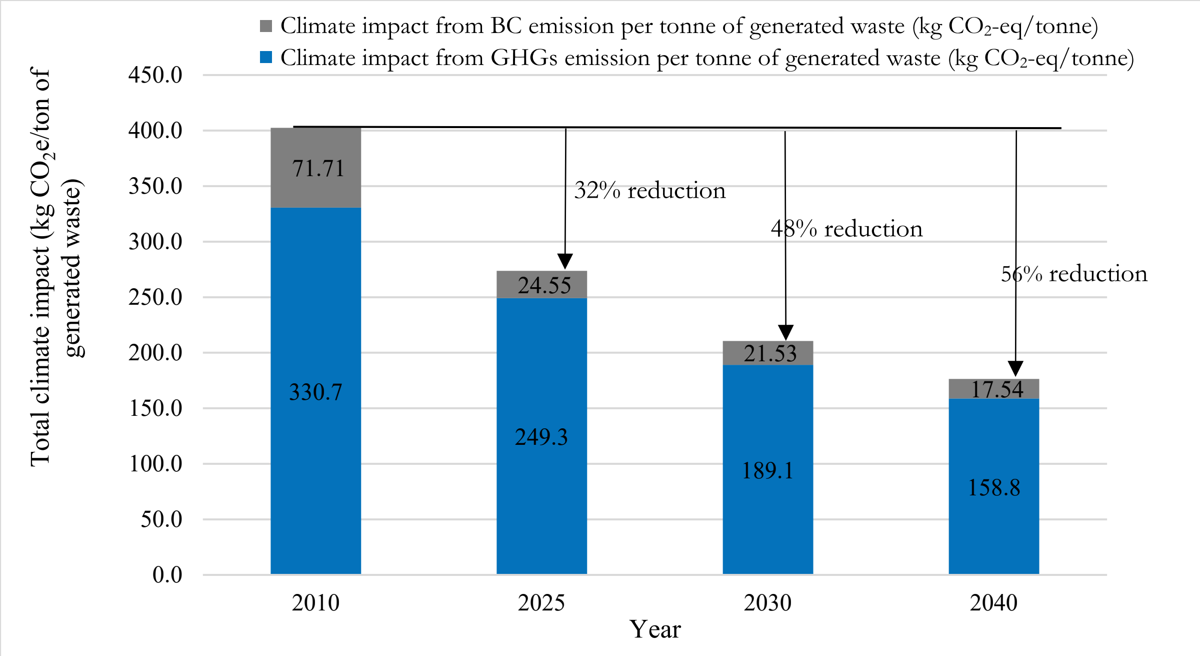

Figure 1. Aggregated GHG and BC reduction potential through the proposed strategies

As shown in Figure 1, the total climate impact mitigation potentials from MSW management through the proposed seven strategies in projected years of 2025, 2030 and 2040 are 32%, 48% and 56%, respectively, relative to the 2010 base year practices.

The strategy also identified a number of crosscutting considerations, which are crucial enabling mechanisms for the SLCP reduction strategies to be successfully and sustainably implemented. The NSWMC is currently updating these cross-cutting considerations in the National Solid Waste Management Strategy (NSWMS).

I. CONTEXT

1.1 STATUS OF MUNICIPAL SOLID WASTE MANAGEMENT IN THE PHILIPPINES

On January 26, 2001, Republic Act (RA) 9003, otherwise known as the Philippine Ecological Solid Waste Management Act of 2000, was signed into law. This law provides for the necessary institutional support mechanisms and instructs all local government units (LGUs) to establish ecological solid waste management (ESWM) programs within their jurisdictions. Triggered by problems emanating from the ubiquitously improper waste disposal, the Philippine Congress envisioned RA 9003 to provide integrated solutions suitable for a developing country while recognizing future opportunities for policy enhancements through the creation of a multi-agency NSWMC, wherein DENR-EMB provides secretariat support.

In 2004, the NSWMC released the National Solid Waste Management Framework (NSWMF), which puts emphasis on measures to encourage waste avoidance, reduction and recycling as highlighted by RA 9003 provisions on mandatory segregation at source and waste diversion targets of at least 25% at the beginning, which should be increased thereafter. NSWMF encourages lowest-level LGUs, particularly the barangays, or village-based political subdivisions, to compost biodegradable wastes and establish materials recovery facilities (MRFs) to improve resource recovery, whereas collection and management of residual and special wastes are assigned to the next level of administration, such as city and municipal LGUs. According to RA 9003, all dumpsites should have been closed by 2006 and residual waste should be managed at sanitary landfills (SLFs) or integrated eco-centers for final processing and safe disposal. LGUs are also required by law to submit their 10-year solid waste management (SWM) plans for approval of NSWMC [Philippine Congress, 2000].

More than a decade after the passage of RA 9003, enforcement and compliance remained a challenge due to technical, organizational, political and financial limitations of responsible agencies and LGUs [Premakumara et. al, 2014; Premakumara et. al., 2016]. A comprehensive ESWM-wide analysis of issues and gaps was undertaken to formulate the NSWMS for 2012-2016 [Acosta et al., 2012]. The NSWMS consists of ten components: Bridging policy gaps and harmonizing policies, Capacity development, Social marketing and advocacy, Sustainable financing, Creating economic opportunities, Knowledge management on technologies and innovation, Organizational development and enhancing inter-agency cooperation, Compliance monitoring, enforcement and recognition, Good governance, Caring for vulnerable groups, and Reducing disaster and climate change risks [NSWMC, 2012].

In 2014, DENR-EMB, through the NSWMC Secretariat and the Environmental Education and Information Division (EEID), compiled the available information on ESWM compliance from 2008-2013 following a previous effort on presenting the National State-of-the-Brown Environment Report (NSOBER) for 2004-2007 [DENR-EMB, 2014]. The data revealed that the Philippines' average MSW generation rate at base year 2010 was 0.40 kilograms per capita per day, although reported values by LGUs ranged from 0.10 to 0.79. In 2010, the country's population of 92,337,852 generated about 13.48 million metric tons, or 36,935 tons of MSW on a daily basis, of which Metro Manila contributed around 22.2%. As illustrated in Figure 2, it was projected that by the end of 2018, daily waste generation would be 43,684 tons and Metro Manila would contribute around 26.1% of the total. This amount is expected to further increase with the growth of population and economic activities.

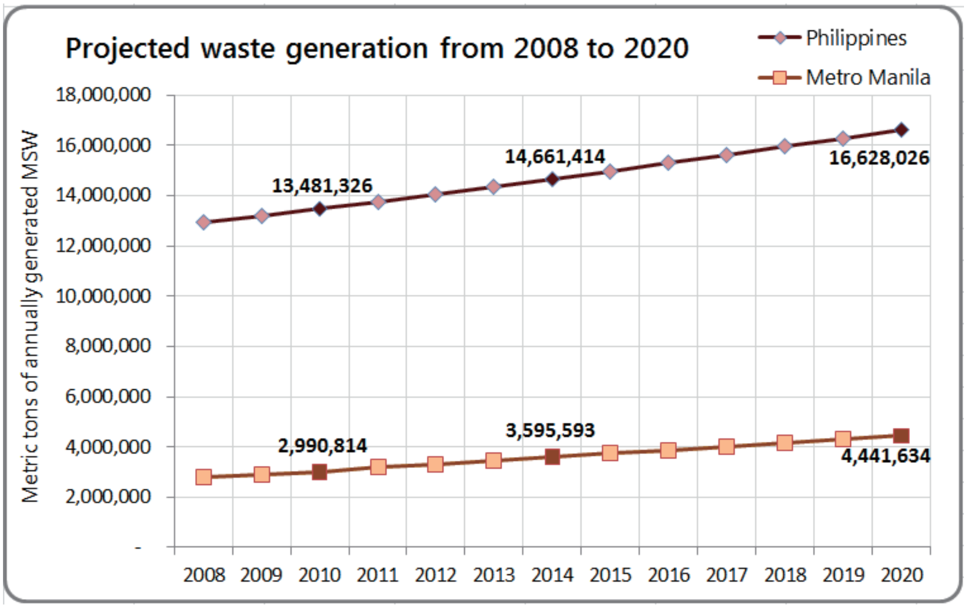

Figure 2. Projected annual waste generation rates, in tons per year [DENR-EMB, 2014]

In 2010, households generated the bulk of MSW, comprising 56.7% of waste tonnage. Commercial sources such as general merchandise stores and restaurants contributed 27.1%, of which public or private markets accounted for two-thirds of this share. About 12.1% of waste originated from institutional sources such as government offices, educational and medical institutions while the remaining 4.1% represents municipal wastes from the industrial and manufacturing sector (See Figure 3).

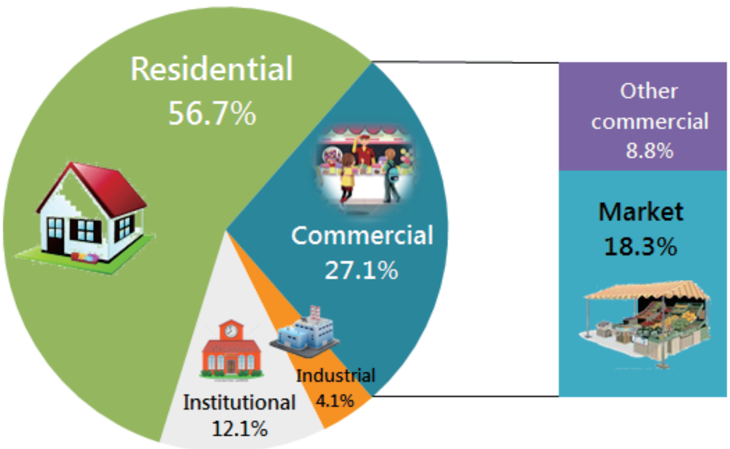

Figure 3. Sources and percentage contribution in tons of MSW [DENR-EMB, 2014]

As shown in Figure 4, about half (52.31%) of MSW generated in the country is biodegradable in nature although primary data suggest that figures can range from 30% to as much as 78%. Typical bio-waste consists of kitchen or food waste and yard or garden waste. From the available information, it could be estimated that 86.2% of compostable waste comes from food scraps while 13.8% are leaves, twigs, and other yard wastes. About 27.78% of the waste is classified by LGUs as recyclable materials and this rate can range between 4.1% and 53.3%. Plastic packaging materials comprise around 38% of this waste fraction, followed by paper and cardboard waste (31%). The remaining 31% comprises metals, glass, textile, leather and rubber. Household healthcare waste, waste electrical and electronic equipment, bulky waste and other hazardous materials that enter the municipal waste stream are classified as special wastes and contribute around 1.93% by weight (this figure can range from negligible values up to 9.2%). Finally, residual makes up 17.98% of generated MSW in the country. Most LGUs present this data as a combination of disposable wastes as well as inert materials, which comprise about 12% of the residual waste.

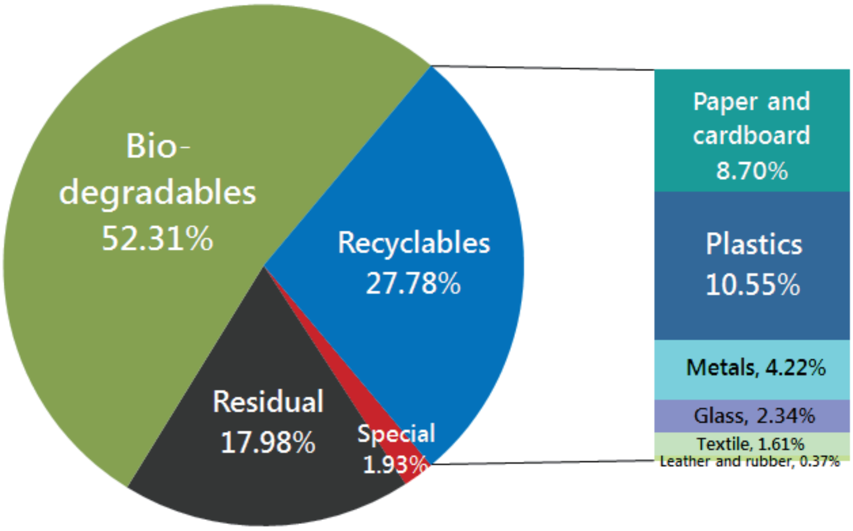

Figure 4. Composition of MSW in the Philippines by weight [DENR-EMB, 2014]

During the course of data analysis, it appears that most LGUs strictly sort the waste fractions according to material type. Available Waste Analysis and Characterization Study (WACS) data did not distinguish the economic value or market value of materials, which are the primary driving forces in determining whether a material is indeed recyclable or just 'potentially recyclable'. In this regard, the NSWMC released a standardized guideline for LGUs in conducting WACS in 2018.

The DENR-EMB/NSWMC Secretariat continues to track the implementation of RA 9003 through its monitoring database, which consolidates information from EMB regional offices. As of December 2018, 39.4% of the 1,715 provinces, cities and municipalities in the Philippines have 10-year SWM plans that comply with Section 16 of RA 9003. Another 53.2% had reached the evaluation stage while the remaining 7.4% or 121 LGUs had not submitted 10-year plans.

Photo: Legazpi City uses the standard color-coded waste bins.

Many LGUs and private entities have done well in implementing ESWM programs, such as segregation at source, promotion of reduce, reuse and recycle (3Rs), and development of recycled products and markets. Waste avoidance, reduction and reuse are priority ESWM options but are largely influenced by public participation, incentives and disincentives. Waste diversion through composting, recycling and resource recovery required effective separation at source, segregated storage and segregated collection. A number of enabling policies and social marketing campaigns were already initiated by the government to support waste avoidance and diversion programs but these needed to be reinforced and expanded.

As for the individual or shared facilities that receive or process biodegradable or recyclable materials as mandated by Section 32 of RA 9003, about 24% of the 42,036 barangays have already established MRFs servicing 32% of all barangays in the country. Biodegradable wastes are mostly being processed through various aerobic composting technologies although some LGUs also have small-scale anaerobic digesters. Recyclables are typically sold to junk dealers, consolidators and recyclers. In many cases, the informal waste sector (IWS) brings the sellable materials to junkshops or waste generators bring materials to designated collection points, recyclables collection events or waste market fairs. The potential role of the IWS still needs to be recognized and integrated into the formal ESWM system.

Photos: Compartmentalized (L) and segregated collection trucks (R) support resource recovery in Marikina City

Meanwhile, waste disposal remains a challenge since a total of 353 illegal dumpsites have to be closed and rehabilitated in accordance with Section 37 of RA 9003. This is offset by the fact that there has been a steady increase in the number of SLFs being established and LGUs having access to them; from 33 SLFs that cater to the residual waste of 78 LGUs in 2010, about 353 LGUs already have access to 165 SLFs in December 2018 [DENR-EMB/NSWMC, 2018].

Photos: Centralized gravity-driven MRFs are built in the Integrated Eco-Centers in Negros Island [Acosta, et al., 2013]

There are many issues that need to be addressed covering the different functional elements of ESWM. Waste management facilities, especially SWDS, have been prone to accidents such as trash-slides and SWDS burning. At the same time, the waste sector is contributing to the release of greenhouse gases (GHGs) and SLCPs into the atmosphere that causes anthropogenic climate change. With the use of the GHG inventory guidelines developed by the Intergovernmental Panel on Climate Change (IPCC), the GHG emission inventories conducted by the Philippines for base years 1994, 2000, and 2010 revealed that the waste sector, comprising both MSW and wastewater sub-sectors, is a large contributor of methane gas. This fact brought to light the many sources of this SLCP from the MSW sector, including the need for enhanced waste diversion, decrease in mixed waste disposal, and CH_4 capture and utilization whenever applicable. The need for an integrated biodegradables management system as well as the country's policy on landfill gas venting at SWDS as a minimum allowable requirement will have to be revisited. Note that in the Philippine context, landfill gas may refer to gases emanating from any type of SWDS.

Photos: Methane is generated from the anaerobic decomposition of organics in SWDS. While avoidance may be achieved through waste diversion, methane from existing SWDS may be captured, flared, and/or utilized such as this methane-to-electricity project in Quezon City.

The combustion of poorly maintained or aged collection vehicles as well as open burning of waste at backyards, communal areas, and SWDS also contribute to another SLCP emission – black carbon. Implementing efficient waste collection systems would not only reduce pressure on the funds of LGUs but also render socio-political approval since this functional element of ESWM is very visible to the public. The same is true for backyard burning, which transpires since households have limited alternatives when they have no access to waste collection services. Meanwhile, some cases of landfill fires might be deliberate, but some are caused by the intense heat from the sun or deep-seated fires from CH_4 buildup in the waste mass. When not properly addressed, these could directly or indirectly lead to other negative effects on public health, air pollution, ecosystem degradation, or even plainly lost opportunities to bring back waste materials into economically useful lifecycles such as sustainable consumption and production (SCP). It should be noted that the IPCC guidelines do not yet cover BC assessment in the national inventory; as such, BC has not yet been incorporated in official national GHG inventory reports.

1.2 ABOUT SHORT-LIVED CLIMATE POLLUTANTS

GHGs are gases that trap heat in the atmosphere; they contribute to the greenhouse effect on earth by absorbing infrared radiation. The primary driver in the radiative forcing of climate is the increasing concentration of various GHGs in the atmosphere – several of which occur naturally – but increases in atmospheric concentrations over the last 250 years are due largely to human activities. Aside from the amount released into the atmosphere, the impact of each GHG on anthropogenically driven climate change is based on its corresponding GWP, which is a relative measure of how much heat a certain mass of a GHG traps in the atmosphere relative to the amount of heat trapped by a similar mass of CO_2.

All current GHG emissions and other climate forcing agents affect the rate and magnitude of climate change over the next few decades. SLCPs are powerful climate forcers that remain in the atmosphere for a much shorter period of time than CO_2, yet their potential to warm the atmosphere can be many times greater. The SLCPs such as BC, CH_4, tropospheric ozone, and hydrofluorocarbons are the most important contributors to the man-made global greenhouse effect after CO_2, responsible for up to 45 % of current global warming [CCAC, 2018a]. Certain SLCPs are also dangerous air pollutants that have harmful effects on people, ecosystems, and agricultural productivity. Near-term reductions in short-lived climate forcing agents can have a relatively fast impact on climate change and possible co-benefits for air pollution [CCAC, 2018a; IPCC, 2014b].

The two primary SLCPs emanating from the MSW sector are CH_4 and BC. Although the effects of CH_4 emissions are well understood, evaluation of the possible effects of BC on climate change is relatively new. RA 8749, or the Philippine Clean Air Act of 1999, does not classify most climate pollutants as air pollutants, yet BC can still be included in the agenda since it is a co-indication of the existence and magnitude of certain regulated air pollutants.

Methane

Methane gets released as fugitive emissions whenever fossil fuels are extracted from the ground. It is also emitted as a by-product of livestock and other agricultural practices, through the anaerobic decay of organic matter such as biodegradable waste, and from incomplete combustion during open burning as an intermediate reduced product during the pyrolysis stage.

Methane is an SLCP with an atmospheric lifetime of around 12 years. Per unit of mass, the impact of CH_4 on climate change, i.e., GWP, over 20 years is 84 times greater than CO_2; over a 100-year period it is 28 times greater [CCAC, 2018a]. Globally, over 60% of total methane emissions come from human activities [CCAC, 2018a]. Atmospheric methane concentrations have grown because of human activities related to agriculture, including rice cultivation and ruminant livestock; coal mining; oil and gas production and distribution; biomass burning; and MSW landfilling.

Methane is generally considered second to CO_2 in its importance to climate change. Recent research suggests that the contribution of methane emissions to global warming is 25% higher than previous estimates. Methane is a key precursor gas of the harmful air pollutant, tropospheric ozone with increased CH_4 emissions responsible for half of the observed rise in tropospheric ozone levels. While CH_4 does not cause direct harm to human health or crop production, ozone is responsible for about 1 million premature respiratory deaths globally [CCAC, 2018a; IPCC, 2014b].

Black Carbon

Black carbon (commonly known as soot) is a potent climate-warming component of particulate matter (PM) formed by the incomplete combustion of fossil fuels, wood and other fuels. Complete combustion would turn all carbon in the fuel into CO_2, but combustion is never complete and CO_2, carbon monoxide (CO), volatile organic compounds (VOCs), and organic carbon and BC particles are all formed in the process. The complex mixture of particulate matter resulting from incomplete combustion is often referred to as soot. When suspended in the atmosphere, BC contributes to warming by converting incoming solar radiation to heat. It also influences cloud formation and impacts regional circulation and rainfall patterns [CCAC, 2018a].

Black carbon is a SLCP with a lifetime of only between 4 and 12 days after release in the atmosphere but has significant GWP values. Although the effects of CH_4 emissions are well understood, there are large uncertainties related to the effects of BC. During 100 years after emission, 1 kilogram (kg) of BC produces as much forcing of between 100 and 1,700 kg of CO_2 while for a 20-year time period, the GWP ranges from 270 to 6,200 [IPCC, 2014b]. For the purposes of EQT analysis, the government adopted 680 [Bond and Sun, 2005] as GWP for BC. BC is a particularly notorious warmer because it absorbs most of the intercepted visible light, whereas the impact of CO_2 occurs over a limited range of infrared wavelengths. In 2015, it was estimated that about 6.6 million tons of BC were emitted [IPCC, 2014b]. The main driver for BC emissions is the presence and enforcement of environmental regulations, particularly on open burning and air pollution control of mobile and stationary sources.

Black carbon is always co-emitted with other PM and gases, some of which have a cooling effect on the climate. The type and quantity of co-pollutants (which differ according to sources) that release a high ratio of warming to cooling pollutants represent the most promising targets for mitigation and achieving climate and health benefits in the near term. Black carbon and its co-pollutants are also key components of fine particulate matter ($PM_{2.5}$) air pollution, the leading environmental cause of poor health and premature deaths. With diameters of 2.5 micrometers or smaller, $PM_{2.5}$ can penetrate into the deepest regions of the lungs and facilitate the transport of toxic compounds into the bloodstream. Each year, an estimated 7 million premature deaths are attributed to household and ambient $PM_{2.5}$ air pollution. Several studies have demonstrated that measures to prevent BC emissions can reduce near-term warming of the climate, increase crop yields and prevent premature deaths [CCAC, 2018a].

1.3 PROCESS FOR DEVELOPING THE SECTORAL SLCP REDUCTION STRATEGY

Development of the national strategy was a multi-stakeholder participatory process executed by DENR and NSWMC. A CGE was formed to provide inputs into the strategy through a series of capacity building programs and consultation workshops, which were supported by IGES.

The first national awareness workshop was carried out on November 23, 2017 in Quezon City to create awareness on the climate and waste nexus, and how the extent and effectiveness of the present waste management system affects SLCP emissions. It also helped in reviewing the current national waste management policies and practices as well as explore future plans to reduce SLCPs from the MSW sector in line with the Sustainable Development Goals (SDGs) and the Philippine ratification of the Paris Agreement.

To build the capacities of governments in establishing baseline SLCP emissions with the use of EQT, a regional training workshop was conducted on April 2-4, 2018, in Bacolod City. A total of nine cities and one province from across the region (Thailand, Myanmar, Cambodia, Indonesia and Philippines) attended the workshop, which focused on understanding drivers of SLCP emissions generated by MSW, impacts and effects of SLCPs, ways to calculate SLCP emissions potentials, and available strategies for mitigating SLCPs in the MSW sector in view of policy, technology and finance issues. A site visit was also organized to observe good practices associated with ESWM and encourage the documentation of options for future local SLCP action plans. Through this workshop, DENR and NSWMC also had the opportunity to better understand the EQT, potential data, and assumptions needed for the use of EQT, albeit with the use of national data.

From April to July, the trained LGUs worked on completing their respective local EQTs. During this time, the focal persons from DENR-EMB and IGES did background research on the outlines and contents of the existing SLCP reduction strategies of California, Canada, and Mexico; reviewed alignments with national policies and plans; and compiled basic information on the country's challenges and proposed solutions to address ESWM gaps vis-à-vis SLCP emissions.

On July 31, 2018, the NSWMC deliberated on and promptly approved the proposed resolution to create an NSWMC committee for the development of the national strategy to reduce SLCP from the MSW sector in the Philippines. The initiative is seen as another anchor to enhance the implementation of RA 9003 and other environmental laws, contributes to national development plans, and an instrument to materialize the Philippines' contribution to the Paris Agreement. The strategy development process would analyze the MSW sector and its emissions from an LCA perspective. Aside from CH_4, which is covered in IPCC-based GHG inventories, SLCP analysis would also encompass waste collection and the recycling of non-biodegradables. Furthermore, the process is in line with the Philippines' Medium Term Plan on SLCP Reduction 2016-2021 – Supporting National Planning for Action (SNAP), which was submitted during the 21st Session of the Conference of Parties (COP21) in Paris to CCAC. A copy of the said resolution is in Annex A.

In this regard, the NSWMC recommended for the newly created committee to provide guidance and inputs to FGDs and public consultation. The members appointed to the committee included DENR as Chair, Recycling Sector as Co-Chair, Department of Science and Technology (DOST), Department of the Interior and Local Government (DILG), Metro Manila Development Authority (MMDA), Department of Agriculture (DA), and Non-Government Organization (NGO). This committee has also invited other member agencies of NSWMC and resource persons/experts from CCC, selected LGUs, academe, research institutions, MSW contractors, and other practitioners, forming the CGE. It was also agreed for the committee to adopt national ESWM information that is based on officially adopted or published government reports, databases, and publications, and duly vet on unavailable information based on experts' judgement as necessary.

As DENR and NSWMC commenced with strategy development, it became imperative for national stakeholders to finally establish the nationwide sources and quantities of SLCP emissions from the MSW sector and base their strategies on the merits of the different mitigation scenarios. The accuracy of the results would largely depend on the availability of national baseline data that best represents the Philippine situation for reference year 2010. National publications are available for some data but other data would be based on expert judgement based on interpolated local data extrapolated from the accomplished local EQTs of selected partner LGUs and local SWM plans. A workshop was conducted on August 29, 2018 to present the available 2010 baseline data and have it vetted by the CGE. Moreover, the workshop provided a venue for the CGE to collectively agree on three ideal mitigation scenarios to generate results as preliminary reference to policy makers on the high potential of the MSW sector in avoiding or reducing SLCP emissions.

Figure 5. Stakeholders and experts in the first FGD

On September 5-7, 2018, DENR, NSWMC, and IGES jointly organized the first FGD to provide inputs to the first draft of the strategy document. The CGE, as shown in Figure 5, provided technical expertise in reviewing existing national and state SLCP strategies and customizing an outline for the Philippine MSW sector; identifying the root cause of SLCP emissions from MSW; analyzing the gains, challenges, and remaining gaps in ESWM implementation; and proposing nationwide strategic measures to reduce SLCP emissions with initial reduction targets. The inputs from this FGD formed the basis for developing the first draft of the strategy document.

Figure 6. Stakeholders and experts in the second FGD

Following this, a second FGD was organized on November 6-8, 2018, to revisit the initially identified strategic measures and map them in a results chain, which took into account the targets based on strategic outcomes. The strategies were further cross-checked for consistency with or in support of other national policies, plans, and programs of the government and the private sector, including but not limited to, development, climate and sectoral targets. The interactions and interdependencies among the different measures were also analyzed to guide decision-makers in prioritizing measures to enable a strategic and programmatic approach. In anticipation of a subsequent action plan to elaborate on this SLCP reduction strategy, the CGE also identified the different actions, activities or milestones needed to achieve each strategic measure. A list of experts and participants to the FGDs is shown in Annex B.

After this, a public consultation was held on November 29, 2018, wherein the draft document was presented to a wider group of stakeholders. Comments and suggestions were gathered and taken into consideration during the deliberation by the NSWMC Committee on Climate Change on December 17, 2018. The final versions of the strategies, targets, and activities have been consolidated and integrated into the final draft of the strategy document. Those sectoral targets later served as the basis for calculating the equivalent CH_4 and BC reduction goals.

Figure 7. Participants in the public consultation

Figure 8. Deliberation of comments and suggestions by NSWMC Committee

A final review of the NSWMC Committee has been carried out prior to proposing a resolution for NSWMC to adopt it as a national guideline, which finally took place on March 20, 2019.

1.4 BASELINE SLCP EMISSIONS FOR THE MSW SECTOR

Prior to the formulation of the national SLCP reduction strategy, it was deemed imperative for national stakeholders to first understand the sources and quantities of SLCP emissions from the MSW sector in order to understand the merits of the different mitigation scenarios. The EQT developed by IGES on behalf of the CCAC-MSW Initiative was used for this purpose, albeit with national coverage. With EQT, LGUs can undertake a rapid assessment of the SLCP emissions associated with their current waste management practices, i.e. business-as-usual (BAU), and identify suitable alternative solutions or future scenarios based on life cycle analysis (LCA) as shown in Figure 9. The EQT was developed in line with IPCC 2006 and other internationally recognized guidelines and emission factors. Through its use, policy makers can also keep records and monitor mitigation efforts over time.

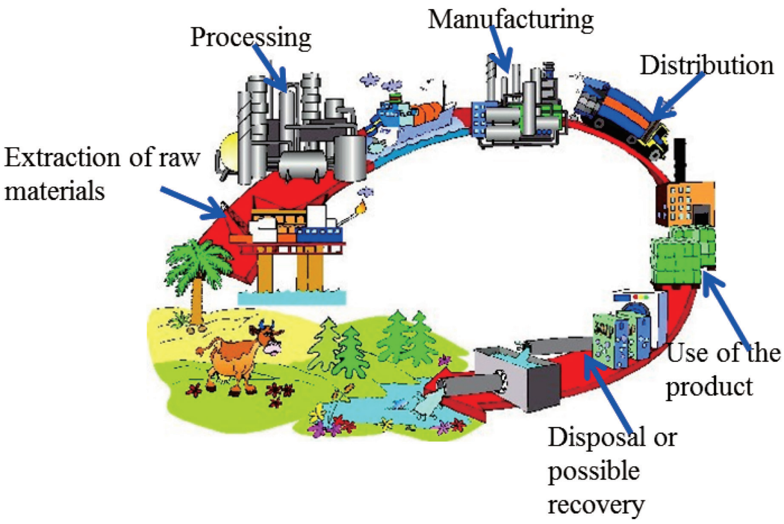

Figure 9. Life cycle thinking as the basis for MSW management assessment

The accuracy of the national EQT results is largely dependent on the availability and reliability of national data. Year 2010 was selected as the reference year for baselining to be consistent with the periodic planning cycle and GHG inventory year of the Philippine government as well as the start year of the BAU projections as basis for the proposed NDC. National publications are available for some data but for the rest, there was a need to rely on expert judgement or extrapolation from the local EQT data provided by partner LGUs. A national data-vetting workshop allowed for the consolidation of these national baseline data, which were progressively refined during FGDs. Figure 10 shows the vetted national baseline waste stream analysis data.

In the baseline scenario, 90% of generated waste is collected by the formal, semi-formal and informal systems. Of this, only 18.4% of collected waste is being separated for resource recovery (2.9% for composting and 15.5% for recycling), and the remaining mixed waste is disposed of in three main types of SWDS: open dumps (ODs), control dumps (CDs) and SLFs. Part of the uncollected waste is burned (24%) while the remainder is assumed to be either managed on-site through household composting or used as animal feeds (16%) or improperly disposed (60%).

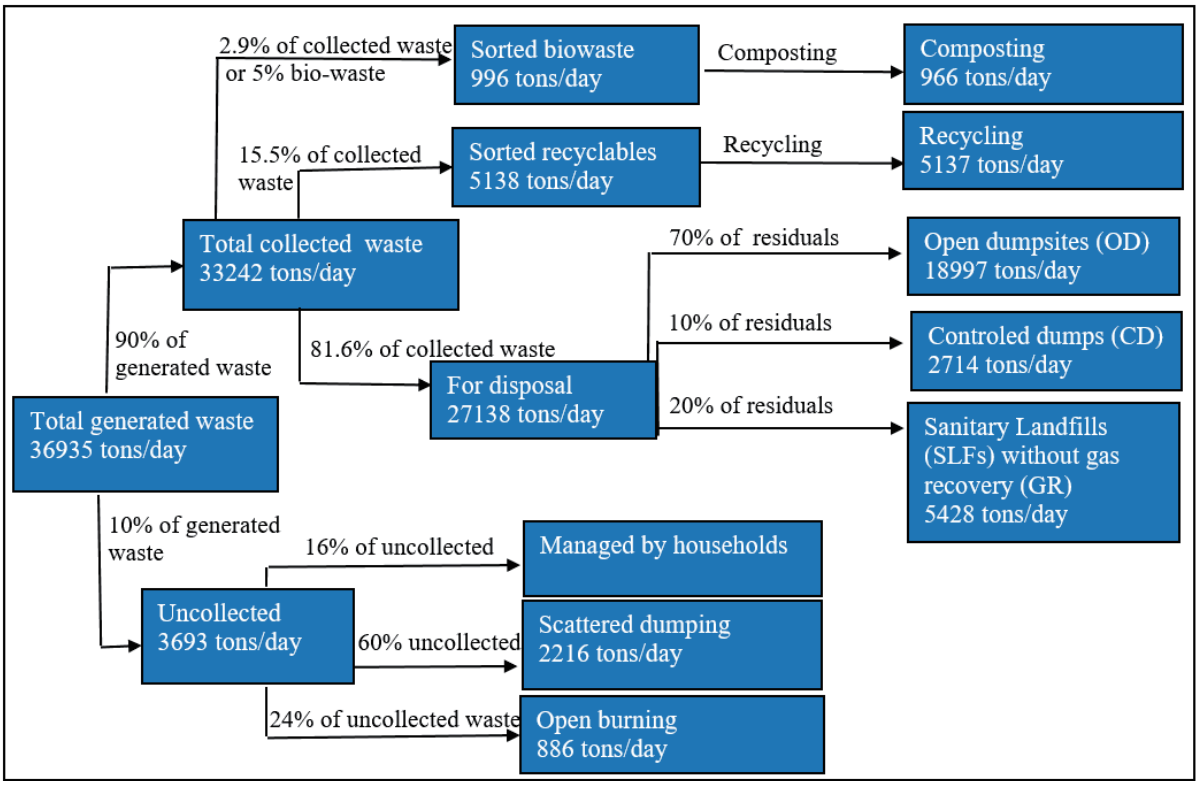

Figure 10. Waste flow and mass balance from 2010 BAU scenario

The baseline data from 2010 were used as inputs to the EQT to quantify the corresponding SLCP emissions per MSW management component. Figures 11 and 12 show the GHG, comprising CH_4, CO_2 and N_2O, as well as BC emissions from MSW in 2010, respectively.

The data analysis shows that SWDS released the bulk of the GHGs during the base year. As detailed in Table 2, the net GHG emissions from the annually generated MSW at 2010 base year would be around 4.46 million tCO_2e, 5.54 million tCO_2e of these [as before: confusing since 2nd number is larger than first] are contributed by CH_4 alone whereas resource recovery efforts contributed to the saving of around 1.08 million tCO_2e of other GHGs, which resulted in a negative value.

Table 2. Overall climate impact in 2010 BAU, in million tCO_2e

Description	Unit	2010
Climate impact from CH_4 (i)	million tCO_2e /yearly generated MSW	5.54
Climate impact from BC (ii)	million tCO_2e /yearly generated MSW	0.97
Climate impact from other GHGs (iii)	million tCO_2e /yearly generated MSW	- 1.081
Climate impact from all GHGs (i) +(iii)	million tCO_2e /yearly generated MSW	4.46
Climate impact from all SLCPs (i)+(ii)	million tCO_2e /yearly generated MSW	6.50
Net Climate impact (i)+(ii)+(iii)	**million tCO_2e /yearly generated MSW**	**5.42**

Figures 11 and 12 show GHG and BC emissions on per ton of input MSW per process. The unit "ton" in the y-axes refer to per ton of organic waste in composting, per ton of recyclables in recycling, and per ton of mixed MSW in transportation, open dumping, controlled dumping, sanitary landfilling, uncollected waste, and burning in uncontrolled SWDS. Net GHG and BC emissions per ton of generated waste from integrated waste management is estimated based on the formula below:

Net GHGs emissions from generated waste (kg CO_2e/ton of generated waste) = total GHGs emissions from transportation (kg CO_2e/ton of waste) + % of waste use for composting/100 × net GHGs emissions from composting (kg CO_2e/ton of organic waste) + % of waste to recycling/100 × net GHGs emissions from recycling (kg CO_2e/ton of recyclables) + % of waste to open dumping/100 × GHGs emissions from open dumping (kg CO_2e/ton of mixed waste) +% of waste to control disposal/100 ×GHGs emissions from control disposal (kg CO_2e/ton of mixed waste)+ % of waste to sanitary landfilling/100 × net GHGs emissions from landfilling (kg CO2e/ton of mixed waste)+ % of waste uncollected/100 ×GHGs emissions from uncollected waste (kg CO_2e/ton of mixed waste) +% of waste burned in uncontrolled dumpsites /100 ×GHGs emissions from uncontrolled burning in dumpsites (kg CO_2e/ton of mixed waste).

Figure 11 illustrates the equivalent results on a per-ton basis, wherein the net GHG emissions would be about 331 kg CO_2e per ton of input MSW into each process.

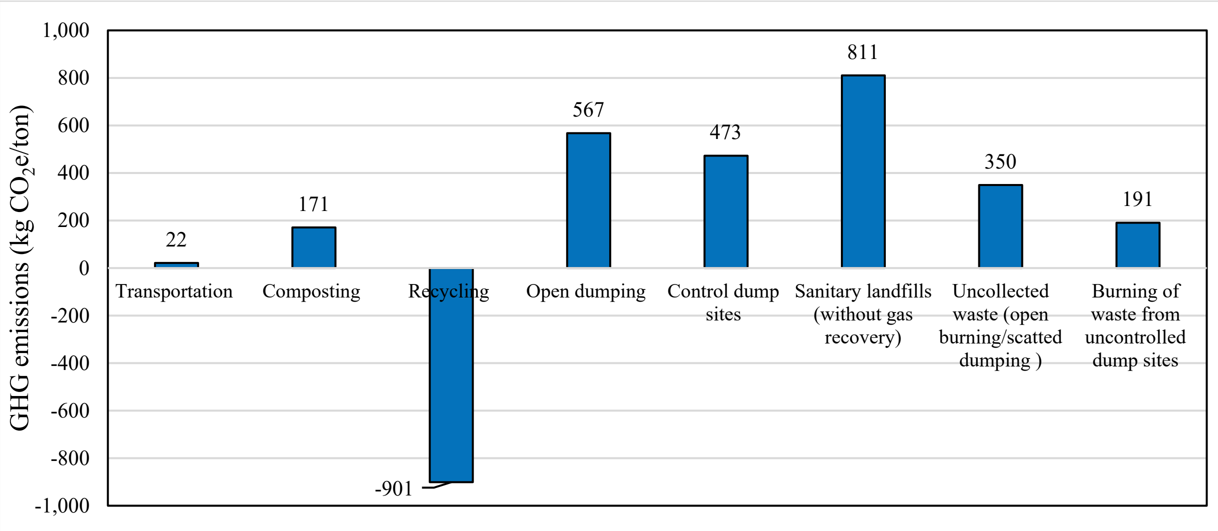

Figure 11. GHG emissions from 2010 BAU scenario

Figure 12 shows the BC emissions from each MSW management element from the 2010 BAU scenario. Open waste burning at unmanaged dumpsites and backyards has been found to be the major source of BC. It was estimated that the MSW sector released 1,422 tons of BC, or the equivalent of 0.105 kg BC per ton of input waste into each process in 2010.

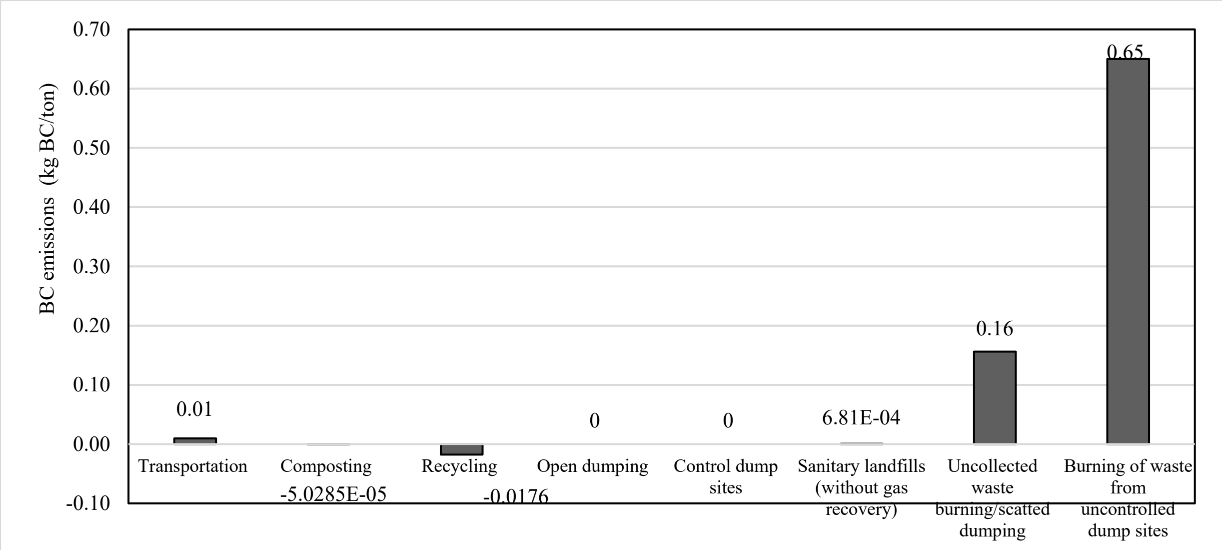

Figure 12. BC emissions from 2010 BAU scenario

GWP values for BC have not yet been finalized and different sources suggest different values. For baselining purposes, local experts in the CGE have commonly agreed to adopt 680 kg CO_2e per kg BC as the GWP value based on the Fifth Assessment Report (AR5) prepared by IPCC [IPCC, 2014b; Bond and Sun, 2005]. The climate impact due to BC emissions from burning one ton of MSW would then be equivalent to 71.71 kg CO_2e, which adds up to 0.97 million tCO_2e in 2010. This value could be much higher as the European Investment Bank in 2016 suggested BC to have a warming impact on climate 1,055-2,020 times stronger than CO_2 over a 100-year time horizon.

In total, net baseline emissions from GHGs and BC are equivalent to 5.43 million tCO_2e. If SLCPs only (CH_4 and BC) are considered, the total baseline emissions would be equal to 6.50 million tCO_2e of which about 15% is due to BC.

1.5 OPPORTUNITIES AND BENEFITS IN REDUCING SLCPS IN THE MSW SECTOR

In general, 'mitigation' is the effort to control the human sources of climate change and their cumulative impacts, notably the emission of GHGs and other pollutants, such as BC particles, that also affect the planet's energy balance. Mitigation also includes efforts to enhance the processes that remove GHGs from the atmosphere, known as sinks. Based on IPCC's AR5, global mitigation scenarios reaching about 450 to about 500 parts per million (ppm) CO_2e by 2100 show reduced costs for achieving air quality and energy security objectives, with significant co-benefits for human health, ecosystem impacts, and sufficiency of resources and resilience of the energy system [IPCC, 2014c].

The short period of time in which SLCPs can be removed from the atmosphere presents an opportunity for quick, coordinated action to address global warming over the near term. When combined with significant measures to cut CO_2 emissions, SLCPs play an important role in slowing the rate of global warming and achieving the 2°C target set by the Paris Agreement (PA) on Climate Change. Such actions would also prevent climate tipping points that could exacerbate long-term climate impacts and make adapting to climate change harder, especially for the poor and most vulnerable [CCAC, 2018b].

Any SLCP control measure should involve cost-effective technologies and practices that already exist and are considered low-hanging fruits. Practical SLCP reduction actions deliver not only benefits for the climate but other co-benefits such as air quality, public health and development as well. These measures can mitigate negative impacts on food, water and economic security for large populations throughout the world by reducing negative effects on public health, agriculture and ecosystems. If quickly implemented, SLCP mitigating measures can cut the amount of warming that would occur over the next few decades by as much as 0.6°C, while avoiding 2.4 million premature deaths from outdoor air pollution annually by 2030, and preventing 52 million tons of crop losses per year [CCAC, 2018b].

The United Nations Environment Programme (UN Environment) and World Meteorological Organization (WMO) have identified a package of control measures that can achieve 90% of total potential emissions reductions for BC, CH_4, and hydrofluorocarbons. Aside from the agriculture sector and the use of fossil fuels, CH_4 reduction measures were identified in the waste management sector. Low-hanging fruits in the MSW sector include: (a) separation and treatment of biodegradables and converting such into compost or bio-energy and (b) collection, capture, and use of landfill gas. Meanwhile, BC reduction measures in the MSW sector may come in the form of: (a) use of cleaner fuels, diesel particulate filters for vehicles, and soot-free trucks and (b) banning of open burning of MSW [CCAC, 2018b].

Behavior, lifestyle, and culture have a considerable influence on resource and energy use and associated emissions, especially when complemented with technological and structural change. Emissions can be substantially lowered through changes in consumption patterns (e.g., mobility demand and mode, energy use in households, choice of longer-lasting products) and dietary change and reduction in food wastes. Systemic approaches and collaborative activities across companies and sectors can reduce energy and material consumption and thus GHG emissions. Cooperation across companies and sectors could include the sharing of infrastructure, information, and waste heat utilization. Important options for mitigation in waste management are waste reduction, followed by re-use, recycling and energy recovery. As the share of recycled or reused material is still low (e.g., globally, around 20% of MSW is recycled), waste treatment technologies and recovering energy to reduce demand for fossil fuels can result in significant direct emission reductions from waste disposal [IPCC, 2014c].

In the Philippines, the climate impacts of three ideal, maximum-effort scenarios have been quantified using the EQT to provide an initial reference to policy makers on the large potential of properly managing the country's MSW on SLCP reduction. Ideal Scenario 1 considers an improved waste collection rate with separation of a higher percentage of organic waste for resource recovery via composting or digestion while keeping all other BAU parameters fixed. Scenario 2 considers the parameters set in Scenario 1 but with an additional increase in the amount of recyclables recovered and processed. Meanwhile, Scenario 3 considers Scenario 2 with the cessation of use of dumpsites by 2030 and offsetting the waste disposal tonnage with the use of properly managed SLFs with gas recovery (GR) systems.

The initial analysis of preliminary national data, which were later refined during the FGDs, revealed that CH_4 is the most significant contributor of SLCPs from the MSW sector in the Philippines due to conventional disposal methods. Meanwhile, open waste burning is a main driver of BC emissions. Enhancing recycling and SLF energy recovery rates has GHG/SLCP saving potentials. With careful selection of suitable technologies to match with waste characteristics and local conditions, it is fully possible to maximize GHG/SLCP mitigation targets at the national level. Specific strategies and corresponding targets identified during the FGDs, public consultation and committee meetings further refined data and information to assess SLCP reduction potentials of the agreed-on strategies relative to BAU.

2. CURRENT POLICIES AND PLANS RELATED TO SLCP MITIGATION

The formulation of strategies to reduce SLCPs from the MSW sector in the Philippines has legal and planning standing in the country, whether as anchor, enabling environment, or contributory factor in supporting the implementation of measures.

Philippine Constitution

Foremost is the Constitution, which is the supreme law of the Republic of the Philippines and was ratified in February 2, 1987. Section 15 under Article II declares that "the State shall protect and promote the right to health of the people …", while Section 16 states that "the State shall protect and advance the right of the people to a balanced and healthful ecology in accord with the rhythm and harmony of nature." In Section 17, the constitution also provides "priority to education, science and technology to … accelerate social progress, and promote total human liberation and development."

RA 9003 and related Waste Sector Policies

This strategy document's contribution to the full realization of RA 9003 and its implementing rules and regulations (IRRs) have already been mentioned under the "Context" section of this document. SLCP reduction strategies are consistent with RA 9003's provisions on the mandatory segregation (Sections 21 and 22), segregated collection, transfer and transport of waste (Sections 23 to 25), and mandatory solid waste diversion starting at 25% (Section 20). The establishment of MRFs and markets for recyclables and compost products are also elaborated in Sections 26 through 35. The closure and rehabilitation of dumpsites and the establishment of properly managed SLFs have potential to further reduce SLCPs and these actions are provided for from Sections 37 to 44 of RA 9003. Moreover, the penal provisions under Sections 48 and 49 of the law prohibit acts such as littering, open burning, collection of unsegregated waste, mixing of source-separated MSW, and misrepresentation of toxic waste as recyclables.

Philippine Development Plan

The Philippines has also released its medium-term plan with sub-sector outcomes that are aligned with the goals of reducing SLCPs from the sector. Approved on February 20, 2017 by the National Economic Development Authority (NEDA) Board, PDP 2017–2022 was the first medium-term plan to be anchored on the 0–10 point Socioeconomic Agenda. It is geared towards the AmBisyon Natin 2040 national long-term vision, which articulates the Filipino people's collective vision of a "matatag, maginhawa, at panatag na buhay para sa lahat" (strongly-rooted, comfortable, and secure life for all), which entails laying down the foundation for more inclusive growth, a high-trust and resilient society, and a globally competitive knowledge economy.

Many SLCP/ESWM-relevant measures are embedded in the sub-sector outcomes under Chapter 19 (Accelerating Infrastructure Development) and Chapter 20 (Ensuring Ecological Integrity, Clean and Healthy Environment) of the PDP. Strategies and initiatives mentioned in PDP Chapter 19's sub-sector outcome 2 include those intended to improve transport, energy, and social infrastructure. Under "Energy", the PDP plans to institute policy measures to support the full implementation of RA 9513, the Renewable Energy (RE) Act of 2008; maintaining the share of RE in the energy mix; and prioritizing the provision of electricity services in off-grid areas.

Under "Transport", it was planned to improve road-based transport through engineering, enforcement, and education; implement the motor vehicle inspection system; and other initiatives such as fleet modernization, route rationalization, and use of environmentally sustainable urban transport systems. These are related to Chapter 20's sub-sector outcome 2, specifically on the enforcement of environmental laws related to air quality management, wherein the PDP recommends to strengthen the enforcement of antismoke belching and vehicle emission testing as well as to promote environmentally-sustainable transport, use of cleaner fuels, and conversion to fuel-efficient engines.

Meanwhile, ESWM infrastructure is embedded under "Social Infrastructure" and its implementation would provide conducive access to basic social services necessary for human capital development. LGUs will be provided assistance in complying with the requirements of RA 9003. There will also be public awareness programs to promote proper waste management and investments in relevant technologies will be undertaken to improve ESWM throughout the country. DENR-EMB, in coordination with NSWMC and relevant stakeholders, will implement strategies in support of RA 9003, such as promote clustering of LGUs for common SWM facilities and services to take advantage of economies of scale; fully utilize the national and regional ecology centers as possible venues for trainings or education in integrated SWM; provide an incentive mechanism to local recycling industries; adopt alternative technologies, including waste-to-energy, as SWM solutions, considering institutional, legal, and technical limits; intensify the promotion of segregation-at-source by engaging local communities to participate in "learning by doing" programs, IEC campaigns, and social marketing programs on SWM; and operationalize the SWM fund and assess the re-institutionalization of the national government-LGU cost sharing scheme for SWM.

Initiatives under "social infrastructure" are complemented by strategies identified in Chapter 20's sub-sector outcome 2, which espouses the enforcement of environmental laws, including those related to land quality management. Compliance of LGUs to RA 9003 will be enforced particularly on the establishment of MRFs and treatment facilities; closure and rehabilitation of remaining dumpsites; formulation of local SWM plans; and promoting the practice of 3Rs and proper waste management. This sub-sector outcome reiterates the strategic clustering of SLFs and SWM technologies and mentions the need to provide alternative livelihood activities for waste pickers in the remaining dumpsites identified for closure. Furthermore, the government will develop and implement SCP policies and initiatives including: the formulation of a "polluters pay" policy; establishment of a sustainable market for recyclables and recycled products; strengthening of the certification and information systems for green products and services; strengthening the implementation of Philippine Green Jobs Act; promotion of green procurement in the public and private sectors; promotion, development, transfer, and adoption of eco-friendly technologies, systems, and practices in the public and private sectors by increasing access to incentives and facilitating ease of doing business and other related transactions; and promoting the conduct of a GHG inventory in the public and private sectors.

Similarly, Chapter 20's sub-sector outcome 3 mentions plans to develop a database to measure emission reductions per sector. Pursuant to Executive Order (EO) 174 series of 2014, which institutionalizes the Philippine Greenhouse Gas Inventory Management and Reporting System (PGHGIMRS), the PDP mandates conducting a GHG inventory for waste, agriculture, forestry, energy, transport, and industry sectors to assist in the monitoring, reporting and verification (MRV) of the country's GHG emissions.

Chapter 19's subsector outcome 3 ensures the resilience and securing the operational life of infrastructure facilities by incorporating climate change adaptation (CCA) and disaster risk reduction (DRR) measures. Chapter 20's sub-sector outcome 3 promotes the implementation of

CCA and DRR across sectors, particularly at the local level. It also plans for the strengthening of the monitoring and evaluation (M&E) of the effectiveness of CC and DRRM actions in line with the SDGs, Sendai Framework, and United Nations Framework Convention on Climate Change (UNFCCC) commitments.

The intensification of infrastructure-related research and development (R&D) is espoused by Chapter 19's subsector outcome 4, which aims to institutionalize R&D expertise and facilities. The government will pursue programs to develop R&D on, among others, RE technologies; cost-efficient technologies for wastewater and solid, hazardous, and health care waste management; new transportation technologies; climate change- and disaster resilient infrastructure designs; emerging information and communication technology applications or platforms; and new methodologies for gathering and managing science-based data.

Subsector outcome 1 of Chapter 20 highlights the mainstreaming accounting and valuation in the development planning to ensure that due importance and appropriate management will be given to these finite ecosystem resources. It also encourages the development of a policy for payments for ecosystem services, which will provide an alternative source of income to the local communities.

Like those before it, PDP 2017-2022 has an accompanying Results Matrix that lists the specific programs for the implementing agencies that will be monitored. It also has a Public Investment Program that identifies budgetary requirements and the sources of funds. The programs outlined will also be cascaded to the Regional Development Offices that will formulate individual Regional Development Plans and Investment Programs for specific areas [NEDA, 2017]. Annex C shows SLCP/ESWM-relevant indicators and targets in the draft Results Matrix for the PDP as of October 2017.

National Climate Change Policies

RA 9729, otherwise known as the Climate Change Act of 2009, as amended by RA 10174 also known as the People's Survival Fund Act of 2011, and its IRRs, form the backbone of the country's policy on climate change adaptation and mitigation. RA 9729 provides for the policy framework in addressing the growing threats of climate change to community life and environment through the National Framework Strategy on Climate Change (NFSCC) 2010-2022, which was adopted in April 2010. This framework has been translated into a National Climate Change Action Plan (NCCAP) 2011-2028 with strategic priorities following thematic outcomes: food security, water sufficiency, ecological and environmental stability, human security, climate-smart industries and services, sustainable energy, and capacity development. The NCCAP outlines the current situation of the country and its agenda for adaptation and mitigation to completely address the challenges of climate change.

ESWM falls under the "Climate-Smart Industries and Services (CSIS)" pillar of NCCAP but may also contribute to the other thematic priority areas of "Sustainable Energy" and "Ecosystems and Environmental Stability". The overall agenda of the CSIS thematic priority is "to have a climate change-resilient, eco-efficient and environment-friendly industries and services, and sustainable towns and cities promoted, developed and sustained". The immediate outcome under CSIS associated with ESWM is that "green cities and municipalities are developed, promoted, and sustained" with corresponding output that leads to "ESWM implemented towards climate change mitigation and adaptation." To this end, three main activities have been identified: (a) intensify waste segregation at source, resource recovery, composting, and recycling, (b) regulate the use of single-use and toxic packaging materials, and (c) close down polluting waste treatment and disposal facilities.

The issuance of EO 174 in 2014 provided the framework and policy for government agencies to take the lead in conducting periodic GHG emissions inventories. Previous inventories have been carried out by consultants for base years 1994 and 2000; in 2018, sectoral lead government agencies were able to submit inventory reports for base year 2010 following a series of capacity building activities to ensure sustainability of the process. Specifically, it was found that the waste sector, which comprises solid waste and wastewater per IPCC guidelines, generated 9.198 million tCO_2e of emissions due to CH_4 in 1994, of which solid waste accounted for 0.30273 million tons of CH_4 or 6.357 tCO_2e. The baseline emissions in 2000 revealed 11.60 million tCO_2e of GHGs from the entire waste sector, of which 0.25939 million tons of CH_4 emanated from the MSW sub-sector or equivalent to 5.45 million tCO_2e. Meanwhile, the submitted GHG inventory for the waste sector using base year 2010 considered the GHGs CH_4, CO_2, and N_2O, which totaled 13.80 million tCO_2e, of which 4.70 million tCO_2e was contributed by baseline MSW management practices. This figure was based on the CBA study conducted in preparation for NDC submission. For comparative purposes, the draft IPCC 2006 worksheets for the MSW sub-sector for the same 2010 base year revealed 5.59 million tCO_2e from waste disposal (CH_4), biological treatment (CH_4 and N_2O), and backyard burning (CH_4, N_2O and CO_2), which is closer in value to the EQT estimate of 5.54 million tCO_2e (CH_4 emissions only).

EO 174 also paved the way for the creation of an online platform dubbed the National Integrated Climate Change Database and Information Exchange System (NICCDIES), which serves as the Philippines' MRV hub. The NSWMC and DENR-EMB are the lead database keepers for the waste sector in NICCDIES to update information on GHG emissions, mitigation actions, and MOI.

The NICCDIES will also support complementary government initiatives to track, monitor, and report climate change projects, activities, and programs (PAPs) through the process of Climate Change Expenditure Tagging (CCET). The CCET aims to serve as an effective basis for allocating and prioritizing government resources by generating timely statistics and baselines to evaluate the impact of climate public expenditures. The national CCET is mandated by Joint Memorandum Circular (JMC) 2015-01 between the CCC and the Department of Budget and Management (DBM), enabling oversight for the agencies to track, tag, and analyze climate change-related expenditures based on set PAPs typologies. In 2006 for example, it was found that 157.4 million Philippine pesos (PHP) were allocated for CCA while PHP 18.7 million of government funds were allotted for climate change mitigation (11% share in CCET). LGUs are also asked to tag and track climate change expenditures in the local budget as provided by DBM-CCC-DILG JMC 2014-01.

Contributions to Global Climate Change Initiatives to reduce GHGs

In the months leading to COP21 in Paris, the country submitted its INDC on October 1, 2015. It states that "The Philippines intends to undertake GHG (in CO_2e) emissions reduction of about 70% by 2030 relative to its BAU scenario of 2000-2030. Reduction of CO_2e emissions will come from energy, transport, waste, forestry and industry sectors. The mitigation contribution is conditioned on the extent of financial resources, including technology development and transfer, and capacity building, that will be made available to the Philippines".

On December 21, 2015, DENR-EMB, NSWMC, and CCC conducted an FGD to identify the implementation requirements to realize the nominated measures to reduce GHGs in the MSW sector [CCC, 2015]. Actions have been clustered according to:

1. Control of open burning (backyard and SWDS)
2. Optimization of waste collection and routing schemes
3. Segregation of recyclables for MRF and then for subsequent recycling
4. Diversion of organic waste through aerobic composting

5. Diversion of organic waste through anaerobic digestion (with gas capture and/or utilization)
6. Methane capture/treatment at SWDS: Use of methane-oxidizing or eco-efficient soil cover (EESC) at smaller dumpsites
7. Methane capture/treatment at SWDS: Flaring of gas at bigger dumpsites
8. Methane recovery and utilization at SWDS: Electricity generation at very big SWDS
9. Leachate collection and treatment
10. Co-processing (alternative fuels and raw materials) in cement kilns / Residuals waste-to-energy (WTE)

On March 6, 2017, the country ratified the PA on Climate Change on signing the accession instrument by President Rodrigo Duterte and after the Senate unanimously gave its concurrence to PA ratification on March 14, 2017. At present, the government is revisiting the results of the enhanced CBA study completed in January 2018 to agree upon the country's NDC.

Contributions to Global Climate Change Initiatives to reduce SLCPs

In April 2015, the Philippines, through the DENR, signified its intent to join the CCAC through a letter to the Executive Director of UN Environment. The following month, the Philippines was accepted as the 48th country member of CCAC. In less than a year, in DENR Usec. Leones' memorandum to all bureaus of the DENR, SLCP management was included in the way forward discussions that need actions from the designated bureau, EMB where CCD is also housed, the CCAC focal point. On May 5, 2016, the CCAC Secretariat had informed their developing country partners of the release of two calls for expression of interest, through their SNAP Initiative. The Philippines answered both calls with expression of interest and before the year ended, the CCAC Secretariat confirmed support for the Philippines in its effort to develop a national plan on SLCPs.

The Philippines' Medium Term Plan on SLCP Reduction 2016-2021 under SNAP was submitted to CCAC during COP21 in Paris, and includes plans to: (a) enhance national capacity to take action on prioritized measures to mitigate SLCPs, (b) develop a national action plan for SLCP reduction in the Philippines, (c) leverage finance to support SLCP mitigation programs and initiatives in the country, and (d) enhance awareness and promote SLCP mitigation in the Asia Pacific region. So far, the Philippines has initiated a number of activities in relation to SNAP. Under the first objective, an orientation workshop, stocktaking forum, and a training on Long-range Energy Alternatives Planning (LEAP)-Integrated Benefits Calculator -have so far been carried out. Major activities under the second objective (national action planning) include the assessment of SLCP emissions and baseline scenarios; development of a national planning document and identification of implementation pathways; and promotion of financing and mainstreaming of SLCP mitigation measures. Further initiatives include the strict implementation of the Philippine Clean Air Act and RA 9003 as well as the inclusion of SLCP, specifically BC, in the country's NDC.

3. ISSUES, GAINS AND REMAINING GAPS

Issues and concerns in ESWM implementation in the Philippines have been identified and clustered according to the different functional elements of managing MSW. Policy/institutional, finance/resource, technology/technical, awareness/behavioral/capacity building/enforcement, and others/crosscutting constraints and limitations have been listed down and clustered as shown in Annex D. Clustered issues have been further synthesized to analyze what has been done so far to address these constraints (Gains), determine the remaining barriers that need to be removed (Challenges), and identify further prospects (Opportunities) to enhance ESWM implementation to contribute to SLCP reduction, which are illustrated in Annex E.

On the overall aspects of ESWM, including Waste Generation

In general, the Philippine MSW sector is still striving to achieve full compliance with RA 9003 amidst the many challenges many developing countries similarly face. Although policy makers have made headways in instituting supporting policies and IRRs, there remains insufficient monitoring and assessment of the effectiveness and efficiency of policies. There are also deficiencies in data management for information coming from the local, regional and national levels, as illustrated by the absence of a definitive waste stream or flow analysis. Implementers raise the issue of the highly bureaucratic procedures in government procurement and untapped or suboptimal partnerships with donors, financing institutions and the private sector.

The MSW sector's interface with climate-relevant initiatives such as addressing GHGs and SLCPs requires strong and harmonized policy, strategic actions, and targets. A high amount of data is required to assess the baselines and SLCP reduction potentials, which revert back to the challenge of data management. Even the gathering and periodic updating of ESWM information entail corresponding financial resources to carry them out. Nevertheless, the country's NSWMS for 2012-2016, which identifies CCA and mitigation measures at least for GHGs as one of its ten main components, is currently being updated by NSWMC. For SLCP reduction, the national and state strategies of Canada, Mexico, and California are available for benchmarking and IGES/CCAC's EQT is available for baselines setting and updating.

At the local level, many LGUs still failed to submit their 10-year SWM plans and those who did needed to implement, monitor, and update their local 10-year plans and ordinances. Other issues raised were the limitations in creating local staff positions focused on ESWM, which might entail an amendment to RA 7160 or the Local Government Code; lack or insufficient local budget for provincial, city, and municipal environment and natural resources offices (ENROs); and restrictive procurement procedures. For example, besides hauling, LGUs are not allowed by the Commission on Audit (COA) to enter into a long-term contract on ESWM; even for infrastructure projects, a joint project arrangement or public-private partnership (PPP) contract is required for LGUs to have longer contracts. Financial limitations, lack of budget both from the national government and allocation from LGUs, unavailability of land or space for facilities, the high cost of technologies, incompatible or insufficient capacities of facilities, and the lack of resourcefulness and collaboration among stakeholders meant that the resources needed to improve inefficient systems could not be provided.

The culture of overconsumption and disposal entail behavioral change that requires systematic social marketing and information, education, and communication (IEC) campaigns alongside the establishment of consistent systems and sufficient facilities. The public's lack of awareness on MSW sectoral and climate policies as well as inadequate enforcement are oftentimes driven by local leaders' inadequate political will or support and lack of motivation to prioritize ESWM in the agenda. There is also a need for institutionalized incentives or rewards systems for LGUs with best practices and knowledge sharing among LGUs and lessons from other countries.

Source Separation, Segregated Collection, and Transport

The support of households, commercial establishments, markets, institutions, and industries in source separation remains a challenge for LGUs. In many cases, the initial headway gained in getting the buy-in of the general public is lost due to unsegregated collection or even re-mixing of waste. The insufficient capacities of processing facilities along with lack of enforcement are usually the causes for disincentives in source segregation and segregated collection, which encourage the culture of mere disposal as the ultimate solution.

There also appears to be a need for a policy mandate to encourage the private sector to carry out customized systems for waste segregation among which may entail guidelines on extended producer and/or consumer responsibility. In certain areas in the country, materials that are typically considered as recyclables do not have a market and are not being collected due to logistics issues, compounded by the archipelagic nature of the Philippines. There is also a clamor for dedicated collection of biodegradables from food industries or establishments as well as from public markets where the bulk of organic wastes are generated. The willingness for the food establishments to pay will be a challenge but could be a source of cost recovery. Service providers may be identified and business opportunities could be opened up for the private sector.

Air and climate pollutants such as BC emanate from the combustion of vehicles used in the MSW sector. Being one of the more expensive elements in the ESWM system, some LGUs and contractors continue to use outdated vehicle models for waste collection amidst the lack of policy on fleet modernization. Further factors leading to high BC emissions are the inefficient waste collection techniques and routing schemes.

Management of Recyclables

In the Philippines, the informal waste sector (IWS) and the semi-formal sector contribute to bulk of the buy back, collection, and recovery of recyclable materials, especially those that have relatively significant economic value. Door-to-door scrappers and junkshops imperceptibly yet significantly contribute to the diversion of recyclables and enable their return to the useful economic cycle. Their contribution varies and is not adequately tracked; policy implementation concerning the IWS is deemed inadequate, sometimes due to the fact that they survive in the existing system anyway.

The recyclables market appears to be inadequate and suffer from variability; some areas do not even have a market due to logistics and low buying prices of recyclable materials. Materials that have little economic value tend to not be collected and become part of residual waste collection and disposal. Over past decades, much has depended on the fluctuating global market and prices as primary drivers for recycling. A few years after the 2008 global recession, the recyclable sector saw very dismal recovery rates in the Philippines since the informal and semi-formal waste sectors preferred to concentrate on high value materials such as scrap metals rather than glass or paper, from which they earned very little. In cases of uncontrollable open burning, the combustion of these non-biodegradable materials significantly contributes to BC emissions.

LGUs are expected to put in place MRFs in conjunction or in cooperation with junkshops, yet only one-third of all barangays currently have access to these facilities. Ideally, MRFs should serve not just a sorting area but include processing activities as well. There is a lack of awareness, appropriateness, and R&D on technology options and selection processes. The capacities and efficiencies of pre-processing or recycling facilities also appear insufficient; the majority of recyclables are currently being exported to other countries. The importance of having a proper database is highlighted once more since a comprehensive and up-to-date list, types of materials handled, and capacities of recycling facilities are not yet available.

With the high potential of recycling to reduce SLCPs along the life cycle of recyclables or potentially recyclable materials, many opportunities exist to divert more fractions away from disposal facilities. The presence of willing buyers of recyclable materials, the contribution of private investors and the government to expand the coverage and capacities of recovery and recycling facilities, and the availability of knowledge and finance windows from developed countries have yet to be fully explored.

In the meantime, LGUs are challenged to keep recyclable fractions clean, i.e., segregated and not merely recovered from mixed waste, in order to command a higher selling value. There is also a need to engage recyclers to put up facilities all over the country to optimize recovery and recycling rates.

Management of Biodegradables

Comprising more than half of the country's generated MSW, managing this huge amount of biodegradables is a challenge. Along with kitchen waste, poor post-harvest processes contribute to more wastage of food produce, which contributes to bio-waste in public markets and from agricultural trading hubs. While a number of composting facilities have been reported to receive and process organic wastes, the capacities of these facilities remain untracked and conclusively insufficient based on the amount of these wastes still ending up at SWDS. This may be attributed to many factors, which include the lack of technical knowledge on composting, the absence of publicized technical guidelines on proper composting, incompatible sizing and design of facilities, lack of areas and spaces in highly urbanized cities, and the need for R&D on new, high-rate, and small-footprint technologies to compost biodegradable MSW.

For highly urbanized cities or high-income LGUs that lack space for aerobic composting, the potential to establish centralized anaerobic bioprocessing facilities remains unexplored. Anaerobic digestion technologies are widely used in the Philippine agriculture sector yet are not applied on a large scale to process MSW. The cost of technologies and the highly hydrolyzable nature of MSW may be the prohibitive factors that need to be addressed by policy makers and technical experts, including the provision of guidance on the suitability and operational requirements of anaerobic digestion to manage MSW in urban settings (CCC, 2015).

Meanwhile, composting and compost quality guidelines have already been passed and approved by NSWMC. Many IEC materials have been formulated based on the experience of practitioners but these may have to be subjected to review by technical experts so that implementers can operate properly. It may also help if science-based IEC materials were developed and disseminated in different languages and dialects all over the country.

At the other end of the spectrum is the use and application of compost produced from MSW. There remains a challenge to promote or sell compost products from the sector primarily due to the social perception that all MSW-based compost products contain many impurities. The presence of expertise and facilities on composting would then have to be complemented by public engagement to segregate waste to ensure compost quality by controlling the substrate. If good quality compost and compost analysis were applied, there would be increase in the nutritional value of the soil thereby contributing to co-benefits such as abatement of land degradation, improved agricultural outputs at lower prices, and increased food security.

In terms of leveraging, there is a need to understand the entire process, i.e. the fact that investment in composting will not generate much return, meaning the private sector may not be interested. Good quality compost products command a high market value and bioprocessing opens up employment opportunities to society. Reducing the amounts of biodegradables ending up in SWDS significantly avoids methane generation and the risks of spontaneous combustion, eliminates odor during waste collection and transport, and reduces ESWM costs. More government support and cooperation are needed in this case.

Other Resource and Energy Recovery Solutions

It also has to be realized that methane gas emanating from mixed MSW causes the generation of methane, which is an energy-rich gas. Methane can be captured from anaerobic digestion facilities and landfill gas. Some small-scale anaerobic digesters already capture and utilize biogas for cooking and some SWDS have implemented landfill gas collection and flaring or electricity generation.

RA 9003 requirements on dumpsite closure are generic in nature; they do not consider the amount and depth of the waste body at the SWDS. Gas flaring is currently not mandated by law, which only specifies mere gas venting as a minimum requirement. The Clean Development Mechanism used to be a prominent driving force to undertake biogas recovery but the current trends in the carbon market have discouraged proponents from searching for alternative financing or cost recovery options. Specifically, landfill gas flaring offers no income at all while the competitive rates to supply electricity to the grid remain dependent on feed-in tariff policies, which will not last long.

Meanwhile, the socio-political acceptance of technologies for the recovery of energy from non-biodegradable wastes with low economic value but containing high energy content remains a barrier for WTE in the Philippines. Confusing policies, mistrust over waste acceptance and air pollution control technologies, high capitalization requirements, and issues on the economies of scale are setbacks to exploring its potential as an ESWM option. Nevertheless, government guidelines on the use or co-processing of source-separated MSW as alternative fuels and raw materials (AFR) in cement kilns are already available. A number of LGUs are already cooperating with licensed cement manufacturing companies yet some are limited by logistics and cost issues to transport waste for processing in cement plants as AFR.

Waste Disposal

Only 21% of LGUs have access to SLFs and more than 400 dumpsites in the country still need to be closed and rehabilitated, many of which are located in unsuitable sites such as ravines, natural depressions with low water tables, and sometimes along coastal areas. The presence of organics in disposed waste caused by non-segregation and mixed waste collection enable the generation of methane in SWDS. This is aggravated by the fact that some of these facilities are either non-engineered, improperly designed, or operationally mismanaged. The Ombudsman's filing of cases against non-compliant LGU officials and personnel has effectively served as an eye opener for LGUs about their responsibilities under RA 9003, which is hoped to be sustained.

In terms of financing, the 20% LGU budget allocation in the local development plans (LDP) can be a budget source, especially now that DILG guidelines allow for its use in environmental infrastructure projects if sufficiently available. Many LGUs are not yet familiar with all the possible PPP options and clustering arrangements to choose from, which will enable consistent and proper facility management due to enhanced economies of scale. Larger SWDS also enable gas recovery to be feasible for at least partial cost recovery.

Smaller dumpsites also generate gas albeit with not enough concentrations to recover energy. Small LGUs should have the option to implement cost-effective dumpsite rehabilitation programs. The use of EESC is a promising option to properly close small SWDS while at the same time capturing any remnants of methane from escaping into the atmosphere but this entails an amendment to the closure and rehabilitation IRRs. Two case studies on the use of methane-oxidizing soil cover conducted in the Visayas are available as a starting point for preparing a feasibility study (FS) or research on its technical specifications. It is expected that such a policy will facilitate the speedy closure of many smaller SWDS all over the country because of ease and lower costs in application.

Open Burning at Backyards and SWDS

There is currently no reliable primary data on open burning and even if there is a database, it is a challenge to monitor and report such infrequent and often quick occurrences, especially at the community level. The behavioral issue of the public's convenience to burn rather than properly manage the waste needs to be addressed in a coordinated manner. The public has to be presented with alternatives to burning because if waste is not being collected in the first place, they might continue the practice. Limited waste collection frequency and coverage as well as inadequate processing facilities also result in increased marine debris.

There are already policies that prohibit open burning but these policies need to be harmonized across the relevant government departments. DENR, DOH, DA, and PIA could work together to iron out any inconsistencies as regards burning practices. Once harmonized, the guidelines should be subsequently communicated to the general public and local enforcement units. Penalties on open burning violators, i.e. both LGUs and communities, are often not imposed.

Open burning at SWDS is within the control of LGUs. Some incidences are intentional where SWDS operators are sometimes accused of doing it to free up space for future waste acceptance. However, some are indirectly unintentionally caused by concentrated solar radiation refracted by glass at the SWDS surface. If conditions are right, SWDS fires can also burn underground due to smoldering deep within the waste body caused by the right oxygen-methane proportions, which are extremely difficult to combat and can burn for days or even weeks [DENR/World Bank, 2013]. Various control measures are available but best available technologies (BAT) and best environmental practices (BEP) should be compiled and published and LGUs would have to be trained on how to properly suppress dumpsite or landfill fires. There is also an ongoing research commissioned by DENR to compare emissions from WTE and open burning, which could feed into the discussions.

4. GUIDING PRINCIPLES

The Philippine waste sector identifies characteristics and indicators for strategic measures deemed doable and sustainable and therefore should be placed high on the agenda. Aside from helping to slow down the rate of near-term global warming, measures to reduce SLCP emissions should be:

Socio-Politically Sustainable. Measures should be prioritized or designed to be socially acceptable to effect maximum public support and cooperation. Practices and technologies should have enough buy-in to be able to withstand administrative transitions and political and policy changes across boundaries, not only at the national but at the local levels as well.

Practical. Strategies and actions should be doable at all levels of LGUs, i.e., provinces, cities and municipalities, and barangays. They should also be practical enough to be replicated in many areas and by other sectors such as businesses, industries, and institutions.

Cost-effective. It should be economically, commercially, and technology feasible to be properly implemented, managed, and sustained.

Funded. The viability and availability of resource allocation for both capital expenditures and operational expenses to implement the measures should be established and programmed. While traditional sources of funding are indispensable, alternative ways and means could be explored, including cost recovery mechanisms, public-private partnership, and market development. Actions could also be leveraged with other market programs, fiscal and non-fiscal incentives, and investments to maximize efficacy.

Green. Eco-friendly practices and technologies should be prioritized to avoid mal-mitigation. It should also be compatible with the Philippine setting.

Fair and inclusive. Strategies should always consider not only the stakeholders who will benefit but also those who may be negatively affected by implementation. It should be programmed to take into consideration all stakeholders, including the informal waste sector, indigenous peoples, affected industries, disadvantaged communities, and those who least receive basic services.

Conducive to Private Sector Participation. Whenever applicable and necessary, strategies should be designed to engage the private sector to attract potential investments, leveraged funds, or corporate social responsibility on ESWM vis-à-vis SLCP reduction goals.

Synergistic. Good strategies are those that can elicit partnerships at all levels and encourage the commitment of implementers and stakeholders to implement actions in a coordinated and synergistic way.

SMART. Measures should have specific, measurable, attainable, realistic, and time-bound (SMART) targets that are achievable and realistic yet allow flexibility for increasing ambition in order to build a more concrete and executable plan for implementation.

MERV-able. Measures should have parameters and indicators designed for future measurement/monitoring, evaluation, reporting, and verification (MERV) to track progress, carry out the necessary corrective measures, and communicate effectiveness of the country's efforts and contributions to SLCP reduction.

Aligned with national goals. To avoid policy inconsistencies and maximize future resource leverage, it is necessary to align strategies with other national plans, policies, and programs, albeit not necessarily on the set targets. The MSW sector determines if related targets are realistic, achievable, compatible, and consistent.

Designed to achieve the most co-benefits. Great strategies are those that reap the most positive impacts not only to climate, but also to local environmental quality, ecosystems, public health, food and water security, climate change adaptation, employment, socio-economic goals, and other development co-benefits.

Leading to transformational change. Incremental, transitional or transformational changes are characteristically profound and refer to the creation or customization of a whole new form, function or structure. Transformation is a change in mindset based on learning and taking actions based on leading with knowledge and courage. Its context in low carbon development is relative to a higher probability of achieving the acceptable levels of reduction. Strategies should be consistent with sustainable development paths.

5. SPECIFIC MEASURES TO REDUCE METHANE EMISSIONS

SLCP strategies for CH_4 and BC sources and emissions have been identified. Preliminary results are shown in Annex E while the consolidated and synthesized results are shown in Annex F. Annex F also elaborates on the corresponding baselines and targets for the main strategic outcomes, including the supporting sub-strategies.

In general, the avoidance of further CH_4 generation can be achieved by diverting biodegradables away from SWDS through segregated collection, processing and treatment. On the other hand, CH_4 reduction can be accomplished by the capture, recovery, and/or utilization of biogas that is generated at SWDS and at anaerobic treatment facilities.

IMPLEMENT COMPREHENSIVE AND STRATEGIC BIODEGRADABLE WASTE MANAGEMENT PROGRAMS

Target: *Increase the diversion of biodegradables away from SWDS by increasing the percentage of biowaste that is composted or digested to 17.9% by 2025, 24.3% by 2030, and 37.1% by 2040, in comparison to 5% in 2010.*

Strategies to divert biodegradables from the MSW stream before reaching SWDS should be implemented in a programmatic manner to achieve the highest impacts. Each source category of biowastes should be managed separately yet in an integrated manner. In this way, implementers can focus on the specific needs of each fraction and consider the most appropriate approach.

Household food and yard waste management program

a. Promote backyard composting whenever feasible.
b. Promote communal/sitio/subdivision/homeowners' association (HOA)/barangay/barangay cluster-level biodegradable waste processing facilities to complement centralized aerobic composting/anaerobic digestion facilities.
c. Multi-level documentation of existing best practice models for the source separation, segregated collection and processing of household kitchen and yard wastes.
d. Establish new systems/cooperation models as a guide for LGUs, including frequency and dedicated collection resources (human or mechanized).
e. Explore PPP to invest financial sources to sustain this biodegradable waste management program.

Management of biowaste from food industries and establishments

a. Institutionalize system (*including specific policy/guidelines*) for systematic segregation, collection, and processing/treatment of biowastes from food processing industries and establishments.
b. Establish and properly operate onsite or offsite centralized aerobic composting/anaerobic digestion facilities.
c. Encourage private waste generators to cooperate, finance sources to invest, and LGUs to recover costs.

Management of biowaste from markets and trading posts

a. Institutionalize system (*including specific policy/guidelines*) for systematic segregation, collection, and processing/treatment of biowastes from public and private markets and agricultural trading posts, including proper post-harvest management.
b. Establish and properly operate onsite or offsite centralized aerobic composting/anaerobic digestion facilities.
c. Encourage private waste generators to cooperate, finance sources to invest, and LGUs to recover costs.

Enhance supporting policies and activities for the increase in biowaste processing/treatment capacities and coverage

a. Develop *technical guidelines* and capacitate LGUs and the private sector on the proper siting, sizing, design, and operations of aerobic composting and anaerobic digestion facilities.
b. Design and provide fiscal or non-fiscal incentives or equity share for private investors venturing into biowaste processing facilities.
c. Conduct market studies and develop markets for compost and energy products from MSW, e.g., National Greening Program, non-fruit bearing trees in urban landscaping, organic farming, for EESC, etc.
   Subject compost products to quality analysis for package labelling to increase market value viz. return on investment.

PROMOTE GAS CAPTURE, RECOVERY, AND TREATMENT DURING OPERATION, AND CLOSURE AND REHABILITATION OF SWDS …

Target (1): *Increase the amount of SWDS gas captured and/or utilized from 0% in 2010 to 36%, 52%, and 54% of the tons of generated CH_4 by 2025, 2030, and 2040, respectively.*

… INCLUDING THE USE OF EESC AT SMALL SWDS

Target (2): *Increase the amount of SWDS gas captured by increasing the percentage of small SWDS that use EESC from none in 2010 to 31% by 2025 and 50% by 2030 and thereafter.*

Biogas is generated both at biodigestion facilities and at SWDS. Methane capture and treatment from digesters, which are controlled systems, are quite manageable. However, many SWDS still generate significant amounts of methane from previously disposed mixed waste, which should be collected, captured, and flared. In smaller SWDS where flaring is not feasible, the use of EESC is another option. EESC also allows for the conversion of CH_4 into biogenic CO_2 just like flaring albeit in a slower combustion process aided by CH_4-eating bacteria.

Promote gas capture by flaring, with recovery and treatment of SWDS gas with at least 20% methane concentration

a. Develop *policies/guidelines* on the capture, recovery and treatment of methane from landfill gas
b. Promote methane capture and flaring of gas at bigger SWDS (20-40% CH_4), including how to sustain without energy by-products.
c. Encourage private and LGU facilities, and tap international market mechanisms and funds, to sustain methane gas capture, recovery and treatment.

Apply EESC at smaller dumpsites to capture methane from SWDS gas at <20% CH_4 concentrations

a. Conduct research and FS to determine the characteristics of SWDS where EESC may be applied (e.g., area, depth, composition of disposed waste) as well as the optimum mixture of soil, compost and other materials, and the appropriate thickness of the EESC layer.
b. Modify SWDS management policies vis-à-vis use of EESC based on research and FS.
c. Encourage LGUs to adopt EESC.
d. Monitor methane emissions, including through research by tapping higher education institutions in the area.

Enhance supporting policies/activities such as continued monitoring of the operation of SLFs and the closure and rehabilitation of SWDS

a. Carry out a policy review on leachate recirculation (to enhance decomposition) and leachate treatment with methane capture by revisiting DAO 2006-09 and DAO 2006-20 on the requirements for leachate management.
b. Continued enforcement for LGUs to close all the remaining dumpsites in the country and their subsequent use of SLFs.
c. Issuance of guidelines on the clustering of LGUs for SLF economies of scale, and proper operations and management, including environmentally sound SWDS gas management.

6. SPECIFIC MEASURES TO REDUCE BLACK CARBON EMISSIONS

In general, the avoidance or reduction of BC generation can be achieved by diverting the recyclable fractions of MSW away from SWDS through segregated collection, processing and treatment. Alternative technologies to enable resource and energy recovery from biogas and from materials with low economic value can indirectly reduce BC emissions by displacing grid-supplied electricity. The prevention and suppression of open waste burning at backyards and at SWDS likewise reduce BC emissions into the atmosphere. While increasing the efficiency of waste collection is a measure to discourage community waste burning and improve the delivery of basic services to the public, it is bound to increase BC emissions due to increased mobile combustion. However, waste collection need not be compromised for the mere goal of reducing SLCPs since alternative options to reduce BC emissions on a per-ton basis may be implemented, including the avoidance of long-haul transport through waste diversion, optimization of waste collection routes, and the use of cleaner vehicles and engines.

IMPLEMENT COMPREHENSIVE AND STRATEGIC RECYCLABLES MANAGEMENT PROGRAMS

> **Target:** *Increase the diversion of recyclables by increasing the percentage of the aggregated amounts of recyclables that are recycled to at least 50%, 55%, and 60% by 2025, 2030, and 2040, respectively.*

This main strategy deals with recycling industry development programs per recyclable fraction or component. Elaborated are the strategies and accompanying actions to improve the collection of recyclables from generators, enhance the capacities of facilities to store and consolidate these materials, and develop the local recycling industry and markets for recyclables and recycled products.

Improve logistics / recovery flow to enhance collection of recyclables from the waste stream

a. Document existing best practice models for the segregated collection of recyclables or establish new systems/cooperation models as a guide for LGUs.
b. Develop business models for LGUs and the private (formal, semi-formal, informal) sector to improve recovery rates and coverage.
c. Enhance incentives/enforcement of proper segregation, secondary storage, and labelling of all recyclables such as paper, aluminum, metals, plastics and glass from households, commercial, market, institutional and industrial sources.
d. Implement efficient scheduling of the collection of recyclables, preferably at least three times a week.
e. Develop models for recyclables collection from islands, far-flung areas, mountains, etc.
f. Transition from informal to a formal system while integrating all players.

g. Codify into local ordinances the no segregation, no collection policy and supporting activities and facilities.

Enhance capacities of MRFs to receive, sort, and pre-process recyclables

a. Develop models and promote the establishment of communal/sitio/subdivision/HOA/ barangay/barangay cluster-level MRFs to complement centralized facilities.
b. Develop *technical guidelines* and capacitate LGUs and accredited junkshops/consolidators on the proper siting, sizing, design, and operations of centralized MRFs and junkshops.
c. Provide a linkage mechanism between the junkshops/consolidators and the generators.
d. Document and monitor the operations and outputs of junkshops and haulers, including the implementation of monthly reporting of the amounts of diverted recyclables.

Support the development of local recyclers, recycling industries, and markets for recyclables and recycled products

a. Update the recycling industry development study, including potentially recyclable materials, with Japan International Cooperation Agency's Study on the Recycling Industry Development in the Philippines in 2008 [JICA, 2008] as a starting point.
b. Support the development of the local recycling industry (per material type) to complement the export-driven recyclables market.
c. Conduct value chain analysis to improve local value creation.
d. Promote sustainable livelihood / income generation programs utilizing recyclable items
e. Organize local industry forums for junkshops, haulers, recyclers, IWS, etc.
f. Identify options/alternatives to low economic value/potentially recyclable waste fractions and issue corresponding *policy/guidelines*.

Shift consumption from single-use disposables to single-use recyclables, whenever possible

a. Promote the use of recycled materials and their products.
b. Develop and issue relevant *policy/guidelines*.
c. Adopt approaches in support of a zero waste management vision.

ADOPT ALTERNATIVE TECHNOLOGIES, INCLUDING WASTE-TO-ENERGY, AS SWM SOLUTION, CONSIDERING INSTITUTIONAL, LEGAL, AND TECHNICAL LIMITS[1]

Target (1): *Increase the amount of captured biogas from digesters and gas from SWDS that are utilized for energy generation (to enable corresponding displacement of grid electricity) from 0% in 2010 to 34% by 2025 and 56% by 2030 and thereafter.*

Target (2): *Increase the percentage of low-economic value waste fractions used for resource and energy recovery from 0% in 2010 to 10%, 30%, and 50% by 2025, 2030, and 2040, respectively.*

Biogas from significantly bigger SWDS and biodigesters have enough methane concentrations to allow for RE generation. While flaring and EESC allows for the reduction of CH_4 emissions, the

[1] PDP 2017-2022, Chapter 19, Subsector Outcome 2: Social Infrastructure (e)

displacement of grid-supplied electricity by the energy produced from biogas has equivalent BC emission reduction through the displacement of fossil fuel combustion in the energy mix. Similarly, the use of AFR and other waste-to-fuel products reduces the consumption of fossil fuels. It also allows for an alternative management of low-value non-biodegradables, which would otherwise end up in SWDS or in the marine environment. Whenever technically and economically feasible as well as environmentally acceptable, resource and energy recovery strategies should be promoted.

Encourage the utilization of recovered/capture gas from anaerobic digesters and SWDS for energy generation, whenever feasible

a. Conduct a baseline and mapping study on SWDS, anaerobic digestion, and mechanical-biological treatment (MBT) facilities that may be capable of generating energy from biogas.
b. Encourage private and LGU facilities to access the incentives provided by the Philippine Renewable Energy (RE) Act and tap international market mechanisms and funds, to sustain methane gas recovery with utilization.

Maximize the adoption of existing and new emerging alternative technologies to recover resources and energy from segregated, low-economic value non-biodegradable waste fractions, e.g., arts and crafts, building materials, use as AFR in cement kilns, other waste-to-fuel options, and others.

a. Evaluate emerging technologies for resource and energy recovery.
b. Adopt *guidelines* for storage facilities for materials with low recycling value but with high energy content, including clear-cut standards and safeguards for the waste to fuels, AFR from MSW, production of hollow blocks and similar alternative products, use in arts and crafts, chemical recycling, etc.
c. Conduct market development study (mapping, type of waste, logistic plan, GHG/SLCP reduction potential, Cost Benefit Analysis).
d. Provide logistical and infrastructure support to enable future resource and energy recovery of (currently) non-sellable non-biodegradables and residuals.
e. Make national financing available for acceptable existing and new emerging alternative technologies.
f. Prepare a strategic plan to address marine debris through a comprehensive approach.
g. Encourage LGUs to enter into agreement with Cement Manufacturing Association of the Philippines, accredited cement manufacturers, and other potential partner organizations.

Enhance supporting policies and implement initiatives to enable resource and energy recovery

a. Review the RE Act and suggest enhancements to RE categories, including a separate one for MSW-based sources, and provide a venue for offtake price discussions.
b. Explore other market mechanisms to co-finance projects, e.g., Clean Development Mechanism, Joint Crediting Mechanism, etc.

IMPLEMENT BAT/BEP TO PREVENT AND CONTROL OPEN BURNING AT SWDS

Target: *Reduce the amount of deposited waste that is burned at SWDS through the closure and rehabilitation of at least 60%, 65%, and 70% of the remaining unmanaged SWDS by 2025, 2030, and 2040, respectively.*

This strategy adapts locally developed BAT/BEP for the prevention and suppression of open burning at SWDS. Surface and deep-seated fires are daily challenges for SWDS operators and there are techniques to prevent and control these types of burning incidences.

Prevent surface and deep-seated fires at SWDS

a. Disseminate *BAT/BEP guidelines* on the prevention of SWDS fires, e.g., gas mixtures, soil cover and other SWDS operational practices.
b. Build capacities of LGUs on SWDS fire prevention.
c. MERV the proper operations as well as the closure and rehabilitation of SWDS and provide findings and recommendations.

Suppress surface and deep-seated fires at SWDS using appropriate fire-fighting techniques

a. Disseminate *BAT/BEP guidelines* on the control/suppression of SWDS fires.
b. Collaborate with LGUs, BFP, LDRRMO and host barangay in the monitoring of fire incidences and suppression at SWDS.

IMPLEMENT BAT/BEP TO PREVENT AND CONTROL OPEN BURNING AT BACKYARDS OR COMMUNAL AREAS …

Target (based on increased waste collection coverage and frequency): *Reduce the amount of waste burned at backyards by 30%, 50%, and 70% by 2025, 2030, and 2040, respectively.*

… BY (AMONG OTHERS) INCREASING WASTE COLLECTION COVERAGE AND FREQUENCY.

Target: *Reduce the amount of uncollected waste from 10% of the generated waste in 2010 to 7%, 5%, and 3% by 2025, 2030, and 2040, respectively.*

This strategy adapts locally developed BAT/BEP to discourage households and communities from open waste burning. This includes clarification of policies, instituting behavioral change, and increasing waste collection coverage and frequency.

Engage public support against backyard burning

a. Harmonize *policies* on open burning including subsequent issuance of a NSWMC Resolution and/or JAO (DENR, DOH, DA, PIA).
b. Conduct workshops/retooling (LGUs, Regional offices of concerned government offices).
c. Develop social marketing and IEC campaigns for public awareness on environment and health impacts of open burning.
d. Encourage LGUs to pass ordinances to enforce RA 9003's prohibited acts: open burning

Enhance residual waste collection coverage and frequency to discourage backyard burning

a. LGUs to improve coverage areas and increase frequency in waste collection by allocating funds, improving logistics, and/or outsource waste collection services.
b. Explore alternative efficient collection scheme for far-flung and island barangays.

PROMOTE THE USE OF LOW-POLLUTING WASTE COLLECTION VEHICLES AND OPTIMIZATION OF MSW COLLECTION ROUTES AND TRANSPORT SCHEMES

Target: *Reduce fuel consumption per ton of waste collected by 3%, 5%, and 10% by 2025, 2030, and 2040, respectively as compared to 8 liters of fuel (95% diesel and 5% gasoline) per ton of collected waste.*

Waste collection is one of the most costly components of the ESWM system. Many LGUs overlook the potential of optimizing collection routes in cost savings and BC reduction. In some cases, the use of transfer stations can further contribute to this goal especially when the SWDS is very far from the collection point. Another strategy is to encourage the use of less polluting vehicles either by discontinuing the use of very old and dilapidated units or by carrying out regular preventive maintenance to maximize fuel efficiency.

Establish optimal waste vehicle collection routing techniques/schemes

a. Develop *technical guidelines* on vehicle route optimization (Euler tour and heuristic methods).
b. Capacitate LGUs and contractors/haulers on vehicle route optimization to reduce costs and emissions.

Implement optimal transfer and transport schemes

a. Develop *technical guidelines* on transfer (operation of transfer stations, when applicable) and transport to reduce fuel consumption (Including inter island collection and transport).
b. Adopt compaction/bailing based on cost-benefit analysis.

Use less polluting vehicles/machineries

a. Ensure the regular conduct of preventive maintenance of vehicles/machineries used in the MSW sector and issue corresponding *policy/guidelines* in cooperation with DOTr and LGUs.
b. Optimize the capacities of vehicles, vehicle types, and machineries to reduce SLCP emissions per ton of waste collected or processed.
c. Modernize fleets or encourage the use of Euro 4-compliant vehicles subject to FS or cost-benefit analysis.

7. AGGREGATED GHG/SLCP REDUCTION POTENTIALS OF STRATEGIES

Specific measures to reduce SLCP emissions are mostly inter-linked and inter-dependent with each other. Hence, individual reduction strategies for 2025, 2030 and 2040 have been grouped together into three mitigation scenarios to evaluate aggregated climate impacts. By following the seven main strategies, potentials for mitigating GHGs and SLCPs from the MSW sector have been quantified and compared to support decision-making processes. Details are in Annex G of this document.

MSW generation rate and management options at the national level are the key data required for the waste flow analysis. Waste generation rate used for 2010 was 36,395 tons per day or 13.48 million tons in the base year [DENR-EMB, 2014] while projected values of MSW generation for 2025, 2030 and 2040 were based on the Mitigation CBA Study [CCC/USAID-B-LEADERS, 2018].

MITIGATION SCENARIOS FOR 2025, 2030 AND 2040

Mass balances and the allocation of the different types of waste fractions to various treatment options were carried out based on the identified strategies and targets. The allocation of waste among different types of disposal sites followed the CBA assessment wherein SWDS have been categorized into three, namely ODs, CDs and SLFs. Disposal rates at different disposal sites were estimated based on the percentages given in the CBA study. Mass balances on BC-relevant functional elements such as enhancing residual waste collection coverage and frequency, discouraging backyard burning, and closure of most of the remaining unmanaged SWDS, were also established. Table 3 shows the summary of results.

Table 3. MSW allocation among different treatment options

Type of treatment	Unit	2010	2025	2030	2040
Transportation	tons/yr	12,133,194	19,098,026	21,981,179	27,692,951
Composting	tons/yr	352,537	1,922,473	2,940,596	5,539,532
Recycling	tons/yr	1,875,245	2,650,108	3,284,567	4,421,165
Open dumping	tons/yr	6,933,788	6,037,530	6,435,097	6,985,812
Control dumping	tons/yr	990,541	4,462,522	4,756,376	5,163,427
Sanitary landfills	tons/yr	1,981,082	4,025,393	4,564,543	5,583,014
Burning of uncollected waste	tons/yr	323,552	344,997	277,657	205,556
Scattered dumping/ uncollected waste	tons/yr	1,024,581	1,092,489	879,247	650,927
Total waste generated	**tons/yr**	**13,481,326**	**20,535,512**	**23,138,084**	**28,549,434**

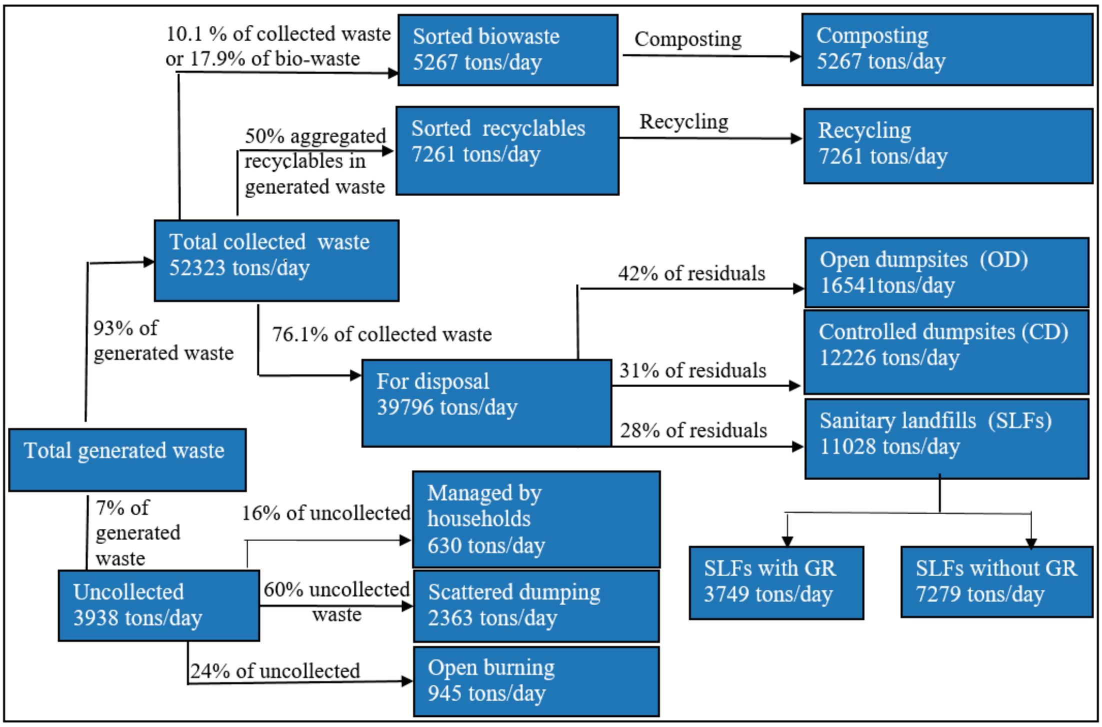

Figure 13. Waste flow and mass balance for the 2025 scenario

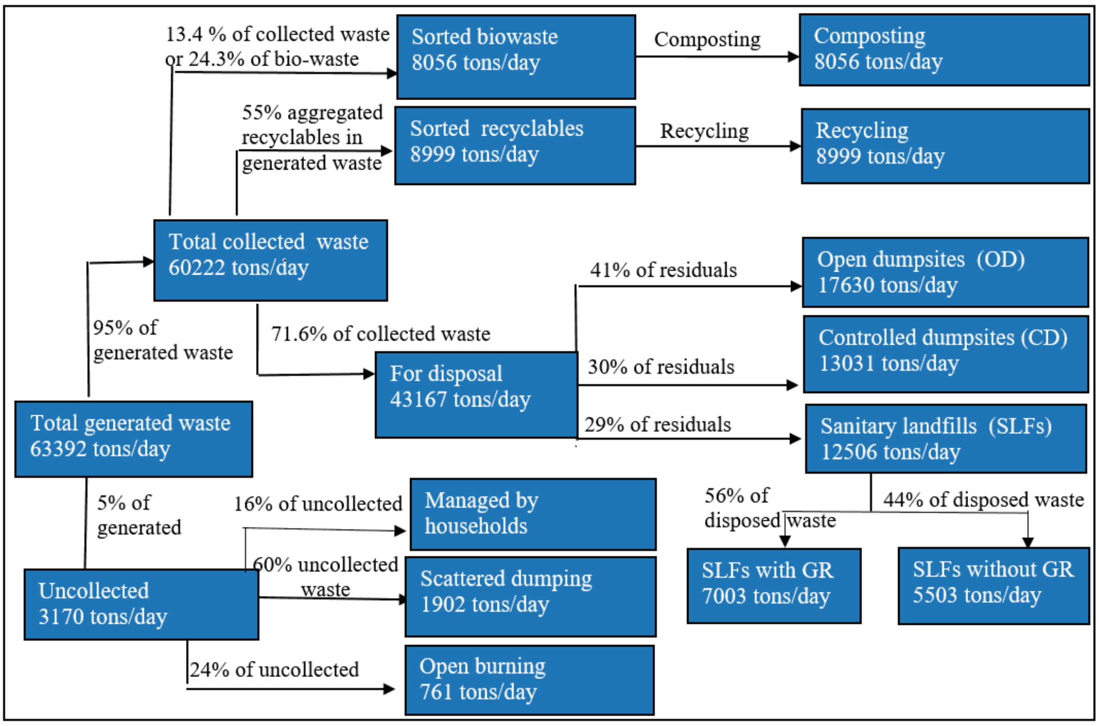

Figure 14. Waste flow and mass balance for the 2030 scenario

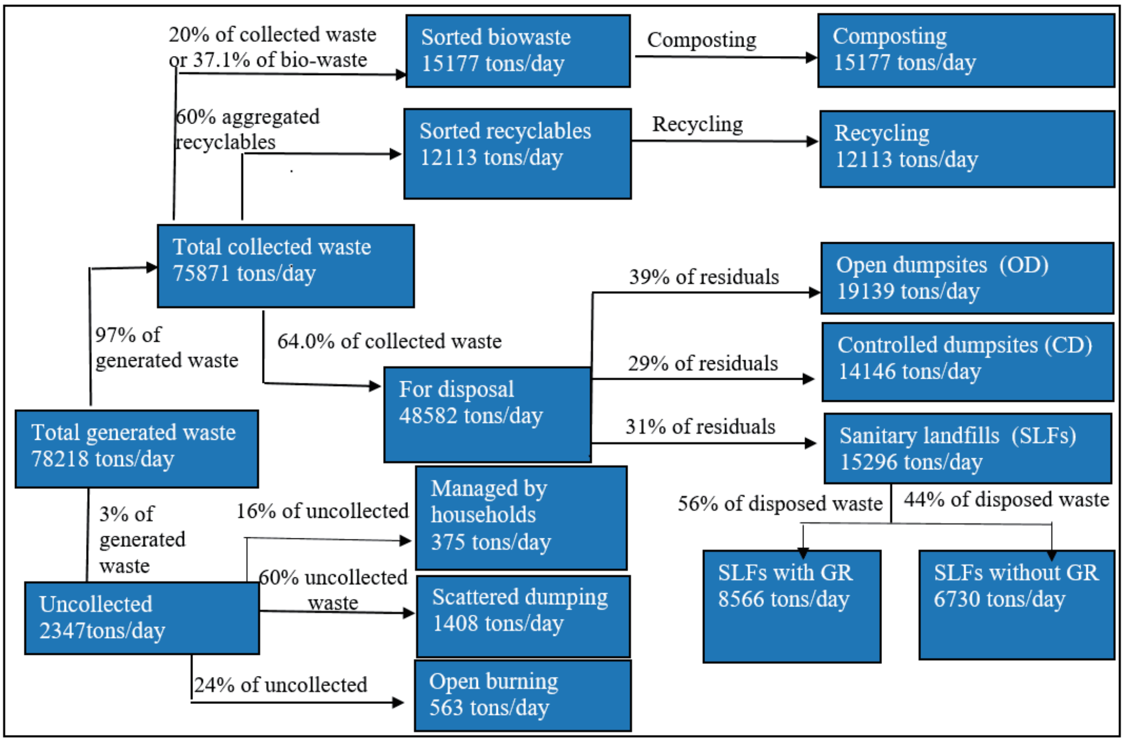

Figure 15. Waste flow and mass balance for the 2040 scenario

Figures 13 to 15 show the resulting waste flow analysis considering the combination of strategies and targets set to reduce GHG and BC emissions. The reduction in the amount of waste that is burned at backyards is reflected in the reduction in the amount of uncollected waste while the incidences of SWDS burning are indirectly correlated to the closure of unmanaged ODs. The assessments of the SLCP reduction impacts of each strategy are discussed in detail in Annex G.

OVERALL CLIMATE IMPACT OF SLCP REDUCTION STRATEGIES

To compare the overall climate impact of the identified strategies on the reduction of CH_4, BC and other GHG emissions between the base year and the projected years of 2025, 2030 and 2040, activity data were converted to tCO_2e for each gas component using the EQT, as shown in Table 4.

Table 4. Overall climate impact of reduction strategies, in million tCO_2e per yearly generated MSW

Description	2010	2025	2030	2040
Climate impact from CH_4 (i)	5.54	6.83	6.57	7.51
Climate impact from BC (ii)	0.97	0.50	0.49	0.50
Climate impact from other GHGs (iii)	- 1.08	- 1.71	- 2.20	- 2.97
Climate impact from all GHGs (i) +(iii)	4.46	5.1	4.38	4.53
Climate impact from all SLCPs (i)+(ii)	6.50	7.34	7.07	8.0
Net Climate impact (i)+(ii)+(iii)	**5.43**	**5.62**	**4.88**	**5.04**

As shown in Table 4, the total climate impact of CH_4 is found to be at least 5 to 15 times higher than the climate impact caused by BC. Emissions from other GHGs (CO_2 and N_2O) in all the years show negative values mainly due to potential CO_2e savings through resource recovery from recycling and avoidance of equivalent amounts of those emissions from conventional processes. The estimated net climate impact caused by BC, CH_4, CO_2 and N_2O from the BAU scenario is 5.43 million tCO_2e, which could be reduced to 5.62, 4.88, and 5.04 million tCO_2e by the years 2025, 2030 and 2040, respectively, if the strategies were to be implemented. Disaggregated data for tCO_2e on the basis of annually generated waste are shown in Figure 16.

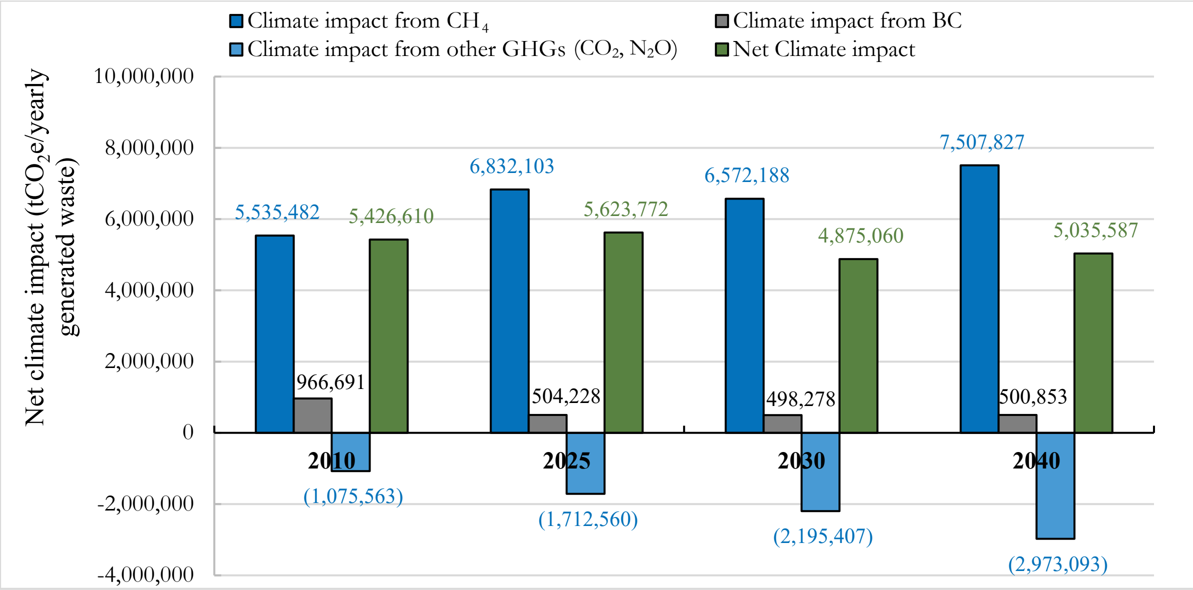

Figure 16. Overall climate impact from improved MSW management (yearly basis)

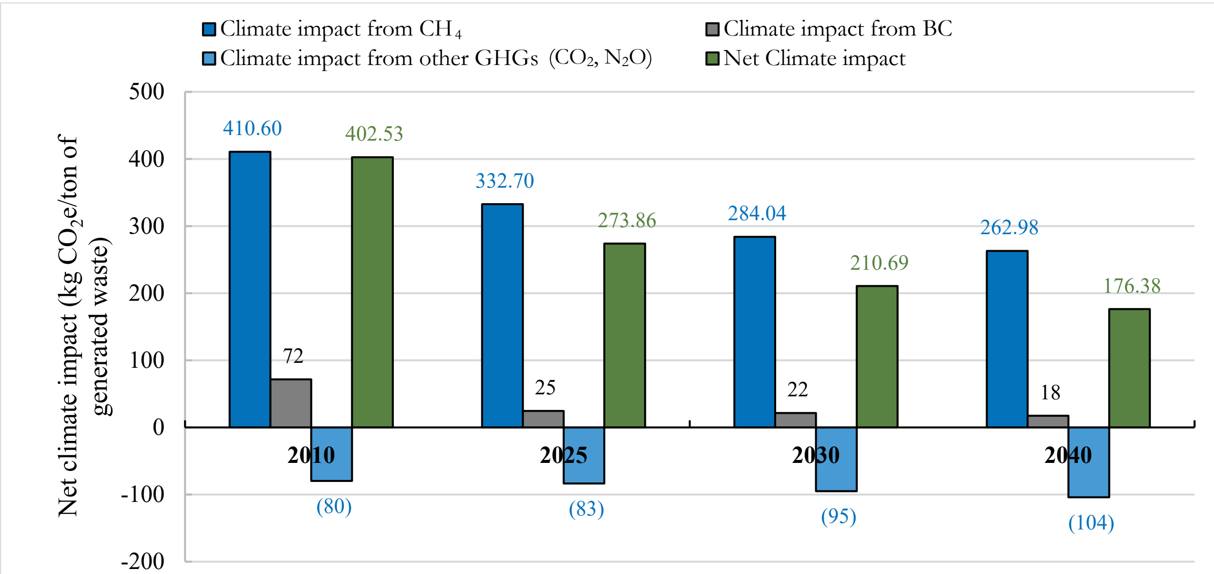

Figure 17. Overall climate impact from improved MSW management (per ton of input waste)

Fluctuations in emission figures can be noticed in the projected years due to variations in waste generation rates and resource recovery rates. Potential mitigation benefits from addressing both GHGs and BC are very important for implementing climate policy and planning. To measure the progress on the effects of the proposed policies and strategies on emissions reduction, emissions and relative emission reductions were quantified per ton of generated waste as shown in Figure 17.

The total climate impact mitigation potentials from MSW management through the proposed seven strategies in projected years of 2025, 2030 and 2040 are 32%, 48% and 56% respectively, relative to the 2010 base year practices, as shown Figure 18. A similar graph, on a per ton basis, has been previously illustrated in Figure 1.

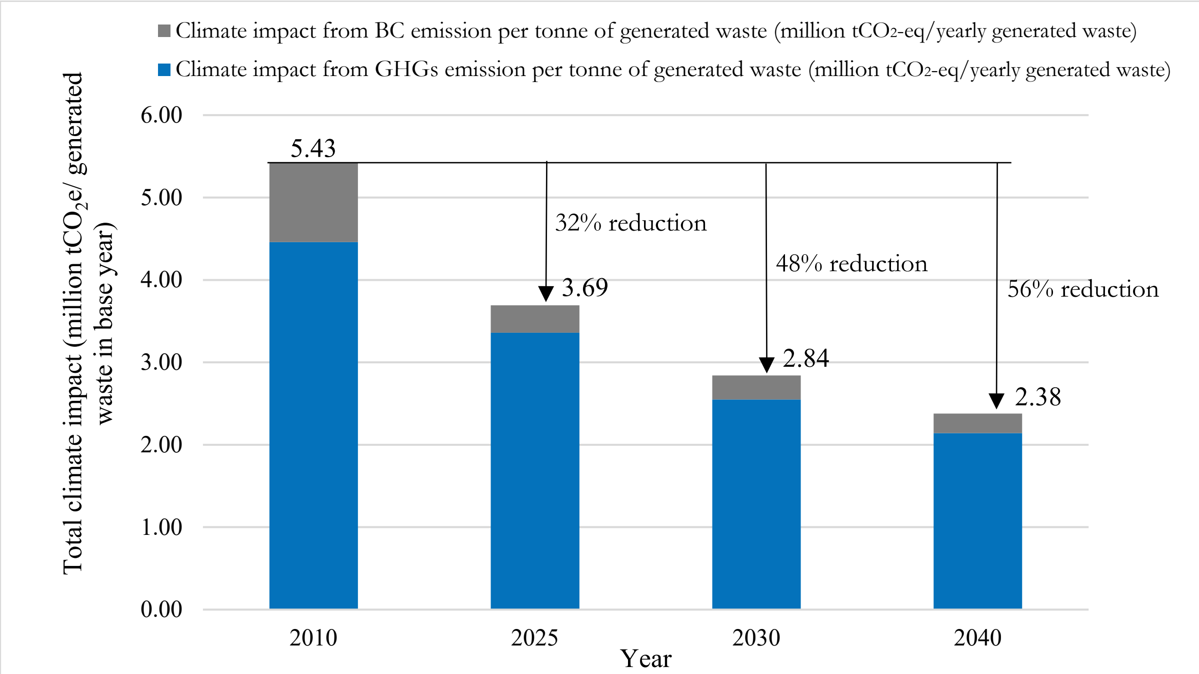

Figure 18. Comparative analysis of climate impacts in base year and projected years (emissions based on the same amount of generated MSW at base year 2010)

Furthermore, a picture of how the emissions from the mitigation scenarios deviate below BAU practices is shown in Figure 19.

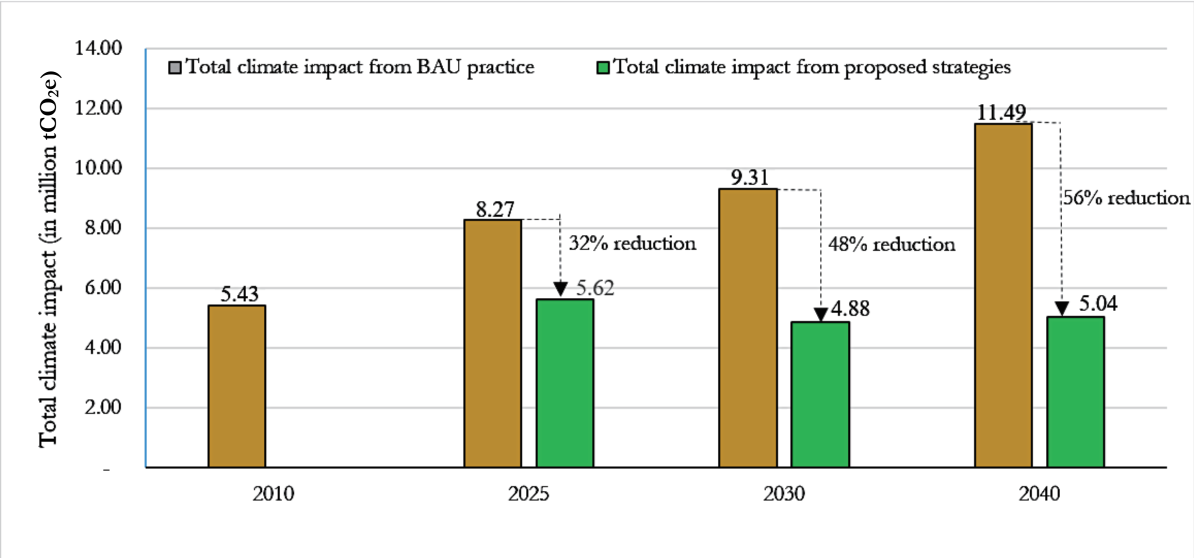

Figure 19. Total climate impact as deviation below BAU practice through proposed strategies

These results have been achieved by providing improved waste collection service, scaling up interventions targeting open burning, and promoting maximum resource recovery (composting and recycling) including by encouraging waste separation and improving the conditions of open dumping and control disposal practices. GHGs and SLCP reduction measures can be accommodated both through strategic planning and selection of appropriate climate-friendly technologies while making efforts to terminate/enhance the condition of conventional disposal practices. As such, a well-designed, integrated waste management system represents an important means of implementation for achieving climate-change mitigation targets in the Philippines. Overall, these findings of quantitative analysis highlight the need for developing a national framework aimed at addressing SLCPs from MSWM, together with its timely and necessary application.

8. CROSSCUTTING CONSIDERATIONS

Several proposed measures to reduce SLCPs cut across the different functional elements of waste management. These measures were originally proposed as crosscutting or "vertical" strategies in support of the identified specific strategies to reduce CH_4 and BC emissions. These will be addressed and strategized in a more holistic manner in view of the current initiative of the NSWMC and DENR to update the country's NSWMS. Nevertheless, these crosscutting considerations remain crucial enabling mechanisms for the SLCP reduction strategies to materialize sustainably.

Adopt and mainstream national SLCP policy or framework objectives. Initially with the Philippine MSW sector, the Philippines should adopt a science-based and customized national policy to reduce SLCPs in line with the country's climate and development goals.

Institutionalize MERV, including SLCP baselining, emission reduction calculations, and performance monitoring, in the national database. Enhance the platform for knowledge and data management for updating the baselines and tracking of the effectiveness of SLCP reduction programs, preferably anchored on existing MERV systems of the MSW sector. This includes consolidation and mapping of activity data for baselining and assessment of mitigation performance such as waste generation and composition, segregated collection and coverage, vehicle routing and fuel consumption, recyclers and recycling rates, bioprocessing capacities, shifts in waste disposal modalities, open burning, and other information to generate waste stream analysis.

Enhance KM, capacity building, and social marketing platforms for SLCP management. Compile best practices, cost-effective technologies, and tools and make such available to the public to foster capacity building and LGU best practice sharing. It is also imperative to design and implement a comprehensive social marketing plan in reducing SLCP emissions from the MSW sector. This includes communicating the impacts and co-benefits of reducing CH_4 and BC emissions.

Provide incentives and rewards to practitioners. Enhance incentive schemes for implementers, communities, barangays, and private sector that practice proper and high-impact ESWM. The criteria used in the rewards system is also good for self-assessment and continuous improvement. The CCC also has programs for recognizing climate action from LGUs and the private sector. The implementation of SLCP actions may be considered or included as criteria for selecting awardees.

Match ESWM technologies and link markets for useful by-products. While many waste fractions already have existing markets, there should be a comprehensive program to link the LGUs and consolidators of recyclables, compost products, energy, and other useful products from the MSW sector. It is also crucial to fill in the market gaps by further developing markets or industries that process these. This is particularly true in light of reduced export markets for recyclables. Whenever necessary, further R&D is needed to foster local value creation and reduce costs of technologies or facilities. This crosscutting consideration should be complemented by providing guidelines and capacity building on technology assessment, selection, and sizing.

Institutionalize ESWM resource requirements. National government agencies (NGAs), LGUs, private implementers, supporting institutions, and the general public should be provided with the necessary resource requirements such as budget, manpower, expertise, and supporting programs. Lobbying for the regular appropriation of funding for RA 9003 implementation could also be carried out at the national and local levels. While government policies on procurement are in place, it is also necessary to review such policies, e.g., allowing the use of government resources for the closure of publicly used SWDS located on private lands.

Optimize PPP potential. Actively engage the participation and support of the private sector in the management of specific waste streams as waste generators or through their corporate social responsibility (CSR) programs. Beyond this, the private sector can leverage funds for attractive investments or be instrumental in making ESWM technologies or businesses available. It is necessary to adopt suitable PPP models or design other models as applicable. It is also important to work with the IWS and the semi-formal sector to maximize SLCP reduction particularly through resource recovery.

Maximize convergence. Strengthen convergence initiatives among government agencies to implement SLCP reduction measures in a coordinated and programmatic manner. Existing partnerships with other relevant stakeholders should be continued while exploring the potential contribution of other stakeholders, both local and international.

9. ACTION PLANNING

It is expected that an action plan shall be prepared to elaborate how the identified SLCP reduction strategies would be timely implemented. The action plan ideally consists of a set of activities, timeframe, responsible offices and organizations, resource requirements, and risks and assumptions to achieve each key initiative. It may be an independent action plan or it could be mainstreamed into other sectoral, climate, investment, or development plans. It is thus imperative to identify how to program strategies and actions in the most effective manner.

9.1 INTERRELATIONSHIPS AND PRIORITIZATION OF MEASURES

While reduction options will all have to be carried out eventually, there are some measures that inevitably serve as direct or indirect driving factors that influence the achievement, or at least initiation, of the other measures. Which and how each measure directly or indirectly influences the others have been evaluated through factor analysis.

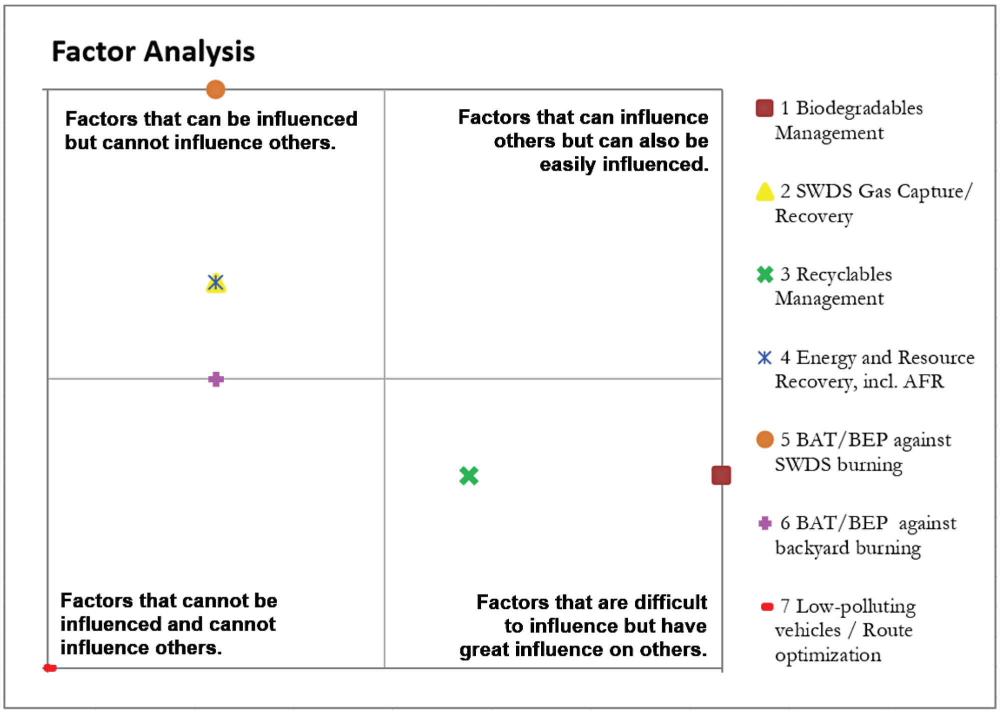

Figure 20. Results of the factor analysis of identified main strategies

As shown in Figure 20, the strategies to segregate and process biodegradables and recyclables are factors that may be considered great influencers. If implemented, they can enhance the implementation of the rest of the identified strategies. Resource and energy recovery, which deal with "by-products", and the prevention of open burning, which are driven by the existence of other functional elements, seem to be dependent on these first two strategies. Between the two BAT/BEP strategies to control open burning, the results of the factor analysis validate that prevention and suppression of burning at SWDS are within the control of local authorities while at backyards relies much more heavily on other factors such as adequacy in waste collection and other measures to transform behavioral change. The analysis also revealed that strategies to promote the use of low-polluting vehicles are perceived as dormant; other drivers need to be set in motion to achieve this strategy.

In addition to the impact of measures on the others, MSW sector stakeholders in the Philippines may be guided by a set of prioritization criteria. The parameters and indicators that have been used to objectively rate and prioritize strategic measures are as follows:

1. Urgency vis-à-vis public service delivery;
2. Significance vis-à-vis RA 9003 implementation;
3. Positive impacts on CH_4 or BC emission reduction; and
4. Co-benefits in terms of economic, social, environmental, adaptation/resilience, and transformational change.

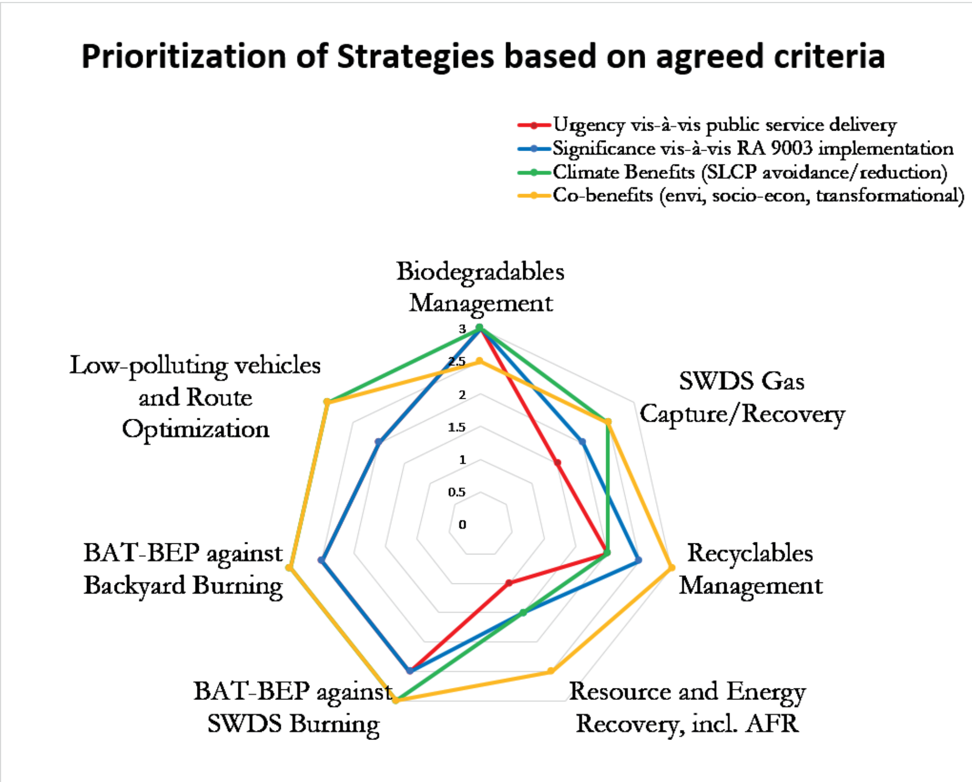

Figure 21. Results of the prioritization of key strategies based on agreed criteria

Using a 0-3 rating system, the results of the prioritization exercise are shown in Figure 21. Similarly to factor analysis, biodegradables management scored the highest in most criteria. In terms of co-benefits, recyclables management, control of open burning, and the use of low-polluting vehicles also scored high in the assessment. The urgency and significance of recyclables management have yet to be appreciated and focused on. Resource and energy recovery measures turned out to be the least urgent and least significant in terms of RA 9003 implementation although the benefits and co-benefits are comparable with the other strategies.

9.2 FURTHER ELABORATION OF STRATEGIC MEASURES

In preparation for the action plan, a preliminary list of activities has been identified by the CGE as a starting point. These items are discussed under the sections on specific strategies to reduce CH_4 and BC emissions. Detailed action planning per strategic measure needs to be undertaken to finalize the list of supporting activities or policies, identify the resource requirements, and schedule the timeline of these activities. It is also necessary to determine the lead agencies and organizations, including non-government actors, which will carry out the PAPs.

In the course of finalizing the activities, technical and economic analysis of options should be carried out to determine feasibility as well as the risks involved in implementation.

9.3 MONITORING, EVALUATION, REPORTING AND VERIFICATION (MERV) SYSTEM

The DENR-EMB, through the SWMD and EEID, periodically revisits the latest trends in the status of the implementation of various environmental laws, including RA 9003, by compiling and analyzing the available information to prepare NSOBERs. The NSWMC Secretariat also frequently prepares the status of RA 9003 implementation as it maintains a database of the compliance of LGUs with the law and as inputs to regular NSWMC meetings. Such a sectoral system already forms the foundation for broader MERV of SLCP reduction efforts through proper ESWM implementation.

More directly, the Philippine government led by the CCC has so far institutionalized PGHGIMRS in line with EO 174. The PGHGIMRS already has a platform for the reporting of sectoral GHG inventories and is currently elaborating on its interface with the reporting of mitigation actions and its co-benefits, which would include INDC/NDC measures, as well as the tracking of MOI. Methane gas as an SLCP is already earmarked in the platform but the reporting of BC baseline emissions and impacts of corresponding mitigation measures could be incorporated in the future.

It is likewise imperative to integrate a MERV system for co-benefits to align strategies with economic development and SDG goals. Ideally, such benefits would be quantified using an agreed set of co-benefit indicators. The PGHGIMRS currently features a voluntary GHG emissions inventory and emission reduction reporting scheme. The NSWMC and DENR may later review the inclusion of GHG/SLCP emission reporting by LGUs as part of the climate-proofing of sectoral policies and in the regular monitoring of the implementation of the local 10-year SWM plans by EMB regional offices.

BIBLIOGRAPHY

Acosta, V., Aguinaldo, E., Lao, C. and Valdez, MDC, 2012. "*Development of the Philippines National Solid Waste Management Strategy 2012-2016*," in The 7th International Conference on Waste Management and Technology, Beijing, China, 2012

Acosta, V., Paul, J. and Hanuschke, K. 2013. Establishment of Eco-Centers (Sanitary Landfill with Resource Recovery Technologies), GIZ Office Manila, Makati City, Philippines, 52pp.

Bond, Tami C. and Sun, Haolin, 2005. Can Reducing Black Carbon Emissions Counteract Global Warming? In: Environmental Science and Technology. URL at: https://pubs.acs.org/doi/full/10.1021/es0480421?mobileUi=0

CCAC, 2018a. Science of short-lived climate pollutants. URL at http://ccacoalition.org/en/content/short-lived-climate-pollutants-slcps

CCAC, 2018b. Short-lived climate pollutant control measures. URL at http://ccacoalition.org/en/content/short-lived-climate-pollutant-control-measures

CCC, 2015. Documentation of the Focus Group Discussion on Climate Change Mitigation Options for the Solid Waste Sector: Assessment of Implementation Requirements, Quezon City, Philippines, December 21, 2015.

CCC/USAID B-LEADERS, 2018. Revised Mitigation Cost-Benefit Analysis Study, Manila, Philippines, January 2018.

DENR-EMB, 2014. National State-of-the-Brown Environment Report for 2008-2013 (Solid Waste Chapter). Quezon City, Philippines.

DENR-EMB/NSWMC, 2018. "National Solid Waste Management Commission's Annual Database," National Solid Waste Management Commission (NSWMC), Quezon City, Philippines, August 2018.

DENR/World Bank, 2013. Training Program for the Prevention of Unintentional Persistent Organic Pollutants (UPOPs) Releases through Proper Solid Waste Management, Iloilo City, Philippines, July 24-25, 2013.

IGES-CCAC, DENR and NSWMC, 2018a. Report on the Regional Workshop on Measuring and Short-Lived Climate Pollutants from the Municipal Solid Waste Sector, Bacolod City, Philippines, April 2-4, 2018.

IGES-CCAC, DENR and NSWMC, 2018b. Documentation of the 1st Focus Group Discussion for the Development of the National Strategy to Reduce Short-Lived Climate Pollutants from the Municipal Solid Waste Sector in the Philippines, Quezon City, Philippines, September 5-7, 2018.

IPCC, 2014a. Fifth Assessment Report (AR5) Full Report. URL at https://www.ipcc.ch/site/assets/uploads/2018/05/SYR_AR5_FINAL_full_wcover.pdf

IPCC, 2014b. Fifth Assessment Report (AR5) Synthesis Report. URL at https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_Chapter08_FINAL.pdf

IPCC, 2014c: Summary for Policymakers. In: Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. URL at https://www.ipcc.ch/pdf/assessment-report/ar5/wg3/ipcc_wg3_ar5_summary-for-policymakers.pdf

JICA, 2008. The Study on Recycling Industry Development in the Republic of the Philippines. URL at http://open_jicareport.jica.go.jp/pdf/11882396.pdf

NEDA, 2017. "The Updated Philippine Development Plan 2017-2022," National Economic Development Authority (NEDA), Pasig City, Philippines, 2017. URL at http://www.neda.gov.ph/2017/07/26/philippine-development-plan-2017-2022/

NSWMC, 2012. The National Solid Waste Management Strategy 2012-2016, Quezon City, Philippines

Menikpura, S.N.M, Premakumara, D.G.J, 2018, Emission Quantifiaction Tool (EQT) for Estimation of GHGs/SLCPs from Solid Waste Sector – Version II, IGES, Japan

Philippine Congress, 2000. Republic Act 9003: Ecological Solid Waste Management Act, Manila, Philippines: House of Representatives, 2000. URL at http://emb.gov.ph/wp-content/uploads/2015/09/RA-9003.pdf

Premakumara, D.G.J., Canete, A.M.L., Nagaishi, M., Kurniawan, T.A., 2014. Policy Implementation of the Republic Act (RA) No. 9003 in the Philippines: a case study of Cebu City. Waste Manage. 34, 971–997.

Premakumara D.G.J, Gilby, S, Kataoka, Y, 2016: Barriers for Implementation of the Philippine National Solid Waste Management Framework at Cities, IGES, Japan.

Premakumara, D.G.J, Menikpura, S.N.M, Singh, R.K, Hengesbaugh, M, Magalang, A.A, IIdefonso, E.T, Valdez, M.D.C.M, Silva, L.C, 2018, Reduction of Greenhouse Gasses (GHGs) and Short-Lived Climate Pollutants (SLCPs) from Municipal Solid Waste Management (MSWM) in the Philippines: Rapid review and Assessment, Waste Management, 80, 397-405

ANNEXES

Annex A.

NSWMC Resolution Creating the Committee on SLCP/Climate Change

Office of the President

NATIONAL SOLID WASTE MANAGEMENT COMMISSION

Department of Environment and Natural Resources

2nd Flr. HRDS Bldg., DENR compound, Visayas Avenue, Diliman, Quezon City, 1100

Tel. Nos. (632) 920-2252 / 920-2279

NSWMC Resolution No. 1227 **Series of** 2018

RESOLUTION CREATING A COMMITTEE ON CLIMATE CHANGE FOR THE DEVELOPMENT OF THE NATIONAL STRATEGY TO REDUCE SHORT-LIVED CLIMATE POLLUTANTS (SLCPs) FROM MUNICIPAL SOLID WASTE MANAGEMENT (MSWM) IN THE PHILIPPINES

WHEREAS, it is the policy of the state to adopt a systematic, comprehensive and ecological solid waste management program which shall ensure, among others, (1) the protection of public health and environment, (2) utilize environmentally-sound methods that maximize the utilization of valuable resources and encourage resource conservation and recovery, (3) set guidelines and targets for solid waste avoidance and volume reduction through source reduction and waste minimization measures in accordance with ecologically sustainable development principles, (4) ensure the proper segregation, collection, transport, storage, treatment and disposal of solid waste through the formulation and adoption of the best environmental practices in ecological waste management excluding incineration, (5) encourage greater private sector participation in solid waste management, and (6) institutionalize public participation in the development and implementation of national and local integrated, comprehensive and ecological waste management programs;

WHEREAS, the enactment of Republic Act (RA) 9003 institutionalized the creation of the National Solid Waste Management Commission (NSWMC), an inter-agency body that is mandated to oversee the implementation of the solid waste management plans and prescribe policies to achieve the objectives of the Act;

WHEREAS, the NSWMC shall oversee the implementation of solid waste management plans and prescribe policies to achieve the objectives of RA 9003, and shall undertake the following activities, among others:

(a) Review and monitor the implementation of local solid waste management plans;
(b) Adopt a program to provide technical and other capability building assistance and support to local government units (LGUs) in the development and implementation of source reduction programs;
(c) Review the incentives scheme for effective solid waste management, for purposes of ensuring relevance and efficiency in achieving the objectives of RA 9003;
(d) Formulate the necessary education promotion and information campaign strategies;
(e) Encourage private sector initiatives, community participation and investments resource recovery-based livelihood programs for local communities;
(f) Propose and adopt regulations requiring the source separation and post separation collection, segregated collection, processing, marketing, and sale of organic and designated recyclable material generated in each LGU; and
(i) Study and review the standards, criteria and guidelines for the promulgation and implementation of an integrated national solid waste management framework.

WHEREAS, the National Solid Waste Management Strategy (NSWMS) is currently being updated in support of the implementation of the National Solid Waste Management Framework (NSWMF) and RA 9003 in general;

Waste No More! Waste No Time!

WHEREAS, the Climate Change Commission (CCC) is currently leading the process of updating the National Climate Change Action Plan (NCCAP) in support of the implementation of RA 9729, otherwise known as the Climate Change Act of 2009 as amended by RA 10174, wherein the MSWM sector forms part of the NCCAP Mitigation Pillar: Climate Smart Industries and Services;

WHEREAS, the Philippines ratified the Paris Agreement (PA) on Climate Change upon signing the accession instrument by President Rodrigo Duterte on March 6, 2017 and after the Senate unanimously gave its concurrence to PA ratification on March 14, 2017;

WHEREAS, the Department of Environment and Natural Resources (DENR) was identified as the lead agency in the conduct of greenhouse gas (GHG) inventory for the waste sector, among others, per Executive Order 174 otherwise known as Institutionalizing the Philippine GHG Inventory Management and Reporting System (PGHGIMRS);

WHEREAS, the MSWM sector has opportunities to enhance the implementation of RA 9003 by concurrently anchoring its strategies to the goals of reducing GHG/SLCP emissions as embedded in the Intended Nationally Determined Contribution (INDC), which was submitted by the Philippines in October 2015 and the recent discussions to propose a Nationally Determined Contribution (NDC);

WHEREAS, the INDC/NDC addresses the GHG/SLCP emissions from the biodegradable fractions of MSW, there presents additional opportunities for the sector to address the management of recyclable components, collection systems, and other functional elements of the MSWM system by concurrently dealing with the other SLCPs such as black carbon (BC) emissions;

WHEREAS, the Institute for Global Environmental Strategies (IGES), under its Climate and Clean Air Coalition (CCAC)-supported Municipal Solid Waste Initiative (MSWI) Project, in conducting research on Reducing Short-Lived Climate Pollutants (SLCPs) from MSWM, supports the Philippine government in the development of the "National Strategy to Reduce SLCPs from MSWM in the Philippines";

WHEREAS, IGES/CCAC's support to strategy development is part of the Philippines' Medium Term Plan on SLCP Reduction (2016-2021) – Supporting National Planning for Action (SNAP), which was submitted during the 21st Session of the Conference of Parties (COP) in Paris to CCAC, and includes:

(a) Enhance national capacity to take action on prioritized measures to mitigate SLCPs
(b) Develop a national action plan for SLCP reduction in the Philippines
(c) Leverage finance to support SLCP mitigation programs and initiatives in the country
(d) Enhance awareness and promote SLCP mitigation in the Asia Pacific region

WHEREAS, the development of the strategy document can be best carried out through a multi-stakeholder participatory process such as focus group discussions (FGDs) and public consultation within the year 2018 so that the resulting output could be best accepted by stakeholders for later review and adoption by the first quarter of 2019;

WHEREAS, the body recommended the creation of the Committee who shall provide guidance and attend the FGDs and public consultation for the Development of the National Strategy to Reduce SLCPs from MSWM in the Philippines to be composed of the following members:

1. Department of Environment and Natural Resources (DENR) (Chair)
2. Recycling Sector (Co-Chair)
3. Department of Science and Technology (DOST)
4. Department of the Interior and Local Government (DILG)
5. Metro Manila Development Authority (MMDA)
6. Department of Agriculture (DA)
7. Non – Government Organization (NGO)

Further, the Committee may invite additional NSWMC members and resource persons/experts from CCC, select LGUs, academe, research institutions, MSWM contractors/practitioners, and others as may be decided upon by the Committee;

Further, the Committee shall adopt national MSWM information that are based on officially adopted/published documents such as those from the Department of Environment and Natural Resources, National State-of-the-Brown Environment Report, Philippine Statistics Authority, and other government reports, databases, and publications, and duly vet on information based on experts' judgement as necessary;

WHEREAS, the Committee shall be composed of permanent or duly appointed representatives preferably with working knowledge on the climate change issues in solid waste management;

WHEREAS, DENR-EMB's Climate Change Division (CCD) and Solid Waste Management Division (SWMD) shall provide the secretariat support and provide research data and information;

WHEREAS, upon approval of this resolution, the Committee on Climate Change shall prepare a timetable for the development of the said national strategy until its approval including the conduct of a public consultation;

WHEREAS, all expenses to be incurred by the Committee in the conduct of Focus Group Discussions (FGD) and Public Consultation (PubCon) shall all be charged under IGES/CCAC support;

NOW THEREFORE, BE IT RESOLVED, AS IT IS HEREBY RESOLVED, the creation of a Committee on Climate Change for the Development of the National Strategy to Reduce SLCPs from MSWM in the Philippines is approved.

This resolution takes effect upon approval.

APPROVED 31 of July 2018.

ATTESTED BY:

BENNY D. ANTIPORDA
DENR Undersecretary for Solid Waste Management and Local Government Units Concerns
Alternate of the Chairman, National Solid Waste Management Commission

Annex B.

Core Group of Experts and Partners Involved in the Development of the Strategy to Reduce SLCPs from the MSW Sector in the Philippines

	Name	Organization/Agency
NSWMC Members		
1	Commissioner (Comm.) Crispian Lao	Recycling Sector Representative (Rep.) and Vice Chair, NSWMC
2	Comm. Rita O. Regalado	Manufacturing Sector Rep., NSWMC
3	Comm. Eugenia Briones	Department of Agriculture (DA) – Bureau of Soils and Water Management (BSWM), NSWMC Rep.
4	Comm. Carlo Mari Tan	Department of the Interior and Local Government (DILG), NSWMC Rep.
5	Ms. Aleya Arca	Department of the Interior and Local Government (DILG), NSWMC Rep.
6	Ms. Desiree Pinca	Metro Manila Development Authority (MMDA), NSWMC Rep.
7	Comm. Mary Cris Base	Technical Education and Skills Development Authority (TESDA), NSWMC Rep.
Other National Government Agencies		
8	Ms. Sandee G. Recabar	Climate Change Commission (CCC)
9	Ms. Ellice Dane Ancheta	CCC
DENR-EMB Climate Change Division		
10	Mr. Albert A. Magalang	Chief, Environmental Management Bureau (EMB)-Climate Change Division (CCD)
11	Ms. Liz Silva	Senior EMS, EMB-CCD
12	Ms. Petra Aguilar	Supervising EMS, EMB-CCD
DENR-CCS		
13	Ms. Kathleen Dominique Cornejo	PMEO, DENR-CCS
DENR-EMB Solid Waste Mgt Division		
14	Dir. Nolan D. Francisco	OIC-Chief, Environmental Management Bureau (EMB)-SWMD, and NSWMC Secretariat Executive Director
15	Dir. Eligio Ildefonso	Former Chief, EMB-SWMD
16	Ms. Maria Delia Cristina M. Valdez	DENR-EMB SWMD

17	Ms. Cynthia Evardone	DENR-EMB SWMD
18	Ms. Maria Krishna Santos	DENR-EMB SWMD
19	Mr. Gerard Jahn Alcon	DENR-EMB SWMD
20	Mr. Karl Christian Boquiron	DENR-EMB SWMD
21	Ms. Rodeth Antonio	DENR-EMB SWMD
22	Mr. Giovanni Miñas	DENR-EMB SWMD
23	Ms. Eliza Canabal	DENR-EMB SWMD
Local Government Units (LGUs)		
24	Ms. Elbe Balucanag	Supervising Environmental Management Specialist (EMS), Provincial Government of South Cotabato
25	Engr. Arthur Batomalaque	GMS, City Government of San Carlos, Negros Occidental
26	Ms. Maecarel Canoreo	SWM Staff, City Government of San Carlos, Negros Occidental
27	Mr. Ferdinand Bautista	MENRO, Local Government Unit (LGU) of the Municipality of Maragusan, Compostella Valley
28	Mr. Jacinto E. Guevara	Senior EMS, LGU Quezon City – Environmental Protection and Waste Management Division (EPWMD)
29	Mr. Jaril Ayron Mustapha	PRA, LGU Quezon City – EPWMD
30	Mr. Eduardo Tiongson	Municipal Councilor, Municipality of Solano
31	Ms. Violeta Faiyaz	City Environment and Waste Management Office (CEWMO), Antipolo City
32	Ms. Daisy Lumio	CEWMO, Antipolo City
Academe		
33	Dr. Aries Roda Romallosa	Central Philippine University (CPU)
34	Mr. Juvy Monserate	Head, Nanotech R&D Facility, Central Luzon State University (CLSU)
35	Ms. Marilou Sarong	Project Technical Staff, CLSU
IGES – CCAC MSWI Project		
36	Dr. Premakumara Jagath Dickella Gamaralalage	Senior Researcher/Program Manager, Institute for Global Environmental Strategies (IGES)
37	Dr. Rajeev Kumar Singh	Researcher, IGES
38	Dr. Nirmala Menikpura	Researcher, IGES
39	Engr. Voltaire Acosta	Consultant for National SLCP Strategy Development for the MSW Sector, IGES

Annex C.

PDP 2017-2022 Results Matrices (Draft) on SLCP/ESWM-relevant Targets/Indicators

PHILIPPINE DEVELOPMENT PLAN RESULTS MATRICES 2017-2022 (as of Oct 2017)

	Indicator	Baseline		Annual Plan Targets						End-of-Plan Target	MOV	Responsible Agency	Reporting Entity	Assumptions and Risk
		Year	Value	2017	2018	2019	2020	2021	2022					
Societal Goal: To lay down the foundation for inclusive growth, a high-trust society and a globally competitive knowledge economy created.														
CHAPTER 19: ACCELERATING INFRASTRUCTURE DEVELOPMENT														
Intermediate Goal 1: Reducing inequality														
Chapter Outcome 1: Access to economic opportunities increased.														
Sub-chapter Outcome 1.1: Competitiveness and productivity of economic sectors increased.														
Aggregate Outputs: Power/Energy	Renewable Energy (RE) capacity increased (MW, cumulative)	2016	6,870	None	None	None	12,027	None	13,014	13,014	Philippine Power Situation Report	DOE	DOE	
Sub-chapter Outcome 1.2: Gaps in basic infrastructure for human capital development reduced.														
Aggregate Outputs: Power/Energy	Proportion of HHs with electricity to total number of HHs increased (%, cumulative)	2016	89.61	90.00	TBD	TBD	TBD	TBD	100.00	100.00	Annual Accomplishment Report	DOE	DOE	
Aggregate Outputs: Social Infrastructure	Proportion of barangays with access to Material Recovery Facilities (MRFs) to total no. of barangays (%, cumulative)	2016	31.85	70	75	80	85	90	95	95	NSWMC Annual Reports	DENR-NSWMC/ EMB	DENR-NSWMC/ EMB	
	Proportion of barangays with access to Sanitary Land Fills (SLFs) to total number of barangays (%, cumulative)	2016	21.87	22.96	24.11	25.31	26.58	27.91	29.30	29.30	NSWMC Annual Reports	DENR-NSWMC/ EMB	DENR-NSWMC/ EMB	
Intermediate Goal 2: Potential growth increased.														
Chapter Outcome 1: Technology adoption advanced and innovation stimulated.														
Sub-chapter Outcome 1.1: Innovative solutions and technologies encouraged/adopted.														
	Conserved annual amount of electricity and fuel increased (in kilotons oil equivalent (KTOE)	2016	1,918.70	325.01	339.39	354.39	370.50	386.72	403.72	403.72	Annual Accomplishment Report	DOE	DOE	
CHAPTER 20: ENSURING ECOLOGICAL INTEGRITY, CLEAN AND HEALTHY ENVIRONMENT														
Chapter Outcome 1: Ecological integrity ensured and socioeconomic condition of resource-based communities improved.														
Sub-chapter Outcome 1.2: Environmental quality improved														
	Percentage of highly urbanized and other major urban centers within ambient air quality guideline value (i.e., PM10 and PM2.5) increased	2015	47	None	None	None	None	None	None	None	Accomplishment Report, Air Quality Status Report	DENR	DENR - EMB	Functional Air Quality Monitoring Stations; Regulated sources of Air pollution Strong support of LGUs, industries/private sector and concerned government agencies (e.g., DTI) in the adoption of cleaner and environment-friendly technologies
Aggregate Outputs	Solid waste diversion rate increased (%, cumulative)	2015	Metro Manila: 48; Outside MM: 46	55	60	65	70	75	80	80	Accomplishment Report	DENR	DENR-EMB	Availability of funds and strong support from LGUs
Aggregate Outputs	Number of eco-labeled products increased	2016	40	None	None	None	None	None	None	None	Progress Report	DTI	PCEPSDI	Strong support from business or industries
Aggregate Outputs	Total energy savings in government offices increased (PHP million)	2015	113.69	None	None	None	None	None	None	None	Certificates of energy savings	DOE	DOE-EUMB	Active participation of government offices
Sub-chapter Outcome 1.3: Adaptive capacities and resilience of ecosystems and communities increased														
Aggregate Outputs: Number of reviewed CC/DRRM-enhanced plans increased	*Comprehensive Development. Plans (CDPs)*	2016	37	None	None	None	None	None	None	None	Progress Report	DILG	DILG	Availability of resources at the LGU level
	Local Climate Change Action Plan (LCCAPs)	2016	1,114	None	None	None	None	None	None	None	Progress Report	CCC	CCC	Availability of resources at the LGU level
Aggregate Outputs: GHG emissions per sector reduced (million MT CO2e)	Energy	2010	56	None	None	None	None	None	None	None	Monitoring, Reporting and Verification; and National Communication	CCC	CCC	Implementation of low carbon strategies/clean/environment friendly technologies
	Industrial	2010	11	None	None	None	None	None	None	None				
	Agriculture	2010	47.8	None	None	None	None	None	None	None				
	LUCF	2010	(83.2)	None	None	None	None	None	None	None				
	Waste	2010	15.3	None	None	None	None	None	None	None				
	Transport	2010	25.3	None	None	None	None	None	None	None				

Annex D.

Issues and Concerns in ESWM Implementation / SLCP Reduction

Categories	Policy/ Institutional	Finance/Resources	Technology/ Technical	Awareness/Behavioral/ Capacity Building/ Enforcement	Others/ Crosscutting
General (overall, including waste generation	• Insufficient monitoring and assessment of effectiveness and efficiency of policies • Need for strong policy, strategic actions, and targets on SLCP in general • Insufficient monitoring and implementation of 10-year SWP plans • High data requirements • Need to update local ordinances and 10-year plans • Absence of local plantilla position focused on SWM • Too many bureaucratic procedures on government procurement and policy development • Untapped partnerships (donors, financing agencies)	• Financial limitations; Lack of budget (national government and allocation from LGUs) • Insufficient incentives and rewards for LGUs with best practice • Updating data requires corresponding resources • Some technologies are expensive • Local budget for PENRO/CENRO/MENRO focusing on SWM • Need for resources to augment inefficient and ineffective systems • Limited procurement procedures • Lack of resourcefulness	• No primary data on waste flow; Poor data management • Insufficient collaboration among stakeholders	• Culture of overconsumption and disposal (lack of concern) • Lack of political will or support • Lack of motivation (prioritization) • Inadequate enforcement • Lack of awareness on policies • Inadequate IEC materials	• Insufficient sharing of city-to-city knowledge • Unavailability of land/spaces for facilities
Source Separation, Segregated Collection and Transport	• Lack of policy mandate for private sector (segregation) • Need for a policy on the modernization of collection vehicles	• Inefficient collection of MSW • Clamor/need for dedicated collection of biodegradables from food industry/establishments • Need for logistics for recyclables			
			• Inadequate segregation and public support • Need for efficient collection routes and vehicles		
			• Outdated vehicles		

Categories	Policy/ Institutional	Finance/Resources	Technology/ Technical	Awareness/Behavioral/ Capacity Building/ Enforcement	Others/ Crosscutting
Management (Recovery and Processing) of Recyclables	• Poor policy implementation on the informal waste sector	• Only 32% of all barangays have access to MRFs; Lack of proper infrastructure and facilities to process recyclables (MRFs, recycling facilities) • Insufficient market for recyclables • Lack of appropriate technology selection • Need for R&D on new technologies and its application for recyclables		• Lack of awareness on technology selection	
			• Weak database and recycling facilities		
Management (Recovery and Processing) of Biodegradables	• Insufficient publicized guidance/guidelines on composting	• Huge amount of biodegradables to be managed • Lack of proper facilities to process biodegradables • Insufficient technical knowledge on composting • Inappropriate capacity of composting facilities • Need for R&D on new technologies and its application for biodegradable MSW		• Low awareness on composting – lack of knowledge on how it should be done • Lack of marketing for composting/promotion	• Lack of area for composting • Poor post-harvest process
Other Resource Recovery, including Energy Utilization					• Social acceptance of technologies
Waste Disposal, including Landfill Gas Management	• Current guidelines for gas management only requires (direct) gas venting as minimum requirement • Guidelines/ FS on the use of EESC at smaller dumpsites		• Use of non-engineered SWDs • Improper design of SWDS	• Dumpsite burning (intentional or not)	• 400+ dumpsites are still operating; Only 21% of LGUs have access to SLFs
			• Lack of knowledge on how to suppress SWDS fires		
		• Need for LGUs to close and rehabilitate remaining dumpsites			
		• Mismanagement of disposal facilities			
Open Burning at Households and Disposal Sites	• Need to harmonize policies on burning across government departments • Inconsistent awareness on government policy(ies) • Very low penalties on violators (LGUs, households)	• No reliable primary data on open burning • Inadequate implementation against open burning		• Lack of harmonized national campaign on open burning • Behavioral issue (convenience of burning waste instead of proper disposal)	

Annex E.

Gains, Challenges, Opportunities, and Proposed Measures

Cat.	Gains (what has been done or achieved so far)	Challenges (remaining barriers to be addressed)	Opportunities (further prospects)	Potential Measures (long list of options)	Priority Measures (short list, clustered)

General (overall, including waste generation)	• NSWMS is currently being updated	• Need to research data as basis to formulate policy
		• Proper data collection and management by LGUs
		• Sufficient allocation of budget by the government for MSW sector
		• LGUs are not allowed by COA to enter into a long term contracts, except for hauling. Even for infrastructure projects, a joint project arrangement or PPP is required for an LGU to have a longer contract.
			• Refer to other countries, e.g., Canada, Mexico, and California (USA) regarding best practices on reducing SLCPs	• Promote the use EQT as guide for LGUs
				• Develop tools for MERV of measures
				• Establish KM on:
				  • Junkshops, consolidators, recyclers
				  • Available technologies on recycling, food waste management, WTE, etc.
				• Strengthen partnerships with stakeholders (summit, workshops, recognition)
				  • Recognize private sector ESWM initiatives
				  • Organize practice sharing among cities for benchmarking
				  • Stakeholders to adopt collaborative research outputs for prioritization
				• Present and lobby to DBM the approval of budget to implement the RA 9003
					• Develop national framework for the reduction of GHG/SLCP emissions from the MSW sector.
					• Develop knowledge management of data (recyclers, consolidators, technologies, good practices, mapping of SLFs)

Cat.	Gains (what has been done or achieved so far)	Challenges (remaining barriers to be addressed)	Opportunities (further prospects)	Potential Measures (long list of options)	Priority Measures (short list, clustered)
Source Separation, Segregated Collection and Transport	• Development of guidelines/policy on extended producers' and/or consumers' responsibility	• Zero mixing of waste at source • Willingness to pay of food industry/ establishments; Identification of service providers	• Revenue generation for the collection of kitchen waste from the food industry; Business opportunities for service providers • Alternative livelihood in MRF operations	• Create local ESWM enforcement team • Separate the collection of kitchen waste from the food industry/establishment • Develop standard collection/routing schemes • Develop a software program to enhance waste collection efficiency	• Develop a system of SWM that will address the reduction of SLCPs through a systematic approach which includes SCP, proper storage of waste, collection, treatment processing, monitoring, data gathering in collaboration with all stakeholders and building partnership • Development of a platform (computer-based) to enhance the efficiency of overall waste management via collaboration with stakeholders • Development of a more comprehensive national strategy to cover all socio-economic, environmental aspects of SWM in individual technology

Cat.	Gains (what has been done or achieved so far)	Challenges (remaining barriers to be addressed)	Opportunities (further prospects)	Potential Measures (long list of options)	Priority Measures (short list, clustered)
Management of Recyclables	• Has been accepted by society as it generates wages/provides employment opportunities	• Capacities and efficiencies of processing facilities are insufficient • Low buying price of recyclables materials	• Contribution of private investors and the government to expand treatment facilities • Donors/ developed countries might provide knowledge and finance • Presence of willing buyers of recyclable materials	• Stakeholder/cross-country collaboration • Incentivize recycling to encourage more people to recycle • Establish mini-MRFs in puroks or accredit junkshops to support barangay-level MRFs, whenever applicable • Improve the value of recyclables by selling clean materials from segregated (not mixed) fractions • Expand export and local markets for recyclables, including enabling the establishment of recycling facilities nationwide	• Facilitate to set quantitative targets at the national level to enhance resource recovery, recycling by year 2020 (i.e. 20% of plastic produced by recycled plastic)

Cat.	Gains (what has been done or achieved so far)	Challenges (remaining barriers to be addressed)	Opportunities (further prospects)	Potential Measures (long list of options)	Priority Measures (short list, clustered)
Management of Biodegradables	• Composting guidelines and compost quality have been passed and approved by NSWMC	• Capacity of processing facilities is insufficient • Less demand for compost from SWM • Composting in HUCs such as in Metro Manila is a challenge • Production of IEC materials (in different languages) to be disseminated in rural areas • In terms of leveraging, there is a need to understand the entire process, i.e. investment in composting will not generate much return in which the private sector may not be interested in.	• Increase the nutritional value of soil if we apply good quality compost-compost analysis • Higher market value of good compost • People are encouraged to do proper segregation of SW, especially biodegradables • Employment opportunities for society/contribute to national income	• Institute a comprehensive food waste management program + policy/system • Expand organic farming/market • Promote urban gardening, including household-based gardening, through the use of compost product • Tap the academe and other credible institutions for the proper training on composting • Identify suitable areas for clustered composting in urban areas • If volume is known, the LGU can buy suitable equipment to intensify composting • Encourage the use of environmentally friendly WTE to augment the need for conventional energy resources	• More systematic collection of food wastes from households (supported by a local ordinance) and collaborate with food waste processors production/co-production of animal feeds • Other biodegradables should be composted, each LGU should/must have a central composting facility

Cat.	Gains (what has been done or achieved so far)	Challenges (remaining barriers to be addressed)	Opportunities (further prospects)	Potential Measures (long list of options)	Priority Measures (short list, clustered)
Other Resource Recovery, including Energy Utilization	• Government guidelines on the use of AFR in cement kilns are available				• Put up more infrastructure to support the use of AFR with government support and administrative orders
Waste Disposal, including Landfill Gas Management	• Ombudsman filing cases on non-compliant cities and municipalities • 20% LGU budget allocation in the LDP can be budget source for environmental protection program	• Continuity of the Ombudsman's program on non-compliant LGUs • Amendment of the LG Code (RA7160)	• Serves as an eye opener for other LGUs to comply with RA 9003	• Mandate certain percentage of LGU budget to SWM • Institutionalize incentives and rewards system: Cleanest and Greenest LGUs and Best SWM Model for Schools focused on segregation, collection, recycling, and composting (cash award) • Create plantilla for LGU ENROs • Strengthen government policies on procurement, including the policy on allowing government resources on closing disposal sites on private lands	• Adopt economically viable technologies applicable to specific requirements • Institutionalize SWM requirements (manpower, budget, plans and programs)
	• Studies on EESC conducted in two LGUs in the Visayas	• Elucidation of pollutants present in the soil	• Develop optimal methods of analysis for QC • Creates employment	• Clustered SLF for better management and cost cutting of operation • Complete FS on the use of EESC for small dumpsites by 2018 • NSWMC to develop guidelines for gas recovery and utilization in SWDS	• Strengthen partnership with relevant stakeholders: PPP for infrastructure for Visayas and Mindanao and incentives for the private sector

Cat.	Gains (what has been done or achieved so far)	Challenges (remaining barriers to be addressed)	Opportunities (further prospects)	Potential Measures (long list of options)	Priority Measures (short list, clustered)
Open Burning at Households and SWDS	• Support to Philippines in BAT/BEP to address open burning • Knowledge products from IPOPs management projects • Ongoing comparative research on the emission of WTE vs open burning	• How to formulate questionnaire based on the effect of open burning vis-à-vis policy formulation • Avoidance of dumpsite burning	• Creation of guiding principles	• Formulate policy on open burning • Enforce segregation at source and segregation collection, and ideally, there should be no waste picking at SWDS • Develop behavioral communication plan to create campaigns that inspire change • Gathering research output from other Asian countries for the development of SLCP policies and standard procedures • Conduct workshops/retooling to harmonize government policy on burning (DOH, DA, DENR, PIA) • Develop a national campaign on open burning policy through television, social media, schools, and households	• Develop behavioral communication change (social marketing) strategies

Annex F.

Key Strategies and their Baselines and Targets

	Main Strategy	Specific Strategies	SLCP	Target/Goal	Baseline and Assumptions	Targets at YYYY [a]		
					2010	2025	2030	2040
1.	Implement comprehensive and strategic biodegradable waste management programs	1.1 Implement source-specific biodegradable waste management program 1.1a Household food and yard waste management program 1.1b Management of biowaste from food industry and establishments 1.1c Management of biowaste from markets and trading posts 1.2 Enhance supporting policies/activities for the increase in biowaste processing/treatment capacities and coverage	CH_4	Increase the diversion of biodegradable waste by increasing the percentage of biowaste that is composted or digested by YYYY.	5% of all biowaste generated was composted (0% was digested) in 2010 [b]	17.9% [c]	24.3% [c]	37.1% [c]
2.	Promote gas capture, recovery and/or treatment during operation, and closure and rehabilitation of SWDS	2.1 Promote gas capture by flaring, recovery and treatment, including utilization whenever possible*, of SWDS gas with at least 20% methane concentration 2.2 Apply EESC at smaller dumpsites to capture methane from SWDS gas at <20% CH_4 concentrations 2.3 Enhance supporting policies/activities such as continued monitoring of the operation of SLFs and the closure and rehabilitation of SWDS [d]	CH_4	Increase the amount of SWDS gas (in terms of CH_4) captured and/or utilized by YYYY.	0% methane has been captured out of 254,828 tons of total generation [e]	36.06% or 136,821 tons of methane will be captured out of 379,384 tons of total generation [e]	52.30 % or 194,248 tons of methane will be captured out of 371,434 tons of total generation [e]	54.08 % or 224,004 tons of methane will be captured out of 414,186 tons of total generation [e]
	… including the use of eco-efficient soil cover (EESC) at small SWDS			Increase the amount of SWDS gas (in terms of CH_4, at 40% collection efficiency) captured through the application of EESC by YYYY.	0% of small SWDS captured methane using EESC [f]	31% of small SWDS captures methane using EESC [f]	50% of small SWDS captures methane using EESC [f]	50% of small SWDS captures methane using EESC [f]

	Main Strategy	Specific Strategies	SLCP	Target/Goal	Baseline and Assumptions	Targets at YYYY [*a*]		
					2010	***2025***	***2030***	***2040***
3.	Implement comprehensive and strategic recyclables management programs (Recycling industry development program)	3.1 Improve logistics / recovery flow to enhance collection of recyclables from the waste stream 3.2 Enhance capacities of MRFs to receive, sort, and pre-process recyclables 3.3 Support the development of local recyclers, recycling industries, and markets for recyclables and recycled products 3.4 Shift consumption from single-use disposables to single-use recyclables, whenever possible	BC	Increase the diversion of recyclables by increasing the percentage of aggregated recyclable fractions that are recycled by YYYY.	Paper recycling rate 33.71% Plastic recycling rate 40.88% Aluminum recycling rate 3.36% Iron/Steel recycling rate 12.99% Glass recycling rate 9.07% [*g*]	At least 50% of the aggregated amount of recyclable fractions is recycled.	At least 55% of the aggregated amount of recyclable fractions is recycled.	At least 60% of the aggregated amount of recyclable fractions is recycled.
4.	Adopt alternative technologies, including waste-to-energy, as SWM solutions, considering institutional, legal, and technical limits [*h*]	4.1 Encourage the utilization of recovered/capture gas from anaerobic digesters and SWDS for energy generation, whenever feasible. 4.2 Maximize the adoption of existing and new emerging alternative technologies to recover resources and energy from segregated, low-economic value non-biodegradable waste fractions, e.g., arts and crafts, building materials, use as AFR in cement kilns, other waste-to-fuel options, and others. 4.3 Enhance supporting policies, make funding available, and implement initiatives to enable resource and energy recovery	BC	Increase the amount of captured biogas and SWDS gas that are utilized for energy generation (to enable corresponding displacement of grid electricity) by __% by YYYY.	0% of biogas captured from anaerobic digesters and SWDS was utilized for energy/ electricity generation in 2010	34% [*i*]	56% [*i*]	56% [*i*]
			BC	Increase the percentage of low-economic value waste fractions used for resource and energy recovery by ___% by YYYY.	0% of segregated, low-economic value waste fractions are utilized for resource and energy recovery in 2010.	10%	30%	50%

	Main Strategy	Specific Strategies	SLCP	Target/Goal	Baseline and Assumptions	Targets at YYYY [a]		
					2010	2025	2030	2040
5.	Implement BAT/BEP to prevent and control burning at SWDS	5.1 Prevent surface and deep-seated fires at SWDS 5.2 Suppress surface and deep-seated fires at SWDS using appropriate fire-fighting techniques	BC	Reduce the amount of deposited waste that is burned at SWDS by ___% by YYYY.	25% of waste that is deposited at unmanaged dumpsites (18,996.6 tpd in 2010) get / is bound to get burned within its lifespan of 20 years = 0.25*6,933,759 = 1,733,430 tons	60% of the remaining unmanaged SWDS have been closed and rehabilitated, hence, negligible chance to burn	65% of the remaining unmanaged SWDS have been closed and rehabilitated, hence, negligible chance to burn	70% of the remaining unmanaged SWDS have been closed and rehabilitated, hence, negligible chance to burn
6.	Implement BAT/BEP to prevent and control open burning at backyards or communal areas	6.1 Engage public support against backyard burning 6.2 Enhance residual waste collection coverage and frequency to discourage backyard burning	BC	Reduce the amount of waste burnt at backyards by ___% by YYYY.	323,550.6 tons (~886.44 tpd) or 24% of the uncollected waste was estimated to be burned in 2010.	30% [b]	50% [b]	70% [b]
	… by (among others) increasing waste collection coverage and frequency.			… by decreasing the amount of uncollected waste (as a ___% of generated waste by YYYY).	1,348,127.5 tons (~3,693.5 tpd, or 10% of generated waste) was uncollected in 2010.	7% of generated waste remains uncollected	5% of generated waste remains uncollected	3% of generated waste remains uncollected
7.	Promote the use of low-polluting waste collection vehicles and optimization of MSW collection routes and transport schemes	7.1 Establish optimal waste vehicle collection routing techniques/schemes 7.2 Implement optimal transfer and transport schemes 7.3 Use less-polluting vehicles/machineries	BC	Reduce fuel consumption per ton of waste collected by ___% by YYYY.	92,211,775 li of diesel (~252,635 lpd) and 4,853,405 li of gasoline (~13,297 lpd) were consumed for the collection & transport of 12,133,147.5 tons of waste (~33,241.5 tpd).	3% reduction in vehicle fuel consumption per ton of waste collected	5% reduction in vehicle fuel consumption per ton of waste collected	10% reduction in vehicle fuel consumption per ton of waste collected

[a] Unless otherwise specified, values were agreed upon during national data vetting, FGDs and consultations.
[b] Value based on Mitigation CBA Study [CCC/USAID B-LEADERS, 2018]

[*c*] Based on interpolated values on the target to compost 50% of generated bio-waste by 2050 in the Mitigation CBA Study [CCC/USAID B-LEADERS, 2018]
[*d*] Note: If with energy generation, strategies are identified under Main Strategy 4 and impacts are on BC reduction.
[*e*] Values initially based on Mitigation CBA Study [CCC/USAID B-LEADERS, 2018]; mathematically cross-checked using the EQT (*See* Annex G). Indicated values in the table already represent the total methane capture due to gas recovery, flaring, for electricity production, application of EESC, rehabilitation, etc.
[*f*] Values based on Mitigation CBA Study [CCC/USAID B-LEADERS, 2018]. Quantitative impacts of these targets are embedded in the analysis for Strategy 2.
[*g*] Baseline values were initially based on a Recycling Industry Development Study, which found recycling rates to be 41.21% (642,610 tons/1,559,510 tons) for paper, 35.37% (243,267 tons/1,261,405 tons) for plastics, 47.42% (46,000 tons/97,000 tons) for aluminum, 38.36% (1,219,000 tons/3,137,000 tons) for iron/steel, and 48.49% (207,154 tons/427,192 tons) for glass [JICA, 2008]. Using the EQT, the values were cross-checked and the composition of collected recyclables in 2010 was derived by assuming collected recyclables by the informal sector would be proportionate to the total available recyclables in generated waste (*See* Annex G).
[*h*] Strategy adopted from PDP 2017-2022, Chapter 19, Subsector Outcome 2 [NEDA, 2017].
[*i*] Values based on Mitigation CBA Study [CCC/USAID B-LEADERS, 2018]. Quantitative impacts of these targets are embedded in the analysis for Strategy 2.
[*j*] Derived values from the corresponding targets set for the percentage of remaining uncollected waste by 2025, 2030 and 2040.

Annex G.

Estimation of GHG and SLCP Emissions from MSW Management in the Philippines

Evaluating the status of Municipal Solid Waste Management (MSWM) and its impacts in relation to climate change is a very important aspect in national policy development process. This section discusses preliminary projections of GHGs and SLCPs emissions associated with MSWM practices in the year 2010 as a BAU baseline and examines future projections for 2025, 2030 and 2040 considering the priority actions identified in RA 9003. Estimation of the GHGs and SLCPs emissions were calculated using the Emission Quantification Tool (EQT), which was developed in line with IPCC (2006), and other internationally recognised guidelines and emission factors. System boundaries for BAUs and future projections, treatment options, potentials for resource recovery, waste flow etc. were defined to be aligned with the seven key strategies explained in the report on "National Strategies to Reduce SLCPs from the Municipal Solid Waste Sector in the Philippines". By following the seven strategies, potentials for mitigating GHGs and SLCPs from MSWM have been quantified, and comparison assessment has been done for enabling decision-making process.

As the initial step of the assessment, mass balance analysis was carried out for daily generated waste as well as annually generated waste in 2010 and future projections of the year 2025, 2030 and 2040. City officials and practitioners would be familiar with daily basis figures, and annual based assessment is required for policy ad decision-making process. Therefore, mass balance analysis was done considering both requirements.

MSW Generation and Collections

MSW generation rate at the national level is the key data required for the waste flow analysis. Waste generation rate in 2010 is the actual waste generation rate in a base year, and CBA derived waste generation values were used for future projections based on the population and per capita waste generation rate. Table 5 shows the waste generation and collection data. Waste collection coverage will be increased from 90% in 2010, up to 97% by 2040 as a key strategy to reduce BC and other GHGs from open burning of uncollected waste at the backyards.

Table 5: MSW generation and collection at the national level in the Philippines

Description	Unit	2010	2025	2030	2040	Reference
Total generated waste	Ton/day	36,935	56,262	63,392	78,218	CBA, 2018
	Ton/year	13,481,326	20,535,512	23,138,084	28,549,434	
Total waste collected	Ton/day	33,242	52,32	60,222	75,871	National Key Strategies and Specific Measures, 2018
Percentage of collection (%)		90	93	95	97	

Composition of MSW

The composition of the generated and collected waste should be provided as accurately as possible in EQT since this data is critically important for the accuracy of the final emission results. National composition data provided by the expert team which have been derived during the data vetting exercise by using best available data was used for the assessment. Based on the waste composition, the total available amount of different waste fractions in each year have been estimated as shown in Table 6.

Table 6: Composition of generating waste in the base year and projections of future

Components	The composition of generated waste (%)	The available amount in generated waste (ton/day)				Reference
		2010	2025	2030	2040	
Food waste	45.09	16,654.05	25,368.39	28,583.46	35,268.3	Data Vetting at National level for EQT, 2018
Garden waste	6.5	2,400.78	3,657.01	4,120.48	5,084.15	
Plastics	10.55	3,896.66	5,935.61	6,687.8	8,251.96	
Paper	8.7	3,213.36	4,894.77	5,515.10	6,804.93	
Textile	1.61	594.66	905.81	1,020.61	1,259.30	
Leather/rubber	0.37	136.66	208.17	234.55	289.41	
Glass	2.34	864.28	1,316.52	1,483.37	1,830.29	
Metal (aluminium + steel)	4.22	1,558.66	2,374.24	2,675.14	3,300.78	
Nappies/diapers (disposable)	5.54	2,046.21	3,116.9	3,511.92	4,333.26	
Wood	0.72	265.93	405.08	456.42	563.17	
Hazardous waste	1.93	712.85	1,085.85	1,223.47	1,509.60	
Others	12.43	4,591.04	6,993.33	7,879.63	9,722.4	
Total	**100**	**36,935**	**56,262**	**63,392**	**78,218**	

Mass balance analysis of MSW management at the national level in the Philippines

Composting

Allocation of different type of waste components for various treatment options was done by following the guidelines provided in the National Key Strategies and Specific Measures (2018). Implementation of comprehensive and strategic biodegradable waste management programs is one of the key consideration and therefore, composting is targeted at the rate of 5% of total generated bio-waste in 2010 and 17.9%, 24.3% and 27.1% in the year 2025, 2030 and 2040 respectively. Separated bio-waste for composting consists of food waste (86.2%) and garden waste (13.8%), see Table 7.

Table 7: Separation of bio-waste for composting

Description	Unit	2010	2025	2030	2040	Reference
Total waste use for composting	Ton/day	966	5,267	8,056	15,177	National Key Strategies and Specific Measures, 2018
Total waste segregation for composting per year	Ton/year	352,537	1,922,473	2,940,596	5,539,532	
Food waste (86.2% biodegradables)	Ton/day	833	4,540	6,945	13,082	Data Vetting at National level for EQT, 2018
Garden waste (13.8 % biodegradables)	Ton/day	133	727	1,112	2,094	

Recycling

Increase the diversion of recyclables by increasing the percentage of aggregated recyclable fractions that are recycled is one of the key strategies to be followed in developing sustainable SWM system. It was assumed that informal sector is contributed for total recyclables collected in the base year (15.5% of total collected waste) while both informal sector and LGUs will be contributing for collection of recyclables in projected years. It has been targeted at least 50%, 55% and 60% of the aggregated amount of recyclable fractions will be recycled in 2025, 2020 and 2040 respectively, see Table 8.

Table 8: Total separated recyclables in the base year and projected years

Description	Unit	2010	2025	2030	2040	Reference
Separated amount use for recycling	ton/day	5,138	7,261	8,999	12,113	National Key Strategies and Specific Measures, 2018
	ton/year	1,875,245	2,650,107	3,284,566	4,421,165	

The composition of recyclables is an important key factor for emission estimation. Composition of collected recyclables in 2010 was derived by assuming collected recyclables by the informal sector would be proportionate to the total available recyclables in generated waste. Composition of recyclables collected by LGUs has been derived by the expert team by using the best available data at the meeting for data vetting, see Table 9 (a). Thus, composition for projected years (2035, 2030and 2040) was derived by aggregating the composition of recyclables collected by informal sector and LGUs see Table 9 (b).

Table 9 (a): The composition of recyclables collected by informal sector and LGUs

Composition of recyclables	Percentage	Collected by informal sector (2010)	Collected by LGUs (2025, 2030, 2040)	Reference
Plastics	%	40.88	16.83	Percentages of recyclables collected by informal sector derived based on the availability of total recyclables in 2010
Paper		33.71	58.15	
Aluminium		3.36	3.53	The composition of recyclables collected by LGUs derived by the expert team at the meeting for Data Vetting at National level for EQT, 2018
Metal/steel		12.99	13.67	
Glass		9.07	7.82	
Total		100	100	

Table 9 (b): Waste composition collected by informal (2010) and derived waste composition (collected by informal sector and LGUs) for 2025, 2030 and 2040

Type	2010	2025	2030	2040
Plastics	40.88	25.95	25.30	24.76
Paper	33.71	48.88	49.54	50.09
Aluminium	3.36	3.46	3.47	3.47
Metal/steel	12.99	13.41	13.43	13.45
Glass	9.07	8.29	8.26	8.23
	100	100.00	100.00	100.00

Final disposal

The major share of generated waste will be disposed at the final disposal sites. The total amount of waste for final disposal is derived by using the formula below.

$$Amount\ for\ final\ disposal = Total\ generated\ waste\ \left(\frac{tonnes}{day}\right) - Total\ seperated\ waste\ for\ composting\ \left(\frac{tonnes}{day}\right) - Total\ seperated\ waste\ for\ recycling\ \left(\frac{tonnes}{day}\right) - Total\ uncollected\ waste\ \left(\frac{tonnes}{day}\right)$$

Table 10: Total mixed MSW for final disposal

Description	Unit	2010	2025	2030	2040	Reference
Total waste for final disposal	Ton/day	27,138	39,796	43,167	48,582	Derived using above formula
	Ton/year	9,905,412	14,525,445	15,756,017	17,732,253	

For this assessment, allocation of waste among different disposal sites were done by following CBA assessment. Disposal sites have been categorised into three, namely Open Dumps (ODs), Control Dumps (CDs) and Sanitary Landfills (SLFs). Disposal rate at different disposal sites was estimated based on the percentages given in CBA assessment, see Table 11. Further, based on the allocation percentages in Table 11, the total disposal amount in different sites have been estimated and presented in Table 11.

Table 11: Allocation of MSW among different disposal sites

Disposal facilities as defined in CBA		2010	2025	2030	2040	Reference
Total open dumpsite	%	70	42	41	39	For 2010, Data Vetting at National level for EQT, 2018, For other years CBA, 2018
Total controlled dumpsites		10	31	30	29	
Total sanitary landfills		20	28	29	31	
Total waste disposal at SLF for energy recovery	%	0	34	56	56	CBA, 2018
The fraction of OD/CD in CAT 4 with Recovery		0	18	30	30	CBA, 2018
Smaller OD/CD dumpsite share		-		58		CBA, 2018
Percentage of small sites with eco-efficient cover (phased from 2018 - 2030)		0	31	50	50	CBA, 2018
Percentage emission reduction for sites with eco-efficient cover				70		CBA, 2018

Table 12: Total MSW disposed at different sites

Type of disposal site	Unit	2010	2025	2030	2040	Reference
Total open dumpsite (OD)	Ton/day	18,997	16,541	17,630	19,139	Identified as "Uncategorised" MCF= 0.6
	Ton/year	6,933,788	6,037,530	6,435,097	6,985,812	
Total controlled dumpsites (CD)	Ton/day	2,714	12,226	13,031	14,146	Identified as Managed-semi-aerobic MCF = 0.5
	Ton/year	990,541	4,462,522	4,756,376	5,163,427	
Total sanitary landfills (SLFs)	Ton/day	5,428	11,028	12,506	15,296	Identified as sanitary landfills. MCF is suggested by expert team MCF =0.95
	Ton/year	1,981,082	4,025,393	4,564,543	5,583,014	

Gas capture, recovery and/or treatment during operation, and closure and rehabilitation of SWDS is one of the key to the strategies. It was assumed that in the year 2010, there is no gas recovery for energy production from SLFs and disposal of MSW was occurred (20% of total disposal waste) at SLFs without gas recovery systems. As stated in CBA study, out of total waste dispose of at SLFs, 34%, 56% and 56% will be dispose at SLFs with energy recovery in the year 2025, 2030 and 2040 respectively. Efficiency of gas collection from SLFs for energy recovery assumed to be 50%. Further, it was assumed that gas will be recovered and flared from SLFs without energy recovery systems in the year 2025, 2030 and 2040 in order to reduce methane emission. In addition, methane will be captured and flared from 18% of ODs/CDs in the year 2025, 30% of ODs/CDs in the year 2030 and 30% of ODs/CDs in the year 2040, see Table 11. Moreover, Eco-Efficient Soil Cover (EESC) will be applied as a strategy for methane emissions reduction from ODs/CDs. Percentage of small sites with eco-efficient cover (phased from 2018 - 2030) will be 31%, 50% and 50% in year 2025, 2030 and 2040 respectively. By following all those strategies, methane emissions can be reduced significantly from waste disposal practices.

Table 13: Total waste disposal at SLFs with energy recovery and SLFs without energy recovery

Description	Unit	2010	2025	2030	2040	Reference
Total waste dispose at SLFs for energy recovery	Ton/day	-	3,750	7,003	8,565	
	Ton/year	-	1,368,633	2,556,144	3,126,488	CBA, 2018
Total waste dispose at SLFs without energy recovery	Ton/day	5,428	7,279	5,502	6,730	
	Ton/year	1,981,082	2,656,759	2,008,399	2,456,526	CBA, 2018

Uncollected waste

One of the major causes for BC emission is burning of uncollected waste at backyards. To reduce BC emission, a strategy has been formulated for enhancing residual waste collection coverage and frequency and then to discourage backyard burning. According to National Key Strategies and Specific Measures, (2018), uncollected fraction of waste is 10% in 2010, and it will be reduced to 7% in 2025, 5% in 2030 and 3% in 2040 (see Table 14). In 2010, it was assumed that 24% of uncollected waste is burned and the remaining 60% and 16% of uncollected waste will be disposed of as scatted dumping and managed by households respectively.

Table 14: Amount of uncollected waste

Description	Unit	2010	2025	2030	2040	Reference
Amount is uncollected	Ton/day	3,693.51	3,938	3,170	2,347	National Key Strategies and Specific Measures, 2018
	Ton/year	1,348,133	1,437,485.84	1,156,904	856,483	

Open burning of MSW

There are two major ways that can cause emissions of BC such as open burning of waste at the backyards which are the most common practice, and burning of disposed waste at the disposal sites. As previously explained, a strategy has been formulated for enhancing residual waste collection coverage and frequency and then to discourage backyard burning. Another strategy has been formulated to close the remaining unmanaged SWDS hence, negligible chance to burn. For instance, on a normalized annual basis, 25% of waste that is deposited at unmanaged dumpsites has been burned based on the likelihood of some SWDS to be burned, the frequency of burning within SWDS' average lifetime of 20 years, and the fraction of waste that gets burned. By implementing a new strategy, 60%, 65% and 70% of remaining unmanaged disposal sites will be closed by 2025, 2030 and 2040 respectively and therefore chances for BC emission will be very low. Amount of MSW burning at backyards and disposal sites have been summarised in Table 15.

Table 15: Amount of waste burning at backyards and uncontrolled disposal sites

Description	Unit	2010	2025	2030	2040	Reference
1. Amount of uncollected waste burned	Ton/day	886	945	761	563	National Key Strategies and Specific Measures, 2018
	Ton/year	323,552	344,996.60	277,657	205,556	
2. Percentage of burning of uncontrolled disposal sites/OD	Percentage (%)	25	10	8.75	7.5	
Amount of waste burned at uncontrolled disposal sites	Ton/day	4,749.17	1,654	1,543	1,435	
	Ton/year	1,733,447	603,753	643,510	698,581	

Summary of MSW treatment using different technologies

As described above, by following the formulated National Key Strategies and Specific Measures, the total generated MSW was allocated for among proposed treatment options see Table 16. GHGs and SLCPs has been quantified for corresponding MSW mass shown in below table under different treatment options.

Table 16: MSW allocation among different treatment options

Type of treatment	Unit	2010	2025	2030	2040
Transportation	Tons/year	12,133,194	19,098,026	21,981,179	27,692,951
Composting	Tons/year	352,537	1,922,473	2,940,596	5,539,532
Recycling	Tons/year	1,875,245	2,650,10	3,284,567	4,421,165
Open dumping	Tons/year	6,933,788	6,037,530	6,435,097	6,985,812
Control dump sites	Tons/year	990,541	4,462,522	4,756,376	5,163,427

Type of treatment	Unit	2010	2025	2030	2040
Sanitary landfills	Tons/year	1,981,082	4,025,393	4,564,543	5,583,01
Burning of uncollected waste	Tons/year	323,552	344,997	277,657	205,556
Scatted dumping/uncollected waste	Tons/year	1,024,581	1,092,489	879,247	650,927
Total waste generated	**Tons/year**	**13,481,326**	**20,535,512**	**23,138,084**	**28,549,434**

Development of Framework for GHGs and SLCPs Estimation.

Identifying key areas of GHGs, SLCPs emissions from waste management across different stages, including collection, transportation, processing, final disposal emissions and avoidance through resource recovery processes is very important for accurate estimation of overall climate impacts. Therefore, waste flow analysis was conducted for baseline scenario (the year 2010) and projected future scenarios in the year 2025, 2030 and 2040. In the baseline scenario, 90% of generated waste is collected, and only 18.4% of collected waste is being separated for resource recovery (2.9% for composting and 15.5% for recycling), and the remaining mixed waste is disposed of in open dumps (ODs), control dumps (CDs) and sanitary landfills (SLFs). Part of uncollected waste (24%) is being burned, and the remaining is assumed to be disposed at scatted dumpsites See Figure 22.

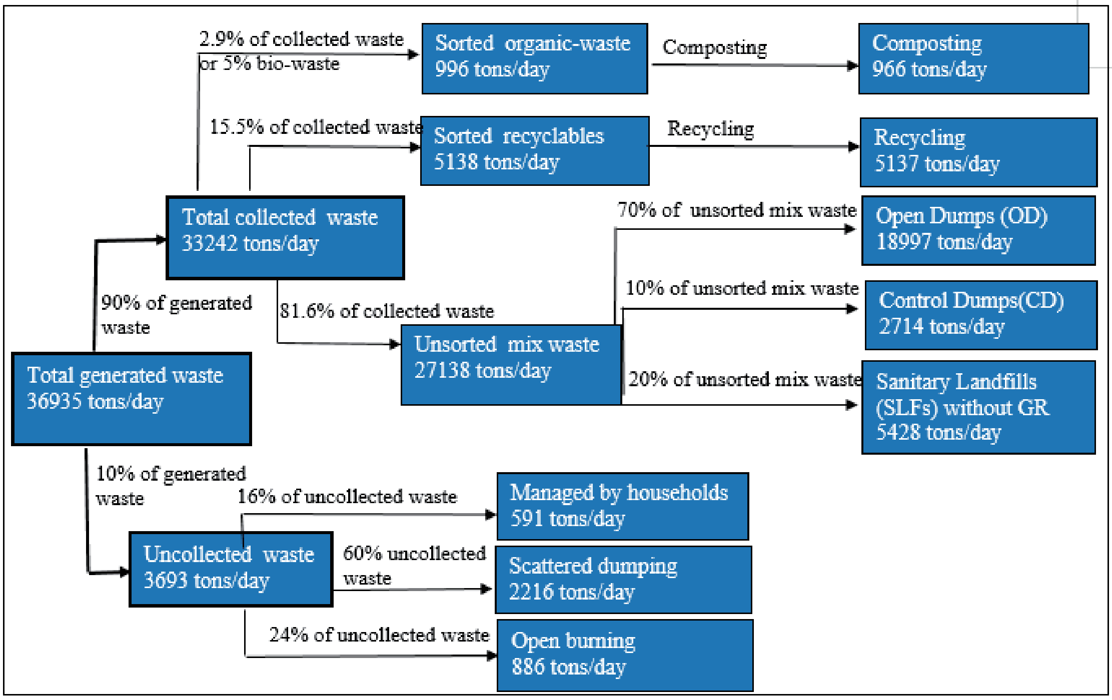

Figure 22: MSW management in the Philippines in the base year 2010

Further, by following the formulated seven strategies to enhance climate-friendly waste management at the national level, three scenarios were identified for the projected years; 2025, 2030, 2040. Scenario I represents the MSWM situation in the year 2025 with improved waste collection service while separating higher percentage of organic waste and recyclables for resource recovery alone with recovering some energy from waste disposal see Figure 24. Scenario II represents the predicted situation of MSW management in the year 2030. In this scenario, further improvement of waste collection rate, termination of some of the dump sites from waste disposal, and enhancement of SLFs practice with energy recovery options are included, see Figure 25. Scenario III represents the MSWM situation in 2040 where highest waste collection service (97%), highest resource recovery rate and termination of some of open dumps and control dumps while enhancing SLFs with energy recovery has been included, see Figure 26. GHGs and SLCPs emissions from each scenario were carried out for the waste flow and mass balances illustrated in Figure 22 - Figure 26.

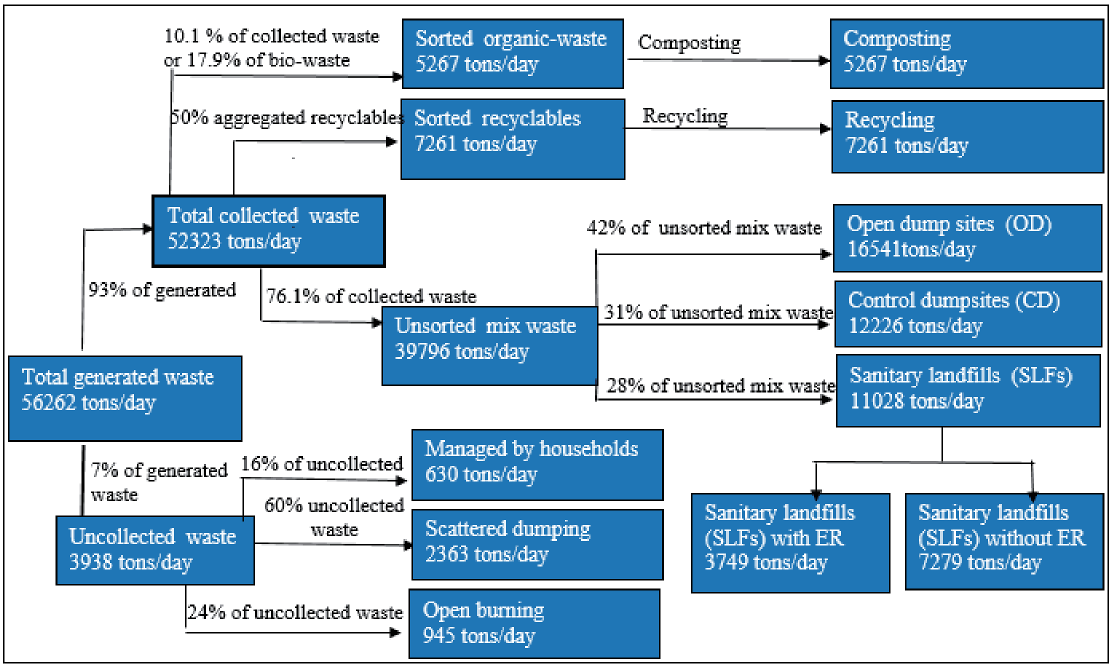

Figure 23: Scenario I- projected MSW management in the Philippines in the year 2025

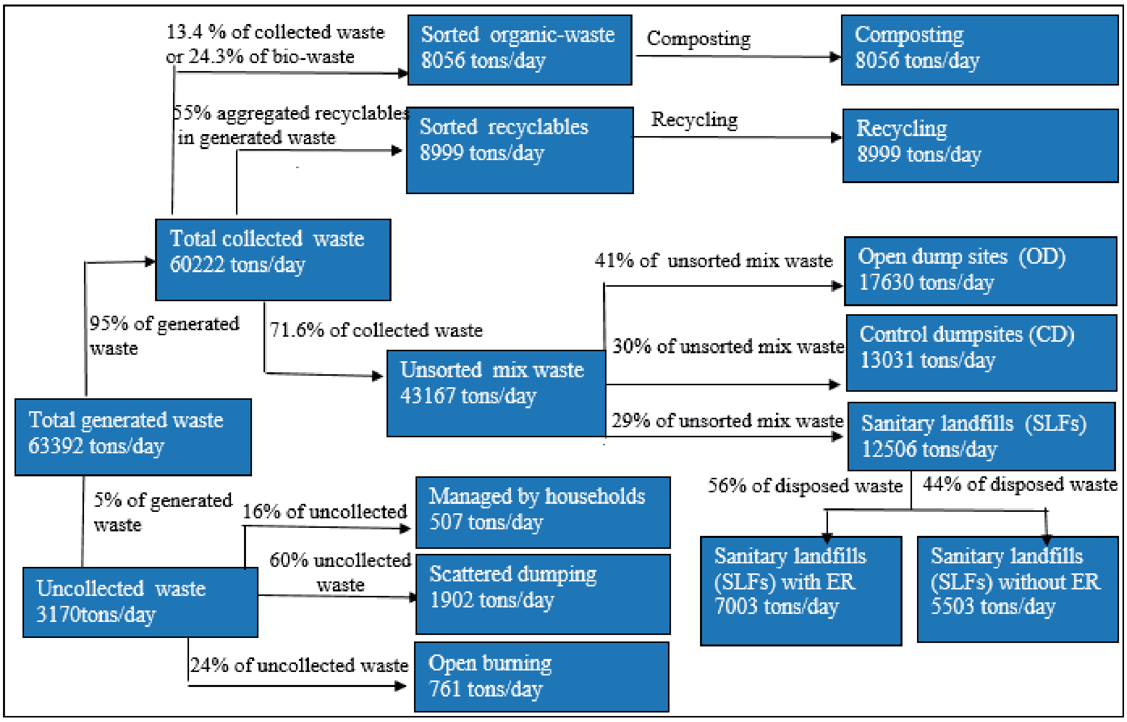

Figure 24: Scenario II- projected MSW management in the Philippines in the year 2030

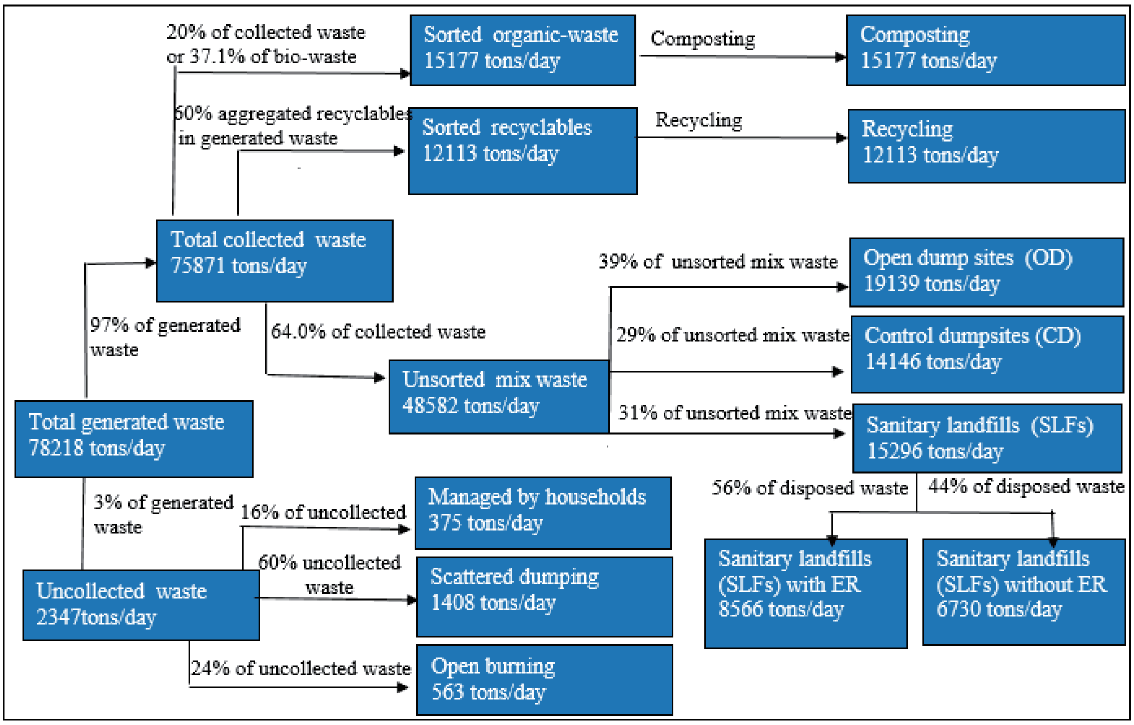

Figure 25: Scenario III- projected MSW management in the Philippines in the year 2040

GHGs/SLCPs Emissions from Baseline Scenario and Projected Scenarios in the Philippines

As stated above, Emission Quantification Tool (EQT) developed by IGES was utilised for GHGs/SLCPs emission estimation in waste sector in the Philippines. GHGs and SLCPs have been estimated as kg of CO_2-eq emission per ton of waste and kg of BC emission per ton of waste under each treatment option. EQT resulted in GHGs emissions from different treatment option in the base year (2010) is illustrated in Figure 26. Highest GHGs emissions have resulted from final disposal options such as open dumping, control dumping and sanitary landfilling without gas recovery due to the emissions of methane during waste degradation. Highest GHGs saving potential is shown from recycling, and net negative value has resulted as a result of resource recovery and avoidance of conventional material production processes. Open burning of waste at backyards or disposal sides also can cause significant GHGs emissions mainly due to CO_2 emissions from burning of plastics.

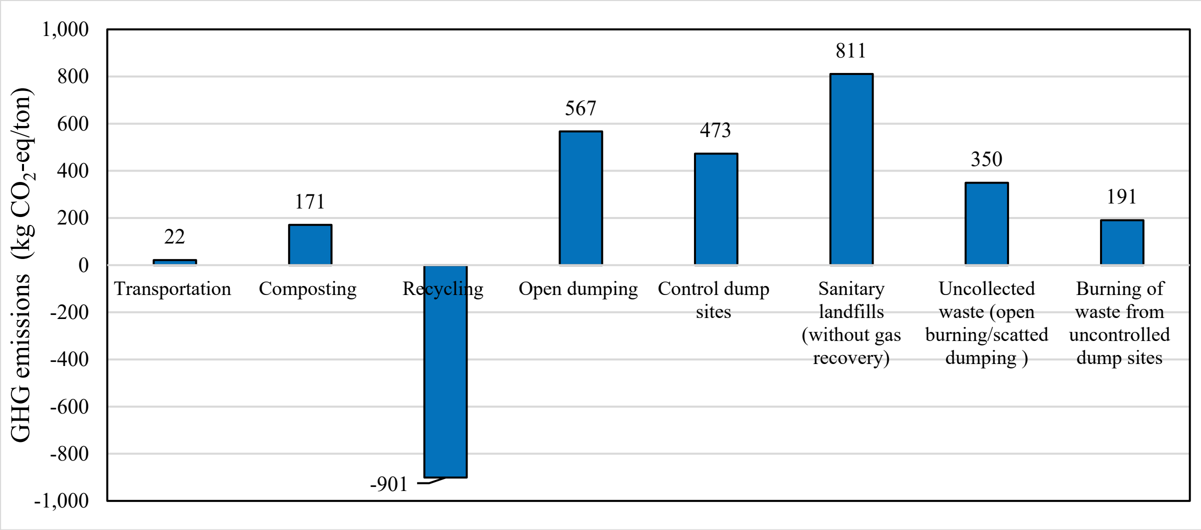

Figure 26: GHGs emissions from different treatment options in the base year (2010).

Similarly, GHGs emission potential from treatment options of projected years (2025, 2030 and 2040) was quantified using EQT. Except in composting, different emission values have been resulted for the same treatment option in future scenarios due to the variations of percentages of resource recovery and subsequent waste compositions. GHGs emissions per ton of waste management using different treatment options are summarised in Table 17.

Table 17: Summary of GHGs emissions in a base year and projected years

Treatment options	GHGs emission	2010	2025	2030	2040
Transportation	kg CO_2-eq/ton of waste	21.54	20.89	20.46	19.38
Composting	kg CO_2-eq/ton of waste	170.75	170.75	170.75	170.75
Recycling	kg CO_2-eq/ton of waste	-901.05	-932.29	-933.66	-934.79
Open dumpin	kg CO_2-eq/ton of waste	567.38	608.00	610.15	609.71
Control dump sites	kg CO_2-eq/ton of waste	472.82	506.67	508.46	508.09
Sanitary landfills (without gas recovery)	kg CO_2-eq/ton of waste	810.74	868.62	871.68	871.05
Uncollected waste (open burning/scatted dumping/managed by households)	kg CO_2-eq/ton of waste	350.35	350.35	350.35	350.35
Burning of waste from uncontrolled dump sites	kg CO_2-eq/ton of waste	190.77	166.40	158.00	152.76

BC emissions from all those treatment options concerning the base year and projected years were also estimated and presented separately due to the absence of universally accepted GWP value for BC. Burning of waste at backyards and uncontrolled disposal sites is responsible for the highest amount of BC emissions, see Figure 27. Transportation of waste and utilization of fossil fuel for operational activities of composting also caused some BC emissions. Resource recovery from recycling resulted in a negative BC emission figures which indicate the potential for BC savings, see Figure 27.

Overall Climate Impact from Annually Generated Waste in the Philippines

Overall climate impact caused due to total generated waste per year would be able to provide some tangible information for policy and decision makers which will be useful for technology selection and policy development. Therefore, both GHGs and BC emissions from individual treatment options from annually disposed waste have been quantified and presented in below tables.

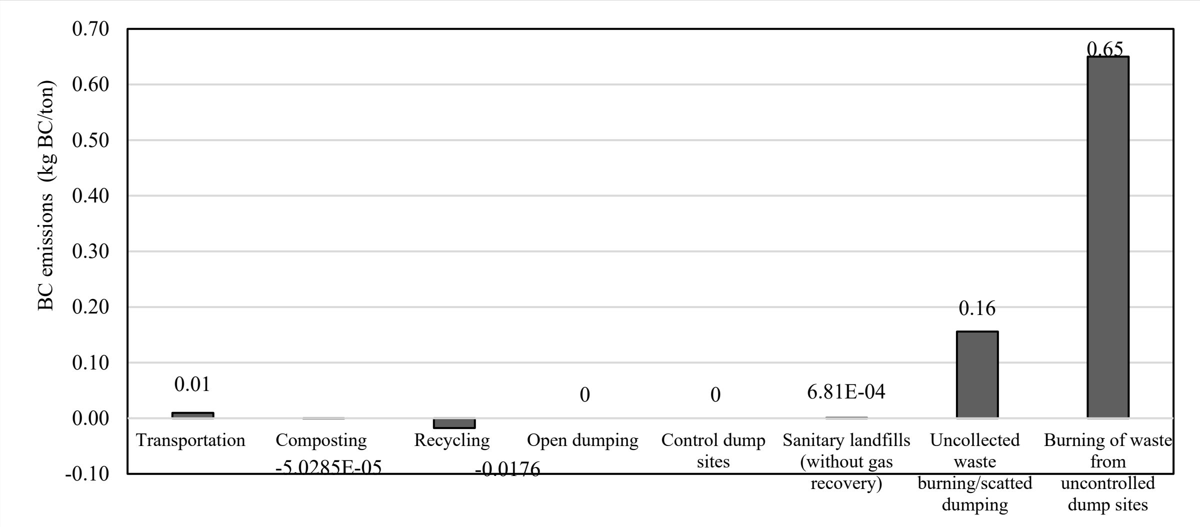

Figure 27: BC emissions from different treatment options in the base year (2010).

Overall climate impact from Transportation, Composting and Recycling

GHGs and SLCPs emissions due to waste transportation, composting and recycling by using EQT. It should be noted that there are negative BC values from composting, and negative GHG and BC values from recycling see Table 18. Negative values indicate a potential saving of GHGs and BC as a result of resource recovery and avoidance of conventional production processes.

Table 18: GHGs/SLCPs emissions from Transportation, Composting and Recycling caused by annually generated waste

Option	Unit	2010	2025	2030	2040
Transportation	tons of GHG/Yearly collected waste	261,324	398,992	449,758	536,804
	kg of BC emissions/yearly collected waste	116,31	177,59	200,190	238,935
Composting	tons of GHG/Yearly composted waste	60,197	328,271	502,120	945,899
	kg of BC emissions/Yearly composted waste	-17.73	-96.67	-147.87	-278.56
Recycling	tons of GHG/Yearly recycled waste	- 1,689,68	- 2,470,682	- 3,066,660	- 4,132,873
	kg of BC emissions/Yearly recycled waste	- 33,093	- 55,413	- 69,147	- 93,599

Overall Climate Impact from Final Disposal Practices

Open dumping (OD)

Open dumping is identified as one of the main disposal methods in base year as well as in the projected years. Even though 100% generated methane from open dumps is emitted to the atmosphere in the base year, some mitigations actions have been proposed in the projected years. Proposed mitigations actions from open dumps include recovery of methane and flaring from large dumpsites at 40% collection efficiency and application of eco-efficient soil cover (EESC) for small dumps which has the potential for oxidation of 70% of generated methane.

Table 19: Summary of GHGs/SLCPs emissions from Open Dump (OD) practice

	Description	Unit	2010	2025	2030	2040
Open dumping	The total was disposed at open dumpsites (OD)	Tons/ yearly dumped	6,933,788	6,037,530	6,435,097	6,985,812
	Total GHG emission potential from OD	GHG (tons of CO_2-eq)	3,281,289	3,404,211	3,635,435	3,940,093
	Emissions from OD with gas recovery					
	Fraction of open dumps with gas recovery	Percentage	0	18	30	30
	Amount of waste of open dump with gas recovery	Tons of disposed	-	1,086,755.41	1,930,529	2,095,744
	(a) Amount of methane recovered and **flared** from gas recovery (40% collection efficiency) from OD	GHG (tons of CO_2-eq)	-	264,300	471,168	511,117
	(i) Amount of methane emissions from OD with gas recovery	GHG (tons of CO_2-eq)	0	396,450	706,753	766,676
	Emissions from OD with Eco-Efficient Soil Cover (EESC)					
	Percentage of small dumpsites (58% of total dumpsites)	Tons disposed	-	3,501,767	3,732,356	4,051,771
	Percentage of small dumpsite with Eco-efficient cover	Tons disposed	-	1,085,547	1,866,178	2,025,886
	(b)Total methane emissions avoidance from small dumpsite with eco-efficient soil cover (70%)	GHG (tons of CO_2-eq)	-	462,011	797,060	864,640
	(ii)Total methane emissions from small dumpsites with eco-efficient cover	GHG (tons of CO_2-eq)	0	198,005	341,597	370,560
	Emissions of open burning at OD					
	Amount of waste burned at dumpsites	Tons of waste/yearly dumped	1,733,447	603,753	643,510	698,581
	(iii) Total GHGs emissions from open burning of waste at OD	GHG (tons of CO_2-eq)	330,694	100,464	101,672	106,712
	Amount of waste disposed at dumpsite with no gas recovery or EESC	tons of disposed of/yearly dumped waste	5,200,341	3,261,474	1,994,880	2,165,602
	(iv) Emissions from waste dispose of at dumpsites with no gas recovery and no EESC (excluding open burning)	GHG (tons of CO_2-eq)	2,950,595	1,982,983	1,217,185	1,320,387
	Total GHGs emissions from open dumping (net emissions) (i)+(ii)+(iii)+(iv)	GHG (tons of CO_2-eq)	3,281,289	2,677,901	2,367,207	2,564,335
	Total GHGs emission avoidance from open dumping practice (a)+(b)	GHG (tons of CO_2-eq)	0	726,311	1,268,228	1,375,758
	Percentage of emission reduction relative to total emission	Percentage (%)	-	21.34	34.89	34.92
	Total BC emissions from open burning	kg of BC/yearly disposed waste	1,126,741	392,439	418,281	454,078

In addition to CH_4 emission, BC and CO_2 can be emitted from dumpsites due to open burning of waste. In fact, in the base year, 25% of disposed waste is burned. Therefore, a new strategy has been formulated to reduce open burning from uncontrolled disposal by closing and rehabilitating the 60%, 65% and 70% of the remaining unmanaged SWDS in 2025, 2030 and 2040 respectively, hence, negligible chance to burn.

Considering all those aspects, GHGs and SLCPs emissions were estimated from the annually disposed waste in open dumps, see Table 19. As a result of formulating new strategies to reduce emissions, GHGs reductions potential due to methane recovery and application of EESC is 21.34%, 34.89% and 34.92% in the year 2025, 2030 and 2040 respectively relative to the gross GHGs emissions potential from open dumps. BC emission potential due to open burning of waste at disposal sites is also calculated and presented in Table 19.

Control Dumping (CD)
A similar approach was followed to quantify GHGs and SLCPs emissions from Control Dumps (CD) due to annually disposed waste considering the proposed strategies on emissions reduction. Similar to open dumps, strategies have been proposed for methane collection and flaring from large CDs and application of EESC for small CDs. The estimated GHGs reductions due to methane recovery and application of EESC is 19.79%, 23.30% and 32.30% relative to the gross emission potentials in the year 2025, 2030 and 2040 respectively, see Table 20. There are no BC emissions from CDs as there is no occurrence of open burning of waste.

Sanitary landfill (SLFs) with energy recovery
Sanitary landfill (SLFs) with energy recovery systems has been introduced as a strategy to reduce methane from the year 2025. Total waste disposal at SLFs for energy recovery is proposed at the rate of 34%, 56% and 56% in the year 2025, 2030 and 2040 respectively. Landfill gas will be captured with 50% collection efficiency, and the captured gas will be utilized to produce electricity. Produced electricity will be utilized to replace conventional electricity and thereby there is a possibility for GHGs savings. GHGs emissions due to uncollected methane and CO_2 emissions from operational activities from SLFs with gas recovery is summarized in Table 21. Further, BC emissions potential due to fossil fuel consumption for operational activities is also quantified (see Table 21). It should be noted that BC avoidance/savings through electricity production from landfill gas and replacement equivalent amount of conventional electricity has not been estimated due to unavailability of BC emissions factors from grid electricity production.

Sanitary landfill (SLFs) without energy recovery
SLFs without energy recovery options is available even in the base year. Implementation of gas recovery from every SLF is not possible. Therefore, most of the small SLFs will remain without energy recovery. However, as stated in the strategies, those SLFs will be equipped for gas collection and flaring systems in projected years (2025, 2030 and 2040) to reduce the methane emission. It was assumed that landfill gas would be captured with 50% collection efficiency and the captured gas will be flared. Table 22 summarises the avoided GHGs emissions due to gas capturing and flaring, total GHGs emission due to methane emission and CO_2 emissions from operational activities and total BC emissions from operational activities.

Table 20: Summary of GHGs/SLCPs emissions from Control Dumps (CD) practice

	Description	Unit	2010	2025	2030	2040
Controlled dumping (CDs)	The total waste dispose at Controlled dumps (CD)	Tons/ yearly dumped	990,541	4,462,522	4,756,376	5,163,427
	Emissions from CD with gas recovery					
	Total GHG emissions potential from CDs	GHG (tons of CO_2-eq)	468,348	2,261,019	2,418,437	2,623,489
	Fraction of CDs with gas recover	Percentage (%)	0	18	30	30
	Amount of waste in CDs with gas recovery	Tons of disposed of/yearly dumped	-	803,254	1,426,913	1,549,028
	Amount of methane recovered and **flared** from gas recovery (40% collection efficiency) from CD	GHG (tons of CO_2-eq)	-	162,793	290,212	314,819
	(i) Amount of methane emissions from CD with gas recovery	GHG (tons of CO_2-eq)	0	244,190	435,319	472,228
	Emissions from CDs with Eco-Efficient Soil Cover (EESC)					
	Percentage of small CDs (58% of total CD)	Tons disposed of/yearly generated waste	-	2,588,263	2,758,698	2,994,787
	Percentage of CDs with Eco-efficient cover	Tons disposed of/yearly generated waste	-	802,361.50	1,379,349	1,497,394
	Total methane emissions avoidance from CDs with eco-efficient cover (70%)	GHG (tons of CO_2-eq)	-	284,572	490,943	532,568
	(ii)Total methane emissions from small CDs with eco-efficient cover	GHG (tons of CO_2-eq)	0	121,959	210,404	228,244
	Amount of waste disposed at CDs with no gas recovery or no EESC	Tons of disposed of/yearly generated waste	990,541	2,856,907	1,950,114	2,117,005
	(iii) Emissions from waste dispose of at CDs with no gas recovery and no EESC	GHG (tons of CO_2-eq)	468,348	1,447,504	991,559	1,075,631
	Total emissions from CDs practice (net emission)	GHG (tons of CO_2-eq)	468,348	1,813,654	1,637,282	1,776,102
	Total emission avoidance from CDs practice	GHG (tons of CO_2-eq)	0	447,365	781,155	847,387
	Percentage of emission reduction relative to the total generation	%	0	19.79	32.30	32.30

Table 21: Summary of GHGs/SLCPs emissions from SLFs with energy recovery

	Description	Unit	2010	2025	2030	2040
Sanitary landfilling with energy recovery	Total waste disposal at SLF for energy recovery	Percentage (%)	0	34	56	56
	Total waste dispose at SLF with energy recovery	Tons disposed of/annually generated waste	0	1,368,634	2,556,144	3,126,488
	Total methane production from SLF with energy recovery	kg of CH_4/yearly disposed waste	0	56,466,106	105,832,890	129,352,517
	Total captured methane (50% collection efficiency)	kg of CH_4/yearly disposed wast	0	28,233,053	52,916,445.	64,676,258
	Electricity production potential from captured methane	MWh/yearly disposed waste	0	141,686	265,558	324,574
	Total avoided GHG through electricity production	GHG (tons of CO_2-eq)	0	70,843.03	132,779	162,287
	Total avoided GHG through methane capture	GHG (tons of CO_2-eq)	0	592,894	1,111,245	1,358,201
	Total avoided GHG through methane capture and electricity production	GHG (tons of CO_2-eq)	0	663,737	1,244,025	1,520,489
	Total methane emissions from SLF with gas recover	GHG (tons of CO_2-eq)	0	592,894	1,111,245	1,358,201
	Other GHG emissions from operational activities	GHG (tons of CO_2-eq)	0	3,019	5,639	6,897
	Total GHG emissions from SLF with energy recovery	GHG (tons of CO_2-eq)	0	595,914	1,116,885	1,365,099
	Total BC emissions from SLF with energy recovery	kg of BC/yearly disposed waste	0	931.88	1,740	2,129

Table 22: Summary of GHGs/SLCPs emissions from SLFs without energy recovery

	Description	Unit	2010	2025	2030	2040
Sanitary landfill without gas recovery	Total waste disposal at SLFs without energy recovery	Tons disposed of/annually generated waste	1,981,082.34	2,656,759.41	2,008,399.03	2,456,526.18
	Total methane production from SLF without energy recovery	kg of CH_4/yearly disposed waste	76,274,064	109,610,909	83,154,589	101,634,335
	Total methane captured (capture efficiency 50%) and flared (flaring efficiency 90%)	kg of CH_4/yearly disposed waste	-	49,324,909	37,419,565	45,735,451
	Total avoided GHG through methane capture and flaring	GHG (tons of CO_2-eq)	-	1,035,823	785,811	960,444
	Total climate impact caused due to methane emission	GHG (tons of CO_2-eq)	1,601,755.33	1,266,006	960,436	1,173,877
	Total GHG emissions from operational activities	GHG (tons of CO_2-eq)	4,371	5,861	4,431	5,419
	Total GHG emissions from SLFs without gas recovery	GHG (tons of CO_2-eq)	1,606,126	1,271,867	964,866	1,179,296
	Total BC emissions	kg of BC/yearly disposed waste	1,349	1,809	1,367	1,673

Table 23: Total GHGs and SLCPs emissions from uncollected waste

	Description	Unit	2010	2025	2030	2040
Uncollected waste	Total uncollected waste	Tons/yearly generated waste	1,348,133	1,437,486	1,156,904	856,483
	Uncollected waste burning/scatted dumping/ managed by households	GHG (tons of CO_2-eq)/Yearly uncollected waste	472,323	503,628	405,325	300,072
	Total BC emissions from uncollected waste (burning/scatted dumping)	kg of BC/yearly uncollected waste	210,309	224,248	180,477	133,611

Total GHGs and SLCPs Emissions from Uncollected Waste

Scatted dumping of uncollected waste would emit methane during waste degradation and BC from open burning of waste at backyards. In the baseline scenario (the year 2010), 10% of waste is uncollected in which 24% has been burned. In order to reduce GHGs and SLCPs from uncollected waste, a new strategy has been formulated to reduce uncollected waste fraction from 10% in 2010 to 3% on 2040. Total GHGs and BC emission from uncollected waste has been summarised in Table 23.

Summary of GHGs Emissions from MSW Management in the Philippines

CH_4 is emissions is the main source for climate impac from waste sector. Total methane emissions potentail from indivitual treatment options in base year and projected years have been presented in Table 24. Aggregated climate impact caused due to all kind of GHGs (CH_4, CO_2, N_2O) emissions from the yearly generated waste in the base year and the projected years is shown in Table 25. It would be hard to measure the progress of formulated policies and strategies on emissions reduction by comparing the total GHGs emissions figures as each year has a different amount of waste input/generated waste. Thus "GHGs emissions per ton of generating waste in the base year and projected years" were quantified to measure the mitigation progress due to policy/strategy implementation (see Table 25). The estimated results showed that GHGs emissions per ton of generated waste are 331 kg CO_2-eq, 249 kg CO_2-eq, 189 kg CO_2-eq and 159 kg CO_2-eq in the year 2010, 2025, 2030 and 2040 respectively.

Further GHGs emission per ton of generate waste in 2025 is 24.6 % lower than 2010. Similarly GHG emissions in 2030 and 2040 is 42.8% and 51.9% lower compared to the base year see Table 25. These figures provide some tangible information about the potential progress that can be made on GHGs mitigation by implementing appropriate policies and strategies at national level.

Table 24: Summary of CH_4 emissions from yearly generated waste

Technology	Unit	2010	2025	2030	2040
Transportation	kg of CH_4/yearly collected waste	10,578	16,150	18,205	21,729
Composting	kg of CH_4/yearly composted waste	1,409,935	7,688,739	11,760,619	22,154,805
Recycling	kg of CH_4/Yearly recycled waste	- 14,970	- 19,794	- 24,459	- 32,841
Open dumping	kg of CH_4/Yearly OD waste	146,918,289	124,968,989	110,263,578	119,614,428
Control dump sites	kg of CH_4/yearly CD	22,302,307	86,364,466	77,965,787	84,576,304
Sanitary landfills with energy recovery	kg of CH_4/Yearly SLFs with ER	0	28233053	52916445	64676258
Sanitary landfills without energy recovery	kg of CH_4/Yearly SLFs without ER	76,274,064	60,286,000	45,735,024	55,898,884
Uncollected waste	kg of CH_4/yearly uncollected waste	16,694,175	17,800,652	14,326,157	10,605,987
Total	**kg of CH_4/yearly generated waste**	**263,594,377**	**325,338,255**	**312,961,356**	**357,515,554**
CH_4 emission per ton of generated waste	kg of CH_4/ton of waste	19.553	15.843	13.526	12.523
Emission reduction relative to the base year 2010	Percentage		19	31	36

Table 25: Summary of GHGs (CH_4, N_2O, CO_2) emissions from yearly generated waste

Technology	Unit	2010	2025	2030	2040
Transportation	Tons of CO_2-eq/Yearly collected waste	261,324	398,992	449,758	536,804
Composting	Tons of CO_2-eq /Yearly composted waste	60,197	328,271	502,120	945,899
Recycling	Tons of CO_2-eq /Yearly recycled waste	- 1,689,688	- 2,470,682	- 3,066,660	- 4,132,873
Open dumping	Tons of CO_2-eq /Yearly open dump waste	3,281,289	2,677,901	2,367,207	2,564,335
Control dump sites	Tons of CO_2-eq /Yearly control dump waste	468,348	1,813,654	1,637,282	1,776,102
Sanitary landfills with energy recovery	Tons of CO_2-eq /Yearly SLFs with energy recovery waste	-	595,914	1,116,885	1,365,099
Sanitary landfills without energy recovery	Tons of CO_2-eq /Yearly SLFs without energy recovery waste	1,606,126	1,271,867	964,866	1,179,296
Uncollected waste	Tons of CO_2-eq /Yearly uncollected waste	472,323	503,628	405,325	300,072
Total	Tons of CO_2-eq **/Yearly generated waste**	4,459,919	5,119,544	4,376,782	4,534,734
Emission per ton of generated waste	kg of CO_2-eq/per ton of generated waste	331	249	189	159
Emission reduction relative to the base year 2010	Percentage (%)		24.64	42.82	51.99

Summary of BC emissions from MSW management in the Philippines

BC emissions summary from the yearly generated waste in the base year and the projected years is presented in Table 26. As explained above, in order to measure the progress on the effect of proposed policies and strategies on emissions reduction, BC emissions potential per ton of generate waste in the base year and projected years were quantified. The estimated results revealed that BC emissions potential per ton of generated waste is 0.105kg, 0.036kg, 0.032kg and 0.026kg for the year 2010, 2025, 2030 and 2040 respectively. Although the magnitude of BC values seems to be low, the climate impact would be significantly high as GWP value of BC is much higher than greenhouse gases. GWP value of BC has not yet been finalised yet and difference sources suggest different GWP values for BC. In fact, according to the European Investment Bank (2016), BC has a warming impact on climate 1,055-2,020 times stronger than CO_2 over a 100-year time horizon. Thus experts have been suggested in data vetting meeting to use GWP value of BC as 680 kg of CO_2-eq/kg. Based on this GWP value of BC, climate impact caused due to BC emissions per ton of generated waste from base year and projected year would be 71.71 kg CO_2-eq, 24.55 kg CO_2-eq, 21.53 kg CO_2-eq and 17.54 kg CO_2-eq in the year 2010, 2025, 2030 and 2040 respectively.

Further BC emission per ton of generated waste in 2025 is 66 % lower than 2010. Similarly, BC emissions in 2030 and 2040 would be 70% and 76% lower compared to the base year see Table 26. These figures provide some noticeable information about climate impact caused from BC emissions and potential mitigation progress though implementing appropriate strategies.

Table 26: Summary of BC emissions from yearly generated waste

Technology	Unit	2010	2025	2030	2040
Transportation	kg of BC/yearly transported waste	116,317	177,594	200,190	238,935
Composting	kg of BC/yearly composted waste	-17.73	-96.67	-147.87	-278.56
Recycling	kg of BC/yearly recycled waste	- 33,093	- 55,413	- 69,147	- 93,599
Open dumping (Burning at disposal sites)	kg of BC/yearly open dumped waste	1,126,741	392,439	418,281	454,078
Control dump sites	kg of BC/yearly CD waste	0	0	0	0
Sanitary landfills with energy recovery	kg of BC/yearly SLFs with energy recovery waste	0	932	1740	2129
Sanitary landfills without energy recovery	kg of BC/yearly SLFs without energy recovery waste	1,349	1,809	1,367	1,673
Uncollected waste	kg of BC/yearly uncollected waste	210,309	224,248	180,477	133,611
Total	**kg of BC/yearly generated wast**	**1,421,604**	**741,512**	**732,762**	**736,548**
BC emission per ton of generated waste	kg of BC/ton of waste generated waste	0.105	0.036	0.032	0.026
Emission reduction relative to the base year 2010	Percentage		66	70	76
Climate impact of BC	kg CO_2-eq/ton of waste	71.71	24.55	21.53	17.54

Overall Climate Impact from MSW Management in the Philippines

In order to compare the overall climate impact due CH_4, BC and other GHGs emissions in based year and projected years, climate impact was quantified in "tons of CO_2-eq/yearly generated waste" concerning the different gas component. Total climate impact of CH_4 is 5-15 times higher than climate impact caused by BC. As seen in Table 27, emissions from other GHGs (CO_2, N_2O) in all the years show negative value mainly due to potential CO_2 savings through resource recovery from recycling. The estimated net climate impact caused due GHGs and SLCPs from the base scenario is 5.42 million tons of CO_2-eq associated with annually generated waste in the Philippines. The overall climate impact from projected years comprises 5.62 million tons of CO_2-eq, 4.87 million tons of CO_2-eq and 5.03 million tons of CO_2-eq in the year 2025, 2030 and 2040 respectively see Table 27 and Figure 5. It should be noted that generated waste amount in 2040 is more than double as compared to 2010. As a mitigation effects of seven strategies formulated, the net climate impact in 2040 is slightly lower than 2010.

Table 27: Overall Climate impact from MSW management in the Philippines (Ton of CO_2-eq/yearly generated waste)

Description	Unit	2010	2025	2030	2040
Climate impact from CH_4 (i)	Tons of CO_2-eq/yearly generated waste	5,535,482	6,832,103	6,572,188	7,507,827
Climate impact from BC (ii)	Tons of CO_2-eq/yearly generated waste	966,691	504,228	498,278	500,853
Climate impact from other GHGs (CO_2 + N_2O) (iii)	Tons of CO_2-eq/yearly generated waste	- 1,075,563	- 1,712,560	- 2,195,407	- 2,973,093
Net Climate impact (i) + (ii) + (iii)	**Tons of CO_2-eq/yearly generated waste**	**5,426,610**	**5,623,772**	**4,875,060**	**5,035,587**

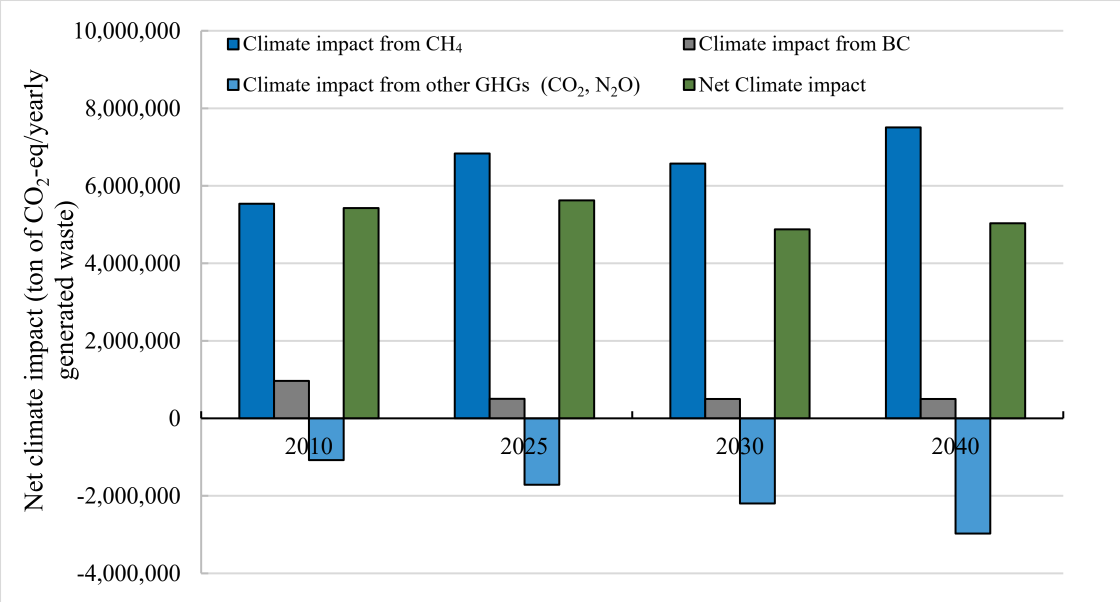

Figure 28: Overall Climate impact from MSW management in the Philippines (Ton of CO_2-eq/yearly generated waste)

Fluctuation of emissions figures can be noticed in projected years (Table 26) due to different waste generation rates and recovery rates. Potential mitigation benefits are resulting from addressing aggregated climate impacts from both GHGs and BC very important for implementing climate policy and planning. In order to measure the real progress on the effect of proposed policies and strategies on emissions reduction, each type of emission (CH_4, BC and other GHGs (CO_2, N_2O)) was quantified "per ton of generating waste" in the base year and projected years, see Figure 29.

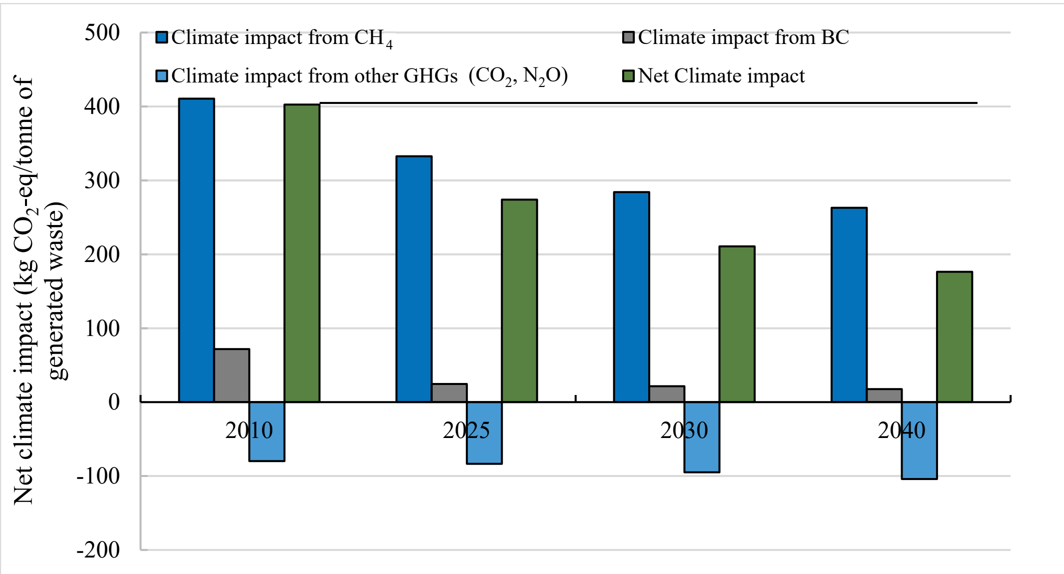

Figure 29: CH_4, BC and other GHGs (CO_2, N_2O) emissions reduction with proposed strategies per ton of generated waste

CH_4 is the major cause for net climate impact, see Figure 28. Negative values has been resulted for other GHGs (CO_2 and N_2O) as a results of resource recovery from recycling activities and avoidance of equivalent amount of those emissions from conventional processes.

Further, aggregated climate impact due to all kind of GHGs (CH_4, CO_2 and N_2O) and BC was quantifies and illustrated in Figure 30. Total climate impact mitigation potentials from MSW management through the proposed seven strategies in projected years of 2025, 2030 and 2040 relative to 2010 base year practice is 32%, 48% and 56% respectively.

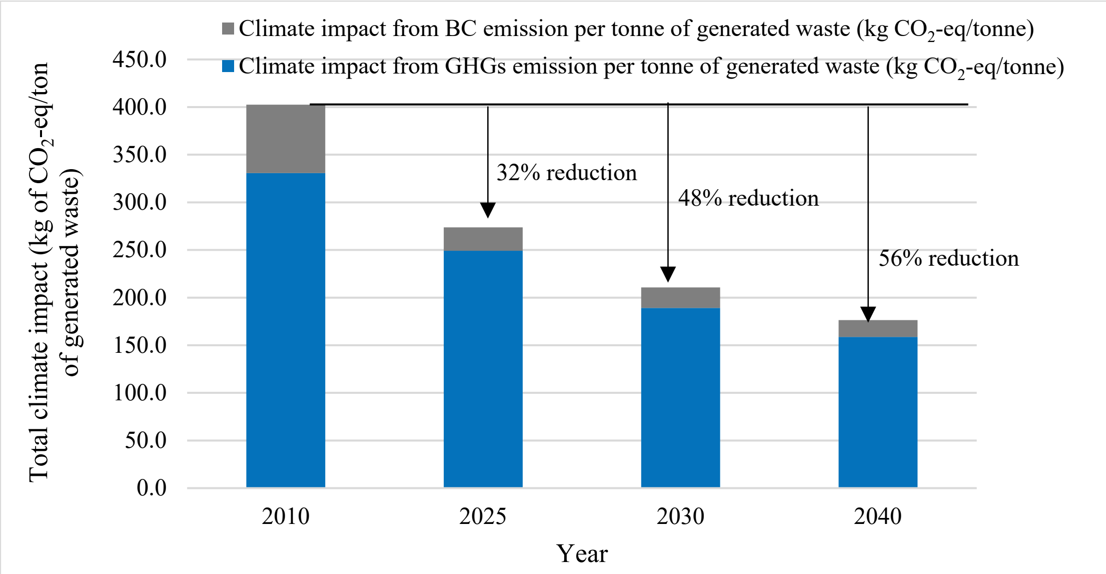

Figure 30: Overall climate impact reduction potential through proposed strategies

These results have been achieved by providing improved waste collection service, scaling up interventions targeting the open burning, and promoting maximum resource recovery (composting and recycling) including by encouraging waste separation and improving the conditions of open dumping and control disposal practices. GHGs and SLCP reduction measures can be accommodated both through strategic planning and selection of appropriate climate-friendly technologies while making efforts to terminate/enhance the condition of conventional disposal practices. As such, a well-designed, integrated waste management system represents an important means of implementation for achieving climate-change mitigation targets in the Philippines. Overall, these findings of quantitative analysis highlight the need for developing a national framework aimed at addressing SLCPs from MSWM, together with its timely and necessary application.

Annex H.

Photo Gallery

Photos from 1st FGD, September 5-7, 2018

Photos from 2nd FGD, November 6-8, 2018

Photos from Public Consultation, November 29, 2018




Photos from NSWMC Committee on Climate Change Meeting, December 17, 2018