2010 Philippine Greenhouse Gas Inventory Report

Executive Summary

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This report summarizes the Philippines' Greenhouse Gas (GHG) Inventory for the year 2010. Like previous national inventories, the 2010 national GHG inventory presents the contributions of six (6) key sectors to the country's emissions and removals, namely: (1) energy; (2) transport; (3) agriculture; (4) forestry and other land use (FOLU); (5) industrial processes and product use (IPPU); and (6) waste.

This report is based on the sectoral greenhouse gas inventory reports from the lead agencies[1] of Executive Order 174 and consolidated by the Climate Change Commission (CCC).

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Introduction

This report summarizes the Philippines' greenhouse gas (GHG) inventory for the year 2010. Like previous national inventories, the 2010 national GHG inventory presents the contributions of six (6) key sectors to the country's emissions and removals, namely: (1) energy; (2) transport; (3) agriculture; (4) forestry and other land use (FOLU); (5) industrial processes and product use (IPPU); and (6) waste. This report is based on the sectoral greenhouse gas inventory reports from the lead agencies[2] of Executive Order 174 and consolidated by the Climate Change Commission (CCC).

In line with the greenhouse gases covered by the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (2006 IPCC Guidelines), there are four (4) GHGs accounted for in this report: (1) carbon dioxide (CO_2); (2) methane (CH_4); (3) nitrous oxide (N_2O) and (4) hydrofluorocarbons (HFCs).

Methodology & Assumption

The methodologies, assumptions, and default data used in the 2010 inventory follow the *2006 IPCC Guidelines,* where applicable. The 2006 IPCC Guidelines was produced by the invitation of the United Nations Framework on Climate Change (UNFCCC) to update the Revised 1996 Guidelines and associated good practice guidance. The 2006 IPCC Guidelines aims to provide internationally agreed methodologies intended for use by Parties to the UNFCCC to estimate greenhouse gas inventories. In comparison, the 2000 national greenhouse gas inventory as reported in the Philippines' Second National Communication to the UNFCCC used in complementary fashion both the 1996 IPCC Guidelines and the 2006 IPCC Guidelines in estimating GHG emissions and removals.

In the 2006 IPCC Guidelines, the simplest methodological approach is to combine information on activity data with emission factors. Activity data provides information on the extent to which human activities take place, while emission factors are coefficients that quantify emissions or removals per unit activity. In the 2010 national inventory, activity data sources are derived from national statistics, government agencies, and the private sector. Default emission factors derived from the 2006 IPCC Guidelines are used for the most part, with country-specific emissions factors being utilized whenever available.

Moreover, Tier 1 method is used in the 2010 national inventory. A tier refers to the level of methodological complexity and effort required to estimate GHG emissions and removals. Tier 1 is the simplest method, while Tiers 2 and 3 are referred to as higher tier methods and are generally considered to be more accurate.

For reporting purposes, non-CO_2 GHGs included in this inventory (i.e., CH4, N2O, and HFCs) were expressed in terms of their carbon dioxide equivalents (CO_2e). Global warming potential (GWP) values were used to estimate equivalent emissions of non-CO2 GHGs. GWP is a measure of how much heat a GHG traps in the atmosphere up to a specific time horizon, relative to that of

[2] *Department of Energy for energy; Department of Environment and Natural Resources for waste, industrial processes and forestry; Philippine Statistics Authority for agriculture*

carbon dioxide. GWP is calculated over a specific time horizon, commonly 20, 100, or 500 years. The IPCC provides accepted values for GWP, which are updated in each IPCC assessment report. In the 2010 national inventory, 100-year GWP values from the IPCC Fourth Assessment Report (AR4) were used (See Table 1).

Table 1. IPCC Global Warming Potential Values

Greenhouse gas	Chemical formula	GWP values for 100-year time horizon		
		Second Assessment Report (SAR)	Fourth Assessment Report (AR4)	Fifth Assessment Report (AR5)
Carbon dioxide	CO_2	1	1	1
Methane	CH_4	21	25	28
Nitrous oxide	N_2O	310	298	265

Summary of the Philippine 2010 National GHGI

In 2010, the Philippines emitted a total of 144.352 million metric tons of CO_2 equivalent (Mt CO_2e) while the FOLU sector's net sequestration 37.007 Mt CO_2e, hence a net emission of 107.345 MtCO_2e (Figure 1. 2010 Philippine GHG emissions and removals. Figure 1, Figure 2, and Table 2).

Figure 1. 2010 Philippine GHG emissions and removals.

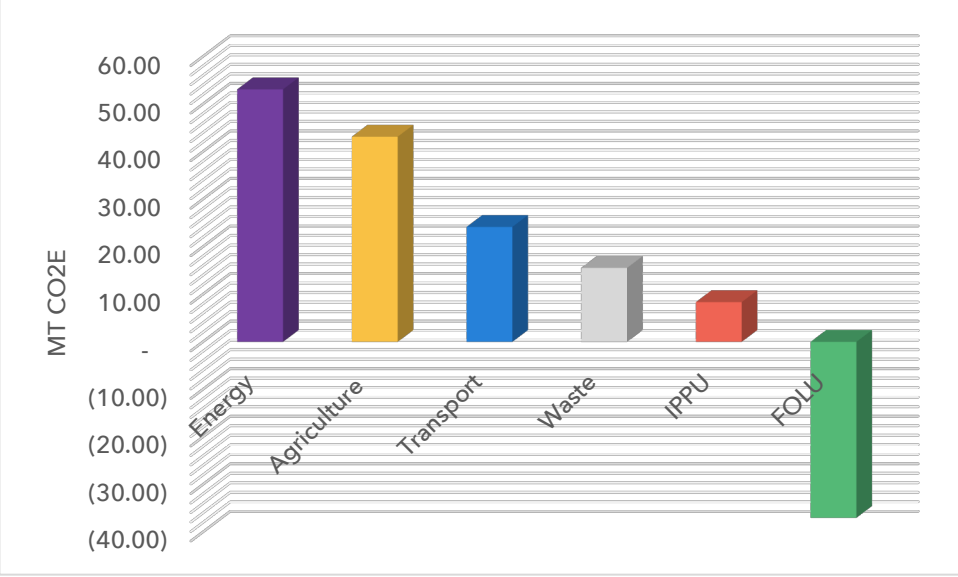


Figure 2. Sectoral emission shares of non-FOLU sectors, 2010 national GHGI

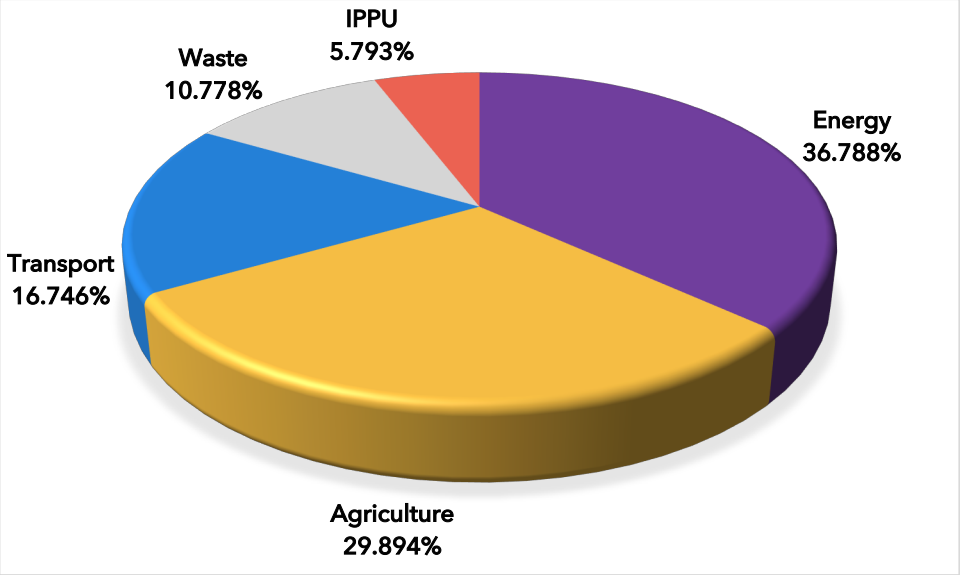


Table 2. Summary of 2010 National GHG Inventory, per sector and per gas (values in Mt CO_2e)

	CO_2	CH_4	N_2O	HFCs	Total
Energy	50.698	1.888	0.519	-	53.105
Agriculture	0.696	33.853	8.604	-	43.152
Transport	23.718	0.125	0.331	-	24.174
Waste	0.015	14.527	1.017	-	15.559
IPPU	7.564	0.009	0.019	0.771	8.363
FOLU	(37.016)	0.007	0.002	-	(37.007)
	TOTAL				*107.345*

2010 GHG Emissions and Removals by Sector

Energy sector

The energy sector was the largest emitting sector in the 2010 national inventory, emitting an estimated 53.105 Mt CO_2e in 2010. Fuel combustion (excluding transportation) accounted for the majority of energy sector emissions – 53.002 Mt CO_2e, equivalent to 99.806% of the sector's total. The remaining of which (0.103 Mt CO_2e; equivalent to 0.194%) were attributed to fugitive emissions, such as those emissions during extraction, transportation, and storage of fuels.

It should be noted that under the IPCC Guidelines, transport is a sub-category of the energy sector. However, due to institutional arrangements to be discussed later, the transport subsector is reported separately for the Philippine national GHG inventory. Thus, that the above-mentioned

values for the energy sector emissions **does not** include transport sector emissions, which is reported under Section 3b of this report.

For the fuel combustion subsector, emissions from energy industries (which includes electricity production and petroleum refining) was the largest at 33.020 Mt CO_2e. Emissions from energy use in manufacturing industries and construction was also significant at 12.040 Mt CO_2e. Major emission contributors among the manufacturing industries were the non-metallic minerals and the food processing industries. Emissions from other sub-categories, which include commercial, industrial, residential, and agricultural energy emissions, were at 7.940 Mt CO_2e in 2010. Note that emissions from these categories were those involving energy use (e.g. fuel use in agriculture and fishing equipment) rather than sectoral process, e.g. rice cultivation.

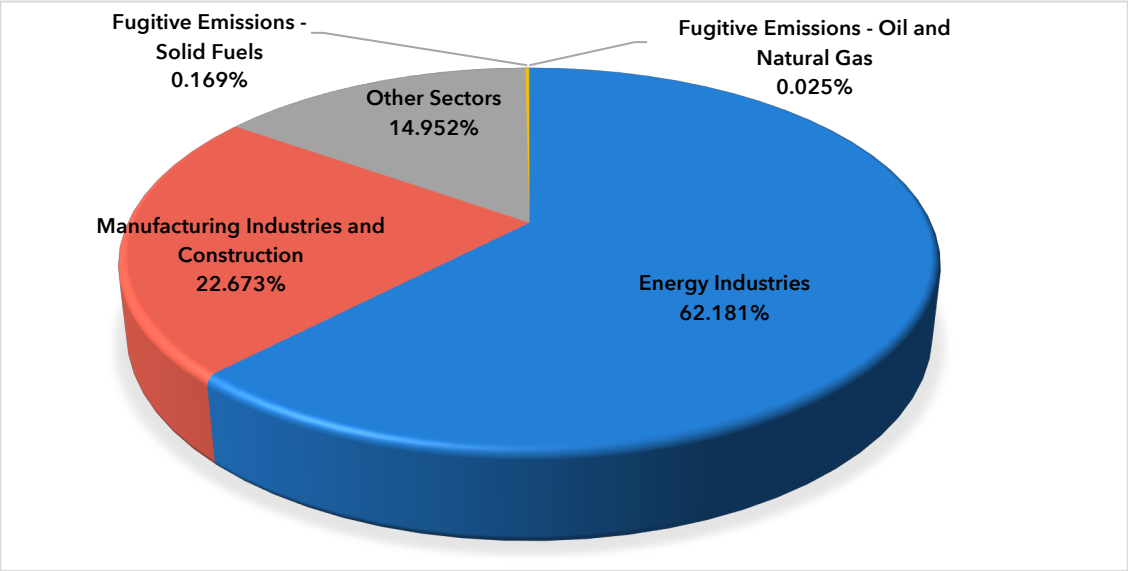
For fugitive emissions, 87% of the total came from coal mining at 0.090 Mt CO_2e in 2010, with the remaining 13% coming from oil and natural gas exploration at 0.013 Mt CO_2e.

The summary of energy sector emissions is shown in Table 3 and Figure 3.

Table 3. Summary of 2010 energy sector emissions, per subsector and per gas (values in Mt CO_2e)

	CO_2	CH_4	N_2O	Total
Energy Industries	32.803	0.049	0.168	33.020
Manufacturing Industries and Construction	11.887	0.055	0.095	12.040
Other Sectors	5.995	1.692	0.257	7.940
Fugitive Emissions – Solid Fuels	-	0.090	-	0.090
Fugitive Emissions – Oil and Natural Gas	0.012	0.001	0.000	0.013
TOTAL				*53.103*

Figure 3. Emission shares of energy subsectors, 2010 national GHGI



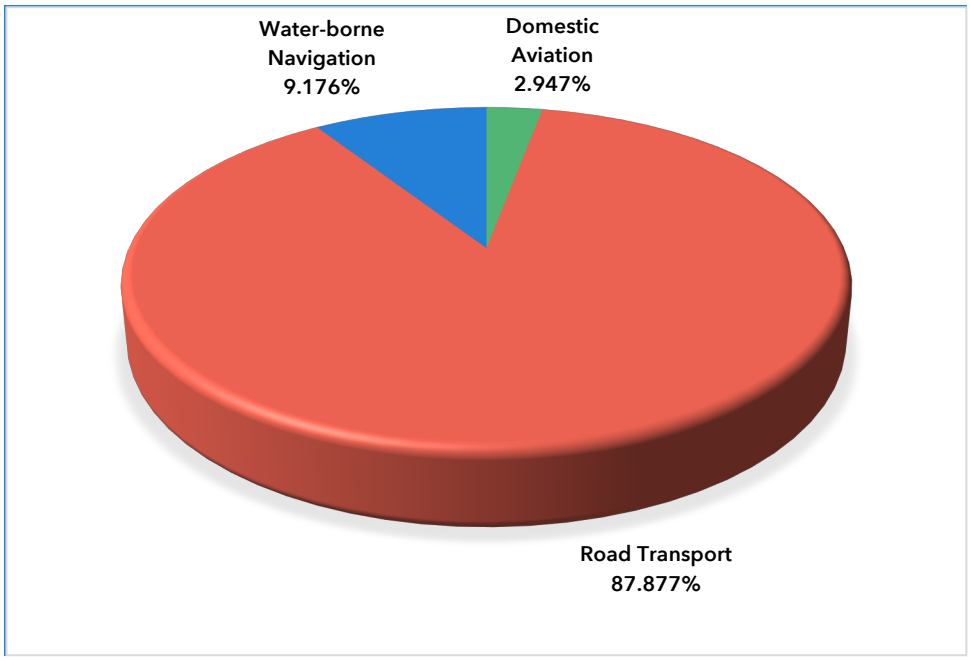
a. Transport sector

The transport sector emitted an estimated 24.174 Mt CO_2e in 2010, making it the third-largest emitting sector in the 2010 national inventory. Under the transport sector, the majority of the emissions was caused by road transportation (21.243 Mt CO_2e, 87.877% of the transport sector total), followed by water-borne navigation (2.218 Mt CO_2e, 9.176% of the transport sector total), and domestic aviation (0.712 Mt CO_2e, 2.947% of the transport sector total). These emission values are summarized in Table 4 and Figure 4 below.

Table 4. Summary of 2010 transport sector emissions, per subsector and per gas (values in Mt CO_2e)

	CO_2	CH_4	N_2O	Total
Domestic Aviation	0.706	0.000	0.006	0.712
Road Transport	20.816	0.120	0.308	21.243
Water-borne Navigation	2.196	0.005	0.017	2.218
TOTAL				24.174

Figure 4. Emission shares of transport subsectors, 2010 national GHGI



Agriculture sector

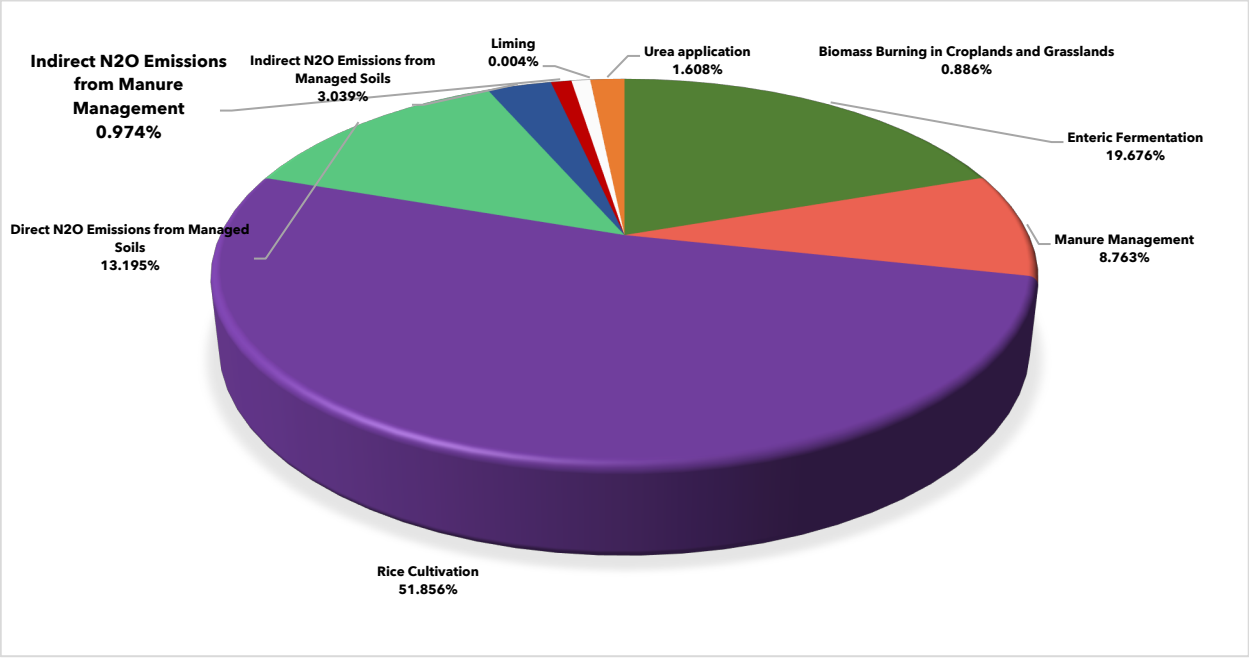
Emissions from the agriculture sector includes direct and indirect emissions by livestock and managed soils. In 2010, 43.152 Mt CO_2e was emitted by the sector, making it the second-largest emitting sector in the national inventory.

Emissions from rice cultivation is the largest contributor in the agriculture sector emissions, with an estimated 22.377 Mt CO_2e in 2010 (51.856% of the agriculture sector total). Other significant subsectors emitters were: enteric fermentation, manure management, and direct N_2O emissions from managed soils. Together, these four subsectors contributed to about 93% of the total agriculture sector emissions. Detailed emission values are shown in Table 5 and Figure 5.

Table 5. Summary of 2010 agriculture sector emissions, per subsector and per gas (values in Mt CO_2e)

	CO_2	CH_4	N_2O	Total
Rice Cultivation	-	22.377	-	22.377
Enteric Fermentation	-	8.490	-	8.490
Manure Management	-	2.699	1.082	3.781
Direct N2O Emissions from Managed Soils	-	-	5.694	5.694
Indirect N2O Emissions from Managed Soils	-	-	1.311	1.311
Direct N2O Emissions from Manure Management	-	-	0.420	0.420
Biomass Burning in Croplands and Grasslands	-	0.286	0.096	0.383
Liming	0.002	-	-	0.002
Urea Application	0.694	-	-	0.694
TOTAL				***43.152***

Figure 5. Emission shares of agriculture subsectors, 2010 national GHGI



FOLU sector

In 2010, the Philippines' FOLU sector was categorized as a net sink, with its CO_2 sequestration exceeding relevant emissions in the sector. The FOLU sector accounted for the removal of an estimated 37.007 Mt CO_2e from the atmosphere in 2010.

Biomass carbon stock from silvopasture is the main contributor to the net sequestration at -51.252 Mt CO_2e in 2010. On the other hand, loss of biomass carbon stock due to deforestation is at 16.125 Mt CO_2e in 2010. Table 6 below summarizes the emission and removals in the FOLU sub-categories.

Table 6. Summary of 2010 FOLU sector emissions, per subsector and per gas (values in Mt CO_2e)

	CO_2	CH_4	N_2O	Total
Biomass Carbon Stock Silvopasture	(51.252)	-	-	(51.252)
Biomass Carbon Stock	11.084	-	-	11.084
Biomass Carbon Stock Deforestation	16.125	-	-	16.125
Biomass Carbon Stock Agroforestry/Perennial Crop	(12.973)	-	-	(12.973)
Biomass Burning - Forests	-	0.007	0.002	0.009
	TOTAL			*(37.007)*

IPPU sector

The IPPU sector emissions is divided in to two general categories: (1) process emissions from industrial processes and (2) product use (lubricants, solvents, substitutes to ozone depleting substances). It is important to note that emissions from fuel use of industries were included in either energy or transport sector, not in the IPPU sector.

The IPPU sector was the lowest emitting sector in the 2010 national inventory at 8.363 Mt CO_2e. About 77% of this is from the mineral industry, which includes cement, lime, and glass production. More than 99% of the mineral industry subcategory emissions was from cement manufacturing. Table 7 and

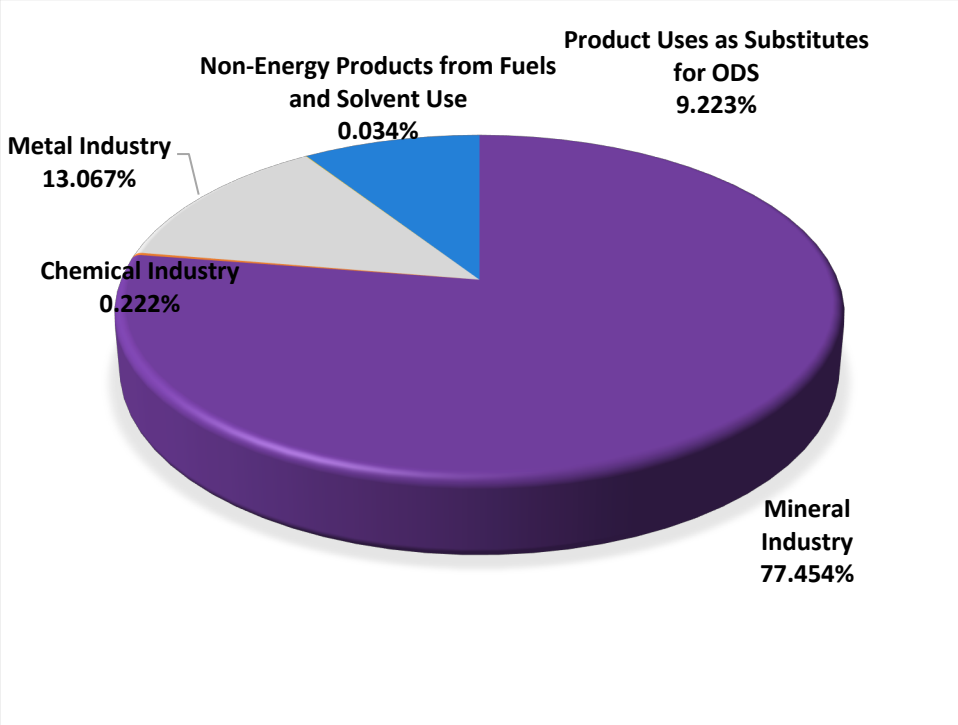
Figure **6** break down the 2010 IPPU emissions based on subcategory and GHG type.

Table 7. Summary of 2010 IPPU sector emissions, per subsector and per gas (values in Mt CO_2e)

	CO_2	CH_4	N_2O	HFCs	Total
Mineral Industry	6.477	-	-	-	6.477
Chemical Industry	-	-	0.019	-	0.019

Metal Industry	1.084	0.009	-	-	1.093
Non-Energy Products from Fuels and Solvent Use	0.003	-	-	-	0.003
Product Uses as Substitutes for ODS	-	-	-	0.771	0.771
TOTAL					*8.363*

Figure 6. Emission shares of IPPU subsectors, 2010 national GHGI



Waste sector

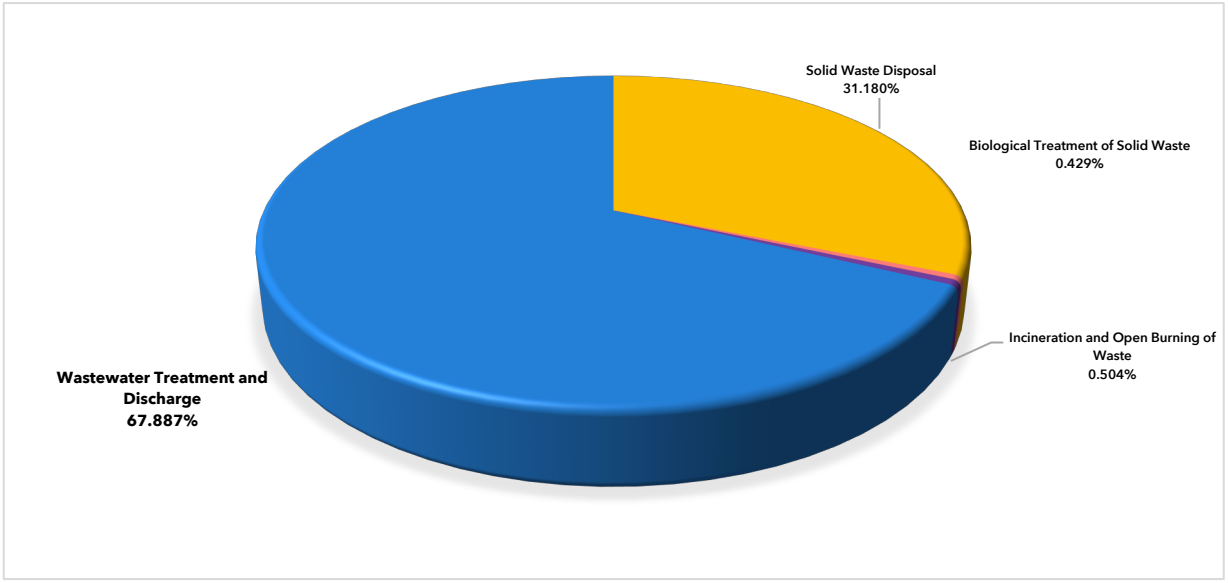
The waste sector emitted 15.559 Mt CO_2e in 2010 and is the fourth-largest emitting sector in the 2010 national inventory. Emissions from wastewater treatment and discharge made up the majority of the waste sector emissions at 67.887%, while solid waste disposal corresponded to the remaining 31.180% of the sectoral emissions. The detailed emission estimates are presented in Table 8, while Figure 7 shows the emissions share of the waste subcategories.

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

	CO_2	*CH_4*	*N_2O*	*Total*
Solid Waste Disposal	-	4.851	-	4.851
Biological Treatment of Solid Waste	-	0.035	0.032	0.067
Incineration and Open Burning of Waste	0.015	0.053	0.011	0.078

Wastewater Treatment and Discharge	-	9.588	0.974	10.562
TOTAL				*15.559*

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



Key Category Analysis

Key categories are critical subsectors of the emission sources that have a significant influence on a country's total inventory in terms of absolute emissions and removals, the trend of emissions and removals, or uncertainty in emissions and removals. The IPCC Guidelines articulates that it is good practice to identify these key categories, and use more rigorous methods of emissions and removals estimations for the key categories only in order to make the most efficient use of available resources.

Further, the IPCC Guidelines provides two quantitative methodological approaches to identify key categories, called Approach 1 and Approach 2. In Approach 1, key categories are identified using a pre-determined cumulative emissions threshold. On the other hand, Approach 2 to identify key categories can be used if category or parameter uncertainties are available. The results of Approach 2 are additional to Approach 1.

For the 2010 National GHG Inventory, Approach 1 is used to identify key categories, summarized in Table 9. Approach 2 cannot be implemented due to data gaps in uncertainty values in this inventory.

Table 9. Summary of Key Category Analysis using Approach 1 Quantitative Method

	IPCC Category Code	IPCC Category	Greenhouse Gas
1	3B1	Forest Land	CO_2
2	1A1	Energy Industries	CO_2
3	1A3	Transport	CO_2
4	3C7	Rice Cultivations	CH_4
5	1A2	Manufacturing Industries and Construction	CO_2
6	4D	Wastewater Treatment and Discharge	CH_4
7	3A1	Enteric Fermentation	CH_4
8	2A	Mineral Industry	CO_2
9	1A4	Other Sectors	CO_2
10	3C4	Direct N2O Emissions from Managed Soils	N_2O
11	4A	Solid Waste Disposal	CH_4
12	3B2	Cropland	CO_2
13	3A2	Manure Management	CH_4
14	1A4	Other Sectors	CH_4

Institutional Arrangements

Developing a comprehensive national inventory in line with the following inventory principles: transparency, accuracy, completeness, consistency, and comparability, is highly contingent on robust institutional arrangements, availability and quality of data, proper understanding of the calculation approaches, and the capacity to compile a national report. Therefore, the participation of relevant agencies as data providers consistent with their respective mandates is crucial to the success of continuous GHG inventory development.

On 24 November 2014, by virtue of Executive Order (E.O.) 174, the Philippine Greenhouse Gas Inventory Management and Reporting System (PGHGIMRS) was institutionalized in relevant government agencies. The Executive Order is envisioned to be an enabling mechanism for the country to transition towards a climate-resilient, low-carbon pathway for sustainable development.

E.O. 174 defined the roles and functions of the agencies involved in its implementation. The CCC serves as the overall lead in the execution of the provisions of the Order. On a specific note, the CCC shall:

1. Provide direction and guidance in the accounting and reporting of GHG emissions from identified key source sectors in order to develop and maintain centralized, comprehensive, and integrated data on GHGs;
2. Develop a system for the archiving, reporting, monitoring, and evaluating GHG inventories in all key sectors; and
3. Provide and facilitate continuous capacity building initiatives in the conduct of GHG inventories to ensure application of updated methodologies.

Further, the Executive Order identified the lead agencies tasked to conduct, document, archive, and monitor sector specific GHG inventories and report to the CCC:

1. The Department of Agriculture and the Philippine Statistics Authority are the lead agencies for the Agriculture sector.
2. The Department of Energy is the lead agency for the energy sector.
3. The Department of Environment and Natural Resources is the lead agency for the waste, industrial processes, and forestry and other land-use sectors; and
4. The Department of Transportation is the lead agency for the transportation sector.

In service to E.O. 174, lead sectoral agencies established their GHG teams internal to their respective institutions through Department/Special Orders (DO/SO). This is summarized in Table 10 below.

Table 10. Department and Special Orders Establishing GHG Teams of E.O. 174 Agencies

Agency	Sector	DO/SO	Description	Approval Date
DENR-EMB	Waste, Industry	SO No. 2016-297	Creation of the EMB GHGI Team for the Implementation of EO 174 Institutionalizing the PGHGIMRS	14 July 2016
DENR-FMB	Forestry and Other Land Use	SO No. 2016-154	Creation of a TWG Integrating Work in the Preparation of Technical and Reporting Requirements to all Forest-related UNFCCC-COP Decisions and Agreements	27 May 2016
DOE	Energy	DO No. 2018-03-005	Institutionalization of the GHG Inventory Team of the Energy Sector	27 March 2018
DOTr	Transport	DO No. 2018-001	Institutionalization of the GHG Inventory Team of the Transport Sector (Air, Rail, Water, and Road)	10 January 2018
PSA	Agriculture	SO No. 2017-10NS-1499	Reconstitution of the GHG Inventory Team	04 October 2017

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The 2006 IPCC Guidelines for National Greenhouse Gas Inventories, United Nations Intergovernmental Panel on Climate Change, 2006.

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Climate Change Commission