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Third Biennial Update Report

Under the United Nations Framework Convention on Climate Change

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Foreword

Indonesia has a prevailing commitment on the implementation of Paris Agreement. Following up the Paris Agreement Work Program or Katowice Climate Package, Indonesia has continued its efforts and actions to strengthen the commitment as a Non-Annex I Party to the United Nations Framework Convention on Climate Change (UNFCCC) through a number of policies, measures and actions to implement a comprehensive nationwide response to climate change, while ensuring the national development in a sustainable manner.

Subsequent to Indonesian First Nationally Determined Contribution (NDC) that has submitted in 2016, Indonesia reinforces its contribution to the global climate as stated in Indonesia Updated NDC, submitted to the UNFCCC in 2021. In addition, responding to the mandate of Paris Agreement that Parties are invited to envisage a long-term climate vision under a half century of strategy on low GHG emission, Indonesia has also submitted Long-Term Strategy for Low Carbon and Climate Resilience 2050. Those documents have reflected the conformity to contribute to the long-term goals of Paris Agreement and national development objectives, taking into account the transformation of our economy, social, and environmental development.

Associated to those documents, a transparent, accurate, comparable, complete, and consistent reports are required to inform the actual achievements of Parties. Thus, responding to this requirement and inline with the mandate of Conference of Parties (COP) 17 Decision (Decision 2/CP 17) Para 41 to non-Annex I Parties, Indonesia reports the updated status up to 2019 through this document, namely Indonesia Third Biennial Update Report, including the Technical Annex on REDD+.

Finally, I would like to extend my appreciation to representatives of Ministries, sub- national government, academic communities, private sectors and civil societies, international agencies, for their contribution in preparing the Third Biennial Update Report.

Dr. Siti Nurbaya

Minister for Environment and Forestry

Preface

Responding to Conference of Party's mandate on Decision 2/CP. 17 Annex III, Indonesia has presented its Third Biennial Update Report (3rd BUR) which conforms the UNFCCC guidelines for Non-Annex I to the Convention. Indonesian 3rd BUR was prepared through a series of development process as a result of coordination from related ministries and institutions, scientists and experts specializing in different disciplines, and has been coordinated by the Ministry of Environment and Forestry.

Indonesia 3rd BUR is an update of Indonesia 2nd BUR, which contains of some updates and improvements on National Circumstances; National GHG Inventory Report of Anthropogenic Emissions by Sources and Removal and Sinks; Information on mitigation actions and their effect; Information on Constraints and Gaps Related to Financial, Technical and Capacity Needs and Received; also updated on Domestic Monitoring Reporting, and Verification. Along with this document, the information on Technical Annex REDD+ has became an inseparable part.

Lastly, I would like to acknowledge a high appreciation to all relevant ministries, institutions, and experts who were on solid team in preparing this document.

Ir. Laksmi Dewanthi, MA., IPU.

Director General of Climate Change

EXECUTIVE SUMMARY

Indonesia, as a Non-Annex I Party to the United Nations Framework Convention on Climate Change (UNFCCC), fulfils one of its commitments to implement the Convention by presenting its First National Communication in 1999, Second National Communication (SNC) in 2010, First Biennial Update Report in 2016, Third National Communication (TNC) in 2017, and second Biennial Update Report (2nd BUR) in 2018. Following Decision 2/CP.17, Indonesia hereby submits its third Biennial Update Report (3rd BUR). This third BUR consists of updates on national greenhouse gas inventories, including a national inventory report and information on mitigation actions, needs and supports received.

This BUR document is supported by GIZ, with additional fundings from the Government of Indonesia and other donors. The preparation process of the third BUR includes consultations with line ministries, academics, and private sectors, to seek opinions and points of views on the elements of the updates that would require improvement in this assessment.

As requested, Indonesia's third BUR is prepared consistent with the UNFCCC reporting guidelines on BUR. Chapter 1 on National Circumstances and Institutional Arrangement, provides information on the updates of Indonesia circumstances and institutional arrangement as the basis for the second BUR development. Chapter 2 on National GHG Inventory, provides information on greenhouse gas emissions and trends between 2000 and 2016. Chapter 3 on Mitigation Actions and Their Effects, reports the progress made toward achieving the GHG emission reduction targets and mitigation actions carried out to achieve the targets. Chapter 4 on Domestic of Measurement, Reporting, and Verification, describes the institutional structures for MRV and MRV process in Indonesia. Chapter 5 on Finance, Technology and Capacity Building Needs and Support Received, reports information on the financial, technological, and capacity building needs and supports received related to the implementation of climate change measures. In addition, the report also includes the REDD+ Technical Annex pursuant to Decision 14/CP.19.

1.1. National Circumstances

Indonesia is located between 6^0 04' 30'' North Latitude and 11^0 00' 36" South Latitude and between 94^0 58' 21" and 141^0 01' 10" East Longitude along the equatorial line covering an area of approximately 8.3 million km^2 with a total coastline length of about 108 hundred km^2 and land territory of about 1.92 million km^2 (BIG, 2018).

Indonesia's population at the end of 1990 was 179,139,000 (BPS 1991) and 237,641.3 at the end of 2010. It has increased by an annual average of 1.49% between 2000-2010 and slows down at 1.25% between 2010-2020, when the population totalled to 270,203.9 million in 2020.

During the period of 2015 – 2020, there was a population structural shift from agriculture to other economic sectors, has become apparent and reflected in the share of each sector to GDP. In 2020, the major contributors to the country's GDP are the manufacturing sector (19.88% of GDP) and agriculture (13.70%). Between 2015 and 2019, the GDP grew at an average of nearly 5.04% per annum and at 2020, it decreased to -2.52% with GDP per capita at 56.9 million compared with IDR 45.1 million in 2015. The global economy contracted very sharply in the latter half of 2019 and slid into a deep recession in 2020, which was triggered by the pandemic COVID-19.

1.2. National GHG inventory

The National Greenhouse Gases Inventory was estimated using Tier 1 and Tier 2 of the 2006 IPCC Reporting Guidelines and the IPCC GPG for LULUCF. In 2019, the total GHG emissions for the three main greenhouse gases (CO_2, CH_4 and N_2O) reached 1,845,067 Gg CO2e. The main contributing sectors were AFOLU including peat fires (50.13%) followed by energy (34.49%), waste (6.52%), and IPPU (3.15%). The GHG emissions (in CO_2 equivalent) were distributed unevenly between the three gases at 85.51%, 10.86% and 3.62% for CO_2, CH_4 and N_2O respectively (Table 1).

Table 1. Summary of National GHG emissions in 2000 and 2019 by gas (Gg CO_2e)

No	Sectors	Year	CO_2	CH_4	N_2O	CF_4	C_2F_6	CO	NOx	NMVOC	SOx	Total 3 Gases
1	Energy	2000	284,503	29,728	3,378			NE	NE	NE	NE	317,609
		2019	615,262	16,464	4,726			NE	NE	NE	NE	636,453
2	IPPU	2000	42,401	98	149	250	22	NO	NO	NO	NO	42,648
		2019	57,252	91	784	46	0	NO	NO	NO	NO	58,128
3	Agriculture	2000	4,710	39,940	39,888			2,737	74	NE	NE	84,537
		2019	7,343	46,407	51,552			2,436	66	NE	NE	105,301
4	FOLU	2000	529,815	1,505	1,040			NE	NE	NE	NE	532,360
		2019	910,280	8,527	6,045			NE	NE	NE	NE	924,853
5	Waste	2000	2,216	57,431	2,544			NE	NE	NE	NE	62,191
		2019	3,026	113,702	3,606			NE	NE	NE	NE	120,333
Total (CO_2-eq)		2000	863,645	128,702	46,998	250	22	2,724	70	0	0	1,039,345
		2019	1,593,163	185,191	66,713	46	0	1,500	41	0	0	1,845,067
Percentage (%)		2000	83.10	12.38	4.52	-	-	-	-	-	-	100.00
		2019	86.35	10.04	3.62	-	-	-	-	-	-	100.00

NE = Not Estimated; NO = Not Occurring

In 2019, the national GHG emissions reached 1,845,113 Gg CO_2e for 5 gases (CO_2, CH_4, N_2O, CF_4, and C_2F_6) or 1,845,067 Gg CO_2e for 3 gases (CO_2, CH_4, N_2O). This figure was 805,496 Gg CO_2e higher than emissions in 2000 and significantly higher than in 2018, which was at the level of 1,592,708 Gg CO_2e. The average of total emissions from 2000 until 2019 was to 1,188,161 Gg CO_2e, reached an all-time high of 2,339,651 Gg CO_2e due to a prolonged El Nino in 2015, and recorded as the lowest of 490,336 Gg CO2e in 2001. Trend of national GHG emission by sector 2000-2019 is given in Figure 2.

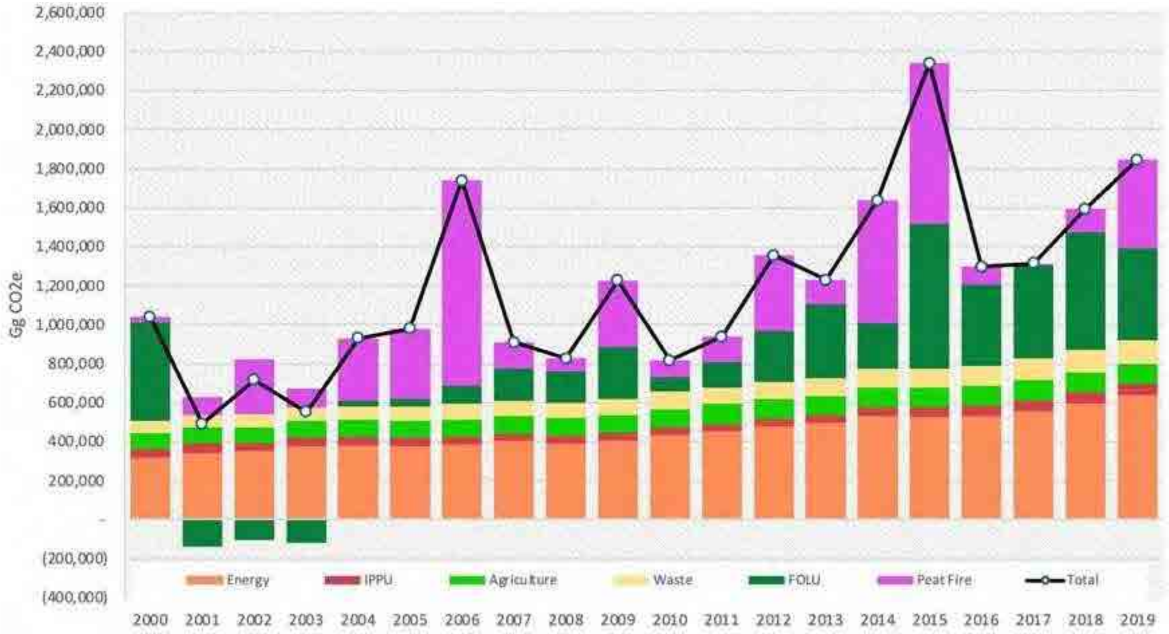

Figure 2. National GHG Emissions Trend (incl. peat fire) in 2000 – 2019

There are 17 key source categories. The dominant source is AFOLU sector (including peat fire). The first four main categories were (i) peat fire, (ii) peat decomposition, (iii) forest land, (iv) energy industries with cumulative emissions as much as 58.65% of the total emission of all sectors in 2016. Meanwhile for key category analysis with exclusion of forest and other land use (FOLU) sector (including peat fire), the first four main categories were (i) energy industries, (ii) transportation, (iii) manufacturing industries and construction, and (iv) wastewater treatment and discharge with cumulative emissions as much as 25.80% of the total emissions excluded FOLU and peat fire in 2019.

1.3. Measures to Mitigate Climate Change and Effect

Indonesia in its NDC commits to reduce the GHG emissions with unconditional target of 29% and conditional target of up to 41% from the BAU emission by 2030. To achieve the GHG emission reduction target, Indonesia focuses its programme on two sectors, i.e., land use change and forestry (LUCF) and energy sector. Both sectors are expected to contribute to around 28.2% of the total national emission reduction target that account for 811 M tonne CO_2e or 28.2% below the baseline 2030 and the rest are contributed by agriculture, IPPU and waste sectors (Table 2). The progress of the achievement of national GHG emission mitigations implementation is assessed by comparing the national GHG emissions level in the year of implementation with the baseline GHG emissions level of unconditional target of the Indonesia NDC. Achievements of national mitigation based on calculations covering 5 sectors (energy, IPPU, forestry, agriculture, and waste) showed that the GHG emissions level in the period 2017 – 2019 fall below the baseline level (Figure 3). In 2017, the estimated emission decreased from the baseline by about 389,000 Gg CO_2e. This was mainly due to the significant decreased in emission from FOLU sectors, specifically emission from peat fire. In 2018, the decreased in emission was due lower emission level compared to baseline in all sectors, with highest contribution from energy sector, amounted to 155,000 Gg CO_2e (Figure 4). However, in 2019, peat fire emission from FOLU sector increased again higher than the baseline level, hence, made 2019 as the year with the lowest emission reduction, amounted to 39,000 Gg CO_2e.

Table 2. GHG emissions level in the BAU, CM1, and CM2 NDC Target

No.	Sector	2010	2030			By Sector (%)	
		Base year	BAU	CM1 (29%)	CM2 (up to 41%)	CM1 (29%)	CM2 (up to 41%)
1	Energy*1	435	1,669	1,356	1,271	11%	14%
2	IPPU	36	69	66	66	0.1%	0.11%
3	AFOLU	757	833	327	152	18%	24%
3.a	Agriculture	110.51	119.66	110.51	115.84	0.32%	0.13%
3.b	Forestry*2	647	714	217	36	17.3%	24%
4	Waste	88	296	284	269	0.40%	1%
	Total	**1,316**	**2,868**	**2,034**	**1,759**	**29%**	**38%**

For energy sector, based on the difference between baseline emission and GHG inventory, it was found that the GHG emission reductions achieved in 2017, 2018 and 2019 reached 129,844 Gg CO_2e, 157,337 Gg CO_2e and 186,932 Gg CO_2e respectively. The reduction in 2019 has exceeded the targeted emission reduction under the NDC CM1. While, based on the emission reduction report of the Ministry of Energy and Mineral Resources (MEMR), the emission reduction obtained from implementing various mitigation actions in 2017, 2018 and 2019 reached 50,710 Gg CO2e, 54,668 Gg CO2e and 64,717 Gg CO2e respectively. These reductions are primarily from 6 groups of activities i.e., (i) end use energy efficiency measures through activities related to energy conservation and audits, (ii) fuel switch to less carbon emission fuel in residential and transport sector, (iii) use of renewable energy for power generation, (iv) deployment of Clean Coal Technology (CCT), (v) utilisation of biofuel and (vi) use of alternative fuels in industry. It should be noted that the emission reduction from alternative energy use in industry is reported by Ministry of Industry (MoI).

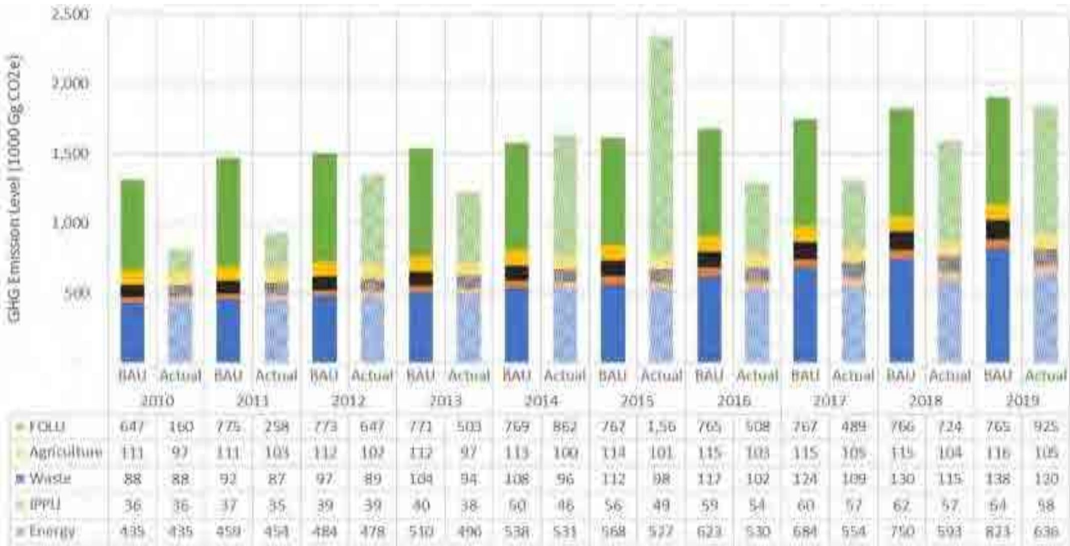

Figure 3. National GHG emissions (by sector) and the corresponding baseline, 2010 - 2016

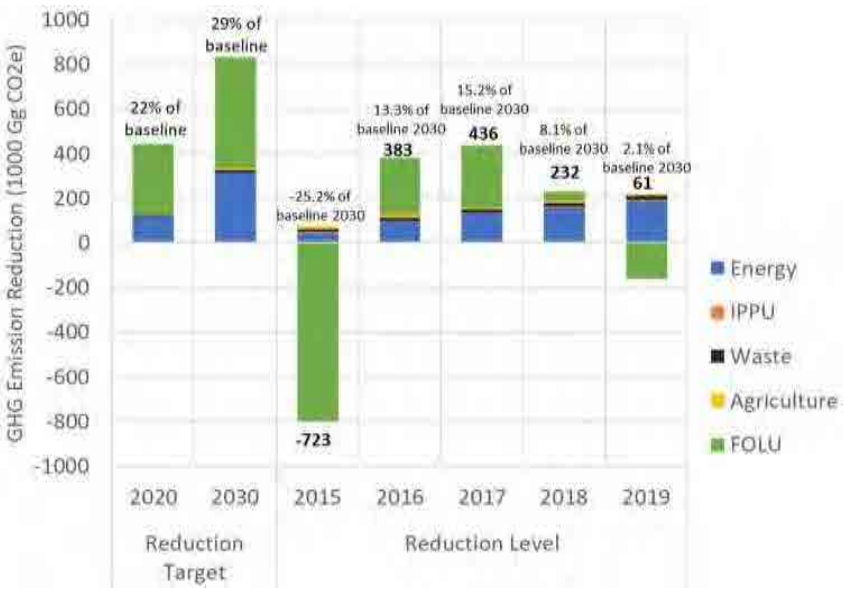

Figure 4. GHG emissions reduction by type of mitigations sector in 2015 and 2016 compared to GHG emissions reduction target of each sector under the NDC in 2030

Based on the emission reduction report of the Ministry of Transportation (MoT), in 2017, 2018 and 2019 the sector has reduced the emissions by 2,223 Gg CO2e, 3,001 Gg CO2e and 4,674 Gg CO2e, respectively. The mitigations activities in this sector are in the form of enhancement of transport efficiency and the increased use of zero and/or low emitting alternative fuels. The activities that have been implemented and resulted in large emission reduction are construction and utilisation of railways, renewal of airplanes, flight operation efficiency improvement, performance-based navigation (PBN), utilisation of effective traffic control, development of mass road transport and development of long-distance ferry in 2019.

The contribution of the Non-Party Stakeholders in meeting the NDC target has not yet been encompassed. The Government of Indonesia is still in the process of improving the National Registry System and MRV to ensure that all mitigation activities implemented by the Party Stakeholders (PS) and Non-Party Stakeholders (NPS) can be captured and reported. Contribution of the NPS in meeting the NDC emission reduction targets will be included in the next submission, if applicable.

1.4. Finance, Technology and Capacity Building Needs and Support Received

Support Needs

The Government of Indonesia requires financial, technology and capacity building supports, particularly for achieving the national emission reduction target of up to 41%. For unconditional target, the Government of Indonesia has committed voluntarily to reduce its emission by 29% in 2030, suggesting that Indonesia required financial, technology and capacity building needs supports to meet the targets.

Financial Needs

To meet the conditional target by 2030 in the NDC, the financial needs from 2018-2030 is estimated to be about USD 285 billion (IDR 3,990 trillion using IDR 14,000/USD exchange rate). This is a conservative estimation on the financial need to meet the Counter Measure 2 (CM2)

Scenario or conditional targets. The estimation is based on the projected financial needs using the existing public climate financing (government expenditure) coupled with the estimated financial needs for specific interventions in waste and IPPU sectors which would normally be done by the private sectors. Estimation on the projected financial requirements will be affected by data used and the accuracy of the current government expenditure on climate actions (baseline). In addition, updates to the government's current climate financing are central to ensure consistency in government expenditure codes under the dynamic government administration.

Technology Needs

Technology needs for achieving the NDC targets are grouped into four sectors namely energy, IPPU, AFOLU and waste. Within the energy sector, the technology needs are summarised in Table 3.

Table 3 Mitigation technology needs of Indonesia's energy sector

No	Sub-sector	Technology
1	Transport	Improvement of public transport; CNG; Intelligent Transport System
2	Power Generation	PV & Pump Storage; Geothermal Power Plant; Advanced Coal Power Plant; Landfill Gas Power Plant; Biomass fuelled power plant; Wind power; Biofuel; Biogas POME
3	Industry	Efficient Electric Motors; Combine Heat and Power; Pump and Fan System; WHB (Waste Heat Boiler); Alternative Fuel; Green Boiler; Green Chiller; Advanced Furnace
4	Building (Residential and Commercial)	Combine Heat and Power; WHB; Efficient Lighting; Green Building; Green Boiler; Green Chiller; Efficient Electric Motors; Gas pipeline network; Solar PV; Solar Water Heater

Mitigation actions in IPPU are carried out in cement, ammonia-urea, aluminium and nitric acid industries. To meet the NDC target, the mitigation actions carried out in these industries are:

a. Cement industry – reduction of clinker/cement ratio to produce blended cement.
b. Aluminium industry – reducing anode effect using ALCAN ALESA Process Control.
c. Nitric acid industry – use of secondary catalyst in Ammonia Oxidation Reactor to reduce N_2O.
d. Ammonia-urea industry – (i) efficiency improvement in conversion of CO to CO_2, (ii) efficiency improvement in CO_2 absorption in scrubber (iii) efficiency improvement in the methanation of CO_2 residue for syn-gas purification.

AFOLU sector are the main contributor of GHG emission in Indonesia. The main sources of emissions are from deforestation and forest degradation, peat decomposition including land and forest fires. The main challenge to accurately measure the achievement of the implementation mitigation actions in this sector is the reliability of monitoring system to detect the change of land covers and to measure emission from peat. The key technology needs for this sector include:

a. Technology for integrated forest-peat carbon measurement and monitoring,
b. Technology for peat land re-mapping,
c. Technology for peat water management,
d. Methodology to determine the peat area affected by fires including to estimate the depth of peat burn (the burnt area and peat depth with an accuracy of 5 cm),
e. Technology for sustainable intensification practices,
f. Technology for developing high yielding varieties, balanced fertiliser application, technology for restoring soil fertility, and
g. Technology for increasing grassland productivity for animal feed.

Waste sector mitigation actions for meeting the NDC targets consist of two groups namely treatment of MSW and treatment of domestic liquid waste LFG recovery in landfills, (composting, 3R (inorganic), and waste to power and heat). The technology needs for waste sector are associated with the mitigation actions presented in the Table 4 below.

Table 4 Mitigation technology needs of Indonesia's waste sector

No	Technology	Remarks
1	Sanitary Landfill and LFG recovery	MSW to gas fuel
2	Semi Aerob Landfill and LFG recovery	MSW to gas fuel
4	In-Vessel Composting	MSW to gas fuel
5	Bio digester - Low Solid	MSW to gas fuel
5	Bio digester - High Solid	MSW to gas fuel
6	MBT (Mechanical Biological treatment) -	Integrated organic and inorganic waste treatment
7	Thermal Conversion: Mass-fired combustion	MSW to power or incineration
8	Thermal Conversion: RDF-fired combustion	MSW to power or incineration
9	Thermal Conversion: Fluidised bed combustion	MSW to power or incineration
10	Gasification technology: Vertical fixed bed	MSW to power or incineration
11	Gasification technology: Fluidised bed	MSW to power or incineration
12	Pyrolysis technology: Fluidised bed	MSW to power or incineration
13	Composting (open window system)	Composting
14	Aerated, centralised domestic liquid waste treatment (IPAL)	Aeration reduces GHG emission
15	Integrated domestic liquid waste treatment (IPLT)	Reduce GHG emission by treating sludge recovered from septic tanks

Capacity Building Needs

For an effective implementation of the mitigation actions, sectoral ministries (party actors), privates and communities (non-party actors) require capacity building. In addition, awareness rising activities need to be implemented, as an integrated way to achieve climate change objectives. The capacity building needs for different level of stakeholder are the following:

a. Capacity development for party and non-party actors to increase their knowledge and understanding on mitigation actions and capacity for translating NDC target into mitigation actions and access to climate finance.
b. Capacity of local governments and private (non-Party actors) in integrating climate change actions into their long-term plan and programmes.
c. Capacity of private sectors to implement mitigation actions includes the use of renewable energy, green building design, zero plastic use, and the use of environmentally friendly materials.
d. Capacity of governments and non-government agencies to carry out GHG inventory and MRV.
e. Awareness and knowledge of agent of changes (religious leaders or ulama, young generation, extension services, journalist etc).

Support Received

Indonesia has closely coordinated its relevant ministries, organisations, companies, and local governments, and continued to enhance collaboration with international organisations and international initiatives for receiving supports in climate change activities.

Financial

Indonesia has received support fund from the GEF for the development of 1st Biennial Update Report (1st BUR) and TNC at the amount of 4.5 million USD, from GIZ and JICA at the amount of 150,000 and USD 6,122,040 respectively to support the development of 1st BUR and TNC. Indonesia also provided Co-Finance for supporting various activities related to the development of the 1st and TNC at the amount of about 21 million USD (MoEF, 2016). For the development of the 2nd BUR, Indonesia provided additional funding at the amount of about USD 40,000 and gained some support from the Government of Norway at the amount of about USD 40,000. For the development of Indonesia BUR 3, Indonesia has received support from GIZ and own state funding of Government of Indonesia. GIZ provided an amount of USD 34,554 for the drafting of Indonesia BUR 3.

In the period of 2015-2016, Indonesia has received financial supports for the implementation of climate actions from various countries and development agencies at an amount of about 1.86 billion USD. The financial supports are mostly in the form of concessional loan and only few as grants. In the 2017-2019 period afterwards, financial support has reached USD 18.21 million. Approximately 89% of the support is in mitigation, i.e., USD 16.15 million (Table 5). Financial support is mainly in the form of grant received by the Directorate General of Climate Change, MoEF. Some of the financial support received is unreported in this BUR 3 due to data limitations. About USD 3,733.32 of the total financial resources were supported by bilateral (78.8%) and multilateral (21.2%) agreements (Table 5).

Table 5 Financial support received for mitigation action in the period 2017-2019 (in million USD)

Financial Instrument	***Sector***	***Bilateral***	***Multilateral***	***Total Received****	***Total Agreement***
Concessional Loan	*Energy*	-	-	-	*1,482.21*
	Transportation	-	-	-	*1,528.56*
	Waste	-	-	-	*147.80*
Sub-total		**-**	**-**	-	***3,158.57***
Grant	*Agriculture*	-	-	-	
	Multi sector	*2.40*	*10.88*	*13.27*	*395.62*
	Energy	-	-	-	*35.06*
	Forestry	-	*2.88*	*2.88*	*137.15*
	Transportation	-	-	-	*1.3*
	Waste	-	-	-	*4.13*
Sub-total		***2.40***	***13.75***	***16.15***	***573.26***
Total		***2.40***	***13.75***	***16.15***	***3,731.83***

*Total received based on funding track by MoEF
Source: MoEF, data processed, 2021

Technology

In term of technology and supports received in the period of up to 2020, Indonesia has received technology supports from various countries and international organisations. The technology supports are received through the implementation of pilot projects in applying low carbon technologies and monitoring technologies in various sectors. Some of the technology supports received is provided in Table 6.

Table 6. Some examples of technology transfer received

No.	Country-specific technology needs	Assistance received from developed country Parties	Time frame	Institution
1.	*Technical assistance supporting Jakarta's transition to e-mobility*	*Climate Technology Centre and Network (CTCN)*	*2020*	*Directorate General of Climate Change Management, Ministry of Environment and Forestry (DG CCM, MoEF)*
2.	*Development of technical needs assessment*	*Climate Governance, GIZ*	*2020*	*Directorate General of Climate Change Management, Ministry of Environment and Forestry (DG CCM, MoEF)*
3.	*Development of technology needs assessment concept for non-land based*	*Climate Governance, GIZ*	*2018-2019*	*Directorate General of Climate Change Management, Ministry of Environment and Forestry (DG CCM, MoEF)*
4.	*Chillers using hydrocarbon*	*Germany*	*2018*	*Directorate General of Renewable Energy and Energy Conservation, Ministry of Energy and Mineral Resources*
5.	*Prototype of energy efficiency for flat/low carbon for Indonesian tropical Cclimate in Tegal City*	*Japan*	*2018*	*Directorate General of Housing, Ministry of Public Works and Housing*

Resources: Data from MoEF

Capacity Building

The assessment on capacity building received was conducted with input from Indonesian ministries/agencies, local governments, the private sector, and NGOs. It includes 6 areas of interest: 1) Education, 2) Training, 3) Public awareness, 4) Public participation, 5) Public access to information, and 6) International cooperation as the implementation of Action for Climate Empowerment (ACE) by UNFCCC under Article 12 of the Paris Agreement. Over the period of 2014-2020, a study of capacity building baseline related to NDC implementation has been conducted by Directorate General of Climate Change, MoEF. Those activities have been identified as enhancing and enabling activities for climate mitigation and adaptation actions. There are total sample of 1,153 of capacity building activities, mostly from energy sector (44%). Other activities are identified in forestry (27%), waste (16%), agriculture (8%), and IPPU (4%) sector. The gap between sectoral capacity building activities that have been conducted for NDC actions may also be limited by unreported data from each sector.

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CHAPTER 1. NATIONAL CIRCUMSTANCES AND INSTITUTIONAL ARRANGEMENT

1.1 National Circumstances

1.1.1 Geographical Profile

Situated in a very unique position, Indonesia lies between two large oceans, the Indian and Pacific Oceans and bridges two continents, Asia and Australia. It is located between 6^0 04' 30'' North Latitude and 11^0 00' 36" South Latitude and between 94^0 58' 21" and 141^0 01' 10" East Longitude along the equatorial line located at exactly 0^0 latitude (BPS 2021). In such a strategic position, Indonesia is the largest archipelagic country in the world, comprised of 34 provinces with the islands stretching along the equator of which are influenced by typical climate condition. Identification, verification, and standardization of island names has been listed in the National Gazetteer, with a total of 16,671 verified and standardized named islands, as of 2018 (UNGEGN 2019). West Papua is the province with the greatest number of islands (4,108 islands) (BPS 2021). With a combined land area of 191,690,677 hectares (Ministry of Internal Affairs Decree No. 72 of 2019*)*, Indonesia has the second longest coastline in the world (95,181 km), with an area of marine waters reaching 5.8 million square kilometers, making up about 71% of the total area of Indonesia (http://kkp/go.id). Map of Indonesia is shown below in Figure 1-1.

Figure 1-1. Map of Indonesia (Source: www.mapofworld.com)

As an archipelago comprising large continental-shelf islands and oceanic islands, Indonesia captures a wide range of biotic variation (it spans two zoogeographical regions, dry and ever-wet tropics), and its ecosystem variation ranges from tropical glacier to mangrove (Jepson and Whittaker 2002). There are seven (7) major biogeographic regions in Indonesia, centered on the major islands and their surrounding seas (Direktorat Pencegahan Dampak Lingkungan Kebijakan Wilayah dan Sektor *dalam* PKTL, 2019). Conservation International considers Indonesia to be one of the 17 "megadiverse" countries, with 2 of the world's 25 "hotspots", 18 World Wildlife

Fund's "Global 200" ecoregions and 24 of the Bird Life International's "Endemic Bird Areas". It also possesses 10% of the world's flowering species (estimated 25,000 flowering plants of which 55% are endemic) and ranks as one of the world's centers for agrobiodiversity of plant cultivars and domesticated livestock. For fauna diversity, about 12% of the world's mammals (515 species) occur in Indonesia, placing it second after Brazil; about 16% of the world's reptiles (781 species) and 35 species of primate place Indonesia fourth in the world; 17% of the total species of birds (1,592 species) and 270 species of amphibians' place Indonesia in the fifth and sixth ranks, respectively, in the world (Convention on Biological Diversity, https://www.cbd.int/countries/profile/?country=id).

In addition to the wealth of biological diversity, Indonesia's unique geology and tectonics give Indonesia its very rich geological diversity. Besides being situated between two oceans and two continents, geologically and tectonically, the Indonesian Archipelago is sandwiched among three giant Earth plates: the Eurasian Plate, the Pacific Plate and the Indian-Australian Plate in Papua. Indonesia also sits in an environment of tectonic condition where oceanic crust subducted beneath the continental crust, generally producing a wide range of strato volcanoes, the volcano that form layered products of lava and pyroclastic. Strato volcano type is generally characterized by its conical shape. In the ranks of the world's volcanoes, Indonesia, is located on what is known as the *Ring of Fire*, a series of volcanoes that surrounds the Pacific. Located on the Ring of Fire, such condition is blessings for the formation of minerals and metals through the formation of magma intrusions, or the formation of basin sediment-carrying deposits of oil-gas and coal. Indonesia's natural settings have produced various landforms and terrains, which could bring disaster with devastating earthquakes, tsunami that hit coastal areas, volcanic eruptions that devastated the areas around its body, intensity and repetitive ground movements and landslides, or widespread flash flooding. Native ecosystems, agriculture and tropical forestry are Indonesia main land uses (Figure 1-2 and Figure 1-3).

Indonesia identified that a big portion of its emission (63%), one of which is caused by land use change (Directorate General of Climate Change Control – MoEF, 2016). Changes in land use up to 2019 are shown in Table 1-1. Areas compensated for forest shows a higher total area than conversion of forest into non forest land uses.

Table 1-1. Forest land use changes in Indonesia in 2019 (ha)

Year	Settlement	Other Non-Forest Uses	Compensated Area for Forest	Conversion of Forest Area into Non-Forest
Up to 2014	893,851.07	6,635,882.32	24,710.64	16,890.45
2015	-	106,283.75	1,467.81	1,380.42
2016	3,774.43	63,660.04	13,828.32	13,006.17
2017	195.76	233,071.11	4,781.38	2,335.96
2018	-	76,719.08	75.17	41.19
2019	2,772.46	5,276.18	28,811.39	28,140.11
Up to 2019	897,302.71	7,190,892.48	73,674.71	61,794.30

Note : - = none/no activity. (Source: MoEF, 2020)

1.1.2 Climatic Profile

Indonesia is generally dominated by a tropical rainforest climate. Due to the presence of warm waters around these islands, the country's temperatures are fairly constant over the year, around 28°C for the coastal plains, 26°C for the mountain areas, and 23°C for higher mountains. Rainfall varies between 1800 and 3200 mm for the lowlands, increasing with elevation, up to 6,000 mm in some mountain areas. Most rainfall occurs during the wet season that lasts from November to April (with a rainfall peak in January and February). The dry season lasts from May to October (with July-September as driest months). Indonesia is located in a disaster-prone area, which, according to the Act No. 24 of 2007 concerning Disaster Management, make Indonesia prone to various types of natural disasters, including earthquakes, tsunamis, volcanic eruptions, floods, droughts, typhoons and landslides.

There are two major seasons, the dry season from May to September and the rainy season between October and April. Monsoon dominates Indonesia's climate, which give a degree of homogeneity across the region. Indonesia lies across the range of the Inter-Tropical Convergence Zone (ITCZ) where the northeast and southeast trade winds penetrate the doldrums. Strong ascending motion, overcast skies, strong squalls, heavy rainfall, and severe local thunderstorms with variable intensities are characteristics of this zone (TNC 2017).

There are three types of rainfall pattern in Indonesia (Aldrian and Sutanto, 2003), i.e.: 1. Monsoon rainfall with a monthly rainfall peak in December; 2. Equatorial rainfall characterized by two monthly rainfall peaks, in March and October; and 3. Localized rainfall pattern in the eastern equatorial part of the country with a monthly rainfall peak in July-August. Overall, these three types of rainfall have resulted in a wet season that varies in length from as long as 280 to 300 days to as short as 10 to 110 days, with rainfall varying from 4,115 mm to as low as 640 mm. The spatial distributions of the rainfall changes vary across months, and within the same island. For example, the increase of rainfall over land areas during the wet season is dominantly found in January especially over Sumatra and Kalimantan and in February over Sumatra. In contrast, the rainfall climatology over both Islands decreases during December. Similarly, the decrease of rainfall during the dry season in June-August, for Java Island, for example, occurs mostly in August.

Rainfall has a strong influence on the quality of human life in this case related to the availability of water resources for consumption and agricultural needs. If the rainfall takes place with high intensity, in a short time it will cause disaster. The National Agency for Disaster Management (BNPB) report mentions that disaster trends in Indonesia are increasing year by year. The disaster of 2016 was the highest recorded in the last decade, where there was a 35% increase compared to 2015. During 2016 there were 2,342 disasters, of which 92% were hydro-meteorological disasters dominated by floods, landslides and puting beliung (light tornado). Increased hydro-meteorological disasters are generally caused by high rainfall in these areas (Avia 2019). It appears that one of the impacts of climate change in Indonesia is the change in rainfall pattern which results in the increased risk and magnitude of hydro-meteorological disaster.

1.1.3 Population and Demographic Profile

By the end of 1990, Indonesia had a population of 179,139,000 (BPS 1991) and 237,641.3 by the end of 2010. It increased by an annual average of 1.49 % annually between 2000-2010 and slows down to 1.25% between 2010-2020, compared to a population of 270,203.9 million in 2020. Within 30 years (1990-2020), Indonesia population has has increased by 50.63%. The most populous province by 2020 was West Java (49.317 million), while the least populous province was West Papua (959,600), which is located in the far eastern region of Indonesia (BPS 2021)

(Figure 1-2). According to the demographic projections of Arifin *et al*. (2018), Indonesia is projected toexperience a substantial population growth of 63.9 million by 2045, an increase of 25.05%.

Figure 1-2. Population density of Indonesia across the geographical setting (Source: BPS 2021)

Approximately 67.1% of the population lives in urban areas. This implies that, while the population continues to rise, the rate of growth is declines. The average population density is 141 inhabitants per km^2 but ranges from 25.8 inhabitants per km^2 in Maluku and Papua to 3606.5 inhabitants per km^2 in Java with a striking 15,907 inhabitants per km^2 in the capital city of DKI Jakarta (BPS 2021). The high population density in Java especially in Jakarta, indicates that Java is the focal point of internal migration. Striking inequality among provinces is one of the main causes affecting internal migration patterns in Indonesia (Astiarani 2020). Based on research by Wajdi *et al*. (2015), urban migration probabilities have been found to be consistently higher than rural migration probabilities, except for Sumatra, suggesting that Indonesia may be at a more advances developmental stage. As a result of the country's demographic transition and rapid in-migration, the impact of the Covid-19 pandemic has been magnified. The island of Java, which has the largest population, accounts for a larger proportion of cases and deaths (Astiarani 2020). As of April 25th of 2021, the Covid-19 pandemic had affected 1,641,194 people and caused the deaths of 44,594 people in Indonesia (https://www.kemkes.go.id/).

According to the UN population projections, Indonesia would rank eighth among the countries contributing to the population growth by 2050. According to several experts, due to the successful past policy that has brought down fertility and mortality rates, today, 28% of Indonesia's population is under the age of 15.8% is 60 years old and older, and 64% population aged in between (15-60 years old). This age composition of age is referred to as the "demographic bonus" (Ariteja, 2017), that is the number of productive people (age 15-64 years) is greater than the unproductive ages. While the numbers of working-age people will continue to grow, the proportion of younger groups (aged 15-29) will decline, most likely due to an increase in the average years of schooling. It is projected that the labor force will grow over the next 25 years at a rate of 0.7% annually. By 2045, Indonesia will see significant population growth - an increase of 63.9 million or 25.05% (Figure 1-3). The labor force is expected to grow over the next 30 years at an annual rate of 0.7 percent and by 2045, it is expected to reach 172.1 million (Arifin *et al*. 2018). Consequently, the country's dependency ratio is seen as dropping from 50.5% to 47.3%.

The decline indicates a reduction in the economic burden for the producing-age population that supports those who are in unproductive ages. This changing age structure could be a catalyst for stimulating economic growth and improving social welfare. The demographic bonus would provide a ”window of opportunity”, which is crucial to Indonesia’s economic situation (Astiarani 2020).

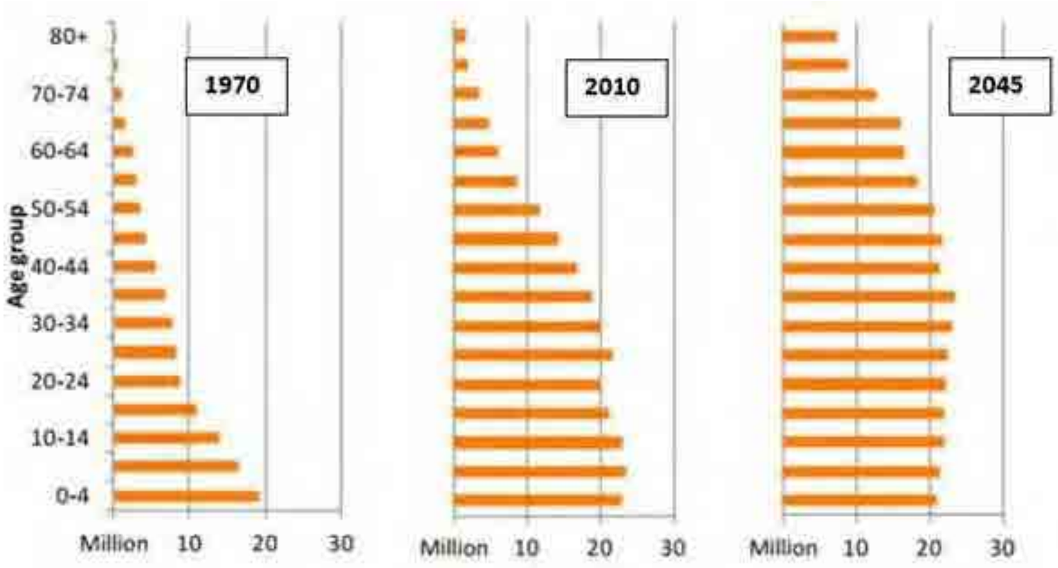


Figure 1-3. Trend of population growth in Indonesia: From pyramid to bullet (Source: Arifin *et al*. 2018)

In 2020 the proportion of people aged over 60 was 9.78%. This indicates that Indonesia is entering the ageing phase of the population where the percentage of peole over the age of 60 is 10% or higher. It is estimated that by 2040, more than a quarter of Indonesia’s population will be above the age of 60. The Indonesian Population Census (BPS 2020a) reported that Indonesian population is currently dominated by generation Z born between 1997-2012 (27.94%) and millennials/generation Y (born between 1981-1996 - 25.87%). This trend is expected to accelerate over the next few years and decades. Life expectancy has increased rapidly over the last three decades. At present, women are expected to reach the age of 73.33 and men are expected to reach the age of 69.44. In spite of this, the population growth has slowed, and the number of births is expected to decrease slightly over the coming decades. The proportion of the elderly in the total population is increasing, as is the mortality rate. In the long run, the population is not expected to increase unlessthere is a surplus of immigrants. If Indonesia is to derive maximum benefits from the demographic bonus, it is necessary to balance the availability of abundant and productive age human resources with an improvement in the quality of education and skills, including its relationship to an open labor market (Bappenas 2017).

1.1.4 Economic Development

Over the 2015 – 2020 period, there has been a structural shift from agriculture to other sectors of the economy, which has become apparent and is reflected in the share of each sector in GDP. In 2020, the main contributors to the country's GDP are manufacturing (19.88% of GDP) and agriculture (13.70%). The breakdown of Indonesian GDP by sector is shown in Table 1-2 (BPS, 2018). Indonesia is the fourth most populated country in the world and is expected to be significantly impacted by COVID-19 over a longer period (Djalante *et al.*, 2020). The effects of COVID-19 are severe and widespread, especially in Indonesia. Indonesia is officially going into recession after Statistics Indonesia (BPS) announced that the country's economy contracted by 3.49% compared to the same quarter last year. This is an increase of 5.05% compared to GDP growth of -5.32% in the second quarter of 2020. The government aims to continue this trajectory by accelerating government spending, particularly in the regions.

COVID-19 has generally disrupted Indonesian economic activity. In addition, the COVID-19 pandemic has had an impact not just about health, but also on the economy and society. Some sectors that have seen significant declines are land-based (agriculture, forestry and fisheries), industry, trade and transportation (transportation and warehousing, and accommodation (providing food and drink accommodation). People who cannot work result in loss of income and reduced purchasing power. In parallel, the industrial sector is experiencing a drastic decline in sales, which forces companies to lay off or dismiss employees because the company is unable to pay employees. The worst impact of COVID-19 in Indonesia, particularly in the industrial sector, is that several major companies have also gone bankrupt as a result of this pandemic.

Agriculture - In the agricultural sector, three subsectors have experienced a significant decline. The food crop sector exsiccates to -10.91% from -5.93%. Meanwhile, the livestock subsector contracted by 1.39% during the quarter. The forestry subsector has grown significantly from -2.84% to 5.31%.

Industrial - Many subsectors that initially tended to experience strong growth experienced a slowdown during the quarter, especially the textile, furniture, and other manufacturing industries. One industry that saw growth during the quarter was the transportation equipment industry, which stood at 4.64%, where the industry contracted the previous year. The decline in the industrial sector was caused by failure to manage economic activity in this pandemic condition optimally. Residents are encouraged to stay home to minimize the spread of the pamdemic, which resulted in the income of the population also declines, leading to a significant drop in demand for goods and services. How we respond to these crises will determine how we address a climate crisis in the decades ahead.

Trade - The trade sector is undergoing a decline in growth, but not before a contraction occur.

Transportation - The transportation and warehousing sector is also decreasing. The rail and warehousing subsectors contracted by -6.96% and -0.73%, respectively, compared to fairly strong growth in the previous years. At the same time, the air transport subsector also dropped by 13.31%.

Accommodation - The accommodation subsector experienced a 4.55% decline due to the widespread closure of accommodation as a result of this pandemic. During this time, growth in the food and beverage subsector decreased, but had no impact on contractions.

Health and Sanitation - Access to safe drinking water and sanitation is essential to allow communities to practice basic hygiene and reduce the transmission of COVID-19. Access to these services in healthcare facilities is critical to preventing infections, reducing the spread of antimicrobial resistance, and providing quality care.

Indonesia is ASEAN's largest economy (BPS 2021). Its GDP in 2019 was IDR 15,833.9 trillion, a growth of more than 6% from the IDR 14,838.3 trillion achieved in 2017 (BPS 2021). Since 2014, the Indonesian government has moved forward with plans to transform Indonesia into a manufacturing hub for South-East Asia. In 2018, it launched the Making Indonesia 4.0 roadmap, which aims to boost the competitiveness of the industry by integrating key innovations like artificial intelligence, robotics and sensor technology. The roadmap focuses on building the capacity of five manufacturing sectors: food and beverages, automotive, electronics, chemicals and textiles and garments (BPS 2021).

Indonesia's economy has grown rapidly in the last 10 years. In 2020, Indonesia's GDP was IDR 10,722 trillion (at constant price 2010), which was much higher than the 2015 value at IDR 8,983 trillion. During 2015 – 2019, the GDP grew at an average of 5.04% annually, but decreased in 2020 until -2,52% (Table 1-2). Based on expenditure component, Indonesia's economic structure in 2019 was dominated by Household Final Consumption Expenditure with 56.62%; followed by Gross Final Consumption Expenditure (GFCE) with 32.33%; and in the third place was Export with 18.41%. While the Import as deduction component on GDP contributed 18.90%. Based on industry, Indonesia's economic structure in 2019 was still dominated by Manufacturing Industry with 19.70%, followed by Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles with 13.01%; Agriculture, Forestry, and Fisheries with 12.72%; and Construction with 10.75%. Those four industries have been contributed to Indonesian economy by 56.18%.

Table 1-2. Share of GDP by Sector, 2015─2020 (in %)

No.	Sector	2015	2016	2017	2018	2019	2020
1	Agriculture, Forestry and Fishery	13.49	13.47	13.16	12.81	12.71	13.70
2	Mining and Quarrying	7.65	7.18	7.58	8.08	7.26	6.44
3	Manufacturing	20.99	20.51	20.16	19.86	19.71	19.88
4	Electricity and Gas	1.13	1.15	1.19	1.19	1.17	1.16
5	Water Supply, Sewerage, Waste Management and Remediation Activities	0.07	0.07	0.07	0.07	0.07	0.07
6	Construction	10.21	10.38	10.38	10.53	10.75	10.71
7	Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles	13.30	13.18	13.02	13.02	13.01	12.93
8	Transportation and Storage	5.02	5.20	5.41	5.38	5,57	4.47
9	Accommodation and Food Service Activities	2.96	2.93	2.85	2.78	2.78	2.55
10	Information and Communication	3.52	3.62	3.78	3.77	3.96	4.51
11	Financial and Insurance Activities	4.03	4.19	4.20	4.15	4.24	4.51
12	Real Estate Activities	2.84	2.82	2.81	2.73	2.78	2.94
13	Business Activities	1.65	1.71	1.75	1.80	1.92	1.91
14	Public Administration and Defence; Compulsory Social Security	3.90	3.87	3.67	3.65	3.61	3.76
15	Education	3.36	3.37	3.29	23.25	3.30	3.56
16	Human Health and Social Work Activities	1.07	1.07	1.07	1.06	1.10	1.30
17	Other Service	1.65	1.70	1.76	1.81	1.95	1.96
	Gross value added at basic price	96.85	96.42	96.15	95.94	95.89	96.36
	Taxes less subsidies on products	3.15	3.58	3.85	4.06	4.11	3.64
	Gross domestic products	100	100	100	100	100	100

Source: BPS (2021)

Between 2015 and 2019, the average annual GDP growth was nearly 5.04% and at 2020, decrease to -2.52% with GDP per capita at 56.9 million compared with IDR 45.1 million in 2015 (Table 1-3). The global economy contracted very sharply in the latter half of 2019 and slid into a deep recession in 2020, which was triggered by the pandemic COVID-19.

Table 1-3. Development of Indonesian GDP and Exchange Rate (Source: BPS 2021)

	2015	2016	2017	2018	2019	2020
GDP in trillion IDR (current price)	11526	12407	13589	14837	15834	15434
GDP/cap in million IDR (current price)	45.1	48.0	51.89	56.0	59.1	56.9
GDP (constant price 2010), in trillion IDR	8983	9435	9913	10426	10949	10722
GDP/cap in million IDR (constant price 2010)	35.2	36.5	38.9	39.5	41.93	58.67
GDP Growth (%)	4.9	5.0	5.1	5.2	5.0	-2.52
Exchange rate, (000 IDR/USD)*	13.759	13.436	13.548	14.481	13.901	14.105

Note: *Bank Indonesia (www.bi.go.id).

On the demand side, domestic consumption and investment were the principal drivers of growth; on the supply side, it was the services sector. The high dependence on resource extraction, raw material exports and portfolio inflows to finance current account deficits leaves the economy vulnerable to shocks and price fluctuations. Conventional sources of growth, such as reliance on a large pool of low-cost labor to ensure competitiveness, may be unreliable in a global context of increased protectionism, shifting global value chains, and rapid technological change. The unemployment rate and the level of poverty have worsened over the course of the pandemic. Child deaths due to COVID-19 are a major concern; Indonesia has one of the highest numbers in the world, with about 2.1% of all deaths (Astiarani 2020). As part of its post-COVID economic recovery framework, Indonesia could be able to address some of these longstanding structural challenges.

In 2020, Indonesia entered into recession for the first time since the monetary crisis of 1998 with GDP of -5.32% and -3.49% for the second and third quarters. Indonesia has an open economy with a large service sector. Based on industry, Indonesia’s economic structure in 2019 was still dominated by Manufacturing Industry with 19.70%, followed by Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles with 13.01%; Agriculture, Forestry, and Fisheries with 12.72 %; and Construction with 10.75%. All four sectors contributed 56.18 percent to Indonesia's economy.

Nearly 85% of Indonesia exports were to the Asia countries. The composition of exports has also changed. Export-import of Non-oil and Gas Industry accounted for USD 129,739.5 million at the end of 2010 and increased to USD 154,997.4 million by 2020 (BPS 2021). The liberalization of the capital markets and the opening up of national economies has increased capital movements between countries. Direct investments from Indonesia exceeded investments flowing into Indonesia during 2018-2020. In 2020, investments from Indonesia reached IDR 413,535.5 billion, which is higher that the two previous years (BPS 2021).

1.1.5 Social Development

Life expectancy in Indonesia has improved significantly in the last five decades, from only 47.9 in 1970 to 71.77 in 2020 (BPS, 2021). Within the education sector, the expected years of schooling has increased from 12.8 years in 2015 to 13.6 years in 2020, while the mean years of schooling slightly increase from 7.9 years in 2015 to 8.2 years in 2020. As the result of sustained efforts, human development indices with new method have increased from 69.55 in 2015 to 71.94 in 2020, which classified Indonesia as a high levels human development country.

Table 1-4. Human Development Index by components

HDI Component	2015	2016	2017	2018	2019	2020
Life Expectancy (e_o)	70.57	70.85	71.13	71.41	71.59	71.77
Expected Years of Schooling (EYS)	12.8	12.9	12.9	12.91	12.95	13.6
Mean Years of Schooling (MYS)	7.9	8.0	8.0	8.17	8.34	8.2
Per Capita Expenditure (000)	10.029	10.419	10.811	11.059	11.300	11.459
Human Development Index	69.55	70.18	70.81	71.39	71.92	71.94

(Source: BPS 2021)

Following the successful revival of the social and economic crisis in 1998-99, Indonesia has shown a growing trend towards poverty reduction. In 2005, the number of people living in absolute poverty has declined from 31.02 million people in 2010 to 26.42 million people (BPS, 2020a), and the people living in relative poverty has declined from 13.33% in 2010 to 9.78% in 2020. Between the periods of 2010-2020, the number of people living in poverty dropped as much as 4.6 million, from 31.02 million in 2010 to 26.42 million in March 2020. By the end of 2020, there were about 26.42 million people living in poverty (BPS 2020a). The number of people living in poverty, has declined steadily until 2019, but increased in 2020 (Table 1-5).

Table 1-5. Indonesian poverty and inequality statistics during March 2010 -2020

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Relative Poverty (% of population)	13.33	12.49	11.96	11.37	11.25	11.22	10.86	10.64	9.82	9.41	9.78
Absolute Poverty (in millions)	31.02	30.02	29.13	28.07	28.28	28.59	28.01	27.78	25.95	25.14	26.42
Gini Coefficient (Gini Ratio)	0.38	0.41	0.41	0.41	0.41	0.41	0.40	0.40	0.32	0.38	0.38

(Source: BPS 2021)

Indonesia has made significant progress in the fight against poverty, increasing the proportion of people living below the national poverty line from 23.4% in 1999 to 9.2% in 2019. The deteriorating labor market will be disproportionately felt by the most vulnerable, including informal sector workers, who account for 57% of the workforce.

Income inequality has increased since 2009, as the incomes of the top deciles of the income distribution have been growing faster than those of the lowest deciles. While women make up most students in tertiary education, 26% of young women were not in employment, education, or training in 2019, compared with 21% of Indonesia’s youth overall, a result of persistent gender inequalities. Women's participation in the workforce stagnated, reaching only 55% in February 2020, compared to 84% for men, and a significant wage gap persists. These factors contribute to lower levels of well-being for women and their households and prevent the economy from deploying the full potential of its human capital. Study by Pardede *et al.* (2020) show that the probability of migration by gender varies according to one's relation to the household head, which highlights the importance of gender and family structure in migration decision-making.

Indonesia ranked 87th out of 157 countries listed in 2018 in the Human Capital Index, placing it among the bottom half of countries globally. The availability of basic education is almost universal in Indonesia, but the quality of education is often poor and varies significantly by province. Indonesia's struggling education system contributes to a shortage of high school graduates with the capacity to become trained as skilled workers. Higher education institutions perform poorly in global rankings. Enrollment in polytechnic programs is low, particularly among women, and the quality of these programs is often poor. While employers frequently report difficulties in finding high-skilled workers, on-the-job training is widely underutilized.

Indonesia aspires to ensure good health outcomes at an affordable cost for all. However, the burden of communicable diseases, coupled with the rising prevalence of non-communicable diseases, challenges an overburdened system that is unable to cope with emerging infectious diseases. The sudden shock of the COVID-19 pandemic overwhelmed the fragile healthcare system and revealed weaknesses in pandemic preparedness, including mitigation, monitoring, response and treatment. The COVID-19 pandemic shows that Indonesia was in poor health before the pandemic, resulting in a high number of fatalities (Astiarani 2020). The limitations of governance and transparency in public health management were evident during the pandemic. Consequently, health outcomes remain low and health inequalities persist. The gaps in health financing leave many people vulnerable to catastrophic health expenditures that erode household income and exacerbate poverty.

As part of its poverty reduction strategy, Indonesia has invested significantly in establishing a social protection system that gives priority to those living below the national poverty line. While the government expanded the coverage and scope of its various social assistance programs when COVID-19 struck, the pandemic exposed the limitations of the overall system, such as insufficient coverage, poor targeting, inadequate benefits, and a lack of integration across social assistance programs and with social security and social insurance schemes. The social protection system needs to become more resistant to exogenous shocks such as natural and non-natural disasters and changes in population structures.

1.2 Sectoral Conditions

1.2.1 Energy Sector

This subsection presents sectoral energy conditions, including an overall view of primary energy supply and final energy consumption (by fuel type and by consuming sub sector) and electric power sub-sector. Figure 1-5 shows the development of Indonesia's primary energy supply from 2000 to 2019. As the figure shows, Indonesia's energy supply consists of fossil fuels (coal, oil, natural gas) and renewable energy (hydropower, geothermal, biomass and biofuels). The country's energy supplies come from exploitation of domestic energy resources and from import, especially crude oil. Between 2000-2019, the total primary energy supply (TPES) grew at an average rate of 2.5% per year from 146 million ton oil equivalent (TOE) in 2000 to 237 million TOE in 2019. In the period of 2016-2019 the TPES grew at higher rate, i.e., 3.8% per year. As shown in Figure 1-5, fossil energy still dominates primary energy supply. In 2019 its share in primary energy supply was 89%. The remaining 11% was accounted by renewable energy. Many efforts still have to be done in the next 5 years to meet the government target on renewable energy which is 23% in 2025. Although Indonesia is endowed with abundant renewable energy resource, its utilization still faces many contraints such as the geographical mismatch between the location of the energy resource and the location of energy demand centers. In addition, in some cases technology investment costs of renewable energy is still higher than that of fossil energy systems. These constraints become challenges for the government in developing policies or regulations which will enable and promote the utilization of renewable energy.

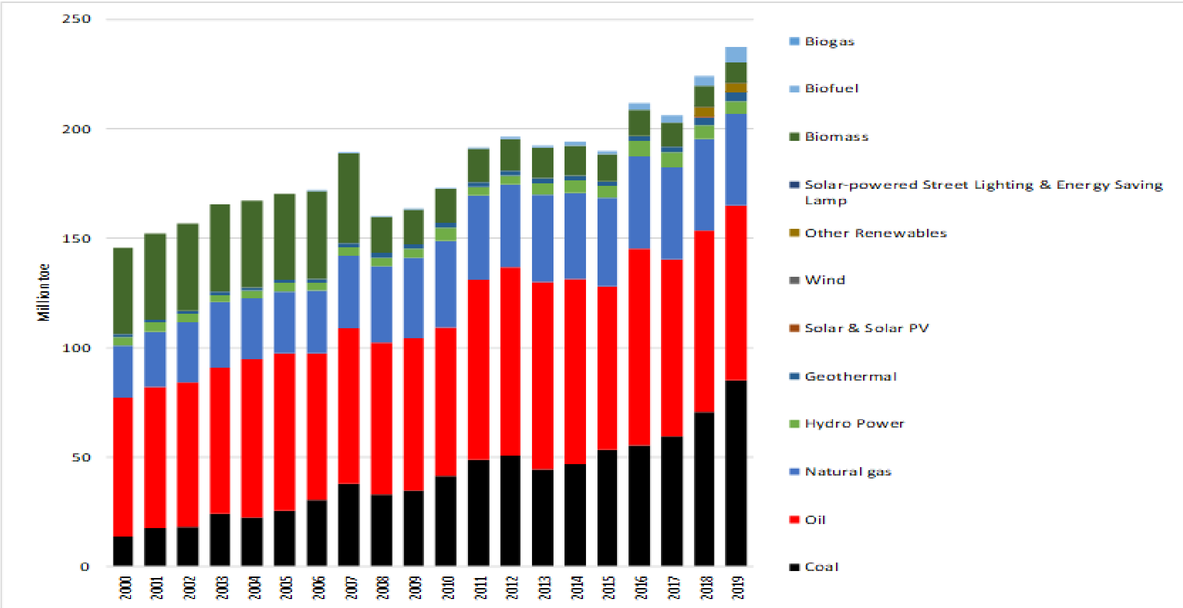


Figure 1-4. Primary energy supply by sources (Source: MEMR 2021)

The previously mentioned primary energy supply is used to meet domestic energy demand. The development of energy demand is indicated by the development of final energy consumption. Figure 1 6 presents the development of Indonesia's final energy consumption by type of consuming sub-sector in the period of 2000-2019. As indicated in the figure, according to the type of consuming sub-sector, the final energy comsumption is grouped into 5 categories: transportation, industry, residential, commercial and other (aggregate of agriculture, construction, mining and unrecorded activities). In the period of 2000-2019, the final energy consumption grew at an average rate of 3.1% per year from 81 million TOE in 2000 to 145 million TOE in 2019. In the period of 2016-2019 the final energy consumption grew at much higher rate i.e 8.2% per year. As depicted in Figure 1 6, the major energy consumers in Indonesia are the transportation and industrial sectors.

By type of consuming sector, between 2000-2019 there was a shift in the proportion of energy consumption. In 2000, the share of of consumption was dominated by industry sector (50%) followed by transport sector (25%). Since 2012 the share of transport sector (43%) surpassed that of industry sub-sector (36%) and in 2019 the share of transport and industry sub-sectors were respectively (42%) and (39%). The remainders of the consumption were shared, in decreasing order, by residential, commerce and other sub-sectors.

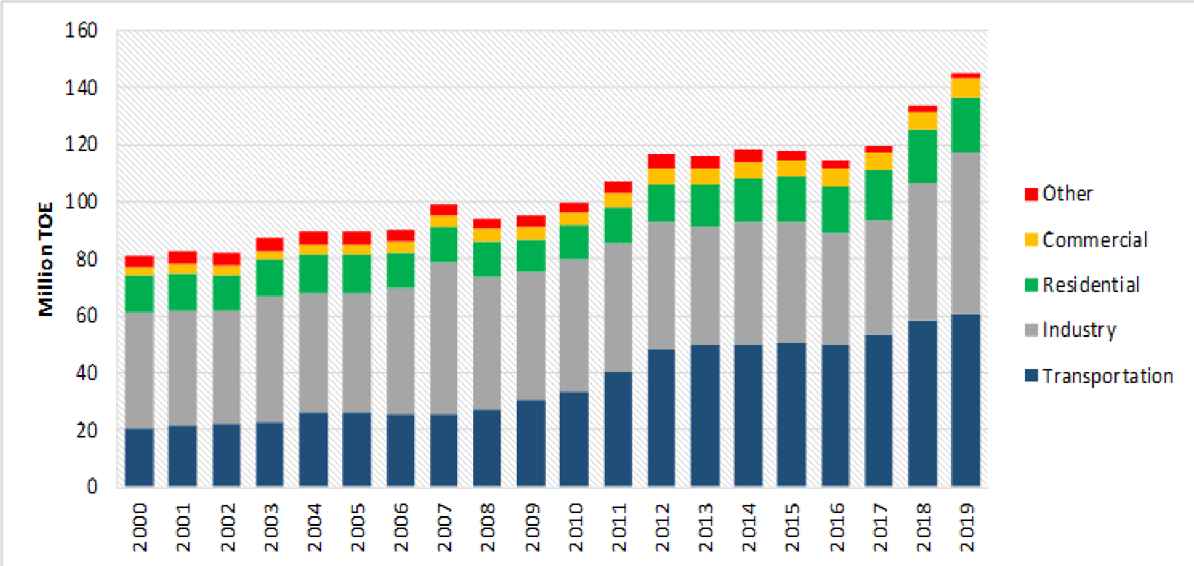


Figure 1-5. Development of final energy consumption (excluding biomass in residential) by sector (Source: MEMR 2021)

By type of fuels, the final energy consumption is composed of fossil fuels (oil fuels, coal, coal briquette, natural gas, LPG), renewable fuels (biomass, biofuel and biogas) and electricity (generated from fossil energy and renewable energy). The development of final energy consumption by type of fuels for 2000-2019 is shown in Figure 1-6. As shown in the figure, oil fuels have been dominating the final energy consumption. This occurs because oil fuels is used in transportation and industry sub-sectors which as mentioned previously are the two dominant energy consumers in Indonesia. Between 2000-2019 there are some notable changes in the proportion of final energy consumption. Share of electricity increased from 9% in 2000 to 16% in 2019. This increase is the result of improved access to electricity, indicated by electrification ratio, that has reached around 95% in 2019. The share of LPG increased from merely 1.5% in 2000 became 7% in 2019. This significant LPG consumption increase is the result of residential kerosene-to-LPG conversion program, launched in 2007. The share of biofuel, that has not been used in 2000, has increased to 4.6% in 2019. This growth is associated with government program to promote production and use of biofuel, especially biodiesel. Coal share increased from 7% (2000) to 17% (2019). This growth is attributed to the increased use of coal (relatively cheap fuel) in industry. In the case of natural gas, although in terms of absolute value the consumption is relatively constant around 13 million TOE, in terms of share it decreased from 16% in 2000 to 10% in 2019.

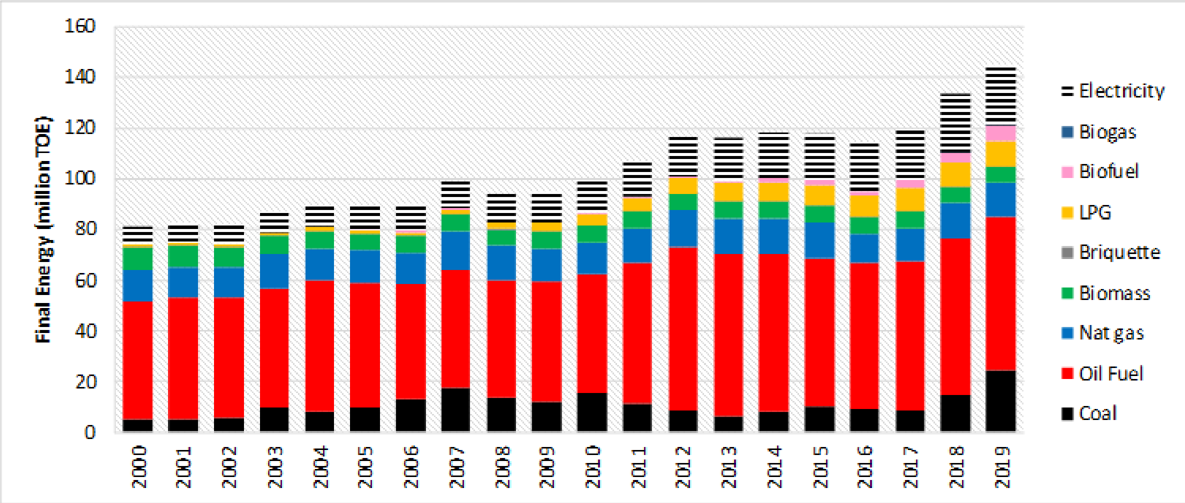


Figure 1-6. Final energy consumption by fuel type (excluding biomass in residential) (Source: MEMR 2021)

Indonesian electricity is supplied by domestic power generation and distribution systems. By type of energy sources, the country's power generations comprise fossil energy (coal, oil, natural gas) and renewable energy (hydro, geothermal, biomass). In addition, there are some small contributions from various energy sources (hybrid, solar PV, wind, waste, biogas). The development of electricity generation by energy source (power mix) for 2000-2019 is shown in Figure 1-7. In this period electricity supply grew at an average rate of 6.4% per year. In 2000 the generation is dominated by fossil energy: coal (37%), natural gas (35%), oil fuels (14%). In total fossil-based power generation accounted 86% of total generation. The remaining 14% is shared by hydropower (11%) and geothermal (3%). In 2019 the share of fossil-based power generation remains dominant (84.1%) but the proportion of the generation has changed to coal 59%, natural gas 21%, oil fuels 3.6%. The remaining 15.9% is shared by hydro (7.2%), geothermal (4.8%) and biomass (3.9%). The coal domination in power sector is due to the fact that, among all power generation system, coal power generation is the cheapest. Although Indonesia is endowed with abundant renewable power resource such as hydro and geothermal, its utilization is contrained by high investment costs and some time mismatch between location of resource and location of demand centers.

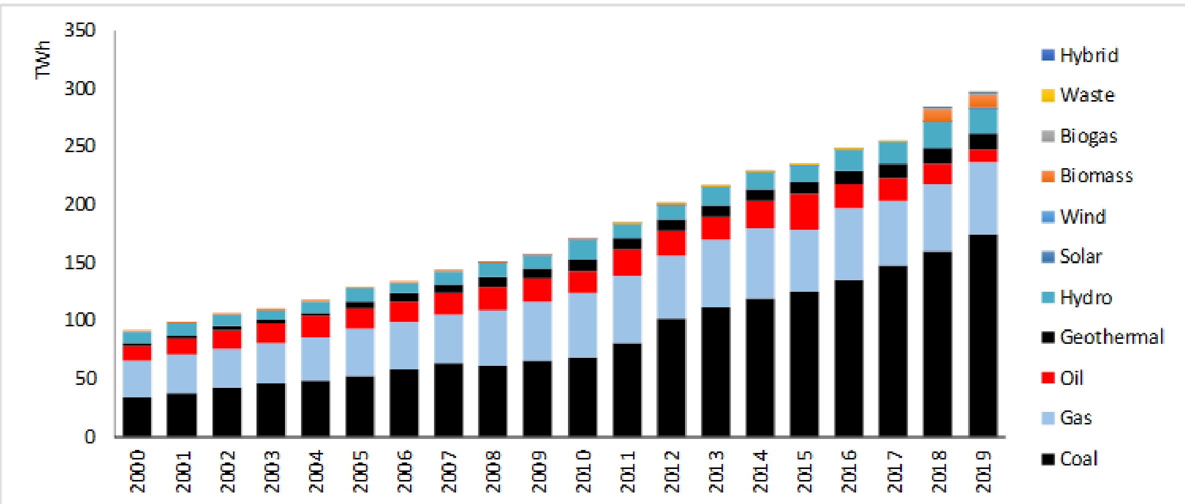


Figure 1-7. Power generated by fuel (Source: MEMR 2021)

The consumption of electricity according to consumer type is evaluated based on electricity sale record by consumer groups, which comprises household, industry, commercial, government, social and street lighting. The development of electricity consumption based on group of consumers for 2000-2019 is shown in Figure 1-8. During this period the electricity consumption grew at a rate of 6.1% per year from 79 TWh in 2000 to 246 TWh in 2019. The dominant consumers are household, industry and commercial, which in aggregat accounts for 95% of total electricity sale in 2000. In 2019 the three consumer groups accounts for 93% of total sales.

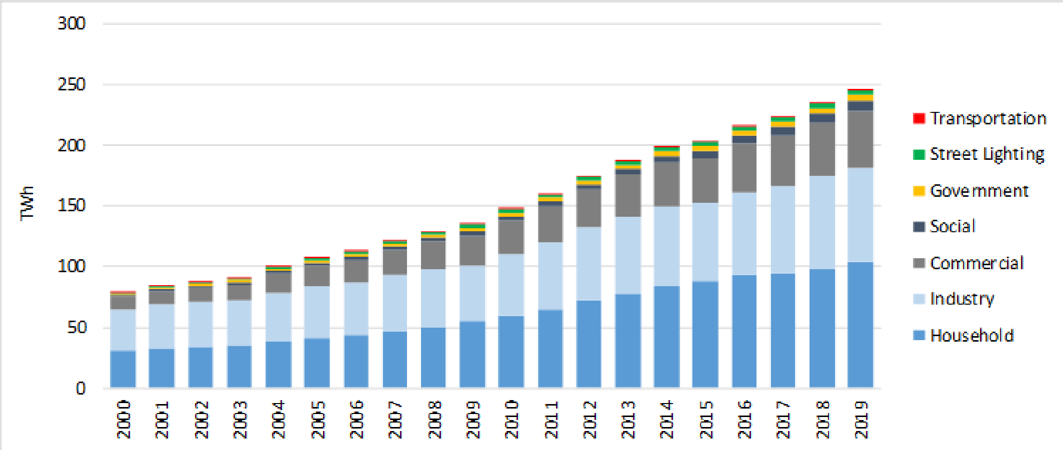


Figure 1-8. Electricity consumption by customer (Source: MEMR 2021)

Electricity consumption described previously, is supplied by power plants, the installed capacity of which for 2000-2019, is presented in Figure 1-9. The total installed capacity from 2001 to 2019 grew at an average rate of 6.2% per year. The 2000 figure is not included in the growth calculation as it also incude captive power in industry, which has been excluded from the plot since 2001. As indicated by the figure that the installed capacity of the power plants has been dominated by coal power plants. The notable development of power plant is the significant growth of geothermal plant from 785 MW in 2001 to 2130 MW in 2019 and the entrance of significant biomass power plant capacity in 2016 that has reached 1763 MW in 2019.

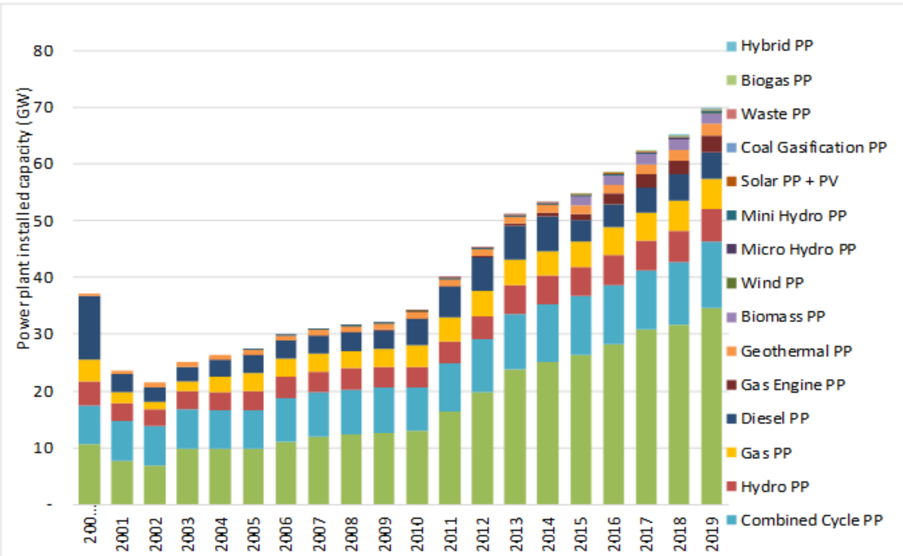


Figure 1-9. Installed capacity of power plant by fuel (* = at 2000, diesel power plant including captive power) (Source: MEMR 2021)

1.2.2 Industry Sector

Industry sector has been playing an important role in Indonesian economy. Since the past decades, this sector has been contributing around 39% - 44% of the country's GDP formation. The important industry includes manufacturing, mining, and quarrying, which together have contributed to around 26.3% of Indonesia's GDP in 2020 (BPS, 2021).

The MoI considered eight priority industries as GHG emissions intensives. Among those industries, cement, basic chemicals (ammonia fertilizer, nitric acid, other petrochemicals), iron and steel making, and metal smelters (nickel, gold, aluminium, and bauxite) are considered as the main sources of IPPU and energy's GHG emissions. These priority industries are expected to grow as planned in the RIPIN (MoI, 2015). RIPIN states that there are 8 types of energy intensive that have to be included in the national GHG emissions mitigations from industry sector. During 2015 to 2035, the growth rate of the national manufacturing industry (exclude oil and gas) is estimated about 10.5%. However, the growth rate of specific industry is not available. Therefore, the projection of industry capacity or product use and the associated GHG emissions are carried out using the trend of current production capacity of those industries and also relevant issues (national or regional GDP and production target).

During 2017-2019, the overall annual growth of industry sector declined from 5.07% (2017) to 5.02% (2019). In the same period, the growth of Non-Oil & Gas Industry sub-sector have also declined from 5.14% (2017) to 4.68% (2019). Among non-oil and gas industries, the sub-sectors that still have high annual growth in 2019 were Food & Beverages Industry (7.78%), Textile and Apparel Industry (15.35%), Paper and Paper Products Industry (8.86%), Chemical Pharmaceuticals, and Traditional Medicine Industry (8.48%) and Furniture Industry (8.35%). The breakdown of annual growth of the gross output of Non-Oil & Gas Industries during 2017-2019 is listed in Table 1-6 while the trend of the growth rate and the production capacity of several industries are presented in Figure 1-10.

Table 1-6. The Annual Growth of Non-Oil & Gas Industry 2017 – 2019 (in Percent) (Source: Secretariat General of Ministry of Trade,2020 in BPS 2021)

No.	Non-Oil & Gas Industry	2017	2018	2019*
1.	Food & Beverages Industry	9.23	7.91	7.78
2.	Tobacco Products Industry	-0.64	3.52	3.36
3.	Textile and Apparel Industry	3.83	8.73	15.35
4.	Leather, Leather Products, and Footwear Industry	2.22	9.42	-0.99
5.	Wood, Wood & Cork Products, and Bamboo & Rattan Plaiting Products Industry	0.13	0.75	-4.55
6.	Paper and Paper Products Industry; Printing and Reproduction of Recorded Media	0.33	1.43	8.86
7.	Chemical, Pharmaceuticals, and Traditional Medicine Industry	4.53	-1.42	8.48
8.	Rubber, Rubber Products, and Plastics Industry	2.47	6.92	-5.52
9.	Non-Metallic Mineral Industry	-0.86	2.75	-1.03
10.	Basic Metals Industry	5.87	8.99	2.83
11.	Fabricated Metal Products Industry; Computer, Electronic and Optical Products Industry; and Electrical Equipment Industry	2.79	-0.61	-0.51
12.	Machinery and Equipment Industry	5.55	9.49	-4.13
13.	Transport Equipment Industry	3.68	4.24	-3.43

14.	Furniture Industry	3.65	2.2	8.35
15.	Other Industry; Repair and Installation of Machinery and Equipment	-1.68	-0.83	5.17
Non-Oil & Gas Industry		**5.14**	**5.17**	**4.68**
National GDP		**5.07**	**5.17**	**5.02**

Note: * very temporary figure

As an overview, cement industries grew relatively high at the rate of 6.2% per year from 43.09 Mton (2010) to 73.9 Mton (2019), while the production capacity has decreased significantly for about -3.6% to 71.2 Mton in 2020 and estimated to be 70.4 Mton in 2021 during COVID-19 pandemic. Ammonia production increased from 4.9 Mton in 2010 to 5.9 Mton in 2017, 6.7 Mton in 2018 and 7.2 Mton in 2019 at a rate of 4.2% per year during 2010-2019. Urea production increased from 6.6 Mton (2010) to 7.2 Mton (2019) with the growth rate of 1.7% per year during 2010 - 2019. Although, there was a decline in production capacity during 2012 to 2013, however, the urea production tent to fluctuate increased. Nitric acid industry has significantly increased with the rate of 31.1% per year from 0.032 Mton (2010) to 0.37 Mton (2019). There are not much additional new nitric acid plants if the development of this industry is only relied on current product utilization (consumers). There is only an additional new plant in 2022 with a capacity of 9 Mton nitric acid per year since the last nitric acid plants (BBRI) construction is 2012. Iron and steel industry production capacity at the moment is around 15 Mton per year (nickel alloy, carbon steel, and stainless steel), which estimated to increase with 6.8% pe year from 2010 to 2019 and is relatively stagnant until 2030. The trend of production growth in shows in Figure 1-10.

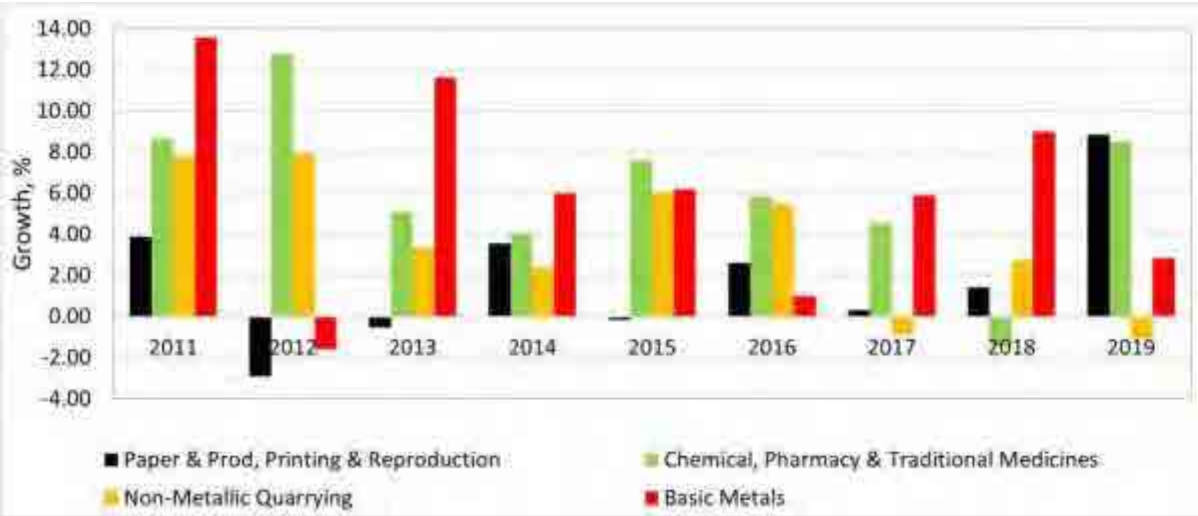


Figure 1-10. The growth rate of production capacity

1.2.3 Transportation Sectors

Indonesia as the largest archipelago with a dense population is faced with the big challenge in transportation sector. Transport demand and supply are influenced primarily by developments in the economy, demographic factors, employment patterns and infrastructure provision. Increased access to high-speed transport has increased the commuting distance between work and home. Indonesia transport network consists of the road, rail, water and air traffic infrastructure. Demand for air transportation services increased annually in line with the increasing of population and welfare of the people. Air transportation has dominant role, especially related to the demand for fast transportation, which ultimately means air transportation. With regard to the implementation of air transportation activities, there are two systems that need to be highlighted, the airport as operators of supporting facilities and the airline companies that operate the aircrafts (BPS 2020b).

Indonesia has a network of 264 domestic airports of which 27 are also international airports. Domestic aviation in Indonesia has increased, in part due to a reduction in the real cost of airfares. Furthermore, international aviation and shipping are critical due to Indonesia geographical setting as archipelagic country and the importance of primary industry and import exports of time-sensitive goods (horticultural products and medical supplies), and tourism to the economy. Based on BPS (2021), the number of domestic arrival passengers was 36.1 million people, and the number international arrival was 3.56 million people.

Being an archipelagic country, sea transportation is one of the most important hub. Indonesia has 90 commercials ports and 165 non-commercial ports (BPS 2020c). The number of domestic sea transport passengers departing in January 2021 was recorded at 1.3 million people, down by 4.05 percent compared to December 2020. As with the number of passengers, the number of goods transported has also decreased by 5.20 percent to 25.7 million tons.

With regard to land transportation, highway is the most important aspects due to its strategic function as the connector between one region and another. The existence of roads as a connector between production sectors and marketing areas is felt very beneficial to improve central of productions and target market, deeply felt very useful in order to improve the economy of a region. In 2019, the length of road in Indonesia reached 544,474 kilometers. Based on the levels of responsibilities, the biggest proportion was regencies /municipalities road with 442,701 kilometers in length or 81.31 percent. Meanwhile, state road and provincial road were each 47,024 kilometers and 54,749 kilometers or 8.64% and 10.05% (BPS 2020d). Indonesia recorded as many as 4,3 million motor vehicles.

Indonesia has many rail networks under centralized authority under BUMN. Promotion of public transport and shifting modes of transportation to rail are one of the mitigation measures in Indonesia's climate policy. As for the number of train passengers, departing in January 2021 is not much different from the other two modes which have also experienced a decline. During January 2021, the number reached 11.9 million people, down 11.95 percent compared to December 2020. Similarly, due to the pandemic, the number of goods transported by trains has also decreased by 8.61% to 4.0 million tons in January 2021 (BPS 2020d).

1.2.4 Telecommunication

In the last five years, the use of Information and Communication Technology (ICT) by households in Indonesia showed a rapid development. ICT development indicators by household in Indonesia shows that the most rapid development of ICT indicators is seen in the use of internet in the households that reached 73.75%. The growth of internet usage in households is followed by a growth of population using cellular phones until 2019 (63.53%) but ownership of computer in households in 2019 decreased to 18.78%. The population that uses the internet has also increased during the period 2015—2019, which was demonstrated by the increasing in the percentage of people who accessed the Internet in 2015 with a percentage of 21.98% to 47.691% in 2019 (BPS 2020e). In agriculture, forestry and rural areas, digitalization can be used to coordinate demand and supply in value chains, linking on- and off- farm data and managements tasks, which are enhanced by context and situation awareness and triggered by real-time events (Rose & Chilvers, 2018) or refer to as smart farming.

1.2.5 Forestry Sector

Indonesia is blessed with a vast tropical forest and provide the means for better livelihood for the environment and socio-economic conditions of the people. Of the 83,931 villages produced by the

2018 Podes, there are 62,546 villages located outside the forest area (74.52 percent), while the number of villages located on the edge of the forest area is 18,617 villages (22.18 percent). The remaining 2,768 villages (3.30 percent) are located within forest areas (BPS 2020g). In addition to short-term benefits in the form of wood products, forests also provide diverse long-term benefits, such as sources of medicinal plants, water environmental services, microclimates, microbes, fungi, guardians of groundwater water balance, maintaining soil fertility, flood prevention, landslides, wildlife habitats, which represent more than 95% of the value of forest resources. Referring to Table 1-6, traditional medicine is one industry that is experiencing high growth in Indonesia, especially since the pandemic Covid-19, highlighting the important of forests.

In general, Indonesia recognizes two status for its land territory, forest and non-forest areas (also known as Other Land Uses or *Area Penggunaan Lain – APL*). The forest area based on forest functions is distinguished into Conservation Forest (*Hutan Konservasi* - HK), Protection Forest (*Hutan Lindung* - HL) and Production Forest (*Hutan Produksi* - HP) (Figure 1-11). Production Forest is further classified as Permanent Production Forest (HP), Limited Production Forest (HPT) and Convertible Production Forest (HPK). The total Indonesia forest land use areas in 2019 was 120,285.7 thousand hectares, of which 21,887.2 thousand hectares are classified as Conservation Forest (HK), 29,202.0 thousand hectares as Protection Forest (HL), 68,837.5 thousand hectares as Production Forest (HP), 26,787.9 hectares as Limited Production Forest (HPT), and 12,847.5 thousand hectares as Convertible Production Forest (KLHK 2020).

Figure 1-11. Map of Indonesian Land Cover 2019 (Source: MoEF 2020)

Table 1-7. Forest land cover of Indonesia in 2019 (Thousand Ha) (Source: KLHK 2020 – Recalculation of Indonesia 2019 land cover)

No.	Land Cover	2019		
		Forest	**Non-Forest (APL)**	**TOTAL**
A. Forest				
1	Primary Forest	39,070.2	1,193.5	40,263.8
2	Secondary Forest	30,460.7	3,846.9	34,307.6
3	Primary Swamp Forest	4,837.7	165.9	5,003.7
4	Secondary Swamp Forest	5,798.6	719.0	6,517.5
5	Primary Mangrove Forest	1,373.5	127.6	1,501.1
6	Secondary Mangrove Forest	1,057.1	353.9	1,411.1
7	Plantation Forest*	4,301.7	807.7	5,109.4
	Area of Forest	**86,899.6**	**7,214.5**	**94,114.1**
B. Non-Forest				
8	Shrubs	7,428.4	5,235.2	12,663.6
9	Swamp Shrubs	5,395.3	2,205.3	7,600.6
10	Savannah	1,762.8	1,148.0	2,910.8
11	Plantation	3,934.9	14,073.0	18,007.9
12	Dryland Farming	1,683.6	7,115.1	8,798.8
13	Mixed Dry Land Agriculture Bush	9,465.4	16,832.1	26,297.5
14	Transmigration Area	13.2	211.4	224.6
15	Field Rice	289.1	7,594.9	7,884.0
16	Fishpond	345.7	625.7	971.5
17	Bare Land	1,578.6	891.3	2,469.9
18	Mining Area	346.0	464.4	810.4
19	Settlement	112.5	3,556.8	3,669.4
20	Swamp	1,025.5	278.5	1,304.0
21	Harbour/ Airport	1.0	23.9	24.9
	Non-Forested Area	**33,382.0**	**60,255.8**	**93,637.8**
	Total	**120,281.6**	**67,470.3**	**187,751.9**

In Indonesia, deforestation and forest degradation are two primary issues related to forestry. The main drivers of deforestation and forest degradation vary among islands. In the early 1980s, the main driver of deforestation in Sumatra Island was the establishment of settlement through transmigration program, while in Kalimantan Island, deforestation was mainly due to excessive timber harvesting

During the past two decades, Indonesia has experienced an increase in deforestation rate from 1990-1996 then it sharply decreases (Figure 1-12). Indonesian government has identified some of the activities causing deforestation, such as, conversion of forest areas for the use of other sectors, such as expansion of agriculture (plantations), mining activities, plantations and transmigration; unsustainable forest management; illegal logging; disruption and occupation of illegal land in forest areas and forest fires (Table 1-8). Among the five major estate crops in Indonesia, namely oil palm, rubber, coffee, cocoa and coconut, oil palm shows the widest area and the highest growth. The annual total land area and oil palm are shown in Figure 1-13 and Figure 1-14.

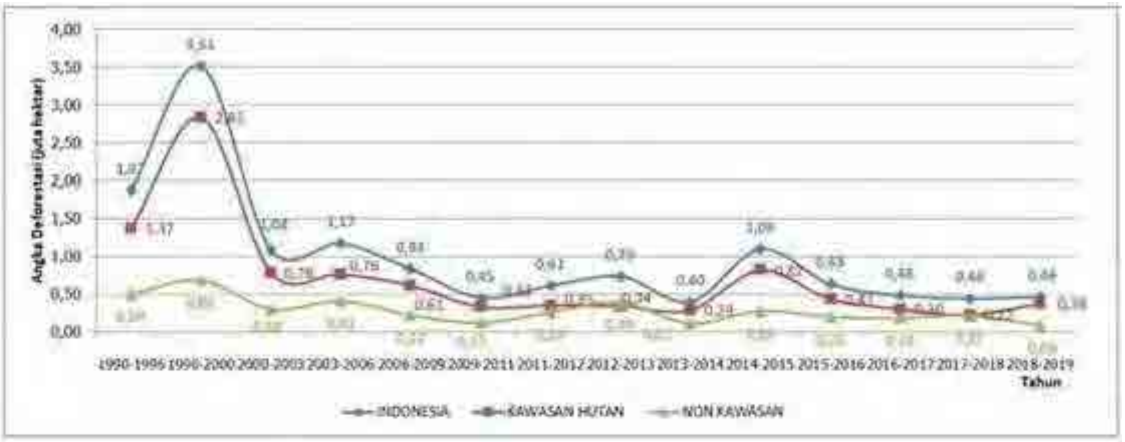


Figure 1-12. Indonesia deforestation rate (1990-2019) (Source: KLHK 2020)

Table 1-8. Recapitulation of reduced forested area in Indonesia and suspected causes (2000 -2018)

Year	Total area of forest[1]	Forest relinquished area (ha)[2]	Relinquishment purposes (ha)				Number of unit/ relinquished forest area for HPH/HTI (000ha)[3]	Others[2]	Forest & land fires (ha)[4]
			Transmigration (ha)[2]	Plantations/agriculture (ha) 2	Husbandry/ Fishery[2]				
2000	108,571,713.28	137,031	n.d	-	n.d	362/ 39,160 (HPH) 98/ 4,440 (HTI)	137,031[3]	8,255
2001	108,565,000.00	26,535	n.d	-	n.d	351/ 36,420 (HPH) 100/ 4,520 (HTI)	26,535[3]	14,351
2002	120,686,412.00	-	n.d	-	n.d	270/ 28,080 (HPH) 103/ 4,550 (HTI)	n.d	36,691
2003	109,961,845.00	-	n.d	-	n.d	267 27,800 (HPH) 105/ 4,630 (HTI)	n.d	148,200
2004	120,152,117.00	-	n.d	-	n.d	287/ 27,820 (HPH 114/ 5,800 (HTI)	n.d	284,000
2005	114,202,709.00	88,945	n.d	88,945.32 (68,769.32 oil palms)	n.d	286/ 27,720 (HPH) 113/ 5,730 (HTI)	34,070	112.700
2006	137,085,000.00	116,710	n.d	116,710.28 (62,907.38 oil palms)	62.907,98 (husbandry)	322/ 28,780 (HPH) 130/ 6,190 (HTI)	53,606.4 3	442,200
2007	137,090,000.00	73,674	n.d	65,809.15 (oil palm with small % rubber)	7.864,84 (fishery)	323/ 28,160 (HPH) 247/ 9,880 (HTI)	7,864.84	204,800
2008	133,694,685.18	70,325	n.d	70,325.23 (oil palms with small % rubber & cacao)	n.d	308/ 25,900 (HPH) 227/ 10,030(HTI)	13,415.7 0	195,900
2009	133,453,366.98	239,618	n.d	239,617.85 (oil palms and small % rubber & cacao)	n.d	304/ 25,660 (HPH) 229/ 9,970 (HTI)	17,609.0 8	252,200
2010	130,785,987.98	8,613	n.d	8,613.00 (oil palms)	n.d	304/ 24,950 (HPH)		3,493.12
2011	131,279,115.98	369,911	3,639.19	365,930.13 (oil palm + small % rubber & sugar cane)	n.d	295/ 24,240 (HPH)	341.22	2,612.09
2012	129,024,612.43	538,915	2.247.45	534,249.72 (oil palms and small % sugar cane)	n.d	294 unit(HPH)	2,417.51	8,268.65

2013	124,022,848.67	224,850	8,348.5	210,972.85 (oil palms); 5,529 (rubber)	n.d	286 unit (HPH)	5,529.00	4,918.74
2014	120,981,305.98	495,651	642.45	489,865.17 (oil palms) 5,143.40 (sugar cane)	n.d	275 (HPH)	n.d	44,411.36
2015	120,773,441.71	67,159	n.d	2,614.00 (rice field) 61,152.38 (oil palms)	n.d	269 (HPH)	6007	2,611,411.44
2016	120,634,821.71	52,167	3,774.43	38,624.03 (oil palms) 2,614 (rice field);	94,62 (cattle ranch)	n.d	3,393	438,363.19
2017	120,773,441.71	185.172	9,341.50[6]	185.172	n.d	n.d	n.d	165,483.92
2018	120,599,794.73	n.d	213,870.26	n.d	n.d	n.d	n.d	529,266.64

Note: n.d = no data

Source: [1] various sources: Dephut (2001), BPN (2002), BPN (2003), BPN (2004), Dephut (2005), Dephut 2008), Dephut (2009), Dirjen PK (2008), Dirjen PK (2009), Dirjen PK (2010), Dirjen PK (2011), Dirjen PK (2012), Dirjen PK (2013), KLHK (2014), KLHK (2015), KLHK (2016), KLHK (2017), DirPPKH 2018; [2]KLHK 2017; [3]Dephut (2009) in FWI (2014); [4]http://sipongi.menlhk.go.id/hotspot/luas_kebakaran; [5]KLHK 2018 (Diskusi Media FMB9); [6]Dirjen PKTL(2017).

In addressing the causes of deforestation and forest degradation, Indonesia has issued and implement five priority policies namely (i) combating illegal logging and forest fire, (ii) restructuring the forestry sector industries including enhancing plantation development, (iii) rehabilitation and conservation of forest, (iv) promoting sustainable forest area, and (v) strengthening of local economies. In addition, Indonesia has imposed a moratorium on the issuance of new concessions in primary forests and peatlands since 2011, provided land for communities, resolved land use conflicts, and monitored environmental permits and law enforcement. In the effort to improve the weak state of open access forest areas and their management, the Government of Indonesia (GoI) has established Forest Management Unit in each province. Forest Management Units (KPH) are the smallest forest area management units at site level. As per October 2019, the total area of KPH in Indonesia is 96,827,334 Ha, divided into 147 units of KPHK covering an area of 12,945,481 Ha, 192 units of KPHL covering an area of 24,957,996 Ha and 338 units of KPHP covering an area of 58,923,857 Ha. The authority to administer KPHP and KPHL lies with the Provincial Government. As of October 2019, through a Governor Regulation, 326 KPHP and KPHL management organizations have been formed in the form of UPTDs located in 29 provinces in Indonesia (SINPASDOK KPH+ 2021).

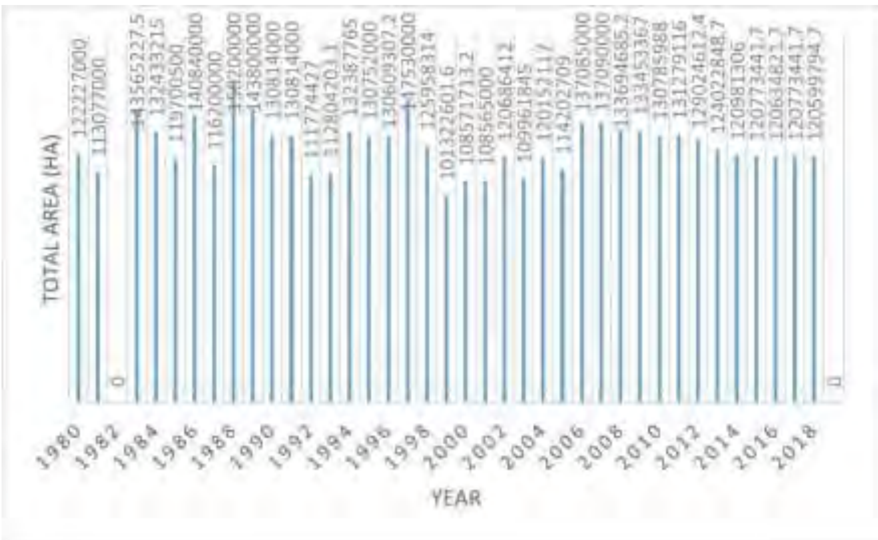


Figure 1-13. Total forest area by year (1980-2018). Source: 1992 -Kehutanan Indonesia 1991/1992; 1993- World Bank (2019); 1994 – BPN; 1995 - Dephut 1995; 1996 - Ditjen Intag 1995/1996; 1997 - Ditjen Intag 1996/1997; 1998 - BPN (1998); 1999- BPN (1999); data for 2000-2018 see sources for Table 1-9

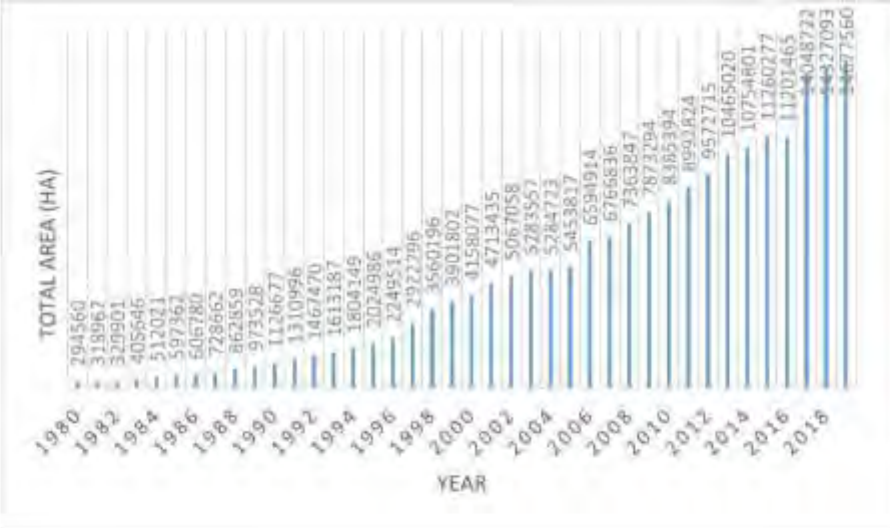


Figure 1-14. Total oil palm plantation area by year (1980-2019) (Source: Oil palm statistics 1980-2019)

The opened area due to deforestation is being rehabilitated through ecosystem restoration. Figure 1-15 shows the achievement of ecosystem restoration in 2020 is 39,471.36 ha. This achievement exceeds the set target of 20,000 ha for 2020 which is carried out through activities of natural mechanisms, rehabilitation and restoration.

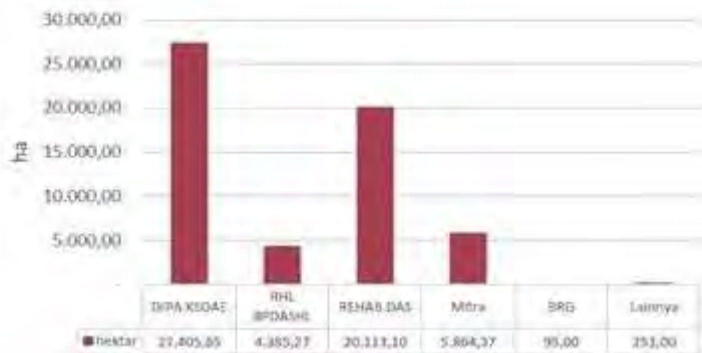


Figure 1-15. Ecosystem rehabilitation in 2020 (planting and maintenance) (Source: Dir KK 2020)

Apart from being a vast tropical forest area, Indonesia is also the largest tropical peatland with a total of 15 million hectares. Peatland has a multifunctionality including water function, niche for specific wildlife, and even production of agricultural and forest commodities. However, Indonesia peatland is also prone to fire due to the natural condition of peat as well as forest clearance. Almost every year forest and peatland fires cause disasters that damaged the environment, health, disrupt the economy, and worsen relations between countries due to haze generated from forest and peatland fires. Therefore, on January 6, 2016, through Government Regulation in Liew of Act No.1/2016 Peatland Restoration Agency (BRG) was established to accelerate the recovery of hydrological and vegetation of degraded peatland that caused by forest and peat fires.

BRG is mandated to restore degraded peatlands in 7 priority provinces (Figure 1-16) (BRG 2020). The total indicative peatland restoration area identified by the BRG is 12.9 million hectares, consisting of post-2005 fires restoration priority (956,000 hectare), peat dome canals restoration priority (protected zone) (4.3 million hectare), peat canal restoration priority (utilization zone) (1.8 million hectare) and non-canal peat dome restoration priority (protected zone) (5.7 million hectare). Out of the total indicative peatland restoration area, BRG designate 2.67 million hectares of priority degraded peatland to be restored by 2020 as stated in the Regulation of BRG's Head No. 16/2018.

Figure 1-16. Extent of peatland and peatland restoration in 7 priority provinces in Indonesia (Source: BRG 2020)

1.2.6 Agriculture Sector

Located within the strategic equatorial line, Indonesia geographical condition indicates its importance as the main site for agricultural development. At least, the use of agricultural land consists of two main categories, namely rice fields (irrigated field and non-irrigated field) and non-rice field (dry field garden, shifting cultivation and temporarily unused land. Development of agricultural land area for the 2015-2019 period is shown in Table 1-9. There was a quite significant increase in the overall harvested area and paddy production. In the period 2014-2018, the annual growth of paddy harvested area and production are at a rate of 3.67% and 2.26% respectively.

Table 1-9. Land area by utilization in Indonesia, 2015 – 2019 (ha)

No	Land type	Year					Growth (%)
		2015	**2016**	**2017**	**2018[1]**	**2019[2]**	**2019 over 2018**
1	Paddy Field	8,092,907	8,187,734	8,164,045	7,105,145	7,463,948	5.05
	Irrigated Paddy field	4,755,054	4,782,642	4,745,809	-	-	-
	Non-Irrigated Paddy field	3,337,853	3,405,092	3,418,236	-	-	-
2	Non Paddy Field (Non Wetland)	29,392,324	28,555,790	29,121,269	27,730,369	29,353,138	5.95
	Dry Field/Garden	11,861,676	11,539,826	11,704,769	11,696,845	12,393,092	-1.29
	Shifting Cultivation	5,190,378	5,074,223	5,248,488	5,256,324	5,188,658	9.22
	Temporarily Unused Land	12,340,270	11,941,741	12,168,012	10,777,200	11,771,388	5.05

Source : BPS (2015 – 2017) and Minister of ATR/BPN;BPS (2015 – 2019) for non-paddy field)

Note: 1) The number is based on the minister decree of ATR/BPN-RI No. 399/Kep-23.3/X/2018.

2) The number are based on the Decree of the Minister of ATR / Head of BPN No.686 / SK-PG.03.03 /XII/2019 dated 17 December 2019

Data in Table 1-10, indicates that for the 2015-2019 period, the area of paddy field experienced fluctuation. The increase in area occurred in 2016 and 2019, while the decrease in area occurred in 2017 and 2018. However, in the 2015-2019 period, the accumulative area of paddy has decreased by 628,959 hectares. This means that the average annual decline in paddy field area is 125,792 hectares. This is risky considering that the government is promoting food security, especially for the commodity of rice, corn and soybeans. Similarly, within the same period, the area of dry field/garden has fluctuated annually. The increase in area occurred in 2017 and 2019, while a decrease in area were observed in 2016 and 2018. Nevertheless, during the 2015-2019 period, in aggregate the dry field/garden area increased by 531,416 hectares. This means that during the last five years, the average annual increase in the area of dry field/garden was 106,283 hectares. However, during the 2015-2019 period, in aggregate the dry field/garden area increased by 531,416 hectares. Furthermore, the area of Temporarily Unused Land in 2019 will reach nearly 12 million hectares, indicating that there are still many agricultural lands that have not been used optimally. In other words, optimization of Temporarily Unused Land is an opportunity as well as a challenge in agriculture sector.

Apart from the paddy field, agriculture commodities in Indonesia also include estate crops. Some of the most planted crops are oil palm, rubber, coconut, cocoa and coffee. The growth of the five estate crops for the past five years is presented in Table 1-10. Between 2016 – 2020, coffee shows a steady growth, while cocoa and coconut tend to decline by year. Rubber showed a slight increase while the growth of oil palm plantation has increased significantly since 2016 although the rate of growth is slowing down (Areas of Estate Crops in Indonesia, 2017-2019).

Table 1-10. Planted area of five estate crops (000 hectare)

No	Area	2016[a]	2017[b]	2018[b]	2019[c]	2020[c]
1	Oil palm	11,233.4	12,383.1	14,327.1	14,456.6	14,858.3
2	Rubber	3,644.8	3,659.1	3,671.3	3,675.9	3,681.3
3	Coconut	3,653,7	3,473.2	3,475.5	3,401.9	3,396.8
4	Cocoa	1,720.8	1,653.1	1,678.3	1,560.7	1528.4
5	Coffee	1,246.7	1,238.5	1,241.5	1,245.2	1,242.8

(Source: BPS [a]2018, [b]2019, [c]2021)

The slowing rate of oil palm plantation growth was due to the issuance of Presidential Instruction (Inpres) Number 8 of 2018 concerning Postponement and Evaluation of Oil Palm Plantation Licensing and Increasing Productivity of Oil Palm Plantations (Inpres Moratorium). The objective of the Moratorium is so that existing permits can be utilized according to their designation to avoid abandoned land. Abandoned land became the focus of the government because they were seen as unproductive, hence did not provide any added value for the welfare of the people. The five-year moratorium stated the postponing of the issuance of forest release forms during the moratorium's implementation, which is three years since the Inpres was first issued. This postponement also applies to ongoing forest release applications that have been submitted, but not yet completed or has been identified as being in productive forest areas. It also applies to ongoing forest release applications that have obtained principle approval, in which the area boundary has not changed and is in productive forest areas. The government will also review all oil palm plantation permits that have been issued, by conducting assessment of the fulfillment of the permits' holders obligations, which include the allocation of 20 percent of total plantation to plasma and development of High Conservation Value Forest (HCVF) areas. The government will ensure the fulfillment of oil palm fruit supplies to the industry through land productivity improvement efforts, instead of land expansion.

To enhance the economic benefits of oil palm plantation and reduce any potential damaging ecological impacts, the Indonesian government establish the Indonesian Sustainable Palm Oil (ISPO), which is a certification system, which aims to create a more sustainable Indonesian palm oil industry and to support the Indonesian President's commitment to reduce greenhouse gas emission by ensuring the implementation of regulations regarding oil palm plantation. Currently, ISPO is mandatory for companies and voluntary for smallholders. Once they are certified, they are able to meet the global demands for sustainable palm oil products, and get a priority privilege to sell their Fresh Fruit Bunch (FFB) to ISPO certified companies. They also gained knowledge on good agriculture practices, which will help improve the productivity and quality of their crops. This is expected to increase their overall revenue, and at the end help to reduce deforestation and environmental damage from the expansion of plantation and unsustainable practices.

Other than cash crops and estate crops, husbandry is also important for Indonesia. The livestock population generally shows a steady increased in the period 2016-2020. Table 1-11 shows that poultry, especially broilers, are the main contributors to livestock population, followed by goats, beef cattle and sheep. Droughts can result in reduced pasture production and lower livestock performance.

Table 1-11. Livestock Population in Indonesia, 2016 - 2020

No	Population	Year				
		2016	2017	2018	2019	2020*)
I	**Large Livestock**					
1	Beef Cattle	15,997	16,429	16,433	16,930	17,467
2	Dairy Cattle	534	540	582	565	568
3	Buffalo	1,355	1,322	894	1,134	1,179
4	Horse	424	409	378	375	392
II	**Small Livestock**					
1	Goat	17,862	18,208	18,306	18,463	19,096
2	Sheep	15,717	17,142	17,611	17,834	17,769
3	Pig	7,904	8,261	8,254	8,521	9,070
III	**Poultries**					
1	Native Chicken	294,333	299,701	300,978	301,761	308,477
2	Layer	161,364	258,844	261,933	263,918	281,108
3	Broiler	1,632,801	2,922,636	3,137,707	3,169,805	2,970,494
4	Duck	47,423	49,056	50,528	47,783	48,588
5	Muscovy Duck	8,170	8,502	9,024	9,446	9,656
IV	**Other Livestock**					

1	Rabbit	1,202	1,244	1,332	1,247	1,255
2	Quail	14,088	14,570	14,062	14,844	14,820
3	Pigeon	2,476	2,503	2,644	2,711	2,710

(Source: Ditjen PKH 2020)

1.2.7 Waste Sector

Waste management is still one of the major sources of environmental problems in Indonesia. Based on its type, the waste can be categorized into: (i) municipal solid waste (MSW), (ii) domestic wastewater (DWW), (ii) industrial wastewater (IWW) and industrial solid waste (ISW), and (iii) other wastes, including electronic waste, hazardous waste, infectious waste, etc. Concerning the GHG emissions reported in this BUR 3, the main sources of GHG emissions only cover MSW, DWW, IWW and ISW while the hazardous waste, infectious waste, and electronic waste are not included due to limited data and information.

The GHG emissions is estimated using assumptions that the rate of increase in the amount of waste generation and waste to be treated in each of treatment unit is affected by several parameters, i.e., population, economic, regulations, policies, lifestyle, treatment plans, and source reduction rate of the waste. The population and economic growth used in estimating waste generation refers to the data from BPS Statistics (see Sub-chapter 1.1.3 and 1.1.4)

Municipal Solid Waste Management

Currently, most of the Municipal Solid Waste (MSW) is transported to landfill or solid waste disposal site (SWDS) after it is reduced at sources, composted, recycled, and recovered. The total MSW has increased 1.3% per year from 59.5 Mton in 2010 to 67.1 Mton in 2019. The MoEF estimated that the number has increased to 67.8 Mton in 2020, while in 2025 the MSW is estimated to be 71.3 Mton. If it is assumed that MSW can be reduced at sources and the generation is estimated to keep increasing with 25 ton/capita/year and the growth rate 0.6% per year (2020-2050), the MSW is estimated to reach 83.8 Mton in 2050.

The MSW was managed through (i) treatment at SWDS (68.7%); (ii) reduction at sources (5.1%) by 3R, composting, and converting to energy/material; and (iii) open burning and others (26.2 %). It should be noted, most of SWDS are operated as open dumping with more than 10 meters pile high (unmanaged landfill). Limited numbers of these SWDS are equipped with LFG recovery system for flaring, for electricity generation, and for biogas (LFG) recovery and distribution to households.

Law No. 18/2008 concerning the MSW management obliged the national and sub-national government with support by community and business to ensure the implementation of good and environmentally friendly MSW management in accordance with the objectives of the Law. The implementation of the MSW management Law is supported by the National Policy and Strategy for the Management of Household Waste and Household-like Waste as referred to Jakstranas (Presidential Regulation No. 97/2017), in which at the Sub-national level the implementation of the Jakstranas is referred to the Jakstrada (Ministerial Regulation No. P.10/Menlhk/Setjen/Kum.1/4/2018). The MSW management plans for reducing the waste generation are set under Jakstranas and Jakstrada, where the MSW generation is targeted to be reduced by 30% (20.9 MTon) in 2025 through source reduction and 3R (+ composting).

The MSW management is also regulated under MoEF Regulation No. P.76/Menlhk/Setjen/ Kum.1/10/2019 (ADIPURA) where Cities and Regencies included in the ADIPURA Program also have to report their waste management. The Clean City (Adipura) program has been started in

2013 where most of the pattern of domestic waste management in urban area were dominated by "collect, transport, and dump" system. After that, new paradigm on waste management were developed in several activities, i.e., waste reduction at source, reuse, recycle and composting, extended producer responsibility, waste to energy, and improvement of several landfills. Such activities were expected to solve domestic waste management problem that occur in Indonesia.

In addition to those regulation and policies, the Presidential Regulation No. 35/2018 was released to encourage the use of MSW for electricity generation (PLTSa) and the use of MSW for RDF (refuse-derived fuels). This regulation not only regulates the waste management through waste to energy but also supports the achieving of GHG emission reduction from the waste sector.

Domestic Wastewater Treatment (WWT)

Based on the data of Indonesia's BPS Statistics, 89% of people live in urban area can access toilet (individual or communal), while in rural area only 71%. The remaining population cannot access the toilet as well as the septic tank (households or population with no septic tank). The government plan has targeted that all people have access to the toilet whether it is individual or communal. Most of those toilets have septic tank/latrine to treat the black water, while small fraction of those toilets has channel to wastewater sewerage to treat the grey water in a centralized WWT plant. The use of centralized treatment and/or bio-digester are limited.

The associated GHG emissions from domestic wastewater are influenced by wastewater characteristics and types of the WWT technology. The total degradable organic compound in wastewater (TOW) is the main characteristics that significantly affect the GHG emissions generation of the treatment plants while the type of treatment technology will determine GHG emissions factor of each WWT plant.

The values of TOW of domestic WWT are presented in Figure 1-17. Figure 1-17 shows that more people are able to access toilet equipped with septic tank in line with the government program for the improvement of sanitation and health. It is also expected that beyond 2030, the use of septic tank reduced by increasing the amount of wastewater treated in centralized system (aerobic).

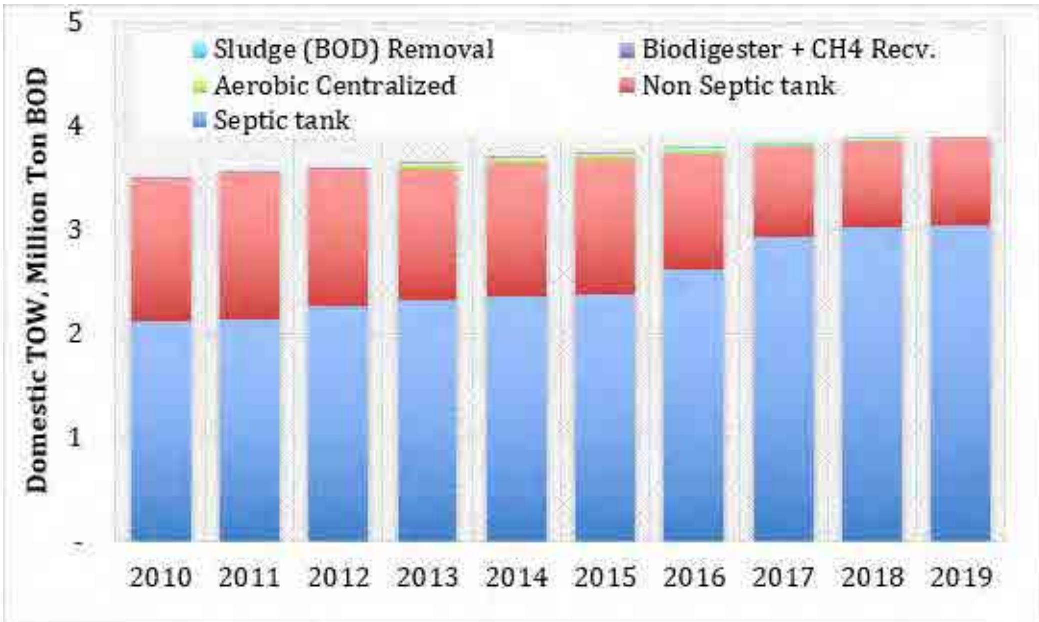


Figure 1-17. Value of TOW in Domestic WWT 2010-2019

Industrial Waste Treatment

Industrial wastewater treatment is the main source of GHG emissions from the waste sector, i.e., 35.8% of total GHG emissions of waste sector in 2019. The GHG emissions are generated from wastewater and solid waste treatment and/or handling units of various industries, particularly food and beverage, agro-industries, alcohol refining, petroleum refineries, oleochemical, plastic resins, CPO based biofuels and others as listed in IPCC2006 and refined 2019 Guidelines. The GHG emissions from the industrial waste treatment are influenced by the characteristics and the amount of the waste to be treated and the types of waste treatment technology. The production capacity of the industry determines the amount of the waste to be treated.

The load capacity of industrial WWT and solid waste is estimated with assumptions that the load will continue to increase in line with the increasing of production capacity of agroindustry, food and beverage industry, and pulp paper industry (see Figure 1-17 for industrial production level). These industries are considered as priority industries, which has priority to continuously developed and expected to grow such as planned in 'RIPIN' (Rencana Induk Pembangunan Industri Nasional, National Development Plan of National Manufacturing Industry) during 2015 to 2035. In the RIPIN, it was stated that those industries are to be included for the GHG mitigation plans.

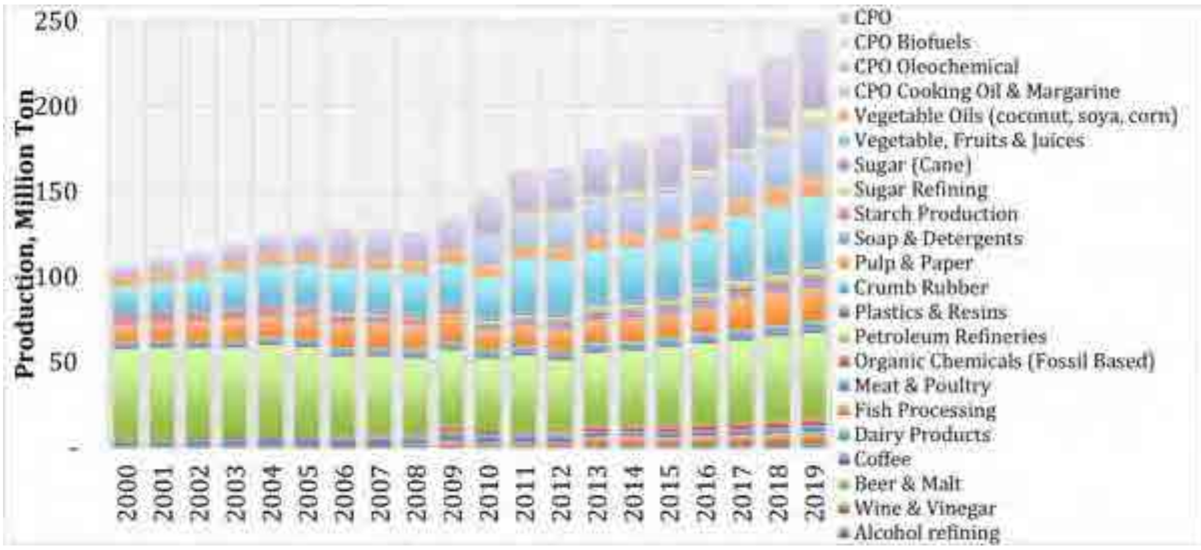


Figure 1-18. Industrial Production 2000-2019

Science and technology evolution followed by industrial development, has improved the quality of human life, and changed the lifestyle of consumption patterns and production. In line with the increasing use of chemical products, the variety and amount of ingredients, chemicals would also increase, some of which are hazardous and toxic which are termed "Hazardous and Toxic Materials", in which in Indonesia it better known as B3 waste. In addition, there are also materials that are "environment- unfriendly ", namely the materials which if not managed and or handled properly, will degrade the environment.

During 2010-2014, the distribution and utilization of B3 wastes in Indonesia consisted of 200 types of B3 wastes amounted to 3 million tons, and the figure tends to increase annually. However, not all B3 wastes can be controlled and recorded, particularly the illegally imported B3 such as mercury and pesticide. To overcome this, the MoEF is continuously improving the

National System of National B3 Management, that includes an integrated application of online reporting of import and export realization, distribution, and utilization of B3 and also registration and notification of B3. The following Table 1-12 is the amount of B3 wastes that were managed during the 2015 - 2019 period (Statistics PSLB3 2019).

Table 1-12. Managed B3 wastes in the period of 2015 - 2019

No	Sub Sector	2015		2016		2017		2018		2019	
		Industries (Unit)	Hazardous Waste Managed (Million Ton)	Industries (Unit)	Hazardous Waste Managed (Million Ton)	Industries (Unit)	Hazardous Waste Managed (Million Ton)	Industries (Unit)	Hazardous Waste Managed (Miilion Ton)	Industries (Unit)	Hazardous Waste Managed (Million Ton)
1	PEM	34	90.4	55	65.2	53	55.1	69	32.3	70	39.7
2	Infrastrucure and service	108	31.4	86	1.2	64	1.2	89	3.5	120	1.4
3	Manufacture	91	1.8	68	5.5	75	0.39	140	4.97	150	1.01
4	Agro-Industry	36	2.2	77	1.7	70	3.6	101	12.7	110	2.8
	Total	269	125.8	286	73.5	262	60.3	399	53.5	450	44.9

(Source: Directorate General of Waste and Hazardous Waste Management 2019)

1.2.8 Water Sector

Water sector includes clean water supply and wastewater management, which is one of the industrial sectors that will rapidly develop in Indonesia. The total water availability in Indonesia is 690 × 109 m^3 per year, which is a lot more than the demand of 175 × 109 m^3/year. Kalimantan and Papua, which house only 13% of the total population in Indonesia, has about 70% of the water resources, yet the two islands are not the main centers of economic activities as Java is (Figure 1-19; ADB 2016). The government is planning to achieve the Sustainable Development Goals (SDGs) which is targeting the total (100%) access to clean water and sanitation in 2030.

Figure 1-19. Water availability and critical conditions in each Indonesia main island (Source: Bappenas 2015)

Indonesia has almost 8,000 watersheds (*Daerah Aliran Sungai* [DAS]), which are managed in 131 river basins. Five river basins (304 DAS) cross international boundaries (Malaysia, Timor-Leste, and Papua New Guinea), 29 basins (859 DAS) cross provincial boundaries, and 37 basins are considered to be of national strategic importance.

Based on the National Water Security issued by ADB (2016), Indonesia has an NSW Index of 2 (from a scale of 5), meaning that more than half of the population has access to simple drinking water and sanitation facilities, the provision of clean water services is starting to develop, water resource is started to be used to support economic activities to improve the quality of drinking water and several efforts in overcoming drinking water-related disasters. Until 2018, access to proper drinking water in Indonesia has reached 87.75%. However, only 6.8% of the population has enjoyed safe access. There is still a gap of 80.95% of the population in 2018 whose access still needs to be improved from proper access to safe access. Overall, as many as 93.2% of the population did not have secure access (Bappenas 2019 in Purwanto 2020).

Development planning that takes into account climate change in the water sector can be illustrated through water security so that it can help form the basis of policy planning, management and development of water resources including investment of economic value in the future. Indonesia is affected by floods every year (Bappenas 2018). Environmental problems, such as erosion, soil degradation and depletion of groundwater resources, also present challenges for effective water management (NWP, 2016) and prevent the achievement of water security.

Based on the Ministerial Decree of Public Works and Housing No. 08/Prt/M/2018, Indonesia has as many as 215 dams/reservoirs stretching from the West to the East of Indonesia. The Jatiluhur/Djuanda Reservoir is the reservoir with the highest volume of water, reaching 1,000,000,000 m^3 with the largest allocation of utilization for hydropower plants (15,000,000 ha). The construction and operation of dams has provided a variety of services important to a growing human population (e.g., hydropower (Figure 1-20), flood control, navigation, and water supply) (Deemer *et al*. 2016). The construction of reservoirs can play a role in overcoming flooding in areas that have lost water catchment areas, especially in the rainy season which has the potential to increase the flood discharge from existing rivers.

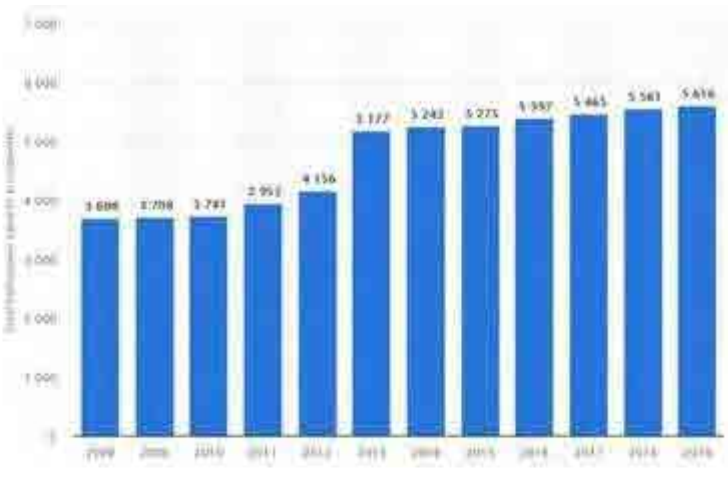


Figure 1-20. Total hydropower capacity in Indonesia from 2008-2019 (Source: https://www.statista.com/statistics/872912/total-hydropower-capacity-in-indonesia/)

Currently, about 40% of Indonesia's energy sources are derived from oil. If this source were replaced by hydropower, Indonesia would see a stark decrease in its carbon emissions (Minister of Environment and Forestry, 2021). In 2015, the total capacity of hydropower plants installed in Indonesia was 5079 MW. At the same time, total electricity produced from hydropower plants was 13,741 GWh (MEMR, 2016 in DEN 2017). Then, the capacity factor of hydropower was only 31%. The reason why the average capacity factor of hydropower plants is quite low in Indonesia is that some of the plants are operated as peak load, especially the plants in Java Island such as Cirata and Saguling hydropower plants. The life-cycle CO^2 emissions from hydropower originate from construction, operation and maintenance, and dismantling. Possible emissions from land-use related net changes in carbon stocks and land management impacts are very small.

1.2.9 Coastal and Marine Sector

As ocean is an integral part in the climate balance, this also means that Indonesia has a significant role in shaping global climate through its waters. The United Nations Framework Convention on Climate Change (UNFCCC) and its Paris Agreement recognized the value of sustainably managing and ensuring the integrity of coastal wetland ecosystems:

- UNFCCC Article 4.1 (commitments): "all Parties shall promote sustainable management, and promote and cooperate in the conservation and enhancement, as appropriate, of sinks and reservoirs of all greenhouse gases, including biomass, forests and oceans as well as other terrestrial, coastal and marine ecosystems."
- Paris Agreement (preambular): "Noting the importance of ensuring the integrity of all ecosystems, including oceans, and the protection of biodiversity…". and also mentioned in Paris Agreement Article 5.1: Parties should take action to conserve and enhance, as appropriate, sinks and reservoirs of greenhouse gases as referred to in Article 4, paragraph 1 (d), of the Convention, including forests.

Having its water area greater that its inland area, has increased the significance of Indonesia coastal and marine resources, because they provide various natural, biological and non-biological resources of high economic and ecological values. Nevertheless, Indonesia position makes it vulnerable to natural disasters, namely coastal inundation and coastal instability, which is related to the process of abrasion/erosion and coastal sedimentation. The vulnerability issues are very relevant to infrastructure development being promoted.

Sea level rise, extreme weather and global warming have devastating consequences for archipelagic countries like Indonesia. Warming temperatures in the oceans are bleaching coral reefs. that can be induced by human activities such as coastal development, land-based pollution, blast fishing, mining activities, and tourism, which have been contributing to the decline of coral reef covers in the last 5 years. According to Hadi *et al*. (2019), out of the total 1153 reefs, 33.82% are categorized poor, 37.38% categorized fair, 22.38% are categorized good and 6.42% are categorized excellent (Figure 1-21). Meanwhile, the percentage of sea grass cover was only 42.23 percent. This percentage is less than 60 percent, so it is included in the category of 'less healthy' status (Sjafri *et al*. 2018).

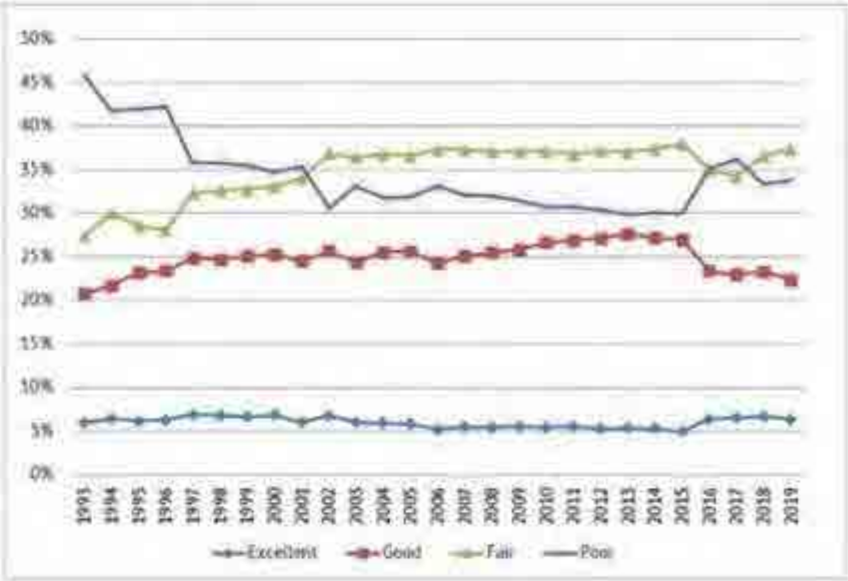


Figure 1-21. Trend of Indonesia coral reef conditions from 1993 to 2019 (Source: Hadi *et al*. 2019)

Indonesia is home to the world's largest blue carbon ecosystem (23 percent of the total global blue carbon ecosystem is located in Indonesia) (Murdiyarso *et al*. 2015). Blue Carbon is an important factor for national food security, livelihood, and resilience of coastal communities. Blue carbon ecosystems provide a number of valuable ecosystem services that contribute to human wellbeing, including provisioning (e.g., timber, fuelwood, and charcoal), regulating (e.g., flood, storm, tsunamis, sea level rises and erosion control; prevention of saltwater intrusion), habitat (e.g., breeding, spawning and nursery habitat for commercial fish species, including rare species and apex predator; biodiversity), and cultural and educational services (e.g., recreation, aesthetic, and eco-tourism) (Pendleton *et al*. 2012, Nelleman *et al*. 2008).

At least two types of an ecosystem that considered as blue carbon in Indonesia. i.e., mangrove that covers around 3.4 million ha (23% of global) (Giri et al. 2011) and seagrass beds that cover 18% of global seagrass. Globally, it is estimated that seagrass has carbon stock values between 4.2 and 8.4 PgC (Fourqueran et al. 2012) and mangroves between 4-20 PgC (Donato et al. 2011). Overall, mangrove forests in Indonesia have a carbon sequestration potential of 170.18 Mt CO2/year with Kalimantan Island having the highest potential (Figure 1-22 dan Figure 1-23).

Figure 1-22. Potential of Indonesia's mangrove carbon stocks (Source: Wahyudi *et al.* 2018)

In addition to from mangroves, seagrass beds are also potential blue carbon ecosystem. According to the Nature Geosciences study, even though it is only 0.2 percent of the earth's surface, the seagrass beds are capable of storing 19.9 billion metric tons of carbon BPS (2020g). This fact supports the idea that restoration and protection of seagrass beds is a significant step in preventing climate change, especially in coastal areas. Seagrass beds act like forests on land in reducing carbon dioxide (CO_2). Like other terrestrial plants, seagrass utilizes carbon dioxide (CO_2) for photosynthesis process and store it in the form of biomass. Result of the research conducted by the Research Center for Oceanography LIPI, indicates that seagrass beds can absorb an average of 6.59 tons C/ha/year or equivalent to 24.13 tons of CO_2/ha/year (Sjafrie *et al*. 2018).

Figure 1-23. Potential of Indonesia's seagrass carbon stocks (Source: Wahyudi *et al.* 2018)

The challenge for Indonesia is the high rate of mangrove deforestation. According to MoEF in 2017-2018 there was deforestation of 4,914.9 ha of primary mangrove forest and 31,607.8 ha of secondary mangrove forest, so that the total area of mangrove deforestation in that year was 36,522.7 ha. Food and Agriculture Organization FAO (2007 in BPS) noted that the annual mangrove deforestation in Indonesia in 2000-2005 was 1.6 percent, in the last three decades, Indonesia lost 30 percent of its mangroves. According to Campbell and Brown (2015 in BPS, 2020f). FAO (2007) states that the main causes of mangrove loss in Indonesia include aquaculture, including conversion of shrimp ponds known as the "blue revolution" (in Sumatra, Sulawesi and East Java), logging and land conversion for agriculture or salt ponds (in Java and Sulawesi) and degradation due to oil spills and pollution (in East Kalimantan). Loss of mangrove forests in Indonesia accounts for 42 percent of greenhouse gas emissions due to the destruction of coastal ecosystems, including swamps, mangroves and seagrass (Murdiyarso *et al*., 2015; Pendleton *et al*., 2012). The high greenhouse gas emissions released due to mangrove deforestation make the effects of climate change worse.

Deforestation of blue carbon ecosystems can release around 1.02 billion tons of carbon dioxide or the equivalent of 19 percent of emissions from tropical deforestation globally (Pendleton *et al*. 2012). This amount will certainly contribute to a large greenhouse gas (GHG) effect which will further aggravate climate change conditions. The carbon stored 3.14 billion tons in mangroves (Murdiyarso *et al*. 2015) and 0.39 billion tons in seagrass (Alongi *et al.* 2016). The total area of mangrove forest from 1950-2017 is depicted in Figure 1-24.

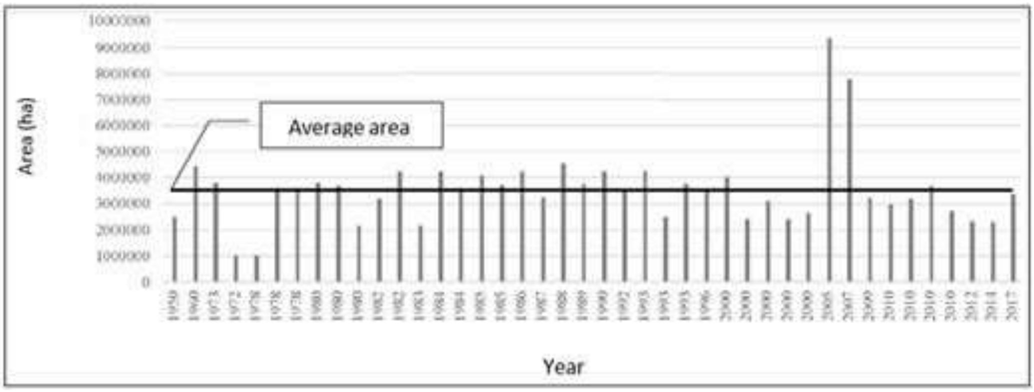


Figure 1-24. Total area of Indonesia mangrove from 1950-2017 (Source: Rahadian *et al.* 2019)

Based on data from the Directorate General of Land Rehabilitation and Social Forestry, the current level of damage to mangrove forests is about 5.9 million hectares or around 68.8 percent, of which 1.7 million hectares or around 44.73 percent occur in forest areas. Meanwhile, damage that occurred outside forest areas reached 4.2 million hectares or 87.5 percent (Dir KK 2020). Data shows that the number of fishery households (capture fisheries and sea) shrunk by around 0.85 million over 18 years from 2.49 million to 1.64 million (BPS, 2020h).

1.2.10 Cross-cutting Sectors

To achieve GHG emission reduction significantly, increased human resources capacity and institutional capacity in every sector and region become very important. Policy decisions, including future commitments, may progressively ensure the long-term success of the emissions reduction. Active participation from several stakeholders, including from central and local governments, private sector, and individuals are necessary, given that potential efforts in the sectors are cross-cutting (for example transportation policy can involve agency/ministry of Energy and Mineral Resource (MEMR), industries, public works, etc.) and multi governmental levels (central, provincial and city). In addition, local governments are expected to participate in developing mitigation action scenarios as local governments will have roles in the monitoring and reporting of mitigation action implementation.

To further ensure that the benefits flow in a way that avoids bureaucratic delays, while fulfilling principles of good financial governance, ERPA funding at the central level will be managed by the Environmental Fund Management Agency (BLU-BPDLH) while key decisions for disbursement at the subnational level will be made by the provincial government. Furthermore, benefits cannot be allocated purely based on reduced emissions from a historical baseline, as that would ignore site-specific factors, including the significant contributions of local communities, and especially "Adat" communities, that have sustainably managed forests for centuries. Thus, the allocation of benefits also considers investment costs, and a portion of funding will be set aside for rewarding past sustainable practices.

A strategic plan for financing climate change mitigation and adaptation has been developed in Indonesia. A Presidential Regulation on Environmental Economic Instrument (as an umbrella for Public Services Agencies, BLU) has been enacted (Presidential Regulation No 46 year 2017), as well as Presidential Decree No. 77/2018 Management of Environmental Funds (BLU-BPDLH) has been issued. The BLU-BPDLH will be functioned as a public service agency that is able to receive and manage the funds. There are also existing vertical and horizontal benefit sharing mechanisms at the national and sub-national levels, such as fiscal transfers, trust funds, Village funds, and General Services Agencies (BLU). Lessons have been learned for the development of horizontal benefit sharing mechanisms from experience with REDD+ Demonstration Activities and projects at the site level.

1.3 Institutional Arrangement in Developing BUR

Presidential Regulation No. 16/2016 stipulates that the leading institution for the coordination of climate change governance and implementation of the Climate Change Convention at national level is assigned to the Directorate General of Climate Change (DGCC) of the Ministry of Environment and Forestry. In the preparation of the BUR 3, coordination and collaboration were developed by DGCC engaging other Ministries/Agencies to create effective institutional arrangements for planning. Data were gathered from various ministries and agencies. The coordination among sectors and directorates was similar and followed the institutional arrangement for the development of national communications as depicted in Figure 1-25.

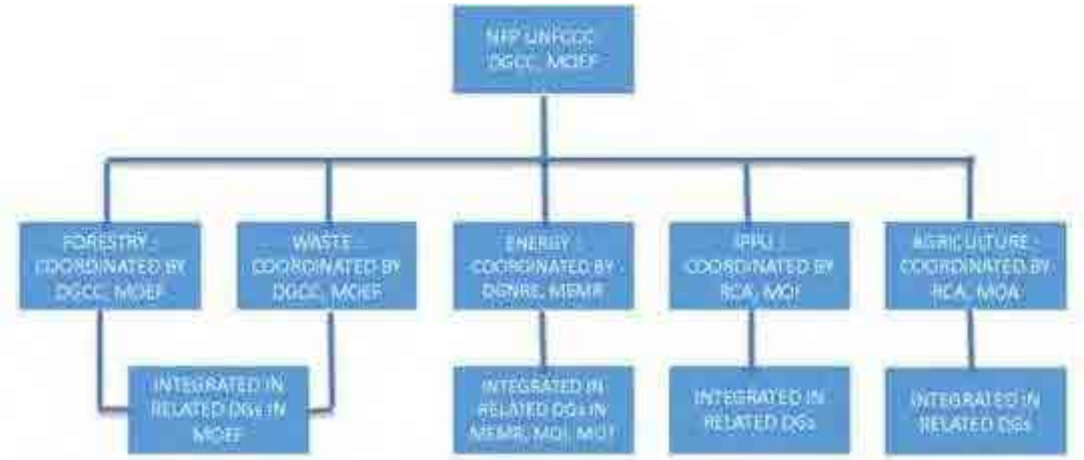


Figure 1-25. Institutional arrangement in the development of national communication

The institutional arrangements for the Third Biennial Update Report involves the following ministries and institutions: BAPPENAS (Ministry of National Development), Ministry of Agriculture, Ministry of Energy and Mineral Resources, Ministry of Industry, Ministry of Transportation, Ministry of Public Works and Housing, Ministry of Higher Education and Research and Technology, Coordinating Ministry of Economy, Agency of the Assessment and Application of the Technology (BPPT), Meteorological, Climatological and Geophysical Agency (BMKG), National Disaster Management Authority (BNPB), Statistic Indonesia (BPS), BIG and LAPAN, as well as National Peatland Restoration Agency and Research Institutes (ITB, IPB). For the BUR 3, the DGCC, MoEF had coordinated the whole process of the development and submission of the document following the institutional arrangement as summarized in Table 1-13.

Table 1-13. Institutional arrangement for the BUR 3

Working Group	**I**	**II**	**III**	**IV**
Chapter	National Circumstances and Institutional Arrangement	National GHG Inventories	Mitigation Actions and Their Effects	Financial, Technology, Capacity Needs and Support Received for Climate Change Activities

Coordinator:	Director of GHG Inventory and MRV, MoEF	Director of GHG Inventory and MRV, MoEF	Director of Mitigation of Climate Change, MoEF	Director of Sectoral and Regional Resources Mobilization, MoEF
Relevant Ministries/Agencies:	• BPS • BIG • BMKG • MEMR • Ministry of Transportation • Ministry of Agriculture • Ministry of Industry • Research Institutes (IPB & ITB)	• MoEF • Ministry of Agriculture • MEMR • Ministry of Industry • Ministry of Transportation • Ministry of Public Works and Housing • BPS • BIG • LAPAN • Research Institutes (ITB, IPB, CIFOR)	• MoEF • BAPPENAS • Ministry of Energy and Mineral Resources • Ministry of Transportation • Ministry of Agriculture • Ministry of Industry • Ministry of Public Works and Housing • Ministry of Agraria Affairs and Spatial Planning/ National Land Agency • National Peatland Restoration Agency • Research Institutes (ITB, IPB)	• MoEF • BAPPENAS • Ministry of Agriculture • MEMR • Ministry of Industry • Ministry of Transportation • Ministry of Public Works and Housing • MoMEF • Ministry of Higher Education and Research and Technology • Coordinating Ministry of Economy • Agency of the Assessment and Application of the Technology (BPPT) • BMKG • National Disaster Management Authority (BNPB) • BPS • BIG • LAPAN

CHAPTER 2. NATIONAL GREENHOUSE GAS INVENTORY

2.1 Introduction

The National Greenhouse Gas (GHG) Inventory is compiled from the 2006 IPCC Guidelines and the 2013 Wetlands Supplement, which covers GHG emission and/or removal from energy, Industrial Processes and Products Use (IPPU), Agriculture, Forestry and Other land use (AFOLU), and waste sectors for the period of 2000-2019. The type of gases reported are five out of the six main GHG categories of the 2006 IPCC Guidelines, i.e., carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), perfluorocarbons or PFCs (CF_4 and C_2F_6) while other gases (HFCs and SF_6) were not estimated due to the unavailability of data. Non-CO_2 gases, i.e., CO, NOx, NMVOC, and SOx are not required to be reported in the National GHG Emissions Inventory under the 2006 IPCC Guidelines, but the NO_x and CO are reported in the agriculture sector.

2.2 Institutional Arrangements

The institutional arrangement for the development of National GHG Inventory is regulated pursuant to the Ministerial Regulation No. 73/2017 on Article 9 Point (1). Point G of Annex 1 to this regulation refers to the unit responsible for the sources of GHG emissions in each sector and their tasks as presented in Table 2-1.

Table 2-1. Institutional Arrangement

Sector/Categories	Sub sectoral Responsible Units
A. GHG Emissions from Energy	
Coordinator: Ministry of Energy and Mineral Resources (MEMR) - Centre for Data and Information Technology	
Reference Approach	Centre for Data and Information Technology-MEMR
Electricity generation	Centre for Data and Information Technology-MEMR
Oil and gas *(Fuel + Fugitive)*	Centre for Data and Information Technology-MEMR
Coal mining (*Fuel + Fugitive*)	Centre for Data and Information Technology-MEMR
Transportation	Centre for Data and Information Technology-MEMR
	Centre for Sustainable Transportation Management - Ministry of Transportation (MoT)
Energy industry	Centre for Data and Information Technology-MEMR
	Centre for Research and Development of Green Industry and Environment-Ministry of Industry (MoI)
Energy in commercial areas	Centre for Data and Information Technology, MEMR
Energy in residential areas	Centre for Data and Information Technology, MEMR
B. GHG Emissions from Industrial Processes and Products Use (IPPU)	
Coordinator: Ministry of Industry (MoI)- Centre for Research and Development of Green Industry and Environment	
Industrial Processes	Centre for Research and Development of Green Industry and Environment and Centre for Data and Information, MoI
	Directorate for Industrial Statistics-National Bureau of Statistics of Indonesia, BPS)
Products use	Centre for Data and Information Technology, MoI
C. GHG Emissions from Waste Management	
Coordinator: Ministry of Environment and Forestry (MoEF)—Directorate of Waste Management	
Municipal Solid Waste (MSW)	Directorate for Waste Management, MoEF
	Directorate for Development of Environmental Sanitation and Housing-Ministry of Public Works and Housing (MPWH)
Domestic Wastewater	Directorate for Water Pollution Control, MoEF

Sector/Categories	Sub sectoral Responsible Units
	Directorate for Development of Environmental Sanitation and Housing, MPWH
	Centre for Research and Development of Housing and Settlement, MPWH
Industrial Solid Waste (including Pharmaceutical Waste)	Directorate for Management of Hazardous Waste, MoEF
	Centre for Research and Development of Green Industry and Environment, MoI, Centre for Data and Information, MoI
	Directorate of Statistical Industry, BPS
Industrial Wastewater	Secretariat for the Directorate General Control of Pollution and Environmental Damage, MoEF; Directorate for Performance Appraisal of Hazardous Waste Management, MoEF
	Centre for Research and Development of Green Industry and Environment, MoI, Centre for Data and Information, MoI; Directorate for Beverage, Tobacco, and Refreshment Industry, MoI, Directorate for Food, Marine and Fishery Products Industry, MoI
	Directorate of Statistical Industry, BPS
D. GHG Emissions from Agriculture	
Coordinator: Ministry of Agriculture (MoA)— Planning Bureau	
Livestock	Directorate General for Animal Husbandry and Health, Centre for Data and Information, Planning Bureau, Centre for Livestock Research and Development, Agency for Research in Agriculture Environment, MoA
	Directorate for Animal Husbandry, Fisheries, and Forestry, BPS
Aggregate Sources and Non-CO_2 Emissions	Directorate General for Crops, Directorate General for Agricultural Infrastructure and Facilities, Directorate General for Horticulture, Directorate General for Plantation, Centre for Data and Information, Planning Bureau, Centre for Agricultural Land Resources, Agency for Research in Agriculture Environment, MoA
	Directorate for Statistics on Crops, Horticulture and Estate, BPS
D. GHG Emissions from Forestry and Other Land Uses	
Coordinator : Ministry of Environment and Forestry (MoEF)— Directorate of GHG Inventory and MRV	
Forestry and Other Land Uses	Directorate General for Sustainable Production Forest Management, Centre for Data and Information, Directorate for Forest Resources Inventory and Monitoring, Centre for Research and Development on Social Economy Policy and Climate Change, Centre for Forestry Research and Development, Directorate for Peat Damage Control, MoEF
	Centre for Agricultural Land Resources, MoA
	Deputy for Thematic Geospatial Information -- Geospatial Information Agency
	Remote Sensing Application Centre, Deputy for Remote Sensing-- National Institute of Aeronautics and Space (*LAPAN)*

The arrangement is set out in Point (3) of Article 9 which stipulates the sectoral subunit responsible for providing data, information and estimates, related to their subsector's GHG Inventory to the Sectoral Coordinator. Article 9 Point (4) requires Sectoral Coordinators to compile and transmit data and information (including GHG emissions estimates) and report to the MoEF. Previously, sectors only supplied the data, while the MoEF calculated the emission. In accordance with Ministerial Decree No. 73/2017, the sectors are also responsible for performing the calculation of emissions and QA/QC. However, for the time being, sectors provide the data and also calculate the emissions through a series of data consolidation.

2.2.1 Time Series

The GHG inventory reported in this BUR 3 corresponds to GHG emissions and sinks for the period of 2000 – 2019. The GHG emissions for the period 2017 – 2019 period are supplementary inventory data to the BUR 2, in which the GHG emissions from 2000 to 2016 constitute the updated GHG inventory of the BUR 2 document. The updated inventory includes methodological changes, activity data due to some revisions of relevant sector data, emission factors, and other relevant data on nearly all sectors of GHG emission sources and sinks (except the IPPU subsector category). In addition, the BUR 3 also covers other sources (categorisation of subsectors). Discussion of the updated dataset is presented in the Sectoral Emission subsection.

2.2.2 National Emissions

Indonesia has completed the National GHG Emissions and Sinks Inventory for the three main gases, i.e., CO_2, CH_4 and N_2O, including PFCs (CF_4 and C_2F_6) and non-CO_2. The calculation of PFCs is used to estimate the GHG emission reduction potential resulting from Indonesia's aluminium industry IPPU mitigation actions, while the calculation of non-CO_2 emissions covers GHG emissions from biomass combustion in the Aggregate and Non-CO_2 Emissions Sources on Land (AFOLU) category.

The 2019 National GHG of Emissions and Sinks Inventory shows the total of the three main gases (CO_2, CH_4, and N_2O) has reached 1,845,067 Gg CO_2e. It increased by 805,722 Gg CO_2e or 77.52% from its emission level in 2000. The average annual growth of these GHG over the 2000-2019 period was 10.52%. The GHG was dominated by CO_2 (86.35%), followed by CH_4 (10.04%) and N_2O (3.62%). Table 2-2 summarises the national GHG inventory while detailed data on GHG emissions and sinks are presented in Table 2-4. Referring to Table 2-4, the primary sources of the five gases are AFOLU and peat fire, which accounted for 55.83% of total GHG (three gases) followed by energy, waste, and IPPU, i.e., 34.49%, 6.52%, and 3.15% respectively. In the absence of FOLU (Forestry, and Land Use) and peat fire, energy sector was the main contributor accounting for 69.16% of the total GHG emissions (Figure 2-1).

Table 2-2. Summary of National GHG Emissions in 2000 and 2019 (Gg CO_2e)

No	Sectors	Year	CO_2	CH_4	N_2O	CF_4	C_2F_6	CO	NOx	NMVOC	SOx	Total 3 Gases
1	Energy	2000	284,503	29,728	3,378			NE	NE	NE	NE	317,609
		2019	615,262	16,464	4,726			NE	NE	NE	NE	636,453
2	IPPU	2000	42,401	98	149	250	22	NO	NO	NO	NO	42,648
		2019	57,252	91	784	46	0	NO	NO	NO	NO	58,128
3	Agriculture	2000	4,710	39,940	39,888			2,737	74	NE	NE	84,537
		2019	7,343	46,407	51,552			2,436	66	NE	NE	105,301
4	FOLU	2000	529,815	1,505	1,040			NE	NE	NE	NE	532,360
		2019	910,280	8,527	6,045			NE	NE	NE	NE	924,853
5	Waste	2000	2,216	57,431	2,544			NE	NE	NE	NE	62,191
		2019	3,026	113,702	3,606			NE	NE	NE	NE	120,333
Total (CO_2-eq)		2000	863,645	128,702	46,998	250	22	2,724	70	0	0	1,039,345
		2019	1,593,163	185,191	66,713	46	0	1,500	41	0	0	1,845,067
Percentage (%)		2000	83.10	12.38	4.52	-	-	-	-	-	-	100.00
		2019	86.35	10.04	3.62	-	-	-	-	-	-	100.00

NE = Not Estimated; NO = Not Occurring

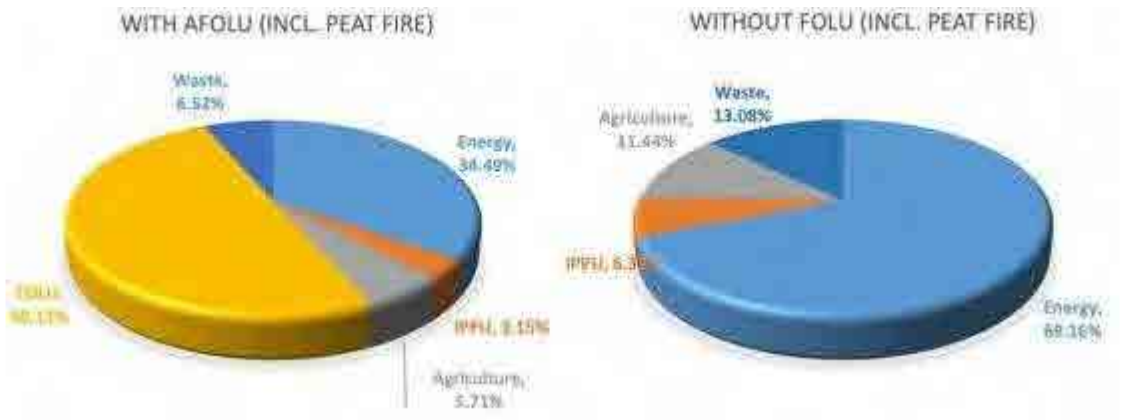


Figure 2-1. National GHG Emissions by Sector in 2019

2.2.3 Sectoral Emissions

This section describes the national GHG inventory from 2000 to 2019. The inventory for 2000-2016 was reported in BUR 2. In this section, the BUR 2 inventory is maintained up to 2019, according to sector category. The GHG inventory includes all anthropogenic emissions by sources/sinks, i.e., energy, IPPU, AFOLU, and waste category.

The methodology used for estimating GHG emissions or removals from 2000 to 2019 was based on the 2006 IPCC Guidelines. In some sectors, activity and local emission updates are available for 2000-2016. Emission estimates for the 2017-2019 period were also based on up-to-date activity and local emission factors (for selected sectors).

With reference to the 2006 IPCC Guidelines, the estimated GHG emissions cover 3 (three) gases, as follows: CO_2, CH_4, and N_2O that generated from all sectors, i.e. energy, IPPU, AFOLU, and waste sectors. The Global Warming Potential (GWP) values follow the IPCC's Second Assessment Report as indicated in Table 2-3 below.

Table 2-3. Global Warming Potential Values*)

Greenhouses Gas	Chemical Formula	GWP
Carbon dioxide	CO_2	1
Methane	CH_4	21
Nitrous oxide	N_2O	310
PFC-14	CF_4	6,500
PFC-116	C_2F_6	9,200
Sulphur hexafluoride	SF_6	23,900

*) Based on *Second assessment Report (SAR) for 100 years*

Table 2-4. Summary of 2019 National GHG Emissions (Gg CO_2e)

Categories	Total 3 Gases	Net CO_2 (1) (2)	CH_4	N_2O	HFCs	PFCs	SF_6	Other halogenated gases with CO_2 equivalent conversion factors (3)	Other halogenated gases without CO_2 equivalent conversion factors (4)	NOx	CO	NMVOCs	SO_2
	CO_2 equivalents (Gg)												
Total National Emissions and Removals	**1,845,067**	**1,593,163**	**185,191**	**66,713**		**46**							
1 ENERGY	**636,453**	**615,262**	**16,464**	**4,726**									
1A Fuel Combustion Activities	**615,945**	**609,094**	**2,135**	**4,715**									
1A1 Energy Industries	289,001	287,750	75	1,176									
1A2 Manufacturing Industries and Construction	136,179	134,985	385	810									
1A3 Transport	157,771	154,280	927	2,563									
1A4a Commercial/Institutional	2,163	2,097	54	13									
1A4b Residential	25,700	24,880	680	140									
1A5 Other/Non-Specified	5,130	5,102	15	13									
1B Fugitive Emissions from Fuels	**20,508**	**6,168**	**14,329**	**11**									
1B1 Solid Fuels	2,688	NE	2,688	NO									
1B2 Oil and Natural Gas	17,821	6,168	11,642	11									
1B3 Other Emissions from Energy Production	NE	NE	NE	NE									
1C Carbon Dioxide Transport and Storage	**NO**	**NO**											
1C1 Transport of CO_2	NO	NO											
1C2 Injection and Storage	NO	NO											
2 INDUSTRIAL PROCESSES AND PRODUCT USE	**58,128**	**57,252**	**91**	**784**		**46**							
2A Mineral Industry	**32,762**	**32,762**	**NE**	**NE**									
2A1 Cement Production	30,156	30,156	NE										
2A2 Lime Production	125	125	NE										
2A3 Glass Production	50	50	NE										
2A4a Ceramic production	4	4	NE										
2A4b Other Process Uses of Carbonates	2,333	2,333	NE										
2A4d Other Carbonate Consumption	94	94	NE										
2A5 Other (please specify)													
2B Chemical Industry	**13,616**	**12,741**	**91**	**784**									
2B1 Ammonia Production	9,703	9,703											
2B2 Nitric Acid Production	784	NA		784									
2B3 Adipic Acid Production	NO	NO	NO	NO									

Categories	Total 3 Gases	Net CO_2 (1) (2)	CH_4	N_2O	HFCs	PFCs	SF_6	Other halogenated gases with CO_2 equivalent conversion factors (3)	Other halogenated gases without CO_2 equivalent conversion factors (4)	NOx	CO	NMVOCs	SO_2
	CO_2 equivalents (Gg)												
2B4 Caprolactam, Glyoxal and Glyoxylic Acid Production	NO	NO	NO	NO									
2B5 Carbide Production	31	31											
2B6 Titanium Dioxide Production	NE	NE	NE	NE									
2B7 Soda Ash Production	NE	NE	NE	NE									
2B8a Methanol	310	276	35										
2B8b Ethylene	2,080	2,023	57										
2B8c Ethylene dichloride and VCM	485	485	NA										
2B8f Carbon Black	224	223	0.1										
2B9 Fluorochemical Production					NO	NO	NO	NO	NO				
2B10 Other (please specify)													
2C Metal Industry	**7,473**	**7,473**	**0**	**NE**		**46**							
2C1 Iron and Steel Production	6,927	6,927	0	NE									
2C2 Ferroalloys Production	NE	NE	NE	NE									
2C3 Aluminium Production	376	376	NE			46							
2C4 Magnesium Production	NE	NE			NE	NE	NE	NE	NE				
2C5 Lead Production	88	88											
2C6 Zinc Production	83	83											
2C7 Other (please specify)													
2D Non-Energy Products from Fuels and Solvent Use	**4,126**	**4,126**	**NE**	**NE**									
2D1 Lubricant Use	232	232											
2D2 Paraffin Wax Use	3,894	3,894	NE	NE									
2D3 Solvent Use													
2D4 Other (please specify)													
2E Electronics Industry	NE	NE	NE	NE	NE	NE	NE	NE	NE				
2E1 Integrated Circuit or Semiconductor	NE	NE		NE	NE	NE	NE	NE	NE				
2E2 TFT Flat Panel Display					NE	NE	NE	NE	NE				
2E3 Photovoltaics					NO	NO	NO	NO	NO				
2E4 Heat Transfer Fluid								NE	NE				
2E5 Other (please specify)													
2F Product Uses as Substitutes for Ozone Depleting Substances	NE	NE	NE	NE	NE	NE		NE	NE				

Categories	Total 3 Gases	Net CO_2 (1) (2)	CH_4	N_2O	HFCs	PFCs	SF_6	Other halogenated gases with CO_2 equivalent conversion factors (3)	Other halogenated gases without CO_2 equivalent conversion factors (4)	NOx	CO	NMVOCs	SO_2
	CO_2 equivalents (Gg)												
2F1 Refrigeration and Air Conditioning	NE	NE			NE	NE		NE	NE				
2F2 Foam Blowing Agents	NE	NE			NE	NE		NE	NE				
2F3 Fire Protection	NE	NE			NE	NE		NE	NE				
2F4 Aerosols					NE	NE		NE	NE				
2F5 Solvents					NE	NE		NE	NE				
2F6 Other Applications													
2G Other Product Manufacture and Use	NE	NE	NE	NE									
2G1 Electrical Equipment	NE												
2G2 SF6 and PFCs from Other Product Uses	NE												
2G3 N_2O from Product Uses	NE			NE									
2G4 Other (please specify)													
2H Other (please specify)	150	150	NE	NE									
2H1 Pulp and Paper Industry	147	147	NE										
2H2 Food and Beverages Industry	2	2	NE										
2H3 Other (please specify)													
3 AGRICULTURE, FORESTRY AND OTHER LAND USE	**1,030,154**	**917,623**	**35,264**	**50,290**						66	2,436		
3A Livestock	**26,977**												
3A1 Enteric Fermentation	17,898		17,898										
3A2 Manure Management	1,772		1,772										
3A2b Direct N_2O Emissions from Manure Management	7,307			7,307									
3B Land	**910,280**	**910,280**	**0**	**0**									
3B1 Forest Land	-355,211	-355,211	NE	NE									
3B2 Cropland	83,146	83,146	NE	NE									
3B3 Grassland	77,806	77,806	NE	NE									
3B4 Wetlands	0	0	NE	NE									
3B5 Settlements	60,330	60,330	NE	NE									
3B6 Other Land	189,604	189,604											
Peat Decomposition	398,178	398,178	NE	NE									
Peat Fire	456,427	456,427	NE	NE									

Categories	Total 3 Gases	Net CO_2 (1) (2)	CH_4	N_2O	HFCs	PFCs	SF_6	Other halogenated gases with CO_2 equivalent conversion factors (3)	Other halogenated gases without CO_2 equivalent conversion factors (4)	NOx	CO	NMVOCs	SO_2
	CO_2 equivalents (Gg)												
3C Aggregate Sources and Non-CO_2 Emissions Sources on Land	**92,896**	**7,343**	**35,264**	**50,290**						66	2,436		
3C1 Biomass Burning	16,649	NE	10,029	6,620						66	2,436		
3C2 Liming	2,160	2,160											
3C3 Urea Application	5,182	5,182											
3C4 Direct N_2O Emissions from Managed Soils	31,800			31,800									
3C5 Indirect N_2O Emissions from Managed Soils	7,526			7,526									
3C6 Indirect N_2O Emissions from Manure Management	4,343			4,343									
3C7 Rice Cultivations	25,235		25,235										
3C8 Other (please specify)	0	NE	NE	NE									
3D Other	**NE**	**NE**	**NE**	**NE**									
3D1 Harvested Wood Products	NE	NE	NE	NE									
3D2 Other (please specify)	NE	NE	NE	NE									
4 WASTE	**120,333**	**3,026**	**113,702**	**3,606**									
4A1.2 Industrial Solid Waste Disposal	20		20										
4A2 Unmanaged Municipal Solid Waste Disposal	38,487		38,487										
4B1 Biological Treatment of Domestic Solid Waste	2		0,06	2									
4B2 Biological Treatment of Industrial Solid Waste	2		1	1									
4C2 Open Burning of Waste	5,296	3,025	1,923	348									
4D Wastewater Treatment and Discharge	76,416		73,161	3,255									
4D1 Domestic Wastewater Treatment and Discharge	23,584		20,329	3,255									
4D2 Industrial Wastewater Treatment and Discharge	52,832		52,832										
4E Other	111	1	109										
5 OTHER	NE			NE									
5A Indirect N_2O Emissions from the Atmospheric Deposition of Nitrogen in NOx and NH_3	NE			NE									

Categories	Total 3 Gases	Net CO_2 (1) (2)	CH_4	N_2O	HFCs	PFCs	SF_6	Other halogenated gases with CO_2 equivalent conversion factors (3)	Other halogenated gases without CO_2 equivalent conversion factors (4)	NOx	CO	NMVOCs	SO_2
	CO_2 equivalents (Gg)												
5B Other (please specify)	NE			NE									

Notes

NE = Not estimated — Emissions and/or removals occur but have not been estimated.

NA = Not applicable — The activity or category exists but relevant emissions and removals are considered never to occur.

NO = Not occurring — The activity or process does not exist in Indonesia.

2.2.3.1 Energy

This section provides updates on all relevant GHG emissions data from all categories sector sources of GHG emissions and improvements with regard to source categories and data sources. The categorisation of subsector reported in this BUR 3 is the same as that of BUR 2, i.e., 1A1 Energy Industry, 1A2 Manufacturing Industry and Construction, 1A3 Transportation, 1A4 Other: Residential and Commercial, 1A5 Non-Specified and 1B Fugitive emission. In the BUR 2, fuel combustion data for the period of 2000-2016 referenced fuel consumption data in HEESI (Handbook of Energy and Economics Statistics of Indonesia) 2016 and 2018. In this BUR 3, the activity data is updated from HEESI 2021. Emission levels for the energy sector were estimated using emission factors from the Tier 1 methodology outlined in the 2006 IPCC Guideline.

Based on energy data, data on fuel combustion for an industry subsector is data collected at the plant level data through the MoI. GHG emissions from fuels combustion in manufacturing industry were grouped under Category 1.A.2 Manufacturing Industries. In the BUR 2, these GHG emissions were disaggregated into:

1.A.2.a	:	Iron and steel,
1.A.2.c	:	Chemicals (ammonium fertiliser, EDC/VCM, carbide, Ethylene oxide, and others),
1.A.2.d	:	Pulp, Paper, and Print,
1.A.2.e	:	Food Processing, Beverages, and Tobacco,
1.A.2.f	:	Non-metallic minerals (cement, ceramic and glass), and
1.A.2.m	:	Non-specified industry. This category consists of industries other than those included in 1.A.2.a, 1.A.2.c, 1.A.2.d, 1.A.2.e and 1.A.2.f.

In transport sector, the emissions are disaggregated into:

1.A.3.a	:	Civil Aviation,
1.A.3.b & 1A.3.c	:	1.A.3.b Road Transportation and 1.A.3.c Railway referred as Land transportation. It should be noted that the data of fuels combustion in land transport can not be disaggregated into road and railway.
1.A.3.d	:	Water-Borne Navigation.

In 1.A.4 Other sectors consists of Residential and Commercial subsectors. 1.A.5 Non-specified category refers to subsectors that were not specified in the main subcategories, i.e. agriculture, construction, and mining (ACM). Under the BUR 3, GHG emissions from this subcategory was still aggregated due to limitation in fuel use data for each subsector, i.e., agriculture, construction and mining subcategory. It was difficult to disaggregate the fuels used in the ACM subsectors as disaggregation would require extensive survey activity, which would require considerable in terms of budget and human resources, while the GHG emissions from ACM were relatively low.

Additionally, other sources were not included in the National GHG Inventory, i.e., gas processing plant that emit CO_2 as fugitives (1 B). Going forward, Indonesia will implement carbon capture and storage (CCS) or utilization (CCUS) to mitigate GHG emissions. It should be noted that the implementation of CCS/CCUS will generate GHG emission from CO_2 transportation, injection and storage. Consequently, whenever CCS/CCUS is implemented, CO_2 emissions produced by the CCS/CCUS facility are to be included in the national inventory.

Calculation of Energy Sector GHG Emissions Based on Sectoral and Reference Approaches

The Reference Approach is a top-down approach, using Indonesia's energy supply data to calculate CO_2 emissions from combustion mostly fossil fuels. The Sectoral Approach is a bottom-up approach, using final energy consumption data. It is good practice to apply both sectoral and reference approaches to estimate a country's CO_2 emissions from fuel combustion and to compare the results of both approaches. The following section discusses Indonesia's GHG emissions inventory based on sectoral and references approaches.

GHG Emission Estimates and Trends Under Reference Approach

As part of the reference approach, the GHG emissions inventory was aggregated according to the type of fuel consumed nationally. Referring to national fuel supply data for 2000 to 2019, GHG emissions were estimated using the reference approach. The results of the estimate are shown in Figure 2-2. Figure 2-2 shows that GHG emissions tend to fluctuate over the 2000-2019 period, but overall, they tend to increase. In 2000, the GHG emissions amounted to 301,734 Gg of CO_2 and rose to 643,129 Gg CO_2 in 2019. On average, over the 2000-2019 period, emissions grew 4.1% per year. Over the 2000-2016 period, the source of GHG emission was dominated by liquid fuels, however since 2017, emissions are dominated by solid fuels (coal). This is due to the increase in electricity production and coal is the least expensive fuel for electricity production. Of the total emissions in 2019 of 643,129 Gg CO_2, 51% (328,057 Gg CO_2) were attributable to coal. Oil (liquid fuels) accounted for 35% (225,682 Gg CO_2), and the remaining 14% (89,390 Gg CO_2) represented natural gas (gas fuels).

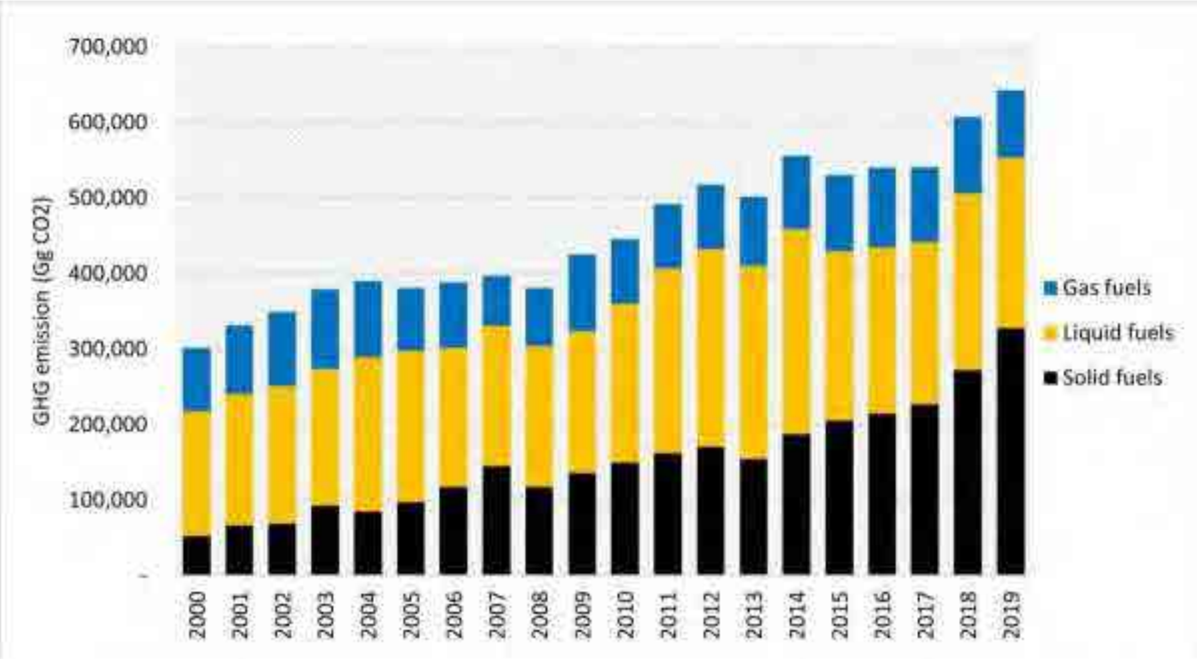


Figure 2-2. GHG emission under reference approach by fuel type in 2000-2019

Estimates and Trends of GHG Emission Under Sectoral Approach

Under the sectoral approach, GHG emissions are grouped by emissions subsector. Sectoral emissions for the period 2000-2019 are presented in Figure 2-3, in which it shows a slight fluctuation in emissions, but overall, the emissions trend is increasing. In this period, emissions increased at an average rate of 3.7% per year, from 317,609 Gg CO_2e in 2000 to 636,453 Gg CO_2e in 2019. In 2019, total emissions were 636,453 Gg CO_2e, including GHG emissions from fugitives. The emissions were dominated by electricity generation (43%), followed by transportation (24.8%), manufacturing industries (21.4%), residential (4.0%), fugitives emission from oil and gas (2.8%), 2.4% for oil and gas industries, 0.8% for non-specified, 0.4% fugitives emission from surface coal mining, 0.3% for commercial, and 0.003% for coal processing.

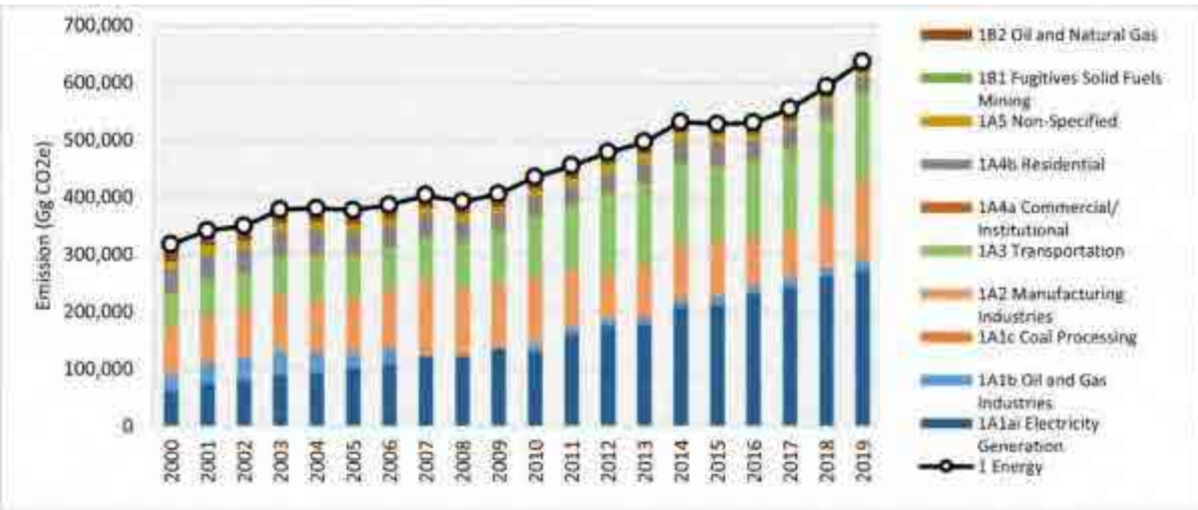
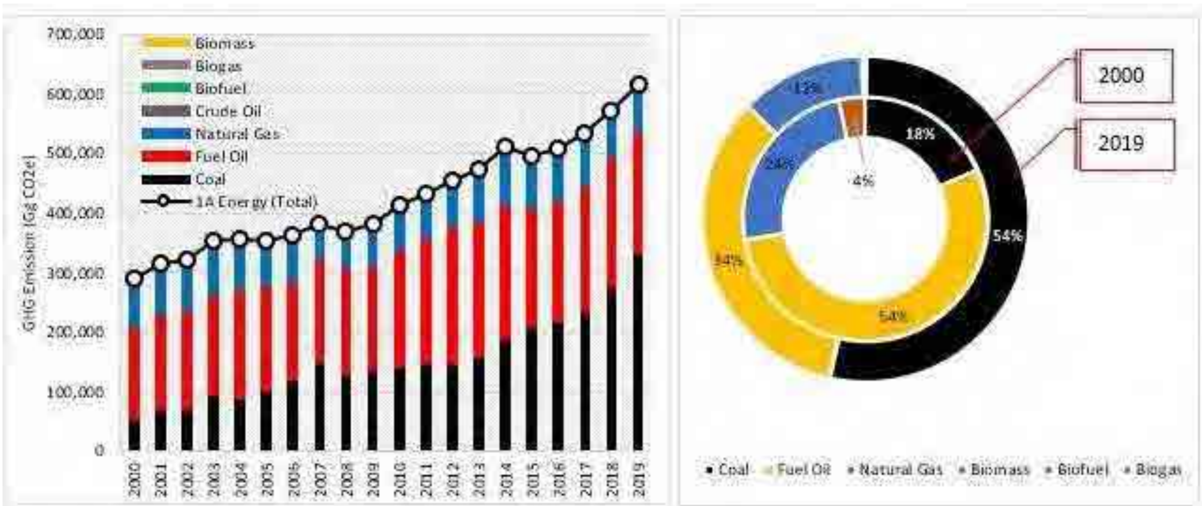


Figure 2-3. Sectoral approach to GHG emission in 2000-2019

It should be noted that the emissions levels for the year 2010-2016 reported in this BUR corresponds to the revised version reported in BUR 2. The revision was undertaken because in the BUR 2, emissions from the use of coal during these years, were calculated using inaccurate activity data, whereas data on national coal consumption included unknowingly/unintentionally data on coal exports. Coal data used to estimate emissions updates (2017-2019) are already accurate.

By fuel type, in 2000, GHG emissions from fuel combustion (excluding fugitive emissions) were dominated by fuel oil (54%), followed by natural gas (24%), coal (19%), and wood (3%). However, in 2019 there was a shift in the distribution of emission by fuel type i.e., the emission is dominated by coal (53.6%), followed by oil (34%), natural gas (13%), and the remaining in small quantities are biomass, biofuels, and biogas combustion. Figure 2-4 illustrates the development and distribution of emissions by fuel type.



(a) (b)

Figure 2-4. GHG emissions under sectoral approach: (a) by fuel type for period 2000-2019 and (b) shares by fuel type for 2000 and 2019

In contrast to the source of emissions in the reference approach, which are all combustion emissions, the source of emissions in the sectoral approach consists of combustion and fugitive emissions. Figure 2-5 depicts the development of fuel combustion and fugitive emissions over the 2000-2019 period, while details on energy sector GHG emissions for the three 2019 gases, are provided in Table 2-5.

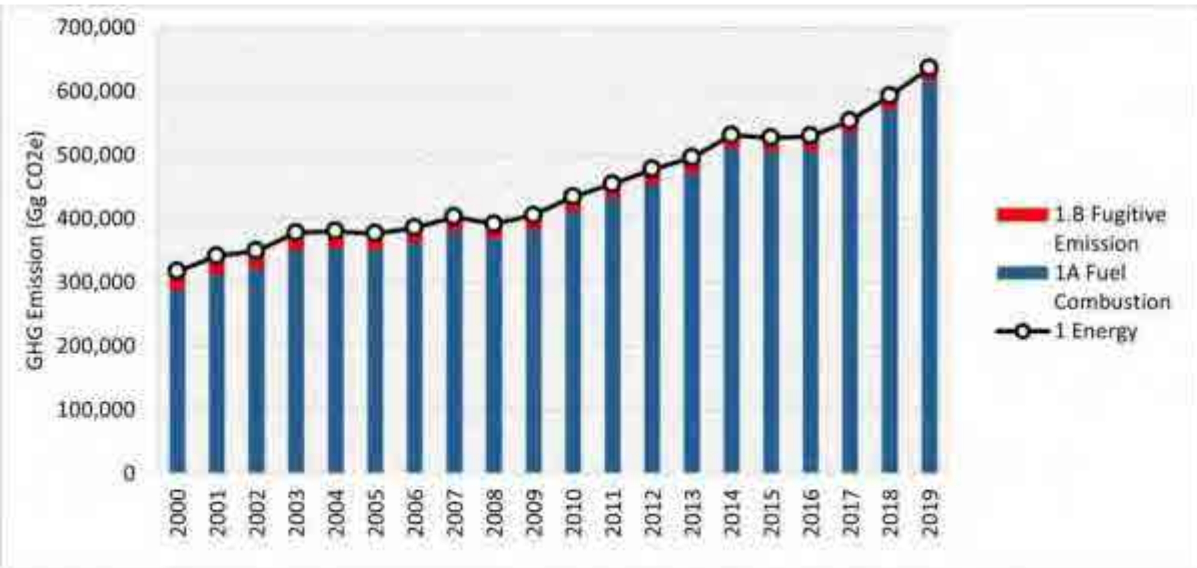


Figure 2-5. GHG emission under sectoral approach

Table 2-5. Summary of the 2019 GHG Emissions from Energy Sector

Code	Categories	CO_2	CH_4	N_2O	Total
		Gg CO_2	Gg CH_4	Gg N_2O	Gg CO_2e
Sectoral Approach					
1	Energy	615,262	784	15	636,453
1A	Fuel Combustion	609,094	102	15	615,945
1A1	Energy Industry	287,750	4	4	289,001
1A1a	Main Activity Electricity	272,288	3	4	273,523
1A1ai	Electricity Generation	272,288	3	4	273,523
1A1b	Oil and Gas Industry	15,443	0.3	0	15,459
1A1c	Coal Processing	19	0.0	0.0	19
1A2	Manufacturing Industry	134,985	18	3	136,179
1A2a	Iron and Steel	24,924	2.5	0.4	25,093
1A2c	Chemical	10,495	0.7	0.1	10,539
1A2d	Pulp, Paper, and Print	12,830	1.2	0.2	12,910
1A2e	Food Processing, Beverages, and Tobacco	14,211	0.25	0.03	14,224
1A2f	Non-Metallic Mineral Industry	20,234	1.8	0.3	20,357
1A2m	Non-specified Industry	52,291	12	2	53,066
1A3	Transportation	154,280	44	8	157,771
1A3a	Civil Aviation	12,450	0.1	0.3	12,560
1A3b & 1A3c	Land Transportation: Road and Railways	141,736	44	8	145,116
1A3d	Water-Borne Navigation	94	0.01	0.00	95
1A4	Other Sectors	26,977	35	0.5	27,863
1A4a	Commercial/ Institutional	2,097	2.6	0	2,163
1A4b	Residential	24,880	32	0.5	25,700
1A5	Non-Specified	5,102	0.7	0	5,130
1.B	Fugitive Emission	6,168	682	0	20,508
1B1	Solid Fuels	-	128	-	2,688
1B1a	Coal Mining and handling	-	128	-	2,688

Code	Categories	CO_2	CH_4	N_2O	Total
		Gg CO_2	Gg CH_4	Gg N_2O	Gg CO_2e
1B1ai	Underground coal mining				-
1B1aii	Surface coal mining	-	128		2,688
1B2	Oil and Natural Gas	6,168	554	0	17,821
1B2a	Fugitives Oil	1,972	481	0	12,074
1B2b	Fugitives Natural Gas	4,196	74	0	5,746
CO_2 from biomass combustion for energy		39,926	-	-	39,926

Based on gas types, the 2019 GHG emissions from energy sector were dominated by CO_2 (97%), followed by CH_4 (2%), and N_2O (1%) (see Figure 2-6).

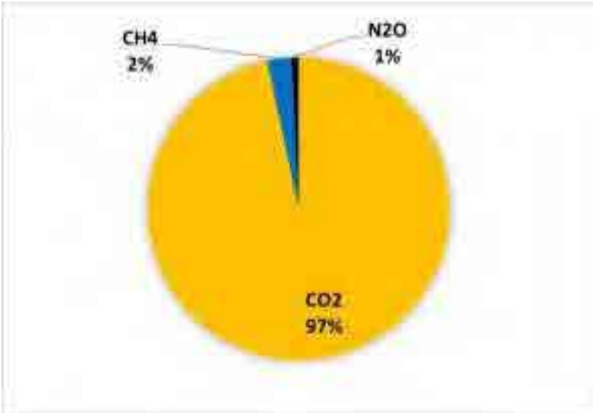


Figure 2-6. Share of GHG emissions in the energy sector in 2019 by type of gas

Differences Between Reference vs Sectoral Approaches

In accordance with the 2006 IPCC Guidelines, it is good practice to apply both the Sectoral Approach (bottom-up methodology) and the Reference Approach (top-down methodology) to estimate CO_2 emissions from fuel combustion and to compare the results of both independent estimates. The Reference Approach is a method applied to energy supply as apparent consumption. Based on the reported fuel consumption, each fuel has a carbon content that was used to estimate GHG emissions. Figure 2-7 shows the differences between reference and sectoral approaches over the period 2000-2019. The discrepancy between the two emissions, ranged between -5.0% to +8.5%. With the exception of some years, emissions calculated by reference approach generally exceeded the sectoral approach.

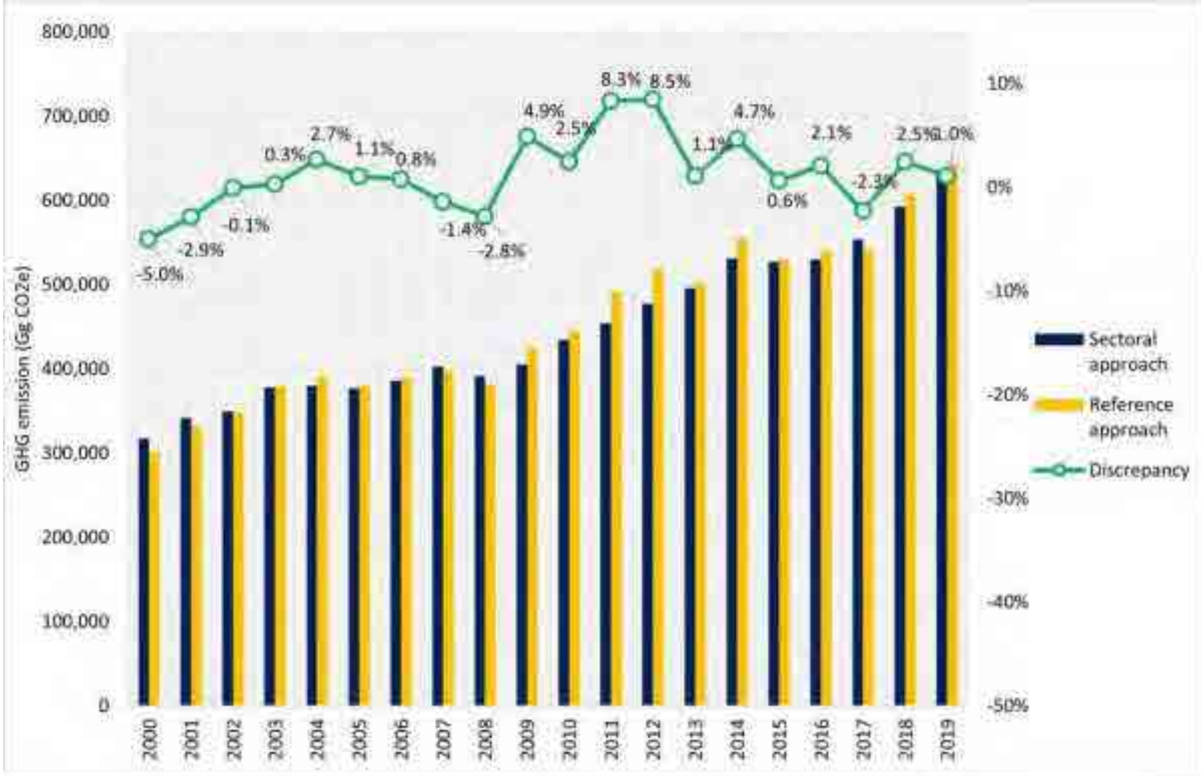


Figure 2-7. Differences in reference and sectoral approaches

GHG Emission by Subsector

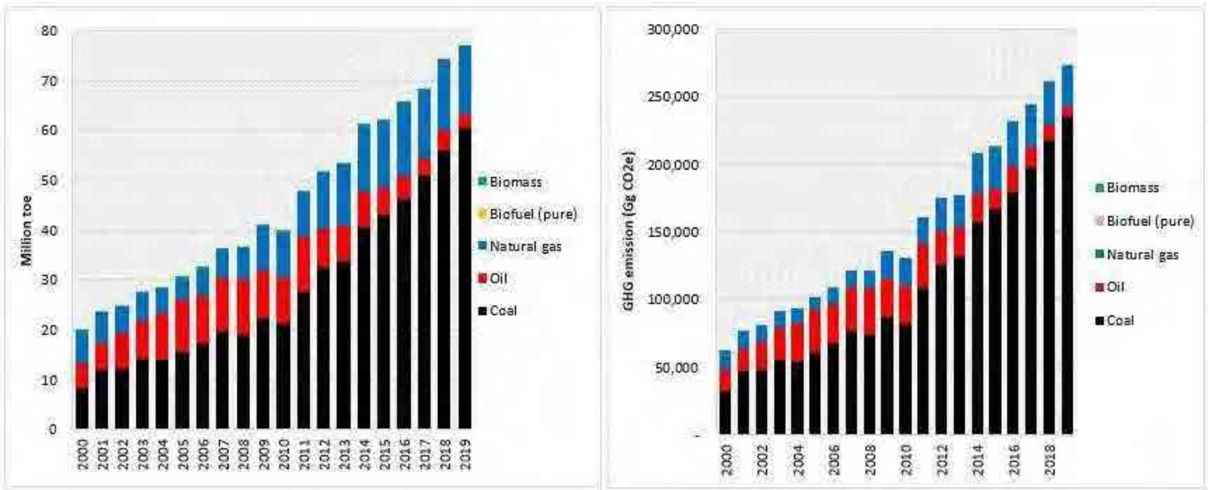
Detailed GHG emissions estimates for each emission subsectors are presented in the following subsectors: electricity production, oil and gas industries, coal processing, manufacturing, transportation, commercial and residential.

GHG Emission in Electricity Generation Subsector

Electricity generation is currently the largest GHG emitter among GHG emitters in the energy sector, representing 43% of energy sector emissions in 2019. The main source of emissions is coal combustion, while the remaining emissions are generated by the combustion of natural gas and liquid hydrocarbon. Changes in fuel consumption and the associated emissions from electricity generation from 2000 to 2019 are presented in Figure 2-8.

In this period, fossil fuel use has increase b an average of 7.5% annually, from 19.65 million toe in 2000 to 77 million toe in 2019. In 2019, coal consumption for electricity generation was 60.5 million toe, which is 78% of total fossil fuel consumption. Other fossil fuel accounted for 18% (13.70 million toe) of electricity generation in 2019 for natural gas and 4% (2.9 million toe) for oil.

GHG emission from electricity generation increased by an average of 8.1% per year from 62,030 Gg CO_2e in 2000 to 273,523 Gg CO_2e in 2019. Coal accounts for approximately 86% (234,831 Gg CO_2e) of total GHG emissions from electricity generation subsector in 2019.



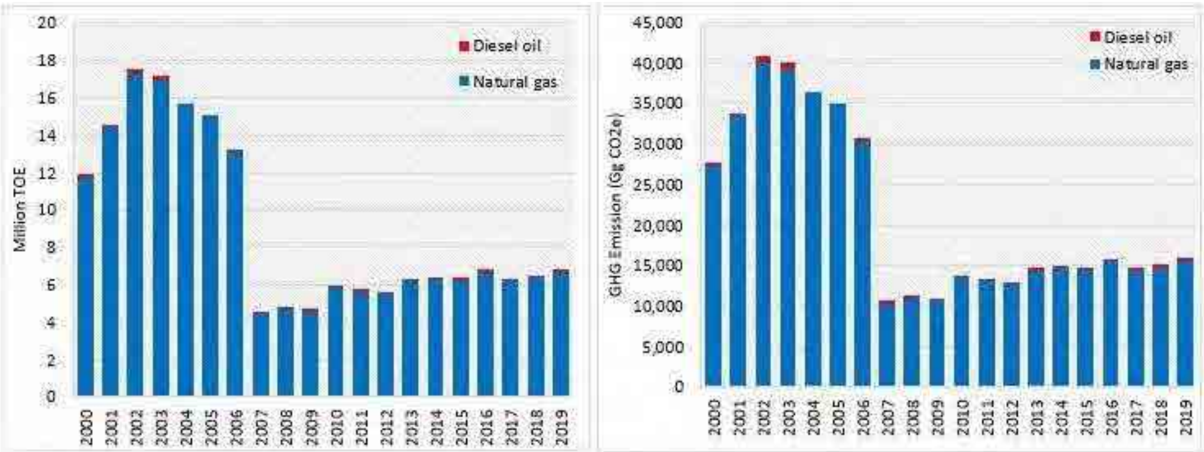
(a) (b)

Figure 2-8. The 2000-2019 electricity production subsector profile a) Energy use and (b) GHG emission

GHG Emission in Oil and Gas Industry Subsector

In the oil and gas industry subsector, GHGs are emitted by the combustion of fossil fuels during own use activities, transmission and distribution of fuels. The types of fossil fuels used by the oil and gas industry include diesel oil, crude oil and natural gas. Fossil energy use in then oil and gas industry between 2000 and 2019 is presented in Figure 2-9, which shows a fluctuation in consumption over the period of 2000-2006, followed by a sharp decline in 2007. This was followed by a modest gradual increase in consumption. As a result, trend in GHG emissions from the oil and gas industry is consistent with the trend in fuel consumption.

In 2019, GHG emissions from the oil and gas industry were 15,084 Gg CO_2e, almost entirely (98%) can be attributable to natural gas and the remaining 2% (374 Gg CO_2e) is attributable to diesel.

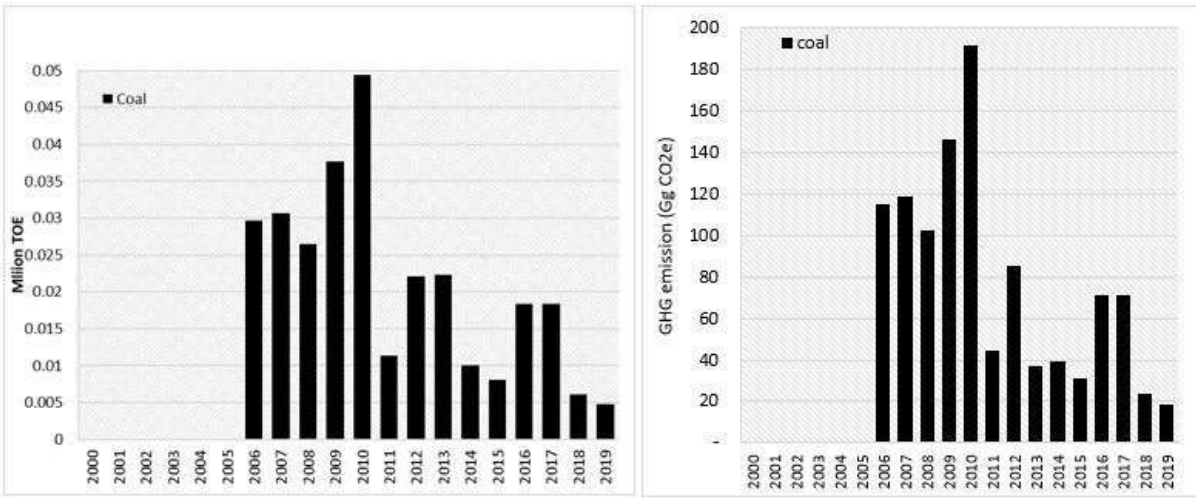


(a) (b)

Figure 2-9. The 2000-2019 gas industry subsector profile a) Energy use and (b) GHG emission

GHG Emission in Coal Processing Subsector

Figure 2-10 (a) depicts the current energy consumption in coal processing and the GHG emissions associated with energy consumption in Figure 2-10 (b). The figures show that coal processing had been carried out since 2006. Energy consumption in this subsector has fluctuated, with a declining tendency. Energy consumption in 2006 was 0.03 million toe and fell to 0.005 million toe in 2019. Sources of GHG emissions in coal processing originated from the combustion of coal and coal briquettes. The development of the associated GHG emissions correspondingly follows the trend in energy consumption. In 2019, GHG emissions from coal processing were 19 Gg CO_2e.



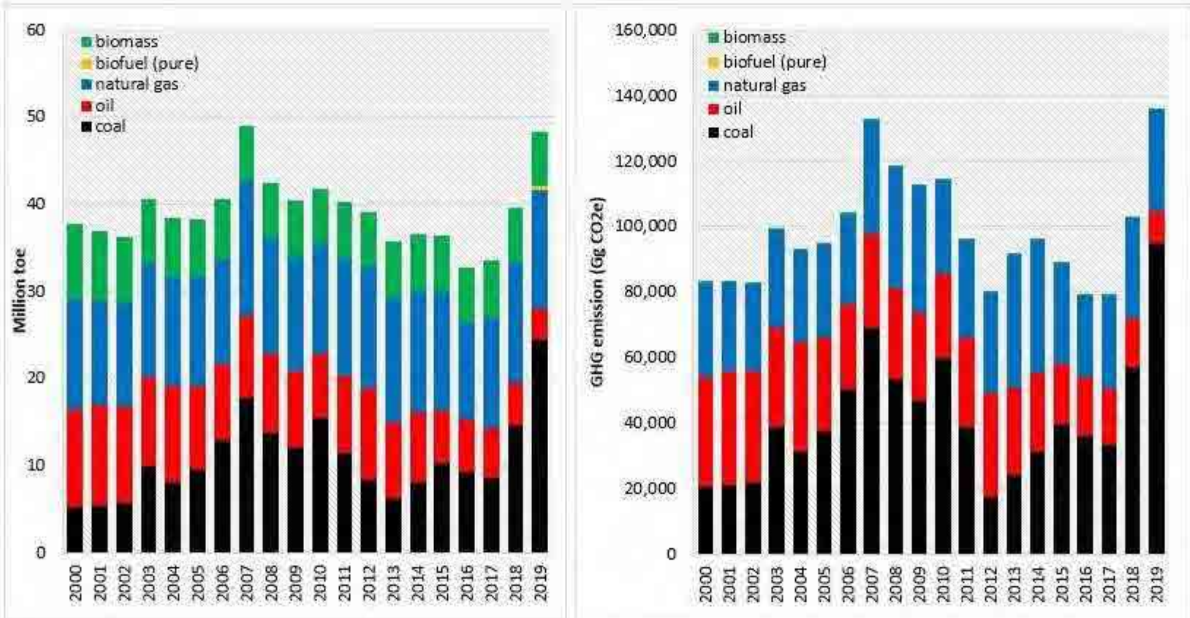
(a) (b)

Figure 2-10. The 2000-2019 coal processing subsector profile a) Energy use and (b) GHG emission

GHG Emission in Manufacturing Industries Subsector

For the manufacturing subsector, GHG emissions are calculated based on fuel combustion in this subsector. Changes in energy consumption in manufacturing industries for the period of 2000-2019 are presented in Figure 2-11 (a). Figure 2-11 (a) shows that energy consumption is dominated by fossil fuels, i.e., natural gas followed by oil and coal, even though in 2019, there is a shift in energy consumption by fuel type from oil to coal. Coal represented 51% of total energy consumption in this sector (24 million toe), followed by natural gas 28% (14 million toe), commercial biomass 13% (6 million toe), oil 7% (3.6 million toe), and the remaining less than 1% is biofuel (pure). It is noteworthy that biofuel is combusted as a mixture of 30% FAME (biodiesel) and 70% diesel.

Figure 2-11 (b) shows the GHG emissions associated with the combustion of these fuels. It is apparent from this figure that GHG emissions from coal combustion are the largest source of GHG emissions in this subsector. In 2000, the total GHG emissions from this subsector were 83,369 Gg CO_2e then rose to 1.6 times to reach 136,179 Gg CO_2e in 2019. In 2009, coal combustion was the largest emitter, accounting for 70% of total GHG emissions (95,166 Gg CO_2e), followed by 23% natural gas (30,661 Gg CO_2e) and 7% oil fuels (9,881 Gg CO_2e).



(a) (b)

Figure 2-11. The 2000-2019 manufacturing industry subsector profile a) Energy use and (b) GHG emission

With respect to the 2006 IPCC, the level of GHG emissions is broken down into several types of high-intensity energy industries. However, given the limited data, the types of industry included in this inventory are Iron and Steel (1A2a), Chemical (1A2c), Pulp, Paper, and Print (1A2d), Food Processing, Beverages, Tobacco (1A2e), Non-metallic mineral industry (1A2f), and Non-specified industry (1A2m).

The GHG emission level is calculated based on the energy consumption by fuel type of each industry. The energy consumption by industry type is shown in Figure 2-12.

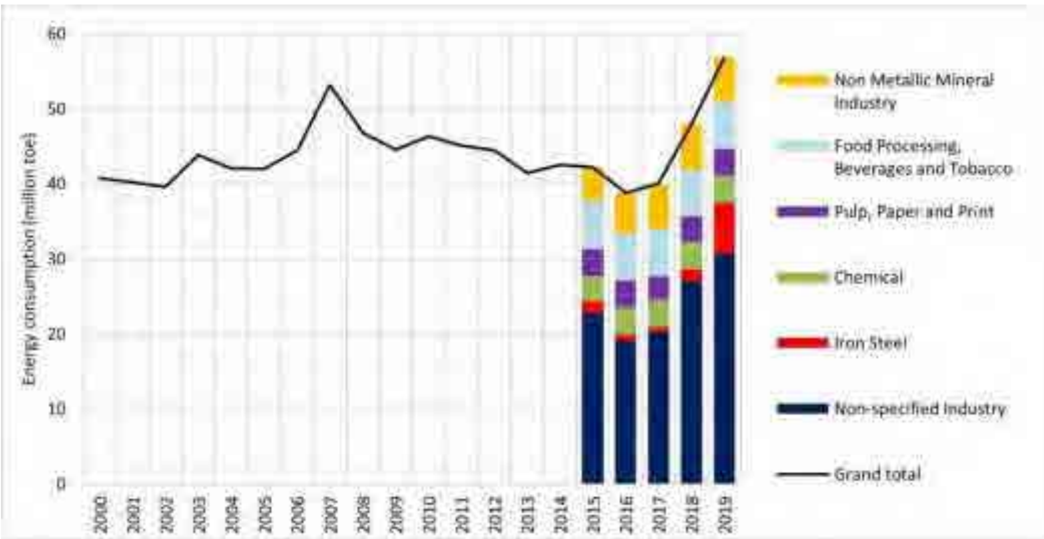


Figure 2-12. The 2000-2019 energy consumption by industry type

The GHG emission development profile for each industry subsector for the period of 2015 to 2019 is presented in Figure 2-13, which indicates that disaggregation of GHG emissions only covers 2015-2019. Prior to 2015, disaggregation cannot be carried out due to limited activity data for each of industry type. It is important to note that the level of GHG emissions (total and disaggregated) in 2010-2016 has been revised from the level reported in BUR 2 due to improvements in activity data over those year.

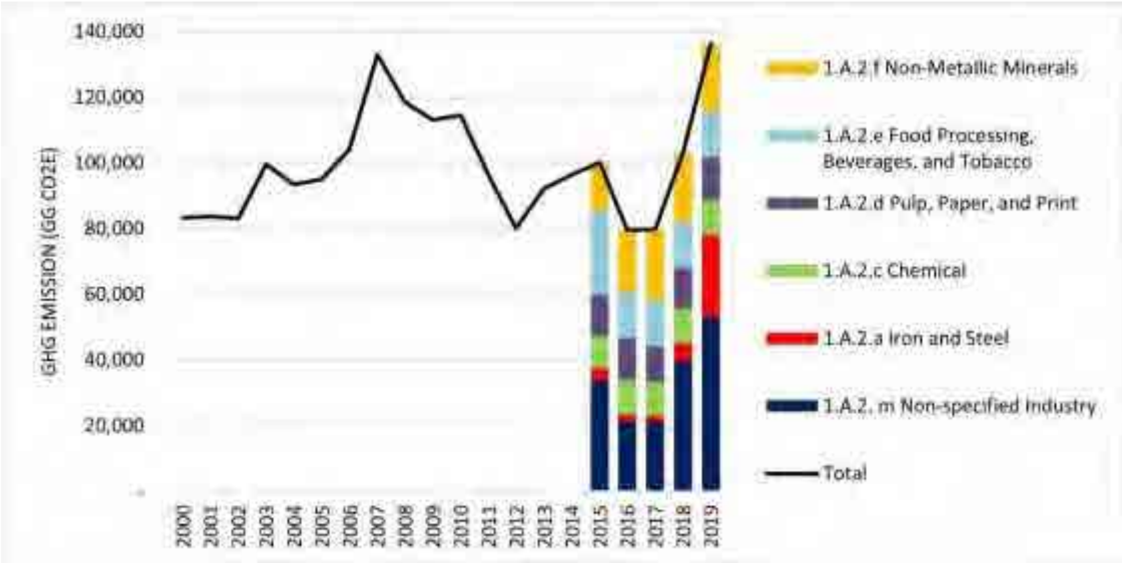
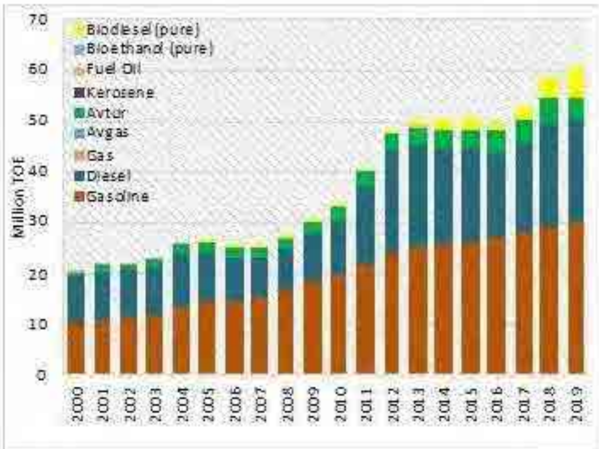


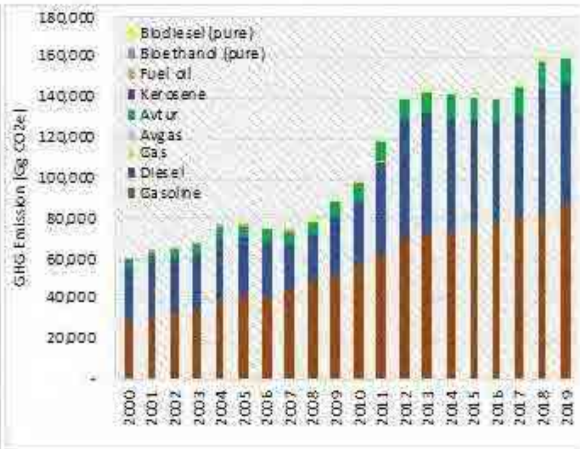
Figure 2-13. GHG emission from 2000 to 2019 by industry type

GHG Emission in Transport Subsector

The transport sector is one of the most important subsectors of energy consumption subsector in Indonesia. Since 2012, transportation has become the most energy-intensive subsector. The trend in energy consumption in this sector over the period of 2000-2019 is illustrated in Figure 2-14 (a). During this period, energy consumption in transport increased by an average rate of 5.9% per year. In 2019, energy consumption amounted to 60.61 million toe (excluding electricity), most was 50% gasoline (30 million toe), followed by 33% diesel (20 million toe), 10% biofuel pure (6 million toe), 7% avtur (4.33 million toe), and the rest composed of natural gas, fuel oil, and avgas.

Figure 2-14 (b) illustrates the GHG emissions associated with energy consumption in the transport subsector between 2000 and 2019. The average growth of GHG emission over this period was 5.3% per year. The total GHG emissions in 2019 from transportation were 157,771 Gg CO_2e.





(a) (b)

Figure 2-14. The 2000-2019 transport subsector profile: (a) Energy use and (b) GHG emission

Energy and GHG emissions from the transport subsector is disaggregated into 1A3a civil aviation, 1A3b & 1A3c Land Transport (Road and Railways), and 1A3d Water-Borne Navigation. Transport GHG emissions were dominated by land transport activities (Figure 2-15). In 2019, the share of land transport emissions were 92% (145,116 Gg CO_2e), followed by air transport 8% (12,560 Gg CO_2e), and water-borne navigation 0.1% (95 Gg CO_2e).

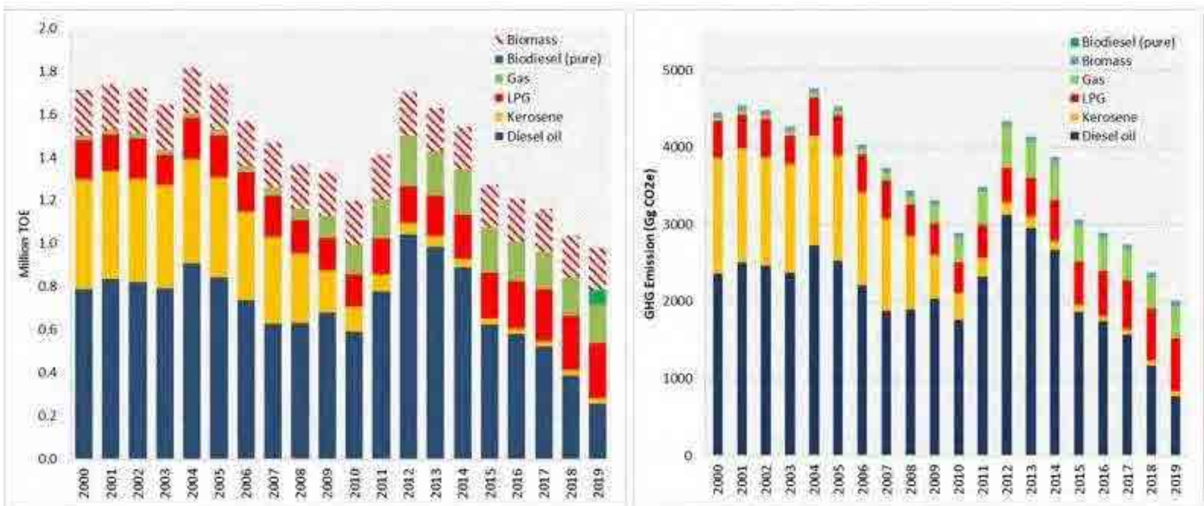
Figure 2-15. Profile of GHG emission in transport subsector, based on type of activity 2000-2019

GHG Emission in Commercial Subsector

Figure 2-16 (a) shows the trend in energy consumption in the commercial subsector over the period of 2000-2019. The figure shows that energy usage has fluctuated over this period. A comparison of 2000 and 2019 indicates the significant decline of energy consumption in the commercial sector.

In 2019, the energy consumed by the commercial subsector reached 0.98 million toe (excluding electricity). The share of energy use was dominated by 26% diesel (0.26 million toe) and 26% LPG (0.26 million toe), while 20% generated by biomass (0.19 million toe), 18% natural gas (0.18 million toe), 7% biodiesel pure (0.07 million toe) and 2% kerosene (0.02 million toe).

The trend in GHG emissions from the commercial sector follow the trend in energy consumption (see Figure 2-16 (b)). In 2019, the total GHG emission level was 2,163 Gg CO_2e.



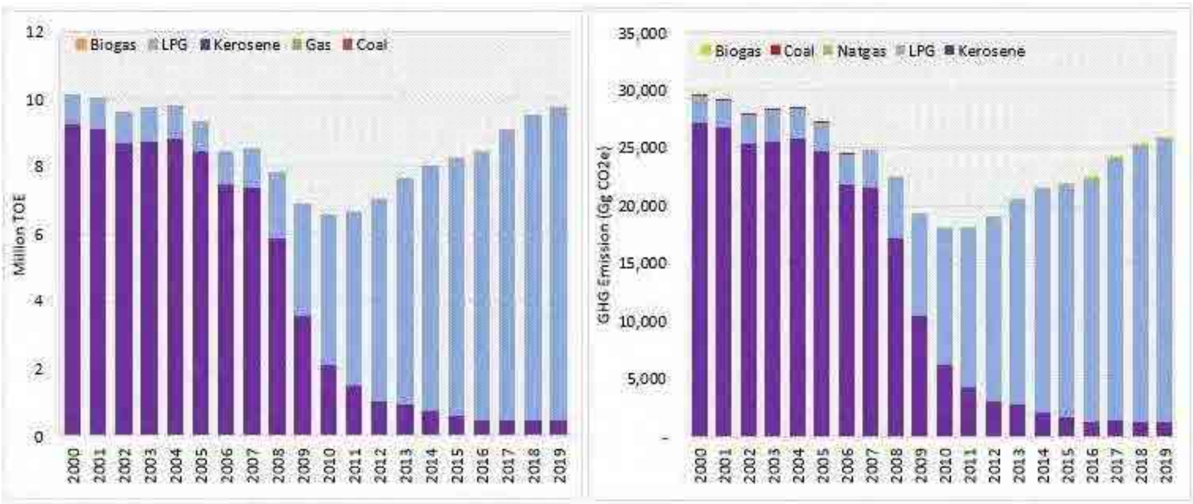
(a) (b)

Figure 2-16. The 2000-2019 commercial subsector profile a) Energy use and (b) GHG emission

GHG Emission in Residential Subsector

Changes in energy consumption and associated GHG emissions from the residential subsector over the 2000-2019 period are presented in Figure 2-17 (a) and Figure 2-17 (b) respectively. Between 2000 and 2011, energy consumption declined but then followed by an increase. By fuel type, kerosene dominated between 2000 and 2007. Since 2008, the share of kerosene has been decreasing, replaced by LPG which then becomes the most dominant fuel in residential sector. In 2019, residential energy use was 9.75 million toe, which was 95% LPG-dominant (9 million TOE), followed by kerosene 4% (0.42 million toe) and less than 1% were shared by natural gas (0.034 million toe) and biogas (0.02 million toe). Coal briquette was used in the residential sector only during the 2000-2006 period.

As shown in Figure 2-17 (b), development of GHG emissions from the residential subsector follows the development of the energy use. As of 2019, total GHG emissions were 25,700 Gg CO_2e.



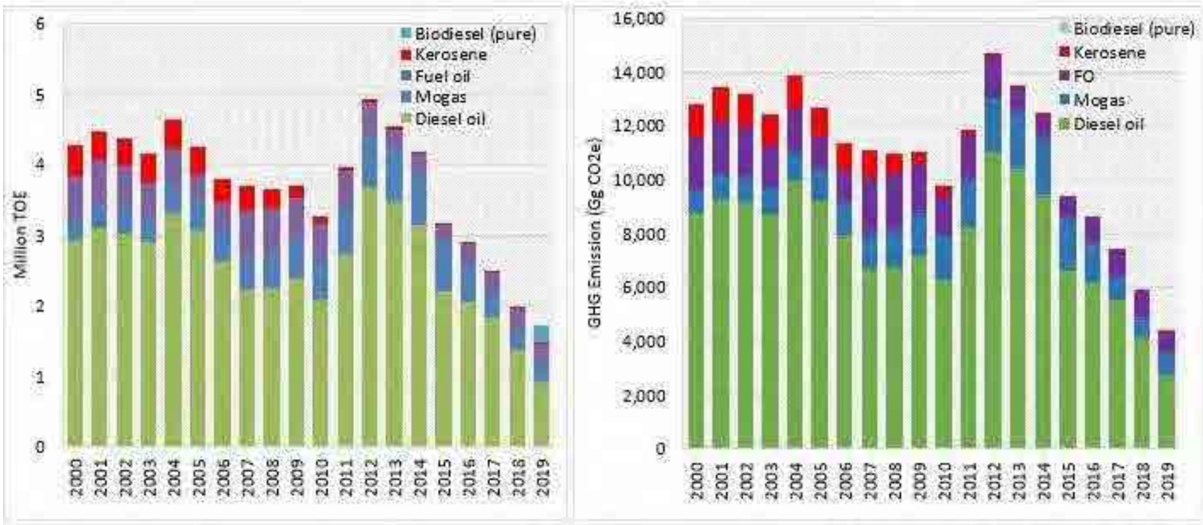
(a) (b)

Figure 2-17. The 2000-2019 residential production subsector profile a) Energy use and (b) GHG emission

GHG Emission in Non-Specified Subsector

GHG that have been emitted by energy-consuming activities that are not included in the categories described above are classified as emissions from Non-Specified subsector. Energy consumption and associated GHG emissions from this subsector over the 2000-2019 period are illustrated in Figure 2-18 (a) and Figure 2-18 (b) respectively. During the period 2000-2019, energy consumption has fluctuated but has tended to decline. The energy consumption in 2019, was 1.72 million toe, dominated by 53.5% diesel (0.92 million toe), 17.2% mogas (0.30 million toe), 14.5% fuel oil (0.25 million toe), 13.7% pure biodiesel (0.24 million toe), with the remaining 1.1% (0.02 million toe) attributable to kerosene.

As shown in Figure 2-18 (b), trend in the GHG emissions from the non-specified subsector during the period of 2000-2019 follows the trend of the energy consumption, in which in 2019, the GHG emission from this subsector was 5,130 Gg CO_2e.



(a) (b)

Figure 2-18. The 2000-2019 non-specified subsector profile a) Energy use and (b) GHG emission

GHG Emission from Fugitives

Fugitive GHG emissions include emissions from the oil and gas industry and coal mining. Figure 2-19 depicts changes in fugitive GHG emissions between 2000 and 2019. The figure shows that emissions have fluctuated but have a tendency to decrease. Sources of emissions are dominated by oil-related activities, followed by natural gas and coal mining. In 2019, the fugitive GHG emissions was 20,508 Gg CO_2e, which were attributable to oil activity (12,074 Gg CO_2e), natural gas activities (5,746 Gg CO_2e) and coal mining (2,688 Gg CO_2e).

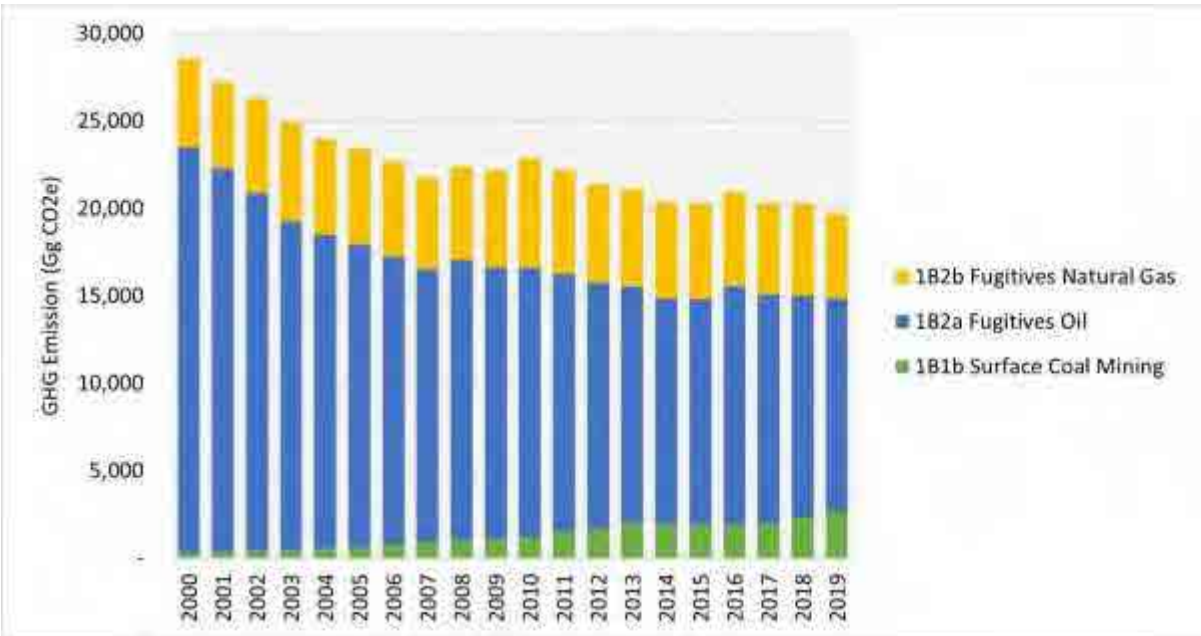


Figure 2-19. Development of fugitive GHG emissions 2000-2019

Table 2-6. Detailed GHG Emissions Data for The Energy Sector for Reference Approach for the period 2000-2019 (unit: Gg CO2e)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1. Liquid Fuels	164,914	174,125	182,003	181,234	204,341	199,636	183,869	185,707	186,400	188,125	210,441	243,878	262,190	255,883	271,569	223,560	220,606	215,526	234,188	225,682
2. Solid Fuels	52,911	67,199	69,334	93,076	85,518	97,997	118,121	145,745	118,057	135,904	150,024	162,633	170,858	154,837	187,476	205,753	214,607	226,794	272,744	328,057
3. Gas Fuels	83,909	90,847	97,907	104,927	100,795	83,393	87,199	65,831	76,452	101,482	85,083	85,797	85,302	90,935	96,795	101,106	105,334	99,018	100,853	89,390
Total	**301,734**	**332,171**	**349,244**	**379,238**	**390,655**	**381,025**	**389,190**	**397,283**	**380,908**	**425,511**	**454,548**	**492,308**	**518,349**	**501,655**	**555,840**	**530,420**	**540,547**	**541,338**	**607,786**	**643,129**

Table 2-7. Detailed GHG Emissions Data for The Energy Sector for Sectoral Approach for the period 2000-2019 (unit: Gg CO_2e)

Sector Unit: Gg CO2e	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1 Energy	317,609	341,919	349,485	378,050	380,434	376,988	386,100	402,989	391,784	405,653
1A Fuel Combustion	288,243	313,935	322,452	352,353	355,804	352,933	362,794	380,722	368,842	382,772
1A1 Energy Industries	119,716	110,764	119,793	130,168	129,518	127,816	137,094	124,026	124,405	136,599
1A1a Main Activity Electricity and Heat Production	62,030	76,614	80,964	90,946	93,516	101,948	108,930	121,696	121,940	136,058
1A1ai Electricity Generation	62,030	76,614	80,964	90,946	93,516	101,948	108,930	121,696	121,940	136,058
1A1b Oil and Gas Industries	27,686	34,151	38,829	39,242	36,002	25,857	28,049	2,211	2,442	395
1A1c Coal Processing	-	-	-	-	-	-	115	119	103	146
1A2 Manufacturing Industries	83,369	83,555	83,034	99,575	93,449	95,048	104,245	132,982	118,579	112,972
1A2a Iron and Steel										
1A2c Chemical										
1A2d Pulp, Paper and Print										
1A2e Food Processing, Beverages and Tobacco										
1A2f Non Metallic Mineral Industry										
1A2m Non-specified Industry										
1A3 Transportation	59,659	63,556	64,921	66,805	76,295	76,191	71,924	74,226	78,840	89,476
1A3a Civil Aviation	3,010	3,683	3,997	4,821	5,090	5,006	6,070	6,440	6,017	6,855
1A3b & 1A3c (Land Transportation, Road and Railways)	56,266	59,484	60,556	61,675	69,093	70,147	65,659	67,498	71,741	82,337
1A3d Water-Borne Navigation	384	388	369	309	311	237	195	286	281	234
1A4 Other Sectors	42,734	42,695	41,599	41,962	42,728	41,220	38,241	38,453	36,003	32,749
1A4a Commercial/Institutional	4,419	4,501	4,446	4,237	4,731	4,497	3,997	3,695	3,406	3,287
1A4b Residential	38,315	38,193	37,152	37,725	37,988	36,723	34,244	34,756	32,597	29,462
1A5 Non-Specified	12,765	13,366	13,185	13,823	13,822	12,667	11,290	11,035	10,936	13,027
1B Fugitive Emission	29,366	27,984	27,034	25,697	24,630	24,055	23,306	22,267	22,942	22,881
1B1 Fugitives Solid Fuels Mining	336	404	451	498	577	666	845	946	1,048	1,117
1B1a Coal Mining and handling										
1B1ai Underground coal mining										
1B1aii Surface coal mining										
1B2 Oil and Natural Gas	29,030	27,580	26,583	25,199	24,053	23,389	22,461	21,321	21,894	21,763
1B2a Fugitives Oil										
1B2b Fugitives Natural Gas										
Biomass	174,977	174,762	175,439	176,461	176,225	175,700	179,708	178,481	180,770	181,608

Sector Unit: Gg CO2e	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1 Energy	434,715	454,484	477,050	496,030	531,142	527,103	529,576	553,974	593,027	636,453
1A Fuel Combustion	411,929	431,529	455,570	474,092	509,734	505,852	507,674	532,073	571,956	615,945
1A1 Energy Industries	144,526	173,003	187,631	189,860	223,213	226,278	246,051	258,041	276,242	289,001
1A1a Main Activity Electricity and Heat Production	130,886	160,771	174,873	177,294	208,671	211,936	231,370	243,629	261,427	273,523
1A1ai Electricity Generation	130,886	160,771	174,873	177,294	208,671	211,936	231,370	243,629	261,427	273,523
1A1b Oil and Gas Industries	13,449	12,988	12,672	12,529	14,503	14,331	15,409	14,341	14,751	15,459
1A1c Coal Processing	192	44	86	37	39	31	71	71	24	39
1A2 Manufacturing Industries	114,542	96,171	80,028	92,072	96,422	100,174	79,484	79,663	103,167	136,179
1A2a Iron and Steel						3,591	1,991	1,780	5,241	25,093
1A2c Chemical						9,716	11,517	10,431	10,557	11,539
1A2d Pulp, Paper and Print						12,574	12,725	10,819	12,296	12,910
1A2e Food Processing, Beverages and Tobacco						25,838	14,223	14,225	14,224	14,224
1A2f Non Metallic Mineral Industry						14,529	16,620	21,306	20,996	20,397
1A2m Non-specified Industry						33,916	21,398	21,102	39,853	53,056
1A3 Transportation	108,264	117,570	139,271	143,243	141,520	128,010	136,405	147,230	157,522	157,771
1A3a Civil Aviation	9,838	8,900	9,730	10,395	10,554	10,022	12,170	13,408	14,279	12,560
1A3b & 1A3c (Land Transportation, Road and Railways)	98,136	108,465	129,343	132,732	130,870	117,092	124,118	133,680	143,127	145,116
1A3d Water-Borne Navigation	229	206	197	126	96	86	109	110	116	95
1A4 Other Sectors	32,092	32,136	33,969	35,416	36,136	37,132	36,001	38,045	27,994	27,863
1A4a Commercial/Institutional	3,793	3,462	4,306	4,103	3,834	4,418	2,918	3,182	2,653	2,163
1A4b Residential	28,299	28,674	29,663	31,313	32,303	32,720	33,164	34,863	25,341	25,700
1A5 Non-Specified	12,505	11,848	14,670	13,501	12,443	14,258	8,853	9,095	7,031	5,130
1B Fugitive Emission	22,786	22,955	22,280	21,938	21,408	21,250	21,901	21,901	21,071	20,508
1B1 Fugitives Solid Fuels Mining	1,200	1,541	1,684	2,069	1,998	2,013	1,990	1,990	2,433	2,688
1B1a Coal Mining and handling										
1B1ai Underground coal mining										
1B1aii Surface coal mining										
1B2 Oil and Natural Gas	21,586	21,414	20,596	19,869	19,410	19,237	19,912	19,912	18,638	17,821
1B2a Fugitives Oil										
1B2b Fugitives Natural Gas										
Biomass	187,624	182,206	183,620	193,155	201,711	201,431	199,831	199,831	199,831	39,926

Key Category Analysis (KCA)

The results of the KCA revealed that the primary sources of GHG emissions in energy sector were fuel combustion in electricity generation (43%), followed by transport (24.8%), and manufacturing industries (21.4%) (Table 2-8).

Table 2-8. Key Category Analysis for Energy Sector in 2019

Code	Categories	Total GHG Emissions ($Gg\ CO_2e$)	Level/ Rank	Cumulative
1A1ai	Electricity Generation	273,523	43.0%	43.0%
1A3	Transport	157,771	24.8%	67.8%
1A2	Manufacturing Industries	136,179	21.4%	89.2%
1A4b	Residential	25,700	4.0%	93.2%
1A1b	Oil and Gas Industries	15,459	2.4%	95.6%
1B2a	Fugitives Oil	12,074	1.9%	97.5%
1B2b	Fugitives Natural Gas	5,746	0.9%	98.4%
1A5	Non-Specified	5,130	0.8%	99.2%
1B1aii	Surface coal mining	2,688	0.4%	99.7%
1A4a	Commercial/ Institutional	2,163	0.3%	100.0%
1A1c	Coal Processing	19	0.003%	100.0%
		636,453		

Plan of Improvement for Energy Sector

1. Disaggregate for land transportation subsector.
2. Using national emission factor (Tier 2), for which need to develop emission factors of CH_4 and N_2O.
3. Include fugitive emissions from gas processing plant (venting in upstream oil and gas processing) and fugitives from oil fuels terminal (to be estimated at least using Tier 1).

2.2.3.2 Industrial Processes and Product Use (IPPU)

The GHG emissions sources from activities related to Industrial Process and Product Use (IPPU) are from industrial processes, the use of carbonates and GHGs in products, and non-energy uses of fossil fuel carbon. In Indonesia, the main sources of GHG emissions are from industrial processes that chemically or physically transform materials and release carbon dioxide (CO_2) during processes. Clinker production processes in cement industry, blast furnace in iron and steel industry, ammonia and other chemical products manufactured from fossil fuels used as chemical feedstock are industrial processes that release a significant amount of carbon dioxide (CO_2).

During processing, numerous emissions, not just CO_2 but also nitrous oxide (N_2O) from the nitric acid industry, perfluorocarbons (PFCs) as CF_4/C_2F_6 from aluminium industry, and CH_4 from petrochemical industries, are produced from industrial processes, whereas emissions of hydrofluorocarbons (HFCs) and sulphur hexafluoride (SF_6) emissions are released during their use of these gases in the product. Indonesia also releases HFCs and SF_6, however HFCs and SF_6 are not included in the GHG Inventory in this BUR 3 since the data and information on the sources and activity of such gases are still under preparation.

Sources of GHG category includes:

1. Mineral production processes, i.e., cement (2A1), lime (2A2), glass (2A3), and other processes using carbonates (ceramics (2A4a), soda ash (2A4b), and other carbonate consumptions (2A4d));

2. Chemical processes, i.e. ammonia (2B1), nitric acid (2B2), carbide (2B5), and petrochemicals (2B8);
3. Metal production processes, i.e. iron and steel (2C1), aluminium (2C3), lead (2C5), and zinc (2C6);
4. The use of non-energy products from fuels and solvent, i.e. lubricant (2D1) and paraffin wax (2D2);
5. Other carbonate consumptions, i.e., the use of carbonate for pulp and paper industry (2H1), food and beverages industry (2H2).

In pulp and paper industry, the carbonate is used as chemical makeup during the re-causticising process. Although the level of usen is not important, GHG emissions from this process are included in the National GHG emission inventory.

Certain categories are not included in BUR 3, among other things:

1. GHG emissions that are not estimated (NE)
   1. Uses of products as substitutes to Ozone Depleting Substances (ODS) (2F1-2F4) have not been estimated in this BUR 3 due to the collection of data con the activity being prepared;
   2. The production of Ferroalloy (2C2) and magnesium (2C4) are also excluded due to difficulty in data collection;
   3. Electronic industry (2E1-2E4) is excluded because the available data is aggregated production capacities with no without distinction between GHG-emitting and non-GHG-emitting industries not generating GHG emissions (such as assembly industries);

2. GHG emission that do not occurring (NO)
   a) Chemical production for category of adipic acid productions (2B3), caprolactam, glyoxal, glyoxylic acid (2B4), titanium dioxide (2B6), and natural soda ash (2B7), fluorochemical production (2B9);
   b) Use of carbonate in non-metallurgical magnesia production and other industries.

Differences Between GHG Emission Estimates in the BUR 2 and BUR 3

The GHG emissions from IPPU estimates in the BUR 3 were updated with respect to the previous BUR 2. The GHG emissions level is recalculated due to there are some improvements of activity data with the latest data from the industry and emission factors with updated data from the plants.

In the cement productions, the GHG emissions are estimated using the 2006 IPCC TIER 2, in which local emission factors (EF) (at plant level) and activity data (clinker and cementitious of each cement plant) are developed by cement industry group through their association under the coordination of MoI. In the BUR 2, GHG emissions for the 2000-2009 period were estimated using the default EF value (IPCC 2006) as no EF data were available for the 2000-2009 period, whereas GHG emissions for 2010-2016 have been estimated using plant level data. However, the cement industries group improved the EFs and activity data for the period 2010-2016 . Therefore, in the BUR 3, GHG emissions for 2010-2016 are recalculated using these updated data. For the period 2017-2019, estimated GHG emissions use the updated production capacity of clinker and cementitious and the following plant's EFs, namely 0.4332 (2017), 0.4193 (2018), and 0.4081 (2019) tonne CO_2/tonne cementitious.

With respect to ammonia production, the fertiliser industries also improved EF and activity data based on plant data. In BUR 3, GHG emissions for the 2011 to 2014 period are recalculated using the updated EF and activity data. . Furthermore, estimates of GHG emissions for the period 2015-

2016 refer to BUR 2. After 2016, GHG emission estimates use plant data for the period 2017 through 2019.

The first plant has been in operation since 1990 and three additional plants have been in service since 2012. Two existing facilities are equipped with N_2O abatement technology. By 2022, there is expected to be an additional production plant, which is also equipped with N_2O abatement technology. Each of these technologies has its own emission factor. In contrast to BUR 2, where GHG emissions were estimated using Tier 1 with the default 2006 IPCC EF value. GHG emissions in this BUR 3 are estimated from the plant and EF data by technology type in each industry using Tier 1 Refinement of IPCC 2006. A new calculation of GHG emission levels is performed between 2000 and 2019.

In the steel industry, data on EF and the activity of each processing and production are improved. In BUR 2, it was assumed that there is no DRI processing unit for 2001-2009. However, the updated data show that the DRI processing unit remained in operation until 2014 and ceased in 2015. Therefore, GHG emissions from the DRI treatment unit for the period 2000-2014 are included in the IPPU national GHG emissions inventory. GHG emissions are calculated using TIER 1 (IPCC2006) with EF 0.001. In 2015, to replace the old (gas-based) DRI processing unit, A new blast furnace facility has been developed and operated with a production capacity of approximately 1.2 Mton/yr. The blast furnace uses coal as an input material. In the blast furnace, a Sinter Plant was developed with a production capacity of about 1.7 Mton/year and a Coke Oven Plant with 0.555 Mton/year. Based on this updated activity data, GHG emissions from the iron and steel industries are recalculated using the IPCC 2006 TIER 1 methodology.

Concerning the use of carbonate in industries, there is an error in the use of EF, where the EF of sodium carbonate is exchanged with an EF of calcium carbonate. Therefore, in BUR 3, GHG emissions for the period 2000-2019 for the use of both carbonate types are recalculated using these enhanced EFs data.

The results of the GHG emissions calculations updated in BUR 3 are provided in Figure 2-20. Whereas the comparison of BUR 2 and BUR 3 emission estimates is shown in Figure 2-21. The graph shows that the difference between the two inventories is relatively small, averaging 1.0%.

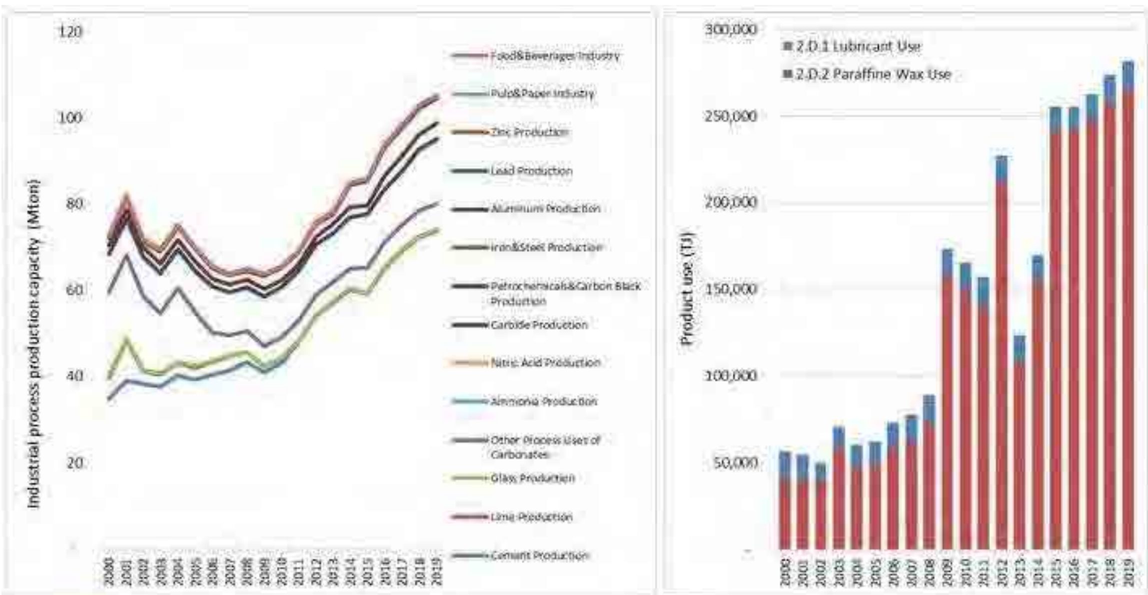


Figure 2-20. Production Capacity and Product Use of the GHG Inventory for the IPPU Sector, 2000-2019

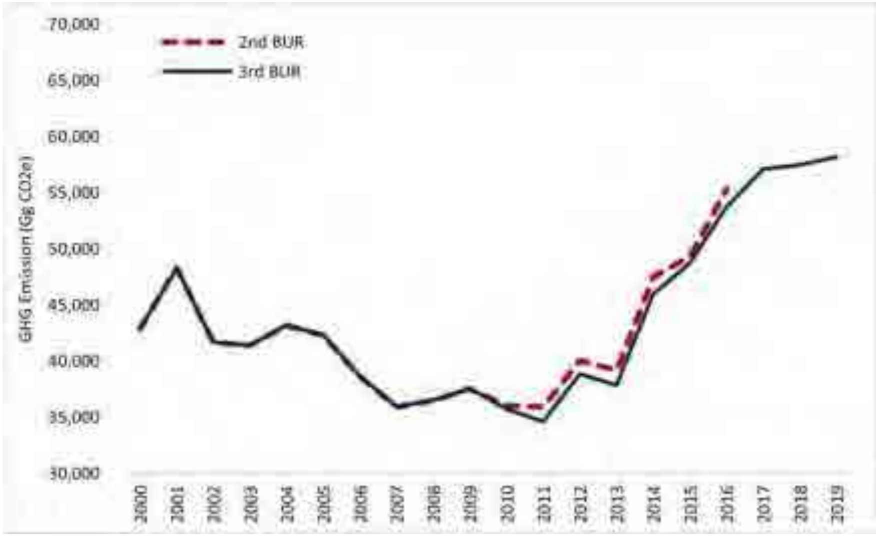


Figure 2-21. Differences between BUR 2 and BUR 3 GHG emission levels in the IPPU sector

The updated calculation of GHG emissions from all IPPU emission sources over the 2000-2019 period is shown in Figure 2-22. Figure 2-23 also shows the share of GHG emissions per source and type of gas in 2019. The figure shows that the main source of IPPU GHG emissions in 2019 is cement production. (30,156 GgCO_2e) followed by ammonia production (9,703 Gg CO2e), iron and steel making (6,927 Gg CO2e), products used (4,126 Gg CO2e), and other carbonate used industries (2,333 Gg CO2e). In Indonesia, the GHG emissions of the IPPU sector is dominated by CO_2. The BUR 3 reports five gases, i.e., CO_2, CH_4, N_2O, and PFC (CF_4 & C_2F_6). GHG emissions from HFC and SF_6 are not reported in the National GHG Inventory as these emissions calculations are still being developed.

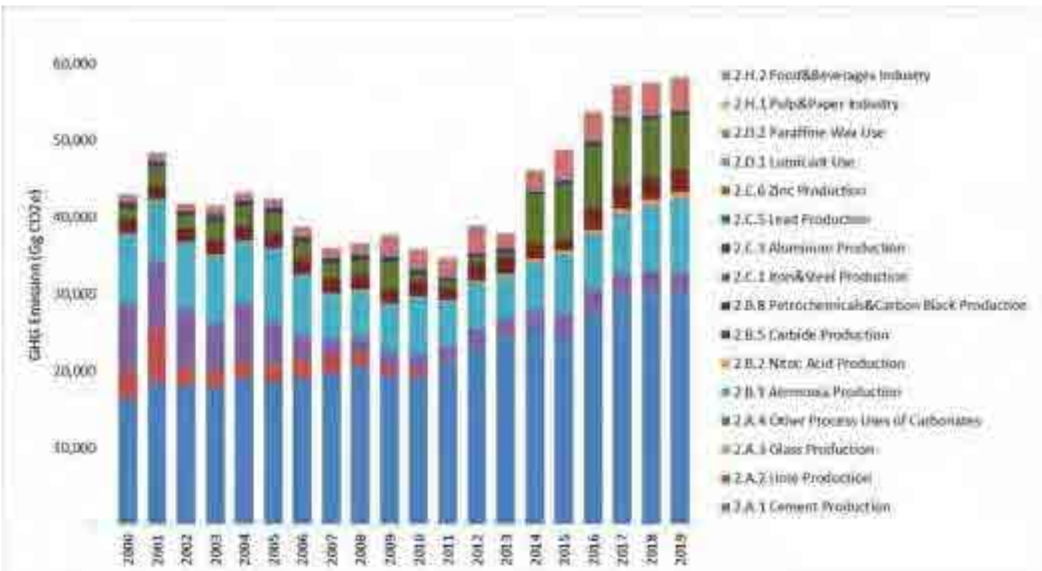


Figure 2-22. GHG emission by Sources for the period 2000-2019

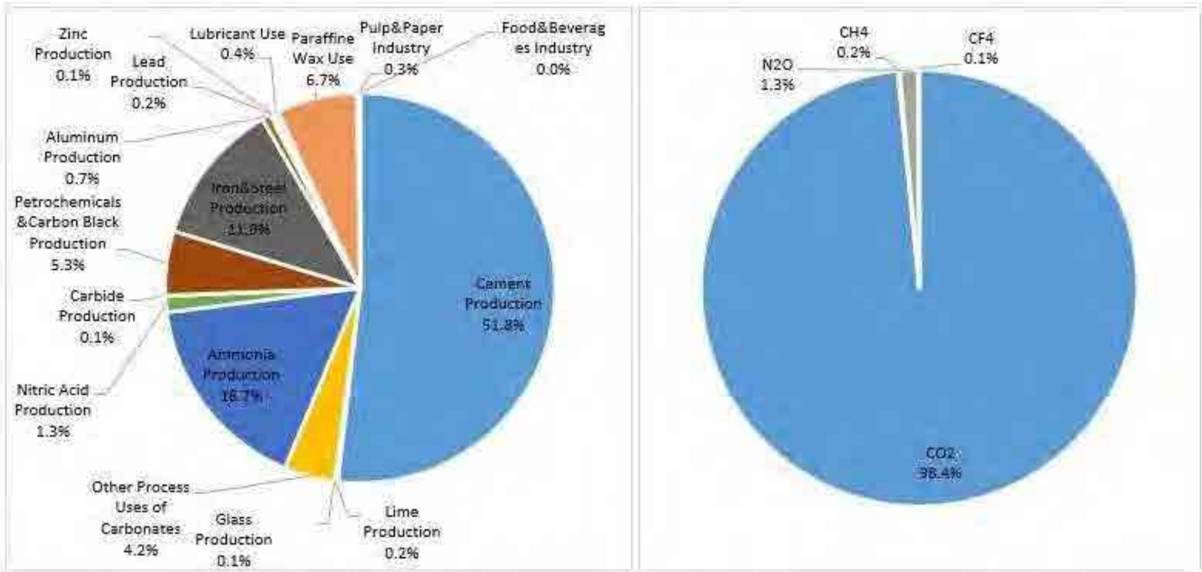


Figure 2-23. The share of greenhouse gas emissions per source and type of gas in 2019

The results of the calculation of GHG emissions per source for 2019 from the IPPU sector are presented in Table 2-9. As shown in Table 2-9, the IPPU emissions for the five gases in 2019 was 58,173 Gg CO_2e. If the calculation was limited to the three main gases (CO_2, CH_4, and N_2O), then the GHG emissions in 2019 would be 58,128 Gg CO_2e (see Table 2-9). It should be noted, if the GHG emissions of the five gases in 2019 is compared with those in 2000, the GHG emissions in 2019 are 1.36 times that of 2000. Between 2000 and 2019, the level of GHG emissions in the IPPU category increased by 1.6% per year on average.

Table 2-9. GHG emissions of IPPU by gases by source category in 2019, (Gg CO_2e)

Category		CO_2	CH_4	N_2O	HFCs	CF4	C2F6	SF6	Total 3 gases	Total all 5 gases
2A1	Cement production	30,156							30,156	30,156
2A2	Lime production	125							125	125
2A3	Glass production	50							50	50
2A4a	Ceramic production	4							4	4
2A4b	Other use of carbonate and soda ash	2,333							2,333	2,333
2A4d	Other carbonate consumption	94							94	94
2B1	Ammonia production	9,703							9,703	9,703
2B2	Nitric acid production			784					784	784
2B5	Carbide production	31							31	31
2B8	Petrochemical and carbon black								-	-
2B8a	Methanol	276	35						310	310
2B8b	Ethylene	2,023	57						2,080	2,080
2B8c	Ehtylene dichloride and VCM	485	-						485	485
2B8f	Carbon black	223	0.11						224	224
2C1	Iron & Steel production	6,921	-						6,927	6,927
2C3	Aluminium production	376				46			376	422
2C5	Lead production	88							88	88
2C6	Zinc production	83							83	83
2D1	Lubricants use	232							232	232
2D2	Paraffin wax use	3,894							3,894	3,894
2H1	Others - sodium carbonate in pulp & paper industry	147							147	147
2H2	Other - sodium carbonate in food & beverages industry	2							2	5
Total		**57,252**	**91**	**784**	**-**	**46**	**-**	**-**	**58,128**	**58,173**

The KCAs of IPPU GHG emissions is conducted for 22 categories of GHG emission sources included in national GHG emissions. The KCA result in emissions in 2019 is given in Table 2-10. There were seven major contributors to the 22 source categories, namely cement production, ammonia production, iron and steel production, paraffin wax use, ethylene production, nitric acid production, and aluminium production.

Table 2-10. Key Category Analysis (KCA) of the IPPU emissions in 2019

Category		GHG Emission (3 gases), Gg CO_2e	Level/Rank	Cumulative
2A1	Cement production	30,156	51.9%	51.9%
2B1	Ammonia production	9,703	16.7%	68.6%
2C1	Iron & Steel production	6,927	11.9%	80.5%
2D2	Paraffin wax use	3,894	6.7%	87.2%
2A4b	Other use of carbonate and soda ash	2,333	4.0%	91.2%
2B8b	Ethylene	2,080	3.6%	94.8%
2B2	Nitric acid production	784	1.3%	96.1%
2B8c	Ethylene dichloride and VCM	485	0.8%	97.0%
2C3	Aluminium production	376	0.6%	97.6%
2B8a	Methanol	310	0.5%	98.1%
2D1	Lubricants use	232	0.4%	98.5%
2B8f	Carbon black	224	0.4%	98.9%
2H1	Others - sodium carbonate in pulp & paper industry	147	0.3%	99.2%
2A2	Lime production	125	0.2%	99.4%
2A4d	Other carbonate consumption	94	0.2%	99.6%
2C5	Lead production	88	0.2%	99.7%
2C6	Zinc production	83	0.1%	99.9%
2A3	Glass production	50	0.1%	99.9%
2B5	Carbide production	31	0.1%	100.0%
2A4a	Ceramic production	4	0.01%	100.0%
2H2	Other-sodium carbonate in food & beverages industry	2	0.00%	100.0%
Total		**58,128**		

Plan of Improvements for IPPU Sector

1. Include HFCs and SF_6 in the national GHG emissions inventory as data and information pertaining to the sources and activity of these gases are currently being prepared.
2. Continuity and coherence in plant level activity data and emission factors will be provided by the Ministry of Industry.
3. Include more industries and associations in the establishment and maintenance of the IPPU sector emissions inventory.
4. Develop national emission factors at the plant level with relevant stakeholders that will be updated on an annual basis.

2.2.3.3 AFOLU (Agriculture, Forestry and Other Land Use)

Sources of GHG emissions and removals from AFOLU reported in this BUR 3 are similar to those for BUR 2. The estimation covered emissions from Agriculture and FOLU.

Agriculture Sector

Emissions of GHGs from the agricultural sector were from livestock and aggregate sources and terrestrial sources other than CO_2 for the period 2000 to 2019. There is no update on the EFs used, i.e., the same ones as BUR 2, except changes in the adjustment factor for the cattle and buffalo population and the method of calculating the harvested rice area.

Livestock Sector

Data on live stocks and information pertinent to the GHG inventory were collected from a single source, i.e., the Statistics of Agriculture year 2000 – 2019.

Methane emissions from enteric fermentation and manure management as well as N_2O emissions from manure were calculated for six species of livestock: beef cattle, dairy cattle, buffalo, goat, sheep, and horse. Each animal category were divided into some subcategories depending on the age of the animals (see Table 2-11). Methane emissions from enteric fermentation and manure management were also computed using local EFs. In BUR 2, the total population of dairy cattle, other cattle and buffaloes has been adjusted by a correction factor of 0.75, 0.72 and 0.72 to reflect the representation of youth and adults. Meanwhile, in BUR 3, the correction factor is removed, resulting in livestock emissions in BUR 3 being slightly higher than in BUR 2 for the 2000-2016 period. For The estimation of direct and indirect N_2O emissions, an assumption based on the national condition was again applied to determine the types of treatment for the management of cattle manure, as used in BUR 2.

Table 2-11. Local share of population by animal, emission factor and weight of livestock

Livestock	Subcategory	Sex	Percentage (%)	EF CH_4 Enteric Fermentation (Kg CH_4 /year/head)	EF CH_4 Manure Management (Kg CH_4 /year/head)	Local Livestock Weight (Kg)
Beef cattle	Weaning (0-1 yo)	Female + Male	19.3	18.1839	0.7822	63.00
	Yearling (1-2 yo)	Female + Male	25.85	27.1782	1.6202	134.48
	Young (2-4 yo)	Female + Male	18.15	41.7733	3.4661	286.00
	Mature (> 4 yo)	Female + Male	26.89	55.8969	3.6352	400.00
	Imported (fattening)	Male	9.81	25.4879	7.9662	500.00
Dairy cattle	Weaning (0-1 yo)	Female + Male	21.73	16.5508	0.5167	46.00
	Yearling (1-2 yo)	Female + Male	24.03	35.0553	2.5152	198.64
	Young (2-4 yo)	Female + Male	21.7	51.9609	5.5262	275.00
	Mature (> 4 yo)	Female + Male	32.54	77.1446	12.181	402.50
Buffalo	Weaning (0-1 yo)	Female + Male	16.32	20.5531	0.7476	100.00
	Yearling (1-2 yo)	Female + Male	20.67	41.1063	3.9864	200.00
	Young (2-4 yo)	Female + Male	20.74	61.6594	8.9695	300.00
	Mature (> 4 yo)	Female + Male	42.27	82.2126	15.9457	400.00
Goat	Weaning	Female + Male	27.12	2.2962	0.0252	8.00
	Yearling	Female + Male	26.9	2.6482	0.017	20.00
	Mature	Female + Male	45.98	3.2705	0.0295	25.00
Sheep	Weaning	Female + Male	27.66	1.3052	0.0079	8.00
	Yearling	Female + Male	25.9	4.3304	0.0465	20.00
	Mature	Female + Male	46.44	5.2502	0.0752	25.00
Swine	Weaning	Female + Male	32.3	0.4331	0.0013	15.00
	Yearling	Female + Male	32.74	1.0291	0.0075	60.00
	Mature	Female + Male	34.96	1.2785	0.0115	80.00
Horse	Weaning	Female + Male	18.82	25.9888	0.5967	200.00
	Yearling	Female + Male	22.62	53.2693	2.5071	350.00
	Mature	Female + Male	58.56	74.8457	4.9494	500.00
Poultry						
Native	-	-	-	-	0.0031	1.50
Layer	-	-	-	-	0.0043	2.00
Broiler	-	-	-	-	0.0039	1.20
Duck	-	-	-	-	0.0035	1.50

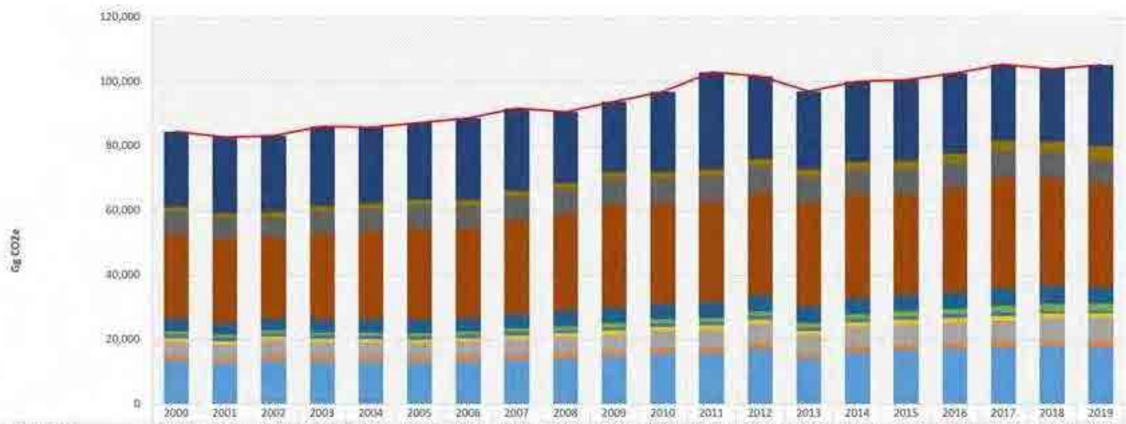
Aggregate Sources and Non-CO_2 Emission Sources on Land

Under this category, sources of GHG emissions may be classified into seven subcategories: (a) 3C1 biomass burning, (b) 3C2 liming, (c) 3C3 urea application, (d) 3C4 direct N_2O emission from managed soil, (e) 3C5 indirect N_2O emission from managed soil, (f) 3C6 indirect N_2O emission from manure management, and (g) 3C7 rice cultivation. In addition to emissions from burning biomass on agricultural land (3C1b) and grasslands (3C1c), in this BUR 3, emissions from burning biomass on forest land are also estimated, while emissions from other lands (3C1d) are still excluded due to unavailability of data activity on burned area. However, emissions from biomass burning of FL including on CL and GL are reported in FOLU sector because these emissions are the result of forest and land fires.

The activity data used to estimate emissions comes from various sources. The Centre for Data and Information provided additional data on biomass burning and urea application. – MoA, who also provided data on lime application, and N_2O from managed soil, with additional information from the Indonesia Fertiliser Producer Association (*Asosiasi Produsen Pupuk Indonesia* – APPI). Activity data from biomass burning is derived from rice cultivation in wetlands and drylands, as well as forest and land fires. Meanwhile, activity data for estimating methane emissions from rice cultivation were provided by the MoA Data and Information Centre and Statistics Indonesia.

GHG Emissions on Agriculture Sector

In 2000, the total GHG emissions in agriculture sector from the three main gases (CO_2, CH_4 and N_2O) after recalculation was 84,537 Gg CO_2e and increased significantly to 105,301 Gg CO_2e in 2019.



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
CH4 Rice Cultivations	23,335	23,403	23,486	24,635	23,610	24,008	25,370	25,569	21,965	21,970	24,848	30,063	25,517	24,057	24,919	25,237	24,886	23,677	22,712	25,235
Indirect N2O Manure Management	1,322	1,399	1,697	1,658	1,603	1,644	1,658	1,779	1,792	1,939	1,944	2,165	2,305	2,336	2,489	2,605	2,727	2,978	3,059	4,343
Indirect N2O Managed Soils	6,952	6,853	6,656	7,033	6,994	7,195	7,183	7,406	7,666	7,953	7,788	7,810	7,941	7,912	7,843	7,728	7,964	8,200	7,977	7,526
Direct N2O Managed Soils	26,472	25,969	24,913	26,688	27,359	28,239	27,674	29,011	30,375	32,085	31,235	31,320	32,191	32,482	31,919	31,297	32,464	34,550	33,404	31,800
CO2 Urea Fertilization	3,900	3,562	3,547	3,809	4,056	4,210	4,124	4,440	4,581	4,865	4,709	4,813	4,853	5,030	4,836	4,746	4,867	5,300	5,715	5,182
CO2 Liming	810	866	907	869	917	947	965	1,011	1,074	1,200	1,262	1,293	1,357	1,433	1,564	1,717	1,836	2,054	2,125	2,160
Non-CO2 Biomass Burning GL	1,232	1,090	1,088	1,115	1,145	1,163	1,117	1,173	1,082	1,052	1,114	1,020	1,132	952	1,021	1,016	1,162	1,196	843	822
Non-CO2 Biomass Burning CL	1,100	1,093	1,107	1,108	1,092	1,122	1,174	1,212	1,275	1,319	1,312	1,330	1,366	1,384	1,389	1,455	1,434	1,408	1,385	1,255
Direct N2O Manure Management	4,496	4,374	4,647	4,555	4,550	4,567	4,721	4,932	5,074	5,297	5,561	5,746	6,217	5,825	6,320	6,464	6,470	6,720	6,914	7,307
CH4 Manure Management	1,326	1,271	1,376	1,337	1,321	1,270	1,300	1,334	1,358	1,404	1,470	1,439	1,552	1,271	1,460	1,516	1,564	1,605	1,658	1,772
CH4 Enteric Fermentation	13,591	12,905	13,846	13,358	13,302	13,045	13,408	13,890	14,376	14,872	15,712	15,981	17,263	14,366	16,332	16,904	17,266	17,676	18,266	17,898
Total	84,537	82,786	83,269	86,166	85,949	87,411	88,693	91,756	90,616	93,956	96,955	102,979	101,693	97,046	100,092	100,685	102,640	105,363	104,053	105,301

Figure 2-24. Emission from Agriculture sector for the period of 2000-2019

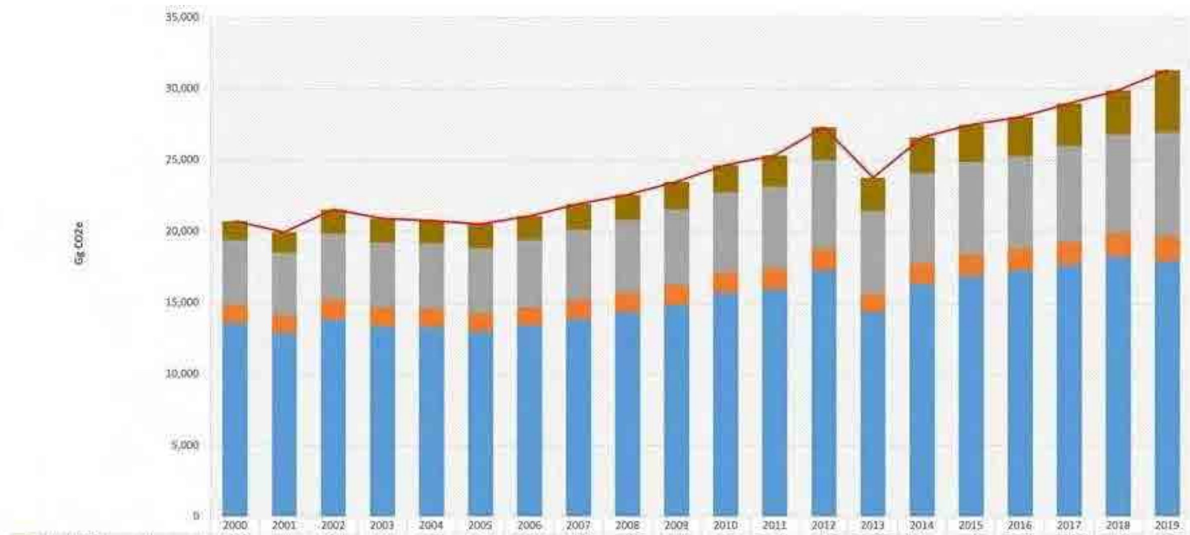
Figure 2-24 shows that, by source category, the GHG emissions in 2019 came directly from N_2O from managed soils. (30.20%), methane from rice cultivation (23.96%), methane from enteric fermentation (17.00%), indirect N_2O managed soils (7.15%), direct N_2O manure management (6,94%), CO_2 urea fertilisation (4,92%), and indirect N_2O manure management (4.12%). These seven sources accounted for over 94.00.% of total GHG emissions from the agricultural sector.

GHG Emissions on Livestock

In 2019, total GHG emissions of 2 gases (CH_4 and N_2O) from cattle were 31,321 Gg CO_2, which exceeds the 2000 emissions of 20,736 Gg CO_2. It increased by 10,585 Gg CO_2e (51.05%) with average annual growth of 2,33% during period of 2000-2019. This was caused by a significant growth in the population, particularly from beef cattle.

The main source for 2019 was CH_4 releases from enteric fermentation 17,898 Gg CO2e. (57.14%), followed by direct N_2O emission from manure management 7,307 Gg CO_2e (23.33%), indirect N_2O emissions from manure management 4,437 Gg CO_2e (13.87%), and CH_4 emission from manure management 1,772 Gg CO_2e (5.66%) as presented on Figure 2-25.

Methane emissions from enteric fermentation were concentrated in beef cattle. (70.0%), sheep (8.5%), buffalo (8.0%), goats (6.3%), dairy cattle (3.4%), horses (2.8%), and others less than 1% in 2019, while from manure management was beef cattle (61.6%), poultry (17.3%), buffalo (13.2%), dairy cattle (4.4%), and others less than 3.5% in 2019 (Figure 2-26).



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Indirect N2O Manure Management	1,322	1,399	1,697	1,658	1,603	1,644	1,658	1,779	1,792	1,939
Direct N2O Manure Management	4,496	4,374	4,647	4,555	4,550	4,567	4,721	4,932	5,074	5,297
CH4 Manure Management	1,326	1,271	1,376	1,337	1,321	1,270	1,300	1,334	1,358	1,404
CH4 Enteric Fermentation	13,591	12,905	13,846	13,358	13,302	13,045	13,408	13,890	14,376	14,872
Total	20,736	19,949	21,565	20,909	20,777	20,526	21,087	21,934	22,600	23,512

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Indirect N2O Manure Management	1,944	2,165	2,305	2,336	2,489	2,605	2,727	2,978	3,059	4,343
Direct N2O Manure Management	5,561	5,746	6,217	5,825	6,320	6,464	6,470	6,720	6,914	7,307
CH4 Manure Management	1,470	1,439	1,552	1,271	1,460	1,516	1,564	1,605	1,658	1,772
CH4 Enteric Fermentation	15,712	15,981	17,263	14,366	16,332	16,904	17,266	17,676	18,266	17,898
Total	24,687	25,331	27,336	23,798	26,602	27,489	28,027	28,978	29,897	31,321

Figure 2-25. Trend in CO_2e Emission from Livestock, 2000-2019

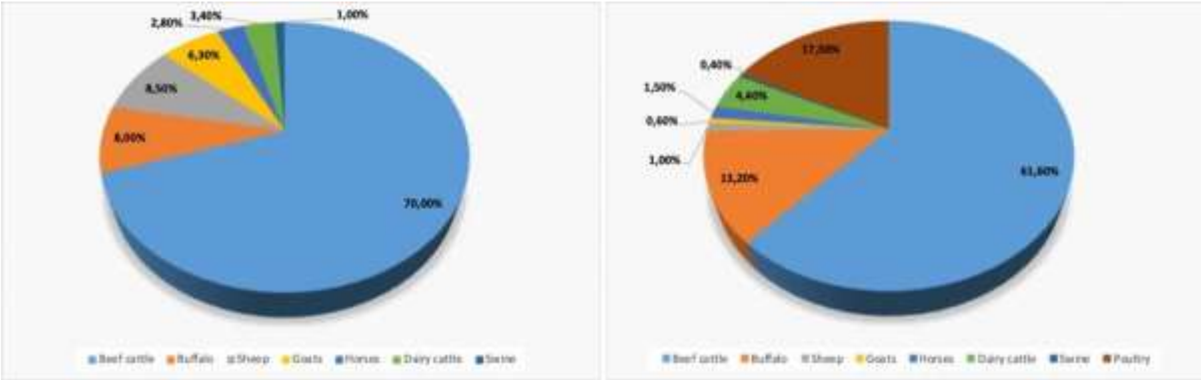


Figure 2-26. Contribution to methane emissions from (a) enteric fermentation and (b) manure management by livestock species in 2019

Aggregate Sources and Non-CO_2 Emission Sources on Land

In 2019, emissions from this subcategory for 3 gases (CO_2, CH_4 and N_2O) were 73,980 Gg CO2e, a 10.179 Gig CO2e increase (15,95 %) relative to 2000 emission level. Overall, emissions in this sector increased by an average annual growth of 0.82% between 2000 and 2019 (Figure 2-27). The largest emissions were derived from direct N_2O managed soils of 31,800 Gg CO_2e (42.98%), followed by CH_4 rice cultivation with emission of 25,235 Gg CO_2e (34.11%), and indirect N_2O managed soils 7,526 Gg CO_2e (10.17%), urea fertilisation 5,182 Gg CO_2e (7.00%), liming application 2,160 Gg CO_2e (2.92%), biomass burning CL 1,255 Gg CO_2e (1.70%) and biomass burning GL with emission as much as 822 Gg CO_2e (1.11%).

The result of KCA for agriculture sector is presented in Table 2-12. The main contributors of emissions in agriculture sector were in direct N_2O managed soils, CH_4 rice cultivation, CH_4 enteric fermentation, indirect N_2O managed soils, direct N_2O manure management, CO_2 urea fertilisation and indirect N_2O manure management as the main contributors of emissions in agriculture sector.

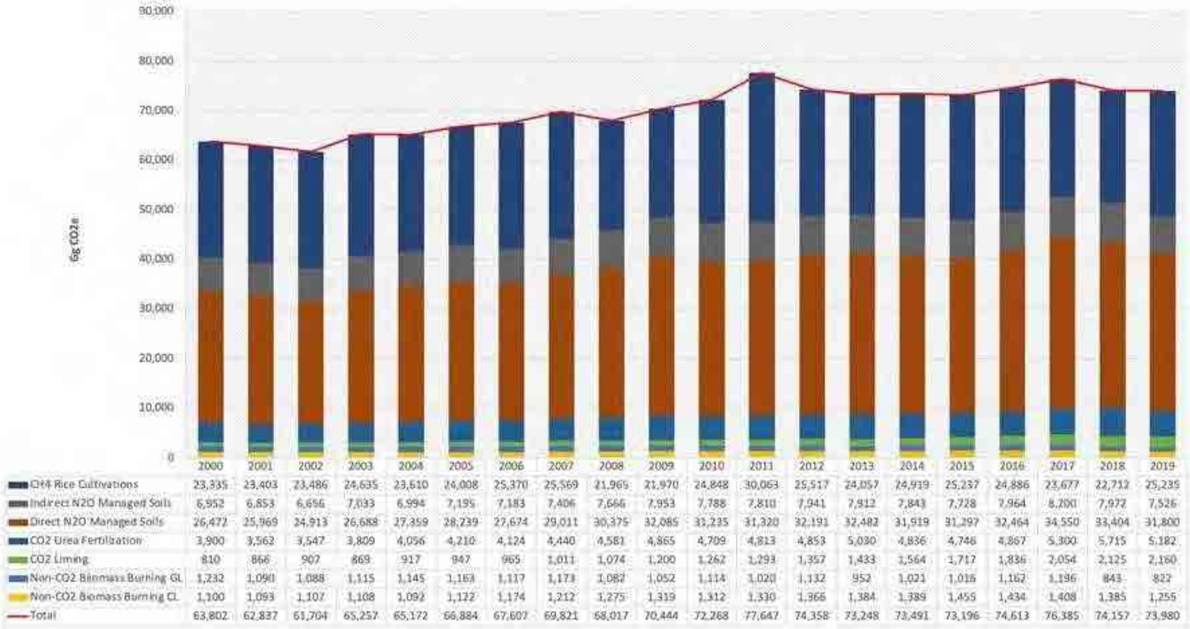


Figure 2-27. Emissions from aggregate sources and non-CO2e sources on land for the period 2000 to 2019

Table 2-12. Key Category Analysis for Agriculture Sector in 2019

Code	Category	GHG	($GgCO_2e$)	Level/Rank (%)	Cumulative (%)
3C4	Direct N_2O Managed Soils	N_2O	31.800	30.20	30.20
3C7	Rice Cultivations	CH_4	25.235	23.96	54.16
3A1	Enteric Fermentation	CH_4	17.898	17.00	71.16
3A2b	Indirect N_2O Managed Soils	N_2O	7.526	7.15	78.31
3C5	Direct N_2O Manure Management	N_2O	7.307	6.94	85.25
3C3	Urea Fertilisation	CO_2	5.182	4.92	90.17
3C6	Indirect N_2O Manure Management	N_2O	4.343	4.12	94.29
3C2	Liming	CO_2	2.160	2.05	96.35
3A2	Manure Management	CH_4	1.772	1.68	98.03
3C1.b	Biomass Burning CL	CH_4, N_2O	1.255	1.19	99.22
3C1.c	Biomass Burning GL	CH_4, N_2O	822	0.78	100.00

Plan of Improvement in Agriculture Sector

Improvement plans for the agriculture sector will be implemented in the future, with a focus on livestock. (ii) refine the assumptions of the manure management system widely used in Indonesia, (ii) the calculation of CH_4 and N_2O emissions will take into account the age composition according to the reporting year and the production system (tier 1a); and (iii) The cattle population will take into account data on livestock imports from the BMS and will not be estimated based on the total proportion of cattle, while for aggregate sources and emissions other than CO_2, among others. (i) improve the method for estimating harvested area for the cultivation of rice in lowlands using the KSA method for the period 2000-2017, (ii) use the actual consumption of agricultural lime by identifying institutions and activities that use lime for agricultural activities, (iii) conduct research with the MoA to determine the combustion factor of agricultural land and (iv) identification of data on activities that reduce GHGs from oil palm plantations and other products.

Differences of GHG Emission Estimates in BUR 2 and BUR 3 for Agriculture Sector

The emissions of agricultural sector reported in BUR 3 are lower than those in BUR 2 (Table 2-13). This difference is primarily due to changes in harvested area for rice cultivation in the lowlands and the lack of correction factors for livestock populations in the estimation of livestock emissions. As noted earlier, the harvested area for rice cultivation in the lowlands is calculated using a new approach called the sample area frame. (KSA) since 2018 (https://ksa.bps.go.id/ - in Indonesian) and the value is lower than harvested area in previous years. To ensure the consistency of the data, the harvested area from 2000 to 2017 is recalculated using the relationship between harvests areas estimated using the KSA method and the old method. In the meantime, the livestock population in BUR 3 is no longer adjusted by 0.7 for buffalo, dairy cattle and other cattle, particularly for estimating CH_4 emissions from enteric fermentation and manure management because BUR 3 used level 2 emission factors (Table 2-13).

Table 2-13. Comparison of emissions estimated in BUR 3 and BUR 2 for agriculture

Agriculture (in Gg CO2e)	2000	2001	2002	2003	2004	2005	...	2012	2013	2014	2015	2016
BUR 2	95,201	94,134	93,856	94,863	96,586	98,492		106,777	106,814	107,319	111,830	116,690
BUR 3	84,537	82,786	83,269	86,166	85,949	87,411		101,693	97,046	100,092	100,685	102,640
Difference	-10,664	-11,348	-10,587	-8,697	-10,637	-11,081		-5,084	-9,768	-7,227	-11,145	-14,050

GHG Emissions from FOLU Sector

The emission/removal from FOLU is classified into 12 categories, i.e. (1) forest land remaining forest land (3B1a), (2) land converted to forest land (3B1b), (3) cropland remaining crop land (3B2a), (4) land converted to cropland (3B2b), (5) grassland remaining grassland (3B3a), (6) land converted to grassland (3B3b), (7) wetlands remaining wetlands (3B4a), (8) land converted to wetlands (3B4b), (9) settlements remaining settlements (3B5a), (10) land converted to settlements (3B5b), (11) other land remaining other land (3B6a), (12) land converted to other land (3B6b).

The total CO_2 emissions/removals from C stocks changes for each land use category is the sum of all subcategories taking into account the five carbon pools: (i) above-ground biomass, (ii) below-ground biomass, and (iii) soil. The GHG estimates for FOLU consist of three gases: CO_2, CH_4 and N_2O. CH_4 and N_2O emissions sources calculated following fires from 2000 to 2019.

Land cover map produced by the Ministry of Forestry was used as the basis for generating activity data to estimate GHG emissions/removal of FOLU. The dataset were data on years 2000, 2003, 2006, 2009, 2011, 2012, 2013, 2014, 2015, 2017, 2018, and 2019. Particularly for the land cover dataset from 2000 to 2016, it was reinterpreted using Landsat imagery and other satellite images. So that data on forest activity and other land uses have changed from what is used in the BUR.2. Furthermore, the area burned from 2000 to 2019 for BUR 3 was estimated using a modified methodology. , in which The burn area estimate was based not only on the hot spots and fire suppression report used in BUR 2, but also on the analysis of the Landsat images. Due to different methodologies, emissions from peat fires in 2000 and 2016 are slightly higher than the emissions reported in BUR2.

Since 2006, there have been only six broad land use categories in the IPCC GL, the land cover categories produced by the MoEF were re-grouped according to the 2006 IPCC GL as shown in Table 2-14. To ensure that variations between regions in emission/removal calculations are taken into account, land cover types were stratified into seven large groups of islands. , i.e.

Sumatra, Java, Kalimantan, Sulawesi, Bali and Nusa Tenggara, Maluku and Papua, and two soil types, i.e. mineral soil and peat soil.

Table 2-14. Grouping of land cover category produced by the MoEF to the 2006 IPCC Land Use category

No	Land cover class	2006 IPCC land use	Abbreviation	Note
	Forest			
1.	Primary dryland forest	Forest	FL	Natural forest
2.	Secondary dryland forest	Forest	FL	Natural forest
3.	Primary mangrove forest	Forest	FL	Natural forest
4.	Secondary mangrove forest	Forest	FL	Natural forest
5.	Primary swamp forest	Forest	FL	Natural forest
6.	Secondary swamp forest	Forest	FL	Natural forest
7.	Plantation forest	Forest	FL	Plantation forest
	Other Land Use			
8.	Estate crop	Crop land	CL	Non-forest
9.	Dryland agriculture	Crop land	CL	Non-forest
10.	Mixed dryland agriculture	Crop land	CL	Non-forest
11.	Shrub	Grassland	GL	Non-forest
12.	Swamp shrub	Grassland	GL	Non-forest
13.	Savannah and Grasses	Grassland	GL	Non-forest
14.	Paddy Field	Crop land	CL	Non-forest
15.	Open swamps	Wetland	WL	Non-forest
16.	Fishponds/aquaculture	Wetland	WL	Non-forest
17.	Transmigration areas	Cropland	CL	Non-forest
18.	Settlement areas	Settlement	ST	Non-forest
19.	Port and harbour	Other land	OL	Non-forest
20.	Mining areas	Other land	OL	Non-forest
21.	Bare land	Other land	OL	Non-forest
22.	Open water	Wetland	WL	Non-forest
23.	Clouds and no data	No data	-	-

Figure 2-28 summarises GHG emissions from FOLU between 2000 and 2019, with an annual average of 515,318 Gig CO_2e. In 2019, the emissions amounted to 924,853 Gg CO2e for 3 gases. (CO_2, CH_4 and N_2O). Emissions fluctuation over the 2000-2019 period has been influenced by emissions from peat fires as a source of emissions. In the past 5 years, i.e., 2015, as a result of the El Nino-Southern oscillation, emissions from peat fires reached 822,736 Gg CO2e, equivalent to 52.53% of total FOLU emissions. Emissions from peat fires after 2015 were lower, while in 2016, emissions were estimated at 90,267 Gig CO2e (17,78%), in 2017 to 12.512 Gg CO2e, in 2018 to 121,322 Gg CO2e and in 2019 to 456,427 Gg CO2e compared to 2015. Emissions trend from peat fire is presented in Figure 2-29.

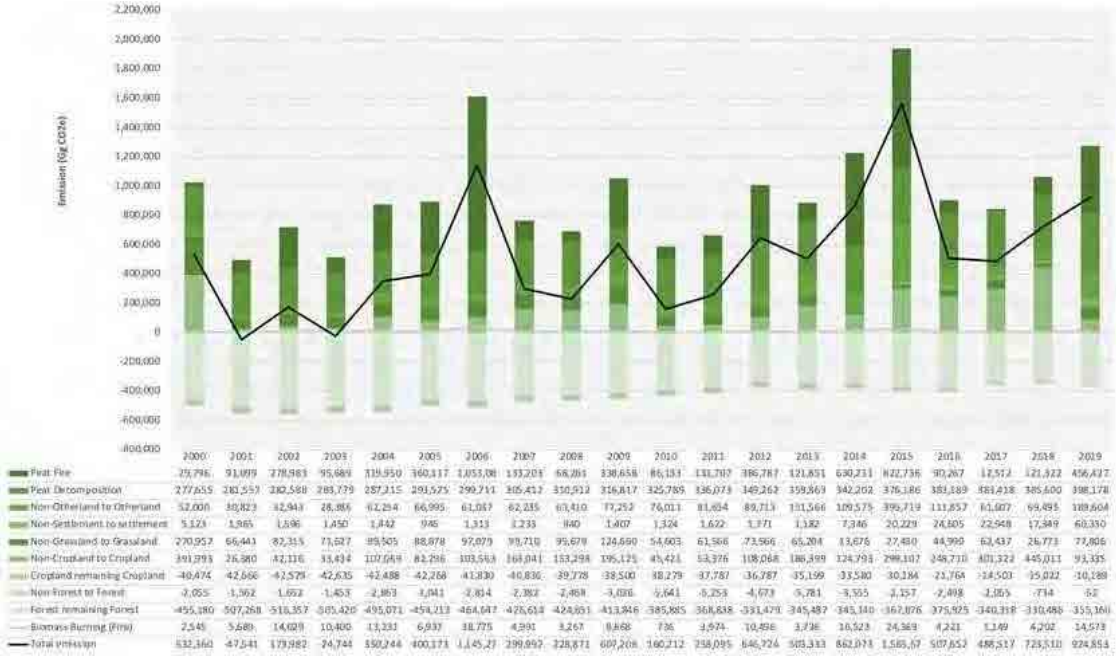


Figure 2-28. GHG emissions from FOLU in 2000 – 2019

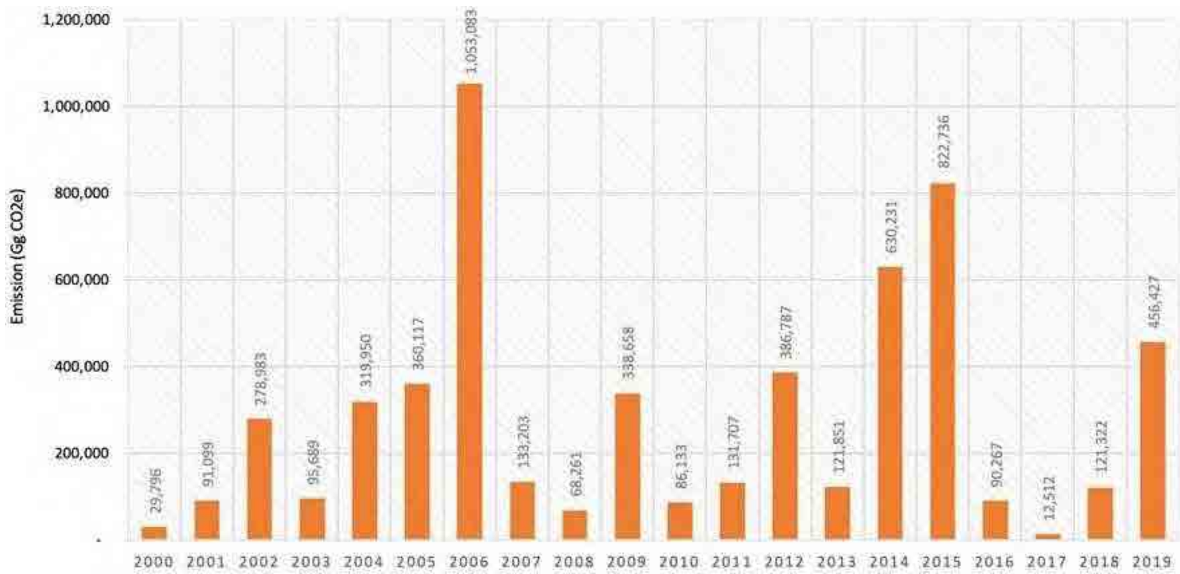


Figure 2-29. Emissions from peat fire

Figure 2-29 shows that the average emission from peat fire fluctuated year to year. The average emission from 2000 until 2019 was 281,441 Gg CO_2e, reached an all-time high of 1,053,083 Gg CO_2e in 2006 and followed by 822,736 Gg CO2e in 2015 due to a prolonged El Nino, and recorded as the lowest of 29,796 Gg CO_2e in 2000.

As seen in Table 2-15 on KCA for FOLU sector, the main sources of emissions from FOLU are Peat Fire, Peat Decomposition, Forest remaining Forest, Non-Other Land to Other Land, Non-Cropland to Cropland, and Non-Grassland to Grassland, which all contributed to 95% of emissions in FOLU sector.

Table 2-15. Key Category Analysis on FOLU sector

Code	IPCC Category	GHG	$\lvert GgCO_2e \rvert$	Level/Rank	Cumulative Contribution (%)
Other	Peat fire	CO_2	456,427	27.57	27.57
Other	Peat decomposition	CO_2	398,178	24.05	51.62
3B1a	Forest remaining forest	CO_2	355,160	21.45	73.07
3B6b	Non-other land to other land	CO_2	189,604	11.45	84.52
3B2b	Non-cropland to cropland	CO_2	93,335	5.64	90.16
3B3b	Non-grassland to grassland	CO_2	77,806	4.70	94.86
3B5b	Non-settlement to settlement	CO_2	60,330	3.64	98.50
Other	Biomass Burning (fire)	CH_4, N_2O	14,573	0.88	99.38
3B2a	Cropland remaining cropland	CO_2	10,189	0.62	100.00
3B1b	Non-forest to forest		52	0.00	100.00

Plan of Improvement in FOLU Sector

Improvement plans for the FOLU sector will be implemented in the future, among other things: (i) use of appropriate emission factors and high tiers (Tier 2/Tier 3) for key categories, (ii) consider estimating flooded land emissions with the 2019 IPCC Refinement, (iii) the use of appropriate methodologies and assumptions for the estimation of greenhouse gas emissions/removals such as include a water level in the calculation of emissions from peat decomposition and include the categories of carbon from mangrove soil in the GHG inventory, and (iii) identification of forest sector activities that have the potential to reduce GHG emissions, followed by the development of methods for estimating GHG emission reductions.

Differences of GHG Emission Estimates in BUR 2 and BUR 3 for FOLU Sector

The FOLU sector emissions reported in BUR 3 are lower than the BUR 2 (Table 2-16). As previously stated, this difference is primarily due to changes in land use data. Land remains in the same category, and land converted to another category (land use transition) due to the use of reinterpreted land use maps; changes in the burned area of peatland because of the use of the latter method as explained above; and Includes emissions from biomass combustion for CL and GL, excluding rice and rice fields because they are already estimated in the agriculture sector.

Table 2-16. Comparison of emissions estimated in the BUR 3 and BUR 2 for FOLU

FOLU (in Gg CO2e)	2000	2001	2002	2003	2004	2005	...	2012	2013	2014	2015	2016
BUR 2	505,368	380,129	674,941	461,034	707,870	698,525		694,978	607,328	979,422	1,569,064	635,448
BUR 3	532,360	-47,541	173,982	-24,744	350,244	400,173		646,724	503,333	862,073	1,565,579	507,652
Difference	26,992	-427,669	-500,959	-485,778	-357,625	-298,352		-48,254	-103,995	-117,349	-3,485	-127,796

Table 2-17. Summary of emissions from FOLU Sector (in Gg CO_2e) in 2000-2019

Code	Source Category	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
3B1a	Forest remaining Forest	-455,180	-507,268	-516,357	-505,420	-495,071	-454,213	-464,647	-426,614	-424,651	-413,846	-385,885	-368,838	-331,479	-345,487	-345,140	-367,876	-375,925	-340,318	-330,486	-355,160
3B1b	Non-Forest to Forest	-2,055	-1,562	-1,652	-1,453	-2,863	-3,041	-2,814	-2,382	-2,468	-3,036	-5,641	-5,253	-4,673	-5,781	-3,555	-2,157	-2,498	-2,055	-734	-52
3B2a	Cropland remaining Cropland	-40,474	-42,666	-42,579	-42,635	-42,488	-42,268	-41,830	-40,836	-39,778	-38,500	-38,279	-37,787	-36,787	-35,199	-33,580	-30,184	-21,764	-14,503	-15,022	-10,189
3B2b	Non-Cropland to Cropland	391,993	26,380	42,116	33,434	107,069	82,296	103,563	163,041	153,298	195,125	45,421	53,376	108,068	186,399	124,793	299,107	248,710	301,322	445,011	93,335
3B3a	Grassland remaining Grassland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3B3b	Non-Grassland to Grassland	270,957	66,441	82,315	71,627	99,505	88,878	97,079	99,710	95,679	124,660	54,603	61,566	73,566	65,204	13,676	27,450	44,990	62,437	26,773	77,806
3B4a	Wetland remaining Wetland	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
3B4b	Non-Wetland to Wetland	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
3B5a	Settlement remaining Settlement	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3B5b	Non-Settlement to settlement	5,123	1,965	1,596	1,450	1,442	946	1,313	1,233	940	1,407	1,324	1,622	1,771	1,182	7,346	20,229	24,605	22,948	17,349	60,330
3B6a	Otherland remaining Otherland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3B6b	Non-Otherland to Otherland	52,000	30,823	32,943	28,386	62,254	66,995	61,037	62,235	63,410	77,252	76,011	81,654	89,713	151,566	109,575	395,719	111,857	61,607	69,495	189,604
Other	Biomass Burning (fire)	2,545	5,689	14,029	10,400	13,231	6,937	38,775	4,991	3,267	8,668	736	3,974	10,496	3,736	16,523	24,369	4,221	1,149	4,202	14,573
Other	Peat Decomposition	277,655	281,557	282,588	283,779	287,215	293,525	299,711	305,412	310,912	316,817	325,789	336,073	349,262	359,863	342,202	376,186	383,189	383,418	385,600	398,178
Other	Peat Fire	29,796	91,099	278,983	95,689	319,950	360,117	1,053,083	133,203	68,261	338,658	86,133	131,707	386,787	121,851	630,231	822,736	90,267	12,512	121,322	456,427
	Total	532,360	-47,541	173,982	-24,744	350,244	400,173	1,145,270	299,992	228,871	607,206	160,212	258,095	646,724	503,333	862,073	1,565,579	507,652	488,517	723,510	924,853

2.2.3.4 Waste

GHG emissions from the waste sector reported to date in BUR 3 cover emissions from four broad source categories, namely domestic solid waste (MSW), domestic waste water (DWW), industrial waste water (IWW), and industrial solid waste (ISW) treatments. In the treatment of MSW, the estimation of GHG emissions has been improved by updating data on the amount of MSW treated in landfill or solid waste disposal sites. (SWDS), composted, 3R (particularly waste paper recycled), and the number of LFG (landfill gas) recovery systems installed in the landfills. All of these improvements make reference to the updated (most recent) data from ADIPURA and surveys.

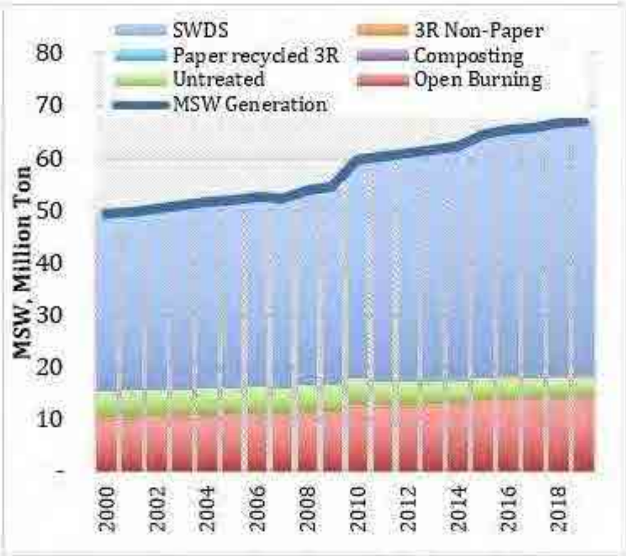
GHG emissions from ISW treatment have also been enhanced by the inclusion of a new source category in the ISW. The previous calculation (BUR 2) of the GHG emissions from the ISW was limited to the GHG emissions from sludge treatment in integrated pulp & paper industries and sludge handling (anaerobic pond) in paper industries, where the sludge treatment covers landfill, treated in an aerobic pond, composting, and utilised for raw materials and energy. In this BUR 3, the sources of GHG emissions from ISW are added by including additional sources of emissions, i.e. industrial solid waste treatment such as empty fruit bunches (EFB) in the palm oil mills.

In the DWW treatment, the scope of GHG emissions inventory is improved by complementing the data on the quantity of sludge that is removed from the septic tank and processed in the sludge treatment facility, the number of septic tanks that is replaced with bio-digester equipped with biogas recovery, and the amount of DWW that is treated in centralised WWTP. It should be noted that GHG emissions from DWW treatment in the TNC were estimated based on data from DWW treatment facilities published by the Ministry of Health while in the BUR 2, these emissions have been estimated on the basis of data on DWW treatments in the People's Welfare Statistics by BPS when more comprehensive and yearly data are available. Similarly, BUR 3 estimates also refer to Welfare Statistics

GHG Emissions from Municipal Solid Waste (MSW)

The MSW management stream data used to estimate GHG emissions are mainly derived from the ADIPURA database, while the quantity of LFG recovered was estimated from surveillance investigations by MoEF. The ADIPURA database, especially with respect to the MSW generation and management of stream, has been used to estimate the GHG emissions since 2003. While not all cities in Indonesia are covered by the data, they can still be used to estimate the national waste stream, that includes MSW delivered to SWDS, composted, 3R (recycled paper), incinerated for energy generation, etc. After 2014, this database was enhanced by the inclusion of more cities with higher MSW coverage with at least 80% of the national MSW generated.

In BUR 2 and BUR 3, the 2015 data were estimated due to the lack of data in ADIPURA database. However, after 2015 and beyond, the data refer back to the ADIPURA database, as the database has been continuously refined to become consistent, regular and timely. Figure 2-30 shows the waste stream used in this BUR 3 and LFG (as methane) recovery from landfills.



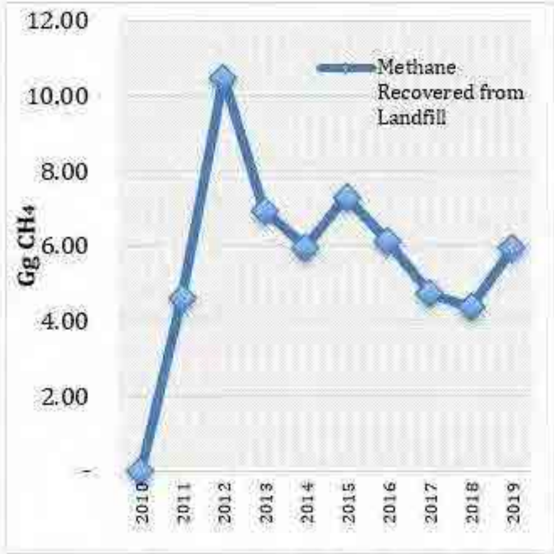


Figure 2-30. MSW management stream data and methane recovery from landfill for estimation of the GHG emissions from MSW category

Among these treatments, the main contributors to national GHG emissions are the treatment of MSW in SWDS, followed by open burning and composting. GHG emissions (N_2O and CO_2) from composting are lower than those from SWD waste. Therefore, it is considered as mitigation measures. Along with the increase in composting activities, GHG emissions from composting increased significantly at a rate of 20.4% per year between 2000 and 2019, whereas SWDS GHG emissions have increased by 2.4% and open burning has increased by 1.7%. To 2019, GHG emissions from the SWDS amounted to 38,487 (87.9% of total emissions from MSW treatments), open burning was 5,296 Gg CO_2e (12.1%), and composting was 2.16 Gg CO_2e (0.005%).

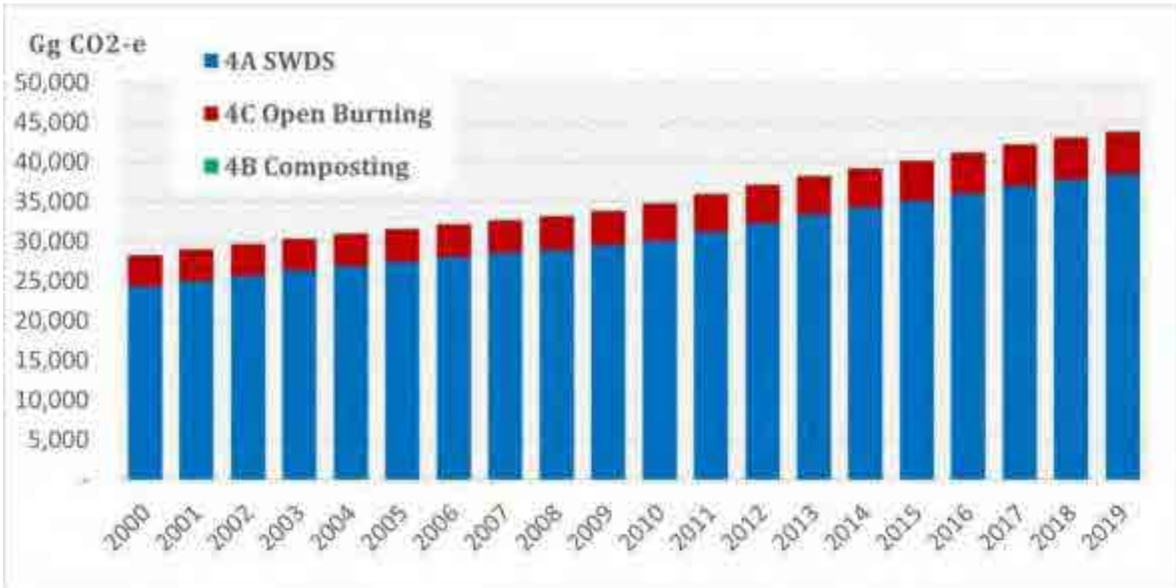


Figure 2-31. GHG Emissions from MSW

GHG Emissions Estimate from Domestic Wastewater

The GHG emissions from DWW treatment were estimated based on population data, the default parameter of the BOD (IPCC 2006), statistical data of protein consumptions (BPS, 2019), and the statistics available on the level of use of treatment types. The parameter used to estimate GHG emissions from domestic wastewater is presented in Table 2-18. For reporting purposes, this BUR 3 uses updated statistics. The results of GHG emissions estimation are shown in Figure 2-32. It shows that GHG emissions in 2019 were 23,584 Gg CO_2e, which comprises of 20,329 Gg CO_2e from CH_4 emissions and 3,255 Gg CO_2e from N_2O emissions. The average GHG emissions growth rate since 2000 has been approximately 2.4% per year..

Table 2-18. Parameters used in GHG emissions estimate of domestic wastewater

Parameter	Characteristics		
BOD	40 gram/capita/day (14.6 kg/capita/year)		
Max CH_4 production capacity	0.6 kg CH_4/kgBOD		
Protein consumption per capita per year* and total TOW of Domestic WWT per year	**Year**	**Protein consumption, Kg/cap/year**	**TOW, Million Tonne BOD/year**
	2000	17.76	3.01
	2001	17.76	3.06
	2002	19.87	3.10
	2003	20.21	3.15
	2004	19.95	3.19
	2005	20.17	3.24
	2006	19.58	3.29
	2007	21.05	3.33
	2008	20.98	3.38
	2009	19.84	3.43
	2010	20.08	3.48
	2011	20.53	3.53
	2012	19.40	3.58
	2013	19.37	3.63
	2014	19.68	3.68
	2015	20.12	3.73
	2016	20.68	3.77
	2017	22.70	3.82
	2018	22.70	3.86
	2019	22.68	3.91
Fraction of N in protein	0.16 kg N/kg protein		
F non-consumption protein	1.10		
F industrial and commercial co-discharged protein	1.25		
N removed with sludge (default is zero)	0 kg		
Emission factor	0.005 kg N_2O-N/kg N		
Conversion factor of kg N_2O-N into kg N_2O, 44/28	1.57		
N_2O Emissions from wastewater plants (default value is zero)	0 kg N_2O-N/kg N		

*Based on daily protein consumption per capita, which are released in the Statistics Indonesia (BPS)

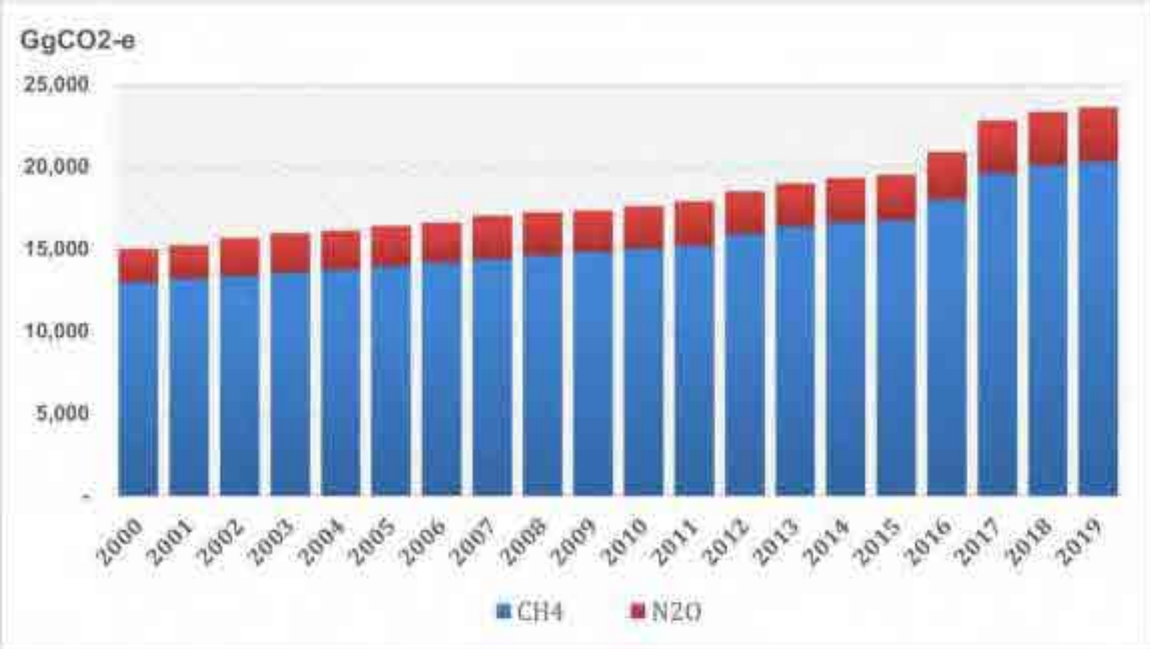


Figure 2-32. The GHG emissions from domestic wastewater for the 2000-2019 period

GHG Emissions Estimates from Industrial Wastewater

In BUR 3 report, GHG emission estimates for industrial wastewater (IWW) were improved. Including updated data on activities associated with the treatment and management and methane recovery of pulp and paper and CPO, and also updated with the industry's starch production capacity activity data. As with other industries, these estimates used to be based only on the production capacity of available statistical data. Figure 2-33 presents the total TOW in industrial wastewater, which is consistent with production capacity data used in estimating GHG emissions from industrial WWT.

Other improvement is the use of MCF default value of the WWT in starch industries with higher MCF, i.e., 0.9 that is a deep anaerobic WWT unit. Primary field surveys for a number of starch industries in Lampung showed that WWTP in most starch industries could be classified as a deep anaerobic lagoon. In the previous TNC and BUR 2 of the National GHG Inventory, WWT was assumed to be shallow anaerobic ponds., in which the TNC used a mean value of MCF (=0.2) while the BUR 2 used the maximum default value of MCF (= 0.3).

In addition, the POME EF treated in open ponds referred to the BLE (2010) Guideline of Sustainable Biomass Production [Indonesian Sustainable Palm Oil, ISPO], in which the EF is 0.51 kg CO_2e/kg CPO or 0.16 kg CO_2e/kg POME with 3.25 kg POME/kg CPO). In the previous National GHG Inventory (TNC and BUR 2), EFA parameters refer to those indicated by regulation of quality standards (wastewater generation) and some facilities, environmental data (COD), as there are no default data available from ISPO yet.

Therefore, in the BUR 3, the national GHG estimates are recalculated from 2000 to 2019, as presented in Figure 2-34. IWWT GHG emissions for 2019 amounted to 52,832 Gg CO_2e.

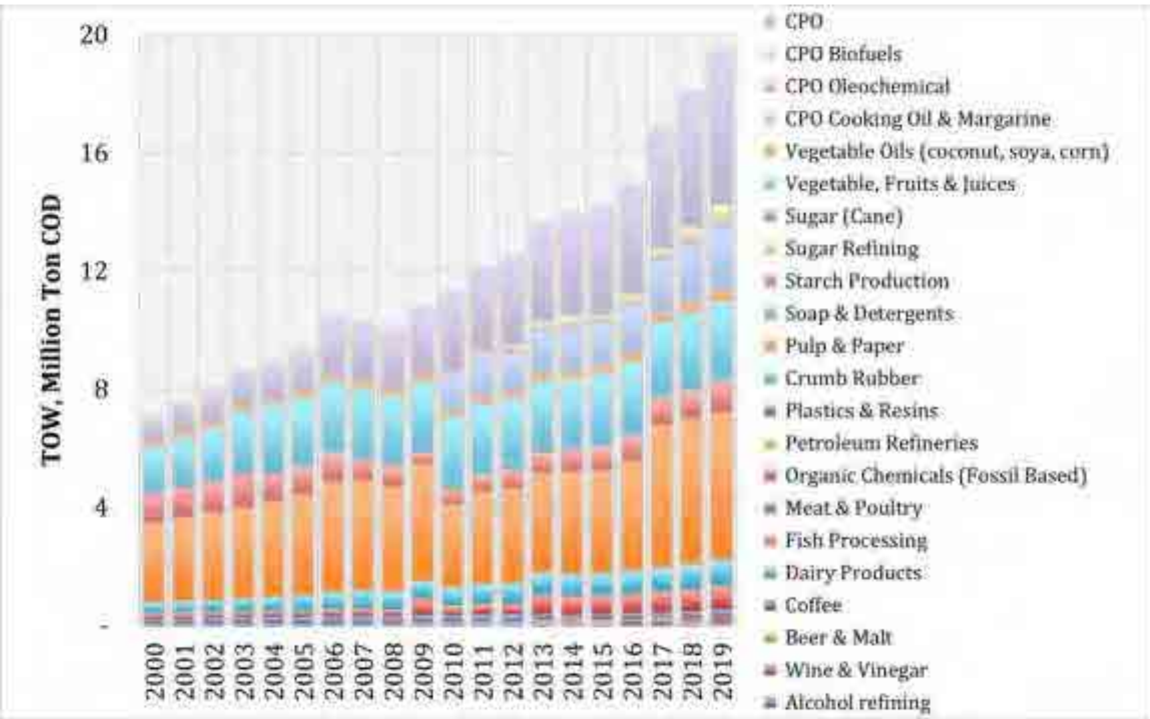


Figure 2-33. Industrial TOW to estimate GHG emissions from industrial wastewater

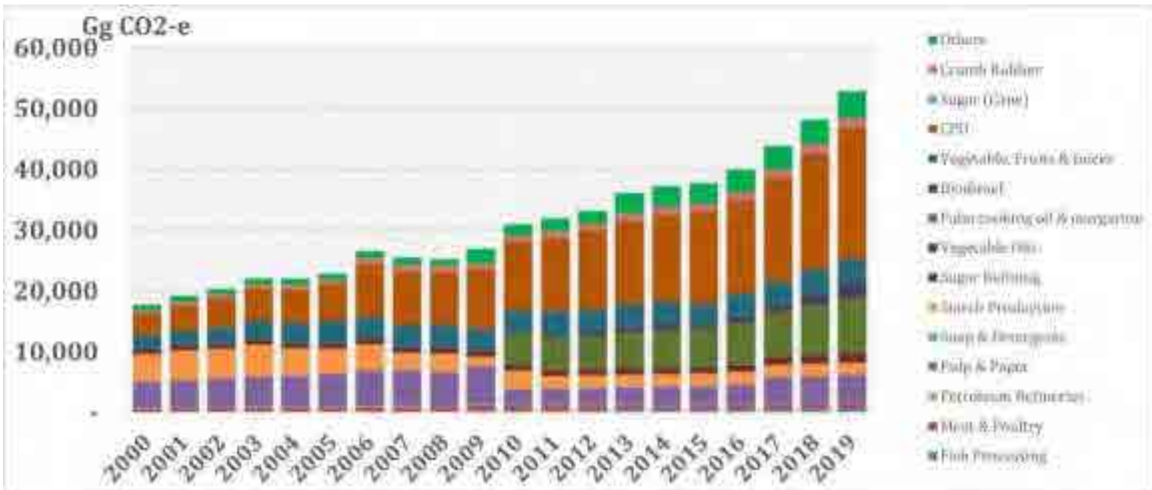


Figure 2-34. GHG Emissions from Industrial Wastewater, 2000-2019

GHG Emissions from Industrial Solid Waste

The GHG emissions from ISW treatment began to be reported in the national inventory at BUR 2. Coverage of the ISW inventory was restricted to GHG emissions from pulp and paper mill sludge treatment. GHG emissions from this treatment were estimated based on the quantity of sludge to be treated, the organic matter content of the sludge and the type of sludge treatment. The quantity of sludge is proportional to the productive capacity of the related industry. For this BUR 3, the inventory includes a new category, which is GHG emission from EFB treatments.

Historically, the EFB was incinerated in a conventional furnace. This furnace was not suitable for incineration of the EFB and was not equipped with an air pollution control system, so the flue gas did not meet the air quality standard. As the Environmental Management Regulation (Act No 32/2009) is published, any activity that does not meet the air quality standard will be sanctioned by law. Since then, the processing of the EFB has changed from incineration to stockpiling. Under this legislation, GHG emissions were calculated assuming that incineration occurred prior to 2010 and that stocks were used to treat EFB since 2010. However, efforts to use EFB to reduce EFB piles have been implemented. The initiatives not only reduce the piles but also reduce the GHG emission. Uses of the EFB, for example, include cattle feed, mulch, traded as fuels, and composting.

Figure 2-35 provides an update on GHG emissions from the ISW category from 2010 to 2019. In 2019, the total GHG emissions of ISW reached 132 Gg CO_2e, which comprises of 111 Gg CO_2e from sludge handling, 20 Gg CO_2e from sludge landfill, 1.71 Gg CO_2e from sludge composting, and no emission from EFB. The sludge is derived from the WWTP of pulp and paper industry.

In the future, other WWTP sludge treatments from other industries, such as starch, food and beverages, etc., should be included. Sludge handling includes treatment in open ponds and the pre-treatment process for the use of biofuels (drying). The GHG emissions from pulp and paper sludge treatment and other new sources (i.e., EFB processing) are categorised as Other - ISW Handling, as provided in Figure 2-35.

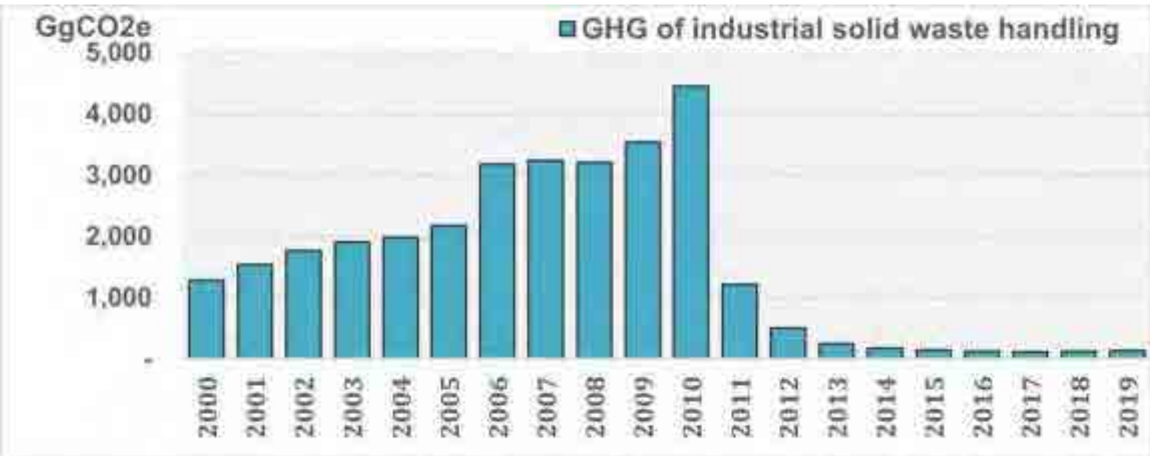


Figure 2-35. GHG Emissions from Industrial Solid Waste, 2010-2019

Summary of the GHG Emissions from Waste Category

Figure 2-36 summarises the GHG emissions calculations for the period 2000 to 2019. The main contributor is industrial waste treatment, comprising industrial wastewater and solid waste, with a value of 52,864 Gg CO_2e in 2019, followed by MSW treatment with 43,785 Gg CO_2e and domestic wastewater treatment (DWW) with 23,584 Gg CO_2e. GHG emissions from MSW and DWW treatment tend to increase slightly over the period 2000-2019, in line with population growth, Whereas emissions from an industrial waste processing have increased significantly as associated industries have developed.

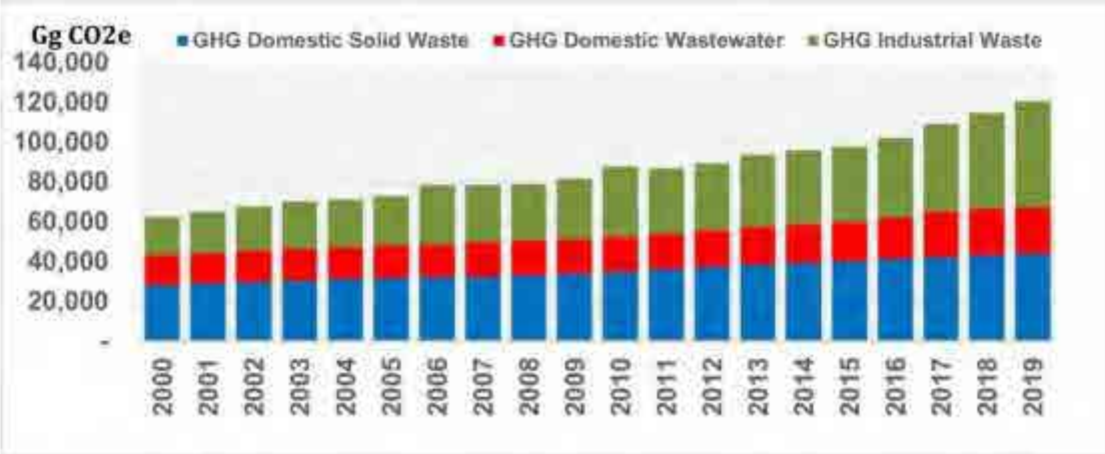


Figure 2-36. GHG Emissions from Waste Sector, 2000-2019

The GHG emissions of waste sector in 2019 were 120,333 Gg CO_2e and were dominated by GHG emissions from the industrial waste (44%), followed by MSW (36%) and domestic wastewater (20%) respectively. According to the type of gas, CH_4 is the major gas produced in this sector. (94.49%). The distribution of GHG emissions from the waste sector in 2019 by gas source and type is shown in Figure 2-37. Additionally, the common format for reporting GHG emissions from the waste sector is shown in Table 2-19 below.

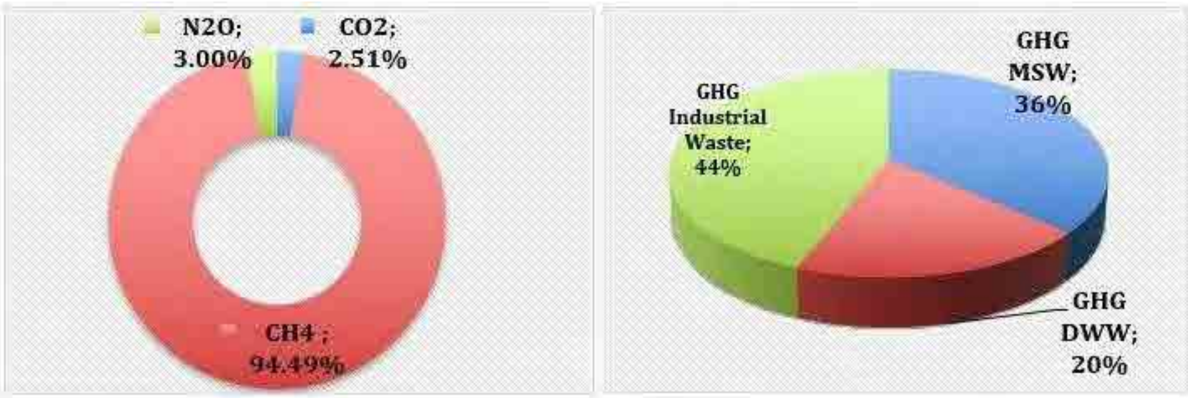


Figure 2-37. The distribution of GHG emissions from the waste category by type of gas (left) and by category of sources (right) in 2019

Table 2-19. Common reporting format of the GHG emissions from waste category in 2019

GHG Source and Sink Categories	CO_2(1)	CH_4	N_2O	CO_2-e
	(Ggram CO_2e)			
Total waste	3,026	113,102	3,606	120,333
A. Solid waste disposal				
1.1 Managed Domestic Waste Disposal Sites				
1.2 Managed Industrial Waste Disposal		19,95		20
2. Unmanaged Domestic Waste Disposal Sites		38.487		38.487
3. Uncategorised Waste Disposal Sites				
B. Biological treatment of solid waste				
1. Composting of domestic solid waste		0,06	2,10	2,16
2. Composting of industrial solid waste		0,90	0,80	1,71
3. Anaerobic digestion at biogas facilities				

GHG Source and Sink Categories	CO_2[(1)]	CH_4	N_2O	CO_2-e
	(Ggram CO_2e)			
C. Incineration and open burning of waste				
1. Waste incineration				
2. Open burning of domestic solid waste	3.025	1.923	347,64	5.296
D. Wastewater treatment and discharge				
1. Domestic wastewater		20.329	3.255	23.584
2. Industrial wastewater		52.832		52.832
3. Other (as specified in Table 5.D)				
E. Other (please specify):				
1. Industrial Solid Waste Handling	1,14	109		111
[1)] CO_2 emission from waste sector is derived from fossil content (C2) and as CO_2-equivalent emitted from pre-treatment of biomass fuel (E1)				

Key Category Analysis

According to the KCA, the major sources of GHG emissions from the waste sector are IWW treatment, unmanaged MSW SWDS, DWW treatment, and ISW handling under "Other" category (see Table 2-20).

Table 2-20. Key Category Analysis for waste sector in 2019

Code	Category	Total GHG Emissions	Level/Rank	Cumulative
4 D 1	Industrial Wastewater Treatment and Discharge	52.832	43,90%	44%
4 A 2.1	Unmanaged Domestic Solid Waste Disposal	38.487	31,98%	76%
4 D 1	Domestic Wastewater	23.584	19,60%	95%
4 C	Open Burning of Domestic Solid Waste	5.296	4,40%	100%
4 E	Other - Industrial Solid Waste Handling	111	0,09%	100%
4 A 1.2	Managed Industrial Solid Waste Disposal	20	0,02%	100%
4 B 1	Biological Treatment of Domestic Solid Waste	2,16	0,002%	100%
4 B 2	Biological Treatment of Industrial Solid Waste	1,71	0,001%	100%
TOTAL		**120,333**	**100%**	

Plan of Improvement for Waste Sector

The plan of improvements for the waste sector include:

1. Improvement of MSW stream data through surveys of MSW management at local governments or provinces and composition and characteristics of MSW discharged to the SWDS using SDWS or landfill surveys where characteristics include dry matter content (DMC) and degradable organic carbon (DOC);
2. The improvement of data related the DWW treatment, i.e., types and number of septic tank, the amount of sludge recovery, other DWW treatments types (bio-digester, centralised, aerobic or anaerobic), DWW characteristics, MCF of waste treatment, and EF of each treatment. The improvement will be achieved by gathering research data, the Settlement Development Research Centre, and other relevant institutions. Data on septic tank utilisation could also refer to data from Ministry of Health (MoH), Welfare Statistics (*SKR BPS*), monitoring results of the Ministry of Public Works and Housing (MoPWH). In addition, it is also important to add the necessary bio-digester data from activities where the realisation is greater than those collected by the MoEF, i.e., data developed by the Ministry of Public Works and Housing, international cooperation (e.g., BORDA), NGOs (Clinton Programme, Bali Focus, etc.), Islamic boarding schools, real estate settlements (e.g., BSD City), and sanitation programmes on bio-digesters;

3. Improve data related to the recovery of sludge from IWW treatment plants, which can be carried be achieved by integrating the data collection with existing monitoring activities of the Directorate of MSW Management and Hazardous Waste (PSLB3) - MoEF;
4. Incorporate GHG emissions from WWTP of industrial estate and the sludge treatment of WWTP in industries into the national GHG emissions inventory;
5. Improve data collection on methane recovery and use from WWTP in industries that are generally incorporated into renewable or alternative energy use data;
6. Include hazardous waste in GHG emission sources in the waste category.

2.2.4 The National GHG Emissions Trend

In 2019, the national GHG emissions for the five gases (CO_2, CH_4, N_2O, CF_4, and C_2F_6) were 1,845,113 Gg CO_2e, or 1,845,067 Gg CO_2e for 3 gases (CO_2, CH_4, N_2O). The total figure for the five gases was 805,496 Gg CO_2e, which was higher than emissions in the year 2000 and significantly higher than that in 2018 (1,592,708 Gg CO_2e). The average total emissions from 2000 to 2019 was 1,188,161 Gg CO_2e, reaching a record high of 2.339.651 Gg CO_2e due to a prolonged El Nino in 2015 resulting in numerous peat fires. The lowest GHG emissions was recorded at 490,336 Gg CO2e occurring in 2001. Figure 2-38 below portrays the national GHG emissions trend by sector during the period of 2000-2019.

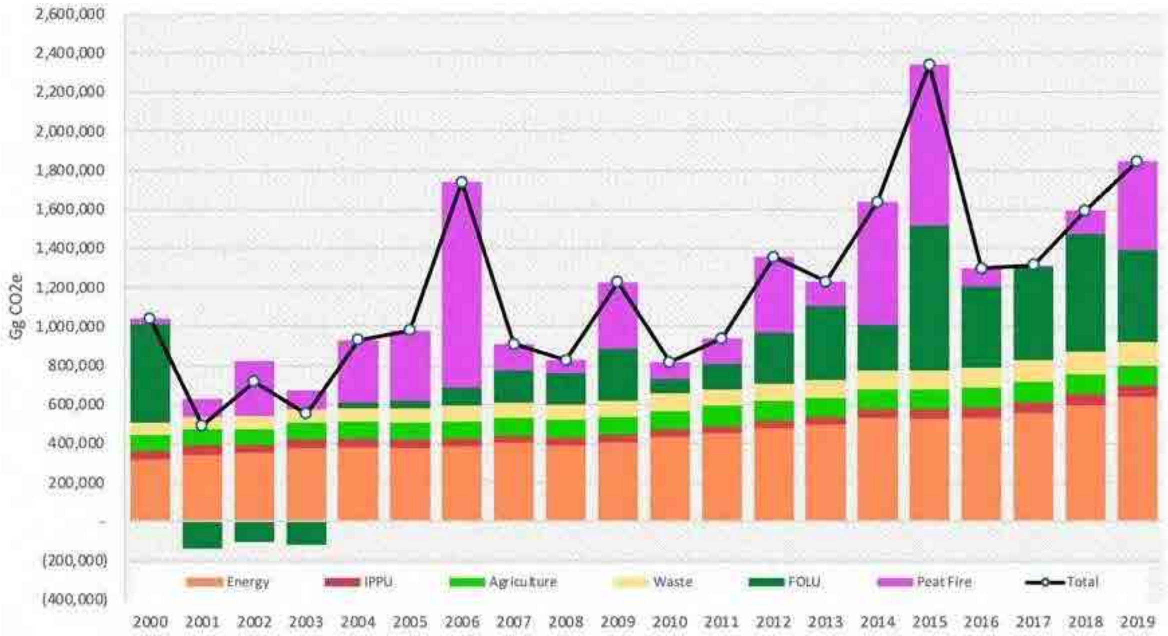


Figure 2-38. National Trend for GHG Emissions by Sector in 2000 – 2019

Over the 2000 – 2019 period, national GHG emissions increased by an average rate of 10.52% per year with AFOLU including peat fires, and 3.21% per year without FOLU and peat fires. This indicates that land-based sectors, particularly forestry, have made significant contributions to the national GHG emissions (Table 2-21).

Table 2-21. Annual growth of emissions by sector 2000-2019

Sector	Increase (%)
Energy	3.78
IPPU	1.94
Agriculture	1.19
Waste	3.56
FOLU	18.46

2.2.5 Key Category Analysis (KCA)

Using a single approach for all emission sources including the AFOLU sector, 17 key source categories were identified in which the AFOLU sector was predominant (including peat fire). The first four main categories were (i) peat fires, (ii) peat decomposition, (iii) forestland, (iv) energy industries with cumulative emissions of up to 58.65% of the total emissions of all sectors in 2019 (Table 2-22). Meanwhile, for analysis of key categories excluding FOLU sector and peat fires, 16 key sources have been identified (Table 2-23). The first four major categories were (i) energy industries, (ii) transport, (iii) manufacturing and construction, and (iv) wastewater treatment and discharge with cumulative emissions up to 70.54% of the total emissions excluded FOLU and peat fires in 2019.

Table 2-22. Key Category Analysis for National GHG Inventory

Code	Categories	Emissions 2019 (Gg CO_2e)	Absolute GHG Emissions 2019 (Gg CO_2e)	Level/ Rank (%)	Cumulative (%)
Other	Peat Fire	456,427	456,427	17.86%	17.86%
Other	Peat Decomposition	398,178	398,178	15.58%	33.44%
3B1	Forest Land	-355,211	355,211	13.90%	47.34%
1A1	Energy Industries	289,001	289,001	11.31%	58.65%
3B6	Other Land	189,604	189,604	7.42%	66.07%
1A3	Transport	157,771	157,771	6.17%	72.24%
1A2	Manufacturing Industries and Construction	136,179	136,179	5.33%	77.57%
3B2	Cropland	83,146	83,146	3.25%	80.83%
3B3	Grassland	77,806	77,806	3.04%	83.87%
4D	Wastewater Treatment and Discharge	76,416	76,416	2.99%	86.86%
3B5	Settlements	60,330	60,330	2.36%	89.22%
4A2	Unmanaged Municipal Solid Waste Disposal	38,487	38,487	1.51%	90.73%
3C4	Direct N_2O Emissions from Managed Soils	31,800	31,800	1.24%	91.97%
2A1	Cement Production	30,156	30,156	1.18%	93.15%
1A4b	Residential	25,700	25,700	1.01%	94.16%
3C7	Rice Cultivations	25,235	25,235	0.99%	95.15%
3A1	Enteric Fermentation	17,898	17,898	0.70%	95.85%
1B2	1B2 Oil and Natural Gas	17,821	17,821	0.70%	96.54%
3C1	3C1 Biomass Burning	16,649	16,649	0.65%	97.20%
2B1	2B1 Ammonia Production	9,703	9,703	0.38%	97.57%
3C5	3C5 Indirect N_2O Emissions from Managed Soils	7,526	7,526	0.29%	97.87%
3A2b	3A2b Direct N_2O Emissions from Manure Management	7,307	7,307	0.29%	98.16%
2C1	2C1 Iron and Steel Production	6,927	6,927	0.27%	98.43%
4C2	4C2 Open Burning of Waste	5,296	5,296	0.21%	98.63%
3C3	3C3 Urea Application	5,182	5,182	0.20%	98.84%
1A5	1A5 Other/Non-Specified	5,130	5,130	0.20%	99.04%
3C6	3C6 Indirect N_2O Emissions from Manure Management	4,343	4,343	0.17%	99.21%

2D2	2D2 Paraffin Wax Use	3,894	3,894	0.15%	99.36%
1B1	1B1 Solid Fuels	2,688	2,688	0.11%	99.46%
2A4b	2A4b Other Process Uses of Carbonates	2,333	2,333	0.09%	99.56%
1A4a	1A4a Commercial/Institutional	2,163	2,163	0.08%	99.64%
3C2	3C2 Liming	2,160	2,160	0.08%	99.73%
2B8b	2B8b Ethylene	2,080	2,080	0.08%	99.81%
3A2	3A2 Manure Management	1,772	1,772	0.07%	99.88%
2B2	2B2 Nitric Acid Production	784	784	0.03%	99.91%
2B8c	2B8c Ethylene dichloride and VCM	485	485	0.02%	99.93%
2C3	2C3 Aluminium Production	376	376	0.01%	99.94%
2B8a	2B8a Methanol	310	310	0.01%	99.95%
2D1	2D1 Lubricant Use	232	232	0.01%	99.96%
2B8f	2B8f Carbon Black	224	224	0.01%	99.97%
2H1	2H1 Pulp and Paper Industry	147	147	0.01%	99.98%
2A2	2A2 Lime Production	125	125	0.00%	99.98%
4E	Other (waste)	111	111	0.00%	99.99%
2A4d	2A4d Other Carbonate Consumption	94	94	0.00%	99.99%
2C5	2C5 Lead Production	88	88	0.00%	99.99%
2C6	2C6 Zinc Production	83	83	0.00%	100.00%
2A3	2A3 Glass Production	50	50	0.00%	100.00%
2B5	2B5 Carbide Production	31	31	0.00%	100.00%
4A1.2	4A1.2 Industrial Solid Waste Disposal	20	20	0.00%	100.00%
2A4a	2A4a Ceramic production	4	4	0.00%	100.00%
2H2	2H2 Food and Beverages Industry	2	2	0.00%	100.00%
4B1	4B1 Biological Treatment of Domestic Solid Waste	2	2	0.00%	100.00%
4B2	4B2 Biological Treatment of Industrial Solid Waste	2	2	0.00%	100.00%

Table 2-23. Key Category Analysis for the National GHG Inventory without FOLU and Peat Fire

Code	Categories	Emissions 2019 (Gg CO2e)	Absolute GHG Emissions 2019 (Gg CO2e)	Level/Rank (%)	Cumulative (%)
1A1	Energy Industries	289,001	289,001	30.91%	30.91%
1A3	Transport	157,771	157,771	16.88%	47.79%
1A2	Manufacturing Industries and Construction	136,179	136,179	14.57%	62.35%
4D	Wastewater Treatment and Discharge	76,416	76,416	8.17%	70.53%
4A2	Unmanaged Municipal Solid Waste Disposal	38,487	38,487	4.12%	74.64%
3C4	Direct N_2O Emissions from Managed Soils	31,800	31,800	3.40%	78.05%
2A1	Cement Production	30,156	30,156	3.23%	81.27%
1A4b	Residential	25,700	25,700	2.75%	84.02%
3C7	Rice Cultivations	25,235	25,235	2.70%	86.72%
3A1	Enteric Fermentation	17,898	17,898	1.91%	88.63%
1B2	Oil and Natural Gas	17,821	17,821	1.91%	90.54%
3C1	Biomass Burning	16,649	16,649	1.78%	92.32%
2B1	Ammonia Production	9,703	9,703	1.04%	93.36%
3C5	Indirect N_2O Emissions from Managed Soils	7,526	7,526	0.81%	94.16%
3A2b	3A2b Direct N_2O Emissions from Manure Management	7,307	7,307	0.78%	94.95%
2C1	Iron and Steel Production	6,927	6,927	0.74%	95.69%
4C2	Open Burning of Waste	5,296	5,296	0.57%	96.25%
3C3	Urea Application	5,182	5,182	0.55%	96.81%
1A5	Other/Non-Specified	5,130	5,130	0.55%	97.36%
3C6	Indirect N_2O Emissions from Manure Management	4,343	4,343	0.46%	97.82%
2D2	Paraffin Wax Use	3,894	3,894	0.42%	98.24%
1B1	Solid Fuels	2,688	2,688	0.29%	98.53%
2A4b	Other Process Uses of Carbonates	2,333	2,333	0.25%	98.77%
1A4a	Commercial/Institutional	2,163	2,163	0.23%	99.01%
3C2	Liming	2,160	2,160	0.23%	99.24%
2B8b	Ethylene	2,080	2,080	0.22%	99.46%

Code	Categories	Emissions 2019 (Gg CO2e)	Absolute GHG Emissions 2019 (Gg CO2e)	Level/Rank (%)	Cumulative (%)
3A2	Manure Management	1,772	1,772	0.19%	99.65%
2B2	Nitric Acid Production	784	784	0.08%	99.73%
2B8c	Ethylene dichloride and VCM	485	485	0.05%	99.78%
2C3	Aluminium Production	376	376	0.04%	99.83%
2B8a	Methanol	310	310	0.03%	99.86%
2D1	Lubricant Use	232	232	0.02%	99.88%
2B8f	Carbon Black	224	224	0.02%	99.91%
2H1	Pulp and Paper Industry	147	147	0.02%	99.92%
2A2	Lime Production	125	125	0.01%	99.94%
4E	Other (waste)	111	111	0.01%	99.95%
2A4d	Other Carbonate Consumption	94	94	0.01%	99.96%
2C5	Lead Production	88	88	0.01%	99.97%
2C6	Zinc Production	83	83	0.01%	99.98%
2A3	Glass Production	50	50	0.01%	99.98%
2A3	2A3 Glass Production	50	50	0.01%	99.99%
2B5	Carbide Production	31	31	0.00%	99.99%
2B5	2B5 Carbide Production	31	31	0.00%	99.99%
4A1.2	Industrial Solid Waste Disposal	20	20	0.00%	100.00%
4A1.2	4A1.2 Industrial Solid Waste Disposal	20	20	0.00%	100.00%
2A4a	Ceramic production	4	4	0.00%	100.00%
2A4a	2A4a Ceramic production	4	4	0.00%	100.00%
2H2	Food and Beverages Industry	2	2	0.00%	100.00%
4B1	Biological Treatment of Domestic Solid Waste	2	2	0.00%	100.00%
4B2	Biological Treatment of Industrial Solid Waste	2	2	0.00%	100.00%
2H2	2H2 Food and Beverages Industry	2	2	0.00%	100.00%
4B1	4B1 Biological Treatment of Domestic Solid Waste	2	2	0.00%	100.00%
4B2	4B2 Biological Treatment of Industrial Solid Waste	2	2	0.00%	100.00%

2.2.6 The Uncertainty Analysis

Data uncertainty for 2019 activity and EFs are the same as reported in the BUR 2. The result of the uncertainty analysis showed that the overall uncertainty of the Indonesia's National GHG inventory with AFOLU (including peat fire) for 2000 and 2019 were approximately 20.0% and 19.9% respectively. A higher level of uncertainty, 10.4% for 2000 and 13.8% for 2019, occurred when the FOLU was excluded from the analysis.

CHAPTER 3.MITIGATION ACTIONS AND THEIR EFFECTS

3.1 Introduction

Mitigation actions in Indonesia are implemented under the framework of Paris Agreement (PA). Indonesia has ratified the PA after Act No. 16/2016 and submitted the Nationally Determined Contribution (NDC) in October 2016, with a commitment to reduce GHG emissions by 29% unconditionally and up to 41% conditionally from the BAU emissions in 2030. This chapter reports on the progress of the implementation of mitigation policies and programmes and their impacts on GHG emissions reductions in the context of achieving the NDC target. This chapter covers data updates related to the reduction target and implementation of policies and programmes for all sectors, specifically those occurring between 2017 and 2019.

3.2 Mitigation Programmes in Indonesia

3.2.1 Emission Reduction Target

The commitment made by the Indonesian NDC to meet the 2030 emission reduction target is presented in Table 3-1. Similar to the pre-2020 voluntary commitment, Indonesia focuses its programme on the reduction of GHG emissions in five sectors namely land use change forestry (LUCF), energy, agriculture, IPPU and waste. The distribution of emission reduction targets for each sector is determined by considering the contribution of each sector to the total national emissions. Forestry/peatland and energy are the two mains contributors to national emissions.

The two sectors are expected to contribute approximately 28.2% of the total national emission reduction target of 811 M tones CO_2e or 28.2% below the 2030 baseline, while the remainder is fulfilled by agriculture, IPPU and waste. Figure 3-1 indicates the GHG emission reduction target for all sectors relative to 2010 baseline and 2030 baseline emissions under the unconditional (CM1) and conditional (CM2) mitigation scenarios.

Table 3-1. GHG emissions level in the BAU and GHG emissions reduction in 2020 and 2030 (M tones CO_2e)

No.	Sector	2010	2020			2030			Reduction 2030		By Sector (%)	
		Base year	BAU	CM1	CM2	BAU	CM1 (29%)	CM2 (up to 41%)	CM1 (29%)	CM2(up to 41%)	CM1 (29%)	CM2 (up to 41%)
1	Energy*1	435	904	785	751	1,669	1,356	1,271	313	398	11%	14%
2	IPPU	36	67	65	64	69	66	66	2.7	2.7	0.1%	0.11%
3	AFOLU	757	880	560	346	833	327	152	506	681	18%	24%
3.a	Agriculture	110.51	115.96	112.75	115.23	119.66	110.51	115.84	9	4	0.32%	0.13%
3.b	Forestry*2	647	764	447	231	714	217	36	497	677	17.3%	24%
4	Waste	88	146	144	144	296	284	269	11	26	0.40%	1%
	Total	1,316	1,994	1,551	1,303	2,868	2,034	1,759	833	1,109	29%	38.7%

Notes: *1 including fugitive emissions, *2including peat fire, BAU = Business-As-Usual, CM1 = unconditionally mitigation scenario (considers sectoral development target), CM2 = conditionally mitigation scenario (implemented with additional international support)

The above commitments are prerequisites for embarking on a more ambitious commitment to further reductions by 2030. The commitments will be implemented through both land and non-land-based sectors. The land-based sectors comprise agriculture and forestry, including peat management, effective land use and spatial planning, sustainable forest management including social forestry programme, restoration of degraded ecosystems functions including in wetlands to improve agriculture and fisheries productivities. The non-land-based sectors include the enhancement of energy conservation, the promotion of clean and renewable energy sources, the improvement of IPPU technology and the improvement of waste management nationwide.

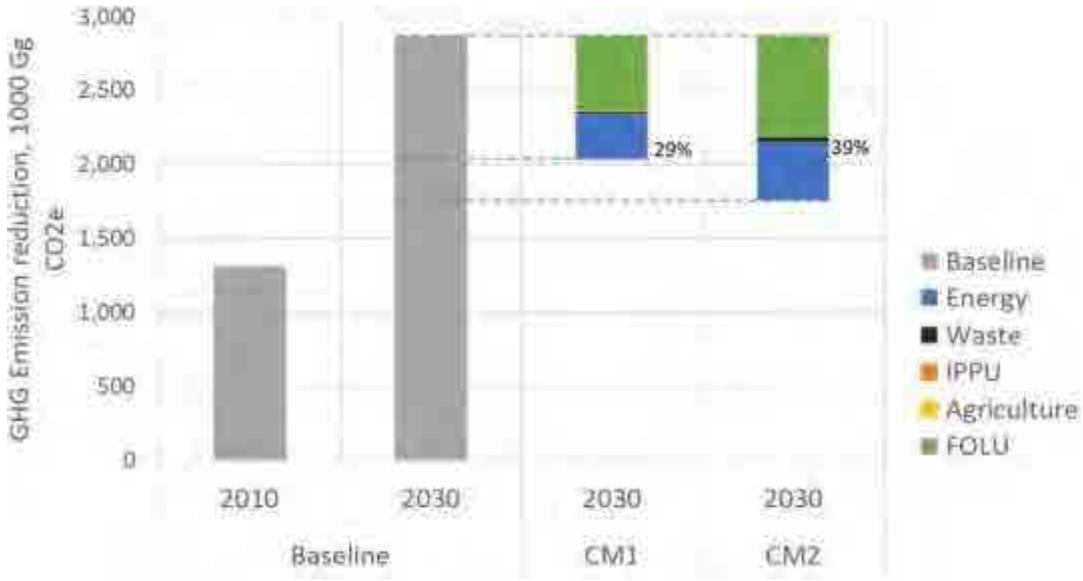


Figure 3-1. GHG emissions reduction target for all sectors relative to 2010 baseline year and 2030 baseline emissions under the conditional mitigation scenario

3.2.2 National Mitigation Programmes

Mitigation actions in Indonesia are classified into sectors and implemented by the Party stakeholders (PS) and Non-party stakeholders (NPS). PS is Government of Indonesia (GoI) represented by relevant ministries. The NPS comprises local governments (provinces, regencies, and cities), businesses, and communities. After the GoI has ratified the PA, the roles of NPS will be encouraged to support the achievement of the NDC target. The PS national mitigation action plans are categorised into energy, IPPU, AFOLU, and waste sectors. The list of mitigation activities by PS is presented in Figure 3-2.

Energy
1. Energy efficiency in final demand
2. Clean coal technology in power
3. Renewable energy in power
4. Fuel switching
5. Post mining reclamation

IPPU
1. Reduction of clinker to cement ratio
2. Improvement of ammonia plant technology
3. Other actions in steel industry and aluminum smelter

Waste
1. Enhanced LFG recovery
2. Enhanced composting and 3R
3. Enhanced RDF utilization
4. Management of domestic WWT
5. Management of industrial WWT

Agriculture
1. The use of low-emission crops
2. Implementation of water efficient system in paddy field
3. Manure management for biogas
4. Feed supplement for cattle

FOLU
1. Reduction of deforestation in mineral and peatland
2. Reduction of forest degradation in mineral and peatland
3. Sustainable forest management to restore production forest
4. Development of community forest & village forest
5. Establishment of timber plantation and private forest
6. Land rehabilitation to enhance carbon sink
7. Restoring degraded peatland
8. Improved peatland water management

Source: Indonesia first NDC and other sources
Figure 3-2. Mitigations actions in the First NDC Indonesia

In addition to the aforementioned climate change mitigations, there are mitigation actions classified as 'Supported Mitigation Actions' and 'International Market'. Supported mitigation actions are implemented with additional international support while the international market is implemented through the existing international carbon market. Elaboration of each type of the mitigation actions is discussed in the following sections.

3.2.3 Mitigation Policy

Indonesia has a strong legal foundation for developing, issuing and implementing climate change mitigation policies and programmes for each sector at national and local levels that are directly and indirectly affecting the climate change. Direct policies are issued to provide the environment that support the implementation of the mitigation programmes, whereas the indirect policies encourage the development of enabling conditions. The legal instruments discussed in BUR 3, cover all legislations and regulations, direct policies, as well as enabling policies that were not covered by the TNC and BUR 2 because of their relatively new and/or publication following ratification of the PA.

3.2.3.1 Energy Sector

The GoI has released a number of policies and regulations to improve mitigation that could directly and indirectly promote the implementation of climate change mitigation. One of the important policies in the energy sector that supports climate change mitigation actions and that would eventually set Indonesia on the path to decarbonisation is the Government Regulation No. 79/2014 on National Energy Policy. This regulation sets out the targets of primary energy supply mix that supports climate change mitigation:

a) New and renewable energy is expected to reach at least 23% in 2025 and 31% in 2050;
b) Oil is expected to reach less than 25% in 2025 and less than 20% in 2050;
c) Coal is expected to have a minimum target of 30% in 2025 and 25% in 2050; and
d) Gas is expected to have a minimum target of 22% in 2025 and 24% in 2050.

The GoI has also issued other policies in support of climate change mitigation actions. A list of these policies is provided in Table 3-2, which is an update of the policies previously reported in BUR 2.

Table 3-2. Policy instruments for supporting mitigation actions in energy sector

Mitigation Measures	Policy Instruments	Description/remarks
Enhancement of renewable energy in building sub-sector	MEMR Ministerial Regulation No.16/2019, revision of MEMR Ministerial Regulation No.13/2019 on Rooftop Solar PV, revision of MEMR Ministerial Regulation No.49/2018 on Rooftop Solar Cell	Regulate business arrangement of electricity from rooftop solar PV between PLN and solar PV owner.
	MEMR Ministerial Regulation No.12/ 2018 on Revision of Ministerial Regulation No. 33/2017 - The supply of solar lamp	Regulate the supply of solar lamps to community without access to electricity.
Enhancement of renewable energy in transport sub-sector	MEMR Ministerial Regulation No.41/ 2018 on Supply and Utilisation of Biodiesel and Palm Oil Plantation Fund.	Regulate the supply and utilisation of biodiesel under the framework of Palm Oil Plantation Fund.
	Presidential Decree No.66/2018 concerning the 2nd Revision to the Presidential Decree No.61/2015 on Collection and Utilisation of Palm Oil Plantation Fund	Regulate the collection and utilisation of palm oil plantation fund, among others for enhancing biofuel development.
	Ministerial Regulation No. 12/2015 on Biofuel Blending.	Regulate the utilisation and administration of biofuels.
Enhancement of renewable energy utilisation	Presidential Decree No.22/2017 concerning the National Energy General Plan.	Provision of the general plan of the national energy (targeting the renewable energy shares of 23% in 2025 and 31% in 2050)
Enhancement of renewable energy utilisation and energy conservation	MEMR Ministerial Regulation No.12 /2018 on the Revision of Ministerial Regulation No 39/2017 on The Implementation of Renewable Energy Utilisation and Energy Conservation	Revised version of provisions that regulate the implementation of renewable energy utilisation and conservation, including the purchase of renewable electricity
	MEMR Ministerial Regulation No.39/2017 on the implementation of Renewable Energy Utilisation and Energy Conservation.	Provisions of the implementation of renewable energy utilisation and conservation, including the purchase of renewable electricity.
Enhancement of energy efficiency measures	MEMR Ministerial Regulation No.57/2017 on Energy Performance Standard and Labelling of Efficient Air Conditioners	Regulate the energy performance standard and labelling of efficient air conditioners.
Enhancement of renewable energy utilisation	MEMR Ministerial Regulation No.188.K/HK.02/MEM.L/2021 on RUPTL 2021-2030	Electricity supply business plan of PT PLN

3.2.3.2 IPPU and Energy in Industry Sector

To support and facilitate mitigation actions in industries, the Ministry of Industry (MoI) has issued policy instruments to encourage increased use of alternative energy and material, and to enhance energy efficiency measures that could reduce GHG emissions from the energy and IPPU sectors. Table 3-3 presents energy policy instruments and IPPU-related mitigation actions in the industry sector relative to those listed in BUR 2.

Table 3-3. Policy instruments for supporting mitigation actions in energy and IPPU sector in industries (additional to those listed in BUR 2)

Mitigation Measures	Policy Instruments	Description/remarks
Development of Green Industry in Cement Manufacturing	Ministerial Regulation No.512 /M-IND/Kep/12/2015 on Green Industry Standards for Portland Cement	Describes the definition, the requirement criteria of green industries (i.e., energy efficiency measures and low carbon alternative fuels and materials (AFR) that reduce GHG emissions), verification method, and general requirements for integrated cement industry.
Development of Green Industry in Fertiliser Manufacturing	Ministerial Regulation No. 148/ M-IND/Kep/3/ 2016 on Green Industry Standard for the Manufacture of Single Artificial Fertiliser Macro Primary Nutrient Industry	Describes the definition, requirement criteria for green industries (i.e., energy efficiency measures that reduce GHG emissions), verification method, and general requirements for fertiliser industry, especially the Single Artificial Fertiliser Macro Primary Nutrient Industry.
Development of Green Industry in Fertiliser Industry	Ministerial Regulation No. 27/ 2018 on Standardisation of Green Industry for Urea, SP-36, and Ammonium Sulphate Fertilisers	Describes criteria for green industry, verification method, and general prerequisites for fertiliser industry.
Development of Green Industries in Indonesia	Ministerial Regulation No. 51/ 2015 concerning the Guidelines for the Development of Green Industry Standards	The guideline is anticipated for the preparation of Green Industry Standard applicable to different industries. The guideline contains provisions regarding requirement criteria of green industry including definition of standards for raw materials, energy, auxiliary materials, waste management, and corporate management for green industry.
Development of Green Industries in Integrated Pulp Paper Industry	Ministerial Regulation No. 514/ M-IND/Kep/12/2015 on Green Industry Standards for Pulp and Integrated Pulp Paper	The standard describes the definition, requirement criteria of green industries (energy efficiency measures, raw material and water savings, low carbon alternative fuels, recycle materials utilisations, and cleaner production measures) that reduce GHG emissions, verification method, and general requirements for pulp and integrated pulp paper industries.

3.2.3.3 Waste Sector

The GoI has committed to further reductions in emissions from waste management by 2020 and beyond. This would be done through the development of a comprehensive and coherent policy, institutional strengthening, improved financial mechanisms, technological innovation, and social-cultural approaches. These aim to improve the policies and institutional capacities at national and local levels, enhance the management capacity of urban wastewater, reduce landfill waste through reduce-reuse-recycle approach, and utilise waste for energy production. The list of additional core actions and legal instruments relevant to BUR 2, is given in Table 3-4.

Table 3-4. Policy instruments for supporting mitigation actions in the waste sector (additional to those listed in BUR 2)

Mitigation Measures	Policy Instruments	Description/remarks
Implementation of 3R (Reduce, Reuse, Recycle), composting, and environmentally friendly final processing	Act No.18/2008 concerning waste management	Regulates environmental-based waste management in central and regional government, including partnership with waste management business entity.
Conversion of waste into Energy	Presidential Regulation No 35/2018 concerning the Acceleration of The Construction of PLTSA (Municipal Solid Waste Fuelled Power Plant)	Provisions concerning the acceleration of clean technology construction of municipal solid waste fuelled power plant at provincial, city/ regency levels.
Policy on waste management at national level	Presidential Regulation No. 97/2017 concerning Policy and National Strategies (JAKSTRANAS) on National Waste Management Policies and Strategies for Households Waste and Waste Similar to Household Waste	• Is a road map towards clean energy from waste by reducing and handling Household Waste and Household Waste, and • JAKSTRANAS is strategies, programmes, and targets for reducing and handling of household waste and wastes similar to household waste at national level.
Policy on waste management for subnational	Ministerial Regulation No. P.10/ MENLHK/SETJEN/PLB.0/4/2018 on the Guideline of Policy Formulation and Subnational Strategies (JAKSTRADA) for Households Waste and Waste Similar to Household Waste	JAKSTRADA is a direction of policies and strategies in reducing and handling household waste and waste similar to household waste at subnational level (provinces, regencies, cities), which are integrated and sustainable in nature.

3.2.3.4 AFOLU Sector

Development of Forest Management Unit (*KPH*) is one of the key policies to improve the management of land and forest resources. Under this policy, no forests in Indonesia are open accessed, which normally poses a high risk of illegal activities resulting in uncontrolled deforestation and forest degradation. The government has well implemented this policy. About 531 KPHs have been established, covering a total area of about 84 million ha. This means that almost all forested areas are managed by KPHs. Nevertheless, the management capacity of the KPHs still require much strengthening. In addition, the GoI has also enacted a number of new policies and regulations to support the implementation of climate change mitigation actions, as shown in Table 3-5.

Table 3-5. Policy instruments for supporting mitigation actions in AFOLU sector (additional to those listed in BUR 2)

Measures	Policy Instrument	Description/remarks
Reduced deforestation and forest degradation	Presidential Instruction No. 6/2017 and No.5/2019 regarding new permits moratorium and governance improvement	Regulate the moratorium/suspension of new licences and the improvement of primary forest governance and peatlands.
	Minister of Environment and Forestry Regulation No. 17/2017 regarding protection of primary forest and peatland under concession area of timber plantation	Regulates to conserve the primary forest and peat ecosystem with essential function (no logging allowed) which located under the work area of private timber plantation.
	Minister of Environment and Forestry Regulation No. 83/2016 regarding granting forest access to community through social forestry	Policy on forest management system employed by the community to improve their livelihoods and life quality as well as developing the forest potentials.
Sustainable Forest Management	Minister of Environment and Forestry Regulation No. 30/2016 on the Performance Evaluation of Forest Management	Policy that mandates all forest concession holders to obtain forest sustainable management certification, to ensure they apply sustainable management practices.
	Directorate General of sustainable production forest management (PHPL) Regulation No.9/2018 regarding Reduce Impact Logging (RIL) Technique	Policy that mandates forest concession holders applying RIL technique to increase timber logging efficiency and minimise ecological impact from the logging activity.
Carbon sink enhancement	Minister of Environment and Forestry Regulation No. 62/2019 on the arrangement of private timber plantation area to optimise the production function	Policy that allows planting of no- timber commodities (e.g., food crops, bioenergy, and agroforestry) for unproductive land or silviculture technique of clear cutting with enhanced regeneration (THPB) for natural forests in the concession area of private timber plantation.
	Government Regulation N.46/2017 on Economic instrument for environment	Innovative policy to grant incentive (e.g., loosen administrative process, awards, public announcement regarding the private's positive performance, etc.) to timber plantation concession holder who implement business activity that positively improve the environment (e.g., increased planting rate according to the work plan).
	Minister of Environment and Forestry Regulation No. 39/2016 on the Revision to the Ministerial Regulation No. 9/2013 regarding Guidance and Support/Incentive on Forest and Land Rehabilitation	Policy that provides supports and incentives for the rehabilitation of degraded lands and forests and optimising the use of unproductive lands through the planting of multi-purpose tree species (MPTS) under an agroforestry system.
Peat ecosystem management	Minister of Environment and Forestry Regulation No. 15/2017 regarding peatland water level monitoring	Policy that mandates all peat land managers to maintain the peatland water level not more than 40 cm.

	Presidential Regulation No. 57/2016 on the Revision to the Presidential Regulation No. 71/2014	A more rigid policy regulates the use of peat lands. This policy also mandates the governments at all levels to develop integrated peatland protection and management actions and to restore/rehabilitate the degraded peatlands.
Enhancement of Land, Forest, and Peat Fire Management	Presidential Instruction No. 11/2015 regarding Land and Forest Fire Management	Policy that mandates all level of governments to develop land and forest fire management system at their jurisdictions and implement sanctions for business players who do not implement fire management within the area under their jurisdictions.
	Minister of Agriculture Regulation No. 5/2018 on Land Clearance and Management for Plantation Without Burning	Policy that mandates all estate crop concession holders to maintain environmental sustainability and not using fire for land clearing and land management.

3.2.4 Institutional Arrangement

The implementation of climate change mitigation policies and actions follows several phases of planning, implementing, monitoring, reporting, verification and/or registration as shown in Figure 3-3.

Previously, MoEF as the NFP of UNFCCC, coordinated institutions responsible for Indonesia's implementation of climate change mitigation actions conducted by relevant ministries as shown in Table 3-6 and NPS, together with Bappenas and Ministry of Home Affairs, referred to Presidential Regulation No. 61 of 2011. Following the ratification of the PA and submission of the first NDC, the mitigation action plan is prepared by the relevant ministries and coordinated by the MoEF, ensuring that this action plan is integrated into the sectoral planning and programme. Implementation, monitoring and reporting of the mitigation actions are undertaken by relevant ministries and the reports are submitted to the MoEF for verification, and subsequently recorded in the National Registry System managed by the MoEF.

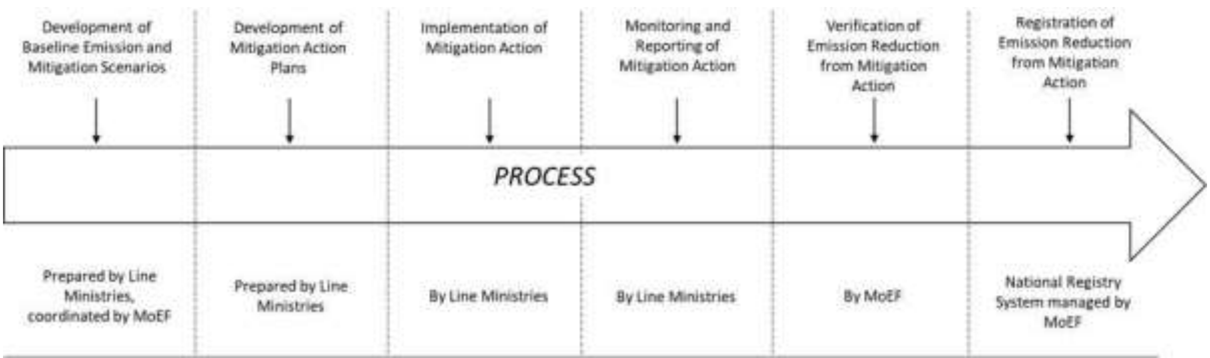


Figure 3-3. Institutional arrangement for the implementation of climate change mitigation at national level

Table 3-6. Institutions responsible for the implementation of sector-specific mitigation actions and reporting

Sector	Ministry	Responsible Unit
Energy	Ministry of Energy and Mineral Resources	Directorate General for New Renewable Energy and Energy Conservation
	Ministry of Transportation	Secretary General for Ministry of Transportation Directorate General for Land Transportation Directorate General for Sea Transportation Directorate General for Air Transportation Directorate General for Railways
	Ministry of Industry	Industrial Research and Development
IPPU	Ministry of Industry	Agency for Industrial Research and Development
AFOLU	Ministry of Agriculture	Agency for Research and Development Secretariat General
	Ministry of Environment and Forestry	Directorate General for Forest Planning and Environmental Governance Directorate General for Control of Protection Forest Watershed Directorate General for Sustainable Forest Management Directorate General for Natural Resources and Ecosystem Conservation Directorate General for Social Forestry and Environmental Partnership Directorate General for Law Enforcement of Environment and Forestry Directorate General for Climate Change Control
Waste	Ministry of Public Works and Housing	Directorate General for *Cipta Karya* Directorate General for Human Settlements
	Ministry of Environment and Forestry	Directorate General for Pollution Control and Environmental Damage Directorate General for Management of Solid Waste, Hazardous Waste and Hazardous Materials

3.3 Implementation of National Mitigation Programmes and Their Effects

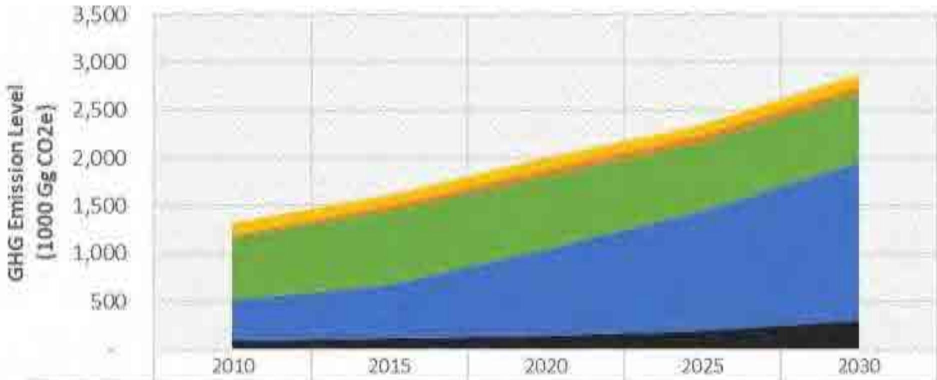
GHG emission reductions are defined according to the difference between the baseline emission level and the mitigation emission level. Baseline emission is the projected GHG emission level in the absence of mitigation, i.e., implementing a business-as-usual national development, where all decisions and options related to development do not take into consider aspects associated with climate change mitigation efforts. The baseline emission is subject to the definition of "business-as-usual (BAU)", as well as the calculation methodology and assumptions of the variables to estimate emissions.

3.3.1 Baseline Emissions

Depending on the purpose of the emission reduction calculation, there are two types of baseline data, the project baseline and sectoral baseline. The **project baseline** is the baseline emission used to calculate the emission reduction for a project-wide mitigation action whereas **sectoral baseline** is the baseline emission used to determine the emission reduction based on a sector-wide mitigation activity. Project-wide emission reductions must be recorded in the National Registry System that records the achievement of GHG emission reductions. Achievement of the emission reduction at the sector level, should be reported to the UNFCCC in the context of Indonesia's commitment to reduce GHG emissions, i.e., Indonesia NDC under the PA.

National baseline emissions can be established either using an integrated model covering all sectors of national development or by developing sectoral modelling of all sectors and summarising the results to produce the national baseline emission. In the case of Indonesia, the country's baseline emission projection used the second approach, where the baseline emission is the aggregation of four sector baseline emissions, e.g., energy, IPPU, AFOLU (Agriculture, Forestry and Land Use) and waste.

The national baseline is the projection of the BAU scenario up to 2030 using the base year 2010. The baseline emission is referred to calculate the NDC reduction target, which is set at 29% below the baseline emission level in 2030 under unconditional target and 41% with international support under conditional target. The baseline emission was developed by the responsible unit in each sector and coordinated by the Directorate General of Climate Change, MoEF. Figure 3-4 presents an aggregate of GHG emissions projection results under the baseline scenario of all sectors.



	2010	2015	2020	2025	2030
Agriculture	111	114	116	117	120
IPPU	36	56	67	68	69
FOLU	647	767	764	721	714
Energy	435	568	904	1,257	1,669
Waste	88	112	146	192	296

Figure 3-4. GHG emissions projection under the baseline scenario of all sectors

Adjustments were made to the GHG emission baseline projection, due to changes in activity data and emissions factors. In the energy sector, the adjustment is made by excluding exported coal data from domestic coal consumption. In the AFOLU sector, the improvement concerns the separation of concession and non-concession areas of natural forests. The objective of the improvement is to underline the restoration activity of the natural production forest, which took place mainly in the concession area. In the IPPU sector, the adjustments include updates of activity data and improvement of emissions factors (EFs).

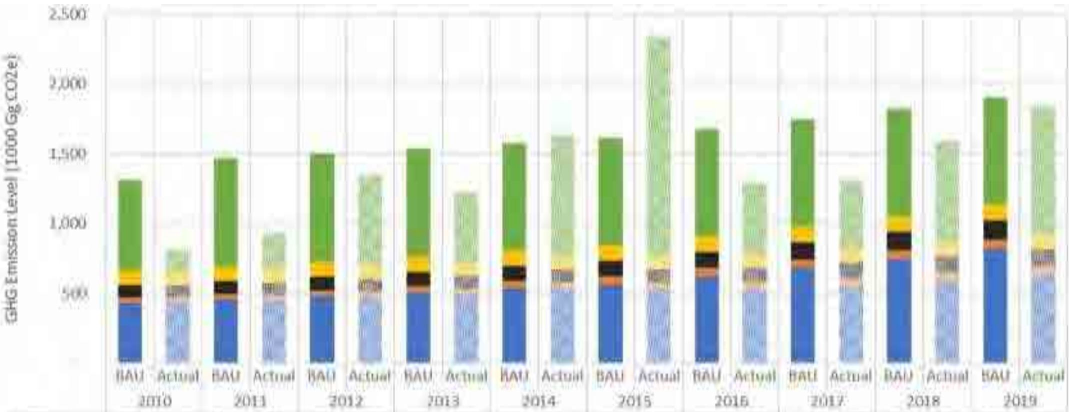
In the cement industry, the number of cement companies in the baseline scenario of BUR 3 was broadened to include plants that were not included in the baseline development. Other factors that also affect the baseline are the revised plant reference emissions factors. In ammonia production, activity data were improved since 2020. In the iron and steel industry, improvements have been made following technological change (from DRI/direct reduced iron to blast furnace and BOF/basic oxygen furnace).

In waste sector, the baseline adjustment was made due to the changes in activity data in industrial wastewater treatment and an additional category of industrial solid waste that is, the inclusion of empty fruit bunch (EFB) treatment. It should be noted that the baseline data for EFB treatment was based on the assumption that after 2009 there was no incineration of the EFB at the CPO mills. This is due to governmental regulations that prohibit the elimination of EFB by conventional incineration (*tanur*). Therefore, the EFB is stored in stockpiles. The baseline emissions are calculated according to the assumption that the EFB is stockpiled (after 15 years, it is categorised as an unmanaged-deep disposal site).

3.3.2 Progress of National Mitigations

The progress in meeting national GHG emission mitigations achievement is assessed by comparing the national level of GHG emissions in the implementation year with the baseline level of GHG emissions of unconditional Indonesia NDC target. The emission level is the result of the national GHG emission inventory process (see Chapter 2). In measuring the achievement of emission reduction targets by 2020 and 2030, the emission reduction for this particular year is compared with the NDC reduction target in 2020 and 2030. The use of this approach to measure performance may not represent the actual GHG emission reduction performance given that not all GHG emission reductions from mitigation actions implemented are well documented, due to the limited monitoring capacity and policies implemented. Therefore, the magnitude of the achievements measured using this approach is called as the "emission reduction potential".

The results of the calculation of the five sectors (energy, IPPU, forestry, agriculture, and waste) showed that the GHG emissions level for the period 2017 to 2019 is below the baseline level (Figure 3-5). In 2017, the emission reduction from the baseline was estimated to be approximately 436,000 Gg CO_2e. This is mainly due to the significant reduction in emissions from the forest and other land use (FOLU) sectors, specifically emission from peat fire. In 2018, the decrease in emission was attributable to lower than baseline emissions in all sectors (232,000 Gg CO_2e of emission reduction), with the largest contribution from the energy sector, being 157,000 Gg CO_2e (Figure 3-6). However, in 2019, peat fire emission from the FOLU sector increased further from the baseline. As a result, this made 2019 as the year with the lowest emission reduction, amounted to 61,000 Gg CO_2e (Figure 3-6).



	2010 BAU	2010 Actual	2011 BAU	2011 Actual	2012 BAU	2012 Actual	2013 BAU	2013 Actual	2014 BAU	2014 Actual	2015 BAU	2015 Actual	2016 BAU	2016 Actual	2017 BAU	2017 Actual	2018 BAU	2018 Actual	2019 BAU	2019 Actual
FOLU	647	160	775	258	773	647	771	503	769	862	767	1,56	765	508	767	489	766	724	765	925
Agriculture	111	97	111	103	112	102	112	97	113	100	114	101	115	103	115	105	115	104	116	105
Waste	88	88	92	87	97	89	104	94	108	96	112	98	117	102	124	109	130	115	138	120
IPPU	36	36	37	35	39	39	40	38	60	46	56	49	59	54	60	57	62	57	64	98
Energy	435	435	459	454	484	478	510	496	538	531	568	527	623	530	684	554	750	593	823	636

Figure 3-5. The 2010-2019 national GHG emissions (by sector) and the corresponding baseline

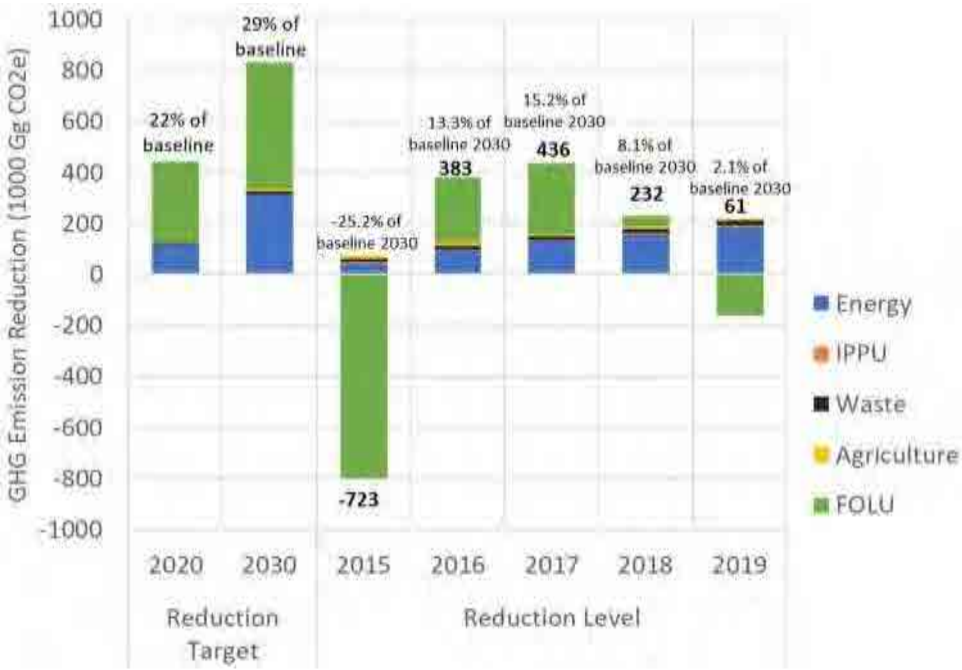


Figure 3-6. GHG emissions reduction by sector in 2017 - 2019 relative to each sector's NDC 2020 and 2030 GHG emission reduction target

3.3.3 Progress of Mitigations in Energy Sector

GHG emissions reduction targets of mitigation actions under unconditional and conditional NDC scenarios in the energy sector are 11% and 14% respectively of the baseline emissions in 2030 (see Table 3-1). The impacts of implementing mitigation actions have resulted in the reduction of emissions. This is indicated by the gap between baseline emission and inventory emission levels for the corresponding year as shown in Figure 3-7. The inventory levels are all below baseline emissions, meaning that there are accomplishments in reducing emissions. By comparing the inventory emission and the baseline emissions level, the reduction in GHG emission was found to be 129,844 Gg CO2e (2017), 157,337 Gg CO2e (2018) and 186,932 Gg CO2e (2019). The figure shows that the inventory levels are lower than the targeted unconditional mitigation scenario (CM1), implying that in 2019, the achieved emission reduction has exceeded the target emission reduction under the NDC CM1.

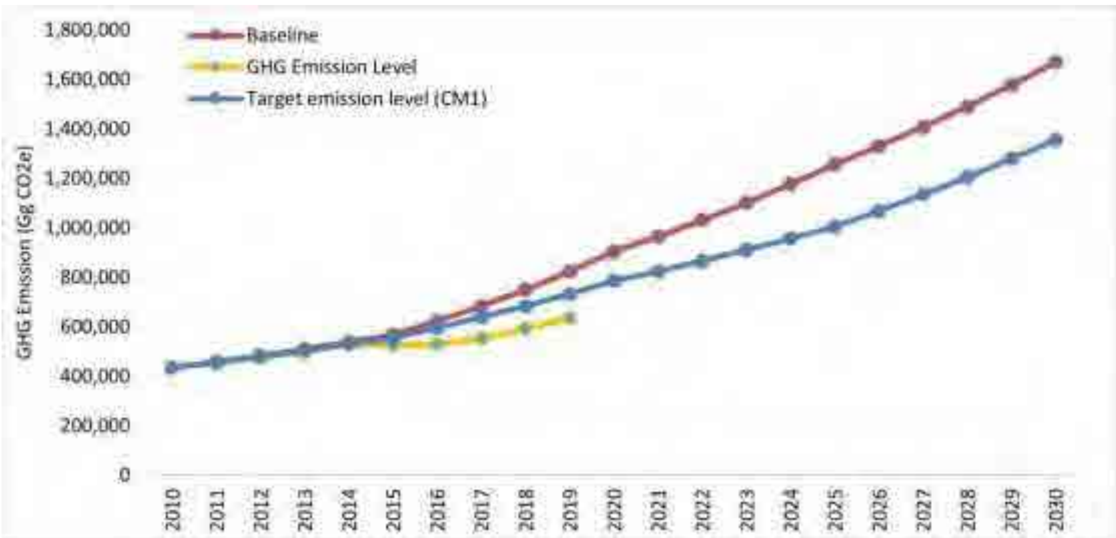


Figure 3-7. GHG emissions level of energy sector and the corresponding baseline emissions

The GHG emission reduction achieved in 2017-2019 for the energy sector is equivalent to about 19%, 21% and 22.7% below the baseline emissions for the corresponding year. The achieved emission reduction by sector for 2016-2019 are presented in Figure 3-8. It is also shown in the figure the emission reduction target under CM1 scenario and the emission reductions percentage calculated from individual mitigation actions (by-project" emission reduction), claimed/reported by sub-sectors that are responsible in the implementation of the actions. Figure 3-8 shows that the achieved sectoral emission reductions are all higher than the emission reduction targets and differences exist between sectoral reduction achievement and the reductions reported/claimed by the Parties implementing mitigation actions. The latter figures are all below those of the former. This is likely due to the fact that not all mitigation actions that have been conducted and resulted in emission reductions, have been reported/claimed by the implementing Parties.

Over the 2016-2017 period, the GHG emissions reduction report found that the claim was above the target as the monitoring activity was well carried out. However, the claim fell below the target in 2018-2019, which means that monitoring activity needs to be improved in the future. Figure 3-8 also shows that the estimated achievements are still higher than those reported due to the achievement of GHGs, not only due to mitigation actions, but also due to other factors, i.e., reduction in demand, pandemic, and not all mitigation implemented are adequately documented and reported.

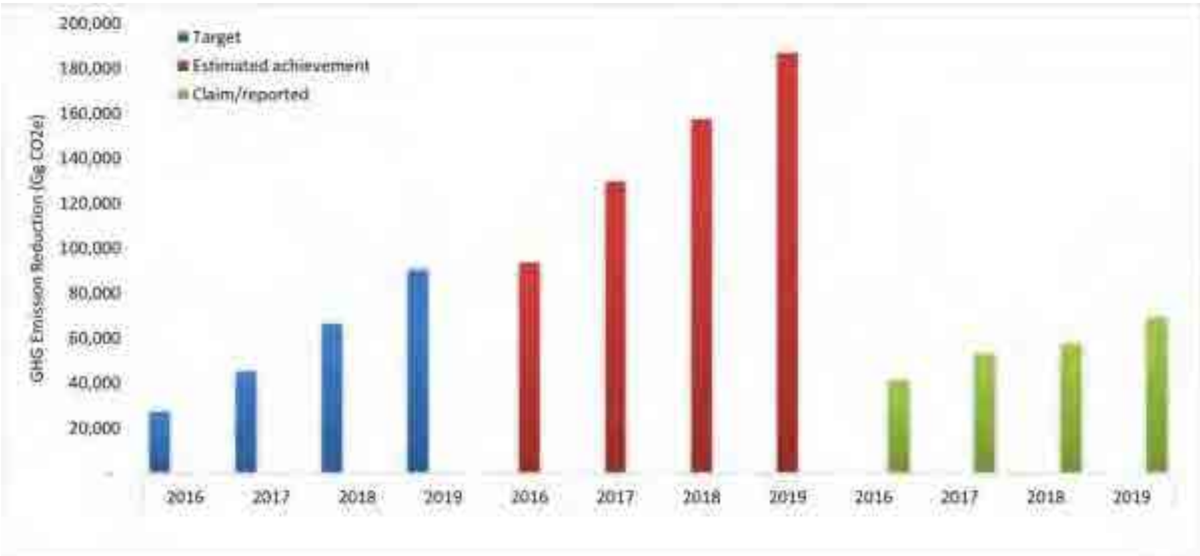


Figure 3-8. GHG emission reduction target, estimated achievement and claim/reported (Gg CO_2e) in 2016-2019

Besides being evaluated based on the level of emission inventory, emission reductions were also evaluated based on records of activities and the associated emission reduction results reported to relevant ministries. According to the emissions reduction report of the Ministry of Energy and Mineral Resources (MEMR), the emissions reduction through the implementation of various mitigation actions in 2017, 2018 and 2019 are 50,710 Gg CO_2e, 54,668 Gg CO_2e and 64,717 Gg CO_2e respectively. The breakdown of emissions reductions for each type of mitigation over these three years is presented in Figure 3-9. The figure shows that the emission reductions resulting from mitigation actions in the energy sector are primarily attributable to six groups of activities, namely (i) end-use energy efficiency measures through energy conservation activities and audits, (ii) fuel switch to lower carbon emissions in residential and transport sector, (iii) use of renewable energy for power generation, (iv) deployment of Clean Coal Technology (CCT), (v) utilisation of biofuel and (vi) use of alternative fuels in industry. It should be noted that the reduction of alternative energy emissions for industry is reported by MoI.

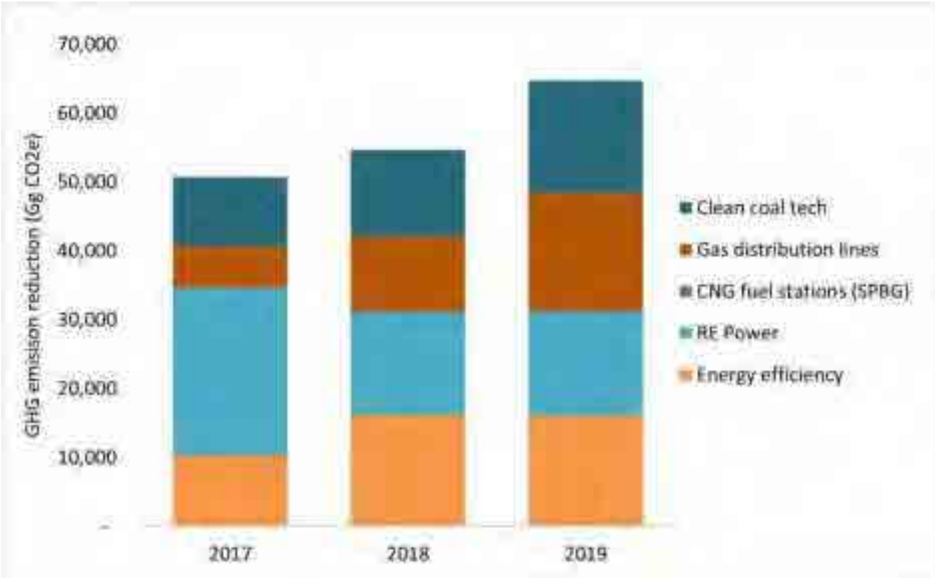


Figure 3-9. Reduced GHG emissions in the energy sector by type of mitigation actions in 2017-2019

Based on the emissions reduction report of the Ministry of Transportation (MoT), in 2017, 2018 and 2019, the sector has reduced the GHG emissions of 2,223 Gg CO_2e, 3,001 Gg CO_2e and 4,674 Gg CO_2e, respectively (Figure 3-10) from mitigations activities to enhance transportation efficiency and the increased use of zero and/or low emission alternative fuels. The activities that were implemented that significantly reduced emissions were the construction and use of railways, the renewal of aircraft, improvement of the efficiency of flight operations, performance-based navigation (PBN), utilisation of effective traffic control, development of mass road transport and development of long-distance ferry in 2019.

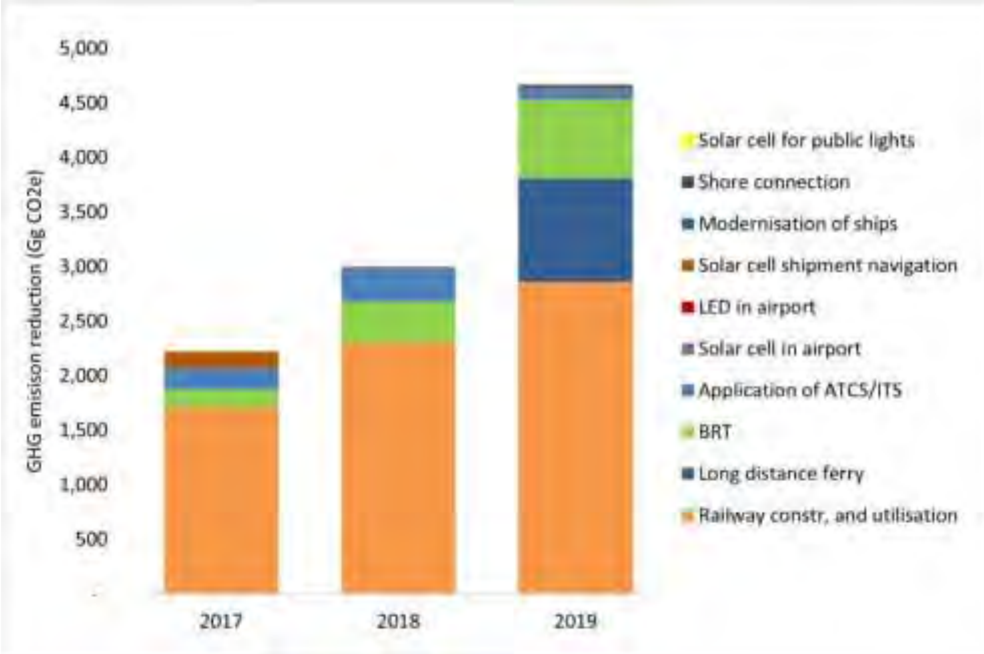


Figure 3-10. Reduced GHG emissions in the transport sector by type of mitigation actions in 2017-2019

In addition to the mitigation activities shown in Figure 3-9 and Figure 3-10, other mitigation activities with significant impacts on reducing the GHG emissions level in the energy sector, have not been reported (Figure 3-8). If the 2017 total emissions reduction reported by the MEMR, MoI and MoT were compared to the emission reduction calculated from the comparison of GHG emission levels (inventory) with the corresponding baseline emission of the NDC, there is a discrepancy of about 76,911 Gg CO_2e or 60% of the emission reduction value derived from baseline-vs-inventory levels. The discrepancies for the years 2017, 2018 and 2019 are summarised in Table 3-7. The discrepancy is considered to be the reduction in emissions due to other emissions, i.e., emission reductions that were not reported by the MEMR, MoI, and MoT as well as emissions reductions due to other factors such as economic situation, changes in fuels price, etc. Brief information on mitigation activities implemented in the energy and transport sectors is provided in Appendix 1 and Appendix 2.

Table 3-7. Summary of the achievement of GHG emissions reduction record 2017 – 2019

No	GHG emissions reduction	GHG Emissions Reduction (Gg CO_2e)		
		2017	2018	2019
A	Comparison of actual GHG emission with the corresponding baseline emissions	129,844	157,337	186,932
B	GHG Emissions reduction from activities (reported by ministries)			
B.1	MEMR and MoI	50,710	54,668	64,717
B.2	MoT	2,223	3,001	4,674
B.3	Others (discrepancy)	76,911	99,669	117,541
	Sub-total B	129,844	157,337	186,932

3.3.4 Progress of Mitigations in Industrial Process and Product Use

Referring to the updated Indonesia's NDC, the targets of the GHG emissions reduction under unconditional NDC (CM1) and conditional NDC (CM2) scenarios for the industrial process and product use (IPPU) sector are, 0.10% (CM1) and 0.11% (CM2) respectively, below the baseline emissions level in 2030 (see Table 3-1). The impacts of the implementation of mitigation actions have resulted in the reduction of emissions level (compared below to the baseline emissions). This is indicated by the gap between baseline emission and inventory emission level at the corresponding year as shown in Figure 3-11.

Since this subsection reports the achievement of emissions reductions from mitigations implemented during 2017–2019 that were mostly carried out using domestic resources, therefore, the target of unconditional NDC (CM1) was used for assessing the success of mitigation achievement. The GHG emission reductions achieved in 2017-2019 for IPPU sector were 2,866 Gg CO2e, 4,755 Gg CO2e and 5,708 Gg CO2e below the baseline emissions in the corresponding year. The GHG emission reduction targets of the Indonesia NDC from IPPU category in 2030 is presented in Figure 3-12.

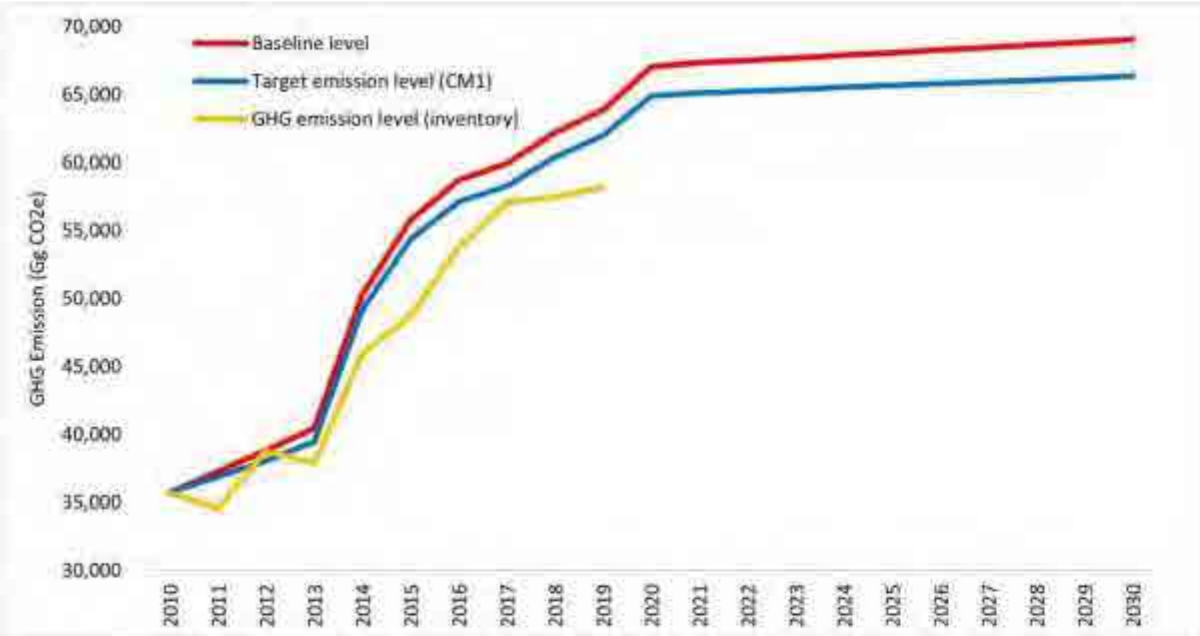
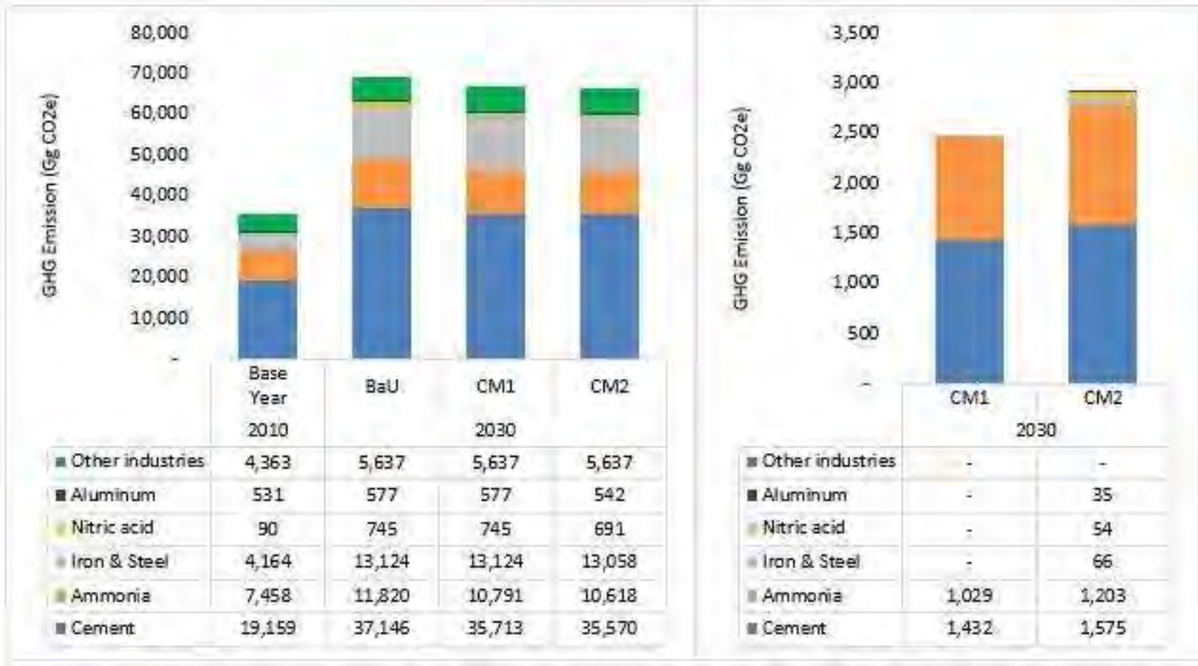


Figure 3-11. GHG emissions of the IPPU sector and the corresponding baseline emissions

Mitigation measures for achieving the NDC (CM1) target include (a) increase the use of alternative materials for blended cement, in which the use of alternative materials will replace some of the clinker to reduce the clinker to cement ratio from 83% in 2010, to 75% in 2030 (for 50% of the total cement productions) and (b) improve the efficiency of ammonia production plants to reduce the use of natural gas as a feedstock, as well as energy supply in ammonia plants and improving the efficiency of CO_2 recovery in the primary reformer of the fertiliser industry.

Mitigation measures for achieving the NDC (CM2) target include (a) enhance the reduction potential of the unconditional NDC (CM1) by increasing the implementation of more mitigation measures, (b) improve most of processing systems in smelter industries, (c) utilized secondary catalyst in nitric acid production, and (d) the claim of GHG emissions reduction in aluminium smelter from the CDM project of PFCs reduction in PT Inalum (North Sumatra) after this CDM project was completed phase out in 2017.



	Base Year 2010	BaU 2030	CM1 2030	CM2 2030
Other industries	4,363	5,637	5,637	5,637
Aluminum	531	577	577	542
Nitric acid	90	745	745	691
Iron & Steel	4,164	13,124	13,124	13,058
Ammonia	7,458	11,820	10,791	10,618
Cement	19,159	37,146	35,713	35,570

	CM1 2030	CM2 2030
Other industries	-	-
Aluminum	-	35
Nitric acid	-	54
Iron & Steel	-	66
Ammonia	1,029	1,203
Cement	1,432	1,575

Figure 3-12. GHG emission reduction targets of Indonesia NDC from IPPU sector in 2030

The assessment of the GHG emission reduction potential of the IPPU sector is performed by comparing the GHG baseline emission intensity level and the GHG emission inventory, then multiply the intensity reduction by the current production used in the GHG emission inventory. The approach is used to avoid the effect of changes in production capacity on the results of the reduction potential estimates. The baseline IPPU emission level and the GHG emission inventory level for 2010 to 2019 are presented in Figure 3-13.

The potential GHG emission reduction is calculated by multiplying the actual production capacity or product consumption by the differences between the baseline GHG emission intensity and inventory of each industry/plant. Comparison of the baseline GHG emission intensity and inventory for the same period is presented in Figure 3-14. In addition, the figure also shows the IPPU emission reduction potential. It should be noted that the analysis focuses on industrial processes since most mitigations of the IPPU sector are implemented in the industrial processes.

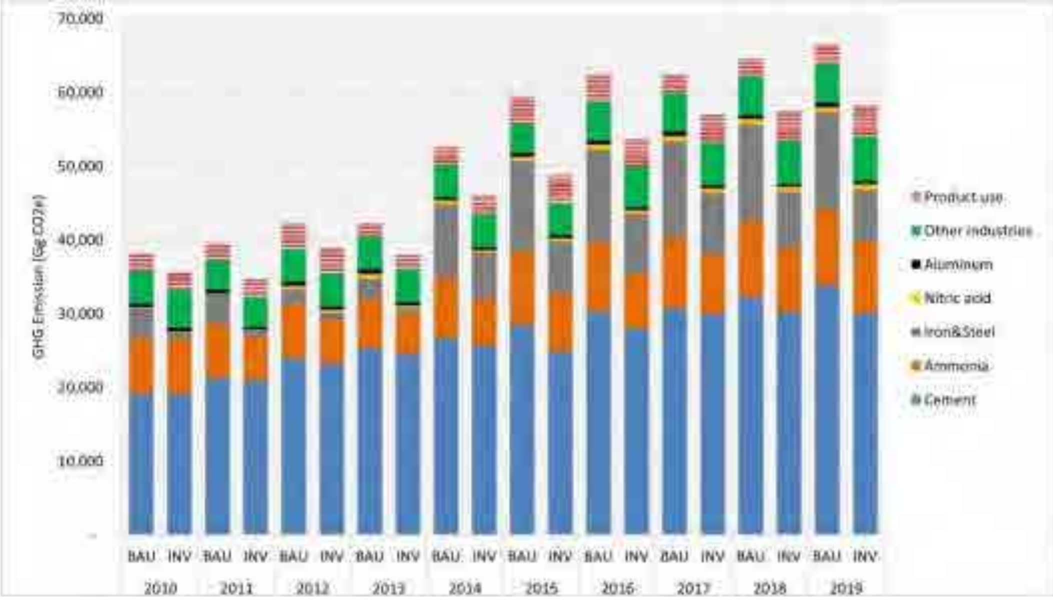


Figure 3-13. Baseline (BAU) and inventory (INV) of GHG emissions for 2010-2019

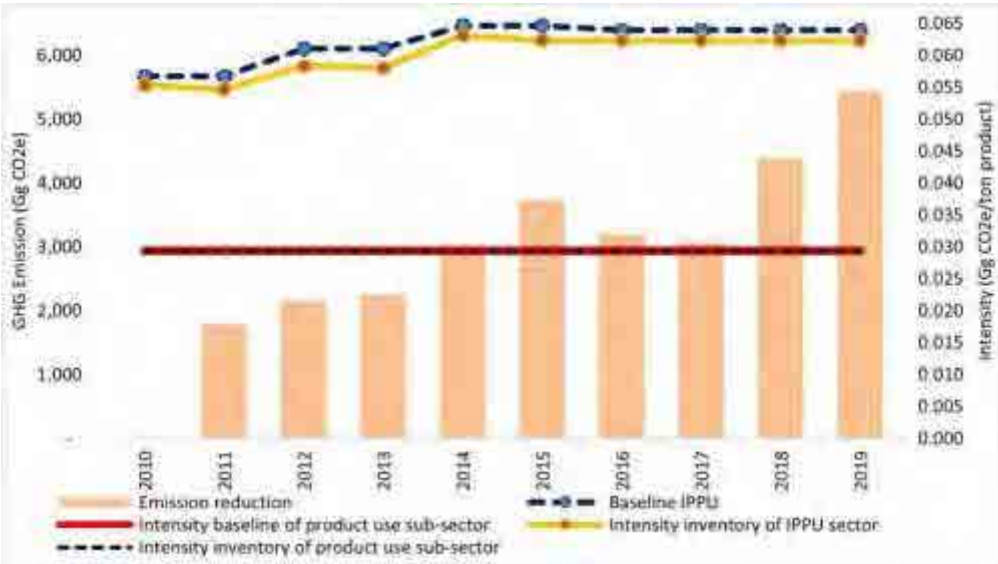


Figure 3-14. GHG emissions intensity and reduction potential of the IPPU sector

Estimates of IPPU emission reduction indicates that the sector's mitigation activities decreased by 55,525 Gg CO_2e or 5.4% from the baseline in 2016 (see Figure 3-13). The trend in reduction potential was 56,880 Gg CO_2e or 5.1% below the baseline in 2017, 57,859 Gg CO_2e or 7.0% below the baseline in 2018, and 58,449 Gg CO_2e or 8.5% below the baseline in 2019.

The results of the IPPU emissions estimates show that the reduction potential in 2016 reached 3,194 Gg CO_2e, and the reductions were 3,072 Gg CO_2e (2017), 4,377 Gg CO_2e (2018), and 5,433 Gg CO_2e (2019), which has exceeded the NDC target. It is important to note that the 2030 IPPU emissions reduction target for these industries is 2,461 Gg CO_2e for NDC (CM1) and 2,933 Gg CO_2e for NDC (CM2). Figure 3-14 shows that the product use subsector has the same baseline and inventory intensity. It indicates there is no mitigation action, and therefore no reduction in GHG emissions is reported in this chapter. It should be noted that the report of GHG emission reduction report for the IPPU sector does not cover HFC and SF_6, which will be reported in the next BUR.

The GHG emission reduction potential is estimated to be primarily due to the contribution of the GHG emissions mitigations carried out in (a) cement industries through 'blended cement' technology, (b) ammonia fertiliser industries through the use of advance technology with high efficiency in the use of natural gas for feedstock and energy in ammonia plants for new fertiliser plants. In addition to these mitigations, there are also mitigation actions in other industries that have also reduced GHG emission levels as a result of the national GHG emissions inventory. The reduction potentials also derive from (a) the use of scrap as mitigation measures in smelter industries, (b) the use of secondary catalyst in the nitric acid productions, and (c) the improvement of production facility in the aluminium smelter using advance technology. It should be noted, the GHG emission reduction potential of the cement industry and aluminium smelter included the GHG emissions reduction claim of the CDM Blended Cement project in the cement industry and the reduction of PFCs in the aluminium smelter following the completion of the CDM projects in 2017.

3.3.4.1 Mitigation in Cement Industries

In cement industries, blended cement technology is implemented as mitigation measures to reduce the IPPU GHG emissions from the cement industries. Comparison of the industry's baseline emission level and GHG emission inventory in the same year, shows that there is a significant reduction in the GHG emissions level. By implementing blended cement technology, the cement industries have met the requirements of the Green Industry Standard, which is efficiency in the use of energy and feedstock.

The baseline IPPU emission level and the cement industry inventory are presented in Figure 3-15. The figure also presents the estimates of the IPPU emission reduction potential from 'cement blended' implementation. The results of the GHG emission estimates indicate that the emission reduction for the four consecutive years, starting from in 2016 were 971 Gg CO2e, 786 Gg CO2e, 1,828 Gg CO2e, 2,698 Gg CO2e, which have exceeded the NDC target. It is important to note that the 2030 GHG emission reduction target for blended cement was 1,432 Gg CO2e for NDC (CM1) and 1,575 Gg CO2e for NDC (CM2).

Some of cement industries have implemented blended cement technology as part of the CDM (Clean Development Mechanism) project that ended in 2017. After the last issuances for carbon credits of the project, the industries have included the IPPU reduction potential in cement industries to achieve the NDC (CM1) target in reducing the national IPPU's emissions (see Figure 3-15).

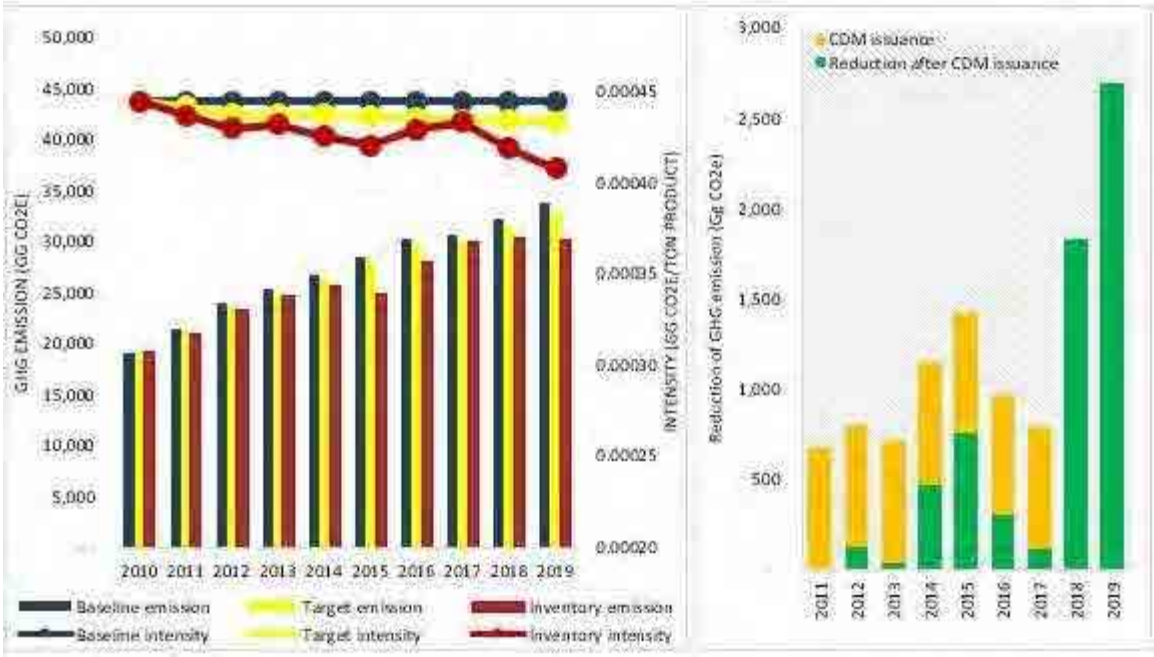


Figure 3-15. GHG emissions of the IPPU sector and the corresponding reduction potential

3.3.4.2 Mitigation in Ammonia (Fertiliser) Industries

In ammonia fertiliser industries, the comparison of the IPPU baseline emissions level and IPPU emission inventory in the same year shows that there is a potential for significant emission reduction. The IPPU emissions from ammonia plants have been reduced by increasing the efficiency of ammonia plant and implementing advanced technology with greater efficiency in the use of natural gas for some of the new plants. It shows that most of the ammonia fertiliser industries have met one of the requirements of the Green Industry Standard, which is the efficient use of natural gas for energy and feedstock.

The IPPU emissions inventory and the baseline emissions from 2010 to 2019 are presented in Figure 3-16 while the IPPU emission intensity for the inventory and baseline, as well as the calculated of IPPU emission reduction potential, are also presented in this figure. The potential for GHG emissions reduction is also shown in this figure. The figure shows that the emission reduction in 2016 reached 2,005 Gg CO_2e. The reductions for three consecutive years, starting in 2017 were 2,080 Gg CO_2e (2017), 2,333 Gg CO_2e (2018), and 2,522 Gg CO_2e (2019), which exceeded the NDC target. It should be noted that the target of the IPPU emissions reduction in the ammonia fertiliser industry in 2030 is 1,029 Gg CO_2e for NDC (CM1) and 1,203 Gg CO_2e for NDC (CM2).

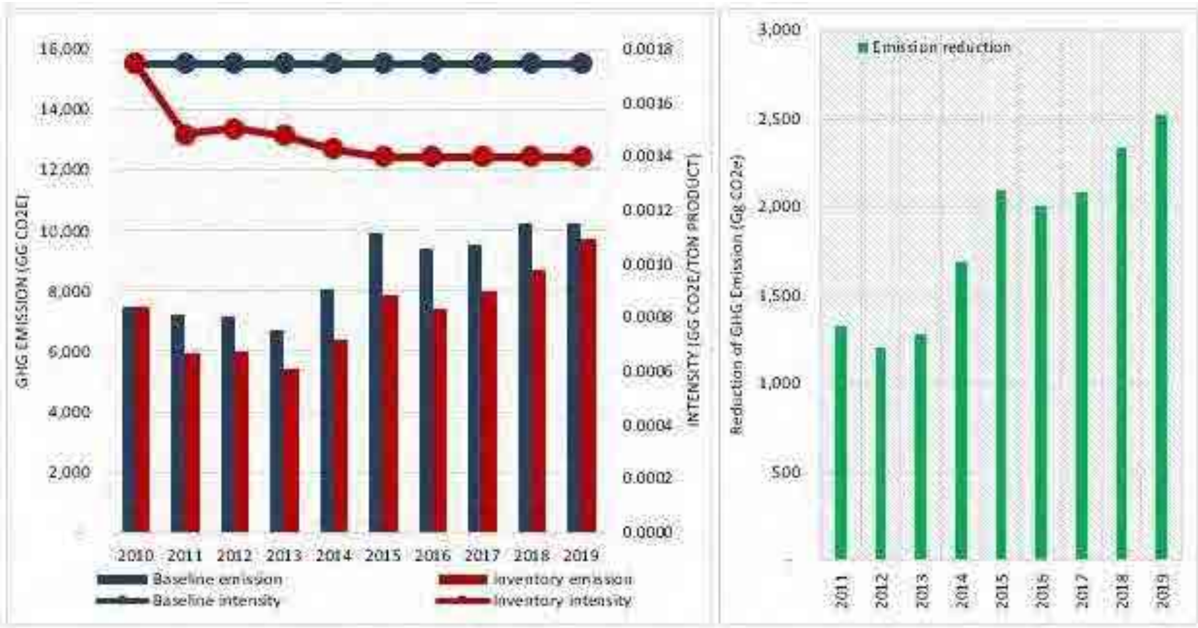
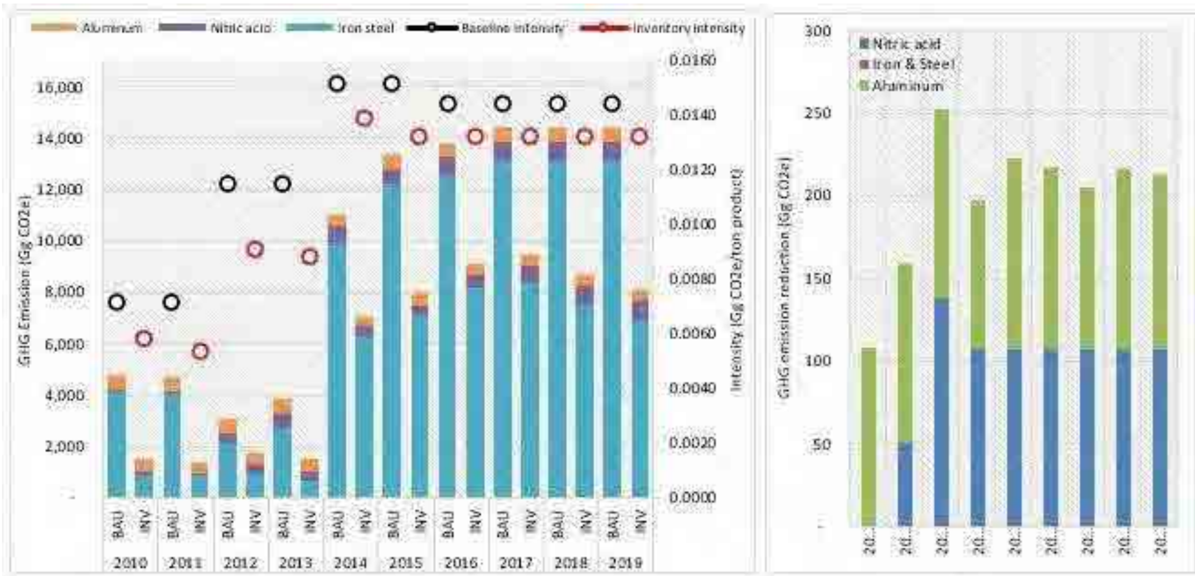


Figure 3-16. IPPU emissions and reduction potential in ammonia plants in 2010- 2019

3.3.4.3 Mitigation in Other Industries

Other IPPU emissions reduction potentials include the main reduction potential resulting from the implementation of mitigations in the following industries, i.e., nitric acid productions, iron and steel making, and aluminium smelter. The GHG emissions inventory of these industries produces a lower level of the GHG emissions when compared with its baseline level.

Figure 3-17 shows the IPPU emissions inventory results and the baseline during 2010-2019 for nitric acid production, iron and steel making, and aluminium smelter. The figure also shows the emission intensity of the inventory and the baseline, as well as the reduction potential.



(a) (b)

Figure 3-17. (a) IPPU GHG emission baseline and inventory and (b) GHG emission reduction for Aluminum, Nitric acid and Iron Steel

3.3.4.4 *Mitigation Measures and The IPPU Emissions Reductions by Type of Gases*

Detailed information on the implemented of mitigation measures and the IPPU emission reduction potential is presented in Appendix 3. Under the project-based MRV, emissions were reduced by 971 Gg CO_2e in 2016, 786 Gg CO_2e in 2017, 1,828 Gg CO_2e in 2018, and 2,698 Gg CO_2e in 2019. The emission reduction achieved in 2019 has exceeded the 2030 NDC target. It should be noted that the target to reduce the IPPU emissions from these industries in 2030 is 2,461 Gg CO_2e for NDC (CM1) and 2,933 Gg CO_2e for NDC (CM2). Figure 3-18 shows the GHG emissions reduction for the claimed and the MRV results.

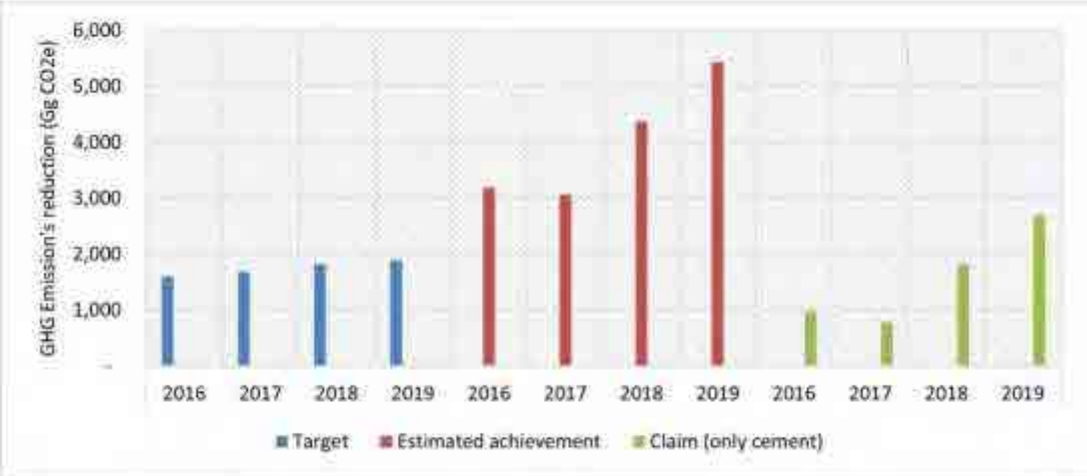


Figure 3-18. The 2016-2019 GHG emissions reductions (target, achievement, claim)

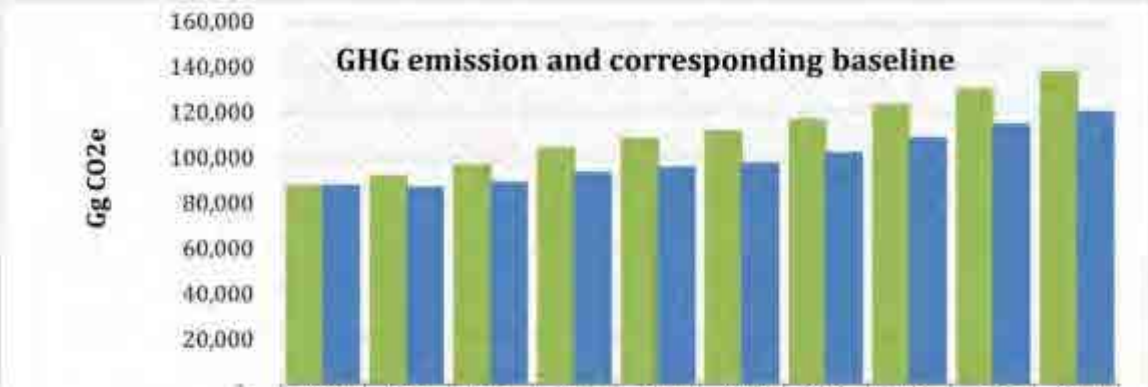
Concerning the IPPU emissions reductions by type of gas, the main reduction in all mitigation measures implemented for the IPPU sector is CO2, which are from the implementation of cement blended technology and the improvement of ammonia production technology. Table 3-8 shows the emissions reduction potential of each implemented mitigations by type of gases.

Table 3-8. The IPPU emission reduction potential of each mitigation by type of gases

Industry	2017					2018					2019				
	CO_2 (Gg)	CH_4 (Gg)	N_2O (Gg)	CF_4 (Gg)	CO_2e	CO_2 (Gg)	CH_4 (Gg)	N_2O (Gg)	CF_4 (Gg)	CO_2e	CO_2 (Gg)	CH_4 (Gg)	N_2O (Gg)	CF_4 (Gg)	CO_2e
Cement	786				786	1,828				1,828	2,698				2,698
Ammonia	2,080				2,080	2,333				2,333	2,522				2,522
Nitric acid			0.35		107			0.35		107			0.35		107
Iron steel	-	-			-	-	-			-	-	-			-
Aluminum	88			11	98	97			12	109	94			11	106
Total	**2,954**	**-**	**0.35**	**11**	**3,072**	**4,258**	**-**	**0.35**	**12**	**4,377**	**5,314**	**-**	**0.35**	**11**	**5,433**

3.3.5 Progress of Mitigations in Waste Sector

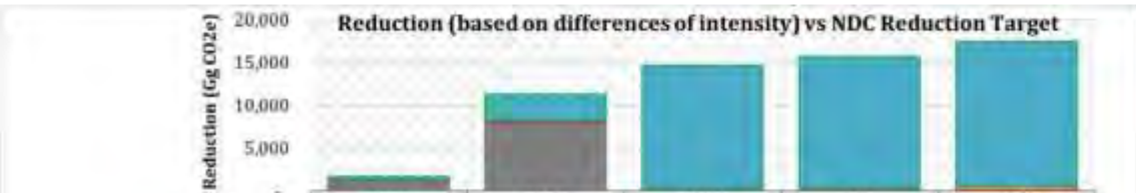
Mitigation strategies for reducing GHG emissions from the waste sector are implemented through reduction, avoidance, destruction, and utilisation of GHG emissions generated during the treatment of municipal solid waste (MSW), domestic wastewater (DWW), industrial solid waste (ISW), industrial wastewater (IWW). The development of GHG emissions inventory 2010-2019 and its corresponding baseline is presented in Figure 3-19. One can see from Figure 3-19, that starting 2015 there is significant difference between baseline and inventory.



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Baseline	87,826	91,896	96,951	104,245	108,503	111,887	116,835	123,519	130,269	137,655
Inventory	87,766	86,936	89,209	93,569	95,884	97,539	102,105	108,939	114,637	120,333

Figure 3-19. GHG emissions of waste sector and the corresponding baseline in 2010 – 2019

For mitigation targets, a reduction in the waste sector in the NDC unconditional scenario (CM1) is targeted at 1,721 Gg CO_2e in 2020 and 11,348 Gg CO_2e in 2030. The reduction in GHG emissions is estimated based on differences in intensity between baseline data and inventory for the same year to avoid fluctuating parameters that are not directly related to mitigation, such as industrial production capacity and population. Based on the most recent data, the reduction in GHG emissions is estimated to be 14,666 Gg CO_2e in 2017; 15,764 Gg CO_2e in 2018 and 17,503 Gg CO_2e in 2019. The high reduction is primarily due to the mitigation of GHG emissions from industrial waste treatment, which is primarily dominated by the change in EFB treatments in CPO mills. However, this mitigation action was not been included in the NDC target due to data limitations when the NDC was developed. Figure 3-20 presents the GHG emission reduction estimate and the NDC target.

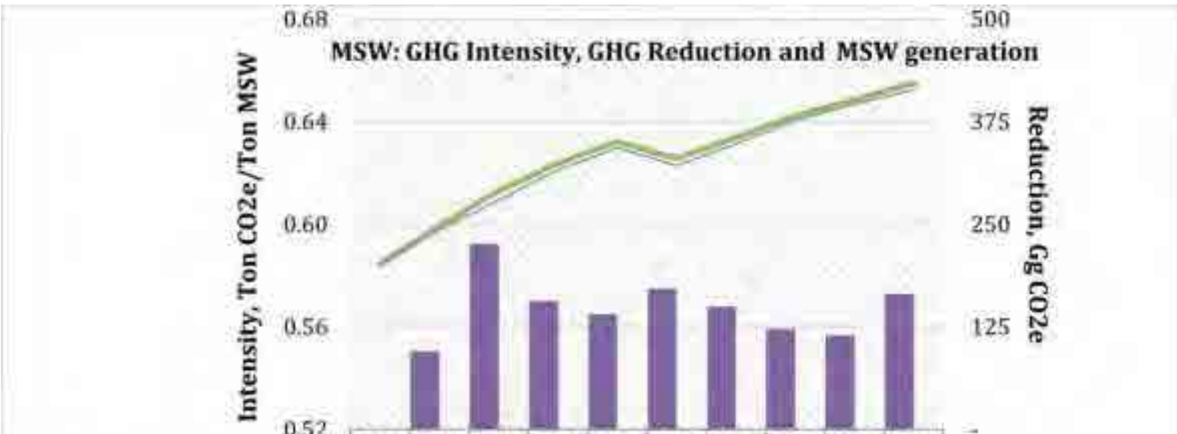


	2020	2030	2017	2018	2019
	CM1 NDC Target		Estimated Achievement		
Industrial Waste	369	3,097	14,368	15,456	16,875
Domestic Wastewater	70	88	175	193	463
Domestic Solid Waste	1,282	8,164	123	115	165

Figure 3-20. The estimated GHG emissions reduction vs the CM1 NDC target

Figure 3-20 shows that the mitigation in industrial waste treatment (use of EFB) contributed significantly to the waste sectors GHG emission reduction target for the waste sector and ensure that the subsector reduction exceeded the 2030 target. For other waste treatment, MSW and domestic wastewater treatments, mitigation accomplishments are still below the target in 2020 and 2030. One reason for poor mitigation performance is a lack of mitigation monitoring (collection and recording of mitigation activity data). Moving forward, there is a need to improve monitoring of mitigation measures.

The breakdown of GHG emissions data for each subsector from 2010 to 2019 is provided in Figure 3-21, Figure 3-22, and Figure 3-23. These figures present the GHG intensity, the level of reduction, and the parameters that affect the level of GHG emissions. Figure 3-21 depicts GHG emissions from MSW treatments, while Figure 3-22 and Figure 3-23 depict GHG emissions from domestic wastewater and industrial waste treatments respectively.

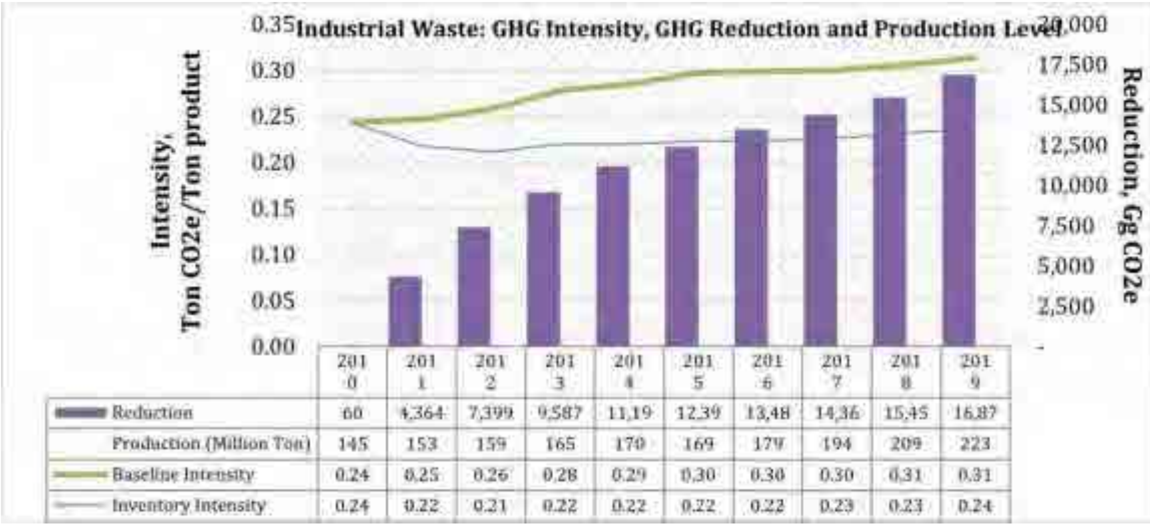


	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Reduction	-	96	227	157	141	172	150	123	115	165
MSW Generation (Million Ton)	60	60	61	62	62	64	65	66	67	67
Baseline Intensity	0.58	0.60	0.61	0.62	0.63	0.63	0.63	0.64	0.65	0.65
Inventory Intensity	0.58	0.60	0.61	0.62	0.63	0.62	0.63	0.64	0.65	0.65

Figure 3-21. GHG Reduction of MSW in 2010 – 2019

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Reduction	0	174	24	896	1,265	1,784	1,136	175	193	463
Population (Million Capita)	239	242	245	249	252	255	258	262	265	268
Baseline Intensity	0.07	0.07	0.08	0.08	0.08	0.08	0.09	0.09	0.09	0.09
Inventory Intensity	0.07	0.07	0.08	0.08	0.08	0.08	0.08	0.09	0.09	0.09

Figure 3-22. GHG Reduction of Domestic WWT in 2010 – 2019



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Reduction	60	4,364	7,399	9,587	11,19	12,39	13,48	14,36	15,45	16,87
Production (Million Ton)	145	153	159	165	170	169	179	194	209	223
Baseline Intensity	0.24	0.25	0.26	0.28	0.29	0.30	0.30	0.30	0.31	0.31
Inventory Intensity	0.24	0.22	0.21	0.22	0.22	0.22	0.22	0.23	0.23	0.24

Figure 3-23. GHG Reduction of Industrial Waste in 2010 – 2019

A breakdown of GHG emission reductions by type of mitigation action is presented Figure 3-24. The figure shows that the major contributor to reducing GHG emissions from the waste sector is the EFB utilisation in the CPO industry. In the baseline, the EFB was incinerated in *tanur* until 2009 and after 2010 it must be stockpiled. After mitigation, the EFB is used as a sources of material and energy. In addition to EFB mitigation actions, other types of mitigation actions that contribute significantly to the emissions reduction include methane recovery from industrial wastewater treatment plant (WWTP), improvement of MSW open dumping of sanitary landfill equipped with landfill gas recovery, utilisation of WWTP sludge in pulp and paper industry, and operation of centralised aerobic domestic WWTP.

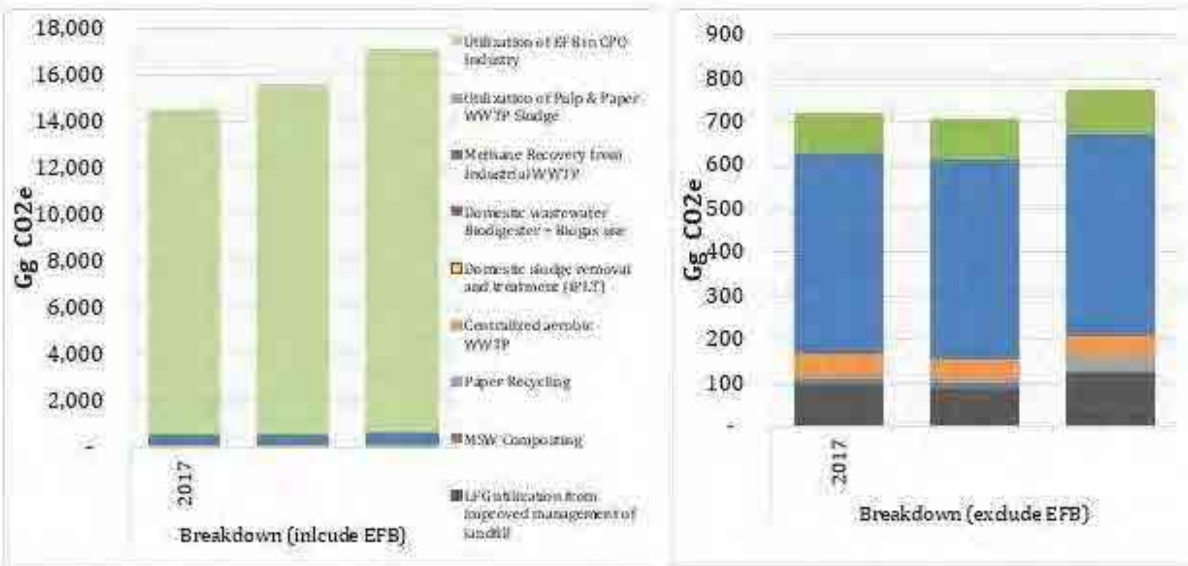


Figure 3-24. GHG emission reduction of waste sector by type of mitigation actions

Table 3-9 below summarises the GHG reduction from mitigations in the waste sector. Detailed information on the required reduction by type of mitigation activities in waste sector is provided in Appendix 3, which presents the comparisons between reduction target, achievement and claim.

Table 3-9. The GHG emissions reduction from mitigations in the waste category

No	GHG Emission Reduction	GHG Emissions Reduction, Gg CO_2e		
		2017	**2018**	**2019**
A	Reduction achievement (intensity differences between baseline and inventory)	14,666	15,764	17,503
B	Reduction claim*			
	Domestic Solid Waste	122	115	112
	Domestic Wastewater	70	57	56
	Industrial Waste (not cover EFB)	119	120	120
	Sub Total B	312	293	288
C	Reduction from EFB mitigation	13,821	14.909	16,317

note: *claimed by ministry from monitoring activities excluding EFB mitigation

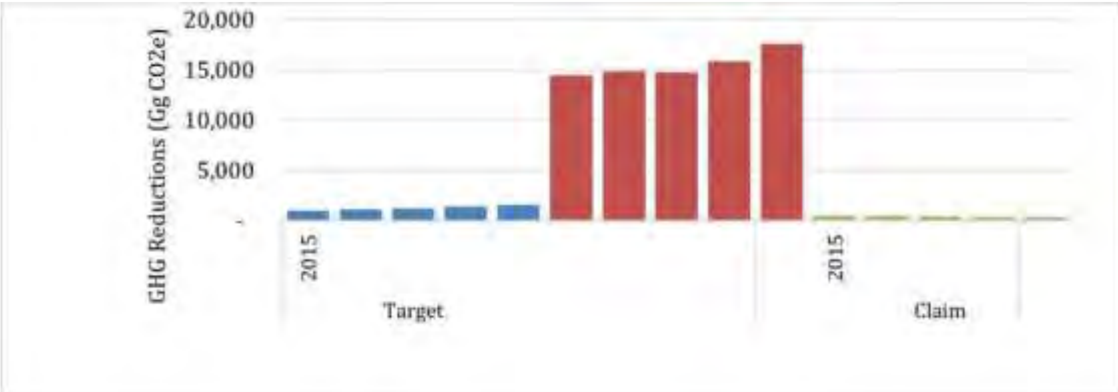


Figure 3-25. GHG emission reduction target, estimated achievement and claim in 2016-2019

Table 3-10 presents the list of mitigation actions and GHG reductions by type of gas in the waste sector in 2017-2019. Some actions may emit small amount of CO_2 or N_2O, but the reduction in CH_4 is still greater; thus, the overall reduction in GHG is positive.

Table 3-10. List of mitigation actions and GHG reductions by type of gas (in Gg CO2e) in waste sector 2017-2019

Subsector	2017				2018				2019			
Mitigation Activity	CO_2	CH_4	N_2O	CO_2e	CO_2	CH_4	N_2O	CO_2e	CO_2	CH_4	N_2O	CO_2e
Domestic Solid Waste												
LFG utilization from improved management of landfill		99		99		92		92		125		125
MSW Composting		13	-0.14	12		10	-0.03	10		7	-1.99	5
Paper Recycling		12		12		13		13		35		35
Domestic Wastewater												
Centralized aerobic WWTP		47		47		41		41		47		47
Domestic WWT sludge removal and treatment (IPLT)		0.59		1		0.53		1		0.53		1
Domestic wastewater Biodigester + Biogas use		0.15		0		0.15		0		0.09		0
Industrial Waste												
Methane Recovery from Industrial WWTP		458		458		458		458		460		460
Utilization of Pulp & Paper WWTP Sludge	-1.04	91	-0.74	89	-1.04	92	-0.74	90	-1.14	100	-0.80	98
Utilization of EFB in CPO Industry		13,821		13,821		14,909		14,909		16,317		16,317

Notes: GHG reduction in Gg CO_2e, (-) negative value means emitting.

3.3.6 Progress of Mitigations in Agriculture Sector

Under the NDC unconditional scenario (CM1), the agriculture emission levels in 2020 and 2030 are projected to reach 112 Mtonnes CO_2e and 110 Mtonnes CO_2e, respectively. Mitigation actions to meet these targets were mainly implemented through five activities (i) optimisation of the land use, (ii) development of plantation area (palm oil, rubber, cocoa) on non-forested land/abandoned land/ degraded land/Other Use Areas (APL) (iii) application of plant cultivation technology (Integrated crop management/*SLPTT*, system of rice intensification/SRI, application of low emission variety), (iv) utilisation of organic fertiliser and bio-pesticide (Organic Fertiliser Management Unit- *UPPO*) and (v) utilisation of manure/urine livestock and agricultural wastes for biogas (*BATAMAS*).

The baseline and actual emissions for the agriculture sector (Figure 3-26) showed that over the 2010-2019 period, the agricultural GHG emission inventory was lower than the baseline, with emission reduction potential ranged from 8-15 thousands Gg CO_2e. However, these values do not describe the true potential to reduce emissions as there is improvement in the method of estimating the area of paddy fields that affects the value of GHG inventory emissions.

Previously, paddy fields were estimated based on field observation/survey, which was time-consuming and prone to human error. Under the new spatial and statistical approach known as Sample Area Framework (KSA), paddy fields are estimated with remote sensing data and validated by field observation. However, the updated data are currently only available for 2018-2019; therefore, these data were used to adjust the historical area of paddy fields from 2000 to 2017.

The result of the adjustment showed a smaller paddy area, of which reduces the value of GHG inventory from the previous accounting in the BUR 2. Currently, the adjustment was made only for the actual issuance. In the next reporting, the baseline emissions will also be revised to reflect the new information. Based on an approximate estimate, the actual GHG emissions inventory for 2017-2019 was above the adjusted baseline, with a discrepancy of 12.58, 2.94, and 3.84 thousand GgCO_2e, respectively.

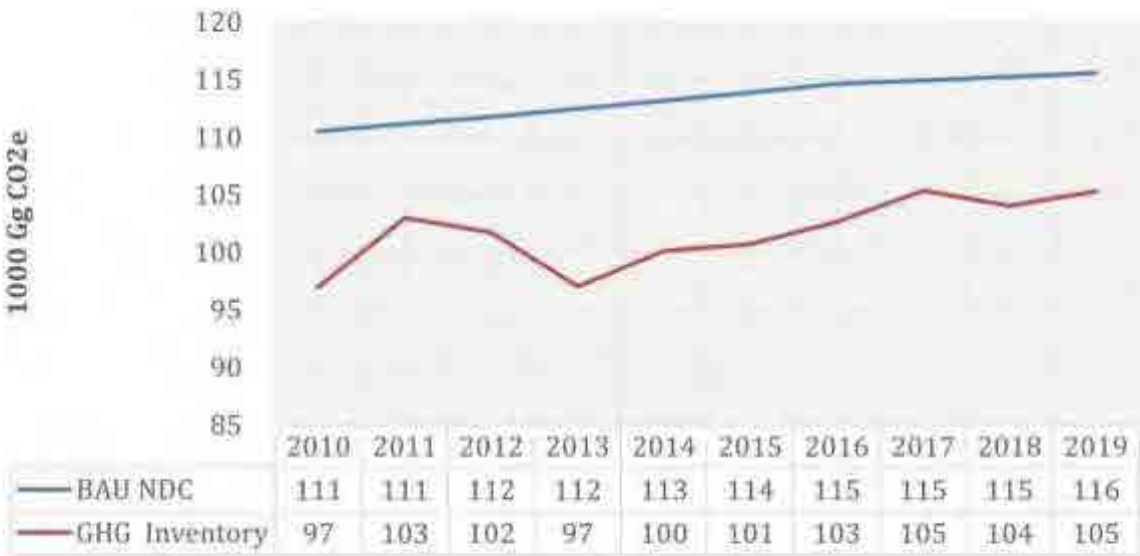


Figure 3-26. Baseline and actual emissions for agriculture sector

The estimate of the reduction in emission from the agriculture sector may be underestimated as the mitigation measures reported were those implemented by the PS (Ministry of Agriculture/MoA). There are mitigation activities undertaken by NPS, where the impacts of the implementation on emission reduction could not be measured due to lack of institutional mechanisms in data collection for such activities.

Based on the emission reduction report of the MoA, the implemented agriculture mitigation activities in 2017, 2018, and 2019 have reached 8.26 million tonnes CO_2e, 12.67 million tonnes CO_2e, and 11.20 million tonnes CO_2e, respectively. Nevertheless, following verification of the estimates, the emission reductions for the three consecutive years starting from 2017, were 10.67 million tonnes CO_2e, 8.86 million tonnes CO_2e, and 12.00 million tonnes CO_2e, respectively. Detailed information on mitigation activities implemented in agriculture sector is presented in Appendix 5.

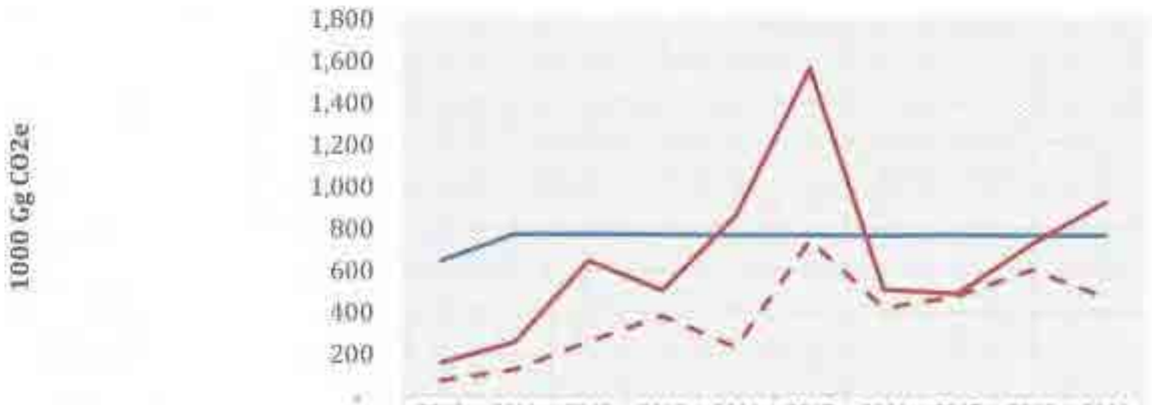
There is a discrepancy in the estimated emission reductions reported by the sector and those calculated based on the difference between the NDC baseline emission and GHG inventory. The discrepancy can be explained by the difference in the activity data of the baseline projection and the actual activity data of the statistics office. In the NDC model, the estimation of paddy field area for example, is affected by the assumption used in the baseline. The area required to meet production targets would depend on the land productivity and cropping intensity assumptions for the baseline and assumption of paddy field conversion area. If it is lower than the baseline, the assumption used for the conversion rate of rice area is higher than the actual rate, the projected paddy area may be lower than the actual value, resulting in emissions below the baseline. If the decrease in paddy area below the baseline is much higher than the actual rate, then the implementation of the measures cannot be taken into account, if the calculation of the emission reduction has been calculated by comparing the NDC baseline with the GHG inventory.

3.3.7 Progress of Mitigations in Forestry Sector

Under the NDC unconditional scenario (CM1), the emission levels for the FOLU sector in 2020 and 2030 are projected to reach 447 Mtonnes CO_2e and 217 Mtonnes CO_2e respectively. To meet this target, the main mitigation activities to be implemented should include (i) reduction in deforestation, (ii) increase the implementation of sustainable forest management practices, (iii) rehabilitation of degraded land, (iv) restoration of peatland, and (v) suppression/prevention of land and forest fires.

Based on the difference in emission levels between the NDC baseline and the GHG inventory, emissions from this sector in 2010-2019 were shown to be below the baseline, except for 2014 , 2015, and 2019 (Figure 3-27). The increase in emissions during these years was mainly due to the increase in emissions from peat fires, due to an extreme drought caused by the El Nino event which caused a major large fire throughout the country. The emissions from peat fires in 2014, 2015, and 2019 measured to be 630.23, 822.74, and 456.43 thousands $GgCO_2$e, respectively. In 2016 – 2018, where there is no influence of extreme drought, the levels of emission from the forestry sector is below the baseline, with the reduction level amounted to 257,000 $GgCO_2$e, 279,000 $GgCO_2$e, and 43,000 $GgCO_2$e, respectively. Strong influence of peat fires on forestry sector emissions illustrated in Figure 3-27, where without peat fires, the 2019 GHG emission level was below the baseline, as there is mitigation action for deforestation has significantly reduced emissions (Appendix 6).

As discussed earlier in Chapter 2 of the National GHG Inventory, the methodology for estimating the annual area of peat fires is being improved, from hotspot estimation to semi-automatic approach using remote sensing data to obtain more precise result. The update process resulted in higher area burned; therefore, the value of peat fire emissions is higher than the accounting value of BUR 2.



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
BAU NDC	647	775	773	771	769	767	765	767	766	765
GHG Inventory with peat fire	160	258	647	503	862	1,560	508	489	724	925
GHG Inventory without peat fire	74	126	260	381	232	743	417	476	602	468

Figure 3-27. Baseline and actual emissions for FOLU sector with and without peat fire

Referring to Appendix 6 which summarise the reported forestry sector mitigation activities, the forestry mitigation activities implemented in 2017, 2018, and 2019 have reached 307.99 million tonnes CO_2e, 165.63 million tonnes CO_2e, and 100.90 million tonnes CO_2e emission reduction, respectively. Following verification, the emission reductions were 295.58 million tonnes CO_2e, 297.82 million tonnes CO_2e, and -23.46 million tonnes CO_2e, respectively.

As previously mentioned, there is still discrepancy between the emission reduction measured from the national GHG inventory and the reported mitigation actions. In the case for forestry sector, the main reasons were due to limitations in the spatial resolution of the satellite data, different approach used, impact from land-based policy, and unreported mitigation activities by NPS. The activity data used in calculating the GHG inventory for the FOLU sector are derived from satellite data. Some of the FOLU mitigation activities may not be capable of being captured by the satellite, particularly where the scale of the implemented area is relatively small, such as land rehabilitation activity. In addition, estimation of peat decomposition emissions in the GHG inventory does not fully account for the impacts of restoring the hydrological state of implementation of peat restoration, as it still derived from the land cover information. Since peatland emission is a major contributor of emissions in forestry sector, capturing the hydrological impacts of peat restoration on the emission factors should be the main concern for further improvements.

For the calculation method, reported mitigation actions estimate emissions from land use change using the stock-difference, while the national GHG inventory has adopted the gain-loss method. The inconsistency method also results in a minor discrepancy between the GHG inventory and the reported mitigation actions. In addition, as GoI currently setting up institutional arrangements to enable data transfer between sectors and related ministries, there are still uncaptured mitigation activities due to disconnected sub-sectoral data from ministries and other institutions to MoEF. This affects the discrepancy of the emission reduction measured from inventory and mitigation activities. Other than the limitation approach and unreported mitigation activities, the difference of the emission reduction value allegedly come from the policy impact. As land-based policies have been well developed in Indonesia (Table 3-5), there should be a significant, yet uncaptured, emission reduction impact from these policies.

3.4 Implementation of Mitigation Actions by NPS and Their Effects

The contribution of emission reductions resulting from the implementation of mitigation activities by the NPS to the achievement of the NDC target was not included. The Government of Indonesia is still the process of upgrading the National Registry System and MRV to ensure all mitigation activities are implemented and reported by the associated PS and NPS. The contribution of the NPS to the achievement of the NDC emission reduction target will be included in the next submission, as required.

3.4.1 Subnational Mitigation Activities

In meeting the NDC target for the emission reduction, NPS at the subnational level has also contributed to the achievement of the unconditional NDC (CM1) as well as conditional NDC (CM2) targets through the implementation of several mitigation measures. However, only a few that has reported the impacts of the mitigation actions on reducing the emissions due to lack of the data. For example, DKI Jakarta has reported its achievement in reducing the GHG emissions. During 2015 – 2018, DKI Jakarta could reduce GHG emission of about 9,257,230 tonnes CO_2e in 2015, 8,368,861 tonnes CO_2e in 2016, 8,129,108 tonnes CO_2e in 2017 and 9,342,222 tonnes CO_2e 2018 (see Table 3-11).

Table 3-11. Estimated emission reductions for DKI Jakarta (tonnes CO_2e)

by Sector / by Authority	2015	2016	2017	2018
Sector				
Energy	9.138.320	8.267.585	8.049.993	9.273.093
Waste	118.910	101.276	79.115	68.690
AFOLU	-	-	-	439
Total	9.257.230	8.368.861	8.129.108	9.342.222
Authority Level				
High	309.918	356.998	451.034	879.684
Medium	13.789	23.611	71.789	85.040
Low	8.933.523	7.988.251	7.606.286	8.377.499
Total	9.257.230	8.368.861	8.129.108	9.342.222

Source: Environmental Agency of DKI Jakarta's GHG Report (*Pelaporan Penurunan Emisi Gas Rumah Kaca Provinsi DKI Jakarta 2019, DLH DKI Jakarta, 2019*)

3.4.2 ADIPURA Clean City Programme

At the city level, the implementation of mitigation programmes is supported by the Clean City Programme (Adipura). As reported in BUR 2, the Adipura encourages each municipality to maintain urban cleanliness as an indicator of the quality of the environment. One of Adipura's criteria is municipal waste management. The GHG mitigation actions that could be implemented are reducing the number of MSW entering landfills through composting activities, reduce-reuse-recycle or 3R, waste bank (Bank Sampah) and improving green open space and preventing forest fire. Cities participating in Adipura must have urban infrastructure and facilities such as urban forest, urban park, waste landfill, waste bank or other waste treatment model and MSW treatment facility.

Based on the report from Adipura Secretariat, the total number of cities that have received the Adipura rewards in 2017-2018 consisted of 156 cities that received Buana grade, 39 cities Kirana grade and three cities received Paripurna grade (the highest grade). One of the cities that received Paripurna grade is the City of Malang. The implementation of solid waste management (LFG and 3R) with emission reduction in the final landfills of Supit Urang and Talang Agung, were approximately 65 and 19 tonnes CO_2e per year respectively. However, cities reporting their emission reductions as a result of urban improvement (e.g., waste management, green space etc.) are still limited.

3.4.3 Proklim Programme

In addition to Adipura, the implementation of Climate Village Programme (Proklim) illustrates the GHG emission reduction potential to contribute to national mitigation achievement. During 2017-2019, the number of Proklim mitigation activities across the 32 provinces reached 1.832 activities. The estimated GHG emission reduction from the implementation of Proklim through the validation process in 78 villages in 22 provinces was 30,153.71 tonnes CO_2e (Figure 3-28). The detail information of GHG emission reduction estimates from Proklim Activities in 2017 – 2019 by region is presented in Figure 3-29.

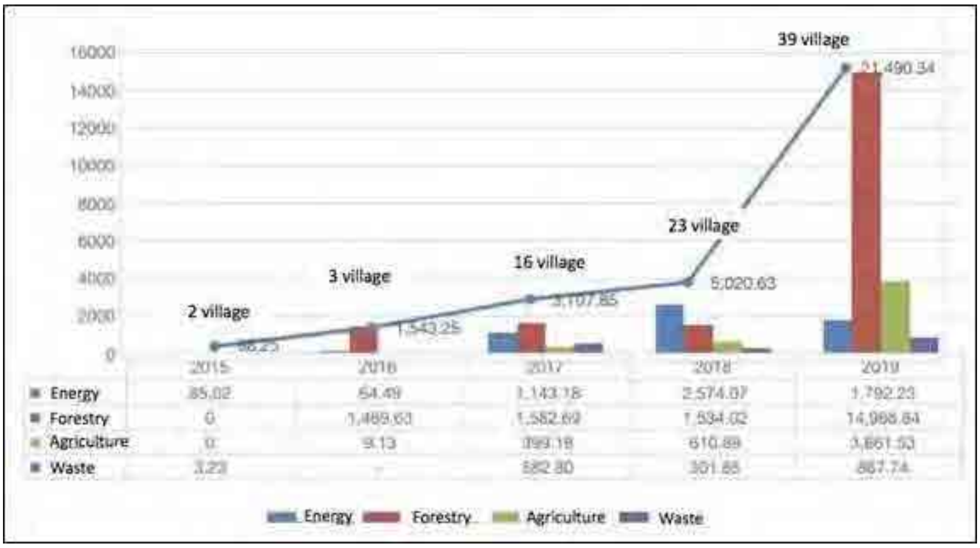


Figure 3-28. GHG emission reduction from Proklim activities 2015-2019 by sector

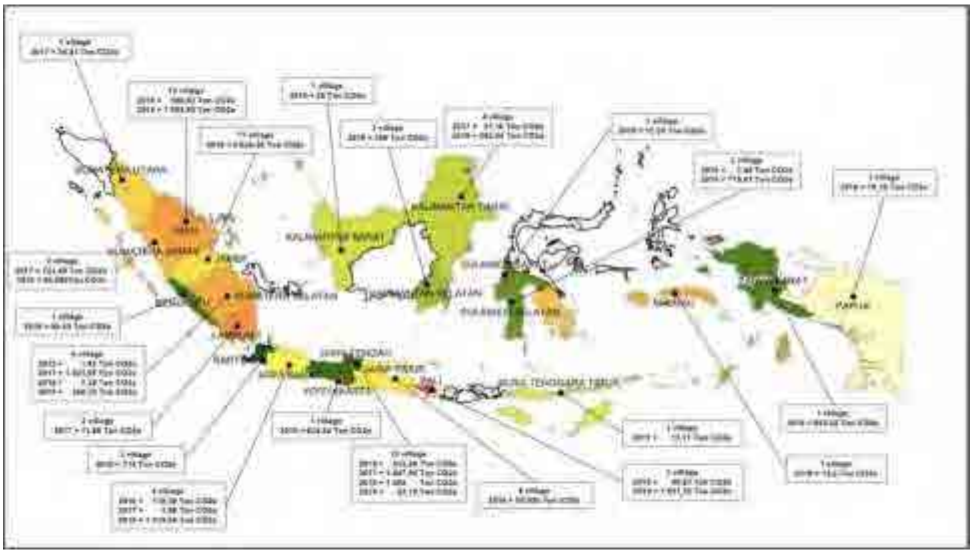


Figure 3-29. GHG emission reduction from Proklim activities 2015-2019 by region

3.4.4 Green Building Certification in DKI Jakarta

Based on the report from Green Building Council Indonesia (GBCI) for the period of 2017-2018, the number of non-government buildings in DKI Jakarta that have been certified by the GBCI is accounted to 10 buildings in 2017 and 10 buildings in 2018. In addition, DKI Jakarta's Agency of Industry & Energy (Dinas Perindustrian & Energi) also reported on achievement of energy conservation in provincial government buildings although those buildings not yet acquiring green building certification. The calculation results of the achievement of the GHG emission reduction potential from the building energy conservation as mitigation measures was 27,993 ton CO_2e (2017) and 37,789 ton CO_2e (2018), which is achieved by mitigations implemented in Provincial Government Buildings as well as Non-Government Buildings (see Table 3-12).

Table 3-12. The GHG Emission Reduction from Energy Conservation in Buildings in DKI Jakarta in 2015-2018

Green Building and Building Energy Conservation of DKI Jakarta	**2015**	**2016**	**2017**	**2018**
Energy Conservation - Provincial Government Building				
GHG Reduction (ton CO2e)		9,519	3,098	12,401
Number of Buildings		14	16	7
Green Building - Non Government Building				
GHG Reduction (ton CO2e)	13,789	14,092	24,895	25,388
Number of Buildings	5	7	10	10

Source: Environmental Agency of DKI Jakarta's GHG Report (Pelaporan Penurunan Emisi Gas Rumah Kaca Provinsi DKI Jakarta 2019, DLH DKI Jakarta, 2019)

3.5 Supported Mitigation Actions

As reported in BUR 2, Indonesia has already received supported mitigation actions from the Nationally Appropriate Mitigation Actions (NAMAs) programmes for Sustainable Urban Transport Programme Indonesia (SUTRI NAMA). This NAMA is implemented together with the Indonesian Bus Rapid Transit Corridor Development Project (INDOBUS). The GoI had signed the international agreement for the implementation of this project in December 2017 and now has finalised the Plan of Operation (PoO). It is expected that the PoO can accelerate the implementation of the project.

3.6 International Market

As outlined in BUR 3, the mitigation actions under the international market are CDM projects. During the period of 2017-2019, there were 118 CDM projects registered at the CDM EB. Of the 118 projects, 21 have produced CERs account for more than 25.885 million tonnes of CO2e. Most CDM projects in Indonesia are related to waste management and alternative energy generation activities, in particular methane prevention in agro-industrial waste treatment.

CHAPTER 4. DOMESTIC OF MEASUREMENT, REPORTING, AND VERIFICATION

4.1 National Registry System for Climate Change (NRS-CC)

Following an obligatory mandate for a ratifying party to provide a transparent framework (Art.13/CP21), the MoEF as the Indonesian National Focal Point (NFP) for the UNFCCC launched the National Registry System of Climate Change (NRS-CC) in 2016. NRS-CC is a web-based system that manages and provides data and information on national mitigation and adaptation activities, pursuant to the MoEF Ministerial Act No.71/2017. The NRS-CC is available from the weblink http://srn.menlhk.go.id/.

Sectors and entities must register their mitigation activities in the NRS-CC prior to being validated and verified. This process is aimed at avoiding duplication, overlapping of activities, double reporting, and double counting. In addition, in order to develop mutual trust and confidence in the promotion of climate-related activities, the NRS-CC system is appropriately designed to be accessible to the public and to individuals/entities for registration or to explore the national mitigation and adaptation activities.

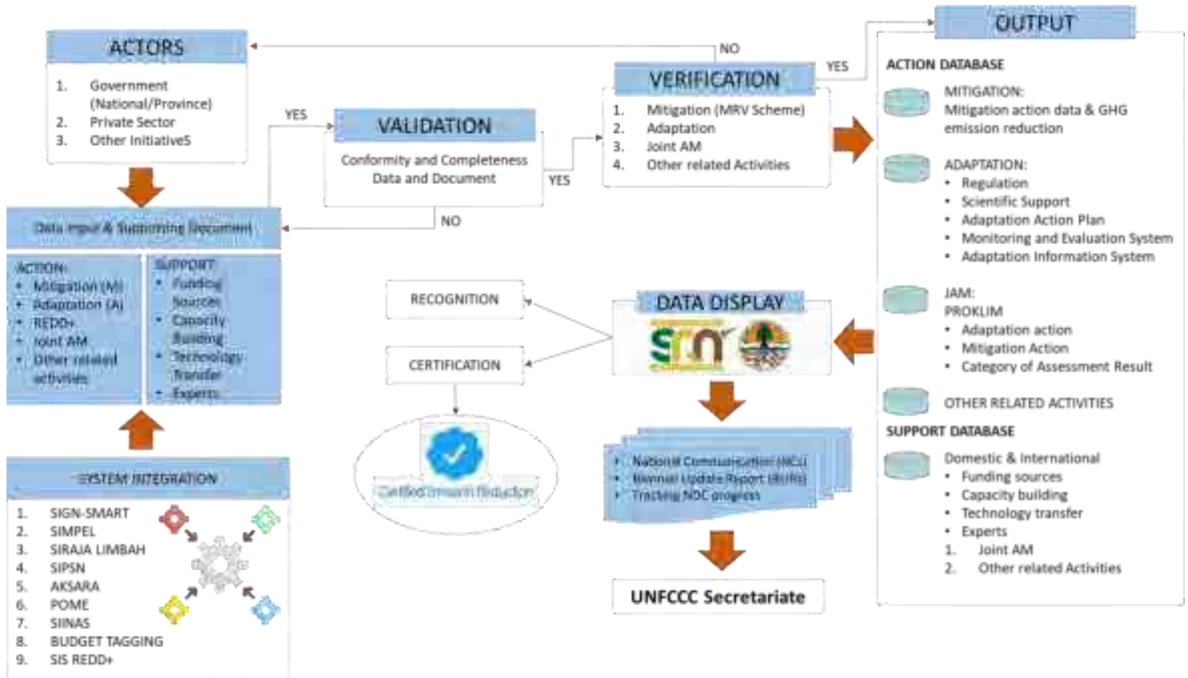


Figure 4-1. Existing workflow of National Registry System for Climate Change (NRS CC) according to Ministerial Law of MoEF No.71 and 72/2017

The workflow of the Indonesia NRS-CC is presented in Figure 4-1. Initially, the proponent, an individual who is responsible for operational activity/business project, should register their actions (e.g., adaptation, mitigation, joint adaptation, and mitigation, etc.), including the support resources they receive (e.g., funding, capacity building, technology, experts, etc.). In the initial registration process, the proponent would be required to enter general activity data (e.g., name of the activity, status, duration, type of the activity, general objectives, and specific objectives) and technical data (e.g., detailed activity data and support received).

Ideally, both general and technical data would need to be linked from other existing information systems in a single integrated system. In this case, it would not be necessary for the proponent to repeat the process of entering similar data/information into two or more information systems.

Workflow as in Figure 4-1 portray NRS-CC as an integrated system that expected to provide one-data of mitigation actions for national level.

Validation and verification of general and technical data will be carried out. Once the activity has gone through this process, this information will be publicly posted on the NRS-CC website, including the quantity of emission reductions. During the final process, the verified activity will be offered the option to receive certification or recognition/label, depending on the proponent's intention. The certification, an Indonesian Certified Emission Reduction (ICER), will be granted to a proponent wishing to enter the national carbon market, while recognition only acknowledges the proponent's efforts to reduce emission. Currently, a verified activity could only be recognized/labelled, since the Government of Indonesia is still in the process of developing a domestic carbon market scheme, including its supporting Presidential Regulation.

4.2 Institutional Process for Validation and Verification

The implementation of MRV in Indonesia follows international guidelines for the national MRV framework, with several adjustments based on national circumstances. The guidelines for the implementation of MRV are set out in the MoEF Ministerial Act No.72/2017. The guideline regulates mechanisms and systems for measuring, reporting, and verifying the impact of climate action including financial resources, technology, and capacity building. This aims to ensure the reliable implementation of climate action.

The following is a summary of the technical validation and verification process:

1. The proponent should register the activity by accessing http://srn.menlhk.go.id/. The applicant will be notified via email with a registration number. Each proponent will be assigned one registration number, irrespective of the number of activities they have registered.
2. Proponent enters the general data. If the general data is approved, the proponent should receive the account number. An account number will be provided for each activity, therefore, a proponent who registers for more than one activity will receive several account numbers.
3. Proponent enters the technical data. If the technical data is validated, the proponent would be provided with the registration number.
4. The MRV team will verify the activity.

The most recent information from the NRS-CC website indicates that the number of the registration, account number, registration number, and verified activity is 1508, 3995, 351, and 326, respectively.

The MoEF Directorate General for Climate Change (DGCC) is the coordinator for the implementation of MRV with the main task of engaging all sectors that implement climate actions, namely government, private, and public. Ideally, the NRS-CC Secretariate is responsible for the validation process and facilitates the verification process as regulated by the MoEF Decision Letter of Directorate General of Climate Change No.13/2018. The NRS-CC secretariate led by DGCC, consists of staff representatives from each Directorate under the DGCC, namely Directorate for GHG Inventory and MRV, Directorate for Climate Change Mitigation, Directorate for Climate Change Adaptation, Directorate for Sectoral and Regional Mobilization Resource, Directorate for Forest and Land Fire Control.

In support of the implementation of the NDC, MoEF Ministerial Decision No.679/2017 establishes the NDC Implementation Secretariat to support the validation and verification process, with a focus on the monitoring process. The NDC Implementation Secretariate, consisting of the Steering Team and the Technical Team, will monitor the registered and verified mitigation and adaptation activities in order to track the progress of the NDC. The NDC Implementation Secretariate is expected to undertake its tasks during the NDC implementation period, which started in 2021. However, due to political dynamic and Government effort to improve better administration for NDC implementation, there are potential changes for NDC implementation secretariate's function and duty.

However, at present, the validation process has been separated for each sector and some sectors require Ministers outside of MoEF to be involved (Figure 4-2). At the moment, the MoEF Climate Change Mitigation Directorate is responsible for the validation of the LUCF and waste sectors only, while for the other sectors, the validation process is performed by the related directorate of each lead ministry (Ministry of Energy and Mineral Resources, Ministry of Agriculture, and Ministry of Industry).

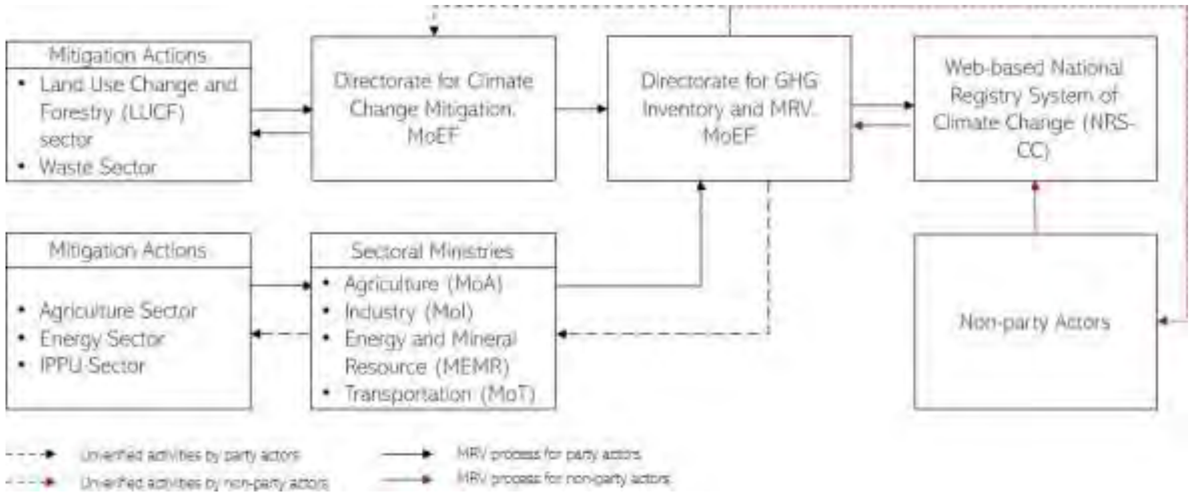


Figure 4-2. Existing institutional process for validation and verification process

The verification process for mitigation measures is implemented by the Directorate of GHG Inventory and MRV of the DGCC. Additionally, DGCC, through the MRV Committee, will verify the results of emission reductions and seek DGCC approval. Prior to approval, the verification report is communicated to the sectors and they may provide their clarifications and views. Subsequently, the GHG Inventory and MRV Directorate will register the activity on the NRS-CC website and the DGCC will publish the report.

As shown in Figure 4-2, the GHG Inventory and MRV Directorate is currently responsible for registering activities performed by the state actors. In the case of the non-state actors, the existing process is already on track, where they manually register the mitigation activity in NRS-CC. In the future, it is expected that both parties and non-parties are expected to register the activity directly at NRS-CC on the web.

The initial stage of the emission reduction verification is done by means of a document review, conducted by the MRV team in collaboration with the methodology panel. Document review is intended to verify the completeness of activity-related documents, appropriateness of methods used to define baseline data and monitoring, and calculation of the emission reduction by referring to the guideline developed by the DGCC. If needed, a site visit is possible. The verification process generally took 15 working days from the day the proponent submitted the emission reduction report. In the case of party actors, the unverified activity will be returned to the responsible ministries, while the non-party actors will be returned directly to the project/activity executor (Figure 4-2).

4.3 Methodological Panel

During the submission process of mitigation actions, it is mandatory for a proponent to follow the methodology provided by the MRV team, as regulated by the Directorate General Law of Climate Change No.9/2018. A Methodology Expert Panel was established to support the implementation of the MRV, comprised of experts from universities, research institutions, and sectoral ministries. The role of the Panel is to identify, analyze, and assess the methodologies developed by the parties to measure emission reductions and to recommend the outcome of the methodological assessment to policy makers in the planning and execution of climate action programs. The panel was established on the basis of the DGCC Directorate General Decision No.22/2017.

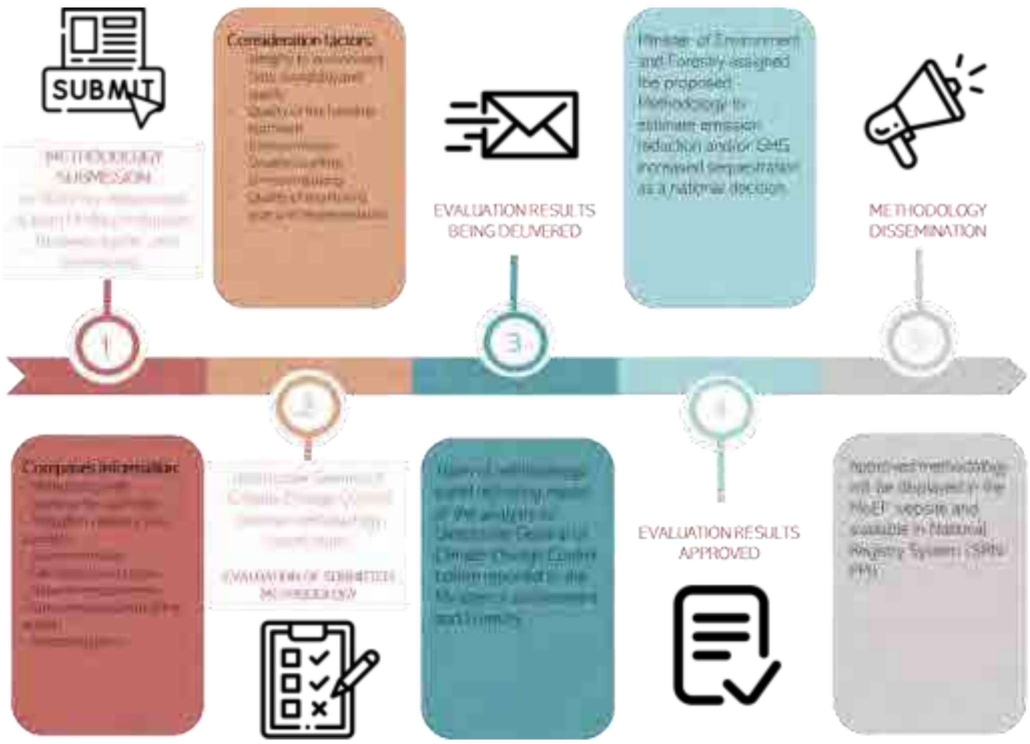


Figure 4-3. Procedure for determining a method for estimating GHG emission

Proponents, including government, business owners, and the community should propose the methodology used to calculate emission reductions and increased carbon sequestration to the DGCC for approval. As shown in Figure 4-3, there are five main steps in the process: submissions, initial assessment, presentation of results to the MoEF, approval, and dissemination. In the first submission process, the proponent should provide general information on the proposed methodology, description of the mitigation actions, emission calculation for baseline and mitigation action, monitoring plan, and supporting documents. In the next stage, the proposed methodology is then evaluated by the Expert Panel on Methodology. The evaluation focuses on quality in determination of baseline data, emissions leakage, calculation of mitigation actions, data required for the implementation of the mitigation actions, and monitoring plan and implementation.

The results of the evaluation will be delivered to DGCC before reporting to the MoEF. The proposed methodology assigned by the Minister will be shared with stakeholders through public consultations with associated parties/stakeholders for response or comment. If required, the Expert panel on Methodology and MoEF will conduct a site visit to carry out a sampling test. The approved methodology to date is outlined in the DGCC Decision Letter No.5/2020, No.14/2020, and No.38/2020.

An alternate methodology could be proposed either in the form of a new proposed methodology or a revised methodology. In the case of the revised methodology, the MoEF may revise the previously approved methodology, taking into consideration the learning process of implementing the methodology in the field. In this case, the revision process would follow a similar process of proposing a methodology as shown in Figure 4-3. The process of submitting the methodology to the approval of the evaluation was approximately 12 months.

4.4 REDD+ Registry System

The achievement of emissions reductions in the forestry sectors is reported by the MoEF's Climate Change Mitigation Directorate, while the DGCC will verify the reports through the MRV team within the Directorate for GHGI and MRV. In the case of sub-national implementation of REDD+, the MRV process, specifically for the process of reporting and verifying, is distinguished by the existence of a sub-national institutional system for REDD+ within a province. This has been regulated in accordance with the MoEF Ministerial Act of No.70/2017.

The reduction of emissions/conserved forest carbon stock/increased forest carbon stock shall be measured by the party responsible for implementing REDD+, the most being twice a year. In such cases, reporting and verification should follow the measurement process, or the most twice a year. As part of the result-based payment submission process, an independent third party will audit the implementation of REDD+ and the result of the verification will be submitted directly to the Director of the DGCC as the national focal point for the UNFCCC.

In the case of a province that has not yet established the institutional system for REDD+, an emissions reduction report is submitted by the Provincial Forest Management Units (FMU) to the DGCC. The FMU will be responsible for coordinating the implementation of REDD+ activities in its management units. If there are REDD+ activities implemented outside the FMUs, the achievement report should be submitted directly by the party implementing the REDD+. Measurement and reporting results should be recorded on the NRS-CC website. The results of the independent audit will be reviewed by the MRV team. The result of the audit by the MRV team, will be received by the DGCC and recorded in the NRS-CC website.

For a province that has established the REDD+ institutional system, an agency assigned by the province will be responsible for the coordination and management of all REDD+ activities in its jurisdiction. The agency, which in most cases is the Provincial Environmental Office or Provincial Forestry Office, will input the REDD+ measurement and report to the web-based NRS-CC MRV team of the DGCC. The results of the independent verifier will be examined by the MRV team. The verified result from the MRV team will be received by the DGCC and recorded in the NRS-CC website.

However, not all provinces were found to have an institutional system for REDD+ prepared with a subnational system, to support the aggregation of the REDD+ data/information within their scope of expertise. Therefore, the MoEF DGCC is preparing to develop a subnational registry system for REDD+ that will be used by a province that has an institutional system for REDD+. Through the subnational registry system, those responsible for implementing REDD+ report on the implementation of REDD+ by the subnational REDD+ institution. To enable the subnational registry system, a sub-administrator at the subnational level would need to be prepared. The sub administrator shall be authorized to compile and aggregate data and information on the implementation of REDD+ in their entity area. Under this condition, the sub administrator will report the REDD+ activity in one jurisdiction entity on the NRS-CC website.

4.5 Plan of Improvement

The Indonesian national MRV has improved considerably over the past three years. To enable system completion and improvement according to user needs, two main supports necessary to improve the MRV system comprises:

1. System integration
   The MoEF and other related ministries have developed information system on mitigation activities for government and the environmental impact of business activity for the private sector. However, these systems still operated independently. In contrast, an integrated information system is crucial to prevent the repetition of the data entry process and to easily track the funding and contributions to climate action of each actor. A list of the information available on the system is provided in Table 4-1.

Table 4-1. List of system information required for system integration

No.	Existing system information	Data and information stored in the system	Users
1	SIGN-SMART (Developed by DGCC of MoEF)	- Data activity - Emission factor - GHG Emission level - BAU emission level	- National, provincial, and local government - Sectoral ministries - Public (guest user)
2	SIMPEL (Developed by of MoEF)	- Detailed information for business activity - Environmental impact from business activity (waste management, air, and water pollution)	- Business owner/private
3	SIRAJA LIMBAH (Developed by of MoEF)	- Company profile - Company licensing - Company's cooperation - Internal and external waste	- Business owner/private - Local government
4	SIPSN (Developed by MoEF)	- Amount of garbage (ton) - Waste managed and unmanaged in waste management facility - Waste composition	- No login option for a user
5	Online Reporting for Energy Management (*Pelaporan Online Manajemen Energi*, POME) (Developed by Ministry of Energy and Mineral Resource)	- Energy use - Energy management (energy conservation program, routine audit, reporting the audit result)	- Business owner - National government
6	SIINAS (Developed by MoI)	- Import recommendation	- Industry association - Provincial and local government

			- Related ministries - public
7	SIS Safeguard (Developed by MoEF)	- Data and information to support the implementation of 7 safeguards as mentioned in Decision 1/CP.16 Para 2.	- Provincial and local government - Related ministries - Private sectors
8	Information system for Shipping and Marine (*Sistem Informasi Perkapalan dan Kepelautan*, SIMKAPEL)	- Data and information of the ship owner to obtain ship safety certificate	- Related ministries - Provincial and local government - Private sectors - Public

2. Improvement of NRS-CC to support national carbon market
   As the Government of Indonesia is currently preparing the Presidential Regulation regarding the national carbon market, the development of software for Indonesia Certified Emission Reduction (ICER) transaction log is necessary. The software serves to track the emission reduction movement of the verified/proponent activity in the national carbon market (e.g., completed transaction, canceled transaction, carry-over status, etc.). In this case, support for capacity building from a country with experienced national carbon market is required.

CHAPTER 5. FINANCE, TECHNOLOGY AND CAPACITY BUILDING NEEDS AND SUPPORT RECEIVED

Supports and lessons-learned including finance, technology and capacity building are important instruments to support developing countries in implementing climate change actions. Indonesia has identified several supports and needs from the assessment in implementing the country's commitment to improve its resilience to the catastrophic impacts of climate change and to shift towards a low carbon and climate change-resilient development pathway. The identification is expected to result in effective support for countries to contribute to global efforts to reduce emissions and adapt to climate change. Therefore, the identification of needs and support received is a crucial element of the implementation of the Indonesia's NDC. This section describes the finance, technology and capacity building needs to assist Indonesia meet its emissions reduction target of up to 41% in 2030 and the supports received from national and international sources. The data used were sourced from official data particularly from the Ministry of Environment and Forestry and the Ministry of Finance.

5.1 Support Needs

The Government of Indonesia has committed voluntarily to achieve emission reduction target of 29% in 2030. To achieve the national emission reduction with international support, Indonesia has estimated the emissions reduction up to 41%. In this section, the required supports are identified in the areas of financial, technology and capacity building needs as described below.

5.1.1 Financial Needs

The Government of Indonesia requires financial supports to meet its emission reduction target of up to 41%. Indonesia estimated the financial requirements for achieving the emission reduction target as defined in the NDC. To achieve the unconditional target in 2030, the financial requirements to 2030 are estimated at about USD 281 billion. This is a conservative estimate of the financial requirement to achieve the Counter Measure 1 (CM1) Scenario or unconditional targets (Table 5-1). The estimate is based on projected financial requirements using the existing public climate financing (government expenditure) added to the estimated financial requirements for specific interventions within the waste and IPPU sectors which would normally be undertaken by the private sector. These combined estimates provide the baseline numbers, which are used to estimate the projected unit cost of emission reductions in each sector. Additional financial requirements to meet the Counter Measure 2 (CM 2) or conditional target have been estimated in the forestry sector at about USD 0.7 billion and in the agriculture sector at about USD 0.013 million. On the other hand, financial requirement to implement adaptation action is estimated at about USD 2.3 – 12.14 billion to build resiliency and adaptive capacity to reduce the risk of loss to 2.87% of GDP.

Table 5-1. Estimated financial requirements to reach the unconditional target in 2030

Sector	Mitigation Action (Program Activity)	Financial needs (billion IDR)	Financial needs (billion USD)[1]
Forest and Land use	Reducing mineral deforestation	76,960	5.40
	Reducing peatland deforestation	801	0.06
	Reducing mineral degradation	76,588	5.37
	Reducing peatland degradation	810	0.06
	Sustainable Forest Management	1,896	0.13
	Land rehabilitation without rotation	4,373	0.31
	Land rehabilitation with rotation	13,892	0.97
	Development of industrial plantation forest	125,280	8.79
	Peatland Restoration[2]	8,253	0.58
	Peat water management	156	0.01
Energy & transportation	Renewable Energy Generator	1,688,000	118.456
	Non-electric renewable energy	84,000	5.89
	Low carbon coal power plant	1,619,000	114
	City gas network and mitan to LPG conversion	17,000	1.19
	Energy conservation	92,000	6.46
Agriculture	Use of Low Emission Varieties in Rice Fields (x000 hectares)	60.93	0.004
	Application of Water-Efficient Rice Field Irrigation System (x000 hectares)	3,186,44	0.22
	Utilization of Livestock Waste for Biogas (x000 livestock)	195.13	0.01
	Feed Supplement Improvement (x000 farm animals)	3,786,89	0.27
IPPU	System software and hardware improvements and incorporating new algorithms in the control system that can reduce AE frequency, duration, and over voltage	85	0.01
	Installation of Co-Processing (AFR) facility to reduce clinker/cement ratio to 75% (2030)	300	0.02
	Construction of a new factory with New/Advanced Technology	40 - 50	0.003 – 0.004
	Substitution and retrofit technology	40	0.003
	Technology Improvement	350	0,02
	Production System Repair	50	0,004
	Installation of Secondary N2O Abatement Catalyst and Operating Costs	45-50	0.003 – 0.004
Waste	Collection & Transport	42,732	2.999
	Final Processing	142,541	10.003
Total[3]		4,002,436	281

[1]Using exchange rate of 1 USD= 14,250 IDR. [2] Cost of emission reduction per timber life cycle is included, as well as cost of new technologies that may occur at any stage of life cycle, and cost of peat management technologies. [3]Financial needs in BUR 3 is larger than reported in BUR 2 due to the additional mitigation programs, differences in cost-methodology used and longer time frame (2011-2030 for agriculture sector and 2013-2030 for forestry sector).

Estimation on the projected financial requirements will be affected by data used and the accuracy of the current government expenditure on climate actions (baseline). To improve the accuracy of baseline data, consideration may need to be given to developing future capital expenditure and operating expenditures for projects related to NDC targets. Relevant projects are primarily in the energy, IPPU, and waste sectors, which generally have such cost structures with different project financiers. The allocation of capital and operating expenditure will also make it possible to specify the amounts invested in the intervention, whether public or private. Moreover, the projected financing requirements for capital and operational expenditures will vary. Another important improvement in the future is an update to the government's current climate financing. This is due to changes in government expenditure codes that occur following the new government administration.

5.1.2 Technology Needs

The required technology-related programs were assessed for ASEAN countries including Indonesia in terms of transparency (i.e. information, knowledge, monitoring, and evaluation system) and transformation (i.e. institution, policy planning, stakeholder engagement, systematic change, and resources). The technological requirements for the implementation of the

Indonesia's NDC involved the development of database management, planning actions for national and local level, finance information access, good practice information, monitoring/tracking system of emission reduction, tracking system for expenditure and finance, tools for assessment, and modelling for long-term projection. However, human resource capacity (including knowledge and skills) and financial support are essensial to be combined with the technology developed. The list of technology needs for adaptation and mitigation actions is shown in Table 5-2. Specific technology needs in mitigation sectors are described in Chapter 5.1.2.1–5.1.2.4.

Table 5-2. Necessary actions for technology needs in adaptation and mitigation actions

Focus Area	***Action and needs related to technology aspect***
Adaptation needs	*Strengthen the scientific information base*
	Mainstream adaptation into sectoral and development planning
	Sustain actions through public-private-people partnerships (PPPP)
	Promote monitoring and evaluation (M&E) of adaptation including adaptation metrics
	Enhance access to international adaptation technology
	Promote adaptation and mitigation co-benefits
	Reskill workforce on priority adaptation knowledge and skill areas
Mitigation Needs	*Facilitate mitigation planning including addressing sectoral challenges (energy, AFOLU, transport, industry, waste)*
	Set long-term mitigation goals/targets and roadmap at national and local level
	Strengthen the modelling capacity for long-term projections
	Track regional progress toward the PA long-term goal (2° or 1.5° target)
	Establish tracking system for expenditure and finance tagging
	Strengthen technology needs assessments
	Promote capacity assessments on technology, finance, and human resources

5.1.2.1 Energy

Based on the technology need assessment, Indonesia identified the technology needs to achieve the NDC target. This target is to be achieved through four categories of mitigation actions: energy efficiency measures, application of clean coal technology in power generation, renewable energy, and fuel switching. The technological needs to achieve NDC targets in energy sector can be grouped according to the transport, power generation, industry and building sub-sectors (Table 5-3).

Table 5-3. Mitigation technology needs in the Indonesian energy sector

No	***Sub sector***	***Technology***
1	*Transport*	*Improvement of public transport; CNG (Compressed Natural Gas); Intelligent Transport System, Mass Rapid Transit (MRT) Technology; High Efficient Cooling System of Refrigeration and Air Conditioning in Transport Refrigeration System and Mobile Air Conditioning*
2	*Power Generation*	*PV & Pump Storage; Geothermal Power Plant; Advanced Coal Power Plant; Landfill Gas Power Plant; Biomass fueled power plant; Wind power; Biofuel; Biogas POME*

3	*Industry*	*Efficient Electric Motors; Combine Heat and Power; Pump and Fan System; WHB (Waste Heat Boiler); Alternative Fuel; Green Boiler; Green Chiller; Advanced Furnace*
4	*Building (Residential and Commerce)*	*Combine Heat and Power ; WHB (Waste Heat Boiler); Efficient Lighting; Green Building; Green Boiler; Efficient Electric Motors; Gas pipeline network; Solar PV; Solar Water Heater; High Efficient Cooling System in Unitary Air Conditioner, Chillers, and Refrigeration of Domestic and Commercial sector*

5.1.2.2 IPPU Sector

GHG emissions from industrial processes are those that are released as a result of the chemical or physical transformation of the raw material into products. Mitigation actions for the Indonesia IPPU sector are carried out in the cement, ammonia-urea, aluminum and nitric acid industries. To meet the NDC target, the mitigation actions carried out in those industries are:

- Cement industry – reduction of clinker/cement ratio to produce blended cement.
- Aluminum industry – reducing anode effect using *ALCAN ALESA Process Control*
- Nitric acid industry – use of secondary catalyst in Ammonia Oxidation Reactor to reduce N2O
- Ammonia-urea industry – (i) efficiency improvement in conversion of CO to CO_2, (ii) efficiency improvement in CO_2 absorption in scrubber (iii) efficiency improvement in the methanation of CO_2 residue for syn-gas purification.

Emission reductions target of Indonesia NDC in the IPPU sector are to be achieved by continuing and enhancing the aforementioned mitigation actions. Therefore, the technologies required by the Indonesia IPPU sector are those associated with the aforementioned mitigation actions. The main mitigation action for unconditional target is for the cement and ammonia-urea industries.

5.1.2.3 Waste sector

Waste sector is Indonesia's fourth largest contributor of GHG emissions. Currently implemented mitigation actions in waste sector include: 3R (*reduce, reuse, recycle*); landfilling of MSW and LFG recovery for cooking in residential; domestic liquid waste treatment (off-site and on-site systems). The mitigation actions for waste sector in Indonesia NDC will consist of two groups the treatment of MSW and the treatment of domestic liquid waste LFG recovery in landfills, (composting, 3R (inorganic), and waste to power and heat). The mitigation of domestic liquid waste will include waste treatment through aerated and centralized liquid waste treatment facilities (IPAL) and treatment of sludge collected from septic tanks in integrated liquid waste treatment facilities (IPLT). To achieve the NDC target, the technology needs of the waste sector are associated with the aforementioned mitigation plan presented in Table 5-4.

Table 5-4. Mitigation technology needs for Indonesia waste sector

No	***Technology***	***Remarks***
1	*Sanitary Landfill and LFG recovery*	*MSW to gas fuel*
2	*Semi Aerobe Landfill and LFG recovery*	*MSW to gas fuel*
4	*In-Vessel Composting and low-solid anaerobic digestion*	*MSW to gas fuel*
5	*Bio digester - Low Solid*	*MSW to gas fuel*
5	*Bio digester - High Solid*	*MSW to gas fuel*

No	Technology	Remarks
6	*MBT (Mechanical Biological treatment) -*	*Integrated organic and inorganic waste treatment*
7	*Thermal Conversion: Mass-fired combustion*	*MSW to power or incineration*
8	*Thermal Conversion: RDF-fired combustion*	*MSW to power or incineration*
9	*Thermal Conversion: Fluidized bed combustion*	*MSW to power or incineration*
10	*Gasification technology: Vertical fixed bed*	*MSW to power or incineration*
11	*Gasification technology: Fluidized bed*	*MSW to power or incineration*
12	*Pyrolysis technology: Fluidized bed*	*MSW to power or incineration*
13	*Composting (open window system)*	*Composting*
14	*Aerated, centralized domestic liquid waste treatment (IPAL)*	*Aeration reduces GHG emission*
15	*Integrated domestic liquid waste treatment (IPLT)*	*Reduce GHG emission by treating sludge recovered from septic tanks*

5.1.2.4 AFOLU (Agriculture, Forest and Other Land Uses)

Forests and other land use sector is one of the main contributors of GHG emissions in Indonesia. The main sources of emissions are from deforestation and forest degradation, peat decomposition including land and forest fires. Thus, a significant emission reduction from this sector will depend on the degree of success of reducing deforestation and degradation in mineral and peat forests and the improvement of the management of peatlands and the prevention/suppression of land and forest fires. The main challenge to accurately measure the achievement of the implementation of mitigation actions in this sector, is the reliability of the monitoring system to detect changes in land cover and measure peat emissions. The Government of Indonesia considered that the key technological needs of this sector include technology for integrated forest-peat carbon measurement and monitoring, technology for peat land re-mapping and technology for peat water management including the method to determine the area of peat affected by fires including an estimation of the depth of peat burning (the burnt area and the peat depth with an accuracy of 5 cm).

On the other hand, reducing deforestation in the future will also depend on the capacity to reduce commercial agriculture expansion, such as cash crops, biofuels and livestock production. This will relate to the capacity to implement integrated landscape /land use planning approach, sustainable intensification of commercial agricultural production, sustainable intensification of the livestock system, sustainable biofuels initiatives, intensification of the smallholder system and diversification of livelihoods; the use of degraded land for expanding agriculture and increasing agricultural production in degraded land. The Indonesian government has considered that some of the key technological needs of this sector are technology for sustainable intensification practices, technology for the development of high yield varieties, balanced application of fertilizer, technology to restore soil fertility and technology to increase grassland productivity for animal feed. Detailed technology needs for AFOLU sector are described in Table 5-5.

Table 5-5. Mitigation technology needs of Indonesia AFOLU sector

No	Sub sector	Technology
1	*Forestry and Other Land Use*	*Zero burning technology, technology to measure and monitor carbon sequestration and emission technology, forest and land fire control system, integrated remote sensing application for measurement and monitoring, agroforestry, land rehabilitation, intensive silvicultural technology, reduced impact logging in production forest, technology for water management, molecular biology for log tracking, tree improvement, species site matching, coastal ecosystem monitoring, coastal protector building technology, coastal reclamation, and groin technology*
2	*Agriculture*	*SRI (System of Rice Intensification), development of organic fertilizer processing unit, direct seed planting system, climate smart agriculture, eco-friendly pesticide, biotechnology engineering of bio peat production, canal blocking in peatland for plantation, improved crop varieties by plant tissue culture, integrated pest control, technology for mariculture development, cattle meat development, waste management through composting or biogas, High Carbon Stock for oil palm plantation, and certification of ISPO (Indonesian Sustainable Palm Oil) and RSPO (Roundtable on Sustainable Palm Oil)*

Other water resource sectors are also important determinants of sustainable agriculture and forestry. The technologies required for adaptation to climate change are rain harvesting technology, domestic water recycling, and water resource modelling.

5.1.3 Capacity Needs

Effective implementation of the mitigation and adaptation actions in sectoral ministries (Party actors), private companies and also communities (non-Party actors), required capacity building. Capacity is needed not only to build the expertise needed to implement technologies, but also to monitor GHG emissions, and to measure the achievement of emissions reductions. Awareness-raising activities need to be implemented in an integrated way, not only for government sector agencies (Party Actors) but also for non-Party actors who have the potential to participate in the implementation of mitigation actions.

Specifically, the capacity building needs for the different levels of stakeholders are presented below, although the needs are not constrained by the points below.

1. Capacity building for Parties and non-Party actors, to improve their knowledge and understanding on mitigation actions and the capacity to translate NDC targets into mitigation actions. Each sectoral ministry should be able to develop a mitigation roadmap to achieve the NDC/global target and integrated mitigation actions across sectors. Key capacity needs include, but are not limited to (i) the ability to develop baseline/reference emission levels as a basis for measuring the achievement of mitigation actions in accordance with the guideline developed by the Government; (ii) capacity to collect and understand data and in to develop templates to facilitate data collection; and (iii) capacity to develop a functional database to track information on GHG emissions, effects of mitigation actions, the impact for socio-economy and environment, financial flows from donor countries/funds, and capacity building and technology transfer activities; (iv) capacity to design and evaluate mitigation actions from GHG inventory data.
2. Capacity of local governments and the private sector (non-Party actors) to incorporate climate change actions into their long-term plans and programs. The provincial, district and municipal governments, are institutions that are key to the success of the national climate

change agenda and therefore need ongoing capacity building. The regional government leads the implementation of various Indonesian commitments at the global level, such as Local Action Plans for Mitigation. Regional governments can mobilize stakeholders at the local level, such as the private sector, communities and local champions, to contribute to adaptation and mitigation actions. Project planning capabilities, as well as the technical drafting of proposals for various funding sources, as well as the capacity to calculate GHG emissions should also be improved.

3. Capacity of private sectors to implement mitigation actions. Type of capacity building for the private sector should be tailored to the field condition, For example:
   i. Mining companies will focus more on the use of renewable energy, along with the processing industry, energy and raw water supply, and waste management,
   ii. Construction and real estate firms will focus more on designing environmentally friendly/green building that can absorb energy and withstand the threat of flooding,
   iii. The trading companies will limit the use of plastic, while the transport companies will cultivate eco-driving as well as the use of gas fuel, and
   iv. Hospitality, information and communication services companies, educational services, tourism, and other services can also contribute to the use of green and environmentally friendly materials.
4. Capacity of governments, including technical experts or research institutes to carry out specific mitigation and adaptation action. The transfer of knowledge and technologies related to new technologies, or the methodology of the actions implemented is required to support the implementation of climate action in their sector or region. Moreover, the identification and recognition/encouragement of good practices implemented by the person/institution responsible for implementing the actions, will encourage the sustainability of the program.
5. Capacity of governments and non-government agencies to carry out GHG inventory and MRV into their long term plans and programs including the collection of reliable activity data, develop and determine appropriate emission factors, select appropriate methodologies, carry out uncertainty analysis of activity data, emission factors and GHG estimates, implement quality control from the entire process of GHG inventory, understand the quality assurance process, understand the data and information filing system related to the GHG inventory, and verify process of mitigation actions including input the actions to national registry system. It includes development of quality activity data and emission factor used to estimate the GHG Inventory to monitor emission reductions from mitigation actions. Estimation of projected baseline emissions and emission reduction through mitigation actions is important as it is used to estimate possible emission reductions to meet the NDC target.
6. Development of technical capacity to develop system information or integrate a web-based system to collect data reporting on GHG inventory and mitigation actions at national and local levels. The use of current national system (e.g. SRN, SIGN SMART) is expected to be developed, rather than to establish new information system. There are a number of local GHG inventory reporting systems and mitigation actions based on a specific national program (e.g. Adipura, Proklim, and PROPER). As a result, data collection should integrate the currently available system with the national GHG Inventory and mitigation actions to ensure full reporting. It should also include the capacity to use spatial data in conjunction with the Geographic Information System.
7. Awareness and knowledge of the agent of changes (religious leaders or *ulama*, youth, outreach services, journalists, etc). The right knowledge of the agent of change in terms of

adaptation and mitigation co-benefits, is very important to accelerate change and to motivate stakeholders to make changes. In community organizations, the role of local figures is quite important to have an impact on a wide range of people. While characterization is not directly related to the environment, the issue of climate change can be entrusted to the system that has been applied in the community, one of them through characterization. Capacity building needs generally include an understanding of climate change, causes, impacts, and ways to implement adaptation and mitigation actions. Specifically, capacity building needs are adjusted to their respective roles: for religious leaders, capacity building is designed to increase their knowledge of climate change communication, and to examine the relevance of climate change issues with scripture verses; for journalists, capacity building for writing news on climate change; for politicians, capacity building on climate change issues in general; and for youth, capacity building in climate change communication, social media, and climate change campaigns. Therefore, networks between governments, scientists, and the community are necessary to promote adaptation and mitigation actions to society and the private sector. On the other hand, dissemination of climate science literacy to government and non-governments concerning risks to the climate change is important. It is expected that it will build community awareness and support the implementation of small-scale mitigation and adaptation actions.

8. Higher education, international graduate studies in climate change and climate change research. At the level of primary and secondary education, integrating climate change into the curriculum in general across the subject. At the same time, challenges in the implementation of climate change capacity building include the limited access to education and learning materials, lack of skills of teachers in the field of interdisciplinary climate change and limited inclusion of climate change in the curriculum. At the university level, climate change has become a subject of study for many researchers and academics. In the current context of teaching and learning in higher education, climate change is embedded in part of the course. Research on climate change adaptation and mitigation has also been carried out, but scientific meeting forums for the exchange of knowledge and information need further improvement.

9. Capacity of governments to access climate finance in their units/agencies including access to information, technical drafting of funding proposals, and technical assistance in developing project plans. Information and access to climate finance is limited to governments, particularly local governments. The implementation of climate action to achieve NDC target by local governments at the provincial, district and city levels is crucial and therefore requires capacity support and funding. Given than the national/regional budget for climate actions may be limited for each local government, additional funds from other sources will assist them in to implement climate actions. On the other hand, monitoring of climate finance received is important in identifying the support received by the national government and the international Party. Therefore, the capacity of the national focal point for implementing budget tagging and climate finance tracking is important.

10. Capacity of governments and non-governments to analyze regulations at local and national level specifically for each sector. Improved knowledge ofn related regulations will contribute to better understanding of the role of stakeholders and may develop the regulations necessary to achieve the emission reduction target. Furthermore, establishing a sound institutional arrangement between and within ministries/agencies in each sector is important to ensure the continuity of data collection.

5.2 Support Received

5.2.1 Financial

5.2.1.1 Support for the development of BUR 3

For the development of Indonesia BUR 3, Indonesia has received support from GIZ, GGGI and own state funding of Government of Indonesia. GIZ provided an amount of USD 34,554 for the drafting of Indonesia BUR 3 and GGGI provided an amount of 12.407 for the finalization and socialization.

5.2.1.2 Support received for supporting the implementation of mitigation actions

The Indonesian government has received financial support from different countries and development agencies for the implementation of climate actions. In the submitted BUR 2, Indonesia received about USD 1,811.63 in concessional loans and USD 36.73 in grants over the period 2015-2016. The funding received was delivered in various sectors by bilateral (USD 1,304.23) and multilateral (USD 544.13) supports. In the 2017-2019 period afterwards, financial support has reached USD 18.21 million. Approximately 89% of the support is in mitigation, i.e. USD 16.15 million (Table 5-6). Financial support is mainly in the form of grant received by the Directorate General of Climate Change, MoEF. Some of the financial support received is unreported in this BUR 3 due to data limitations, but about USD 3,733.32 of the total financial resources were supported by bilateral (78.8%) and multilateral (21.2%) agreements. Statement of the financial instrument received, if the agreement has been completed/partially disbursed, is not recorded due to the unavailability of tracking system.

Table 5-6. Financial support received for mitigation action in the period 2017 -2019 (in million USD)

Financial Instrument	***Sector***	***Bilateral***	***Multilateral***	***Total Received****	***Total Agreement***
Concessional Loan	*Energy*	-	-	-	*1,482.21*
	Transportation	-	-	-	*1,528.56*
	Waste	-	-	-	*147.80*
Sub-total		**-**	**-**	-	***3,158.57***
Grant	*Agriculture*	-	-	-	
	Multi sector	*2.40*	*10.88*	*13.27*	*395.62*
	Energy	-	-	-	*35.06*
	Forestry	-	*2.88*	*2.88*	*137.15*
	Transportation	-	-	-	*1.3*
	Waste	-	-	-	*4.13*
Sub-total		***2.40***	***13.75***	***16.15***	***573.26***
Total		***2.40***	***13.75***	***16.15***	***3,731.83***

*Total received based on funding track by MoEF
Source: MoEF, data processed, 2021

Based on source of funding, most of the support from the bilateral agreement comes from Germany (BMU/GIZ), approximately USD 1.92 million (80%) and followed by Ministry of Infrastructure and Environment of the Netherlands approximately USD 0.47 million (20%) as shown in Table 5-7. The financial support of Germany is used to support investments in climate change mitigation. The Netherlands government provides financial support for multisectoral issues related to establishment of Indonesia's institutional arrangement at the national level. Meanwhile, Indonesia received total financial support of USD 13.75 million from multilateral agreement, mainly from the World Bank, followed by UNDP and the European Union. The World

Bank and UNDP mainly support forestry and multi-sectoral projects, while the European Union supports multi-sectoral projects. Further funding agreements received in Indonesia have been identified under the bilateral program (AFD France, China, EXIM Bank Korea, France, JICA Japan, KfW Germany, Natixis France, USA – MC) and Multilateral program (Asian Development Bank, Danida, FAO, GEF, UKCCU, and CTCN). Information on the status of funding, bth in whole and in part, is limited. Additional funding sources have been received in Indonesia, including from the Government of Norway and the Green Climate Fund for REDD+ activities.

Table 5-7. Financial support received for mitigation action in the period 2017 -2019 by supporting agencies (in million USD)

Type agreement	*Funding sources*	*2017*	*2018*	*2019*	*Total Agreement*
Bilateral	*AFD France*				*51.70*
	China				*176.56*
	EXIM Bank Korea				*50.00*
	France				*124.60*
	Germany				*5.43*
	JICA Japan				*1,951.93*
	Japan				*0.48*
	KfW Germany				*149.24*
	Ministry of Infrastructure and Environment of Netherlands	*0.25*	*0.22*	-	*0.47*
	Natixis France				*84.30*
	U K				*4.40*
	USA – MCC				*332.50*
	Germany (GIZ)				*6.39*
	Germany (BMU / GIZ)	-	-	*1.92*	*4.08*
	GGGI		*1.87*	*1.68*	*3.55*
Bilateral Sub-total		***0.25***	***2.09***	***3.6***	***2,951.06***
Multilateral	*Asian Development Bank (ADB)*				*17.00*
	Danida				*0.17*
	FAO				*0.07*
	GEF				*81.40*
	Research Counsil Norway				
	UKCCU				*0.62*
	UNDP	*1.02*	*1.71*	*1.32*	*10.49*
	Uni Eropa	*1.82*	*1.82*	-	*5.96*
	USAID				*5.00*
	World Bank	*1.09*	*1.81*	*3.16*	*663.57*
	CTCN				*0.03*
Multilateral Sub-total		***3.93***	*5.34*	*4.48*	***784.32***
Total		***4.18***	***5.56***	***6.41***	***3,731.83***

Source: MoEF, data processed, 2021

5.2.2 Technology

The Government of Indonesia has received technology supports from different countries and international organizations in the period of 2018 – 2020, through the implementation of

technology needs assessment and technical assistance. Several examples of the technology support received, are presented in Table 5-8. There are other supports that are unreported in this BUR 3 due to data limitations. Further details on the supports will be provided in the subsequent submissions.

Table 5-8. Some examples of technology transfer received

No.	***Country-specific technology needs***	***Assistance received from developed country Parties***	***Time frame***	***Institution***
1.	*Technical assistance supporting Jakarta's transition to e-mobility*	*Climate Technology Centre and Network (CTCN)*	*2020*	*Directorate General of Climate Change Management, Ministry of Environment and Forestry (DG CCM, MoEF)*
2.	*Development of technical needs assessment*	*Climate Governance, GIZ*	*2020*	*Directorate General of Climate Change Management, Ministry of Environment and Forestry (DG CCM, MoEF)*
3.	*Development of technology needs assessment concept for non-land based*	*Climate Governance, GIZ*	*2018-2019*	*Directorate General of Climate Change Management, Ministry of Environment and Forestry (DG CCM, MoEF)*
4.	*Chillers using hydrocarbon*	*Germany*	*2018*	*Directorate General of Renewable Energy and Energy Conservation, Ministry of Energy and Mineral Resources*
5.	*Prototype of energy efficiency for flat/low carbon for Indonesian tropical Cclimate in Tegal City*	*Japan*	*2018*	*Directorate General of Housing, Ministry of Public Works and Housing*

Resources: Data from MoEF

5.2.3 Capacity Building

The assessment on capacity building received was conducted with input from Indonesian ministries/agencies, local governments, the private sector, and NGOs. It includes 6 areas of interest: 1) Education, 2) Training, 3) Public awareness, 4) Public participation, 5) Public access to information, and 6) International cooperation as the implementation of Action for Climate Empowerment (ACE) by UNFCCC under Article 12 of the Paris Agreement. Over the period of 2014-2020, a study of capacity building baseline related to NDC implementation has been conducted by Directorate General of Climate Change, MoEF (MoEF, 2021). Those activities have been identified as enhancing and enabling activities for climate mitigation and adaptation actions. There are total sample of 1,153 of capacity building activities which is mostly from energy sector (44%). Other activities are identified in forestry (27%), waste (16%), agriculture (8%), and IPPU (4%) sector. The gap between sectoral capacity building activities that have been conducted for NDC actions may also be limited by unreported data from each sector. Further details on activities related to the areas of interest for NDC implementation by sector, is presented in Figure 5-1.

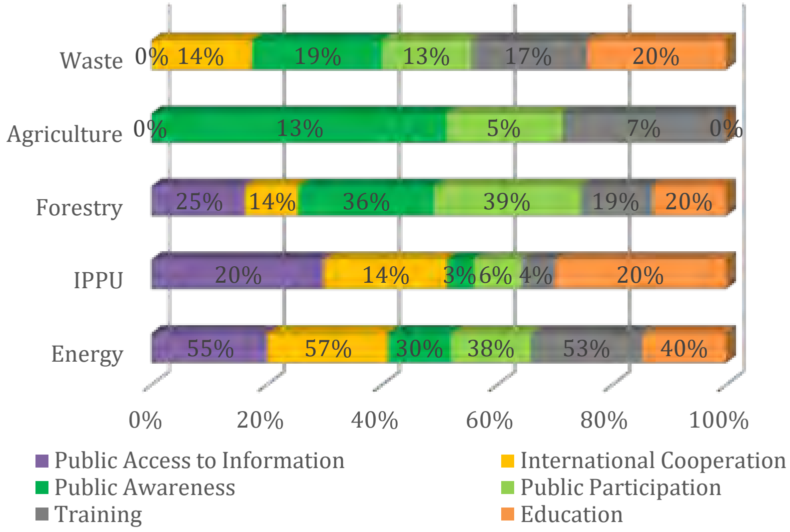


Figure 5-1. Number of capacity building activities for five sectors

Funding is crucial to the implementation of NDC. Under the Paris Agreement (Articles 2, 6, and 9), a coherent funding stream is needed to achieve low-emission development and tackle the resilience to climate change. Until 2020, the Government of Indonesia has received funding support from various sources, both internationally and nationally. Data compiled by Ministry of Environment and Forestry indicates that 81.53% activities are funded by national funds, while 14.05% activities are funded internationally. The remaining 4.42% activities are jointly funded on a national and international levels. The number of capacity-building activities funded at the national and international levels is detailed in Figure 5-2.

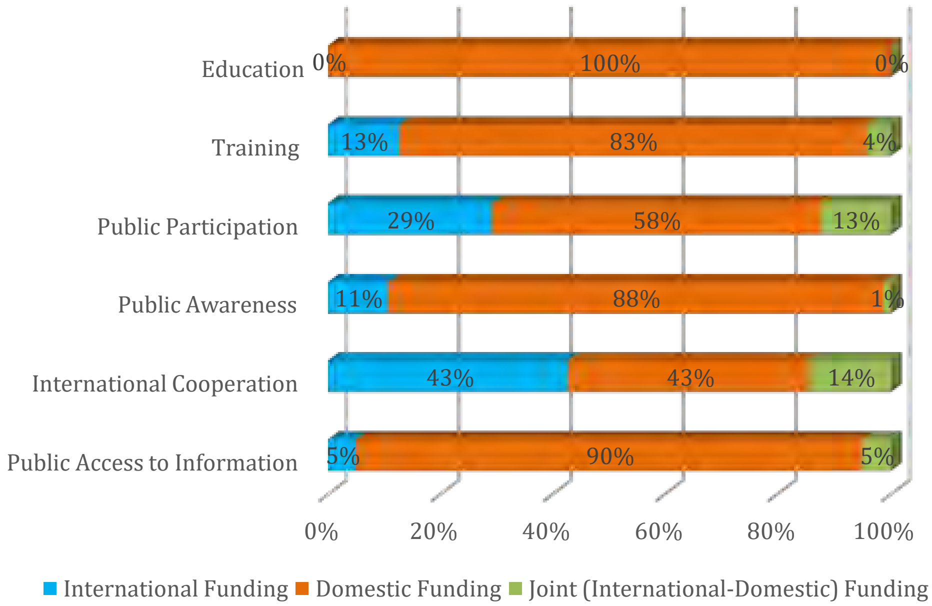


Figure 5-2. Number of capacity building activities by sources of financing

On the other hand, Indonesia has received at least 38 REDD+ demonstration activities that cover the elements of FREL/FRL, MRV, Safeguards, Governance, and REDD+ Activities. It involved many stakeholders including governments, international and local NGOs, and the private sector.

Activities have been implemented in various regions that provide good lessons-learned for Indonesia and have led to the development of National REDD+ Strategy and MRV and Safeguard Information System.

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APPENDICES

Appendix 1 Mitigation actions for energy sector

No	Description of the mitigation actions	Methodologies and assumptions	Objectives	Steps taken or envisaged to achieve actions	Progress of implementation and underlying steps taken or envisaged	Results achieved (claim, 000 tCO_2e)			Results achieved (verification, 000 tCO_2e)			Information on international market mechanisms
						2017	2018	2019	2017	2018	2019	
Efficiency in final energy consumption						13,883.39	16,215.55	16,132.37	10,425.29	16,215.55	16,132.37	
1	Mandatory Energy Management Practices for Energy Intensive Users	Baseline: projected GHG emissions that would be produced by large companies if no-energy-efficiency measures are taken, EF JAMALI electricity grid in 2012 is 0.814 tCO2e/MWh. GHG emissions estimates: Tier 1 of IPCC 2006 GLs. Assumptions: 400 large energy consumers will implement energy efficiency measures (reduction in electricity consumption); Large energy consumers: larger than 6000 TOE annually, improvement of energy efficiency potential (no	Energy efficiency	The Government of Indonesia has issued a series of regulations and tools: Energy Act No. 30/2007; Government Regulation No. 70/2009 concerning Energy Conservation; Ministry of Labour Decree No. 321/MEN/XII/2011 on concerning energy manager on industry; Ministry of Labour Decree No. 323/MEN/ XII/2011 concerning energy manager on building; Ministerial Regulation of MEMR no.14/2012 concerning Energy Management; Ministerial Regulation of MEMR No.57/2017 regarding standard performance of minimum energy and energy saving label for air conditioner.	– Measurement of the achieved mitigation actions was measured based on the available data from 120 companies with energy consumptions above 6000 TOE and has been submitted through the online reporting system (Energy Management Reporting System). – In 2019, there is additional 148 companies. – No agreed methodology yet by Methodological Panel of GHG Inventory. Emission reduction is calculated through POME application from MoI.	4,478.70	6,169.95	2,423.23	4,478.61	6,169.95	2,423.23	N/A

No	Description of the mitigation actions	Methodologies and assumptions	Objectives	Steps taken or envisaged to achieve actions	Progress of implementation and underlying steps taken or envisaged	Results achieved (claim, 000 tCO_2e)			Results achieved (verification, 000 tCO_2e)			Information on international market mechanisms
						2017	2018	2019	2017	2018	2019	
		and low cost): 10%.										
2	Implementation of energy conservation partnership programme	Baseline: Projected GHG emissions that would be produced if no energy efficiency measures are taken. Baseline energy: assessment of the energy audit before mitigation. Energy saving: baseline minus energy level after the mitigation. EF: The EF electricity Jamali grid in 2012 is 0.814 tCO_2e/MWh. GHG emissions estimate: Tier 1 of IPCC 2006 GLs. The associated emissions reduction: calculated from energy saving and relevant emissions factors.	Energy efficiency	The government of Indonesia has issued a series of regulations and tools: Government Regulation No.70/2009 concerning Energy Conservation; Ministry of Labour Decree No.321/MEN/XII/2011 concerning Energy Manager on Industry; Ministry of Labour Decree No.323/MEN/XII/2011 concerning Energy Manager on Building; Ministerial Regulation of MEMR No. 14/2012 concerning Energy Management; and Indonesian National Standard (SNI) for Energy Efficient Buildings (SNI 03-6389-2011, SNI 03-6390-2011, SNI 03-6197-2011, SNI 03-6169-2011).		N/A	N/A	N/A	N/A	N/A	N/A	N/A

No	Description of the mitigation actions	Methodologies and assumptions	Objectives	Steps taken or envisaged to achieve actions	Progress of implementation and underlying steps taken or envisaged	Results achieved (claim, 000 tCO_2e)			Results achieved (verification, 000 tCO_2e)			Information on international market mechanisms
						2017	2018	2019	2017	2018	2019	
3	Energy efficiency improvement household through Compact Fluorescent Lamp (CFL)	Energy saving is estimated from the number of efficient appliances distributed in Indonesia and the equivalent old technology replaced (baseline). Capacity of each appliance is also used in the estimation. Energy saving is baseline minus energy level after mitigation. GHG emissions estimates: Tier 1 of IPCC 2006 GLs. EF: electricity grid of all provinces. Assumption: the sold appliances are used in residential to replace old (inefficient) technology; working hours of appliances: 8 hrs typical (from survey of Indonesian Association of	Energy efficiency	The government of Indonesia has issued a series of regulations and tools: Energy Act No.30/2007; Government Regulation No. 70/2009 concerning Energy Conservation; Ministerial Regulation of MEMR No. 6/2011 concerning labelling of energy efficient appliances.	The methodology is already approved through Decision of Directorate General of Climate Change Control (Dirjen PPI).	5,332.21	4,177.11	6,356.99	2,629.61	4,177.11	6,356.99	N/A

No	Description of the mitigation actions	Methodologies and assumptions	Objectives	Steps taken or envisaged to achieve actions	Progress of implementation and underlying steps taken or envisaged	Results achieved (claim, 000 tCO_2e)			Results achieved (verification, 000 tCO_2e)			Information on international market mechanisms
						2017	2018	2019	2017	2018	2019	
		Luminaire and Electricity/). The calculation is applied to the CFL lamp with energy saving label, considering 8 hours/day operational time.										
4	Energy efficiency improvement household through Air Conditioner (AC) appliance	Energy saving is estimated from the number of efficient appliances distributed in Indonesia and the equivalent old technology replaced (baseline). Capacity of each appliance is also used in the estimation. Energy saving is baseline minus energy level after mitigation. GHG emissions estimates: Tier 1 of IPCC 2006 GLs EF: electricity grid of all provinces. Assumption: the sold appliances	Energy efficiency	The government of Indonesia has issued a series of regulations and tools: Energy Act No.30/2007; Government Regulation No. 70/2009 concerning Energy Conservation; Ministerial Regulation of MEMR No. 6/2011 concerning labelling of energy efficient appliances.	The methodology is already approved through Decision of Directorate General of Climate Change Control (Dirjen PPI).	2,615.62	3,537.70	4,157.69	1,855.13	3,537.70	4,157.69	N/A

No	Description of the mitigation actions	Methodologies and assumptions	Objectives	Steps taken or envisaged to achieve actions	Progress of implementation and underlying steps taken or envisaged	Results achieved (claim, 000 tCO_2e)			Results achieved (verification, 000 tCO_2e)			Information on international market mechanisms
						2017	2018	2019	2017	2018	2019	
		are used in residential to replace old (inefficient) technology; working hours of appliances: 8 hrs typical (from survey of Indonesian Association of Luminaire and Electricity/).										
5	Installation of public solar street lighting	Emission reduction = (kwh before replaced with solar cell) X EF grid	Implementation of new and renewable energy		The methodology is already approved through Decision of Directorate General of Climate Change Control (Dirjen PPI).	2.33	26.86	13.47	3.68	26.86	13.47	N/A
6	Installation of public solar street lighting - LED lighting retrofits	Emission reduction = (kwh reduction due to LED application) X EF grid	Energy efficiency		The methodology is already approved through Decision of Directorate General of Climate Change Control (Dirjen PPI).	7.66	11.39	30.01	11.39	11.39	30.01	N/A
7	Implementation of the Presidential Instruction No.13/2011 on Energy and Water Saving	Energy saving estimate: the energy audit before (baseline) and after the implementation. The associated GHG emissions: Multiplication of the potential energy consumption reduction with emissions factor Assumption: All	Energy efficiency	Presidential Instruction No.13/2011	Program discontinued							N/A

No	Description of the mitigation actions	Methodologies and assumptions	Objectives	Steps taken or envisaged to achieve actions	Progress of implementation and underlying steps taken or envisaged	Results achieved (claim, 000 tCO_2e)			Results achieved (verification, 000 tCO_2e)			Information on international market mechanisms
						2017	2018	2019	2017	2018	2019	
		partners will implement energy conservation programmes.										
8	Utilization of alternative and energy-efficient fuels in industries	GHG emissions estimate: Tier 1 of IPCC 2006 GLs. Baseline: Projected GHG emissions that would be produced if no energy efficiency measures are taken. Baseline estimation: energy audit before mitigations (2010-2011). Energy saving: baseline minus energy level after mitigation. Emissions reduction: Energy savings and relevant emissions factor produced. EF (Emission Factor): The EF electricity grid in 2012 is 0.814	Utilisation of new and renewable energy.	The Government of Indonesia has issued a series of regulations and tools: Energy Act No.30/2007; Industry Act 3/2014; Govt. Regulation No.70/2009 regarding Energy Conservation; Presidential Regulation No.14/2012: Energy Management; President Instruction No.13/2011 on Water & Energy Saving; Presidential Decree No.5/2006 on National Energy Policy; MEMR Regulation No.14/2012 on Energy Management; MEMR Regulation No.13&14/2010 on Competence Standard for Energy Manager on Buildings and Industries; Presidential Regulation No.22/2017 regarding National Energy Plan; Menteri Regulation of MEMR No.12/2018 regarding amendment of MEMR Regulation No.39/2017 regarding physical activity implementation of new and renewable energy and energy conservation.	Constructed in 2013 and established with a total capacity of 0.82 MW.	1,446.88	2,292.26	3,150.70	1,446.88	2,292.26	3,150.70	N/A

No	Description of the mitigation actions	Methodologies and assumptions	Objectives	Steps taken or envisaged to achieve actions	Progress of implementation and underlying steps taken or envisaged	Results achieved (claim, 000 tCO_2e)			Results achieved (verification, 000 tCO_2e)			Information on international market mechanisms
						2017	2018	2019	2017	2018	2019	
		tCO2e/MWh (Jamali); The EF of fossil fuel will depend on fuel type. Assumption: All partners will implement the energy efficiency potential (resulted from the energy audit)										
9	Implementation of Joint Mechanism Indonesia		" National policy for tree planting on post-mining land. The 2010-2020 initial target is the planting of trees on a 72,500 ha of post-mining lands. "		– No methodology approved by GHG Methodological panel team – In the emission reduction, it is included in land sector (FOLU)	N/A	0.28	0.28	N/A	0.28	0.28	N/A
Renewable energy in electricity generation						10,343.39	14,882.20	15,027.00	24,286.15	14,882.20	15,027.26	
10	Electricity generation from natural gas power plants	Baseline: Projected GHG emissions that would be produced if no energy efficiency measures were taken. In the absence of mitigation, the commonly used technology within the region, (i.e., baseline for	Utilisation of new and renewable energy	The Government of Indonesia has issued a series of regulations and tools: Energy Act No.30/2007; Ministerial Regulation of MEMR No.10/2012 concerning The Development of Renewable Energy Project; Ministerial Regulation of MEMR No.49/2018 regarding solar power generation system; Ministerial Regulation of MEMR	The methodology is already approved through Decision of Directorate General of Climate Change Control (Dirjen PPI).	8,050.65	12,481.06	12,891.34	9,727.69	12,481.06	12,891.34	N/A
11	Electricity generation from mini-hydropower plants		Utilisation of new and renewable energy		No methodology approved by GHG Methodological panel team at the moment.	1,107.61	1,160.51	N/A	1,111.70	1,160.51	N/A	N/A
					Starting in 2019, there are options for off-grid.	N/A	N/A	7.97	N/A	N/A	7.97	N/A
					Starting in 2019, there are options for on-grid.	N/A	N/A	238.98	N/A	N/A	238.98	

No	Description of the mitigation actions	Methodologies and assumptions	Objectives	Steps taken or envisaged to achieve actions	Progress of implementation and underlying steps taken or envisaged	Results achieved (claim, 000 tCO_2e)			Results achieved (verification, 000 tCO_2e)			Information on international market mechanisms
						2017	2018	2019	2017	2018	2019	
12	Electricity generation from micro-hydropower plants	micro-hydro is diesel) will determine the estimation. RE generation (substituted fossil energy): MW load x working hrs. GHG reduction: Baseline emission minus zero. Baseline emission: substituted fossil energy x specific fuel consumption x EF. EF fossil fuels: depend on fuel type used in the baseline (diesel).	Utilisation of new and renewable energy	No.12/2018 regarding amendment of MEMR Regulation No.39/2017 regarding physical activity implementation of new and renewable energy and energy conservation.	No methodology approved by GHG Methodological panel team at the moment.	16.37	14.14	N/A	12,278	14.14	N/A	N/A
					Starting in 2019, there are options for off-grid.	N/A	N/A	14.04	N/A	N/A	14.04	N/A
					Starting in 2019, there are options for on-grid.	N/A	N/A	369.11	N/A	N/A	369.11	
13	Electricity generation from solar power		Utilisation of new and renewable energy		No methodology approved by GHG Methodological panel team at the moment.	25.93	11.32	N/A	25.93	11.32	N/A	N/A
					Starting in 2019, there are options for off-grid.	N/A	N/A	9.00	N/A	N/A	9.00	N/A
					Starting in 2019, there are options for on-grid.	N/A	N/A	8.05	N/A	N/A	8.05	N/A
14	Electricity generation from solar rooftop		Utilisation of new and renewable energy		Starting in 2019, there are options for off-grid.	N/A	N/A	0.38	N/A	N/A	0.38	N/A
					Starting in 2019, there are options for on-grid.	N/A	N/A	2.94	N/A	N/A	2.94	N/A
					The methodology is already approved through Decision of Directorate General of Climate Change Control (Dirjen PPI).							
15	Electricity generation from hybrid power plants		Utilisation of new and renewable energy		No methodology approved by GHG Methodological panel team at the moment.	0.89	0.86	0.66	0.89	0.86	0.66	N/A
16	Electricity generation from biomass power plants		Utilisation of new and renewable energy		The methodology is already approved through Decision of Directorate General of Climate Change Control (Dirjen PPI).	1,129.08	1,001.40	1,186.32	1,129.08	1,001.40	1,186.32	N/A
17	Installation of energy saving					1.05	200.91	286.47	1.05	200.91	286.47	N/A

No	Description of the mitigation actions	Methodologies and assumptions	Objectives	Steps taken or envisaged to achieve actions	Progress of implementation and underlying steps taken or envisaged	Results achieved (claim, 000 tCO_2e)			Results achieved (verification, 000 tCO_2e)			Information on international market mechanisms
						2017	2018	2019	2017	2018	2019	
	solar lights (Lampu Tenaga Surya Hemat Energi/LTSHE)											
18	Energy-Sufficient Village Programme		Utilisation of new and renewable energy		Program discontinued and doesn't have monitoring system							N/A
19	Electricity generation from biogas	Baseline: Projected GHG emissions that would be produced in the absence of biogas units; Assumption: biogas as substitute for kerosene stoves; Methodology: Measurement of biogas utilisation in households: Biogas utilisation corresponds with fossil fuel (kerosene) substitution. Associated GHG: the volume of biogas utilisation multiply by kerosene/LPG emission factors. Assumption: Biogas as substitute for kerosene/LPG.	Utilisation of new and renewable energy	The Government of Indonesia has issued a series of regulations and tools: Energy Act No. 30/2007; Ministerial Regulation of MEMR No 10/2012 concerning The Development of Renewable Energy Project.	No agreed methodology yet by Methodological Panel of GHG Inventory	11.81	12.00	12.00	11.81	12.00	12.00	N/A

No	Description of the mitigation actions	Methodologies and assumptions	Objectives	Steps taken or envisaged to achieve actions	Progress of implementation and underlying steps taken or envisaged	Results achieved (claim, 000 tCO_2e)			Results achieved (verification, 000 tCO_2e)			Information on international market mechanisms
						2017	2018	2019	2017	2018	2019	
Additional compressed-natural gas fuel stations (SPBG)						**0.20**	**156.42**	**180.45**	**0.20**	**156.42**	**180.45**	
20	Natural gas utilisation for city public transportation fuels	Baseline: GHG emissions from using liquid fossil fuels; Project emission: GHG emissions after substitution to natural gas; Emission estimates: IPCC 2006 GLs; Verification data required: -Annual gas sales data -Annual LGV sales data.	Utilisation of alternative energy.	The Government of Indonesia has issued a series of regulations and tools: i. Energy Act No. 30/ 2007; ii. Presidential Decree No.5/2006 concerning Energy Policy	No agreed methodology yet by Methodological Panel of GHG Inventory	0.20	156.42	180.45	0.20	156.42	180.45	N/A
Additional gas distribution lines						3,912.46	10,849.90	17,114.98	6,008.30	10,849.90	17,114.98	
21	Enhancement of natural gas pipelines to deliver natural gas to homes	Baseline: GHG emissions from households using LPG or kerosene; Project emission: GHG emissions after substitution to natural gas; Note: EF natural gas is slightly lower than LPG; Emission estimates: IPCC 2006 GLs; Verification data needed: Data of annual gas sales to residential	Utilisation of low-carbon alternative energy, reduction of LPG subsidy, and energy security.	The Government of Indonesia has issued a series of regulations and tools: i. Energy Act No. 30/ 2007; ii. Presidential Decree No.5/2006 concerning Energy Policy	The methodology is already approved through Decision of Directorate General of Climate Change Control (Dirjen PPI)	81.85	104.85	129.65	81.85	104.85	129.65	N/A

No	Description of the mitigation actions	Methodologies and assumptions	Objectives	Steps taken or envisaged to achieve actions	Progress of implementation and underlying steps taken or envisaged	Results achieved (claim, 000 tCO_2e)			Results achieved (verification, 000 tCO_2e)			Information on international market mechanisms
						2017	2018	2019	2017	2018	2019	
		(newly connected)										
22	Construction of Liquid Petroleum Gas (LPG) mini plants	Assumption: availability of LPG plant will contribute in the conversion of kerosene to LPG programme. Baseline: GHG emissions from the use of kerosene. Project emission: emission after the substitution of kerosene to LPG. Emission estimates: IPCC 2006 GLs; Verification data needed: Annual LPG sales (from the mini plant).	Utilisation of low-carbon energy alternatives and energy security.	The Government of Indonesia has issued a series of regulations and tools: i. Energy Act No. 30/ 2007; ii. Presidential Decree No.5/2006 concerning Energy Policy		N/A	N/A	N/A	N/A	N/A	N/A	N/A
23	Mandatory of Biodiesel Utilization in power plants, industries, and transportation sectors	Methodology: IPCC 2006, Tier-1, default EF; Baseline: GHG from the use of liquid fossil fuels in power plants, industries, and transports. Project emission: zero (biofuel is carbon neutral).		The Government of Indonesia has issued a series of regulations and tools: MEMR regulation No. 32/2008 on Mandatory of Biofuels (biodiesel, bio-ethanol, and biogas) Utilisation; MEMR Regulation No. 25/2013 Mandatory of Biofuels (biodiesel, bio-ethanol, and biogas) Utilisation		3,830.61	10,745.05	16,985.33	5,926.45	10,745.05	16,985.33	N/A

No	Description of the mitigation actions	Methodologies and assumptions	Objectives	Steps taken or envisaged to achieve actions	Progress of implementation and underlying steps taken or envisaged	Results achieved (claim, 000 tCO_2e)			Results achieved (verification, 000 tCO_2e)			Information on international market mechanisms
						2017	2018	2019	2017	2018	2019	
		Assumption: biodiesel as substitute for petroleum diesel and bi-ethanol as substitute for gasoline.		(replacing the MEMR Regulation No 32/2008)								
Mitigation actions in power sub-sector, including Implementation of clean coal technology in power plant						18,067.08	12,563.56	19,051.14	9,990.26	12,563.56	16,262.28	
24	Fuel switching of fossil fuel in transport (RON 88 ke RON 90, 92, 98+)				Already constructed in 2010/2011/2012/ 2013 and established in total capacity 111.8 MW	53.50	156.36	196.40	54.64	156.36	196.40	N/A
25	Construction and operation of medium and large scales hydro power plants for electric power grid interconnections (PLN Grid interconnection)	GHG emissions level estimate: IPCC 2006. Emission factor for an electricity system – UNFCCC ver 04.0 EB 75 Annex 15. The GHG reduction estimate: comparison of the baseline emissions level (i.e. condition without mandatory policy) with the resulted emission level.	Obligation to build renewable and alternative energy to achieve an environment friendly power generation in the Electricity sector or obligation to build renewable and alternative power plant into electricity grid interconnection (PLN Grid interconnection)	The Government of Indonesia has issued a series of regulations and tools: Act No. 30 of 2009 on Electricity; Government Regulation No.14 of 2014 concerning Electricity Supply Business; Ministry of Energy and Mineral Resources Decree No.2026.K/20/ MEM/2010 of 2010; Ministry of Energy and Mineral Resources Regulation No.21 of 2013 concerning Electricity Supply Business Plan (RUPTL)	– Constructed in 2010/2011/2012/2013 and established with a total capacity of 111.8 MW – No agreed methodology yet by Methodological Panel of GHG Inventory	325.19	1,191.78	2,264.98	325.19	1,191.78	2,264.98	N/A
26	Construction and operation of supercritical boiler coalfired	GHG emissions level estimate: IPCC 2006. Emission factor	Obligation to build clean energy for fossil fuel power plant	The Government of Indonesia has issued a series of regulations and tools: Act No. 30 of	Constructed in 2010/2011/2012/ 2013 and established with	1,020.01	899.68	1,291.93	1,020.01	899.68	1,291.93	N/A

No	Description of the mitigation actions	Methodologies and assumptions	Objectives	Steps taken or envisaged to achieve actions	Progress of implementation and underlying steps taken or envisaged	Results achieved (claim, 000 tCO_2e)			Results achieved (verification, 000 tCO_2e)			Information on international market mechanisms
						2017	2018	2019	2017	2018	2019	
	power plants for electric power grid interconnections (PLN Grid interconnection)	for an electricity system – UNFCCC ver 04.0 EB 75 Annex 15; The GHG reduction estimate: Comparison of the baseline emissions level (i.e. condition without mandatory policy) with the resulted emission level.	to achieve an environment friendly power generation in Electricity sector or obligation to build renewable and alternative power plants into electricity grid interconnections (PLN Grid interconnection)	2009 on Electricity; Government Regulation No. 14of 2014 concerning Electricity Supply Business; Ministry of Energy and Mineral Resources Decree No.2026.K/20/ MEM/2010 of 2010; Ministry of Energy and Mineral Resources Regulation No. 21 of 2013 concerning Electricity Supply Business Plan (RUPTL)	a total capacity of 1475 MW. The methodology is already approved through Decision of Directorate General of Climate Change Control (Dirjen PPI)							
27	Construction and operation of coal bed methane generation for electric power grid interconnections (PLN Grid interconnection)	GHG emissions level estimate: IPCC 2006. Emission factor for an electricity system – UNFCCC ver 04.0 EB 75 Annex 15; The GHG reduction estimate: Comparison of the baseline emissions level (i.e., condition without mandatory policy) with the resulted emission level.	Obligation to build clean energy for fossil fuel power plant to accomplish an environment friendly power generation in Electricity sector or obligation to build renewable and alternative power plant into electricity grid interconnection (Grid interconnection PLN)	The Government of Indonesia has issued a series of regulations and tools: Act No.30 of 2009 on Electricity; Government Regulation No.14 of 2014 concerning Electricity Supply Business; Ministry of Energy and Mineral Resources Decree No.2026.K/20/ MEM/2010 of 2010; Ministry of Energy and Mineral Resources Regulation No.21 of 2013 concerning	– Constructed in 2013 and established with a total capacity of 2 MW. – No agreed methodology yet by Methodological Panel of GHG Inventory	2,022.80	2,824.35	4,616.67	2,022.80	2,824.35	4,616.67	N/A

No	Description of the mitigation actions	Methodologies and assumptions	Objectives	Steps taken or envisaged to achieve actions	Progress of implementation and underlying steps taken or envisaged	Results achieved (claim, 000 tCO_2e)			Results achieved (verification, 000 tCO_2e)			Information on international market mechanisms
						2017	2018	2019	2017	2018	2019	
				Electricity Supply Business Plan (RUPTL)								
28	Conversion of kerosene to LPG (national programme)	Emission reduction: (emissions from the energy consumption of kerosene) - (emissions from the energy consumption of LPG and kerosene)	Energy security, import reduction, subsidy reduction, and emission reduction	Conversion of kerosene to gas	The methodology is already approved through Decision of Directorate General of Climate Change Control (Dirjen PPI)	12,428.46	7,491.40	7,892.31	6,567.62	7,491.40	7,892.31	N/A
29	Reclamation of post-mining areas/landscapes		National policy for tree planting on post-mining land. The 2010-2020 initial target is the planting of trees on a 72,500 ha of post-mining lands.		– No methodology approved by GHG Methodological panel team – In the emission reduction, it is included in land sector (FOLU)	2,217.13	N/A	2,788.87	N/A	N/A	N/A	N/A
	Total					**46,206.52**	**54,667.62**	**67,219.73**	**50,710.21**	**54,667.62**	**64,717.33**	

Appendix 2 Mitigation actions for transport (Energy sub-sector)

No	Description of the mitigation actions	Methodologies and assumptions	Objectives	Steps taken or envisaged to achieve that action	Progress of implementation and underlying steps taken or envisage	Results achieved (claim, 000 tCO_2e)			Results achieved (verification, 000 tCO_2e)			Information on international market mechanisms
						2017	2018	2019	2017	2018	2019	
Land-transport sub-sector						369.44	676.80	1,747.30	369.44	681.80	1,755.98	
1	Encourage technical efficiency development of transit system – Bus Rapid Transit (BRT)/semi BRT	Emission reduction: (emissions from individual transport before using BRT) - (individual transport emissions after using BRT) + (emissions from BRT).	Reducing congestion, improving transportation services by shortening travel time, reducing consumer costs, saving energy, reducing GHG emissions and reducing air pollution	The Government of Indonesia has issued the Ministry of Transportation and Regional regulation through the local government.	– Up to year 2019, BRT has been implemented in 22 cities including Jakarta (13 corridors). – No agreed methodology yet by Methodological Panel of GHG Inventory	165.70	363.87	716.17	165.70	368.87	724.85	N/A
2	Application of traffic management technology in national main roads (Area Traffic Control System/ ATCS)	Emission reduction: (fuel emission before ATCS) - (fuel emission after ATCS).	Reducing congestion, improving transportation services by shortening travel time and reducing consumer costs, saving energy, reducing GHG emissions and air pollution.	Conducted as a national program under the Ministry of Transportation.	– Implemented in Jakarta (74 units ACTS) and Bandung (12 units ACTS). – No agreed methodology yet by Methodological Panel of GHG Inventory	203.12	309.65	74.40	203.12	309.65	74.40	N/A
3	Implementation of smart driving	Assumption: Emission reduction from smart driving: 10% reduction in fuel consumption after drivers enrolled in trainings	Reducing fuel consumption, reducing GHG emissions and avoiding air pollution.	The Government of Indonesia has issued the Act No. 22/2009 concerning Inland Transport Traffic;	– Conducted by the Ministry of Transportation, National Police, Ministry of Environment and Forestry (at national and sub-national levels). – No agreed methodology yet by Methodological Panel of GHG Inventory	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4	Implementation of traffic impact management on national main roads (ANDALLALIN)				No agreed methodology yet by Methodological Panel of GHG Inventory	N/A	N/A	N/A	N/A	N/A	N/A	N/A

No	Description of the mitigation actions	Methodologies and assumptions	Objectives	Steps taken or envisaged to achieve that action	Progress of implementation and underlying steps taken or envisage	Results achieved (claim, 000 tCO_2e)			Results achieved (verification, 000 tCO_2e)			Information on international market mechanisms
						2017	2018	2019	2017	2018	2019	
5	Modernisation of public transports		Reducing fuel consumption, reducing GHG emissions and avoiding air pollution.		No agreed methodology yet by Methodological Panel of GHG Inventory	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6	Utilisation of Solar Cell for Public Street Lights (Penerangan Jalan Umum/PJU)	Emission reduction: public streetlights using solar cell (PJU) per region x energy of 1 PJU x operation hours per year x emission factor	Reducing fuel consumption, reducing GHG emissions and avoiding air pollution.		No agreed methodology yet by Methodological Panel of GHG Inventory	0.62	3.28	4.73	0.62	3.28	4.73	N/A
7	Implementation of LDF (Long Distance Ferry)				No agreed methodology yet by Methodological Panel of GHG Inventory	N/A	N/A	952	N/A	N/A	952	N/A
Railways sub-sector						1,706.00	2,308.04	2,857.72	1,706.00	2,307.86	2,857.72	
8	Construction of doubleline railway crossings in the Northern Java	Emission reduction: shifting, emission from road transport that reduced with railways - emission produced by railways. Assumption: Number of passengers using railways is calculated by multiplying predicted annual passengers with load factor of 0.7 (*Studi Perhitungan Load Factor Kereta Api Ekonomi Nasional 2009*), average distance length is 0.5 assuming 50% passengers passing through, and the proportion of vehicles using railways are 0.2 (truck), 0.2 (bus), 0.2 (cars), 0.4 (motorcycles)	Reducing congestion, improving transportation services by shortening travel time and reducing consumer costs, saving energy, reducing GHG emissions and air pollution.		No agreed methodology yet by Methodological Panel of GHG Inventory	613.00	1,628.12	1,740.97	613.00	1,628.12	1,740.97	N/A
9	Construction of urban railway system in Greater Jakarta (Jakarta, Bogor, Depok, Tangerang, Bekasi)		Reducing congestion, improving transportation services by shortening travel time and reducing consumer costs, saving energy, reducing GHG emissions and air pollution.		The methodology is already approved through Decision of Directorate General of Climate Change Control (Dirjen PPI)	857.00	169.00	549.92	857.00	169.00	549.92	N/A

No	Description of the mitigation actions	Methodologies and assumptions	Objectives	Steps taken or envisaged to achieve that action	Progress of implementation and underlying steps taken or envisage	Results achieved (claim, 000 tCO_2e)			Results achieved (verification, 000 tCO_2e)			Information on international market mechanisms
						2017	2018	2019	2017	2018	2019	
10	Construction of Trans Sumatra railway lines.		Reducing congestion, improving transportation services by shortening travel time and reducing consumer costs, saving energy, reducing GHG emissions and air pollution.		No agreed methodology yet by Methodological Panel of GHG Inventory	236.00	488.70	559.77	236.00	488.70	559.77	N/A
11	Railways lines to Soekarno-Hatta Airport					N/A	17.13	1.16	N/A	17.13	1.16	N/A
12	Railways line to Kuala Namu Airport					N/A	4.91	3.36	N/A	4.91	3.36	N/A
13	Utilization of LRT system in Palembang City					N/A	N/A	2.54	N/A	N/A	2.54	N/A
Maritime Transport sub-sector						147.67	4.40	31.23	147.67	4.40	31.23	
14	Application of solar cell Shipment Navigation System for efficient harbour management through Sailing Navigation Support Facility (SBNP)	Emission reduction: Fuel for SBNP x Emission Factor			No agreed methodology yet by Methodological Panel of GHG Inventory	141.80	4.38	4.54	141.80	4.38	4.54	N/A
15	Modernisation of ships and ship technology for pioneer ship *	USEPA-ITF. Emission reduction: generator set power x load factor x annual operational hours x Emission Factor CO2			No agreed methodology yet by Methodological Panel of GHG Inventory	5.87	N/A	26.68	5.87	N/A	26.68	N/A

No	Description of the mitigation actions	Methodologies and assumptions	Objectives	Steps taken or envisaged to achieve that action	Progress of implementation and underlying steps taken or envisage	Results achieved (claim, 000 tCO_2e)			Results achieved (verification, 000 tCO_2e)			Information on international market mechanisms
						2017	2018	2019	2017	2018	2019	
16	Shore Connection	Baseline Emission: Multiplying total fuel consumption with Emission Factor of 1 year before mitigation action have been implemented. Emission Reduction: Multiplying total annual electricity consumed with Emission Factor of Electricity divided by (1 – loss transition ion and distribution)	Activity that switch off the auxiliary engine of ships and shift it to electricity in the harbour or shore connection. This program will reduce emission if efficiency of auxiliary engine is low. Emission reduced by this activity is big when the emission factor electricity is low due to utilization of renewable energy plants.		– The activity has been started from year 2018 – The methodology is already approved through Decision of Directorate General of Climate Change Control (Dirjen PPI)	N/A	0.02	0.01	N/A	0.02	0.01	N/A
Air Transport sub-sector						1,322.12	1,163.89	616.65	-	6.84	28.88	
17	Modernisation of air navigation	ICAO Calculation			– No agreed methodology yet by Methodological Panel of GHG Inventory – Data is not supported by calculation worksheet	429.84	367.04	N/A	N/A	N/A	N/A	N/A
18	Completion of systems and procedures for the operation and maintenance of aircraft passengers		Adopting of improvements system, procedures and maintenance of aircraft passengers for fuel and spare parts savings	The Government of Indonesia has issued a series of regulations and tools: i. Act No. 1/2009 concerning Civil Aviation; ii. State Action Plans and National Action Plan for Air Transportation, Ministerial Decree No. 201/2013	– No agreed methodology yet by Methodological Panel of GHG Inventory – Data is not supported by calculation worksheet	519.48	319.47	N/A	N/A	N/A	N/A	N/A

No	Description of the mitigation actions	Methodologies and assumptions	Objectives	Steps taken or envisaged to achieve that action	Progress of implementation and underlying steps taken or envisage	Results achieved (claim, 000 tCO_2e)			Results achieved (verification, 000 tCO_2e)			Information on international market mechanisms
						2017	2018	2019	2017	2018	2019	
19	Performance Based Navigation (PBN)				– No agreed methodology yet by Methodological Panel of GHG Inventory – Data is not supported by calculation worksheet – Program discontinued	362.32	346.21	N/A	N/A	N/A	N/A	N/A
20	Revegetation of airports				– No agreed methodology yet by Methodological Panel of GHG Inventory – Data is not supported by calculation worksheet	10.15	123.33	587.77	N/A	N/A	N/A	N/A
21	Implementation of new and renewable energy technologies				– No agreed methodology yet by Methodological Panel of GHG Inventory – Data is not supported by calculation worksheet	0.33	N/A	N/A	N/A	N/A	N/A	N/A
22	Utilisation of Solar Power Plant				– No agreed methodology yet by Methodological Panel of GHG Inventory – Data is not supported by calculation worksheet	N/A	2.97	14.77	N/A	2.97	14.77	N/A
23	Utilisation of Solar Cell for Airport Lighting				– No agreed methodology yet by Methodological Panel of GHG Inventory – Data is not supported by calculation worksheet	N/A	0.23	8.17	N/A	0.23	8.17	N/A

No	Description of the mitigation actions	Methodologies and assumptions	Objectives	Steps taken or envisaged to achieve that action	Progress of implementation and underlying steps taken or envisage	Results achieved (claim, 000 tCO_2e)			Results achieved (verification, 000 tCO_2e)			Information on international market mechanisms
						2017	2018	2019	2017	2018	2019	
24	Utilisation of Light Emitting Diode (LED) for Runway Lights and Airport Navigation Signboard				– No agreed methodology yet by Methodological Panel of GHG Inventory – Data is not supported by calculation worksheet	N/A	3.64	5.94	N/A	3.64	5.94	N/A
	Total					**3,545.23**	**4,152.13**	**5,252.90**	**2,223.11**	**3,000.90**	**4,673.81**	

Appendix 3 Mitigation actions for IPPU sector

No	Description of the mitigation actions	Methodologies and assumptions	Objectives	Steps taken or envisaged to achieve actions	Progress of implementation and underlying steps taken or envisaged	Results achieved (claim, 000 ton CO2e)			Results achieved (verification 000, ton CO2e)			Information on international market mechanisms
						2017	2018	2019	2017	2018	2019	
1	Reduction of clinker ratio in cement industries.	Baseline: GHG emissions that would be produced if no AFR measures were taken. It is estimated based on GHG intensity of the current technology used in industries in the absence of mitigation actions (existing & new plants in 2009). EF calcination: 0.552 tCO2/t clinker; EF total: 852 t CO2/t Cement. Mitigation target EF (tCO2/t cement): – old technology 0.514–772 – new technology 0.491–488 – calcination 0.325 tCO2/t clinker	Efficient use of raw materials, saving of production costs, reduction of GHG emissions.	The Government of Indonesia has issued a series of regulations and tools: Ministerial Regulation of MoI No.12/2012 concerning Roadmap of CO_2 Emission Reduction in Cement Industry in Indonesia; Ministerial Regulation of MoI No.512/2015 regarding green industry standard for Portland cement; Ministerial Regulation of MoI No.148/2016 regarding green industry standard for single nutrient artificial fertilizer industry; Ministerial Regulation of MoI No.27/2018 regarding green industry standard for urea fertilizer industry, SP-36 fertilizer, and ammonium sulphate; Ministerial Regulation of MoI No.51/2015 regarding guideline to formulate green industry standard; Ministerial Regulation of MoI No.514/2015 regarding green industry standard for pulp and paper industry.	Application of clinker ratio reduction from 0.85 to 0.70 in all cement industries.	786.28	1,827.83	2,697.70	786.28	1,827.83	2,697.70	N/A
2	Natural gas consumption efficiency (feedstock and fuel) for production process (ammonia production industries).	Emission reduction = (GHG emission level of the average existing ammonia plant in 2010) - (GHG emission level of the average ammonia plant after the operation of a more efficient plant)	Increase in production efficiency, savings of production cost and increase of company profits, saving of fuel, reduction of emissions.		A new unit has been operated and retrofit in the ammonia plant	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3	Utilisation of scrap (steel industries)	Emission reduction = ((GHG emissions from pig iron and DRI) + (BOF and EAF GHG	Increase in production efficiency, savings of		Scrap was used as an alternative material (iron	N/A	N/A	N/A	N/A	N/A	N/A	N/A

No	Description of the mitigation actions	Methodologies and assumptions	Objectives	Steps taken or envisaged to achieve actions	Progress of implementation and underlying steps taken or envisaged	Results achieved (claim, 000 ton CO2e)			Results achieved (verification 000, ton CO2e)			Information on international market mechanisms
						2017	2018	2019	2017	2018	2019	
		emissions)) - ((GHG emissions from pig iron and DRI manufacturing processes after scrap use for BOF or EAF) + (BOF GHG emissions and EAF after scrap usage))	production cost and increase of company profits, feedstock supply security, reduction of GHG emissions.		ore) in DRI and Blasick oxygen furnace (BOF).							
4	Reduction of PFCs emissions in aluminum smelter (aluminum industries).	Emission reduction = (emissions from aluminum smelter before the replacement of feeding systems and feeding system automation) - (emissions from aluminum smelters after the replacement of feeding system and feeding system automation) - (emission reduction claimed as CDM project activities)	Increase in production efficiency, savings of production cost and increase of company profits, reduction of GHG emissions.		Implemented at PT. Inalum since 2010.	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Total					**786.28**	**1,827.83**	**2,697.70**	**786.28**	**1,827.83**	**2,697.70**	

Appendix 4 Mitigation actions for waste sector

No	Description of the mitigation actions	Methodologies and assumptions	Objectives	Steps taken or envisaged to achieve actions	Progress of implementation and underlying steps taken or envisaged	Results achieved (claim, 000 ton CO2e)			Results achieved (verification, 000 ton CO2e)			Information on international market mechanisms
						2017	2018	2019	2017	2018	2019	
Domestic solid waste						122.40	115.24	111.73	122.40	115.24	111.73	
1	Implementation of Landfill Gas (LFG) recovery, such as through the rehabilitation/ construction of open dumping waste disposals into sanitary landfills with methane gas management.	Methodology: The amount of landfill gas that would otherwise be released into the atmosphere (if the gas is not recovered for the power plant). Landfill gas recovery is estimated from the number of households utilizing the gas and the average cooking heat demand per household. The LFG is assumed to substitute LPG. Assumptions: – Equivalent 12 kg LPG/month/household. – The heating value of methane gas: 50 MJ/m³. – Specific gas consumption: 0,59 m³ LFG/kWh. – Density of methane gas: 0,656 kg/m³. – 365 days or 12 months annually.	Fertilization of land, reduction of waste in landfills, and reduction of GHG emissions.		Implemented in several municipal landfills: – Balikpapan (Manggar). – Malang (Talangagung, Supit Urang). – DKI Jakarta (Bantar Gebang). – Surabaya (Benowo).	98.30	91.92	91.92	98.30	91.92	91.92	N/A
2	Waste composting at TPA and 3R integrated waste management sites	Methodology: IPCC 2006, FOD (First Order Decay). Baseline: common practice in 2010 (base year): – from total waste production: 72,8% treated in landfill, 21% open burning, 0,07% composting, 0,07% 3R, and 6,2% untreated (source: Adipura Program).	Fertilizing land, reducing waste in the landfill, reducing GHG emissions.			12.44	10.14	5.22	12.44	10.14	5.22	N/A

No	Description of the mitigation actions	Methodologies and assumptions	Objectives	Steps taken or envisaged to achieve actions	Progress of implementation and underlying steps taken or envisaged	Results achieved (claim, 000 ton CO2e)			Results achieved (verification, 000 ton CO2e)			Information on international market mechanisms
						2017	2018	2019	2017	2018	2019	
		– deep-unmanaged landfills, without gas recovery. Assumptions: – The bulk density of waste which treated in TPS3R is the same as the bulk density of waste treated in landfills. – waste treated into compost have 80% organic materials.										
3	Production of 3R paper through the operation of waste banks, temporary disposal sites and 3R integrated waste management site.	Methodology: IPCC 2006, Tier-1, default EF, and local characteristics of MSW Baseline: – Un-managed SWDS (open dumping) of all MSW SWDS w/o CH4 recovery – assumed in 2030 there will be no changes in composting and 3R conducted since 2010. Mitigation: – Managed Deep SWDS of all MSW SWDS with CH4 recovery (power and SRT). – Additional activities in composting and 3R after 2010. – Additional activities through the operation of waste as energy power plant (PLTSa) which will be running in 2020.	Improvement of waste management, avoiding environmental pollution, reducing the use of pulp (wood as raw materials from forests), recovering materials that have economic value, reducing GHG.	The government of Indonesia has issued a series of regulations and tools: Waste Management Act No.18/2008; Government Regulation No.81/2012 on Domestic Waste Management; Ministry of Public Works Regulation 03/PRT/M/2013 concerning Infrastructure for Domestic Waste Management; MoE Regulation No. 13/2012 on Guideline for the Implementation of 3R through Waste Bank; Presidential Regulation No.97/2017 regarding national policy and strategy (JAKSTRANAS) of Household Waste Management and Similar Waste; Ministerial Regulation of MoEF No.10/2018 regarding Guideline to formulate regional policy and strategy in managing		11.67	13.18	14.59	11.67	13.18	14.59	N/A

No	Description of the mitigation actions	Methodologies and assumptions	Objectives	Steps taken or envisaged to achieve actions	Progress of implementation and underlying steps taken or envisaged	Results achieved (claim, 000 ton CO2e)			Results achieved (verification, 000 ton CO2e)			Information on international market mechanisms
						2017	2018	2019	2017	2018	2019	
				Household Waste Management and Similar Waste; Presidential Regulation No.35/2018 regarding acceleration of waste processing into environmentally friendly based electricity.								
4	Application and operation of waste to energy (WTE) power plant or RDF (Refuse Derived Fuel).	Methodology: The amount of landfill gas that would otherwise be released into the atmosphere (if the gas were not recovered for the power plant). Landfill gas recovery estimate: power generation data. Avoided methane potential is corrected by CO2 released from combustion of LFG (methane). Other GHG reductions are estimated from the utilisation of electricity from LFG power plant that substitute the electricity from PLN grid. This reduction is recorded in energy sector. Assumptions: The composition and bulk density of waste treated in TPS3R are the same as the composition and bulk density of waste treated in landfills.	Improvement of waste management, avoiding environmental pollution, reducing the waste significantly, energy recovery of renewable energy, reducing GHG emissions (applied only to the biomass power plants).	Presidential Regulation No.35/2018 concerning the Acceleration of the Construction of Waste Processing Installation Into Environmentally Friendly Electricity Based Energy.	N/A	0.00	0.00	0.00	0.00	0.00	0.00	N/A
Industrial solid waste						89.34	89.81	90.13	89.34	89.82	90.13	
5	Utilisation of wastewater sludge as materials.	Methodology: IPCC 2006, FOD (First Order Decay) for landfill, composting and waste incineration.	Utilizing industrial waste, alternative fuel and material, reducing emissions.	Regulations on waste utilisation.	Implemented in several industries, however this report covers mitigation related to the pulp and paper industry only.	89.34	89.81	90.13	89.34	89.82	90.13	N/A
6	Utilisation of wastewater sludge											N/A

No	Description of the mitigation actions	Methodologies and assumptions	Objectives	Steps taken or envisaged to achieve actions	Progress of implementation and underlying steps taken or envisaged	Results achieved (claim, 000 ton CO_2e)			Results achieved (verification, 000 ton CO_2e)			Information on international market mechanisms
						2017	2018	2019	2017	2018	2019	
	for fuels by incineration.	Baseline: common practice in 2010 (base year): – All sludge treated in landfill (MCF landfill = 1) for integrated pulp and paper industries, – Sludge treated in lagoon (un-aerobic, MCF=0,8) for paper industries.										
7	Utilisation of wastewater sludge for compost.											N/A
Domestic liquid waste						69.96	57.43	56.09	69.96	57.43	56.09	
8	Development of wastewater Treatment (off/on sites)	Methodology: IPCC 2006, Tier-1, default value Baseline: Domestic wastewater is septic tank (w/o CH_4 recovery) common practice in 2010 (base year): – Septic tank in rural 52%. – Septic tank urban 79% (source: People's Welfare Statistics BPS). Mitigation: Centralised domestic WWT is an aerobic sewage type. On-site WWT is a septic tank (CH_4 recovery). Assumptions: – BOD: 40-gram BOD/day/person. – MCF septic tank: 0.3.	Improvement of domestic waste management, avoiding environmental pollution, enhancing community's health and sanitation, reducing GHG emissions.	The government of Indonesia has issued a series of regulations and tools: Govt. Regulation No.82/2001 regarding Water Quality Management and Water Pollution Control; Govt. Regulation No.16/2005 regarding Improvement of SPAM; Ministry of Public Works Regulation No.16/ PRT/M/2008 regarding Wastewater Strategic Policy.	Development of: i. Centralised WWT in 13 locations. ii. Communal septic tank in 82 locations (equipped with CH_4 recovery) (implemented by local governments)	66.70	55.00	55.83	66.70	55.00	55.83	N/A
9	Extraction of domestic sewage (MCK) sludge to be processed in the integrated domestic liquid waste facility or IPLT (based on	Methodology: IPCC 2006, Tier-1, default value Assumption: – BOD: 1000 gram/m3. – IPLT is not emitting GHG.	Improvement of domestic waste management, maintenance of septic tanks, avoidance of environmental pollution,	N/A	Implemented in several districts.	3.10	2.27	0.05	3.10	2.27	0.05	N/A

No	Description of the mitigation actions	Methodologies and assumptions	Objectives	Steps taken or envisaged to achieve actions	Progress of implementation and underlying steps taken or envisaged	Results achieved (claim, 000 ton CO2e)			Results achieved (verification, 000 ton CO2e)			Information on international market mechanisms
						2017	2018	2019	2017	2018	2019	
	DKI Jakarta report only).		enhancement of the community's health and sanitation, reducing GHG emissions.									
10	Operation of communal biodigester wastewater treatment facility, for households.	Baseline: common practice in 2010 (base year) – Septic tank in rural 52%. – Septic tank urban 79% (source: People's Welfare Statistics BPS). Assumptions: – BOD: 40-gram BOD/day/person, all gases have been utilized. – Efficiency of biodigester: 80%. – Equivalent: 12 kg LPG/month/household. – Heating value LPG: 46 MJ/kg. – Heating value methane gas: 50 MJ/kg.	Improvement of domestic waste management, maintenance of septic tank, avoidance of environmental pollution, enhancement of community's health and sanitation, reduction in GHG emissions.	N/A	Implemented in several districts under the national programs coordinated by Ministry of Public Work and Housing, Ministry of Environment and Forestry, Ministry of Health, NGOs, local governments and others	0.15	0.16	0.22	0.15	0.16	0.22	N/A
Industrial wastewater						30.12	30.12	30.12	30.12	30.12	30.12	
11	Methane recovery of industrial wastewater treatment facility.	Baseline: common practice in 2010 (base year): – aerobe system with MCF: 0.3 (EF=0,3*0,25=0,075 kg CH4/kg COD). – sludge has been extracted (S= average in pulp and paper industries: 7 kg COD/ton product).	Improvement of industrial liquid waste management, avoidance of environmental pollution, reduction of GHG emissions.	N/A	Implemented in pulp and paper industry.	30.12	30.12	30.12	30.12	30.12	30.12	N/A
12	Operation of biodigester with methane recovery.											

No	Description of the mitigation actions	Methodologies and assumptions	Objectives	Steps taken or envisaged to achieve actions	Progress of implementation and underlying steps taken or envisaged	Results achieved (claim, 000 ton CO2e)			Results achieved (verification, 000 ton CO2e)			Information on international market mechanisms
						2017	2018	2019	2017	2018	2019	
	Total					311.81	292.60	288.07	311.81	292.60	288.07	

Appendix 5 Mitigation actions for agriculture sector

No	Description of the mitigation actions	Methodologies and assumptions	Objectives	Steps taken or envisaged to achieve actions	Progress of implementation and underlying steps taken or envisaged	Results achieved (claim, 000 tCO_2e)			Results achieved (verification, 000 tCO_2e)			Information on international market mechanisms
						2017	2018	2019	2017	2018	2019	
1	Management of lowland rice field: climate-smart cropping patterns and crop varieties that resistance to dry or wet conditions. These activities will reduce the CH_4 emissions. The emission reduction target for the unconditional (29%) scenario in 2020 and 2030 for the implementation of rice-water irrigation system are 68.1 Gg CO_2e and 178 Gg CO_2e, respectively. Indicator of progress: reduced number of methane-producing bacteria	– The methodology to calculate the achievement of emission reduction is by calculating the difference between the baseline emissions and the actual emissions generated in the reporting year.	Increased crop productivity and optimum management of agricultural resources.	Application of plant cultivation technology with low emission varieties and optimisation of rice fields with a saving irrigation system such as Rice Intensification System (SRI). i. The implementation of recorded SRI/PTT activities is only carried out by the Ministry of Agriculture and is a pilot program.	The application of Plant Cultivation Technology in 2017 was achieved from the action of Low Emission Varieties covering an area of 5,874,524 hectares, while in 2018 the use of low emission varieties was as many as 15 varieties. In 2019, Low Emission Varieties covered area of 6.484.122 hectares	7,750	12,410	11,090	10,250	8,440	11,890	N/A
2	Utilisation of cow manure fertiliser as compost. Indicator of progress: increase use of compost by farmers.	– The methodology to calculate the achievement of emission reduction is by calculating the difference between the baseline emissions and the actual emissions generated in the reporting year.	Optimising the utilisation of manure for fertilisers as well as substitutes for chemical fertilisers.	Development of Organic Processing Unit (UPPO) to provide integrated facilities for processing organic materials (straw, crop residues, livestock waste, organic waste) into composts.	The UPPO mitigation actions in 2017, 2018, and 2019 amounted to 1,400 units, 2,561 units, and 3.061 units respectively.	240	64	10	400	410	10	N/A
3	BATAMAS (*Biogas Asal Ternak Bersama Masyarakat*) - Utilisation of livestock biogas by the community through the	The methodology to calculate the achievement of emission reduction is by calculating the difference	Increase community income through the	Development of Bio-digester of livestock manure.	In 2017, 2018, and 2019 the number of operational BATAMAS were 199 units, 115	270	190	100	20	10	103	N/A

No	Description of the mitigation actions	Methodologies and assumptions	Objectives	Steps taken or envisaged to achieve actions	Progress of implementation and underlying steps taken or envisaged	Results achieved (claim, 000 tCO_2e)			Results achieved (verification, 000 tCO_2e)			Information on international market mechanisms
						2017	2018	2019	2017	2018	2019	
	utilisation of livestock by-products by converting fresh livestock manures into biogas and organic fertilisers. The emission reduction target for the 29% scenario in 2020 and 2030 are 7.9 Gg CO2e and 31.4 Gg CO2e, respectively. Indicator of progress: The biogas is produced from community livestock.	between the baseline emissions and the actual emissions generated in the reporting year. – The 2012 BATAMAS mitigation action was calculated by adding the accumulated 2011 data with 50% of the 2012 data, keeping in mind that since 2012 these activities have been discontinued.	use of biogas and compost.	The 2018 Ministry of Agriculture's Strategic Plan includes an increase in biogas, compost, and liquid fertilizer processing facilities into its work program with an increased implementation target from year to year.	units, and 67 units, respectively.							
	Total					8,260	12,664	11,200	10,670	8,860	12,003	

Appendix 6 Mitigation actions for forestry sector

No	Description of the mitigation actions	Methodologies and assumptions	Objectives	Steps taken or envisaged to achieve actions	Progress of implementation and underlying steps taken or envisaged	Results achieved (claim, 000 tCO_2e)			Results achieved (verification, 000 tCO_2e)			Information on international market mechanisms
						2017	2018	2019	2017	2018	2019	
1	Reduction of deforestation rate is a national mitigation action to prevent the conversion of natural forests to non-forests. Land clearance will release CO_2 emissions into the atmosphere. The decrease of the deforestation rate will directly reduce the GHG emissions. The target of emission reduction in 2020 and 2030 using the 29% scenario are 146,603 Gg CO_2e and 114,687 Gg CO_2e, respectively. Indicator of progress: reduce percentage of converted forests.	Established baseline: the baseline is calculated using a historical approach based on the average rate of deforestation of natural forests that occurred during the period 1990-2012. The calculation of deforestation used is gross deforestation. Achievement of emission reduction is calculated by comparing baseline emissions with actual emissions that generated in the reporting year.	Prevent deforestation due to permanent conversion of natural forest land to non-forest.	The steps taken by the Government of Indonesia in preventing deforestation include Moratorium on primary natural and peat forest policies that have been extended every 2 years. Development of a social forestry program to improve access to forest management by the community; Released Presidential Instruction Number 5 of 2019 concerning Termination of Granting of New Permits and Improving Management of Primary Natural Forests and Peatlands; Released Minister of Environment and Forestry Regulation Number 43 of 2017 concerning Empowerment of Communities Around Nature Reserves and Conservation Forests	In the periods of 2016-2017, 2017-2018 and 2018-2019 the rate of deforestation has decreased respectively by 480,010.8 million ha, 439,439.1 and 462,458.5 million ha. Related to the social forestry scheme, the from the target of 12.7 million ha, the forestry area until 2019 is 4,048,376.82 hectares	77,138	96,079	291,135	64,859	168,571	190,382	N/A
2	Reduction in the number of hotspots through peat fires controls in several fire-prone areas. These activities will indirectly reduce the GHG CO_2 emissions Indicator of progress: reduce number of hotspot in several peat areas in Indonesia	The baseline methodology used modelling on the AFOLU dashboard application concerning historical emissions that occurred during the period 2000-2012 The emission reduction methodology was obtained by	Reducing the level of disturbance on peatlands and reducing the source of fire triggers so that the risk of fire is low	These activities can be carried out through various efforts such as blackout operations, forest patrol, peat restoration and land clearing without burning. These activities can indirectly reduce the number of hotspots. These activities were referring to the Presidential Instruction Number 11 of 2015 concerning Improved Control of Forest and Land Fires	from 2017 to 2019 the area of fire has increased respectively 13,554.62 ha, 131,428.40 ha and 494,450.46 ha.	238,854	146,628	-205,129	238,854	146,628	-205,130	N/A

No	Description of the mitigation actions	Methodologies and assumptions	Objectives	Steps taken or envisaged to achieve actions	Progress of implementation and underlying steps taken or envisaged	Results achieved (claim, 000 tCO_2e)			Results achieved (verification, 000 tCO_2e)			Information on internationa l market mechanisms
						2017	2018	2019	2017	2018	2019	
		comparing the NDC baseline with actual emissions due to peat fires.										
3	Restoration of peatlands is the systematic effort to return the function of the peat ecosystem to its previous state. The central government, private sector, local government, and the community can carry out such activities, which will indirectly reduce the GHG CO_2 emissions in forest sector. Emission reduction targets for the 29% scenario in 2020 and 2030 are 4,049 Gg CO_2e and 6,779 Gg CO_2e, respectively. Indicator of progress: the restored function of peat as water storage and growing media for plants and plants' diversity.	The baseline methodology uses modelling on the AFOLU dashboard application based on the average peat decomposition that occurred during the period 1990-2012. Methodology: Supplementary Guidelines 2013 for Wetland. Assumption: The condition of the water level is increased and leads to a lower level of decomposition.	Restoring the peat ecosystem as before	Peat restoration through rewetting activities, among others, the construction of canal blocks, construction of drill wells and ponds. Minister of Environment and Forestry Regulation Number P.15 Year 2017 concerning Monitoring of Peat Water Levels. Minister of Environment and Forestry Regulation Number P.16 of 2017 concerning technical guidacne for the recovery of peat ecosystem fuction	in the end of 2019, peatland restoration of 3,474,687 hectares has been mapped, consisting of HTI and Oil Palm Plantation, respectively 2,226,779.94 Ha and 1,247,907.78 Ha. the activies carried out through canal blocking construction and vegetation rehabilitation.	-22,682	-45,916	-29,505	-22,681	-19,180	-54,897	N/A
4	Forest and Land Rehabilitation is the effort to restore forests and land areas through planting, reforestation or land reclamation activities. These activities will indirectly reduce the GHG CO_2 emissions in forest sector. Emission reduction targets for the 29% scenario in 2020 and 2030 are -590 Gg CO_2e and 3,641 Gg CO_2e, respectively. Indicators of progress: increased forest and land cover index.	Baseline: the average area of rehabilitated lands in 1990-2012 assuming the survival rates are 21% (2013-2020) and 23% (2021-2030), and increment of 21 m3/ha/year. Calculated based on the differences in absorption between the actual and the baseline uptake.	Improved conditions of critical lands to function optimally and to protect nature and its environment.	Land rehabilitation efforts through critical land rehabilitation, watershed rehabilitation, construction of community seed gardens (KBR), rehabilitation of community forests, and reclamation of former mining areas Minister of Environment and Forestry Regulation Number P.62 of 2019 concerning Industrial Plantation Forests Government Regulation Number 46 of 2017 concerning Environmental Economic Instruments	Forest and land rehabilitation in 2017, 2018 and 2019, respectively: 200,979 Ha, 187,827 Ha and 207,650 Ha, 452 Ha and 32,874 Ha a). RHL 2017 in DTA Waduk, KHPL, Priority DAS, Mangrove Forest, City Forest and KBR each covering an area of 1,750 Ha, 6,845 Ha, 23,792 Ha, 1,175 Ha b). RHL in 2018 in watersheds that support food security in the watershed irrigation RHL Reservoir Mta Addition of	-708	-1,347	-3,052	-708	-1,347	-2,295	N/A

No	Description of the mitigation actions	Methodologies and assumptions	Objectives	Steps taken or envisaged to achieve actions	Progress of implementation and underlying steps taken or envisaged	Results achieved (claim, 000 tCO_2e)			Results achieved (verification, 000 tCO_2e)			Information on internationa l market mechanisms
						2017	2018	2019	2017	2018	2019	
					water each covering an area of: 6,450 Ha, 1,900 Ha, 150 Ha. In DAS Prone / post-vegetative disaster each area is: 16,800 ha with details of disaster-prone RHL, riparian RHL, mangrove RHL and KBR each covering an area of 16,250 ha, 50 ha, 500 ha and RHL on disaster-prone RHL in a civilian technical area as wide as 2,477 ha. c). RHL 2019 includes planting in priority watersheds, mangroves, KBR covering an area of: 206.00 hectares, 1,000 hectares, and 50,956, respectively.							
5	Sustainable Forest Management is the management of forest in accordance with the principles of sustainable development for social, economic and environmental interests. These activities are indirectly able to reduce forest sector GHG CO2 emissions. Emission reduction targets for the scenario of 29% in 2020 and 2030 are -18.667 Gg CO2e and -43.830 Gg CO2e, respectively. Indicators of progress: implementation of the three principles of sustainable forest management, i.e., economic, social and environmental development.	The baseline methodology uses modelling on the AFOLU dashboard application. Calculated based on the differences in absorption between actual and baseline uptake. The emission reduction methodology was obtained by comparing the NDC baseline with actual emissions.	Reducing the level of forest stands damage and promoting better forest regeneration thereby reducing degradation.	Sustainable forest management is carried out through efforts such as: RIL (Reduce Impact Logging), Strengthening the Timber Production System in Natural Forests (TPTI, TPTJ and others), Timber Legality Verification System (SVLK) Regulation of the Director General of PHPL Number P.9 of 2018 concerning the Application of Low Impact Harvesting Techniques (Reduce Impact Logging) in IUPHHK-HA Areas	Regulations issued: Regulation of Director General of Sustainable Production Forest Management Number P.15 / PHPL / PPHH / HPL.3 / 8/2016 concerning Amendment to Regulation of Director General of Sustainable Production Forest Management Number P.14 / PHPL / SET / 4/2016 concerning Implementation Standards and Guidelines Performance Assessment of Sustainable Production Forest Management (PHPL) and Timber Legality Verification (VLK).	15,387	-29,809	28,901	15,259	3,146	48.483	N/A

No	Description of the mitigation actions	Methodologies and assumptions	Objectives	Steps taken or envisaged to achieve actions	Progress of implementation and underlying steps taken or envisaged	Results achieved (claim, 000 tCO_2e)			Results achieved (verification, 000 tCO_2e)			Information on internationa l market mechanisms
						2017	2018	2019	2017	2018	2019	
	Total					307,989	165,635	53,449	295,583	297,818	-23,457	

BUR Technical Annex

Pursuant to Decision 14/CP.19

Results Achieved by Indonesia from Reducing Emissions from Deforestation and Forest Degradation for REDD+ Result-based Payments

Contents

1. Introduction

Indonesia welcomes the opportunity to submit a Technical Annex II to its Third Biennial Update Report (BUR 3) in the context of results-based payments for reducing emissions resulting from deforestation and forest degradation activities, conserving forest carbon stocks, sustainable managing forests, and enhancing forest carbon stocks in developing countries (REDD+), under the United Nations Framework Convention on Climate Change (UNFCCC).

Indonesia underlines that the submission of this Technical Annex II with the results of REDD+ is voluntary and exclusive to obtain and receive result-based payments for REDD+ actions, pursuant to Decision 13/CP.19, paragraph 2, and Decision 14/CP.19, paragraphs 7 and 8.

Accordingly, this submission, does not alter, revise or otherwise adjust the National Determined Contributions (NDCs) voluntarily submitted by Indonesia pursuant to the the UNFCCC Paris Agreement. This submission refers to the reference level described in Indonesia's Forest Reference Emission Level (FREL) in accordance to the Decision 13/CP.19, which was approved following a technical assessment in 2016.

Indonesia noted that the submission of Technical Annex II covered two activities that reduced emissions due to deforestation and forest degradation, and included the decomposition of peat on deforested and degraded peatlands covered in the FREL. This document presents Indonesia's achievements in the aforementioned REDD+ activities from 2018 to 2020 across the country. Indonesia remarks that this document presents the continuing results of the previous document in Technical Annex I to the Indonesia's Second BUR.

The Indonesian government developed this submission with the support of the Working Group of Technical Experts mandated by the Ministry of Environment and Forestry (MoEF) involving national experts contributed to the development of FREL and its technical assessment, also the preparation of the Technical Annex I in Indonesia's Second BUR and its technical analysis.

Priority areas under Technical Annex II are forest areas in 2012 and forest peatlands in 1990 (hereafter will be called the *Performance Assessment Area* (PAA) or *Wilayah Pengukuran Kinerja-WPK* REDD+). Technical Annex II presents ongoing data and information advances to improve Indonesian's submissions.

2. Summary Information from the Technical Assessment Report of FREL

FREL serves as the baseline for estimating country's emission reductions from REDD+ activities. Actual emissions from mitigation periods are compared to FREL baseline figures. The FREL provides an assessment of the reduction in emissions from 2013 to 2020.

The reference period used for the FREL was 1990-2012. The areas covered by the REDD+ implementation include forested areas at the end of FREL period, i.e. 2012 and peatlands that were forested in 1990, which together represented 113.2 million hectares or about 60% of the country's land area.

The FREL covered only estimated CO_2 emissions from deforestation and forest degradation, and included the decomposition of peat on deforested and degraded peatlands. Carbon pools included in the FREL i.e. above-ground biomass (AGB) for deforestation and forest degradation, and soil organic carbon for peat decomposition.

The average annual rate of deforestation over the reference period was 918,678 hectares, and 507,486 hectares for the rate of forest degradation, which amounted to an annual emissions of 293.2 Mt CO_2e yr^{-1} and 58.0 Mt CO_2e yr^{-1}, respectively. Emissions from peat decomposition have increased over time, rising from about 151.8 Mt CO_2e yr^{-1} in the initial period (1990) to about 226.2 Mt CO_2e yr^{-1} at the completion of the analysis period (end of 2012). The increased in annual emissions was attributed to emissions inherited from peat decomposition caused by the previous peatlands activities.

The FREL sets GHG emissions from the aforementioned activities as 568.9 Mt CO_2e for 2013 and 593.3 Mt CO_2e for 2020. These annual emissions served as a reference for measuring emissions reduction. Figure 2-1 provides annual historical emissions from deforestation, forest degradation and (additional) associated peat decomposition (in Mt CO_2e) from 1990 to 2020.

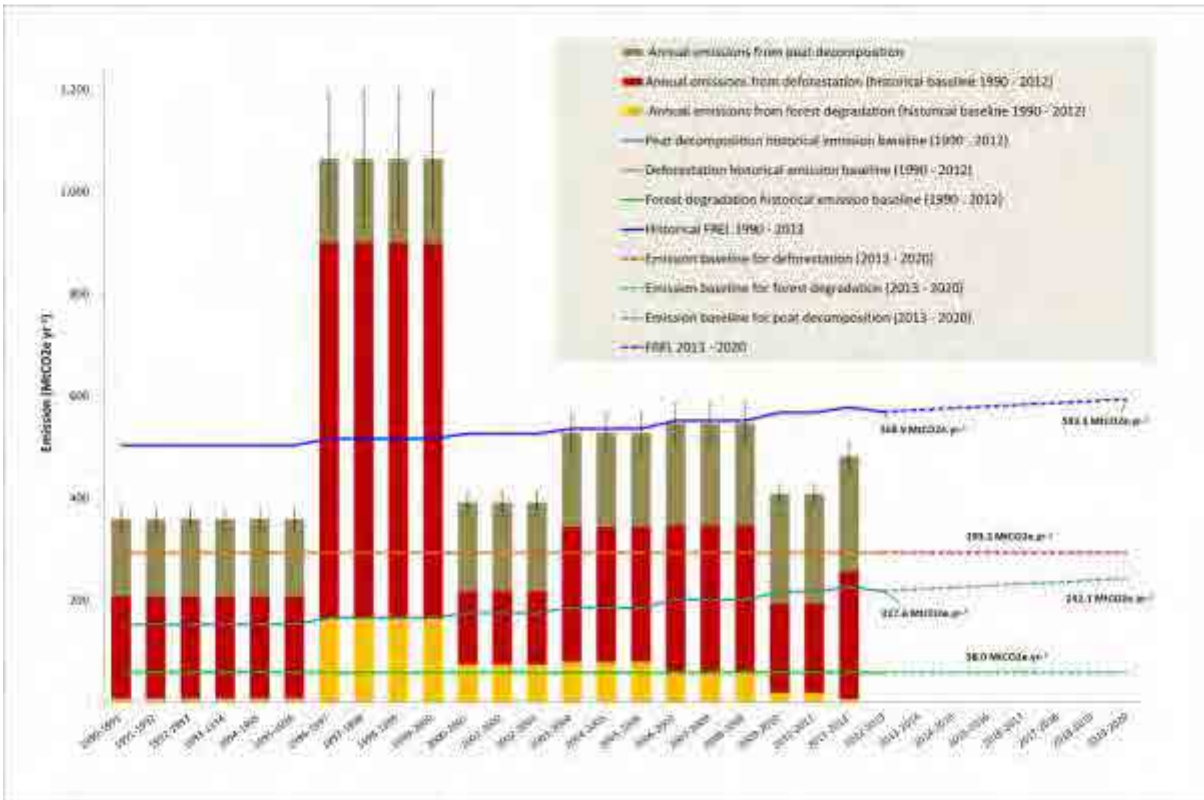

Figure 2-1. Annual and mean annual historical emissions from deforestation, forest degradation and associated peat decomposition (in Mt CO_2e) in Indonesia from 1990 to 2020.

3. Results in Tonnes of CO_2-Equivalent per Year, As Per FREL Assessment

Estimation of CO_2e emissions generated by deforestation, forest degradation, and peat decomposition on deforested and degraded peatlands for the resultant phase, used the same emission factors, approaches and procedures as described in FREL document (https://redd.unfccc.int/files/frel_submission_by__indonesia_final.pdf). The performance of CO_2e emissions reported in this Technical Annex II, was calculated by subtracting the CO_2e emissions from the reference period with the actual CO_2e emission for the 2018 - 2020 period. Annual emissions from deforestation, forest degradation and peat decomposition are given in Table 3-1 and the results of emission reductions are given in Table 3-2.

Table 3-1. Annual emissions from deforestation, forest degradation and peat decomposition activities in 2018-2020.

No	Period	Emissions from Deforestation (tCO_2e)		Emission from Forest Degradation (tCO_2e)		Emission from Peat Decomposition (tCO_2e)	
	(year period)	Reference	Actual	Reference	Actual	Reference	Actual
1	2017 - 2018	293,208,910	145,729,274	58,002,762	**65,328,839**	235,126,319	**270,321,401**
2	2018 - 2019	293,208,910	61,409,997	58,002,762	8,229,666	238,621,941	**280,910,820**
3	2019 - 2020	293,208,910	34,813,149	58,002,762	43,870,742	242,117,562	**281,437,790**
Average		293,208,910	80,650,806	58,002,762	39,143,082	238,621,941	**277,556,670**
Total		879,626,730	241,952,419	174,008,286	117,429,247	715,865,822	**832,670,011**

Note: Values in bold depict higher emissions than the references.

The CO_2e emissions reference from deforestation was derived from the historical emissions from 1990 to 2012, which amounted to 293.2 Mt CO_2e yr^{-1}. Measurements period in 2018-2020 showed that emissions from deforestation were below the reference, averaging approximately 80.6 Mt CO_2e yr^{-1} (Table 3-1). Meanwhile, the average CO_2e emissions generated by forest degradation over the 2018 - 2020 period was approximately 39.1 Mt CO_2e yr^{-1}, which is below the reference emissions (58.0 Mt CO_2e yr^{-1}). The average CO_2e emissions from peat decomposition was higher than the reference emissions (238.6 Mt CO_2e), with an average actual emission of 277.6 Mt CO_2e yr^{-1}. All annual emissions from peat decomposition were above the reference emissions.

The detailed emissions trend over the 2018 – 2020 reference period is presented in Figure 3.1.

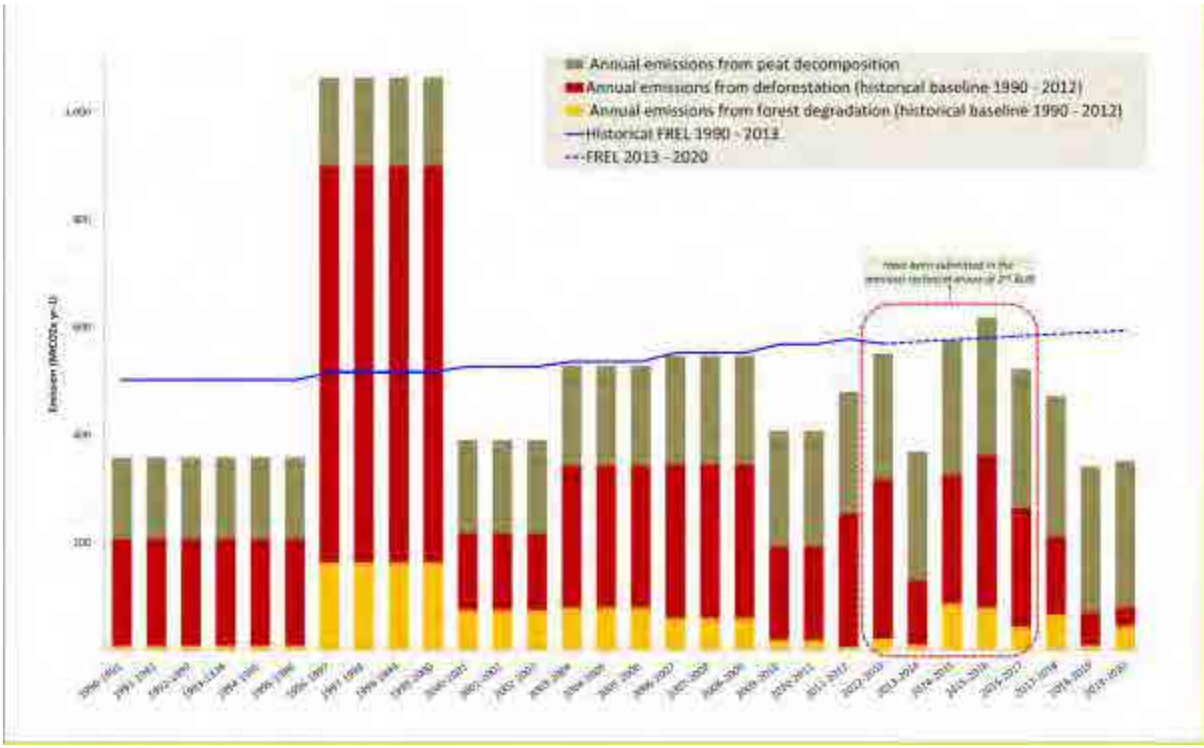

Figure 3-1. Annual emissions from deforestation, forest degradation and peat decomposition.

Between 2018 and 2020, Indonesia reduced deforestation by 637.7 Mt CO_2e compared to the 1990-2012 reference. The reduction in deforestation emission was equivalent to 72.5 % of the reference emissions. The reduction in emissions resulting from deforestation in 2018-2020 (Table 3-2) was the largest contributor to emissions reductions. The total reduction in emissions from forest degradation over the 2018-2020 period relative to the reference period was 56.6 Mt CO_2e, which is equivalent to a 32.5% reduction from reference emissions. In total, Indonesia has reduced its emissions by 694.2 Mt CO_2e by reducing deforestation and forest degradation, representing 65.9% of total emissions over the reference period. However, emissions from peat decomposition exceeded 116.8 Mt CO_2e from the reference. As a result, the excess emissions from peat decomposition reduced the overall emissions reduction from 694.2 Mt CO_2e to 577.4 Mt CO_2e. This translates into a 32.6 % emission reduction compared to reference emissions.

Table 3-2. Reduction in emissions due to deforestation, forest degradation and peat decomposition activities from 2018 to 2020.

Year	Deforestation (tCO2e)	Forest Degradation (tCO2e)	Peat Decomposition (tCO2e)	Total Without Peat Decomposition (TCO2e)	Total with Peat Decomposition (tCO2e)
2017 - 2018	147,479,636	-7,326,077	-35,195,083	140,153,559	104,958,476
2018 - 2019	231,798,913	49,773,096	-42,288,880	281,572,010	239,283,130
2019 - 2020	258,395,761	14,132,020	-39,320,227	272,527,781	233,207,554
Average	212,558,104	18,859,680	-38,934,730	231,417,783	192,483,053
Total	637,674,311	56,579,039	-116,804,190	694,253,350	577,449,160
% reduction from references	**72.5%**	**32.5%**	**-16.3%**	**65.9%**	**32.6%**

4. Demonstration of Consistency in Methodologies Used to Generate Results with FREL Assessment Methodologies

Data analysis presented in this report follows the FREL, which was technically assessed by UNFCCC secretariat in 2016 (http://unfccc.int/resource/docs/2016/tar/idn.pdf). Specifically, the methods used to generate activity data, emission factors, assumptions, definitions, estimation procedures for CO_2 emissions from deforestation and forest degradation, and the decomposition of peat in deforested and degraded peatland forests are consistent with the methodologies used in the FREL.

The analysis was completed for the implementation phase period (2018 – 2020), concentrating on areas still covered by natural forests in late 2012, known as the PAA or *WPK* for REDD+ (Figure 4-1). PAA was used as the focused areas of REDD+ activities implementation and assessment. The PAA has therefore, become the boundary or subject for MRV implementation, under activities that are consistent with those included in the FREL document.

Figure 4-1. Performance Assessment Areas (PAA) or *WPK* for REDD+, covering natural (intact/primary and degraded/secondary) forests by the end of 2012 and forested peatlands in 1990.

As with FREL, the activities included under the current PAA/WPK (2013-2020) are deforestation, forest degradation, and peat decomposition due to deforestation and forest degradation over peatland since 1990. Consequently, other "plus" activities under the REDD+ scheme were not been included, and ultimately not covered under the current MRV system.

Emissions from deforestation, forest degradation and peat decomposition were calculated in accordance with the FREL method by multiplying the transition matrix of land cover change areas in the PAA by the emission factor transition matrix associated with specific changes in land cover. The above-ground biomass data originated from the National Forest Inventory (NFI), and the emission factor for peat decomposition was based on the IPCC default values for tropical peatlands, which are available in "2013 Supplement to the IPCC 2006 Guidelines for National GHG Inventory: Wetlands (2014)".

Deforestation and forest degradation emissions were calculated using the equation below:

$$GE_{ij} = A_{ij} \times EF_j \times \frac{44}{12} \quad (1)$$

Where GE_{ij} = CO_2 emissions from deforested or degraded forest area-i at forest change class-j, in t CO_2e. A_{ij} = deforested or forest degraded area-i in forest change class j, in hectares (ha). EF_j = Emission Factor for carbon stock loss due to change in forest class-*j*, due to deforestation or forest degradation; in tonnes of carbon per ha (tC ha^{-1}). The $\frac{44}{12}$ is conversion factor from tC to tCO_2e.

Emissions from deforestation and forest degradation at period-t (GE_t) were estimated using the following equation:

$$GE_t = \sum_{i=1}^{N} \sum_{j=1}^{P} GE_{ij} \quad (2)$$

Where, GE_t written in t CO_2e, GE_{ij} is emission from deforested or degraded forest area-*i* in forest class-*j* expressed in t CO_2e. *N* is the number of deforested or degraded forest area unit at period-*t* (from t_0 to t_1), expressed without unit. *P* is the number of forest classes meeting the criteria for natural forest.

The calculation of emissions due to peat decomposition is described below:

$$PDE_{ijt} = A_{ijt} \; x \; EF_j \quad (3)$$

Where: PDE_{ijt} is Peat Decomposition Emission (PDE), i.e. CO_2 emission (t CO_2e yr^{-1}) from peat decomposition occurring in peat forest area-*i* that changed into land cover type-*j* within the time period-*t;* A_{ijt} is area-*i* of peat forest that changed into land cover type-*j* within the time period-*t*; EF_j is the emission factor of peat decomposition from peat forest that changed to land cover class-*j* (t CO_2e ha^{-1} yr^{-1}).

Consistent with deforestation and forest degradation activities, emissions from peat decomposition have been calculated from 2018 to 2020. The base calculation of activity data to calculate peatland emissions is the area located on forested peatland in 1990. The reference emissions of peat decomposition for FREL were estimated using a linear equation approach. This estimate will be progressively improved through a step-by-step process to produce higher accuracy in estimations for future implementation.

The decomposition process in organic soils will occur more rapidly when organic soils are drained, resulting in significant emissions to the atmosphere. The aerobic condition resulting from the lowering of water table depth, will increase the aerobic layer, which will accelerate CO_2 emissions from peatlands. As well, when forested peatland are converted to other land uses and drained, the organic soils break down continually for years. These emissions are inherited for years after the initial disturbance, unless the land cover has been altered. Consequently, emissions from peat decomposition will continue to rise with the deforestation of another peatland area.

In terms of coherence, the data, methodologies, and procedures used to derive the results presented in this report, are similar to those used to establish the FREL, as described below:

4.1. Activity Data

Data on activities used for deforestation and forest degradation were land cover data available from NFMS (National Forest Monitoring System) for 2018, 2019, and 2020. The data were generated from Landsat images to capture historical land cover data for deforestation (natural forest loss - primary and secondary forests) and forest degradation (transition from primary forest to disturbed secondary forest) using the same method and procedure as those used for land cover data from 1990 to 2012 in the FREL and the Technical Annex I method (2013-2017) in BUR 2. The land cover maps were produced by the MoEF, which was manually digitised through visual interpretation. The minimum threshold mapping area was 6.25 ha. The activity data used for the peatland decomposition were obtained from peatland spatial map provided by the Ministry of Agriculture and several associated maps, field surveys and ground checks.

4.2. Emission Factors

The primary data source used to calculate emission factors for deforestation and forest degradation was the National Forest Inventory (NFI) plots available at the national level (by the MoEF), complemented by supplementary research plots to fill information gaps for specific forest types (i.e. mangrove forest) that did not have representative NFI plots at the time of assessment. Emission factors for peat decomposition were derived from the 2013 IPCC Wetlands Supplement, primarily from Indonesian data.

4.3. Carbon Pools

The carbon pools presented in this report were above-ground biomass and soil organic carbon, which maintained the consistency of the same pools as the FREL. Above-ground biomass was included for all forest strata, while soil organic carbon was included only for deforestation or forest degradation occurring on peatlands. Other pools (below-ground biomass, litters and deadwoods) were excluded. Organic carbon from soils other than peatlands was also excluded.

4.4. Non-CO_2 Gases

Only carbon dioxide (CO_2) emissions from deforestation and forest degradation were included in FREL. The results presented in this report did not incorporate any other gases, thus maintaining the consistency with the FREL. CO_2 has been the most important gas in terms of forest emissions.

4.5. REDD+ Activities

The REDD+ activities included in this report were FREL-compliant, *i.e*. the REDD+ activities with the highest emissions (deforestation and forest degradation). Therefore, emissions from other REDD+ activities (role of conservation, sustainable management of forests and enhancement of forest carbon stocks) were not included in this report. These other REDD+ activities have been examined as the area for improvement and will be incorporated into future submissions.

5. Description of the National Forest Monitoring System (NFMS) and the Institutional Roles and Responsibilities for the MRV Results

5.1. The National Forest Monitoring System of Indonesia

In 1989, the Indonesian Ministry of Forestry (MoFor) has developed forest resource monitoring as part of the NFI project in Indonesia. The NFI was initially designed to collect information on the distribution of forests, the types of forest cover, and the standing stock volumes for each forest type, including mangroves, peatlands, lowland forests and mountain forests (Revilla and Liang 1989[1], Revilla and Liang 1992[2]).

The NFMS is a component of NFI that relies on the use of satellite imagery to produce the series of land cover maps. The satellite imagery used in the system was pre-dominantly Landsat data, which was introduced during the NFI periods. Following the completion of the NFI project around 1998, operational land cover mapping was transferred to the Directorate General (DG) of Forestry Planning of the MoFor. Under the DG of Forestry Planning, a more systematic monitoring approach was established in 2000, as well as the development of website which shows the integration of spatial data and the report on land cover and land cover change. The system is now known as NFMS (SIMONTANA), which is based on a regular production of a land cover map of Indonesia generated within a three year interval, or less, and delivered in 23 land cover classes including cloud cover class and no-data (Margono et al. 2016[3]).

This submission presents an update information and improvement to the NFMS that has been completed since the first REDD+ Technical Annex in the BUR 2. Improvements to the NFMS were made in phases, including data, methodology and website. Since 2011, the land cover map has been produced annually in line with the availability of free Landsat data. In 2015, the burn scar area mapping was developed by NFMS, not only based on hotspots but also based on satellite imagery and ground verification data. Beginning in 2018, updated land cover data has been combined with automated image processing (change detection/devegetation data) to improve data accuracy and quickly identify forest changes, known as alert data. The NFMS land cover datasets have their own accuracy (Tosiani, 2020 [4]). Beginning in 2019, land cover change uncertainty was calculated using a sample-based estimation method. The 23 land cover classes were classified in five land cover change classifications, i.e. deforestation, forest degradation, forest gain/growth, stable forest and stable non-forest. The NFMS is available online at https://nfms.menlhk.go.id/ and link to https://geoportal.menlhk.go.id/ for data display, viewing and simple analysis.

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[1] Revilla JAV & Liang DH. (1989). The National Forest Inventory (NFI) of Indonesia. Food and Agriculture Organization of the U. N. (Italy) FAO

[2] Revilla JAV & Liang DH. (1992). Supplementary Field Sampling Instructions (no. 2) for the NFI [National Forest Inventory] Project. Food and Agriculture Organization of the U. N. (Italy) FAO

[3] Margono, B.A., Usman, A.B., Budiharto, B., Sugardiman, R.A., 2016. Indonesia's Forest Resource Monitoring. Indonesian Journal of Geography 48, 7. https://doi.org/10.22146/ijg.12496

[4] Tosiani, A., 2020. Akurasi Data Penutupan Lahan Nasional Tahun 1990-2016. Direktorat Inventarisasi dan Pemantauan Sumber Daya Hutan, Ditjen Planologi Kehutanan dan Tata Lingkungan, Kementerian Lingkungan Hidup dan Kehutanan (https://geoportal.menlhk.go.id/~appgis/publikasi/Buku/Buku%20REKALKULASI%20PENUTUPAN%20LAHAN%20INDONESIA/Buku%20Akurasi%20Data%20PL%20Nasional%201990-2016.pdf)

5.2. NFMS: The Institutional Roles and Responsibilities for MRV

MRV requires credible data and information supported by appropriate system. In this context, the NFMS that provides ongoing information on activity data and the emission factor, plays an essential roles. System improvement and continuity of data and methodology are very important to support the MRV system. In addition to the need for an active system, an institutional arrangement describing the relationship and power-sharing among institutions in the implementation of MRV, would also be imminent.

To ensure daily operations and continuity of NFMS to support the Indonesian MRV needs for land-based sector, the system has been managed by the Indonesian MoEF. The Minister of Environment and Forestry Regulation No 18/2015 confers the authority for the monitoring of forest resources to the Directorate General of Forestry Planning and Environmental Arrangement, while authority for MRV is under the Directorate General of Climate Change (DG CC) of the MoEF. The illustration of the arrangement and sharing of powers in dealing with NFMS for MRV in Indonesia was elaborated in the REDD+ Performance document (MoEF, 2018[5]).

With respect to a transparent, accurate, consistent, comparable and comprehensive (TACCC) MRV implementation, Indonesia has established modalities for a National MRV System, which included National MRV Scheme (Ministerial Regulation No 72/2017; http://ditjenppi.menlhk.go.id/reddplus/images/adminppi/permen/P72.pdf), Registry System (Ministerial Regulation No 71/2017; http://ditjenppi.menlhk.go.id/reddplus/images/adminppi/permen/P71.pdf), Guideline for MRV REDD+ (Annex of Ministerial Regulation No 70/2017; http://ditjenppi.menlhk.go.id/reddplus/images/adminppi/dokumen/P.70.pdf), and MRV team under DG CC Regulation Number SK.8/PPI-IGAS/2015. Indonesian MRV system for REDD+ describes the flow of the overall national MRV process with appropriate adjustments to account for alignment with REDD+ financing schemes and its requirements. The Indonesian MRV system for REDD+ is officially presented in the Annex of the Ministerial Regulation on the Guidance for the Implementation of REDD+ in Indonesia. The detailed guideline for MRV for REDD+ is provided in Guideline for MRV REDD+ activities (http://ditjenppi.menlhk.go.id/reddplus/images/adminppi/dokumen/pedoman_mrv_redd.pdf) . In the framework of the above mentioned regulations, the role of the NFMS is imminent.

[5] MoEF, 2018. Indonesia Report on REDD+ Performance, Directorate General of Climate Change. The Ministry of Environment and Forestry. Indonesia. (http://ditjenppi.menlhk.go.id/reddplus/images/adminppi/dokumen/Book_IRPR_KLHK_B5_revisi_4_opt.pdf)

6. Necessary Information to Allow the Reconstruction of the Results

For reconstruction of the results, the data sources required for the reconstruction of the FREL and the REDD+ results are provided at the following sites:

1. Data on forest cover, deforestation and degradation that were produced from Landsat imageries through NFMS for 1990, 1996, 2000, 2003, 2006, 2009, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019 and 2020 are available online at https://nfms.menlhk.go.id/peta
2. The peatland spatial data/map produced by the Ministry of Agriculture (MoA) in 2011 ca be accessed at http://tanahair.indonesia.go.id. The data show calculations of peat decomposition emissions from the 1990 deforested peatlands.
3. Comprehensive information on REDD+ purposes means the provision of data that enable the reconstruction of the FREL and results of the REDD+ can be accessed upon request.

Estimation of emissions from deforestation and forest degradation resulting from the loss of above-ground biomass over two years used the land cover pivot table. Table 6-1 provides an example of land cover pivot table for the Island of Sumatra from 2017 to 2018. Emissions resulting from the change of forest class-j to non-forest classes were calculated using the equation (1). For example, the following equation is used to calculate the emissions from deforestation from primary dryland forest (class code 2001) (GE_{2001}) in t CO_2e (4):

$$GE_{2001} = AD * EF * \frac{44}{12} \qquad (4)$$

Where *AD* is the change of primary dryland forests (code 2001) into non-forests for the period 2017-2018 in hectare; and *EF* is the emission factor for deforestation of the corresponding class in tonne CO_2e/ha (Table 6-2 presents a sample of the calculation of emissions from deforestation of all forest classes in 2017-2018).

Deforestation emissions for other forest classes used a similar equation with corresponding emission factors. Therefore, the total emission from deforestation of all different forest classes is estimated using the equation (5):

$$GE_t = GE_{2001} + GE_{2002} + GE_{2004} + GE_{2005} + GE_{20041} + GE_{20051} \qquad (5)$$

Where 2001 is primary dryland forests, 2002 is secondary dryland forests, 2004 is primary mangrove forests, 2005 is primary swamp forests, 20041 is secondary mangrove forests, and 20051 is secondary swamp forests.

Table 6-1. An example of land use pivot table of deforestation between 2017 and 2018 (in hectares).

Example of land use pivot table		**Remark**
WPK_REDD	(Multiple Items)	*Filter for area in PAA/WPK*
H_NH17	200	*Filter for forest in 2017*
H_NH18	(Multiple Items)	*Filter for non-forest*
Row Labels	Sum of Luas_Hekta	
SUMATRA	76,711.24	*Sum of deforestation in Sumatra*
2001	6,451.30	*Deforestation in primary dryland forest*
2002	49,686.27	*Deforestation in secondary dryland forest*
2004	554.01	*Deforestation in primary mangrove forest*
2005	1,903.04	*Deforestation in primary swamp forest*
20041	3,917.17	*Deforestation in seconadry mangrove forest*
20051	14,199.45	*Deforestation in secondary swamp forest*

Table 6-2. A sample calculation of CO_2 emissions from deforestation due to the loss of above-ground biomass in the 2017-2018 period in Sumatra (detail calculation provided in the annexes).

Land cover Code	Deforestation	Emission Factor (tCO_2-e ha^{-1})	Emission (tCO_2-e)
2001	6,451.30	462.89	2,986,225.54
2002	49,686.27	313.99	15,601,058.81
2004	554.01	454.81	251,967.59
2005	1,903.04	380.51	724,129.14
20041	3,917.17	347.64	1,361,760.08
20051	14,199.45	260.91	3,704,816.42

Emission calculations for forest degradation are the same as for calculating emissions from deforestation.

Calculation of emissions from peat decomposition in a particular year at the time of deforestation and forest degradation used the same basis as the one used to calculate emissions from deforestation and forest degradation, including inherited emission. Deforested and degraded peat forests will generate additional CO_2 emissions in years to come, known as inherited emissions from peat decomposition. Emissions from decomposition of peat are calculated using Equation 3.

In the Technical Annex I to the Indonesia BUR 2, the emission factor used for this land cover transition, was the average emissions factor of both land cover types. For example, in the case of land cover transitions from primary forest to shrub, the emission factor is (0+19)/2 or equals to 9.5 tCO_2e/year. It is also possible to calculate emissions using formula (6).

$$PDE_{ijt} = (\sum(A_{ijt}\ x\ EF_{j\text{-}1}) + \sum(A_{ijt}\ x\ EF_{j\text{-}2}))/2 \quad (6)$$

Where: PDE_{ijt} is Peat Decomposition Emission (PDE), i.e. CO_2 emission ($tCO_2e\ yr^{-1}$) of peat decomposition occurring in peat forest area-*i* that has been altered into land-cover type-*j* within time period-*t*; A_{ijt} is area-*i* of peat forest that changed into land-cover type-*j* within time period-*t*; $EF_{j\text{-}1}$ is the emission factor for peat decomposition of the initial land cover ($tCO_2e\ ha^{-1}\ yr^{-1}$), $EF_{j\text{-}2}$ is the emission factor for the subsequent land cover type ($tCO_2e\ ha^{-1}\ yr^{-1}$)

Table 6-3. A sample calculation of CO_2 emissions from peat decomposisition the period 2017-2018 (detailed calculation are provided in the annexes)

Land Cover Code	Area in 2017 (ha)	Emission Factor ($tCO_2e\ ha^{-1}$)	Emission (tCO_2e)	Area in 2018 (ha)	Emission Factor ($tCO_2e\ ha^{-1}$)	Emission (tCO_2e)
2001	358,483	0.0	0.0	354,918.1	0.0	0.0
2002	290,981	19.4	5,654,727.9	291,820.2	19.4	5,671,039.8
2004	229,040	0.0	0.0	228,254.7	0.0	0.0
2005	2,059,194	0.0	0.0	2,048,963.5	0.0	0.0
2006	473,495	73.3	34,722,998.3	456,908.7	73.3	33,506,638.2
2007	107,737	19.4	2,093,697.7	96,400.8	19.4	1,873,389.7
2010	1,772,953	40.3	71,509,084.3	1,897,715.5	40.3	76,541,193.4
2012	4,037	34.5	139,141.3	5,048.4	34.5	174,000.2
2014	713,696	51.3	36,636,414.2	599,336.6	51.3	30,765,943.2
3000	27,399	34.5	944,338.1	27,401.1	34.5	944,424.3
5001	1,751	0.0	0.0	1,601.3	0.0	0.0
20041	99,258	19.4	1,928,908.0	99,001.5	19.4	1,923,928.2

20051	2,966,928	19.4	57,657,301.2	2,936,913.1	19.4	57,074,011.7
20071	1,550,291	19.4	30,127,314.0	1,497,513.8	19.4	29,101,684.7
20091	172,928	51.3	8,876,950.3	166,753.1	51.3	8,559,994.1
20092	183,835	51.3	9,436,843.1	286,237.4	51.3	14,693,518.1
20093	32,353	34.5	1,115,094.2	47,869.0	34.5	1,649,884.6
20094	785	0.0	0.0	1,160.9	0.0	0.0
20121	72	0.0	0.0	75.9	0.0	0.0
20122	893	51.3	45,852.9	893.2	51.3	45,852.9
20141	3,257	51.3	167,168.9	3,566.0	51.3	183,056.0
50011	62,628	0.0	0.0	63,638.1	0.0	0.0
Grand Total	11,111,991		261,055,834.4	11,111,990.8		262,708,559.0
			Emission 2017-2018			**261,882,196.7**

7. Description of How the Elements Contained in Decision 4/CP.15, Paragraph 1 (c) and (d), Have been Taken into Account

7.1. Use of Current IPCC Guidance and Guidelines

The methods used to calculate the results as presented in this Technical Annex, were consistent with those used in the assessed FREL and complied with the methodologies to estimate national inventories of anthropogenic emissions by sources and removals by sinks of greenhouse gases, as described in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2006) and the 2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands or Wetlands Supplement (IPCC, 2014). The 2006 IPCC Guidelines, particularly Volume 4 (Agriculture, Forestry and Other Land Use), was used as reference to estimate emissions from deforestation and forest degradation. The recent publication of the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2019) is acknowledged, which provide an updated and robust scientific basis for the continuous improvement of national greenhouse gas inventories.

In the IPCC Guidelines, emissions from deforestation refer to changes in carbon stocks from the conversion of forest to another land use category; while emissions from forest degradation refer to changes in carbon stocks of the remaining forest land (land remaining under the same land use category). The IPCC Guidelines takes into account changes in biomass carbon stocks immediately prior to and following conversion. In the FREL, the biomass carbon stocks that existed immediately to the conversion of forests to another land use category, were presumed to be lost after conversion (referring to gross emissions from deforestation). With respect to forest degradation, changes in the biomass carbon stock of land remaining under the same land use category (i.e. Forest Land Remaining Forest Land) were based on the difference in estimates between secondary forest and primary forest carbon stocks.

The 2013 IPCC Wetlands Supplement served as a reference for estimating emissions from peat decomposition due to deforestation and forest degradation occurring on peatlands. Emissions from peat decomposition refer to the emissions from drained organic soils of tropical peatlands as stated the IPCC Wetlands Supplement. In the FREL, emissions from peat decomposition were calculated using changes in land cover post-conversion, which determined peat decomposition rates. For example, decomposition rate of peatlands with annual crops would be different from that with secondary forest or plantations. Although the Wetlands Supplement is intended for “drained organic soils”, the FREL does not differentiate areas with and without drainage, and all secondary peat swamp forests were considered as drained peat forests.

7.2. Establish, in Accordance to National Circumstances and Capabilities, Robust and Transparent National Forest Monitoring System

The activity data used in the FREL and for the calculation of the results presented in this Technical Annex are derived from the land cover data available from NFMS provided by the MoEF. The NFMS includes a comprehensive online monitoring system that provides spatial forest data and summary reports. The current NFMS provides comprehensive data on forest resources, including national data set on forest/land cover including forest/land fires (burn scar datasets), which are periodically updated in a way that is accurate, transparent and credible. As explained earlier, the NFMS is available online at https://nfms.menlhk.go.id/ and linked to https://geoportal.menlhk.go.id/ for data display, viewing and simple analysis.

Indonesia REDD+ scheme focuses on protecting its natural tropical forests, excluding plantation forest. As a consequent, only deforestation and forest degradation occurring in natural forests were included in the REDD+ scheme. Indonesia current submission did not consider forest regeneration (both natural and human intervention), or carbon sequestration that has been absorbed by forest growth. This is different from the net deforestation that accounts for regeneration of secondary forests and plantations. However, net deforestation will be recorded in the GHG inventory and/or the development and elaboration of the "plus" of REDD+.

Forest degradation refers to changes in carbon stocks brought about by the conversion of primary forests into secondary forests. In Indonesia, primary forests apply to all types of undisturbed forests, whereas secondary forests encompass all types of disturbed forests. Emissions from forest degradation were calculated from biomass losses due to changes between primary and secondary forests.

In developing the emission factors, Indonesia mainly used NFI plots data for all forest areas in Indonesia. Data from the NFI plot were also available and included in the NFMS as the main source of emission factors from deforestation and forest degradation activities. Uncertainties associated with estimating biomass stocks used in this submission, ranged from 3% to 50%, based on the availability of NFI plots of each land cover stratum on each main island. Thus, the redesign of the current NFI system is progressing to ensure the sustainability of the measurement of NFI data covering all critical land cover classes and to reduce the uncertainties in emission factor estimates.

The most significant uncertainty is found in estimating peatlands emissions. Current estimates based on the default values of the IPCC Wetlands Supplement, approximately has a 50% uncertainty. Thus, a more detailed approach toward a Tier 3 emission factor is necessary to support peatlands monitoring system including development of parameters to reflect peat conditions. Certain parameters were used in peatlands monitoring in Indonesia, e.g. groundwater level (GWL) was used as an indicator for degraded peatlands and the need to protect peatland ecosystem. Efforts have been made to develop a system for monitoring groundwater level on peatlands, such as SIMATAG-0.4 M (Peat Water Level Monitoring System-0.4 m) developed by MoEF (http://pkgppkl.menlhk.go.id/webgis), and SIPALAGA (Peatland Water Monitoring System) developed by Peatland Restoration Agency (http://sipalaga.brg.go.id). These data could be incorporated into the future estimates of emissions from peat decomposition.

Annex : DetailED Emission Calculation of Deforestation, Forest Degradation and Peat Decomposition

Table annex – 1. Calculation of deforestation emissions in 2017-2018

Island/Land Cover Code	Total Area (ha)	Emission Factor (t CO_2-e ha^{-1})	Emission (t CO_2-e)
SUMATRA	76,711.24		
2001	6,451.30	462.89	2,986,225.54
2002	49,686.27	313.99	15,601,058.81
2004	554.01	454.81	251,967.59
2005	1,903.04	380.51	724,129.14
20041	3,917.17	347.64	1,361,760.08
20051	14,199.45	260.91	3,704,816.42
KALIMANTAN	137,737.94		-
2001	2,593.20	464.27	1,203,936
2002	68,453.04	350.35	23,982,772
2004	174.16	454.81	79,212
2005	140.22	473.57	66,407
20041	14,078.17	347.64	4,894,117
20051	52,299.15	293.83	15,366,971
PAPUA	89,333.36		-
2001	30,443.53	412.05	12,544,224
2002	38,240.59	310.89	11,888,592
2004	2,103.12	454.81	956,521
2005	7,520.44	308.13	2,317,289
20041	553.43	347.64	192,394
20051	10,472.24	251.09	2,629,472
SULAWESI	69,171.06		-
2001	6,166.07	474.26	2,924,330
2002	49,082.44	355.87	17,466,885
2004	1,101.94	454.81	501,174
2005	34.87	369.48	12,884
20041	10,605.28	347.64	3,686,808
20051	2,180.46	221.10	482,107
JAvA	6,716.62		-
2001	1,457.14	458.41	667,961
2002	3,784.11	293.83	1,111,878
2004	14.56	454.81	6,620
20041	1,446.36	347.64	502,812
20051	14.46	274.53	3,970
BALI AND NUSA TENGGARA	30,606.76		-
2001	13,250.42	472.88	6,265,893
2002	11,045.12	280.39	3,096,900
2004	2,188.78	454.81	995,481
20041	3,725.25	347.64	1,295,042
20051	397.19	274.53	109,040
MALUKU	15,324.06		-
2001	100.11	519.41	51,998
2002	14,283.44	382.75	5,467,020
2004	38.54	454.81	17,527
20041	868.01	347.64	301,756
20051	33.96	274.53	9,323
Grand Total	425,601.04		**145,729,274**

Table annex – 2. Calculation of deforestation emissions in 2018-2019

Island/Land Cover Code	Total Area (ha)	Emission Factor (t CO_2-e ha^{-1})	Emission (t CO_2-e)
SUMATRA	57,959.12		
2001	6,506.60	462.89	3,011,825
2002	32,683.13	313.99	10,262,220
2004	204.85	454.81	93,168
2005	58.16	380.51	22,132
20041	8,829.97	347.64	3,069,641
20051	9,676.40	260.91	2,524,695
KALIMANTAN	71,971.23		-
2001	1,827.79	464.27	848,579
2002	53,993.49	350.35	18,916,817
2004	211.76	454.81	96,311
2005	14.39	473.57	6,815
20041	1,687.82	347.64	586,752
20051	14,235.98	293.83	4,182,934
PAPUA	18,495.85		-
2001	7,872.52	412.05	3,243,863
2002	6,687.09	310.89	2,078,945
2004	130.96	454.81	59,560
2005	725.66	308.13	223,599
20041	155.38	347.64	54,017
20051	2,924.24	251.09	734,247
SULAWESI	14,818.76		-
2001	4,279.84	474.26	2,029,763
2002	10,003.06	355.87	3,559,771
2004	64.96	454.81	29,546
20041	382.48	347.64	132,964
20051	88.42	221.10	19,550
JAvA	2,014.63		-
2001	88.55	458.41	40,591
2002	1,893.41	293.83	556,336
2004	22.05	454.81	10,029
20041	10.63	347.64	3,694
BALI AND NUSA TENGGARA	11,908.57		-
2001	1,468.45	472.88	694,404
2002	10,260.35	280.39	2,876,862
2004	45.16	454.81	20,539
20041	134.61	347.64	46,796
MALUKU	3,583.55		-
2001	34.18	519.41	17,752
2002	3,485.56	382.75	1,334,105
2004	4.96	454.81	2,254
20041	37.72	347.64	13,112
20051	21.14	274.53	5,805
Grand Total	**180,751.71**		**61,409,997**

Table annex – 3. Calculation of deforestation emissions in 2019-2020

Island/Land Cover Code	Total Area (ha)	Emission Factor (t CO_2-e ha^{-1})	Emission (t CO_2-e)
SUMATRA	19,268.06		
2001	1,109.42	462.89	513,538
2002	7,320.66	313.99	2,298,623
2005	2,030.90	380.51	772,781
20041	808.71	347.64	281,140
20051	7,998.37	260.91	2,086,877
KALIMANTAN	37,141.39		-
2001	140.63	464.27	65,289
2002	17,270.74	350.35	6,050,867
2004	181.52	454.81	82,557
2005	21.49	473.57	10,179
20041	906.32	347.64	315,072
20051	18,620.69	293.83	5,471,286
PAPUA	7,755.80		-
2001	1,848.27	412.05	761,580
2002	3,812.35	310.89	1,185,218
2004	92.79	454.81	42,202
2005	198.44	308.13	61,146
20041	85.73	347.64	29,804
20051	1,718.21	251.09	431,425
SULAWESI	16,036.80		-
2001	4,492.17	474.26	2,130,461
2002	10,872.23	355.87	3,869,082
2004	9.86	454.81	4,484
20041	662.55	347.64	230,327
JAvA	34.31		-
20041	34.31	347.64	11,927
BALI AND NUSA TENGGARA	13,407.26		-
2001	1,528.98	472.88	723,028
2002	11,814.12	280.39	3,312,519
20041	64.16	347.64	22,304
MALUKU	10,529.11		-
2001	143.88	519.41	74,732
2002	10,377.44	382.75	3,971,988
20041	7.80	347.64	2,711
Grand Total	**104,172.74**		**34,813,149**

Table annex – 4. Calculation of forest degradation emissions in 2017-2018

Island/Land Cover Code	Total Area (ha)	Emission Factor ($t CO_2$-e ha^{-1})	Emission ($t CO_2$-e)
SUMATRA	29,356.77		
2001	22,493.19	148.90	3,349,146
2004	717.50	107.17	76,896
2005	6,146.08	119.60	735,067
KALIMANTAN	29,672.56		-
2001	27,290.25	113.91	3,108,696
2004	2,382.31	107.17	255,316
PAPUA	303,475.61		-
2001	272,160.40	101.16	27,531,656
2004	19,067.56	107.17	2,043,507
2005	12,247.65	57.04	698,634
SULAWESI	9,194.48		-
2001	9,023.49	118.39	1,068,318
2004	170.47	107.17	18,270
2005	0.52	148.38	77
JAvA	933.22		-
2001	933.22	164.58	153,589
BALI AND NUSA TENGGARA	27,349.36		-
2001	26,552.65	192.50	5,111,288
2004	796.71	107.17	85,385
MALUKU	154,346.52		-
2001	154,344.75	136.66	21,092,804
2004	1.77	107.17	190
Grand Total	**554,328.52**		**65,328,839**

Table annex – 5. Calculation of forest degradation emissions in 2018-2019

Island/Land Cover Code	Total Area (ha)	Emission Factor ($t CO_2$-e ha^{-1})	Emission ($t CO_2$-e)
SUMATRA	20,213.32		
2001	703.56	148.90	104,758
2005	19,509.76	119.60	2,333,354
KALIMANTAN	16,014.37		-
2001	14,915.35	113.91	1,699,043
2004	618.79	107.17	66,317
2005	480.23	179.74	86,318
PAPUA	13,382.02		-
2001	13,226.99	101.16	1,338,038
2004	6.54	107.17	701
2005	148.49	57.04	8,470
SULAWESI	9,092.59		-
2001	9,064.28	118.39	1,073,148
2004	28.30	107.17	3,033
BALI AND NUSA TENGGARA	7,878.00		-
2001	7,878.00	192.50	1,516,486
Grand Total	**66,580.30**		**8,229,666**

Table annex – 6. Calculation of forest degradation emissions in 2019-2020

Island/Land Cover Code	Total Area (ha)	Emission Factor (t CO_2-e ha^{-1})	Emission (t CO_2-e)
SUMATRA	683.91		
2001	396.91	148.90	59,098
2004	158.01	107.17	16,934
2005	128.99	119.60	15,427
PAPUA	45,400.93		-
2001	37,088.85	101.16	3,751,896
2004	1,938.22	107.17	207,723
2005	6,373.85	57.04	363,579
SULAWESI	322,348.71		-
2001	322,326.26	118.39	38,161,173
2004	22.45	107.17	2,406
BALI AND NUSA TENGGARA	6,398.99		-
2001	6,398.99	192.50	1,231,782
MALUKU	444.33		-
2001	444.33	136.66	60,723
Grand Total	**375,276.87**		**43,870,742**

Table annex – 7. Calculation of peat decomposition emissions in 2017-2018

Land Cover Code	Total Area (ha)	Emission Factor (t CO_2-e ha^{-1})	Emission (t CO_2-e)
2001	358,523	-	0
2002	291,191	19.4	5,658,815
2004	229,040	-	0
2005	2,064,985	-	0
2006	481,379	73.3	35,301,153
2007	107,919	19.4	2,097,217
2010	1,775,571	40.3	71,614,677
2012	4,037	34.5	139,156
2014	728,376	51.3	37,389,963
3000	27,399	34.5	944,338
5001	1,751	-	0
20041	99,748	19.4	1,938,431
20051	3,317,835	19.4	64,476,587
20071	1,554,535	19.4	30,209,806
20091	172,929	51.3	8,877,044
20092	186,417	51.3	9,569,415
20093	32,353	34.5	1,115,094
20094	785	-	0
20121	72	-	0
20122	893	51.3	45,853
20141	3,537	51.3	181,541
50011	62,637	-	0
Grand Total	**11,501,910**	**Emission 2017**	**269,559,090**

Land Cover Code	Total Area (ha)	Emission Factor (t CO_2-e ha^{-1})	Emission (t CO_2-e)
2001	354,958	-	0
2002	292,031	19.4	5,675,127
2004	228,255	-	0
2005	2,054,755	-	0
2006	464,800	73.3	34,085,298
2007	97,863	19.4	1,901,811
2010	1,904,479	40.3	76,813,992
2012	5,051	34.5	174,087
2014	607,164	51.3	31,167,728
3000	27,401	34.5	944,424
5001	1,601	-	0
20041	99,491	19.4	1,933,451
20051	3,285,968	19.4	63,857,307
20071	1,504,919	19.4	29,245,596
20091	166,755	51.3	8,560,088
20092	288,874	51.3	14,828,843
20093	47,869	34.5	1,649,885
20094	1,161	-	0
20121	76	-	0
20122	893	51.3	45,853
20141	3,900	51.3	200,221
50011	63,647	-	0
Grand Total	**11,501,910**	**Emission 2018**	**271,083,712**

Emission 2017-2018 **270,321,401**

Table annex – 8. Calculation of peat decomposition emissions in 2018-2019

Land Cover Code	Total Area (ha)	Emission Factor (t CO_2-e ha^{-1})	Emission (t CO2-e)
2001	391,055	-	0
2002	251,900	19.4	4,895,261
2004	228,294	-	0
2005	2,004,890	-	0
2006	876,214	73.3	64,255,714
2007	76,894	19.4	1,494,315
2010	2,019,477	40.3	81,452,220
2012	6,175	34.5	212,840
2014	204,350	51.3	10,489,950
3000	36,229	34.5	1,248,703
5001	3,617	-	0
20041	98,929	19.4	1,922,521
20051	3,277,058	19.4	63,684,160
20071	1,550,981	19.4	30,140,738
20091	144,480	51.3	7,416,616
20092	243,342	51.3	12,491,545
20093	24,906	34.5	858,430
20094	1,220	-	0
20121	21	-	0
20122	861	51.3	44,211
20141	5,237	51.3	268,838
50011	55,779	-	0
Grand Total	**11,501,910**	**Emission 2018**	**280,876,064**

Land Cover Code	Total Area (ha)	Emission Factor (t CO_2-e ha^{-1})	Emission (t CO_2-e)
2001	390,308	-	0
2002	252,320	19.4	4,903,413
2004	228,294	-	0
2005	1,985,954	-	0
2006	768,599	73.3	56,363,925
2007	78,322	19.4	1,522,057
2010	2,015,318	40.3	81,284,489
2012	6,161	34.5	212,356
2014	372,547	51.3	19,124,104
3000	36,659	34.5	1,263,518
5001	3,617	-	0
20041	98,400	19.4	1,912,236
20051	3,281,257	19.4	63,765,760
20071	1,501,893	19.4	29,186,784
20091	155,103	51.3	7,961,968
20092	237,956	51.3	12,215,072
20093	24,738	34.5	852,636
20094	1,370	-	0
20121	21	-	0
20122	861	51.3	44,211
20141	6,488	51.3	333,045
50011	55,724	-	0
Grand Total	**11,501,910**	**Emission 2019**	**280,945,576**

Emission 2018-2019 280,910,820

Table annex – 9. Calculation of peat decomposition emissions in 2019-2020

Land Cover Code	Total Area (ha)	Emission Factor (t CO_2-e ha^{-1})	Emission (t CO_2-e)
2001	427,082	-	0
2002	241,360	19.4	4,690,429
2004	230,204	-	0
2005	1,959,043	-	0
2006	911,949	73.3	66,876,281
2007	69,525	19.4	1,351,109
2010	2,120,381	40.3	85,522,020
2012	6,883	34.5	237,248
2014	160,817	51.3	8,255,272
3000	5,052	34.5	174,114
5001	3,943	-	0
20041	100,846	19.4	1,959,783
20051	3,354,287	19.4	65,184,968
20071	1,510,079	19.4	29,345,871
20091	135,651	51.3	6,963,434
20092	185,203	51.3	9,507,110
20093	18,997	34.5	654,765
20094	1,193	-	0
20121	116	-	0
20122	398	51.3	20,454
20141	6,405	51.3	328,814
50011	52,494	-	0
Grand Total	**11,501,910**	**Emission 2019**	**281,071,673**

Land Cover Code	Total Area (ha)	Emission Factor (t CO_2-e ha^{-1})	Emission (t CO_2-e)
2001	426,578	-	0
2002	241,627	19.4	4,695,610
2004	230,011	-	0
2005	1,956,597	-	0
2006	913,445	73.3	66,985,994
2007	74,031	19.4	1,438,668
2010	2,172,567	40.3	87,626,877
2012	7,027	34.5	242,185
2014	153,988	51.3	7,904,731
3000	5,052	34.5	174,114
5001	4,302	-	0
20041	100,953	19.4	1,961,859
20051	3,339,570	19.4	64,898,974
20071	1,463,068	19.4	28,432,291
20091	135,083	51.3	6,934,264
20092	184,788	51.3	9,485,767
20093	19,005	34.5	655,038
20094	1,205	-	0
20121	116	-	0
20122	398	51.3	20,454
20141	6,761	51.3	347,081
50011	65,739	-	0
Grand Total	**11,501,910**	**Emission 2020**	**281,803,907**

Emission 2019-2020 281,437,790

Table annex – 10. Land Cover Code

No	Land-cover class	Land Cover Code
1	Primary dryland forest	2001
2	Secondary dryland forest	2002
3	Primary mangrove forest	2004
4	Primary swamp forest	2005
5	Secondary mangrove forest	20041
6	Secondary swamp forest	20051
7	Plantation forest	2006
8	Dry shrub	2007
9	Estate crop	2010
10	Settlement areas	2012
11	Bare ground	2014
12	Savanna and Grasses	3000
13	Open water	5001
14	Wet shrub	20071
15	Pure dry agriculture	20091
16	Mixed dry agriculture	20092
17	Paddy Field	20093
18	Fish pond/aquaculture	20094
19	Port and harbour	20121
20	Transmigration areas	20122
21	Mining areas	20141
22	Open swamp	50011