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Foreword

Following up the adoption of Paris Agreement, Indonesia has ratified the Paris Agreement through Act No.16/2016, and submitted the First Nationally Determined Contribution (NDC) in November 2016. Along with this commitment, Indonesia continues the efforts and actions 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.

Based on Conference of Parties (COP) 17 Decision (Decision 2/CP 17) Para 41, non-Annex I Parties, consistent with their capabilities and the level of support provided for reporting, should submit their first biennial update report by December 2014. To fulfill this, Indonesia has submitted the First BUR in 2015, which was officially recorded in 2016 by UNFCCC secretariat, and also Third National Communication a year after. An update report to the latest Indonesia National Communication is reported through this Second Biennial Update Report containing the updates of national greenhouse gas inventories, information on mitigation actions and their effects, needs and support received, and monitoring, reporting, and verification (MRV) process. Moreover, Indonesia has presented also a 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 Second Biennial Update Report.

Dr. Siti Nurbaya

Minister for Environment and Forestry

Preface

Responding to COP's mandate on Decision 2/CP. 17 Annex III, Indonesia has presented its Second Biennial Update Report (BUR) which is inline with the UNFCCC guidelines for Non-Annex I to the Convention.

Indonesian Second 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.

This BUR is an update of Indonesia Third National Communication (TNC), which consists of some improvements on National GHG inventory report of anthropogenic emissions by sources and removal by sinks, inter-alia the use of local emission factors on agriculture sector, the more detail sub-category in the use of energy in transport and manufacturing and industries, the non-CO2 emissions on peat fire, and the emissions on industrial waste-water; updated information on mitigation actions and their effect; as well as updated information on constraints and gaps related to financial; technical and capacity needs and received, also updated on MRV system. Other information that Indonesia considers relevant to the achievement of the objective is Technical Annex REDD+.

We acknowledge contributions by relevant institutions and experts during preparation of this Second BUR.

Dr. Ir. Ruandha Agung Sugardiman, M.Sc

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 Up-Date Report in 2016, and Third National Communication (TNC) in 2017. Following Decision 2/CP.17, Indonesia hereby submits its second Biennial Update Report (second BUR). This second 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 the Global Environment Facility (GEF) through the United Nations Development Programme (UNDP), with additional fundings from the Government of Indonesia and other donors. The preparation process of the second BUR include 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 second 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.

1.1. National Circumstances

Indonesia is located between 6°08' North and 11°15' South latitude, and from 94°45' to 141°05' East longitude covering an area of approximately 8.3 million km^2 with a total coastline length of about 108 hundreds km^2 and land territory of about 1.92 million km^2 (BIG, 2018).

Indonesia's population in 2016 has been continuously increasing from 119.21 million in 1971 to 258.50 million (Statistics Indonesia, 2018: 51) with an average annual growth rate of 1.98% (1980-1990) and 1.36% (2010-2016) (BPS, 2017). By 2030, the population of Indonesia would have increased to approximately 296.4 million with an average annual growth rate of 0.98% (BPS, Bappenas and UNFPA, 2018: 3).

Indonesia's economy has grown rapidly in the past 10 years. In 2016, Indonesia's GDP was IDR 9,435 trillion (at constant price 2010), which was much higher than the 2010 value at IDR 6,864 trillion. During 2010 – 2016, the GDP grew at an average of 5.4% annually. In terms of per capita, the GDP grew from IDR 28.8 million per capita in 2010 to IDR 36.5 million per capita in 2016. The major contributors to the country's GDP are service sectors (47% of GDP) and industries (39%). The remaining 14% of the GDP is accounted by agriculture, forestry and fishery sectors. The rapid economic growth has affected the GHG emissions level, particularly from the two main sources of GHG emissions in Indonesia, i.e. FOLU and energy sectors.

In energy sector, the relatively high growth of GDP has affected the GHG emissions generated from energy consumptions and supply. The final energy consumption was 1,122 million BOE in 2016, in which residential, industrial, and transport sectors dominate the final energy consumptions (Source: MEMR, 2018). The highest growth of the energy consumption in 2016 was transport sector with 6.7%, followed by commercial sector with 4.7%, residential sector with 1.9%, and industrial sector with 0.54%. In terms of energy types, the final energy consumption comprises of coal with 63.5 million BOE, oil fuels 407.85 million BOE, natural gas

101.35 million BOE, LPG 56.63 million BOE, and electricity 132.41 million BOE. The electricity consumption was supplied by the 59 GW power plant in 2016, which is mainly supplied by coal at 54.7% of the power generation mix.

The total forest area in Indonesia in 2016 was 95,272 thousand hectares, of which 17,425 thousand hectares are classified as Conservation Forest (HK), 24,094 thousand hectares as Protection Forest (HL), 18,217 thousand hectares as Production Forest (HP), 21,537 hectares as Limited Production Forest (HPT), and 6,455 thousand hectares as Convertible Production Forest.

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 2016, the total GHG emissions for the three main greenhouse gases (CO2, CH4 and N2O) excluding forestry and other land uses (FOLU) and peat fire, amounted to 822,326 Gg CO2e. With the inclusion of FOLU and peat fires, the total GHG emissions from Indonesia become 1,457,774 Gg CO2e (Table 1). The main contributing sectors were AFOLU including peat fires (51.59%) followed by energy (36.91%), waste (7.71%), and IPPU (3.79%) (Table 2 and Figure 1). The GHG emissions (in CO_2 equivalent) were distributed unevenly between the three gases at 82.46%, 13.29% and 4.26% for CO_2, CH_4 and N2O respectively.

Table 1. Summary of National GHG emissions in 2000 and 2016 by gas (Gg CO_2e)

No	Sectors	Year	CO_2	CH_4	N_2O	CF_4	C_2F_6	CO	NOx	NMVOC	SOx	Total of 3 Gases
1	Energy	2000	284,503	29,728	3,378	NO	NO	NE	NE	NE	NE	317,609
		2016	506,473	26,021	5,531	NO	NO	NE	NE	NE	NE	538,025
2	IPPU	2000	42,391	70	149	250	22	NO	NO	NO	NO	42,610
		2016	53,892	82	1,286	48	-	NO	NO	NO	NO	55,260
3	AFOLU	2000	510,140	50,912	39,518	NO	NO	2,724	70	NE	NE	600,570
		2016	638,542	61,486	52,110	NO	NO	3,451	94	NE	NE	752,138
4	Waste	2000	2,216	60,398	2,218	NO	NO	NE	NE	NE	NE	64,832
		2016	2,940	106,212	3,198	NO	NO	NE	NE	NE	NE	112,351
Total (CO_2-eq)		2000	839,250	141,108	45,263	250	22	2,724	70	-	-	1,025,621
		2016	1,201,847	193,801	62,125	48	0	3,451	94	-	-	1,457,774
Percentage (%)		2000	81.83	13.76	4.41	0.02	0.002	0.27	0.01	-	-	100
		2016	82.46	13.29	4.26	0.003	-	0.24	0.01	-	-	100

NE = Not Estimated; NO = Not Occuring

Table 2. Summary of National GHG Emissions (CO2, CH4, N2O) in 2000 and 2016 (Gg CO_2e)

No.	Sectors	Year		Percentage	
		2000	2016	2000	2016
1	Energy	317,609	538,025	30.97	36.91
2	IPPU	42,610	55,260	4.15	3.79
3	AFOLU (incl. peat fire)	600,570	752,138	58.56	51.59
4	Waste	64,832	112,351	6.32	7.71
Total without FOLU & peat fire		520,253	822,326	100	100
Total with AFOLU & peat fire		1,025,621	1,457,774		

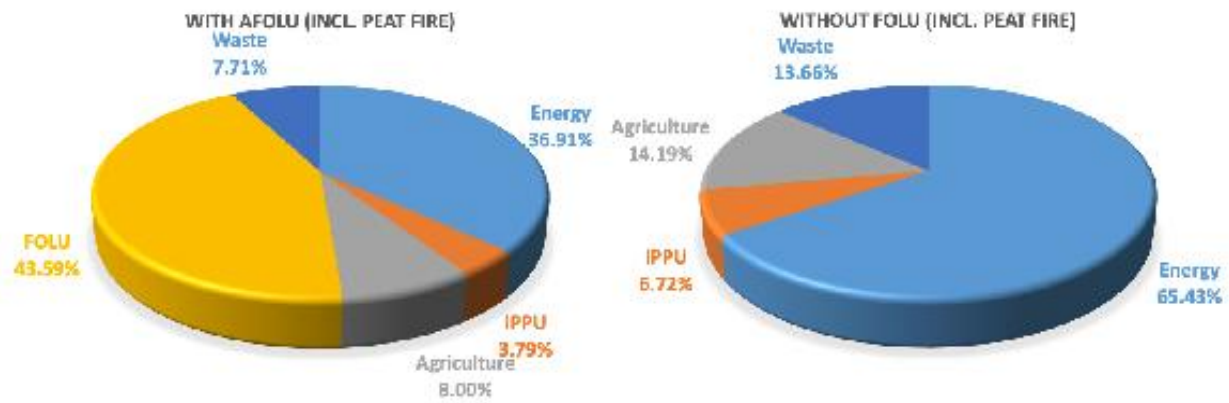


Figure 1. National GHG Emissions (CO_2, CH_4, N_2O) by Sector in 2016

In 2016, the national GHG emissions reached 1,461,367 Gg CO_2e for 5 gases (CO_2, CH_4, N_2O, CF_4, and C_2F_6) or 1,457,774 Gg CO_2e for 3 gases (CO_2, CH_4, N_2O). This figure was 432,152 Gg CO_2e higher than the emissions in 2000 and significantly lower than that in 2015, which was at the level of 2,372,509 Gg CO_2e. While 2015 experiencing an increase of 76% compared to the 2013's emission level (1,349,801 Gg CO_2e). The highest emissions in 2015 compared to previous years were due to the high emissions of peat fires that occurred in the 2015 El Nino year (Figure 2).

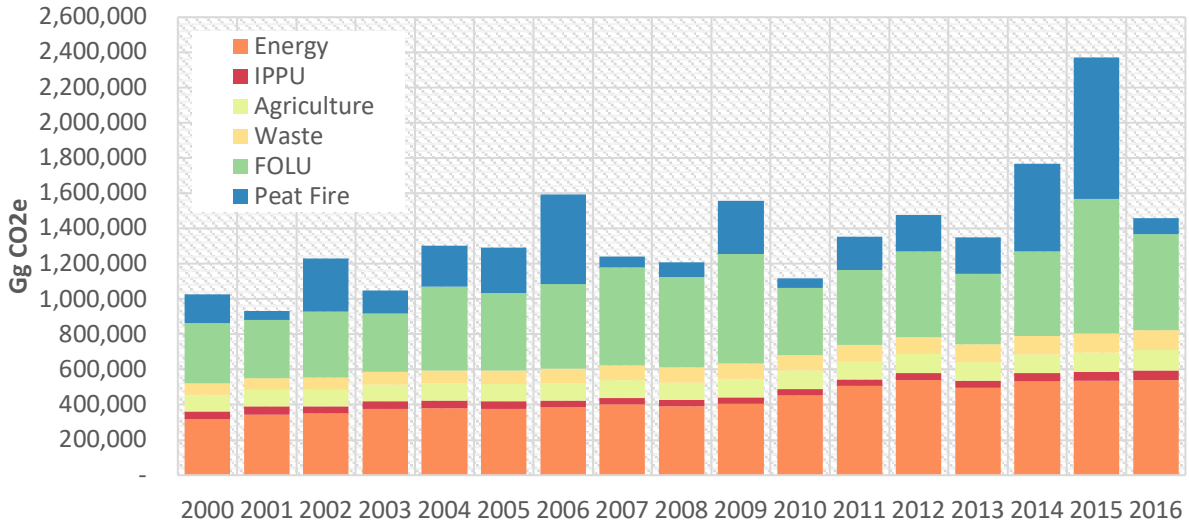


Figure 2. National GHG Emissions Trend (incl. peat fire) in 2000 – 201

Key category has indicated that with the inclusion of AFOLU sector, 18 key source categories were identified, which were dominated by FOLU sector. The first four main categories are (i) peat decomposition, (ii) forest remaining forest (iii) lands to cropland, and (iv) energy industries with cumulative emissions of 1,457,774 Gg CO_2e or 51.59% of the total emissions. Meanwhile, by excluding FOLU (including peat fire) sector, there are 15 identified key sources. The first three main categories are (i) energy industries, (ii) transportation, and (iii) manufacturing industries and construction, with cumulative emissions of 822,326 Gg CO_2e or 60% of the total emissions.

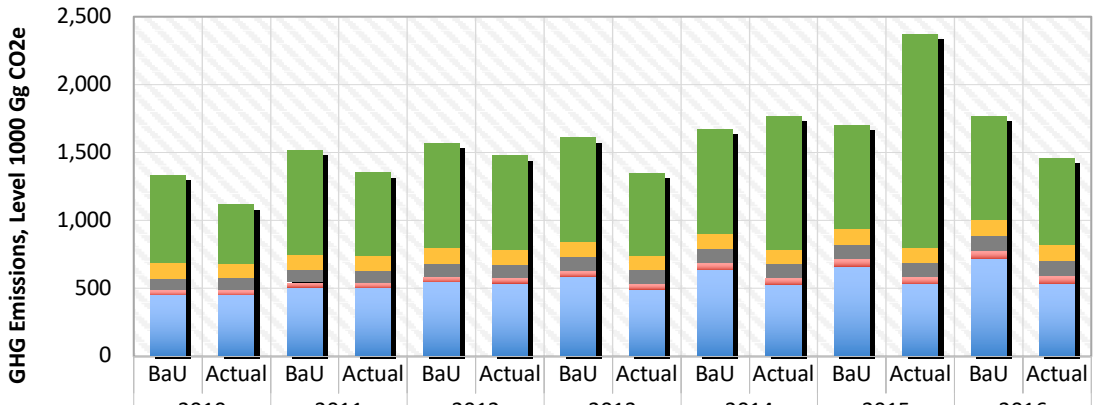
1.3. Measures to Mitigate Climate Change and Effect

Indonesia has ratified the PA under the Act No. 16/2016 and has submitted the Nationally Determined Contribution (NDC) with commitments of reducing the GHG emissions by 29% unconditionally and up to 41% conditionally from the BAU emission by 2030 in October 2016 (Table 3). The report on measures to mitigate climate change and effect is related to achieving the NDC target. The progress report covers an update of data on the implementation of mitigation policy and programmes in all sectors that have been reported in the TNC, mainly those are implemented in 2015 and 2016 for meeting the voluntary reduction target for pre-2020 mandated under the President Regulation No. 61/2011.

To achieve the GHG emission reduction target by 2030, 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 MTon CO_2e or 28.2% below the baseline 2030 and the rest are contributed by agriculture, IPPU and waste sectors (Table 3). 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) show that there was no reduction in GHG emissions in 2014 and 2015 (Figure 3). In 2015, the estimated emission increased much higher from the baseline by about -670 Gg CO_2e. This mainly due to the significant increase in emission from forest and other land use (FOLU) sector. In 2015, the increase in emission was mainly from large fire occurred across the country. However, in 2016 the emission level decreased again below the baseline by about 311,000 Gg CO_2e (Figure 4). Most of the reported emissions reduction achievements have not been verified.

Table 3. 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]	453.2	1,669	1,355	1,271	11%	14%
2	IPPU	36	69.6	66.85	66.35	0.1%	0.11%
3	AFOLU	757	835	327	180	18%	23%
3.a	Agriculture	110.5	119.66	110.39	115.86	0.32%	0.13%
3.b	Forestry[*2]	647	714	217	64	17.2%	23%
4	Waste	88	296	285	270	0.38%	1%
	Total	**1,334**	**2,869**	**2,035**	**1,787**	**29%**	**38%**



	BaU 2010	Actual 2010	BaU 2011	Actual 2011	BaU 2012	Actual 2012	BaU 2013	Actual 2013	BaU 2014	Actual 2014	BaU 2015	Actual 2015	BaU 2016	Actual 2016
FOLU	647	435	769	616	771	695	768	607	766	979	765	1,569	764	635
Agriculture	111	105	111	103	111	107	112	107	113	107	114	112	114	117
Waste	88	88	92	92	96	96	101	101	103	103	106	106	113	112
IPPU	36	36	37	36	41	40	41	39	49	47	53	49	56	55
Energy	453	453	511	507	550	540	590	496	639	531	664	536	723	538

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

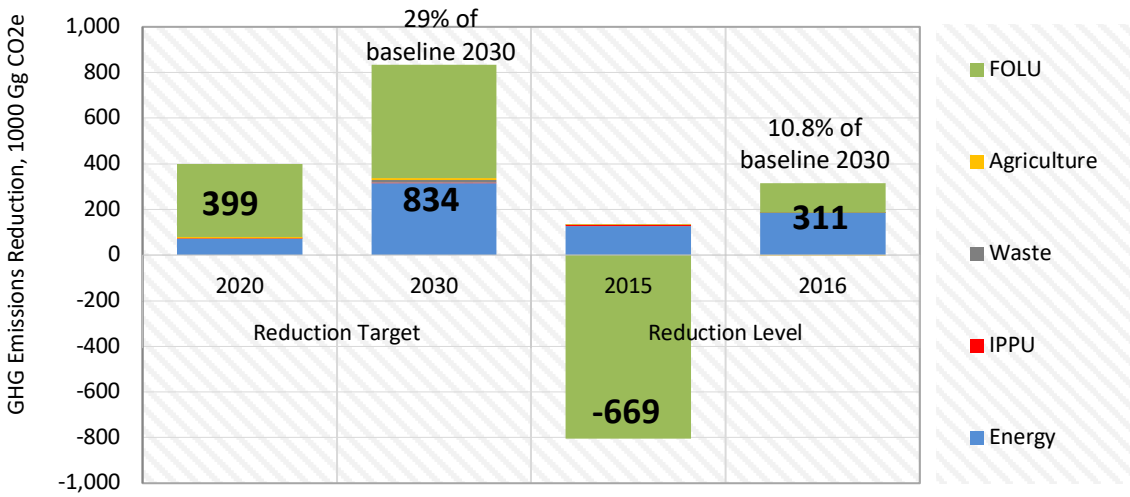


Figure 4. GHG emissions reduction by type of mitigations sector in 2015 and 2016 compared to GHG emissions reduction target of each sector under the NDC in 2030

The emission reduction in energy sector reached about 128,076 in 2015 and 184,509 Gg CO_2e in 2016. This reduction is equivalent to about 4.46% and 6.43% below the NDC baseline emissions in 2030 respectively.

It was found that the GHG emissions reduction potential of IPPU is 4,199 Gg CO_2e in 2015 and 971 Gg CO_2e in 2016. At this level of reduction, mitigations of the IPPU sector has achieved 0.16% (2015) and 0.22% (2016) of the baseline emission in 2030.

Based on the emission reduction report by the Ministry of Agriculture, the impacts of the implementation of mitigation activities on emissions reduction in 2015 and 2016 have reached approximately 1.88 million tonne CO_2 6.95 million tonne CO_2 respectively. Nevertheless, after verification process, the estimate emission reduction increased to 7.43 and 9.17 million tonne CO_2e respectively. In forestry sector, the emission in the period 2010-2016 was below the baseline, except for the years 2014 and 2015. The increase of emission in 2015 above the baseline was mainly due to the increased emissions from peat fires due to the El Nino event that has resulted in huge fires throughout the country. The total area of peat

lands affected by fire was 869,754 ha, and responsible for the emission of about 549.4 million tonne CO_2e. The deforestation also increases from the baseline rate, i.e. up to 1.09 million ha. In the 2016, with the implementation of fire prevention programmes, and avoiding deforestation, the peat fire has reduced significantly to 97,787 ha and eventually deforestation also decreased to 0.63 million ha. Overall, this sector in 2016 was able to reduce the emission by about 132,256 million ton CO_2e.

For waste sector, the GHG emissions reduction in 2015 and 2016 have reached a total of 402 Gg CO_2e and 396 Gg CO_2e respectively, which is accounted for 0.014 % of the NDC baseline emissions in 2030. This figure is equivalent to about 0.02% compared to the NDC reduction target in 2030.

The contribution of the Non Party Stakeholders in meeting the NDC target has not 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 247 billion (IDR 3,461 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.

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 summarized 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 (Waste Heat Boiler); 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, aluminum 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. Aluminum 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 fertilizer 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: 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

Capacity Building Needs

For an effective implementation of the mitigation actions, sectoral ministries (party actors), privates and communities (non-party actors) required capacity building. In addition, awareness rising activities need to be implemented in 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.
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.
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, organizations, 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 Third National Communication (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.

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. Sectors that mostly received the financial supports are the energy and transportation sectors. Based on sources of fund, most of the supports from bilateral agreement are from Japan (JICA), which amounted to about USD 885,11 million (48%) and followed by ADB about USD 403 million (22%), by Germany (KfW, GIZ) about USD 215 million (12%) and by France about USD 124.6 million (6.7%).

Meanwhile from multilateral support, Indonesia has received financial supports totalling to 537.82 USD million, which are mainly from ADB, followed by AIF and World Bank. Despite the bilateral and multilateral suports, Indonesia also received supports from other institutions such as Murata Corporation and from NEWRI Singapore in total 0.2 million USD.

Technology

In term of technology and supports received in the period of up to 2016, Indonesia has received technology supports from various countries and international organizations. 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 recorded in the supported NAMA (National Appropriate Mitigation Action) among others:

a. Low carbon technology:
   - Environment friendly, for example electric car;
   - Renewable Energy Fuel, for example Bio-diesel
   - Low budget and environmental friendly Carbon Capture Storage (CCS);
   - Smart Street Lighting Initiative (SSLI);
   - Energy Efficiency Measures in City Hall/DPRD DKI Jakarta Office;

- Efficient cooling and air conditioning in industry and business;
- Mine Reclamation for Rural Renewable Energy (MORRE);

b. GHG mitigation technology on paddy field and paddy variety
c. Amelioration and fertiliser utilization for efficiency improvement and GHG emission reduction

Capacity Building

The capacity buildings received by Indonesia related to climate change mitigation actions included (i) training activities for technical personnel and policy makers and (ii) pilot activities to strengthen the capacity of stakeholders for the development and implementation of mitigation actions.

In the period of 2015-2016, at least 15 trainings and workshop activities have been implemented to Indonesia conducted within the country and overseas. In addition, many pilot projects have also been implemented to strengthen capacity of various stakeholders including local government in designing and implementing mitigation actions. One of the biggest supports received include demonstration activities for REDD+. At least 37 REDD+ demonstration activities have been implemented in various regions that provide good lesson learnt for Indonesia.

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Glossary of Abbreviation

ACM	Agriculture, Construction, and Mining
ADB	Asian Development Bank
ADIPURA	Prestigious Award for The Clean City
AFOLU	Agriculture, Forestry and Other Land Use
AFR	Alternative Fuel Resource
ALKI	the Indonesian Archipelago Sea Flow
APL	Areal Penggunaan Lain (Non Forest Area)
APPI	Asosiasi Produsen Pupuk Indonesia
BAPPENAS	National Development Agency
BATAMAS	Biogas Asal Ternak Masyarakat (Community Biogas from livestock)
BAU	Business as Usual
BFCP	Berau Forest Carbon Programme
BIG	Badan Informasi Geospasial
BMKG	Badan Meteorologi Klimatologi dan Geofisika (Meteorological, Climatological and Geophysical Agency)
BMUB	German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
BNPB	Badan Nasional Penanggulangan Bencana / National Agency for Disaster Management
BOD	Biological Oxygen Demand
BOE	Biodegradable Organic
BORDA	Bremen Overseas Research and Development Association
BPPT	Badan Penerapan dan Pengkajian Teknologi / Agency of the Assessment and Application of the Technology
BPS	Badan Pusat Statistic (Central Statistics Agency)
BRG	Badan Restorasi Gambut
BSD	Bumi Serpong Damai
BUR	Biennial Update Report
CC	Climate Change
CCROM	Centre for Climate Risk and Oppoptunity Management
CCS	Carbone Caputure and Storage
CCT	Clean Coal Technology
CDM	Clean Development Mechanism
CFES	Community Forest Ecosystem Services
CIFOR	Center for International Forestry Research
CL	Crop Land
CNG	Compressed Natural Gas
CO	karbon monoksida
COD	Chemical Oxygen Demand
COP	Conference of Parties
COREMAP	Coral Reef Rehabilitation and Management Program
CRF	Common Reporting Format
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DANIDA	Danish International Development Agency
DGCC	Directorate General of Climate Change
DKI	Daerah Khusus Ibukota
DNPI	Dewan Nasional Perubahan Iklim
DOC	Degradable Organic Carbon
DPN	National Tourism Destinations
DPRD	Dewan Perwakilan Rakyat Daerah
DSHRF	DANIDA Support to Harapan Rain Forest
DWW	Domestic Wastewater
EBTKE	Energi Baru Terbarukan dan Konservasi Energi
EDC	Ethylene Dichloride
EF	Emission Factor
ESDM	Energi dan Sumber Daya Mineral
EXIM	Export Import
EYS	Expected Years of Schooling
FAO	Food and Agriculture Organization
FFI	Fauna dan Flora International
FL	Natural Forest
FMU	Forest Management Unit
FOLU	Forest land and Other Land Use
FORCLIME	Forest and Climate Change Programme
FORDA	Forestry Research and Development Agency
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Green House Gas
GIZ	Gesellschaft für Internationale Zusammenarbeit
GL	Grass Land
GOI	Government of Indonesia
GW	Gigawatts
HDI	Human Development Index / Indeks Pembangunan Manusia
HEESI	Handbook of Energy and Economic Statistic of Indonesia
HK	Hutan Konservasi (Conservation Forest)
HL	Hutan Lindung (Protected Forest)
HP	Hutan Produksi (Production Forest)
HPK	Hutan Produksi Konversi (Conversion Production Forest)
HPT	Hutan Produksi Terbatas (Limited Forest Production)
IAF	International Accreditation Forum
ICRAF	World Agroforestry Centre
IDR	Indonesian Rupiah
IND	Indonesia
IPAL	Instalasi Pengolahan Air Limbah (Waste Water Treatment Plant)
IPB	Institut Pertanian Bogor
IPCC	Intergovernmental Panel on Cimate Change
IPLT	Instalasi Pengolahan Limbah Tinja (Septage Treatment Plant)
IPPU	Industrial Process and Product Use
ISBN	International Standard Book Number
ISW	Industrial Solid Waste
ITB	Institut Teknologi Bandung
IWW	Industrial Wastewater
JAKSTRADA	Kebijakan dan Strategi Daerah
JAKSTRANAS	Kebijakan dan Strategi Nasional
JCOAL	Japan Coal Energy Center
JICA	Japan International Cooperation Agency
KCA	Key Category Analysis
KEMENPERIN	Kementerian Perindustrian
KESDM	Kementerian Energi dan Sumber Daya Mineral
KLH	Kementerian Lingkungan Hidup
KLHK	Kementerian Lingkungan Hidup dan Kehutanan
KPH	Kesatuan Pengelolaan Hutan / Forest Management Unit
KPHK	Kesatuan Pengelolaan Hutan Konservasi

KPHL	Kesatuan Pengelolaan Hutan Lindung
KPHP	Kesatuan Pengelolaan Hutan Produksi
KPPN	National Tourism Development Zone
KSPN	National Tourism Strategic Areas
LAPAN	National Space Agency
LEMIGAS	Lembaga Minyak dan Gas Bumi
LFG	Landfill Gas
LIPI	Lembaga Ilmu Pengetahuan Indonesia
LPG	Liquid Petroleum Gas
LUCF	Lad Use Change and Forestry
MBT	Mechanical Biological Treatment
MCC	Millennium Challenge Corporation
MCF	Methane Correction Factor
MEMR	Ministry of Energy and Mineral Resources
MENLHK	Kementerian Lingkungan Hidup dan Kehutanan
MMBOE	Million Barrels of Oil Equivalent
MORRE	Mine Reclamation for Rural Renewable Energy
MPTS	Multi-Purpose Tree Species
MPWH	Ministry of Public Works and Housing
MRT	Mass Rapid Transport
MRV	Measurement Reporting, and Verification
MSW	Municipal Solid Waste
MYS	Mean Years of Schooling
NAMA	National Appropriate Mitigation Action
NATCOM	National Communication
NDC	Nationally Determined Contribution
NE	Not Estimated
NEWRI	Nanyang Environment and Water Research Institute
NFP	National Focal Point
NGO	Non-Governmental Organization
NIAES	National Institute for Agro-Envieronmental Sciences
NMVOC	Non-methane volatile organic compounds
NO	Not Occuring
NPS	Non-Party Stakeholders
NRS	National Registry System
NTB	Nusa Tenggara Barat
OCSP	Orangutan Conservation Services Program
ODS	Ozone Depleting Substances
OL	Other Land
OTEC	Ocean Thermal Energy Conversion
PA	Paris Agreement
PCSSF	Papua Civil Society Support Foundation
PFC	Perfluorocarbon
PHKA	Perlindungan Hutan dan Konservasi Alam
POME	Palm oil mill effluent
PPE	Pusat Penelitian Energi
PPI	Pengendalian Perubahan Iklim
PPPTMGB	Pusat Penelitian dan Pengembangan Teknologi Minyak dan Gas Bumi / Centre for Research and Technology Development of Oil and Gas, Ministry of Energy and Mineral Resource
PS	Party Stakeholder
PV	Photovoltaic
QA	Quality Assurance
QC	Quality Control
RDF	Refuse Derived Fuel
RECA	Restoration of Ecosystem in Conservation Areas
REDD	Reducing Emissions from Deforestation and Forest Degradation
RHOI	Restorasi Habitat Orangutan Indonesia
RMU	Rimba Makmur Utama
RPJMN	Mid-Term Development Plan
RSPB	Royal Society for the Protection of Birds (RSPB
SEAP	South East Asia Pacific
SETJEN	Sekretariat Jenderal
SIGN	Sistem Inventory GRK Nasional
SKR	Statistik Kesejahteraan Rakyat
SLPTT	Sekolah Lapangan Pengelolaan Lapangan Terpadu (Field School of Integrated Field Management)
SMART	Sederhana, Mudah, Akurat, Ringkas dan Transparan
SRI	System of Rice Indonesia
SRN	Sistem Registri Nasional
SSLI	Smart Street Lighting Initiative
ST	Settlement
SWDS	Solid Waste Disposal Sites
TAF	The Asian Foundation
TEBE	Towards Enabling Mitigation of Climate Change Through Promotion of Community-Based Economic Growth
TEKMIRA	Teknologi Mineral dan Batu Bara / Research Centre for Mineral and Coal
TFCA	Tropical Forest Conservation Act
TN	Taman Nasional
TNC	Third National Communication
TNMB	Taman Nasional Meru Betiri
TSCF	Trillion Standard Cubic Feet
UK	United Kingdom
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nation Framework on Climate Change Convention
UNFPA	United Nation Population Fund
UNREDD	United Nations Programme on Reducing Emissions from Deforestation and Forest Degradation
UPPO	Unclaimed Property Profesionals Organization
US	United States
USA	United States of America
USD	United States Dollar
VCM	Vinyl Chloride Monomer
WHB	Waste Heat Boiler
WL	Wet Land
WMO	World Meteorological Organization
WRI	World Resources Institute
WWF	World Wide Fund for Nature
WWTP	Wastewater Treatment Plant
YAYORIN	Yayasan Orangutan Indonesia
YTM	Yayasan Timor Membangun
ZEE	Zona Ekonomi Eklusif
ZSL	Zoological Society of London

CHAPTER 1. NATIONAL CIRCUMSTANCES AND INSTITUTIONAL ARRANGEMENT

1.1 National Circumstances

1.1.1 Geography

Information related to the geography of Indonesia refers to the Indonesia's TNC document with an update for the area of the country, which is approximately 8.3 million km^2 with a total coastline length of about 108 hundreds km^2 and land territory of about 1.92 million km^2 (BIG, 2018). The map of Indonesia is shown in Figure 1-1.

1.1.2 Climate

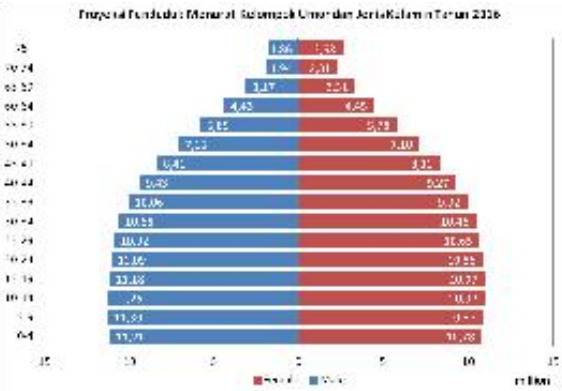
Overall, the climate condition refers to the climate as described in the Third National Communication, since it describes in detail the climatic condition over the past 30 years. Some updated information from WMO (2015), found that global warming has reached a record level due to the increased global temperature caused by human emissions from greenhouse gases in a long-term, and combine with the effects of the extended El Nino. The El Nino event has caused the dry conditions in Indonesia during 2015 and increased the risk of wildfires. Moreover, El Nino is considered as one of the overriding factors in major forest/land fire and haze occurrence and frequency. Outbreaks of crop pests and diseases as well as human vector-borne diseases are often reportedly in connection with these phenomena (Gagnon et al., 2001 Hopp and Foley, 2003). The economic losses due to the climate hazards tend to increase (Boer and Perdinan, 2008). In 2016, the economic losses due to floods and land/forest fires have reached USD 2.5 billion. Based on the estimation by the National Agency for Disaster Management (BNPB), the cost acquired from the infrastructural damages due to floods in 2016, amounted to USD 275 million.

(Source: Geospatial Information Agency of Indonesia, BIG, 2018)
Figure 1-1. Map of Indonesia

1.1.3 Population

Over the past four decades, Indonesia's population has been continuously increasing from 119.21 million in 1971 to become 258.50 million in 2016 (Statistics Indonesia, 2018: 51) with an average annual growth rate of 1.98% (1980-1990) and 1.36% (2010-2016) (BPS, 2017). The population is projected to reach 296.4 million by 2030 with an average annual growth rate of 0.98% (BPS, Bappenas and UNFPA, 2018: 3).

These population are almost evenly distributed between urban and rural areas, although the population tend to reside more in urban area (53.3% in 2015). The urban population are projected to increase to 56.7% in 2020. Based on the age distribution, the population of Indonesia is dominated by those below the age of 45 (see Source: BPS, Bappenas, and UNFPA, 2018).



(Source: BPS, Bappenas and UNFPA, 2018).
Figure 1-2. Indonesian Population Pyramid 2016

1.1.4 Economic and Social Development

During the period of 2010 – 2016, 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 2016, the major contributors to the country's GDP are the service sector (47% of GDP) and industry (39%). The remaining 14% of the GDP is accounted by agriculture, forestry and fishery sector. The breakdown of sectoral shares in Indonesian GDP is shown in Table 1-1 (BPS, 2018).

Indonesia's economy has grown rapidly in the last 10 years. In 2016, Indonesia's GDP was IDR 9,435 trillion (at constant price 2010), which was much higher than the 2010 value at IDR 6,864 trillion. During 2010 – 2016, the GDP grew at an average of 5.4% annually. In terms of per capita, the GDP grew from IDR 28.8 million per capita in 2010 to IDR 36,5 million per capita in 2016.

Table 1-2. Development of Indonesian GDP and Exchange Rate shows the development of Indonesia's GDP.

Life expectancy in Indonesia has improved significantly in the past four decades, from only 47.9 in 1970 to 70.90 (new method)[1] in 2016 (BPS, 2016). Within the education sector, the expected years of schooling has increased from 11.3 years in 2010 to 12.7 years in 2016, while the mean years of schooling slightly increase from 7.5 years in 2010 to 7.9 years in 2016. As the result of sustained efforts, human development indices with new method has increased from 66.5 in 2010 to 70.2 in 2016, which classified Indonesia as a high levels human development country (Table 1-3).

Following the successful recovery from the social and economic crisis in 1998-1999, Indonesia has been showing a steadily increasing trend in alleviating poverty. In 2005, the number of people living in absolute poverty has declined from 47.97 million people in 1999 to 35.10 million people (BPS, 2015:175), and the people living in relative poverty has declined from 23.43% in 1999 to 15.97% in 2005. The number of people living in poverty, however, has increased slightly in 2006 due to the fuel price increased but since then, the number continued to show a declining trend until 2016 (Table 1-4).

Between the periods of 2006-2016, the number of people living in poverty dropped as much as 11.29 million, from 39.30 million in 2006 to 28.01 million in March 2016. By the end of 2016, the number of poor people totalled to about 27.76 million (10.7% of the population) (BPS, 2018).

The employment rate of Indonesian workforce has been improving for the last decade. Though the unemployment rate is still relatively high, it has been decreasing from about 10.3% in 2006 to around 5.6% in 2016 (BPS, 2018).

[1] Since 2010, HDI was calculated using new method. New HDI component are life expectancy at birth, expected years of schooling, means years of schooling, and expenditure per capita

Table 1-1. Share of GDP by Sector, 2010–2016 (in percent)

No.	Sector	2010	2011	2012	2013	2014	2015	2016*
1	Agriculture, Forestry and Fishery	13.93	13.51	13.37	13.36	13.34	13.49	13.47
2	Mining and Quarrying	10.46	11.81	11.61	11.01	9.83	7.65	7.18
3	Manufacturing	22.04	21.76	21.45	21.03	21.08	20.99	20.51
4	Electricity and Gas	1.06	1.17	1.11	1.03	1.09	1.13	1.15
5	Water Supply, Sewerage, Waste Management and Remediation Activities	0.09	0.08	0.08	0.08	0.07	0.07	0.07
6	Construction	9.13	9.09	9.35	9.49	9.86	10.21	10.38
7	Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles	13.46	13.61	13.21	13.21	13.43	13.30	13.18
8	Transportation and Storage	3.57	3.53	3.63	3.93	4.42	5.02	5.20
9	Accommodation and Food Service Activities	2.92	2.86	2.93	3.03	3.04	2.96	2.93
10	Information and Communication	3.73	3.60	3.61	3.57	3.50	3.52	3.62
11	Financial and Insurance Activities	3.49	3.46	3.72	3.88	3.86	4.03	4.19
12	Real Estate Activities	2.89	2.79	2.76	2.77	2.79	2.84	2.82
13	Business Activities	1.44	1.46	1.48	1.51	1.57	1.65	1.71
14	Public Administration and Defence; Compulsory Social Security	3.78	3.89	3.95	3.90	3.83	3.90	3.87
15	Education	2.94	2.97	3.14	3.22	3.23	3.36	3.37
16	Human Health and Social Work Activities	0.97	0.98	1.00	1.01	1.03	1.07	1.07
17	Other Service	1.47	1.44	1.42	1.47	1.55	1.65	1.70
	Gross value added at basic price	**97.37**	**98.01**	**97.84**	**97.51**	**97.51**	**96.85**	**96.42**
	Taxes less subsidies on products	**2.63**	**1.99**	**2.16**	**2.49**	**2.49**	**3.15**	**3.58**
	Gross domestic products	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Note: * Preliminary figures; (Source: BPS, 2018)

Table 1-2. Development of Indonesian GDP and Exchange Rate

	2010	2011	2012	2013	2014	2015	2016*
GDP in **trillion IDR(current price)**	6864	7832	8616	9546	10570	11526	12407
GDP/cap in million IDR (current price)	28.8	32.4	35.1	38.4	41.9	45.1	48.0
GDP (constant price 2010), in **trillion IDR**	6864	7288	7727	8156	8565	8983	9435
GDP/cap in million IDR (constant price 2010)	28.8	30.1	31.5	32.8	34.0	35.2	36.5
GDP Growth (%)	6.2	6.2	6.0	5.6	5.0	4.9	5.0
Exchange rate, (000 IDR/USD)							

Note: * Preliminary figures; (Source: BPS, 2018)

Table 1-3. Human Development Index By Component

HDI Component	2010	2011	2012	2013	2014	2015	2016
Life Expectancy (e_o)	69.81	70.01	70.20	70.40	70.59	70.78	70.90
Expected Years of Schooling (EYS)	11.29	11.44	11.68	12.10	12.39	12.55	12.72
Mean Years of Schooling (MYS)	7.46	7.52	7.59	7.61	7.73	7.84	7.95
Per Capita Expenditure (000)	9 437	9 647	9 815	9 858	9 903	10 150	10 420
Human Development Index	66.53	67.09	67.70	68.31	68.90	69.55	70.18

(Source: BPS, 2016)

Table 1-4. Indonesian poverty and inequality statistics during March 2005-2016

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Relative Poverty (% of population)[1]	15.97	17.75	16.58	15.42	14.15	13.33	12.49	11.96	11.37	11.25	11.22	10.86
Absolute Poverty (in millions)[1]	35.1	39.3	37.17	34.96	32.53	31.02	30.02	29.13	28.07	28.28	28.59	28.01
Gini Coefficient (Gini Ratio)	0.36	-	0.38	0.37	0.37	0.38	0.41	0.41	0.41	0.41	0.41	0.40

(Source: BPS, 2018)

1.2 Sectoral Conditions

1.2.1 Energy Sector

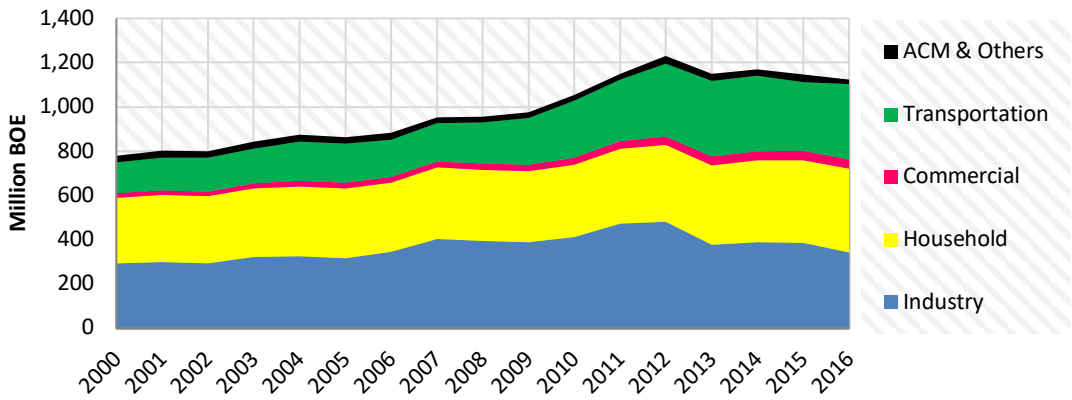
Indonesia's energy supply comes from the exploitation of its wide range of energy resource endowments and from fuel imports, especially oil. Energy resource exploitation also generates government revenues from sales, to domestic and export markets through royalties and taxes (Ministry of Energy and Mineral Resources of Indonesia, MEMR, 2018).

The final energy consumption has developed in line with the economic and population development (Figure 1-3). The final energy consumption was 1,122 million BOE in 2016, dominated by residential, industrial, and transport sectors (Source: MEMR, 2018). In the period of 2000-2012, the total final energy consumption grew steadily at an average rate of 3.7% per annum. However, after 2012, the consumption has been fluctuating but tend to decline. In the period of 2013-2016, the final energy consumption declined at an average rate of –2.2% per annum.

Table 1-5. Indonesia's Energy Resources in 2017

Energy Resource	Reserve	Resource	Production per year (2017)	R/P (Year)
Oil (billion barrels)	7.53		0.292	26
Natural gas (TSCF*)	143		2.9	48
Coal (billion tons)	24	125	0.461	52.1
Coal Bed Methane (TSCF*)		453	-	-
Shale gas (TSCF*)		574	-	-
Potential power				
Hydro	75 GW			
Geothermal	29 GW			
Mini and micro-hydro	19 GW			
Bioenergy**	33 GW			
Solar	208 GW			
Ocean Energy***	18 GW			
Wind	61 GW			

*TSCF: trillion standard cubic feet,
** Total of biomass, biofuels, biogas,
*** Wave, OTEC, tidal power
Source: (2016 EBTKE Statistics published by the Directorate General of New and Renewable Energy and Energy Conservation) and HEESI 2018

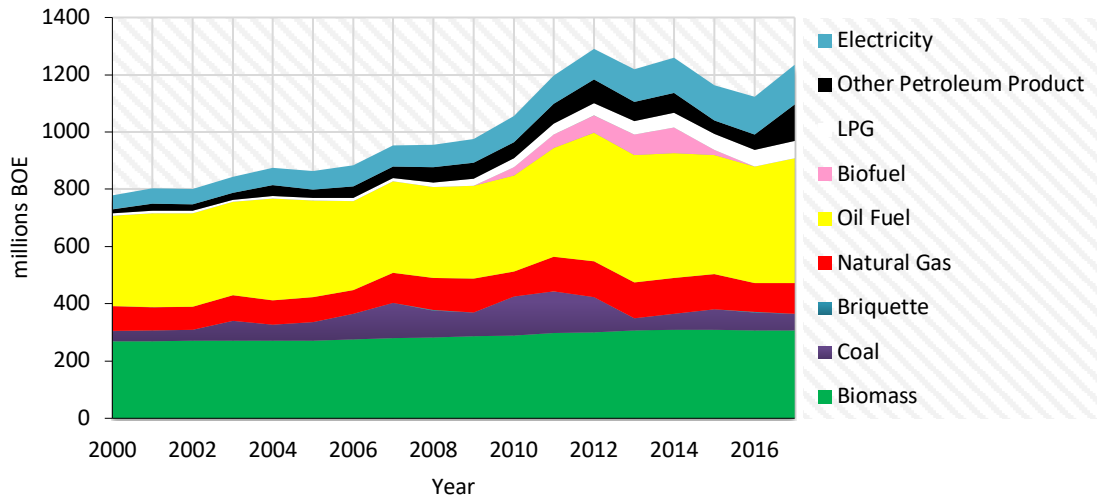


(Source: MEMR, 2018)
Figure 1-3. Development of final energy consumption (including biomass) by sector

The major energy consumers in Indonesia are the household, industry, and transport sectors. In 2016, the shares of these sectors are respectively, 33.7%, 30.6%, 30.2%. The sectors that experienced high consumption growth are transport (6.7% per annum), commercial (4.7%) and industry (4.6%) sectors.

Figure 1-3 indicates that the final energy consumption differs from those presented in the TNC. The difference was due to the difference in data sources referred in the TNC and in this BUR reports. In the TNC, the fuels consumption data for 2000-2014 refer to yearly publication of the Handbook of Energy and Economics Statistics of Indonesia (HEESI) of 2001 until 2016. The data presented in this 2nd BUR refers to HEESI 2016 and 2018. The energy consumption data in HEESI 2016 revised the corresponding data for 2000-2006. The energy consumption data in HEESI 2018 revised the corresponding data for 2007-2016.

By fuel type (Figure 1-4), oil fuels has been dominating the final energy consumption. In 2016, the highest share in final energy consumption is oil fuels (36.3%), followed by biomass (27.3%), electricity (11.3%), natural gas (9.0%), coal (5.7%) and LPG (5%). Biomass is primarily consumed for cooking purposes among the rural households. Other biomass energy consumers include agro industry, small and medium industries, and commercial sectors (restaurants). The fuel type that experienced high annual consumption growth are biofuels (33.9%), LPG (13.9%) and electricity (6.5%). On the contrary the annual consumption growth of coal, oil fuels and natural gas were relatively low of only 3.6%, 1.6%, and 0.9% respectively. The high biofuel consumption growth has resulted from the implementation of biofuel mandatory policy enacted by the Ministry of Energy and Mineral Resources (MEMR). The high growth in LPG consumption was due to the government policy that promotes the shift of residential cooking fuel from kerosene to LPG by reallocating residential sector energy subsidy from kerosene to LPG.

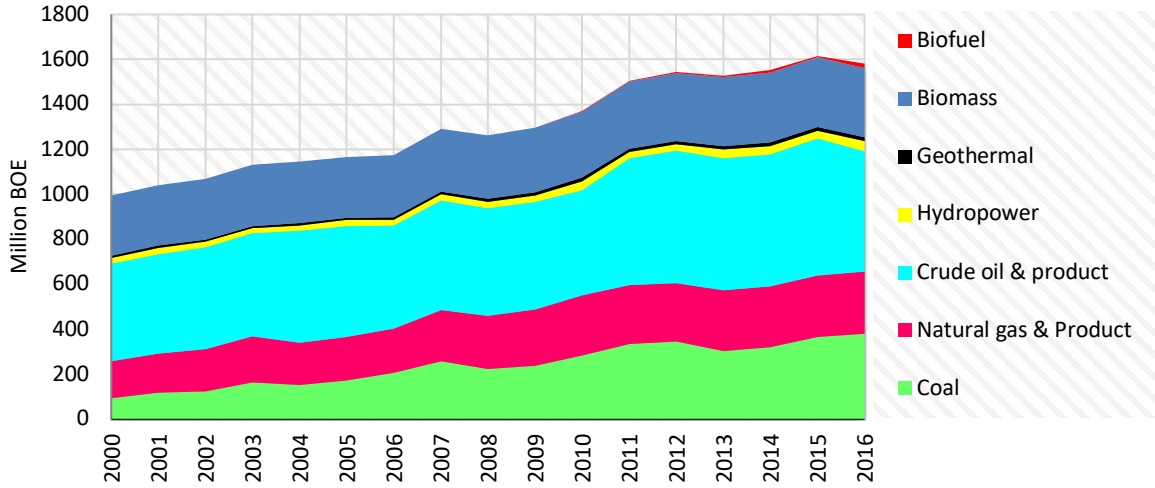


(Source: MEMR, 2018)

Figure 1-4. Development of final energy demand by fuel type

The development of primary energy supply in 2000-2016 is presented in Figure 1-5. In this period, the primary energy supply grew at an average rate of 3% per annum. Figure 1-5 indicates that the majority primary energy supplies are oil, coal, biomass and natural gas. The shares of these fuels in 2016 were respectively, 33.8%, 24.1%, 19.4% and 17.5%. Since Indonesia became the net oil importer in 2004, for energy security reasons, the government has been attempting to shift from oil by promoting energy that are abundantly available within the country i.e. coal, natural gas and renewable energy. These attempts have resulted in the high growth of coal supply (9.1% per year), much higher than the growth of natural gas (3.3% per year) and oil (1.3% per year). These growths have resulted in the decrease of oil share

in the supply mix, from 43.5% in 2000 to 33.8% in 2016, and increase of coal share, from 9.4% in 2000 to 24.1% in 2016.



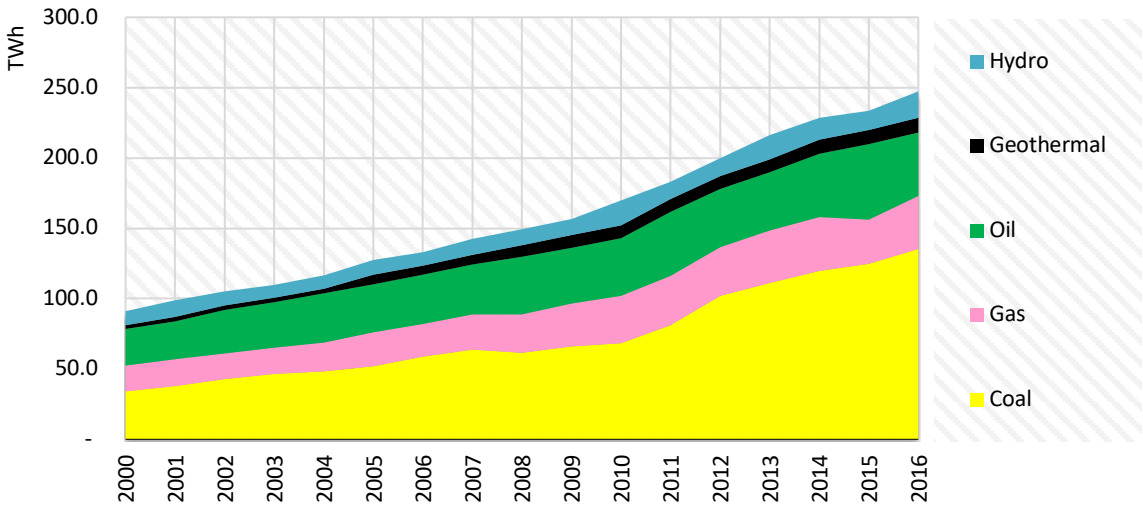
(Source: MEMR, 2018)
Figure 1-5. Development of primary energy supply

The share of electricity in the final energy consumption has been steadily increasing from 6.2% in 2000 to 11.8% in 2016. Between 2000 and 2016, the electricity consumption has grown at an average rate of 6.5%, from 79 TWh in 2000 to 216 TWh in 2016. The electricity consumption was supplied by 59 GW power plant in 2016, an increase from the 37 GW in 2000, which translated to an average annual growth of around 3.0% per annum. Indonesia's electricity is generated using fossil fuels (coal, natural gas, crude oil) and renewable energy sources (hydropower, geothermal, and other R.E: solar PV, wind). Figure 1-6 shows the development of power generation by types of energy sources. In the period of 2000-2016, the electricity generation that have experienced high growths were geothermal (11% per annum) and coal (9.0% per annum). Hydropower, gas fuelled and oil-fuelled power plants grew annually at a rate of 6%, 5% and 4%, respectively. The high growth of coal plants had resulted in significant increase of coal share in the power generation mix, from 37.3% in 2000 to 54.7% in 2016. Despite the high growth, the share of geothermal in power mix was still low, i.e. 4.3% in 2016. Overall, the renewable fuel accounted for around 12% of the total electricity generation in 2016.

1.2.2 Industry Sector

As previously mentioned, 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 sub-sectors include manufacturing, mining and quarrying, which together account to around 28% of the Indonesia's GDP in 2016 (Ministry Of Industry Republic of Indonesia, 2017:59).

Amid 2012-2016, the overall annual growth of industry sector is slightly declined from 6.0% (2012) to 5.0% (2016). Similarly, in the same period, the growth of Non-Oil & Gas Industry sub-sector have also declined from 7.0% (2012) to 4.4% (2016). Among the Non-Oil & Gas Industries, the sub-sectors that had relatively high annual growth in 2016 were Food & Beverages Industry (8.46%), Leather, Leather Products, and Footwear Industry, the Machinery Industry (8.15 %), Chemical, Pharmaceuticals, and Traditional Medicine Industry (5.48%) and Non-Metallic Mineral Industry (5.46%). Details of the annual growth of the Non-Oil and Gas Industry in 2012-2016 is listed in Table 1-6.



(Source: MEMR, 2018)
Figure 1-6. Development of power generation mix

Table 1-6. The Annual Growth of Non-Oil & Gas Industry 2012 – 2016 (in Percent)

No.	Non-Oil & Gas Industry Sub-Sector	2012	2013	2014	2015	2016
1	Food & Beverages Industry	10.33	4.07	9.49	7.54	8.46
2	Tobacco Products Industry	8.82	-0.27	8.33	6.24	1.64
3	Textile and Apparel Industry	6.04	6.58	1.56	-4.79	-0.13
4	Leather, Leather Products, and Footwear Industry	-5.43	5.23	5.62	3.97	8.15
5	Wood, Wood & Cork Products, and Bamboo & Rattan Plaiting Products Industry	-0.80	6.19	6.12	-1.63	1.80
6	Paper and Paper Products Industry; Printing and Reproduction of Recorded Media	-2.89	-0.53	3.58	-0.16	2.16
7	Chemical, Pharmaceuticals, and Traditional Medicine Industry	12.78	5.10	4.04	7.61	5.48
8	Rubber, Rubber Products, and Plastics Industry	7.56	-1.86	1.16	5.04	-8.34
9	Non-Metallic Mineral Industry	7.91	3.34	2.41	6.03	5.46
10	Basic Metals Industry	-1.57	11.63	6.01	6.21	0.76
11	Fabricated Metal Products Industry; Computer, Electronic and Optical Products Industry; and Electrical Equipment Industry	11.64	9.22	2.94	7.83	4.34
12	Machinery and Equipment Industry	-1.39	-5.00	8.67	7.58	5.05
13	Transport Equipment Industry	4.26	14.95	4.01	2.40	4.52
14	Furniture Industry	-2.15	3.64	3.60	5.17	0.47
15	Other Industry; Repair and Installation of Machinery and Equipment	-0.38	-0.70	7.65	4.66	-2.91
Non Oil & Gas Industry		**6.98**	**5.45**	**5.61**	**5.05**	**4.42**
National GDP		**6.03**	**5.56**	**5.01**	**4.88**	**5.02**

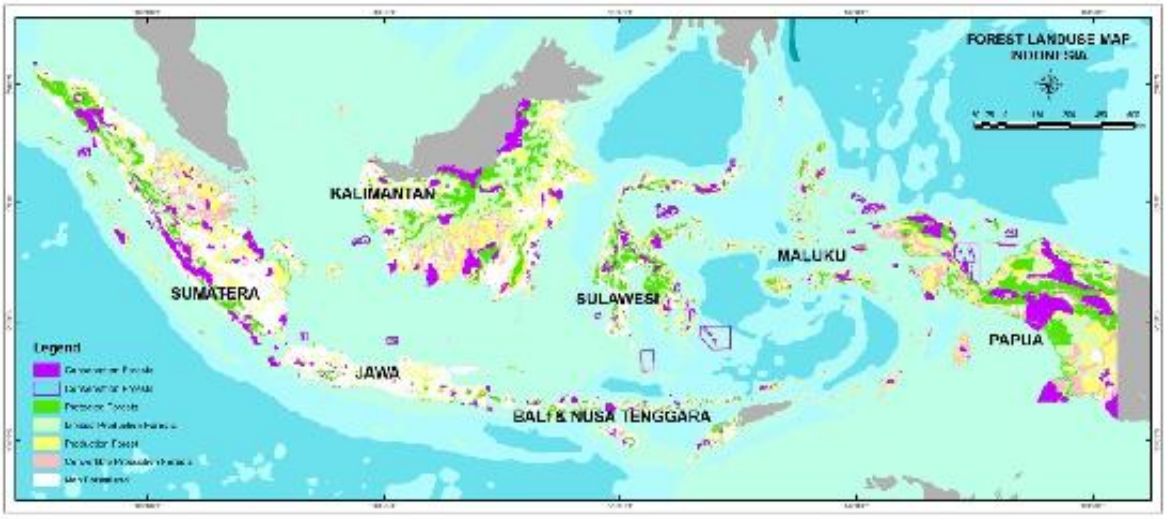
(Source: Ministry of Industry Republic of Indonesia, 2017)

1.2.3 Forestry Sector

Indonesia as an Equatorial country has large tropical forests. Forest resources are very important and proven to provide life and livelihood for the environment and socio-economic conditions of the country. Forest resources support the lives of 48.8 million people (Ministry of Forestry, 2010), of which 60% are directly dependent on shifting cultivation, fishing, hunting, collecting, logging and selling timber and non-timber forest products (Nandika 2005). In addition to short-term benefits in the form of wood, forests also provide very long-term benefits that are very diverse, 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 (Pusdatin, 2016)

In general, Indonesia recognises 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). Production Forest is further classified as Permanent Production Forest (HP), Limited Production Forest (HPT) and Convertible Production Forest (HPK). The total forest land use areas in Indonesia in 2016 was 120,635 thousand hectares, of which 22,110 thousand hectares are classified as Conservation Forest (HK), 29,680 thousand hectares as Protection Forest (HL), 29,248 thousand hectares as Production Forest (HP), 26,789 hectares as Limited Production Forest (HPT), and 12,808 thousand hectares as Convertible Production Forest (HPK; MoEF, 2016).



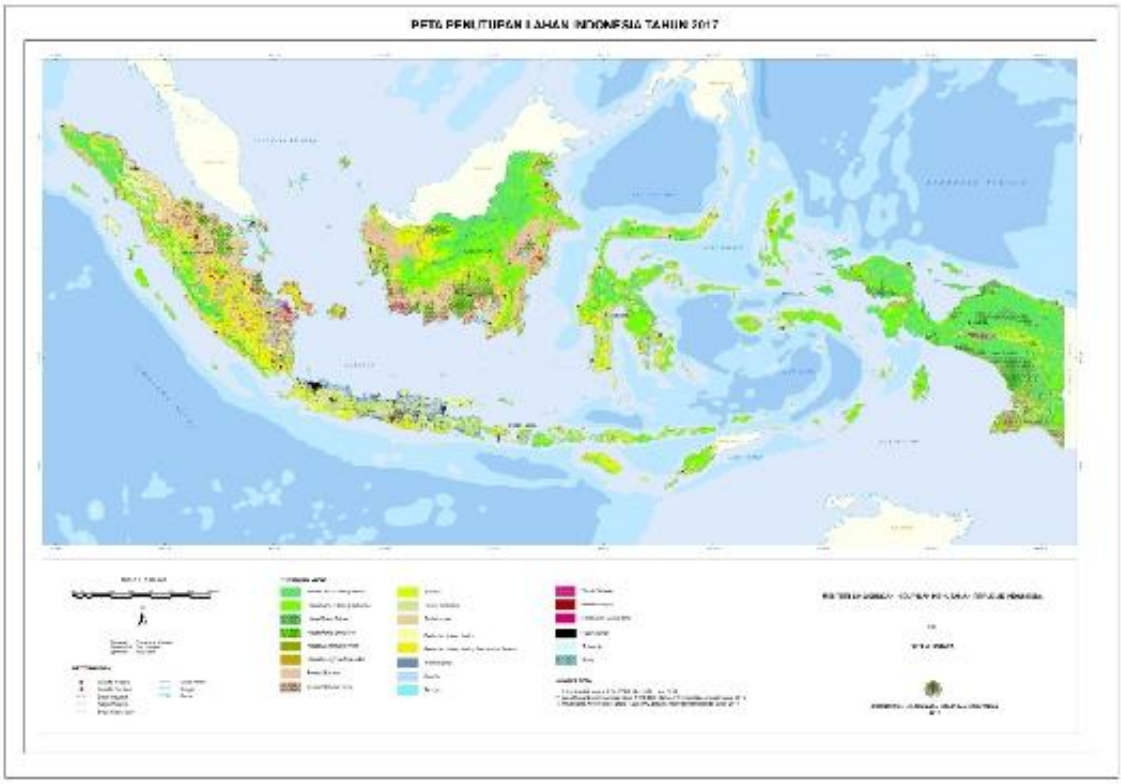
(Source: Ministry of Environment and Forestry, 2016)
Figure 1-7. Forest function designation map based on Minister of Forestry Decree

The certainty of forest land status is an important factor in the efforts to conserve forests, but the certainty of the status of forest land does not guarantee that the region is covered with forests. Table 1-8 shows that the total forest cover area is 95.272 thousand hectares in 2016, while in the APL area is 7.544 thousand hectares.

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 programme, while in Kalimantan Island, deforestation was mainly due to excessive timber harvesting (Ministry of Environment, 2003). It is presumed that logging alone was not responsible for deforestation of Indonesia's tropical forests. 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;

In addressing the causes of deforestation and forest degradation, Indonesia has issued and implement five priority policies to namely (i) combating illegal logging and forest fire, (ii) restructuring of 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 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 GoI has established Forest Management Unit (*Kesatuan Pengelolaan Hutan*–KPH) in each province. As per December 2016, there were about 205 units of KPHs in Indonesia with a total area of 26.75 million hectare. These units consisted of 39 units of KPHL (Protection KPH) model managing around 3.5 million hectare of land and 67 units of KPHP (Production KPH) model managing 12.89 million hectares of land. In addition, until the end of December there were around 99 units of KPHK (Conservation KPH) that were established, consisted of 38 National Parks (Taman Nasional, or TN) and 61 Non-TN (MoEF, 2016).



(Source: Ministry of Forestry, 2017)
Figure 1-8. Land cover map of Indonesia in 2017

1.2.4 Agriculture Sector

Indonesia with the potential of land availability of about 200 million ha is very potential for the development of agriculture sector. There are four primary types of lands under agriculture sector in Indonesia, namely Paddy Field (*Sawah,* consisted of irrigated and non-irrigated paddy fields), Dry Field/Garden (*Tegal/Kebun),* Shifting Cultivation (*Ladang/Huma),* and Temporarily Increased Land. Table 1-9 shows there was a 1.16% increased of paddy field area, from 8 million ha in 2016 to 8.2 million ha, however there was a 2.66 % decreased of dry field area in 2016. As a whole, the land area by utilization can be recognised from Table 1-7.

Table 1-7. Land Area by Utilization in Indonesia, 2012 – 2016 (ha)

No.	Land Type	2012	2013	2014	2015	2016
1	Paddy field	8.132.345,91	8.128.499,00	8.111.593,00	8.092.906,80	8.186.469,65
	a. Irrigated paddy field	4.417.581,92	4.817.170,00	4.763.341,00	4.755.054,10	4.781.494,65
	b. Non irrigated paddy field	3.714.763,99	3.311.329,00	3.348.252,00	3.337.852,70	3.404.975,00
2	Dry Field/Garden	11.947.956,00	11.838.770,00	12.033.776,00	11.861.675,90	11.546.655,70
3	Shifting Cultivation	5.262.030,00	5.123.625,00	5.036.409,00	5.190.378,40	5.073.457,40
4	Temporarily Unused Land	14.245.408,00	14.162.875,00	11.713.317,00	12.340.270,20	11.957.735,70

(Source: Ministry of Agriculture, 2017)

(Source: Ministry of Agriculture, 2017)

Figure 1-9. Agricultural lands area by utilization in 2012-2016

Table 1-8. Forestland cover of Indonesia in 2016 (Thousand Ha)

NO	LAND COVER	FOREST FUNCTION							APL	TOTAL
		Permanent Forest					HPK	Sub Total		
		HK	HL	HPT	HP	Sub Total				
1	2	3	4	5	6	7	8	9	10	11
A. Forest										
1	Primary Forest	10.943,7	13.591,7	7.949,3	3.859,3	36.344,0	1.807,5	38.151,5	1204,6	39.356,1
2	Secondary Forest	3.222,7	7.740,3	10.767,1	7.676,3	29.406,4	3.110,4	32.516,8	3989,3	36.506,1
3	Primary Swamp Forest	1.088,4	1.007,3	1.645,2	674,8	4.415,8	608,4	5.024,2	156,5	5.180,7
4	Secondary Swamp Forest	1.444,7	601,7	578,6	1.977,4	4.602,4	579,6	5.182,0	740,5	5.922,5
5	Primary Mangrove Forest	433,1	547,7	72,2	133,8	1.186,8	167,1	1.353,9	129,7	1.483,6
6	Secondary Mangrove Forest	155,6	306,1	171,9	234,1	867,7	149,4	1.017,1	381,9	1.399,1
7	Plantation Forest *	137,0	299,1	352,6	3.661,7	4.450,4	32,3	4.482,7	941	5.423,7
	Area of Forest	**17.425,2**	**24.093,9**	**21.536,8**	**18.217,5**	**81.273,5**	**6.454,8**	**87.728,3**	**7.543,6**	**95.271,9**
B. Non Forest										
8	Shrubs	744,5	1.515,9	1.529,5	2.720	6.509,6	1.016,8	7.526,4	5.591,4	13.117,8
9	Swamp Shrubs	1.269,3	501,6	508,7	1.830	4.109,1	1.066,7	5.175,9	2.541,7	7.717,6
10	Savannah	537,2	360,2	155,5	227	1.280,2	467,5	1.747,6	1.166,8	2.914,4
11	Plantation	100,3	175,4	405,1	1.258	1.938,2	1.211,9	3.150,1	11.567,4	14.717,5
12	Dryland Farming	169,7	464,8	281,0	556	1.471,6	253,2	1.724,8	7.990,3	9.715,1
13	Mixed Dry Land Agriculture Bush	747,6	1.988,9	1.912,7	2.765	7.413,7	1.635,1	9.048,8	17.663,8	26.712,6
14	Transmigration Area	0,9	0,5	0,3	9	10,8	6,5	17,3	250,3	267,6
15	Field Rice	29,0	62,7	34,4	123	249,2	56,2	305,4	7.535,8	7.841,2
16	Fishpond	43,7	121,5	13,6	168	347,1	1,8	348,9	574,7	923,6
17	Bare Land	467,1	310,3	254,9	902	1.934,7	258,4	2.193,0	1.192,5	3.385,5
18	Mining Area	7,3	23,4	19,5	181	230,9	62,2	293,1	383,9	677,0
19	Settlement	8,6	15,6	7,4	25	56,2	22,0	78,2	3.006,4	3.084,6
20	Swamp	348,5	45,4	129,0	268	790,5	294,9	1.085,4	298,7	1.384,0
21	Harbour/ Airport	0,1	0,1	0,2	0	0,5	0,1	0,7	20,6	21,3
	Non Forested Area	**4.473,8**	**5.586,4**	**5.251,8**	**11.030,2**	**26.342,2**	**6.353,3**	**32.695,6**	**59.784,4**	**92.480,0**
Total Forested **Area** + Non Forest		**21.898,9**	**29.680,5**	**26.788,6**	**29.247,7**	**107.615,7**	**12.808,1**	**120.423,8**	**67.328,0**	**187.751,9**

(*Source:MoEF, 2016*)

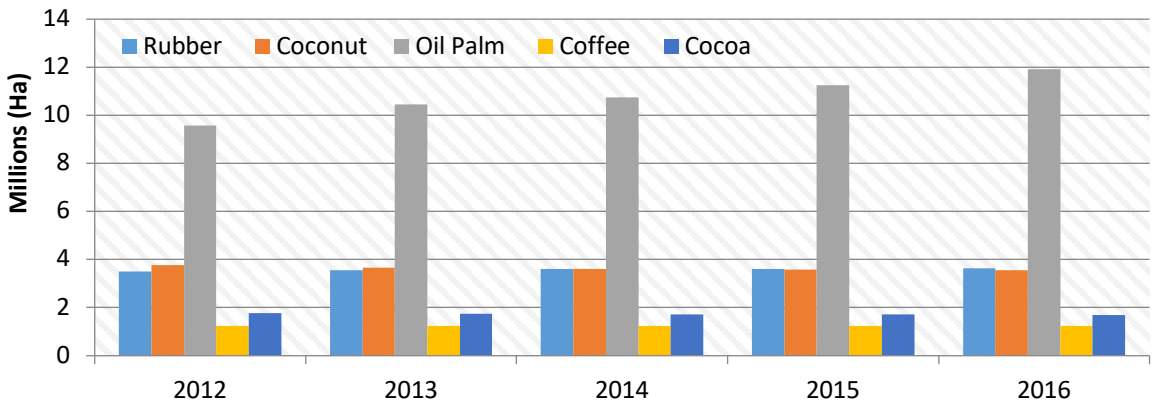
Table 1-9. Production and Harvested Area of Paddy in Indonesia, 2012 – 2016

No.	Commodities	2012	2013	2014	2015	2016
1	Paddy Production (000, ton)	69.056	71.280	70.846	75.398	79.355
	Paddy Harvested Area (000, Ha)	13.446	13.835	13.797	14.117	15.156
2	Wetland Paddy Production (000, ton)	65.188	67.392	67.102	71.766	75.483
	Wetland Paddy Harvested Area (000, Ha)	12.281	12.672	12.666	13.029	13.985
3	Dryland Paddy Production (000, ton)	3.868	3.888	3.744	3.631	3.872
	Dryland Paddy Paddy Harvested Area (000, Ha)	1.164	1.163	1.131	1.087	1.171

(Source: Ministry of Agriculture, 2017)

Table 1-9 shows a quite significant increase in the overall harvested area and paddy production. In the period 2012 – 2016, the annual growth of paddy harvested area and production are at a rate of 3.07% and 3.57% respectively.

Concerning the estate crops area, the growth of palm oil plantation has increased significantly over the last five years (Source: Ministry of Agriculture, 2017) Figure 1-10). The figure shows there was an annual increase of estate crops area. Between 2012 and 2016, the average growth of oil palm plantation increased approximately 5.7% from about 9.5 million ha to 11.9 million ha. Rubber areas have also increased about 0.9%. The area of estate crops in Indonesia can be recognised from Table 1-10.



(Source: Ministry of Agriculture, 2017)

Figure 1-10. Development of estate crops area in 2011-2014

Table 1-10. Areas of Estate Crops in Indonesia, 2012 – 2016

No.	Area	2012	2013	2014	2015	2016
1	Rubber	3.506.201	3.555.946	3.606.245	3.621.106	3.639.092
2	Coconut	3.781.649	3.654.478	3.609.812	3.585.599	3.566.103
3	Oil Palm	9.572.715	10.465.020	10.754.801	11.260.277	11.914.499
4	Coffee	1.235.289	1.241.712	1.230.495	1.230.001	1.228.512
5	Cocoa	1.774.464	1.740.612	1.727.437	1.709.284	1.701.351

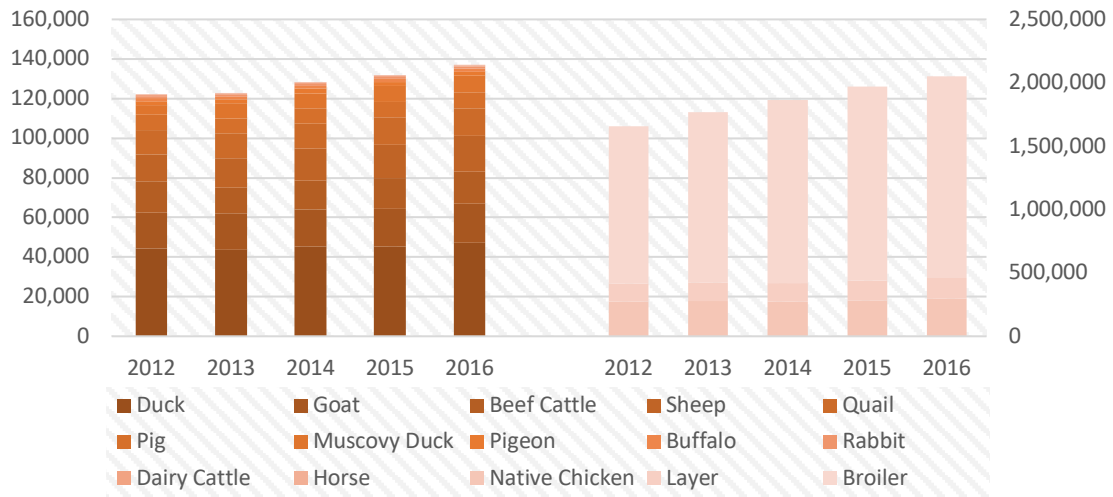
(Source: Ministry of Agriculture, 2017

The livestock population in Indonesia is generally shows a steady increased in the period 2012-2016. Table 1-11 and Figure 1-11 show that poultry, especially broilers, are the main contributors to livestock population, followed by goats, beef cattle and sheep.

Table 1-11. Livestock Population in Indonesia, 2012 – 2016

No	Population	2012	2013	2014	2015	2016
1	Beef Cattle	15.981	12.686	14.727	15.420	16.093
2	Dairy Cattle	612	444	503	519	534
3	Buffalo	1.438	1.110	1.335	1.347	1.386
4	Horse	437	434	428	430	438
5	Goat	17.906	18.500	18.640	19.013	19.608
6	Sheep	13.420	14.926	16.092	17.025	18.066
7	Pig	7.900	7.599	7.694	7.808	8.114
8	Native Chicken	274.564	276.777	275.116	285.304	298.673
9	Layer	138.718	146.622	146.660	155.007	162.051
10	Broiler	1.244.402	1.344.191	1.443.349	1.528.329	1.592.669
11	Duck	44.357	43.710	45.268	45.322	47.360
12	Muscovy Duck	4.938	7.645	7.414	7.975	8.263
13	Rabbit	1.075	1.137	1.104	1.103	1.128
14	Quail	12.357	12.553	12.692	13.782	13.933
15	Pigeon	1.821	2.139	2.433	2.154	2.218

(Source: Ministry of Agriculture, 2017)



(Source: Ministry of Agriculture, 2017)

Figure 1-11. Development of livestock population in 2012-2016

1.2.5 Waste Sector

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 if not properly managed, namely the ingredients called "Hazardous and Toxic Materials" or B3 waste.

In addition, there are also materials that are "environment- unfriendly ", namely the materials which if not managed and or handled properly will damage the ecological order. Most of these chemical products will produce wastes in the manufacturing process, and some of these chemical products will become waste and domestic waste.

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

System of National B3 Management, the system includes an integrated application of online reporting of import and export realization, distribution and utilization of B3 and also registration and notification of B3.

Waste management is still one of the major environmental problems in Indonesia. Domestic waste generation is projected to increase annually, in line with population growth. The MoEF estimated that in 2016, an amount of 65.2-million-tonnes of domestic wastes were generated. The number is estimated to increase in 2018 to be 66.5 million ton; while in 2020 and 2025, the domestic waste generation is expected to be 67.8 million tonne and 70.8 million tonne, respectively. The government has set the policy for the reduction of waste generation and the improvement of waste generation management. Reduction of domestic waste is targeted to be 30% or equal to 20.9 million ton of waste in 2025 (Presidential Regulation number 97/2017).

The Clean City program or Adipura Program, in 2013, described the pattern of domestic waste management in urban area are dominated by a "collect, transport and dump" system. New paradigm on waste management was then being developed through several activities, such as waste reduction at source, reuse and recycle, extended producer responsibility, waste to energy, and improvement on solid waste disposal sites. Such activities are expected to solve domestic waste management problem that occur in Indonesia.

1.2.6 Water Sector

As an archipelagic country, Indonesia constitutes 6% of the world's freshwater reserve or approximately 21% in the whole Asia-Pacific region (Ministry of Public Works, 2007). In 2011, the annual per capita water availability was 16,800 m^3, much higher than the average world's availability of 8,000 m^3 per capita (Ministry of Environment 2011).

However, Indonesia is a tropical country with sufficient water but approximately 70% of the available water reserves are on the Islands of Kalimantan and Papua, which are inhabited by only 13% of the total population, while in Java and Bali, water demand exceeds supply.

Simultaneously, Indonesia is affected by floods every year. Environmental problems, such as erosion, soil degradation and depletion of groundwater resources, also present challenges for effective water management (Netherlands Water Partnership, 2016).

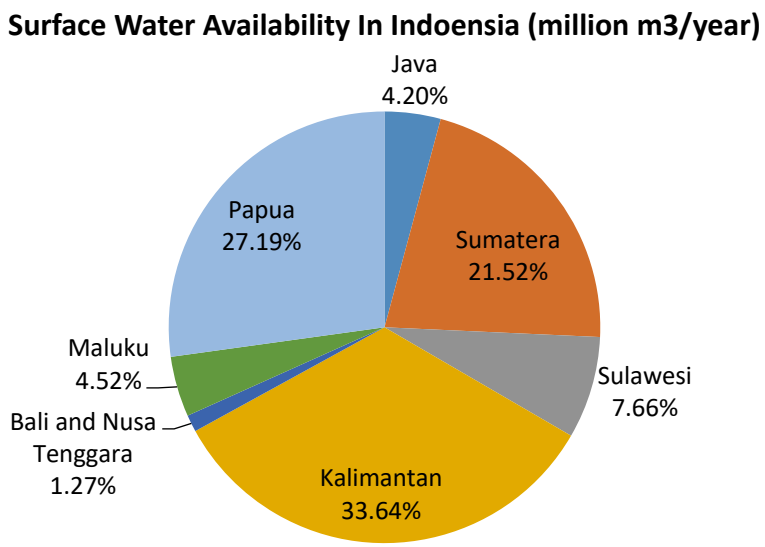
The water resources potentials of each island are the accumulation of the interaction between rainwater, groundwater, and surface water (Ministry of Environment 2012). Table 1-12 and Figure 1-12 illustrates the surface water availability of the main islands in Indonesia in 2012, of which the surface water in Papua and Kalimantan Islands account for more 50% of the national surface water availability.

Table 1-12. Surface Water Availability in Indonesia

Islands	Water Availability (million m3/year)		
	Q-average	Q-80%	Q-90%
Java	164.000	88.909	69.791
Sumatera	840.737	571.703	485.732
Sulawesi	299.218	184.478	154.561
Kalimantan	1.314.021	900.381	727.301
Bali and Nusa Tenggara	49.620	35.632	32.165
Maluku	176.726	132.103	117.296
Papua	1.062.154	794.496	716.443
Total Indonesia	3.906.476	2.707.702	2.303.289

m3 = cubic meter, Q = quarter.

Source: Hatmoko et al. 2012. Water Balance of Water Availability and Water Demand in Indonesia River Basins, Water Resources Research Agency, Bandung



(Source: Hatmoko et al. 2012)
Figure 1-12. Surface water availability in 2012

1.2.7 Coastal and Marine Sector

BIG (2018) states that Indonesia is the largest archipelago in the world consisting of 17,504 islands stratches from Sabang to Merauke. The total area of Indonesia is 8.3 million km^2 consisted of 1.92 million km^2 of land area and 3.25 million km^2 of water body with 3 million km^2 Exclusive Economic Zone (ZEE).

Having its water area greater that its inland area has increase the significance of Indonesia coastal and marine resources, because coastal and marine areas provide various natural, biological and non-biological resources of high economic and ecological values. Coastal area has high economic value with very important natural resources and environmental services potentials.

About 60% or the 150 million people of the total Indonesian population living in coastal areas and around 80% of industries are located in coastal areas due to easier access to transportation to the trade centres. The impacts of natural resources utilization in the coastal area has create some threats to the preservation of very critical ecosystems. There are several regions with potential resources that have not yet been optimally utilized (Adrianto et al., 2015).

The Ministry of Marine Affairs and Fisheries noted that Indonesia marine ecosystem is one of the largest home to a rich diversity of coral reefs. LIPI (2015) states that 30.02 percent of coral reefs locations in 1,259 locations are under inadequate conditions (live coral surface 0-24%); 37.97 percent suffered damage with adequate conditions (live coral surface 25-49 percent); 27.01 percent are still in good condition (live coral surface 50-74 percent); and only 5.00 percent in excellent condition (live coral surface 75-100 percent). Whereas, based on data from the Provincial Marine and Fisheries Service, the average damage, moderate and good percentage of coral reefs is 17.67%, percent in the whole Indonesia. The condition and extent of coral reefs in Indonesia in 2016 can be seen in

Table 1-13.

Table 1-13. Area and Condition of Coral Reef in Indonesia Period 2016

Province	Area (Ha)	Condition (%)		
		Good	Moderate	Damage
Aceh	14689,70	41,64	10,63	47,73
Sumatera Utara	111899,80	26,28	24,00	49,71
Sumatera Barat	21486,99	36,75	-	63,25
Riau	120,00	41,67	12,50	45,83
Jambi	-	-	-	-
Sumatera Selatan	10,30	23,08	23,08	53,84
Bengkulu	5772,87	68,30	18,38	13,32
Lampung	1870,87	0,30	29,13	15,98
Kepulauan Bangka Belitung	67354,17	16,77	13,28	26,57
Kepulauan Riau	-	-	-	-
DKI Jakarta	5000,00	50,00	-	50,00
Jawa Barat	7533,70	2,98	27,70	42,78
Jawa Tengah	779,66	0,10	0,01	0,89
DI Yogyakarta	5100,00	10,00	20,00	70,00
Jawa Timur	17949,24	6,80	17,10	6,85
Banten	1770,50	18,32	11,17	70,52
Bali	2585,36	52,81	38,15	9,04
Nusa Tenggara Barat	27651,62	28,96	27,69	43,36
Nusa Tenggara Timur	154,34	17,60	18,80	23,50
Kalimantan Barat	265928,74	70,00	20,00	10,00
Kalimantan Tengah	35,59	75,60	0,20	24,20
Kalimantan Selatan	13179,18	87,63	10,17	2,20
Kalimantan Timur	782775,53	0,01	0,03	0,02
Kalimantan Utara	141163,00	49,34	33,71	16,95
Sulawesi Utara	28938,80	-	-	-
Sulawesi Tengah	24733,59	60,49	-	39,51
Sulawesi Selatan	11755,07	27,00	32,00	41,00
Sulawesi Tenggara	53153,45	28,00	-	-
Gorontalo	15888,91	64,74	0,41	34,85
Sulawesi Barat	16302,00	26,30	44,74	52,03
Maluku	26729,76	64,97	16,87	18,16
Maluku Utara	-	-	-	-
Papua Barat	492665,00	32,60	42,60	24,80
Papua	232892,20	48,90	19,65	31,44
Indonesia	2503169,93	28,29	18,43	17,67

(Source: Ministry of Marine Affairs and Fisheries, 2017)

Moreover, Indonesia is a country with the largest mangrove forest in the world. The Ministry of Environment and Forestry (2006) shows that Indonesia's mangrove forest area reached a total of 4.3 million hectares. Mangrove forests in Indonesia spread throughout the provinces. Table 1-14 shows that Papua Province has the largest mangrove area, accounts to 1.1 million hectares or 29.05 percent of the total mangrove area in Indonesia, while the smallest mangrove area is in DI Yogyakarta Province, which is 40.10 hectares. Based on data from Ministry of Marine Affairs and Fisheries (2017) the total area of mangrove forest has decreased to 3.9 million hectares in 2016, with mangrove damage in 2016 estimated at 52%. The biggest damage is found in South Sulawesi Province.

Table 1-14. Area and Condition of Mangrove Forest in Indonesia Period 2016

Province	Area (Ha)	Good	Moderate	Damage
Aceh	58.985.57	23.15	56.32	20.53
Sumatera Utara	175.428,80	15,28	51,04	33,67
Sumatera Barat	33.824,09	70,00	-	30,00
Riau	175.607,64	0,36	0,24	0,17
Jambi	12.255,62	84,71	10,70	4,59
Sumatera Selatan	571.778,30	-	-	-
Bengkulu	2.142,25	89,01	4,74	6,26
Lampung	2.162,89	0,20	22,65	17,80
Kepulauan Bangka Belitung	83.107,35	54,75	16,60	11,35
Kepulauan Riau	-	-	-	-
DKI Jakarta	207,29	70,00	30,00	-
Jawa Barat	27.218,36	16,23	32,34	50,54
Jawa Tengah	21.024,04	0,69	0,09	0,22
DI Yogyakarta	40,10	38,39	18,75	42,85
Jawa Timur	19.765,54	2,82	0,03	-
Banten	424,99	11,98	17,91	48,57
Bali	2.225,75	78,95	9,66	11,39
Nusa Tenggara Barat	18.356,88	65,81	28,29	5,90
Nusa Tenggara Timur	51.854,83	-	-	-
Kalimantan Barat	229.396,60	70,00	20,00	10,00
Kalimantan Tengah	-	-	-	-
Kalimantan Selatan	10.538,90	21,95	49,23	26,42
Kalimantan Timur	360.819,26	3,66	3,26	0,16
Kalimantan Utara	180.370,37	69,89	20,96	9,16
Sulawesi Utara	12.036,29	-	-	-
Sulawesi Tengah	24.733,59	60,49	-	39,51
Sulawesi Selatan	41.065,20	22,00	26,00	52,00
Sulawesi Tenggara	62.426,42	-	-	-
Gorontalo	21.101,11	30,89	27,09	42,03
Sulawesi Barat	3.226,00	30,00	40,00	30,00
Maluku	53.029,38	19,97	66,72	13,32
Maluku Utara	-	-	-	-
Papua Barat	456.395,00	0,92	0,00	0,08
Papua	1.148.948,51	-	-	-
Indonesia	3.954.996,92	12,92	8,94	5,66

(Source: Ministry of Marine Affairs and Fisheries, 2017)

To enhance marine ecosystems, interrelated institutions have carried out sustainable collaboration since 2007, and existing initiatives carried out by various parties including the government, environmental and community non-governmental organizations related to coastal and marine management. One of the many initiatives is the Coral Reef Rehabilitation and Management Program (COREMAP) with activities consisting of mapping priority areas for the rehabilitation and use of marine and coastal areas and management of mangrove rehabilitation. Another example is the Coral Triangle Initiative which aims to preserve the marine area in Indonesia, Malaysia, New Guinea, the Philippines, Solomon Islands and Timor Leste. These areas have at least 569 reef-building coral species, and have the potential to generate income and food security for more than 175 million people living in the area (MoMAF, 2017).

Currently, the government has been developing a sea highway program by increasing marine tourism. The Ministry of Tourism (2015) states that this effort to increase the number of tourists by up to 4 times in 2019 and will generate foreign exchange of USD 4 Billion. The government has also established 50 National Tourism Destinations (DPN) covering 88 National Tourism Strategic Areas (KSPN) and 222 National Tourism Development Zone (KPPN). In addition, Indonesia has a great potential to increase trade by sea because its waters are crossed by international

traffic or better known as the Indonesian Archipelago Sea Flow (ALKI).

1.3 Institutional Arrangement in Developing BUR

Presidential Regulation No. 16/2016 stipulates that the mandate for coordination of climate change governance and implementation of the Climate Change Convention at national level is assigned to the Directorate General of Climate Change, Ministry of Environment and Forestry. For the Second BUR, the DGCC, MoEF had coordinated the whole process of the development and submission the document following the institutional arrangement as summarized in Table 1-15. The coordination among sectors and directorates was similar and followed the institutional arrangement for the development of national communications as depicted in Figure 1-13.

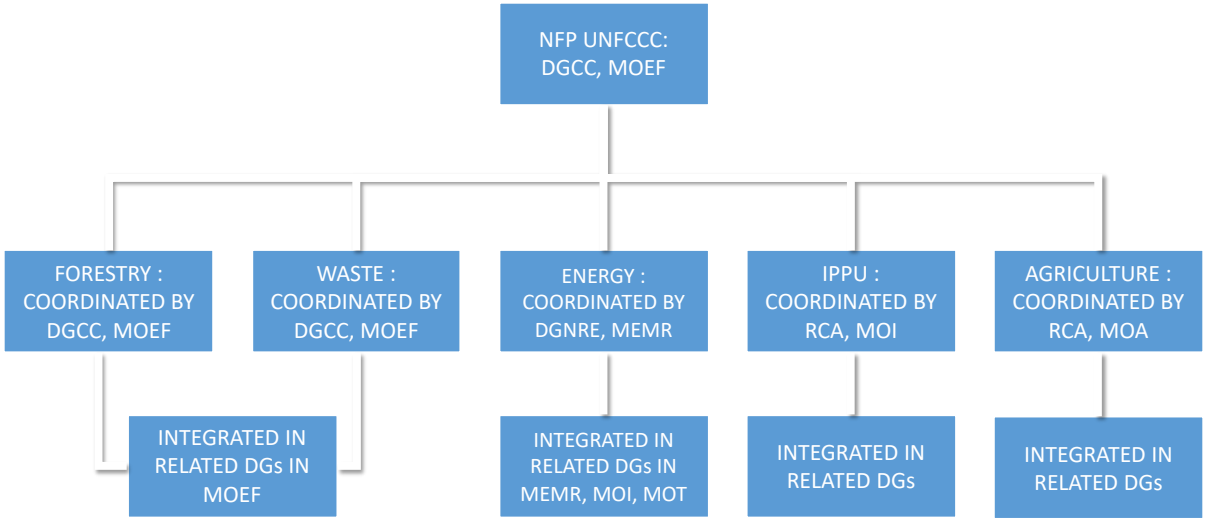


Figure 1-13. Institutional arrangement in the development of national communication

Table 1-15. Institutional arrangement for the Second BUR

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	• 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 covers GHG emission and/or removal from energy, IPPU, Agriculture, Forestry and Other land use (AFOLU), and waste sectors for the period of 2000-2016. Type of gases reported are four out of the six major GHG category 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) have not been estimated due to the lack of available data. Non-CO_2 gases, i.e. CO, NOx, NMVOC, and SOx are not obliged to be reported in the national GHG emissions inventory under the 2006 IPCC Guidelines, however the NO_x and CO are being reported in the agriculture sector.

2.2 Institutional Arrangements

The institutional arrangement of National GHG Inventory development is regulated under the Ministry Regulation No. 73/2017 on Article 9 Point (1). Annex 1 Point G of this regulation appointed responsible unit of GHG emissions sources 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 Transportatior (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-Mo 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)

Sector/Categories	Sub sectoral Responsible Units
Domestic wastewater	Directorate for Water Pollution Control-MoEF
	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 Environmenta 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, anc 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 anc 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-- Statistics Indonesia (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 anc Monitoring, Centre for Research and Development on Social Economy Policy anc 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-- Nationa Institute of Aeronautics and Space (*LAPAN)*

Furthermore, the arrangement has been set on Article 9 Point (3) that Sub sectoral Responsible Units provide data, information and the estimation related to the GHG Inventory on their subsector to the Sectoral Coordinator. Article 9 Point (4) requires Sectoral Coordinators to compile and proceed the data and information (including GHG emissions estimation) and reports them to The MoEF. Previously, sectors only provide the data, while MoEF perform the emission calculation. By the arrangement in Ministerial Decree 73/2017, sectors are also responsible to conduct the emission calculation and QA/QC. However, for the time being, sectors provide the data and also calculate the emissions through a series of data consolidation.

2.3 Overview of Sources and Sinks Category Emission Estimates for 2016

2.3.1 Time Series

The GHG inventory reported in this BUR is GHG emissions and sinks for the period of 2000 – 2016. The GHG in 2015 and 2016 are additional inventory data to the TNC, in which the GHG in 2000 – 2014 are an updated GHG inventory of the TNC document. The updated inventory covers changes in methodology (the use of higher TIER), activity data due to some revisions of data from relevant sectors, emission factors, and other relevant data of almost all sectors of GHG emissions sources and sinks (except IPPU sub-sector category). In addition, the 2nd BUR also covers additional sources (breakdown of subsector categories). The discussion of all the updated data is presented in the sub-section Sectoral Emission.

2.3.2 National Emissions

Indonesia has carried out 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 from mitigation actions for IPPU from Aluminium industry in Indonesia, while the calculation of non-CO_2 covers GHG emissions from Biomass burning under the category of Aggregate Sources and Non-CO_2 Emissions Sources on Land (AFOLU).

The national GHG inventory of emissions and sinks in 2016 shows that the total three main gases (CO_2, CH_4 and N_2O) has reached 1,457,774 Gg CO_2e. It increased by 432,153 Gg CO_2e or 42.14% from the emission level in 2000. The average annual growth of these GHG during 2000-2016 is 2.63%. The GHG was dominated by CO_2 (82.46%), followed by CH_4 (13.29%) and N_2O (4.26%). Table 2-2 presents a summary of national GHG inventory while the detail of GHG emissions and sinks data is presented in Table 2-3. Referring to Table 2-3, the main sources of the three gases are AFOLU (Agricultures, Forestry, and Land Use) and peat fire, which accounted for 51.59% of total GHG (three gasses) followed by energy, waste, and IPPU, i.e. 36.91%, 7.71%, and 3.79% respectively. Without FOLU and peat fire, energy sector was the main contributor that accounted for 65.43% of the total GHG emissions (Figure 2-1)

.

Table 2-2. Summary of National GHG Emissions in 2000 and 2016 (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
		2016	506,473	26,021	5,531			NE	NE	NE	NE	538,025
2	IPPU	2000	42,391	70	149	250	22	NO	NO	NO	NO	42,611
		2016	53,892	82	1,286	48	-	NO	NO	NO	NO	55,260
3	AFOLU	2000	510,140	50,912	39,518			2,724	70	NE	NE	600,570
		2016	638,542	61,486	52,110			3,451	94	NE	NE	752,138
4	Waste	2000	2,216	60,398	2,218			NE	NE	NE	NE	64,832
		2016	2,940	106,212	3,198			NE	NE	NE	NE	112,351
Total (CO_2-eq)		2000	839,250	141,108	45,263	250	22	2,724	70	-	-	1,025,621
		2016	1,201,847	193,801	62,125	48	-	3,451	94	-	-	1,457,774
Percentage (%)		2000	81.83	13.76	4.41	0.02	0.002	0.27	0.01	-	-	100
		2016	82.46	13.29	4.26	0.003	-	0.24	0.01	-	-	100

NE = Not Estimated; NO = Not Occurring

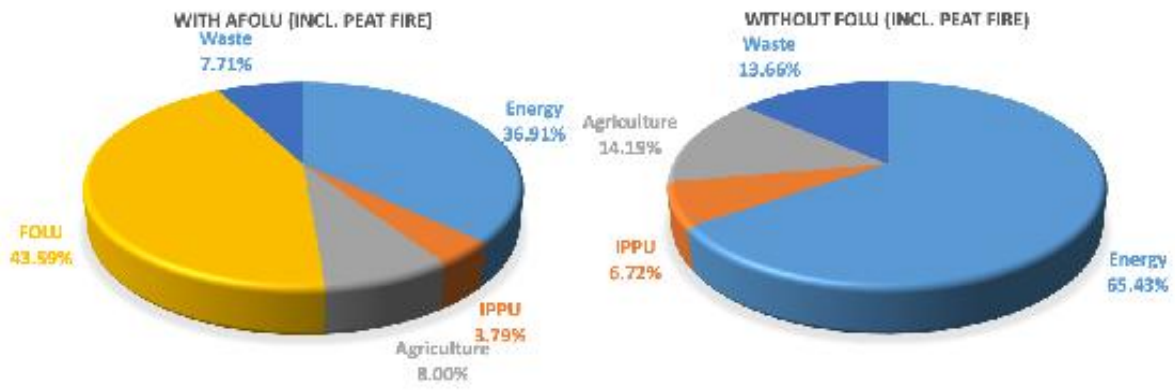


Figure 2-1. National GHG Emissions by Sector in 2016

Table 2-3. Summary of National GHG Emissions in 2016 (Gg CO2e)

Categories	Total 3 Gases	Net CO2 (1) (2)	CH4	N2O	NOx	CO	NMVOCs	SO2	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors (3)	Other halogenated gases without CO2 equivalent conversion factors (4)
	CO2 equivalents (Gg)												
Total National Emissions and Removals	**1,457,774**	**1,201,847**	**193,802**	**62,125**	**94**	**3,451**				**48**			
1 ENERGY	**538,025**	**506,473**	**26,021**	**5,531**	0	0	0	0					
1A Fuel Combustion Activities	**516,124**	**499,586**	**11,019**	**5,519**	0	0	0	0					
1A1 Energy Industries	246,851	245,837	74	940	NE	NE	NE	NE					
1A2 Manufacturing Industries and Construction	87,933	87,124	263	546	NE	NE	NE	NE					
1A3 Transport	136,405	133,518	822	2,065	NE	NE	NE	NE					
1A4a Commercial/Institutional	2,918	2,846	57	15	NE	NE	NE	NE					
1A4b Residential	33,164	21,455	9,778	1,930	NE	NE	NE	NE					
1A5 Other/Non-Specified	8,853	8,806	25	22	NE	NE	NE	NE					
1B Fugitive Emissions from Fuels	**21,901**	**6,887**	**15,002**	**12**	0	0	0	0					
1B1 Solid Fuels	1,990	NE	1,990		NE	NE	NE	NE					
1B2 Oil and Natural Gas	19,912	6,887	13,013	12	NE	NE	NE	NE					
1B3 Other Emissions from Energy Production	NE		NE		NE	NE	NE	NE					
1C Carbon Dioxide Transport and Storage	NE		NE		NE	NE	NE	NE					
1C1 Transport of CO2	NE		NE		NE	NE	NE	NE					
1C2 Injection and Storage	NE		NE		NE	NE	NE	NE					
2 INDUSTRIAL PROCESSES AND PRODUCT USE	**55,260**	**53,892**	**82**	**1,286**	NO	NO	NO	NO	**0**	**48**	**0**	**0**	**0**
2A Mineral Industry	**31,249**	**31,249**	**NE**	**NE**	NO	NO	NO	NO					
2A1 Cement Production	28,710	28,710	NE		NO	NO	NO	NO					
2A2 Lime Production	124	124	NE		NO	NO	NO	NO					
2A3 Glass Production	2	2	NE		NO	NO	NO	NO					
2A4a Ceramic production	3	3	NE		NO	NO	NO	NO					
2A4b Other Process Uses of Carbonates	2,409	2,409	NE		NO	NO	NO	NO					
2A5 Other (please specify)	0	NE	NE	NE	NO	NO	NO	NO					
2B Chemical Industry	**11,395**	**10,027**	**82**	**1,286**	NO	NO	NO	NO					
2B1 Ammonia Production	7,395	7,395	NE	NE	NO	NO	NO	NO					
2B2 Nitric Acid Production	1,286	NE	NE	1,286	NO	NO	NO	NO					

Categories	Total 3 Gases	Net CO2 (1) (2)	CH4	N2O	NOx	CO	NMVOCs	SO2	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors (3)	Other halogenated gases without CO2 equivalent conversion factors (4)
	CO2 equivalents (Gg)												
2B3 Adipic Acid Production	0	NO	NO	NO	NO	NO	NO	NO					
2B4 Caprolactam, Glyoxal and Glyoxylic Acid Production	0	NE	NE	NE	NO	NO	NO	NO					
2B5 Carbide Production	25	25	NE	NE	NO	NO	NO	NO					
2B6 Titanium Dioxide Production	0	NE	NE	NE	NO	NO	NO	NO					
2B7 Soda Ash Production	0	NE	NE	NE	NO	NO	NO	NO					
2B8a Methanol	292	259	33	NE	NO	NO	NO	NO					
2B8b Ethylene	1,783	1,734	49	NE	NO	NO	NO	NO					
2B8c Ethylene dichloride and VCM	395	394	1	NE	NO	NO	NO	NO					
2B8f Carbon Black	219	219	0	NE	NO	NO	NO	NO					
2B9 Fluorochemical Production					NO	NO	NO	NO	NE	NE	NE	NE	NE
2B10 Other (please specify)	0	NE	NE	NE	NO	NO	NO	NO	NE	NE	NE	NE	NE
2C Metal Industry	**8,732**	**8,732**	**0**	**NE**	NO	NO	NO	NO		**48**			
2C1 Iron and Steel Production	8,196	8,196	0	NE	NO	NO	NO	NO					
2C2 Ferroalloys Production	0	NE	NE	NE	NO	NO	NO	NO					
2C3 Aluminium Production	393	393	NE		NO	NO	NO	NO		48			
2C4 Magnesium Production	0	NE			NO	NO	NO	NO	NE	NE	NE	NE	NE
2C5 Lead Production	74	74			NO	NO	NO	NO					
2C6 Zinc Production	69	69			NO	NO	NO	NO					
2C7 Other (please specify)	0	NE	NE	NE	NO	NO	NO	NO	NE	NE	NE	NE	NE
2D Non-Energy Products from Fuels and Solvent Use	**3,746**	**3,746**	**NE**	**NE**	NO	NO	NO	NO					
2D1 Lubricant Use	211	211			NO	NO	NO	NO					
2D2 Paraffin Wax Use	3,536	3,536	NE	NE	NO	NO	NO	NO					
2D3 Solvent Use	0				NO	NO	NO	NO					
2D4 Other (please specify)	0	NE	NE	NE	NO	NO	NO	NO					
2E Electronics Industry	0	0	0	0	NO	NO	NO	NO	0	0	0	0	0
2E1 Integrated Circuit or Semiconductor	0	NE		NE	NO	NO	NO	NO	NE	NE	NE	NE	NE
2E2 TFT Flat Panel Display	0	NE	NE	NE	NO	NO	NO	NO	NE	NE	NE	NE	NE
2E3 Photovoltaics	0	NE	NE	NE	NO	NO	NO	NO	NE	NE	NE	NE	NE

Categories	Total 3 Gases	Net CO2 (1) (2)	CH4	N2O	NOx	CO	NMVOCs	SO2	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors (3)	Other halogenated gases without CO2 equivalent conversion factors (4)
	CO2 equivalents (Gg)												
2E4 Heat Transfer Fluid	0	NE	NE	NE	NO	NO	NO	NO	NE	NE	NE	NE	NE
2E5 Other (please specify)	0	NE	NE	NE	NO	NO	NO	NO	NE	NE	NE	NE	NE
2F Product Uses as Substitutes for Ozone Depleting Substances	0	0	0	0	NO	NO	NO	NO	0	0		0	0
2F1 Refrigeration and Air Conditioning	-	NE			NO	NO	NO	NO	NE	NE		NE	NE
2F2 Foam Blowing Agents	-	NE			NO	NO	NO	NO	NE	NE		NE	NE
2F3 Fire Protection	-	NE			NO	NO	NO	NO	NE	NE		NE	NE
2F4 Aerosols	-				NO	NO	NO	NO	NE	NE		NE	NE
2F5 Solvents	-				NO	NO	NO	NO	NE	NE		NE	NE
2F6 Other Applications	-	NE	NE	NE	NO	NO	NO	NO	NE	NE	NE	NE	NE
2G Other Product Manufacture and Use	0	0	0	0	NO	NO	NO	NO	0	0	0	0	0
2G1 Electrical Equipment	-				NO	NO	NO	NO		NE	NE	NE	NE
2G2 SF6 and PFCs from Other Product Uses	-				NO	NO	NO	NO		NE	NE		
2G3 N2O from Product Uses	-			NE	NO	NO	NO	NO					
2G4 Other (please specify)	-	NE	NE		NO	NO	NO	NO	NE			NE	NE
2H Other (please specify)	138	138	NE	0	NO	NO	NO	NO					
2H1 Pulp and Paper Industry	132	132	NE		NO	NO	NO	NO					
2H2 Food and Beverages Industry	5	5	NE		NO	NO	NO	NO					
2H3 Other (please specify)	0	NE	NE	NE	NO	NO	NO	NO					
3 AGRICULTURE, FORESTRY AND OTHER LAND USE	**752,138**	**638,542**	**61,486**	**52,110**	94	3,451	0	0					
3A Livestock	**20,648**		**14,563**	**6,085**	NE	NE	NE	NE					
3A1 Enteric Fermentation	13,303		13,303		NE	NE	NE	NE					
3A2 Manure Management	1,260		1,260		NE	NE	NE	NE					
3A2b Direct N2O Emissions from Manure Management	6,085			6,085	NE	NE	NE	NE					
3B Land	**635,448**	**631,725**	**2,190**	**1,533**	0	0	0	0					
3B1 Forest Land	-295,852	-295,852	NE	NE	NE	NE	NE	NE					
3B2 Cropland	254,943	254,943	NE	NE	NE	NE	NE	NE					
3B3 Grassland	56,380	56,380	NE	NE	NE	NE	NE	NE					
3B4 Wetlands	0	0	NE	NE	NE	NE	NE	NE					

Categories	Total 3 Gases	Net CO2 (1) (2)	CH4	N2O	NOx	CO	NMVOCs	SO2	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors (3)	Other halogenated gases without CO2 equivalent conversion factors (4)
	CO2 equivalents (Gg)												
3B5 Settlements	35,331	35,331	NE	NE	NE	NE	NE	NE					
3B6 Other Land	136,483	132,760	2,190	1,533	NE	NE	NE	NE					
Peat Decomposition	357,896	357,896	NE	NE	NE	NE	NE	NE					
Peat Fire	90,267	90,267	NE	NE	NE	NE	NE	NE					
3C Aggregate Sources and Non-CO2 Emissions Sources on Land	**96,042**	**6,817**	**44,733**	**44,492**	94	3,451	0	0					
3C1 Biomass Burning	2,941	NE	2,127	814	94	3,451	NE	NE					
3C2 Liming	1,950	1,950			NE	NE	NE	NE					
3C3 Urea Application	4,867	4,867			NE	NE	NE	NE					
3C4 Direct N2O Emissions from Managed Soils	33,416			33,416	NE	NE	NE	NE					
3C5 Indirect N2O Emissions from Managed Soils	8,988			8,988	NE	NE	NE	NE					
3C6 Indirect N2O Emissions from Manure Management	1,274			1,274	NE	NE	NE	NE					
3C7 Rice Cultivations	42,606		42,606	NE									
3C8 Other (please specify)	0	NE	NE	NE	NE	NE	NE	NE					
3D Other	**0**	**0**	**0**	**0**	0	0	0	0					
3D1 Harvested Wood Products	0	NE			NE	NE	NE	NE					
3D2 Other (please specify)	0	NE	NE	NE	NE	NE	NE	NE					
4 WASTE	**112,351**	**2,940**	**106,212**	**3,198**	0	0	0	0					
4A1.2 Industrial Solid Waste Disposal	14		14	NE	NE	NE	NE	NE					
4A2 Unmanaged Municipal Solid Waste Disposal	36,002		36,002	NE	NE	NE	NE	NE					
4B1 Biological Treatment of Domestic Solid Waste	1		0	1	NE	NE	NE	NE					
4B2 Biological Treatment of Industrial Solid Waste	1		1	0	NE	NE	NE	NE					
4C Incineration and Open Burning of Waste	5,146	2,939	1,869	338	NE	NE	NE	NE					
4D Wastewater Treatment and Discharge	71,081		68,222	2,859	NE	NE	NE	NE					
4D1 Domestic Wastewater Treatment and Discharge	21,870		19,010	2,859	NE	NE	NE	NE					

Categories	Total 3 Gases	Net CO2 (1) (2)	CH4	N2O	NOx	CO	NMVOCs	SO2	HFCs	PFCs	SF6	Other halogenated gases with CO2 equivalent conversion factors (3)	Other halogenated gases without CO2 equivalent conversion factors (4)
	CO2 equivalents (Gg)												
4D2 Industrial Wastewater Treatment and Discharge	49,211		49,211		NE	NE	NE	NE					
4E1 Other - Industrial Sludge Handling	106	1	105		0	0	0	0					
5 OTHER	0	0	0	0	NE	NE	NE	NE					
5A Indirect N2O Emissions from the Atmospheric Deposition of Nitrogen in NOx and NH3	0			NE	NE	NE	NE	NE					
5B Other (please specify)	0	NE	NE	NE	NE	NE	NE	NE					

Note: NE = not estimated, NO = not occurred, NA: not applicable

2.3.3 Sectoral Emissions

The following sections discuss the national GHG inventory conducted in 2015 and 2016 and the trend during 2000-2016 by sectoral categories. The GHG inventory covered all anthropogenic emissions by sources/sinks, i.e. energy, IPPU, AFOLU, and waste category.

2.3.3.1 Energy

Updating of all relevant data of the GHG emissions from all sectors category of GHG emissions sources and improvements in terms of source categories and data source are discussed in the following sections.

In the TNC, fuels combustion data in the period of 2000 - 2014 referred to fuels consumption data in HEESI (Handbook of Energy and Economics Statistics of Indonesia) 2001 until 2015, while in the 2nd BUR, the data referred to HEESI 2016 and 2018, in which HEESI 2016 revised the 2000-2006 data while HEESI 2018 revised the 2007-2016 data.

In the TNC, GHG emissions from fuels combustion in manufacturing industry were aggregated into 1.A.2 Manufacturing Industries and Construction Category, in which in the 2nd BUR, those GHG emissions were disaggregated into 1.A.2.a Iron and steel, 1.A.2.c Chemicals (ammonium fertilizer, 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. The data on fuels use in these industries are obtained from industries at plant level through Ministry of Industry (MoI). In transport sector, the emissions are disaggregated into 1.A.3.a Civil Aviation, Land transportation (1.A.3.b Road Transportation and 1.A.3.c Railway), and 1.A.3.d Water Borne Navigation. It should be noted that the data of fuels combustion in land transport cannot be disaggregated into road and railway.

Other/non-specified category referred to sub-sectors that were not specified in the main sub-categories, i.e. agriculture, construction, and mining (ACM). Under the 2nd BUR, the GHG emissions from this sub-category were still aggregated due to the limitation of data related to the use of fuels in each sub-sector, i.e. agriculture, construction and mining sub-category. It was difficult to disaggregate the fuels used in the ACM sub-sectors as the disaggregation would need large survey activity, which would require enormous efforts in terms of budget and human resources, while the GHG emissions from the ACM was relatively low.

The emission factor (EF) of each fuel category used in the 2nd BUR was still the same as those used in the TNC, i.e. referred to the default EF of 2006 IPCC Guideline. Although LEMIGAS (Research Centre for Oil and Gas under MEMR) had developed local EFs for several liquid fuels for the past three years, these EFs had not been used since the EF of each fuel was not distinguished between sub-sector categories where the fuels were combusted and the EFs only covered CO_2 gas. LEMIGAS will improve the EFs that include more types of gases and sub-sector categories where the fuels are combusted. In addition to research study by LEMIGAS, TEKMIRA (Research Centre for Mineral and Coal, MEMR) also carried out a research study in developing local emission factor for CO_2 from the combustion of coal. Similar to the EFs of liquid fuels, there was no specific local EFs for coal used in energy industry, manufacturing industry, or others. Similar to LEMIGAS, TEKMIRA also plans to improve the research study by covering more types of gases and sub-sector categories, while the default values in the 2006 IPCC Guideline have covered three gases, in which the EFs were distinguished between sub-sector categories where the fuels were combusted.

GHG Emission Estimates and Trends under Reference Approach

Under reference approach, GHG emissions inventory was aggregated based on type of fuels combusted at the national level. Refer to the national fuels consumption trend data in the period of 2000 until 2016, the fuels consumption was dominated by oil (liquid fuels), followed by coal (solid fuels) and natural gas (gas fuels). In 2016, liquid fuel accounted for 44.8% of domestic fuels consumption, i.e. 1,192 MMBOE, followed by solid fuel (31.9%), and gas fuel (23.3%). GHG emissions from fuels combustion activities were generated from liquid fuels combustion (40.8%), solid (39.7%), and gas (19.5%) of total GHG

emissions, which accounted for 540,547 Ggram CO_2e. Figure 2-2 presents the development of domestic fuels consumption and the associated GHG emissions. The detail of GHG emissions based on type of fuels is presented in Figure 2-3.

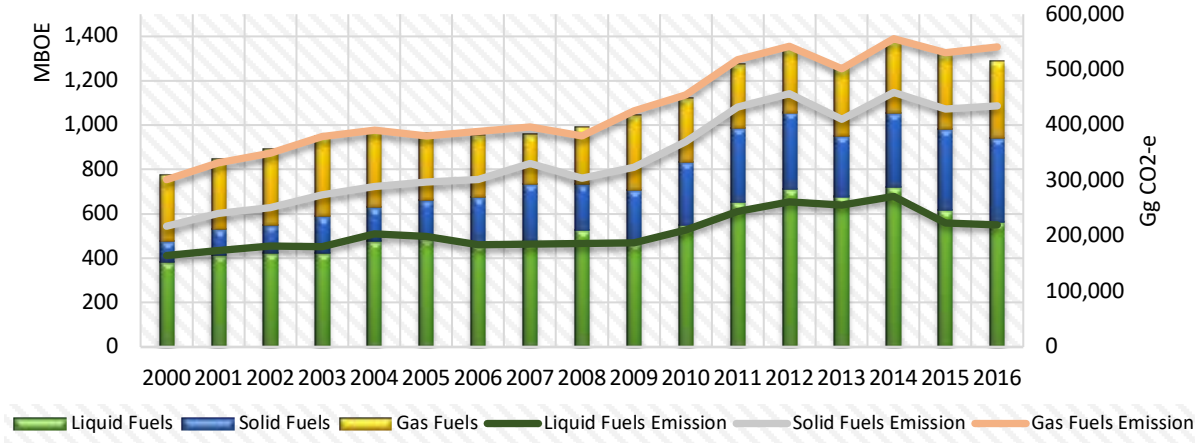


Figure 2-2. Fuels consumption and GHG emissions in energy sector by fuel type in 2000 – 2016

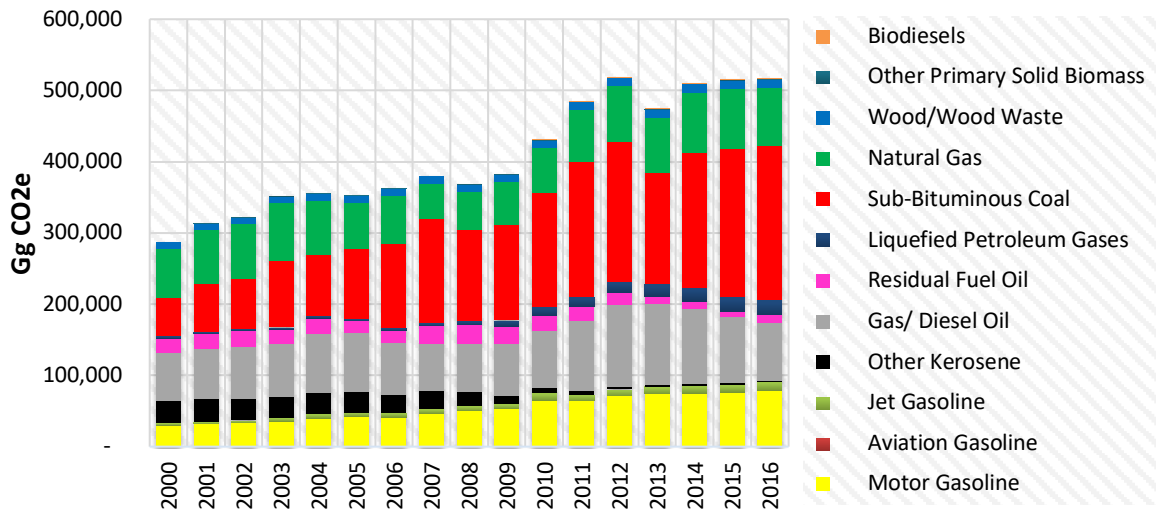


Figure 2-3. GHG emissions in energy sector by type of fuels, 2000 – 2016

GHG Emission Estimates and Trends under *Sectoral Approach*

Under sectoral approach, GHG emissions in 2016 was dominated by power generation (43%), followed by transport (25.35%), manufacturing (16.34%), other (6.71%, accounted for residential and commercial), fugitive (4.07%), and the remaining 1.65% for petroleum refining, ACM, and coal processing of total GHG emissions, which accounted for 538,025 Ggram CO_2e (Table 2-4).

According to the types of gases, the GHG emission from energy sector was dominated by CO_2, followed by CH_4, and N_2O. In 2016, the CO_2 accounted by 94% of total GHG emissions while the CH_4 5%, and N_2O 1% (Figure 2-4). Figure 2-5 presents the trend of GHG emissions by type of fuels and by sector (including fugitives) respectively. It is shown that the rate of emission after 2012 starts to slow down.

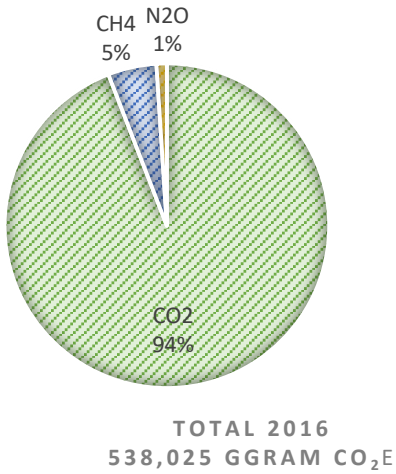


Figure 2-4. The share of GHG emission in energy sector by type of gas in 2016

Table 2-4. Summary of GHG Emissions in Energy Sector in 2016

Code	Categories	2016			
		CO_2	CH_4	N_2O	Total
		Gg CO_2	Gg CH_4	Gg N_2O	Gg CO_2e
Sectoral Approach					
Energy	Energy	506,473	1,239	18	538,025
1.A	Fuel Combustion	499,586	525	18	516,124
1.A.1	Energy Industries	245,837	4	3	246,851
1.A.1.a	Main activity electricity and heat production	230,372	3.23	3.00	231,370
1.A.1.b	Petroleum refining	15,394	0.28	0.03	15,409
1.A.1.c	Coal Processing	71	0.00	0.00	71
1.A.2	Manufacturing Industries and Construction	87,124	13	2	87,933
1.A.2.a	Iron and Steel	338	0.01	0.00	339
1.A.2.c	Chemical	5,654	0.44	0.06	5,683
1.A.2.d	Pulp, Paper, and Print	1,747	0.18	0.03	1,759
1.A.2.e	Food Processing, Beverages, and Tobacco	493	0.01	0.00	494
1.A.2.f	Non-Metallic Minerals	3,749	0.12	0.02	3,756
1.A.2.m	Non-specified Industry	75,144	11.78	1.65	75,904
1.A.3	Transport	133,518	39	7	136,405
1.A.3.a	Civil Aviation	12,072	0.08	0.34	12,178
1.A.3.b & c	Land Transportation (Road and Railways)	121,338	39.05	6.32	124,118
1.A.3.d	Water-Borne Navigation	108	0.01	0.00	109
1.A.4	Other Sectors	24,301	468	6	36,081
1.A.4.a	Commercial/Institutional	2,846	2.70	0.05	2,918
1.A.4.b	Residential	21,455	466	6.23	33,164
1.A.5	Other	8,806	1.20	0.07	8,853
1.B	Fugitive emissions	6,887	714	0	21,901
1.B.1	Solid Fuels	-	95	-	1,990
1.B.1.a	Underground coal mining				-
1.B.1.b	Surface coal mining	-	95		1,990
1.B.2	Oil and Natural Gas	6,887	620	0	19,912
1.B.2.a	Oil	2,208	537	0	13,504
1.B.2.b	Natural gas	4,679	82	0.01	6,408
1.B.3	Other emissions from Energy Production	-	-	-	-

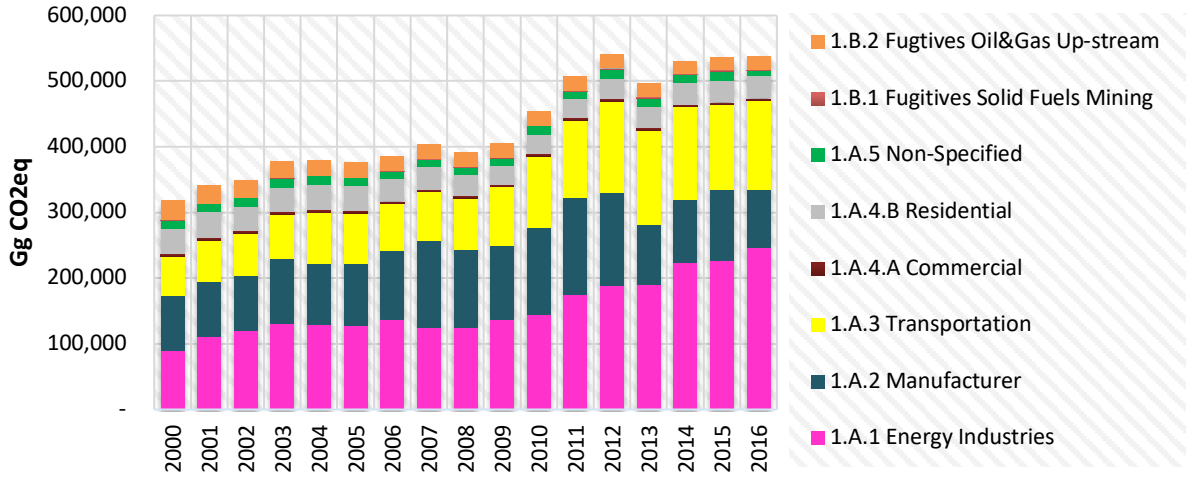


Figure 2-5. GHG emissions in energy sector by sectors (including fugitives), 2000 – 2016

In manufacturing industry, the GHG emissions were disaggregated into six sources as shown in Figure 2-6, where non-specified industry contributed 86% of the total GHG emissions.

In transportation sector, the main source of emission was land transportation that contributed more than 90% of the total transportation emission. The rate of emission of this sector increased significantly between 2008 and 2012, and after that period it remained relatively constant (Figure 2-7).

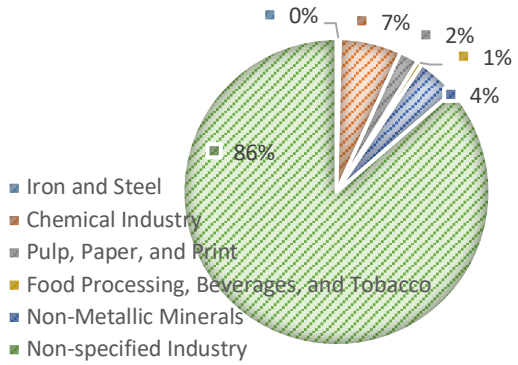


Figure 2-6 . GHG emissions in manufacturing industry in 2016

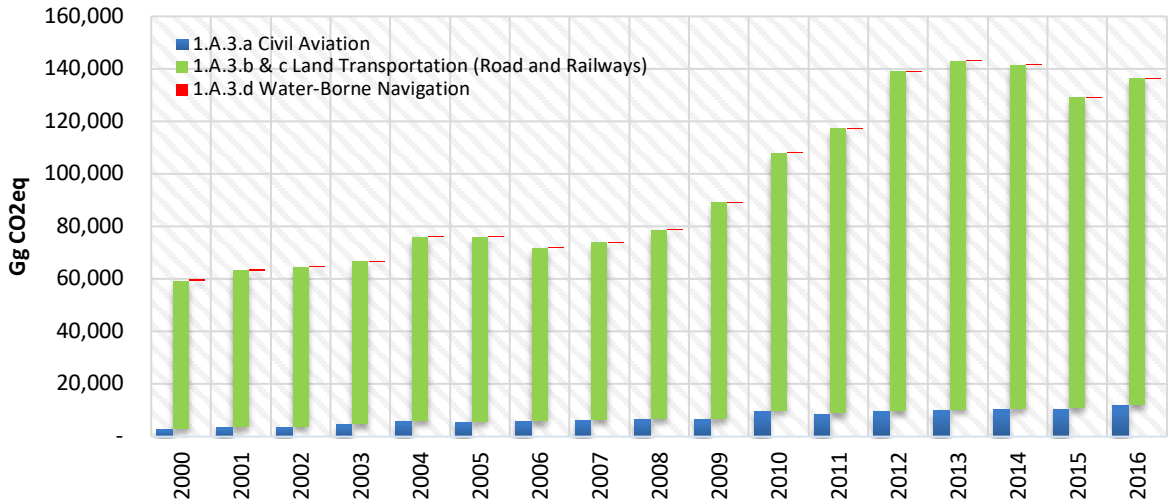


Figure 2-7. GHG emissions in transportation sector, 2000 – 2016

Reference Vs Sectoral Approach

The result of the emissions estimation using the sectoral approach was 0.47% lower than using the reference approach as shown in Figure 2-8**.**

Table 2-5 presents the detail of GHG emissions in energy sector for reference and sectoral approaches in the period of 2000 – 2016.

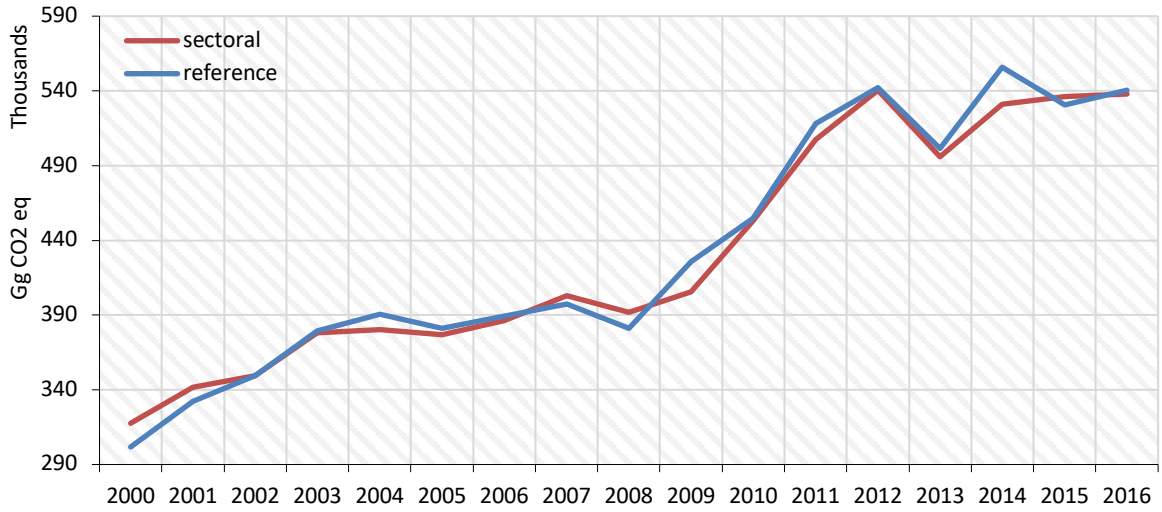


Figure 2-8. Estimated emissions based on Reference and Sectoral Approaches in energy sector

Table 2-5. Detail data of GHG emissions in energy sector for reference and sectoral approaches in the period of 2000 - 2016, Gg CO_2e)

Source of GHG Emissions	Emission (Gg CO2e)																
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
By Type of Fuel																	
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
2. Solid Fuels	52,911	67,199	69,334	93,076	85,518	97,997	118,121	145,745	118,057	135,904	159,328	188,518	194,681	154,837	187,476	205,753	214,607
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
Total by type of fuel	**301,734**	**332,171**	**349,244**	**379,238**	**390,655**	**381,025**	**389,190**	**397,283**	**380,908**	**425,511**	**454,853**	**518,194**	**542,172**	**501,655**	**555,840**	**530,420**	**540,547**
By Sector/Source																	
1.A.1. Energy Industries	**89,716**	**110,764**	**119,793**	**130,188**	**129,518**	**127,816**	**137,094**	**124,026**	**124,485**	**136,599**	**144,526**	**173,803**	**187,631**	**189,860**	**223,213**	**226,278**	**246,851**
1.A.1.a Electricity Generation	62,030	76,614	80,964	90,946	93,516	101,948	108,930	121,696	121,940	136,058	130,886	160,771	174,873	177,294	208,671	211,916	231,370
1.A.1.b Oil and Gas	27,686	34,151	38,829	39,242	36,002	25,867	28,049	2,211	2,442	395	13,449	12,988	12,672	12,529	14,503	14,331	15,409
1.A.1.c Coal Processing	-	-	-	-	-	-	115	119	103	146	192	44	86	37	39	31	71
1.A.2 Manufacturer	**83,369**	**83,555**	**83,034**	**99,575**	**93,449**	**95,040**	**104,245**	**132,982**	**118,579**	**112,972**	**133,062**	**149,044**	**142,597**	**92,072**	**96,422**	**108,201**	**87,933**
1.A.2.a Iron and Steel																389	339
1.A.2.c Chemical																4,924	5,683
1.A.2.d Pulp, Paper, and Print																1,555	1,759
1.A.2.e Food Processing, Beverages, and Tobacco																515	494
1.A.2.f Non-Metallic Minerals																3,542	3,756
1.A.2.m Non-specified Industry																97,275	75,904
1.A.3 Transportation	**59,659**	**63,555**	**64,921**	**66,805**	**76,295**	**76,191**	**71,924**	**74,226**	**78,840**	**89,426**	**108,264**	**117,570**	**139,271**	**143,243**	**141,520**	**129,187**	**136,405**
1.A.3.a Civil Aviation	3,010	3,683	3,997	4,821	6,092	5,806	6,070	6,440	6,817	6,855	9,899	8,900	9,730	10,385	10,554	10,832	12,178
1.A.3.b & c Land Transportation (Road and Railways)	56,266	59,484	60,556	61,675	69,893	70,147	65,659	67,498	71,741	82,337	98,136	108,465	129,343	132,732	130,870	118,269	124,118
1.A.3.d Water-Borne Navigation	384	388	368	309	311	237	195	288	281	234	228	206	197	126	96	86	109
1.A.4.a Commercial	**4,419**	**4,501**	**4,446**	**4,237**	**4,731**	**4,497**	**3,997**	**3,695**	**3,406**	**3,287**	**3,793**	**3,462**	**4,306**	**4,103**	**3,834**	**4,413**	**2,918**
1.A.4.b Residential	**38,315**	**38,193**	**37,152**	**37,725**	**37,989**	**36,723**	**34,244**	**34,758**	**32,597**	**29,462**	**28,299**	**28,674**	**29,663**	**31,313**	**32,303**	**32,720**	**33,164**
1.A.5 Non-Specified	**12,765**	**13,366**	**13,105**	**13,823**	**13,822**	**12,667**	**11,290**	**11,035**	**10,936**	**11,027**	**12,505**	**11,848**	**14,670**	**13,501**	**12,443**	**14,258**	**8,853**
1.A Fuel Combustion	**288,243**	**313,935**	**322,452**	**352,353**	**355,804**	**352,933**	**362,794**	**380,722**	**368,842**	**382,772**	**430,449**	**484,401**	**518,139**	**474,092**	**509,734**	**515,056**	**516,124**
1.B Fugitives	**29,366**	**27,984**	**27,034**	**25,697**	**24,630**	**24,055**	**23,306**	**22,267**	**22,942**	**22,881**	**22,786**	**22,955**	**22,280**	**21,938**	**21,408**	**21,250**	**21,901**
1.B.1 Fugitives Solid Fuels Mining	336	404	451	498	577	666	845	946	1,048	1,117	1,200	1,541	1,684	2,069	1,998	2,013	1,990
1.B.2 Fugitives Oil/Gas	29,030	27,580	26,583	25,199	24,053	23,389	22,461	21,321	21,894	21,763	21,586	21,414	20,596	19,869	19,410	19,237	19,912
1.B.3 Other Emission from Energy Production	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Sectoral	**317,609**	**341,919**	**349,485**	**378,050**	**380,434**	**376,988**	**386,100**	**402,989**	**391,784**	**405,653**	**453,235**	**507,357**	**540,419**	**496,030**	**531,142**	**536,306**	**538,025**

Key Category Analysis (KCA)

Result of Key Category Analysis (KCA) showed that the main sources of GHG emissions in energy sector were fuels combustion in electricity generation, followed by transport, manufacturing industries, residential, and fugitive from oil/natural gas (see Table 2-6).

Table 2-6. Key Category Analysis for energy sector in 2016

Code	Category	Total GHG Emissions	Level/Rank	Cumulative
1.A.1.a	Main activity electricity generation	231,370	43.00%	43.00%
1.A.3	Transport	136,405	25.35%	68.36%
1.A.2	Manufacturing industries and construction	87,933	16.34%	84.70%
1.A.4.b	Residential	33,164	6.16%	90.86%
1.B.2	Fugitive from Oil/Natural Gas	19,912	3.70%	94.57%
1.A.1.b	Petroleum Refining	15,409	2.86%	97.43%
1.A.5	Others (ACM)	8,853	1.65%	99.07%
1.A.4.a	Commercial/Institutional	2,918	0.54%	99.62%
1.B.1	Fugitive from solid fuels	1,990	0.37%	99.99%
1.A.1.c	Coal processing	71	0.01%	100.00%
Total		**538,025**		

2.3.3.2 Industrial Processes and Product Use (IPPU)

The scope of source category of GHG emission from IPPU estimated on this report is similar to the one reported in the latest National Communication. The estimation covers emissions from:

1. Mineral production: cement (2A1), lime (2A2), glass (2A3), and other process utilizing carbonates (ceramics (2A4a), soda ash (2A4b), other carbonate consumption (2A4d);
2. Chemical production: ammonia production (2B1), nitric acid (2B2), carbide (2B5), and petrochemicals (2B8);
3. Metal production: iron and steel (2C1), aluminium (2C3), lead (2C5), and zinc (2C6);
4. Non-energy products from fuels and solvent: lubricant (2D1) and paraffin wax (2D2); and
5. Other industry such as the use of carbonate for pulp and paper industry (2H1) as well as food and beverages industry (2H2). In pulp/paper industry, the carbonate used as chemical make-up during recausticizing process. Although the amount of carbonate form is not significant, the process still releases GHG emissions.

Some categories are not included in the report, inter alia:

1. GHG emissions from 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), since they were not available in Indonesia.
2. GHG emissions from ferroalloy (2C2) and magnesium production (2C4) are also excluded due to difficulty in data collection.
3. GHG emissions from electronic industry (2E1-2E4) is excluded because data was available only in aggregate (from industries generating GHG emissions and industries not generating GHG emissions) such as the assembly industry.
4. GHG emissions from product uses as substitutes for Ozone Depleting Substances (ODS) (2F1-2F4) was also not available. Use of carbonate in non-metallurgical magnesia production and other industries are not available in Indonesia, thus are excluded in the GHG Inventory.

The GHG emission from IPPU was estimated for the five gases, i.e. CO_2, CH_4, N_2O and perfluorocarbon (PFC) in the form of CF_4 and C_2F_6.

Some updates and/or improvements in terms of methodology, time frame and data source are as follow:

1. Tier 2 approach was applied in industries such as cement, ammonia, nitric acid, and aluminium due to their participations in CDM projects.
2. For data source, Indonesia has a new collecting data system under Ministry of Industry, in which some of activity data used for GHG estimation from IPPU are based on the real production data or plant level data reported directly by industries to Ministry of Industry. They are cement, ammonia and urea fertilizer, iron and steel, and chemical industry. Up to the next years, the data generated directly from industry will be improved for other types of industry, so it will minimize the use of assumption based on industries' capacity, which used previously in calculating emissions.

2.3.3.3 GHG Emission Estimates

GHG emissions in IPPU sector was dominated by CO_2 and the rest were CF_4, N_2O, CH_4, CF_4 and C_2F_6. As shown in Table 2-7 and Table 2-8, the GHG emissions in 2016 was 55,307 Gg CO_2e, a 12% higher than the 2015's emission of 49,297 Gg CO_2e. If the calculation was limited to 3 main gases (CO_2, CH_4, and N_2O), then the emission level would be 55,260 Gg CO_2e. Within the period of 2000-2016, the emissions in IPPU sector experienced an average of 0.2% annual increase

Table 2-7 . Summary on GHG emissions from IPPU sector by gas (in Gg CO_2e), 2000-2016

Year	CO_2	CH_4	N_2O	CF_4	C_2F_6	Total	Total 3 Gases
2000	42,391	70	149	250	22	42,883	42,611
2001	47,778	71	149	250	22	48,269	47,997
2002	41,202	65	149	250	22	41,688	41,416
2003	40,913	69	149	250	22	41,402	41,131
2004	42,657	68	149	250	22	43,146	42,874
2005	41,803	72	149	250	22	42,296	42,024
2006	38,145	64	149	260	23	38,641	38,358
2007	35,431	66	149	251	22	35,919	35,646
2008	36,003	72	149	252	22	36,499	36,224
2009	37,062	62	149	250	22	37,546	37,274
2010	35,708	83	90	130	22	36,033	35,881
2011	35,699	76	89	47	-	35,910	35,864
2012	39,623	81	327	47	-	40,078	40,031
2013	38,647	86	382	50	-	39,164	39,114
2014	46,965	70	415	39	-	47,489	47,450
2015	47,892	53	1,303	50	-	49,297	49,247
2016	53,892	82	1,286	48	-	55,307	55,260

In 2016, the largest contributor for GHG emission from IPPU was cement industry, with the emission level by 28,710 GgCO_2 (Table 2-8). The GHG estimation was based on data from national clinker production using national cementitious production data. Table 2-8 shows cementitious data and estimated CO_2 emissions generated. The estimations for cement emission had already used Tier 2 approach with local emissions factors and the activity data generated from the plant basis. Local emission factors for estimation up to 2014 were similar to the emission factors used in the TNC, while for 2015 and 2016 is the factors were 0.424 ton CO_2/ton cementitious and 0.421 ton CO_2/ton cementitious, respectively.

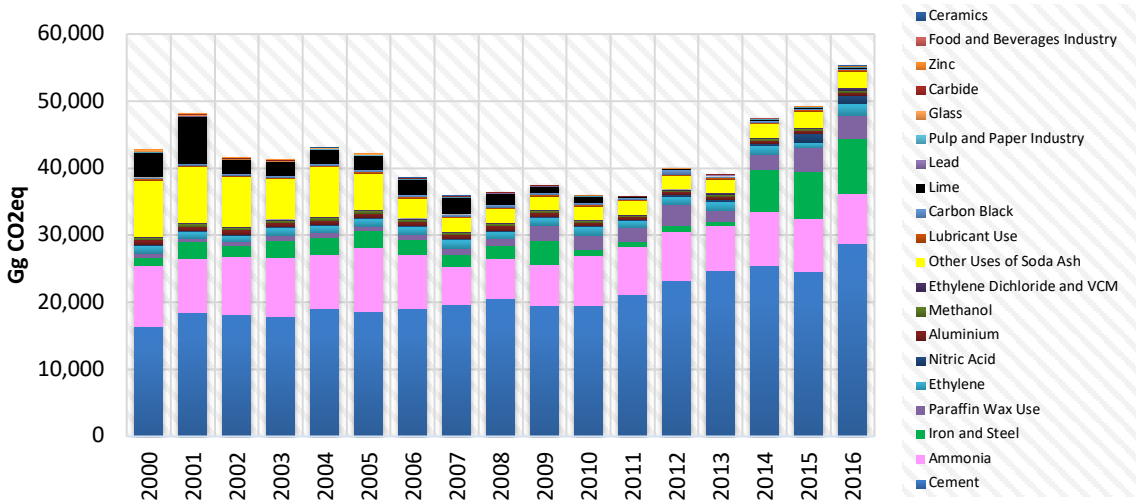


Figure 2-9. GHG Emissions from IPPU Sector by Source Category

Table 2-8. GHG Emissions in IPPU Sector in 2016 (in Gg CO_2e)

Category		CO_2	CH_4	N_2O	HFCs	CF_4	C_2F_6	SF_6	Total
		Gg							(Gg CO_2-eq)
2A1	Cement production	28,710							28,710
2A2	Lime production	124							124
2A3	Glass production	2							2
2A4a	Ceramic production	3							3.0
2A4b	Other use of carbonate and soda ash	2,409							2,409
2B1	Ammonia production	7,395							7,395
2B2	Nitric acid production			4.15					1,286
2B5	Carbide production	25							25
2B8	Petrochemical and carbon black								
	2B8a Methanol	259	1.55						292
	2B8b Ethylene	1,734	2.31						1,783
	2Bbc Ethylene dichloride and VCM	394	0.04						395
	2B8f Carbon black	219	0.01						219
2C1	Iron & steel production	8,196	0.00						8,196
2C3	Aluminium production	393				0.007	-		441
2C5	Lead production	74							74
2C6	Zinc production	69							69
2D1	Lubricants use	211							211
2D2	Paraffin wax use	3,536							3,536
2H1	Others - sodium carbonate in pulp & paper industry	132							132
2H2	Others - sodium carbonate in food & beverages industry	5.1							5.1
TOTAL		53,892	82	1,286	-	48	-	-	55,307

Result of Key Category Analysis (KCA) for IPPU sector is presented in Table 2-9. From 20 emission sources, the six main contributors were: cement industry, ammonia production, iron and steel, paraffin wax use, ethylene, and nitric acid production.

Table 2-9. Key Category Analysis

Code	Category	Total GHG Emissions Gg CO2e	Level/Rank	Cumulative
2A1	Cement production	28,710	51.9%	51.9%
2C1	Iron & steel production	8,196	14.8%	66.7%
2B1	Ammonia production	7,395	13.4%	80.1%
2D2	Paraffin wax use	3,536	6.4%	86.5%
2A4b	Other use of carbonate and soda ash	2,409	4.4%	90.8%
2B8b	Ethylene	1,783	3.2%	94.1%
2B2	Nitric acid production	1,286	2.3%	96.4%
2C3	Aluminium production	441	0.8%	97.2%
2B8c	Ethylene dichloride and VCM	395	0.7%	97.9%
2B8a	Methanol	292	0.5%	98.4%
2B8f	Carbon black	219	0.4%	98.8%
2D1	Lubricants use	211	0.4%	99.2%
2H1	Others - sodium carbonate in pulp & paper industry	132	0.2%	99.5%
2A2	Lime production	124	0.2%	99.7%
2C5	Lead production	74	0.1%	99.8%
2C6	Zinc production	69	0.1%	99.9%
2B5	Carbide production	25	0.0%	100.0%
2H2	Others - sodium carbonate in food & beverages industry	5	0.0%	100.0%
2A4a	Ceramic production	3	0.0%	100.0%
2A3	Glass production	2	0.0%	100.0%
	Total	55,307		

2.3.3.4 AFOLU (Agriculture, Forestry and Other Land Use)

The source of GHG emission and sink from AFOLU calculated on this report is similar with the TNC. The estimation covered emissions from Agriculture and FOLU.

Agriculture Sector

The GHG emission from agriculture sector sourced from livestock and aggregate sources and non-CO2 emission sources on land for the period of 2000 - 2016. Some update from agriculture sector as follows:

- Tier 2 was applied in the livestock category by using local emission factor on enteric fermentation and manure management, and local livestock weight was used in N_2O from manure management.
- Emissions calculation based on livestock subcategory.

Livestock Sector

Livestock data and relevant information to GHG Inventory were gathered from a single source, i.e., the Statistics of Agriculture year 2000 – 2016.

Calculation of methane emission from enteric fermentation and manure management as well as N_2O emissions from manure was undertaken for

6 species of livestock: beef cattle, dairy cattle, buffalo, goat, sheep and horse. Each of species was divided into some subcategories based on age of animals (see Table 2-10). In addition, the methane emission from enteric fermentation and manure management was also calculated by considering the feed intake and energy intake of each subcategory. However, for the estimation of direct and indirect N_2O emissions, an assumption based on national condition was applied to determine the treatment types for cattle manure management.

Table 2-10. Local proportion of population in each animal, emission factor and livestock weight

Livestock	Sub category	Sex	Percentage (%)	EF CH4 Enteric Fermentation (Kg CH4 /year/head)	EF CH4 Manure Management (Kg CH4 /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-CO2 Emission Sources on Land

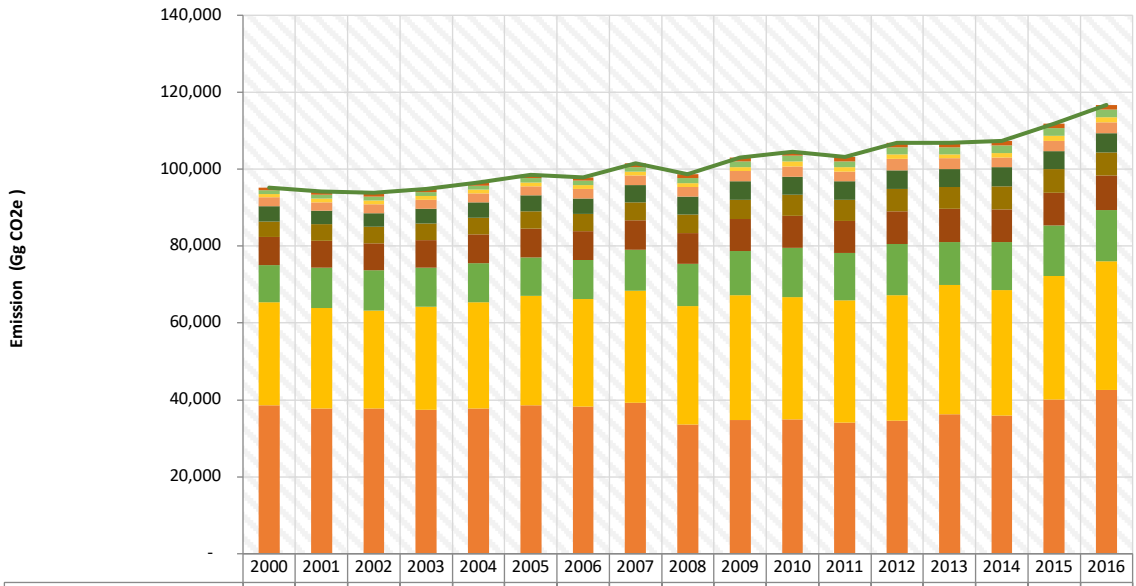
Under this category, the sources of GHG emissions can be classified into seven sub-categories, (a) 3C1 biomass burning, (b) 3C2 liming, (c) 3C3 urea application, (d) 3C4 direct N_2O emission from managed soil, (e) 3C5 indirect N_2O emission from managed soil, (f) 3C6 indirect N_2O emission from manure management, and (g) 3C7 rice cultivation. In this report, emissions from biomass burning in forest land (3C1a) and other land (3C1d) were excluded due to unavailability of activity data on burnt area, while emission from biomass burning in cropland (3C1b) and grassland (3C1c) were estimated.

Activity data used in the emissions estimation were obtained from various sources. Activity data for biomass burning and lime application were provided by the Centre for Data and Information

– MoA, who also provided data on urea application, and N_2O from managed soil, with additional information from the Indonesia Fertilizer Producer Association (Asosiasi Produsen Pupuk Indonesia – APPI). Meanwhile, activity data to estimate methane emission from rice cultivation were provided by the Centre for Data and Information – MoA and BPS.

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 95.201 Gg CO_2e, and increased significantly to 116,690 Gg CO_2e in 2016.



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Indirect N2O Manure	741	771	971	832	834	849	868	920	1,010	973	1,009	1,076	1,151	1,120	1,180	1,229	1,274
Liming	872	933	976	1,001	1,057	1,091	1,146	1,200	1,275	1,441	1,515	1,631	1,771	1,858	1,920	1,962	1,950
Manure Management	933	1,037	1,082	1,050	1,042	1,003	1,032	1,060	1,076	1,113	1,286	1,146	1,235	1,036	1,135	1,221	1,260
Biomass Burning	2,322	2,184	2,235	2,278	2,286	2,366	2,344	2,480	2,469	2,531	2,638	2,539	2,873	2,830	2,654	2,672	2,941
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	4,619	4,836	4,746	4,867
Direct N2O Manure	4,124	4,242	4,385	4,328	4,323	4,427	4,512	4,730	4,938	5,050	5,447	5,470	5,900	5,623	6,007	6,216	6,085
Indirect N2O Soils	7,236	7,089	6,932	7,149	7,388	7,497	7,365	7,632	7,933	8,351	8,310	8,307	8,452	8,670	8,495	8,492	8,987
Enteric fermentation	9,713	10,35	10,54	10,20	10,16	9,994	10,27	10,65	11,05	11,40	12,86	12,26	13,25	11,20	12,52	13,15	13,30
Direct N2O Soils	26,77	26,23	25,36	26,83	27,75	28,54	27,87	29,10	30,64	32,45	31,73	31,78	32,64	33,62	32,57	32,02	33,41
Rice Cultivation	38,58	37,72	37,81	37,37	37,67	38,51	38,28	39,27	33,67	34,77	34,99	34,13	34,64	36,23	35,99	40,11	42,60
Total (in Gg CO2e)	95,201	94,134	93,856	94,863	96,586	98,492	97,828	101,48	98,659	102,95	104,50	103,16	106,77	106,81	107,31	111,83	116,6

Figure 2-10. Emission from Agriculture sector for the period of 2000-2016

Figure 2-10. Emission from Agriculture sector for the period of 2000-2016 shows that by source category, the GHG emission in 2016 originated from rice cultivation (36.51%), direct N_2O from managed soil (28.64%), and enteric fermentation from manure (11.40%). These three sources contributed to 76.55% of the total GHG emissions from agriculture sector.

GHG Emissions on Livestock

In 2016, the total GHG emissions from livestock were 21,922 Gg CO_2e, higher than the 2010's emissions of 15,510 Gg CO2e. It increased by 6,411 Gg CO_2e (41.34%) with average annual growth of 2,58% during period of 2000-2016. This was caused by significant increased in population, especially from beef cattle.

The largest source in 2016 was CH_4 emission derived from enteric fermentation 13,303 Gg CO_2e (60.68%), followed by direct N_2O emission

from manure management 6,085 Gg CO_2e (27.76%), CH_4 emission from manure management 1,260 Gg CO_2e (5.81%), and indirect N_2O emissions from manure management 1,274 Gg CO_2e (6%) as presented on Figure 2-11. Trend in CO2e Emission from Livestock, 2000-2016.

The methane emissions were mostly generated by beef cattle (64.15%), buffalo (9.70%), sheep (9.00%), goats (7.37%), horses (3.94%), dairy cattle (3.13%) and others (2.70%) in 2016 (Figure 2-12)

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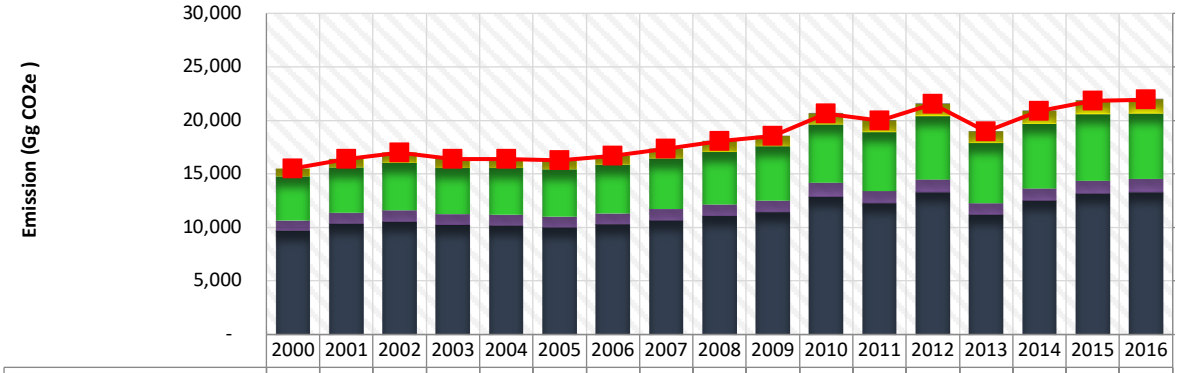


	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Indirect N2O Manure	741	771	971	832	834	849	868	920	1,010	973	1,009	1,076	1,151	1,120	1,180	1,229	1,274
Direct N2O Manure	4,124	4,242	4,385	4,328	4,323	4,427	4,512	4,730	4,938	5,050	5,447	5,470	5,900	5,623	6,007	6,216	6,085
Manure Management	933	1,037	1,082	1,050	1,042	1,003	1,032	1,060	1,076	1,113	1,286	1,146	1,235	1,036	1,135	1,221	1,260
Enteric Fermentation	9,713	10,35	10,54	10,20	10,16	9,994	10,27	10,65	11,05	11,40	12,86	12,26	13,25	11,20	12,52	13,15	13,30
TOTAL	15,51	16,40	16,98	16,41	16,36	16,27	16,69	17,36	18,08	18,53	20,60	19,95	21,54	18,98	20,84	21,81	21,92

Figure 2-11. Trend in CO_2e Emission from Livestock, 2000-2016

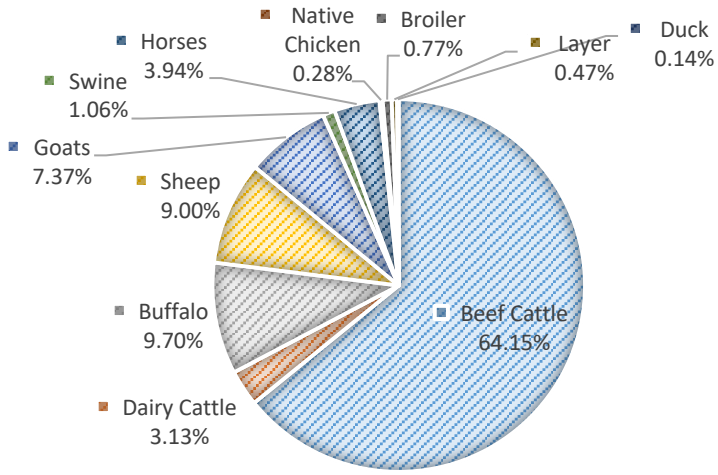
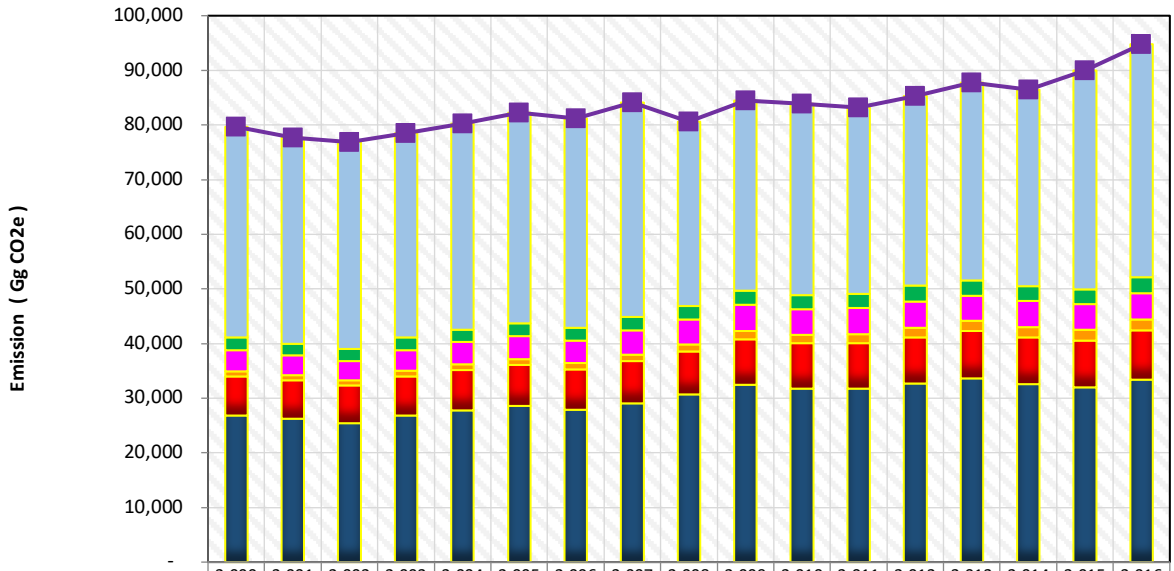


Figure 2-12. Contribution to methane emissions from manure management by livestock species at 2016

Aggregate Sources and Non-CO_2 Emission Sources on Land

In 2016, emissions from this sub-category was 94,766 Gg CO_2e or increased by 15,075 Gg CO_2e (18.92%) from the emission level in 2000 with average annual growth of 942 Gg CO_2e during 2000-2016 (Figure 2-13). The largest emissions was CH_4 derived from rice cultivation with emission of 42,606 Gg CO_2e (44.96%), and followed by direct N_2O from managed soil 33,416 Gg CO_2e (35.26%), indirect N_2O from managed soil 8,987 Gg CO_2e (9.48%), urea fertilization 4,867 Gg CO_2e (5.14%), biomass burning 2,941 Gg CO_2e (3.10%) and liming with emission as much as 1,950 Gg CO_2e (2.06%).

The result of Key Category Analysis is presented in Table 2-11. Key Category Analysis for Agriculture Sector in 2016 resulted in rice cultivation, direct N_2O soils, enteric fermentation, indirect N2O soils, direct N_2O manure management, urea fertilization and biomass burning as the main contributors of emissions in agriculture sector.



	2,000	2,001	2,002	2,003	2,004	2,005	2,006	2,007	2,008	2,009	2,010	2,011	2,012	2,013	2,014	2,015	2,016
Rice Cultivation	38,58	37,72	37,81	37,37	37,67	38,51	38,28	39,27	33,67	34,77	34,99	34,13	34,64	36,17	35,99	40,11	42,60
Biomass Burning	2,322	2,184	2,235	2,278	2,286	2,366	2,344	2,480	2,469	2,531	2,638	2,539	2,873	2,830	2,654	2,672	2,941
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	4,619	4,836	4,746	4,867
Liming	872	933	976	1,001	1,057	1,091	1,146	1,200	1,275	1,441	1,515	1,631	1,771	1,858	1,920	1,962	1,950
Indirect N2O Soil	7,236	7,089	6,932	7,149	7,388	7,497	7,365	7,632	7,933	8,351	8,310	8,307	8,452	8,670	8,495	8,492	8,987
Direct N2O Soil	26,77	26,23	25,36	26,83	27,75	28,54	27,87	29,10	30,64	32,45	31,73	31,78	32,64	33,62	32,57	32,02	33,41
TOTAL	79,69	77,72	76,87	78,45	80,22	82,22	81,13	84,12	80,57	84,41	83,89	83,20	85,23	87,77	86,47	90,01	94,76

Figure 2-13. Emissions from Aggregate sources and non-CO_2 emission sources on land for the period of 2000 – 2016

Table 2-11. Key Category Analysis for Agriculture Sector in 2016

Code	Category	GHG	($GgCO_2eq$)	Level/Rank	Cumulative
3C7	Rice Cultivation	CO_2	42,606.00	37%	37%
3C4	Direct N_2O Soils	CO_2	33,416.00	29%	65%
3A1	Enteric Fermentation	CO_2	13,303.00	11%	77%
3C5	Indirect N_2O Soils	CO_2	8,987.00	8%	84%
3A2b	Direct N_2O Manure Management	CO_2	6,085.00	5%	89%
3C3	Urea Fertilization	CO_2	4,867.00	4%	94%
3C1	Biomass Burning	CO_2	2,941.00	3%	96%
3C2	Liming	CO_2	1,950.00	2%	98%
3C6	Indirect N_2O Manure Management	CO_2	1,274.00	1%	99%
3A2	Manure Management	CO_2	1,260.00	1%	100%

Plan of Improvement in Livestock

Some plans of improvement for livestock will be conducted in the future, i.e. (i) calculation of CH_4 emissions will be based on the type of feed; (ii) N_2O calculation will be performed according to season, because the amount of manure and urine are different between the dry season and the rainy season; (iii) and calculation of both CH_4 and

N_2O emissions will consider age composition according to year of reporting.

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 CO2 emissions/removals from C stock changes for each land use category is the sum of those from these all subcategories taking into account the five carbon pools: (i) above ground biomass, (ii) below ground biomass, and (iii) soil. GHGs that were estimated under the category of FOLU included CO_2, CH_4 and N_2O. However due to limitation of activity data only emission sources of CO_2 are estimated.

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, and 2016.

Since the 2006 IPCC GL has only 6 main land use categories, the land cover categories produced by the Ministry of Environment and Forestry were re-grouped according to the 2006 IPCC GL as shown in Table 2-12. To ensure that variations among regions in the calculation of emissions/removal were considered, land cover types were stratified into seven major island groups, i.e. Sumatera, Java, Kalimantan, Sulawesi, Bali and Nusa Tenggara, Maluku and Papua, and two soil types, i.e. mineral soil and peat soil.

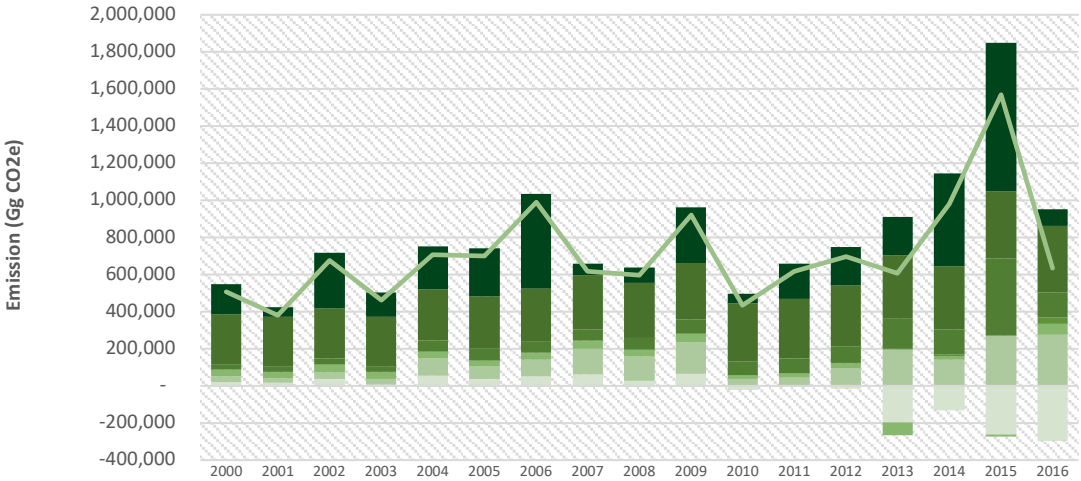
Table 2-12. Grouping of land cover category produced by the Ministry of Environment and Forestry to the 2006 IPCC Land Use category

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.	Pure dry agriculture	Crop land	CL	Non-forest
10.	Mixed dry agriculture	Crop land	CL	Non-forest
11.	Dry shrub	Grassland	GL	Non-forest
12.	Wet shrub	Grassland	GL	Non-forest
13.	Savannah and Grasses	Grassland	GL	Non-forest
14.	Paddy Field	Crop land	CL	Non-forest
15.	Open swamp	Wetland	WL	Non-forest
16.	Fish pond/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 ground	Other land	OL	Non-forest
22.	Open water	Wetland	WL	Non-forest
23.	Clouds and no-data	No data	-	Non-forest

GHG emissions from FOLU in 2000 – 2016 with annual average of 711,040 Gg CO_2e are summarized in Table 2-13 and Figure 2-14. GHG emissions from FOLU in 2000 – 2016. As reported in the 1st BUR, emissions in 2000 and 2012 were 505,368 Gg CO_2e and 694,978 Gg CO_2e. In 2016, the emissions decreased to 635,449 Gg CO_2e.

Fluctuation of emissions in the period of 2000 – 2016 was influenced by emissions from peat fires, as one source of emission. In 2015, emissions from peat fires were recorded as much as 802,870 Gg CO_2e or 51.96% from the total emission of FOLU and decreased to 90,267 Gg CO_2e (7%) in 2016. Emissions trend from peat fire is presented in

Figure 2-15.



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Peat Fire	161,57	50,885	301,75	132,07	232,01	258,88	510,71	62,747	81,744	299,92	51,383	189,02	207,05	205,07	499,38	802,87	90,267
Peat Decomposition	268,57	267,53	268,54	269,65	274,43	280,81	286,28	292,82	297,34	303,56	312,96	322,59	328,56	341,44	341,73	359,62	357,89
Non-Otherland to Otherland	29,585	29,626	31,679	27,448	59,692	64,031	58,587	59,892	60,804	74,028	72,564	78,020	89,692	163,65	134,54	413,79	136,48
Non-Settlement to settlement	1,863	2,199	1,775	1,614	1,482	971	1,348	1,240	931	1,390	1,370	1,677	1,753	1,975	10,257	594	35,331
Non-Grassland to Grassland	36,335	32,319	40,338	36,348	34,802	30,338	34,659	40,477	36,592	47,774	18,164	21,088	25,342	-69,383	17,118	-11,783	56,380
Non-Cropland to Cropland	29,609	22,931	36,709	29,186	93,413	71,680	90,222	140,19	131,46	167,58	38,641	45,658	95,266	197,49	141,48	273,02	276,70
Cropland remaining Cropland	-1,260	-1,274	-1,320	-1,187	-2,647	-2,805	-2,603	-2,152	-2,225	-2,734	-5,183	-4,819	-4,095	-4,909	-3,675	-2,593	-2,223
Forest remaining Forest	20,678	17,537	37,002	7,495	56,129	35,824	51,523	61,158	27,650	66,632	-17,655	77	-11,839	-192,13	-127,70	-260,05	-293,62
Total	505,36	380,12	674,94	461,03	707,87	698,52	989,95	616,55	595,45	920,48	434,78	616,33	694,97	607,32	979,42	1,569,	635,44

Figure 2-14. GHG emissions from FOLU in 2000 – 2016

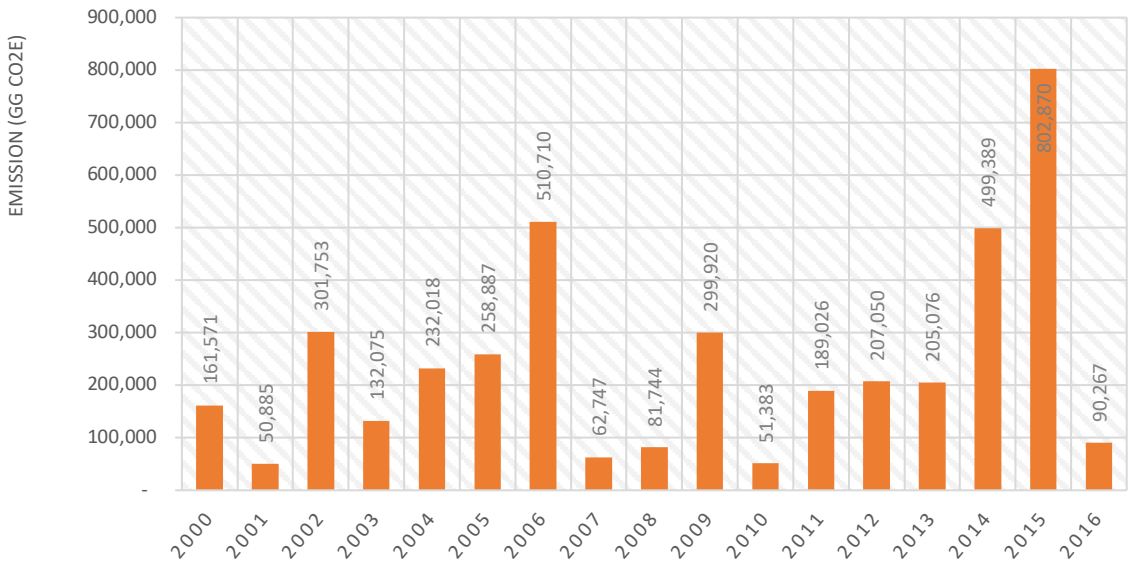


Figure 2-15. Emissions from peat fire

Figure 2-15 shows that the average emission from peat fire fluctuated year to year. The average emission from 2000 until 2016 was 248,488 Gg CO_2e, reached an all-time high of 802,870 Gg CO_2e due to a prolonged El Nino in 2015 and recorded as the lowest of 50,855 Gg CO_2e in 2000.

Burned areas in peat land in the period of 2000 – 2014 were estimated by grid method based on hotspots density and distribution. In the period of 2015 – 2016 there was improvement of the methodology, in which the burned areas was estimated not only based on hotspots and fire suppression report, but also based on the visual interpretation of Landsat images. In the future, this approach will be used to estimate burnt areas of 2000 – 2014 period.

As seen in

Table 2-14. Key Category Analysis on FOLU sector, the main sources of emissions from FOLU are peat decomposition, forest remaining forest, and land use change from non-cropland to cropland with contributions in 2016 as much as 28%, 23%, and 22%, respectively

Key Category Analysis as summarized in

Table 2-14 shows that peat decomposition, forest remaining forest, non-cropland to cropland, non-other land to other land, peat fire, and non-grassland to grassland contributed 95% of emissions in FOLU sector.

Table 2-13. Summary of emissions from FOLU Sector (in Gg CO_2e) in 2000-2016

Code	Source Category	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
3B1a	Forest remaining Forest	20,678	17,537	37,002	7,495	56,129	35,824	51,523	61,158	27,650	66,632	- 17,655	77	- 11,839	-192,135	- 127,701	- 260,052	-293,629
3B1b	Non-Forest to Forest	- 1,260	- 1,274	- 1,320	- 1,187	- 2,647	- 2,805	- 2,603	- 2,152	- 2,225	- 2,734	- 5,183	- 4,819	- 4,095	- 4,909	- 3,675	- 2,593	- 2,223
3B2a	Cropland remaining Cropland	- 41,587	- 41,626	- 41,541	- 41,595	- 41,450	- 41,219	- 40,778	- 39,835	- 38,855	- 37,671	- 37,464	- 36,985	- 36,758	- 35,886	- 33,729	- 6,418	- 21,757
3B2b	Non-Cropland to Cropland	29,609	22,931	36,709	29,186	93,413	71,680	90,222	140,197	131,466	167,580	38,641	45,658	95,266	197,494	141,481	273,025	276,700
3B3a	Grassland remaining Grassland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3B3b	Non-Grassland to Grassland	36,335	32,319	40,338	36,348	34,802	30,338	34,659	40,477	36,592	47,774	18,164	21,088	25,342	- 69,383	17,118	- 11,783	56,380
3B4a	Wetland remaining Wetland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3B4b	Non-Wetland to Wetland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3B5a	Settlement remaining Settlement	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3B5b	Non-Settlement to settlement	1,863	2,199	1,775	1,614	1,482	971	1,348	1,240	931	1,390	1,370	1,677	1,753	1,975	10,257	594	35,331
3B6a	Otherland remaining Otherland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3B6b	Non-Otherland to Otherland	29,585	29,626	31,679	27,448	59,692	64,031	58,587	59,892	60,804	74,028	72,564	78,020	89,692	163,653	134,546	413,797	136,483
Other	Peat Decomposition	268,575	267,531	268,545	269,650	274,431	280,818	286,289	292,825	297,349	303,567	312,968	322,595	328,567	341,443	341,735	359,623	357,896
Other	Peat Fire	161,571	50,885	301,753	132,075	232,018	258,887	510,710	62,747	81,744	299,920	51,383	189,026	207,050	205,076	499,389	802,870	90,267
	Total	**505,368**	**380,129**	**674,941**	**461,034**	**707,870**	**698,525**	**989,956**	**616,550**	**595,456**	**920,485**	**434,788**	**616,335**	**694,978**	**607,328**	**979,422**	**1,569,064**	**635,448**

Table 2-14. Key Category Analysis on FOLU sector

Code	IPCC Category	GHG	Level/Rank	$GgCO_2eq$	Cumulative Contribution (%)
Other	Peat Decomposition	CO2	28%	357,896	28%
3B1a	Forest remaining Forest	CO2	23%	-293,629	51%
3B2b	Non-Cropland to Cropland	CO2	22%	276,700	73%
3B6b	Non-Other land to Other land	CO2	11%	136,484	83%
Other	Peat Fire	CO2	7%	90,267	90%
3B3b	Non-Grassland to Grassland	CO2	4%	56,378	94%

2.3.3.5 Waste Sector

The previous 1st BUR and TNC reports had calculated the emissions of the waste sector only from 3 sub categories, namely GHG emissions from domestic solid waste (MSW), domestic wastewater (DWW), and industrial wastewater (IWW). In this report, improvements were made to include emissions from one new category, i.e. industrial solid waste (ISW). The calculation of industrial solid waste in this report was limited to the calculation of GHG from sludge of landfilled pulp and paper *(landfill of sludge removal)*, sludge of composted pulp and paper *(composting of sludge removal)*, and sludge handling of paper industry.

Regarding domestic solid waste, improvements were made to data on the amount of waste entering landfills, composted, 3R, and LFG recovery based on the updated data of ADIPURA and complemented from surveys. In domestic wastewater treatment, inventory coverage was refined by the availability of data on sludge removed from septic tanks and being treated in sludge treatment facilities, bio-digesters equipped with gas recovery for biogas utilization, and centralized domestic wastewater treatment plant. In addition, the emissions in the TNC report was estimated based on data of domestic wastewater treatment facilities referring to Ministry of Health, meanwhile in this 2nd BUR the estimates refer to Welfare Statistics (*Statistik Kesejahteraan Rakyat, BPS*) due to availability of more complete data and annual data . Calculation of GHG emissions from industrial wastewater, especially paper, had included data on sludge removal and treatment from pulp and paper plants; where sludge from WWTP in paper plants is commonly removed and further treated or utilized.

GHG Emission Calculation

2.3.3.6 GHG Emission Estimate from Municipal Solid Waste (MSW) Management

MSW data are basically derived from ADIPURA database, but documentation of MSW management data is still refined continuously in order to meet consistent, routine and timely reporting. Although the 2016 data can be retrieved, but there are no presentable data reported for 2015 due to improvement in online collecting and reporting system. Hence, the MSW data used were partly from ADIPURA and other source such as projection from MoEF. Before 2014, the MSW management data (SWDS, composting, 3R, etc.) only covered very few cities in Indonesia and only around 2014 the data were collected in greater coverage. Nevertheless, MSW generation data has already been available from ADIPURA since around 2003. Data of MSW management used in this report is presented in Figure 2-16. In addition, LFG recovery data were estimated from surveys and monitoring by MoEF.

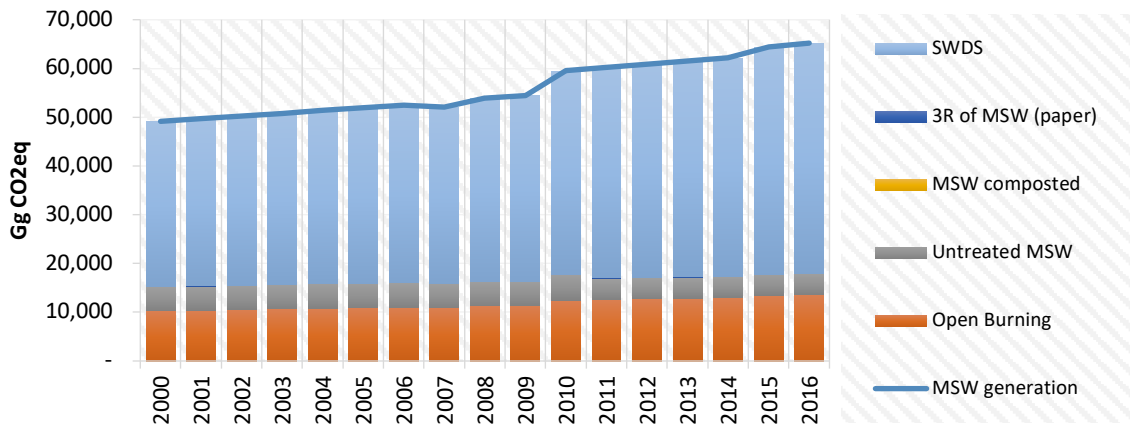


Figure 2-16. MSW management data for GHG estimation from domestic solid waste category

Figure 2-17 depicts GHG emissions estimate resulted from domestic solid waste category. The main contributor to GHG emissions from MSW management was the SWDS, the second largest was open burning, and the smallest was composting that only makes a trace portion. In terms of average annual emissions growth, since 2000 composting seemed to be the highest (14.77%) then followed by SWDS (2.48%) and open burning (1.78%). In 2016, GHG emissions from SWDS accounted to 36,002 Ggram CO_2e (87.49%), open burning amounted to 5,146 Ggram CO_2e (12.51%), and composting only as small as 0.57 Ggram CO_2e (0.0014%).

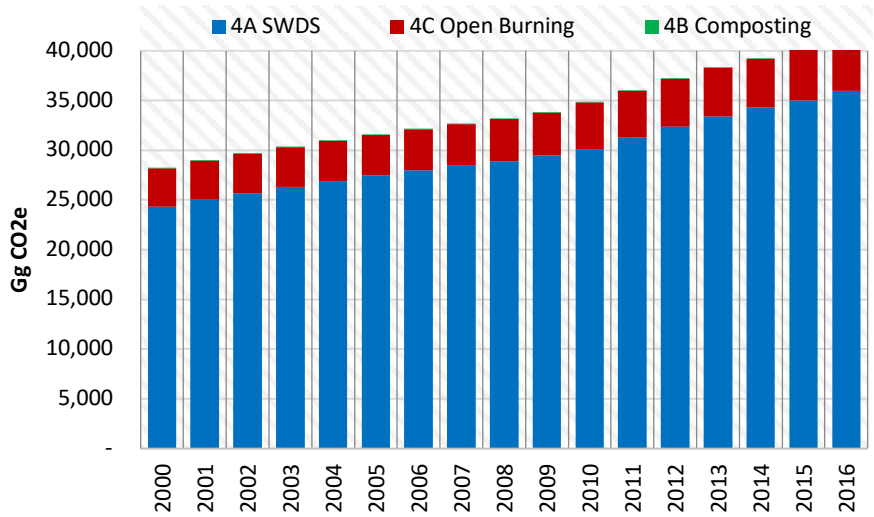


Figure 2-17. GHG Emissions from MSW

2.3.3.7 GHG Emissions Estimate from Domestic Wastewater

GHG emissions from domestic wastewater treatment was estimated from population data, default parameter of BOD, statistics data of protein consumption, and degree of utilization of treatment types from available statistics. Table 2-15 below presents the parameter used in GHG emissions estimate of domestic wastewater.

Table 2-15. 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*	**Year** / **Protein consumption, Kg/cap/year** 2000 / 17.76 2001 / 17.76 2002 / 19.87 2003 / 20.21 2004 / 19.95 2005 / 20.17 2006 / 19.58 2007 / 21.05 2008 / 20.98

Parameter	Characteristics	
	2009	19.84
	2010	20.08
	2011	19.96
	2012	19.58
	2013	19.37
	2014	19.68
	2015	20.12
	2016	20.68
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	
Emissions from Wastewater plants (default = zero)	- kg N_2O-N/kg N	

Based on estimation results as depicted in Figure 2-18, the GHG emissions level in 2016 was 21,870 Ggram CO_2e, wherein about 19,010 Ggram CO_2e originated from CH_4 emissions and 2,859 Ggram CO_2e from N2O emissions. The average annual GHG emissions growth since 2000 was 2.4%.

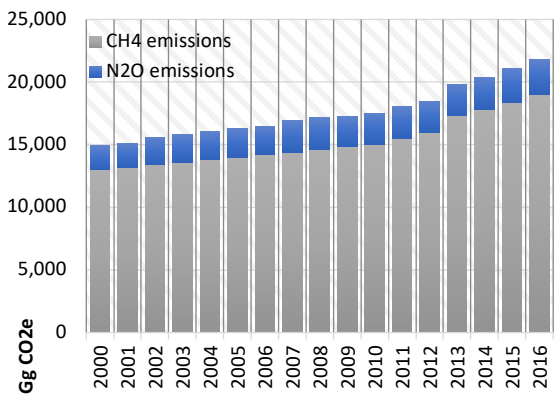


Figure 2-18. GHG emissions from domestic wastewater for the 2000-2016 period

2.3.3.8 GHG Emissions Estimates from industrial wastewater

Improvements of GHG emissions estimates in industrial wastewater category were made due to the newly obtained pulp and paper industry data, although only for period of 2010-2016. Initially, like the other sector of industry, the estimates were based on merely production statistics. Another revision applied to MCF selection of starch industry WWTP, despite the consistent assumption used in the current and precious calculation that the wastewater treatment of the starch industry is shallow anaerobic type, this report uses the maximum default of MCF (= 0.3), while previously the TNC used the mean default of MCF (= 0.2) for shallow anaerobic pond. Figure 2-19 presents the production level of industry to estimate GHG emissions from industrial wastewater treatment.

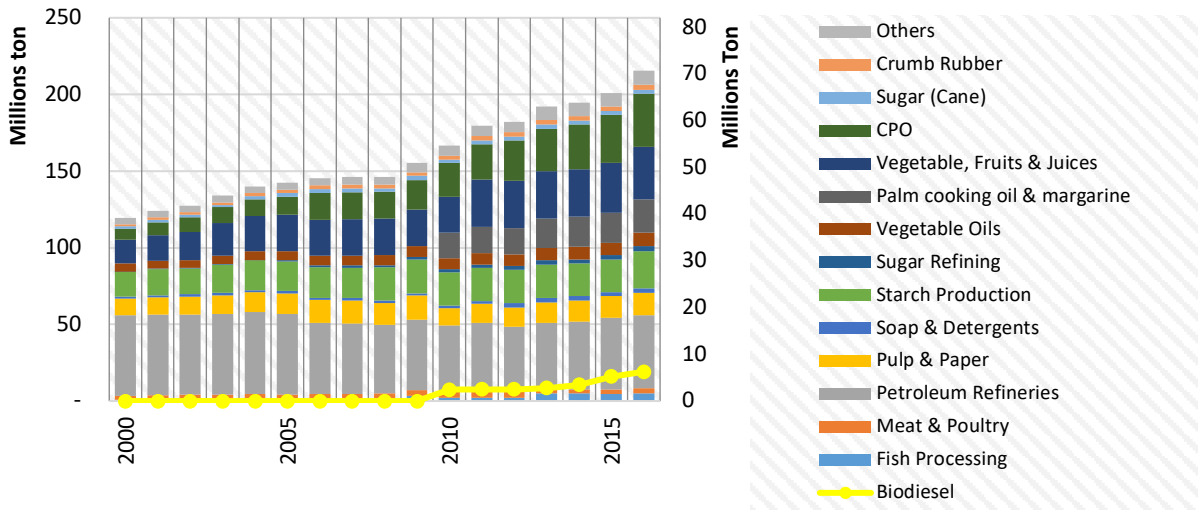


Figure 2-19. Production level to estimates GHG emissions from industrial wastewater

The total GHG emissions from this category in 2016 amounted to 49,211 Ggram CO_2e. Trend of GHG emissions from industrial wastewater in the period of 2000-2016 can be seen in Figure 2-20.

2.3.3.9 GHG Emissions Estimates from Industrial Solid Waste

GHG emissions estimate from industrial solid waste sector is regarded as new category to be reported in this 2nd BUR. The emission was made possible to be estimated because the data had been directly obtained from pulp and paper industry. The data consisted of production level (capacity), organic parameter of wastewater treated in WWTP, and sludge removal and treatment. Plant data were only obtained for period of 2010-2016, hence the estimates of 2000-2009 cannot be made yet.

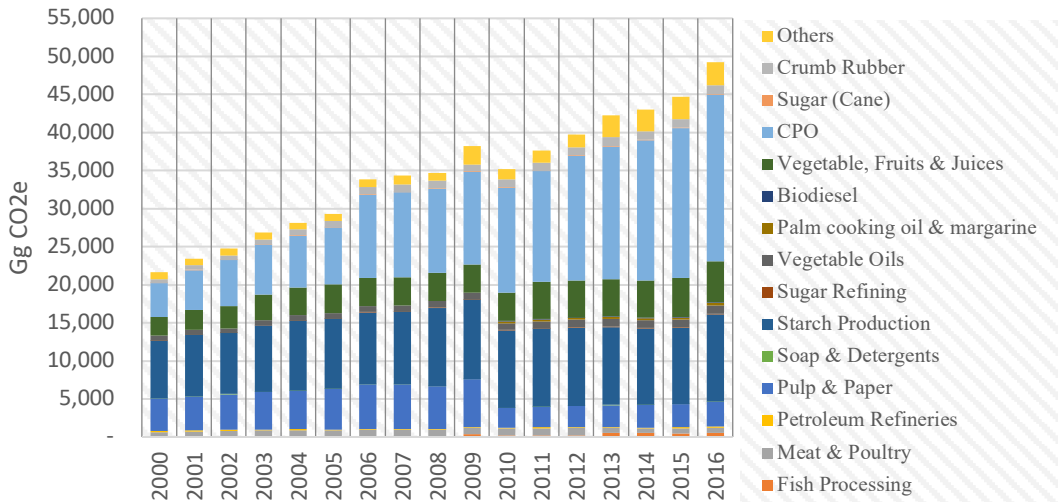


Figure 2-20. GHG Emissions from Industrial Wastewater, 2000-2016

GHG emission during 2010-2016 is presented in Figure 2-21. In 2016, the total sludge emission reached 121.10 Ggram CO_2-e, where about 106.03 Ggram CO_2e originated from sludge handling, 14.01 Ggram CO2-e from landfill of sludge removed, and 1.06 Ggram CO2-e from composting of sludge removed. Sludge handling included sludge treatment in ponds and pre-treatment for biomass fuel use (drying).

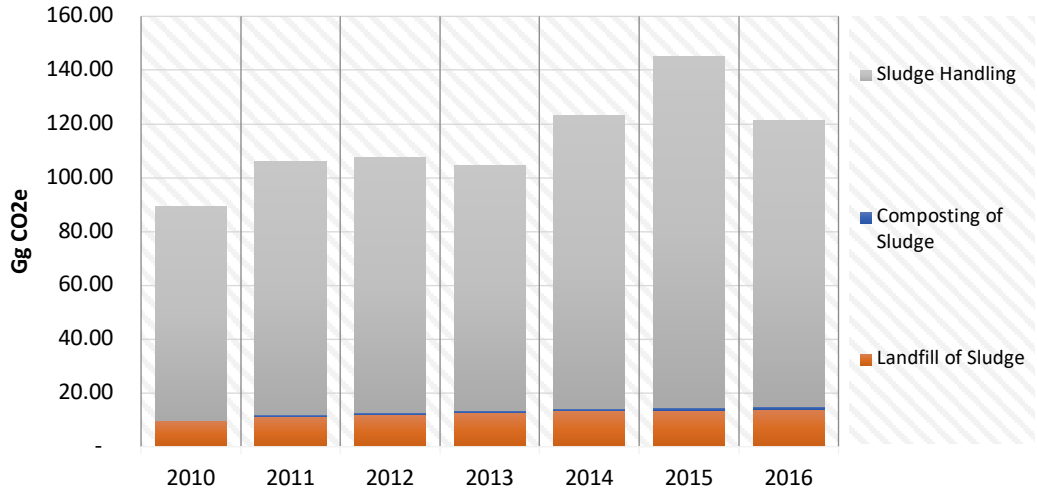


Figure 2-21. GHG Emissions from Industrial Solid Waste, 2010-2016

2.3.3.10 Summary of GHG Emissions Estimates from Waste Sector

Summary of the emissions for 2000 – 2016 period is presented in

Figure 2-22. The GHG emissions from wastewater treatment tend to increase since 2000 up to 2016, especially in industrial wastewater, which emission in 2016 has raised by 2.3 times from that of 2000, giving average annual growth up to 5.26%. Meanwhile, domestic wastewater and domestic solid waste have experienced lower increase from year to year, each with average growth of around 2.39%, and in 2016 resulted in 1.5 higher emissions compare to the level in 2000. Considering new category in GHG emissions of waste sector, i.e. industrial solid waste, the growth was observed only for 2010-2016, where its GHG emissions in 2016 has reached 1.4 times to that of 2010 and grows by 5.21% in average.

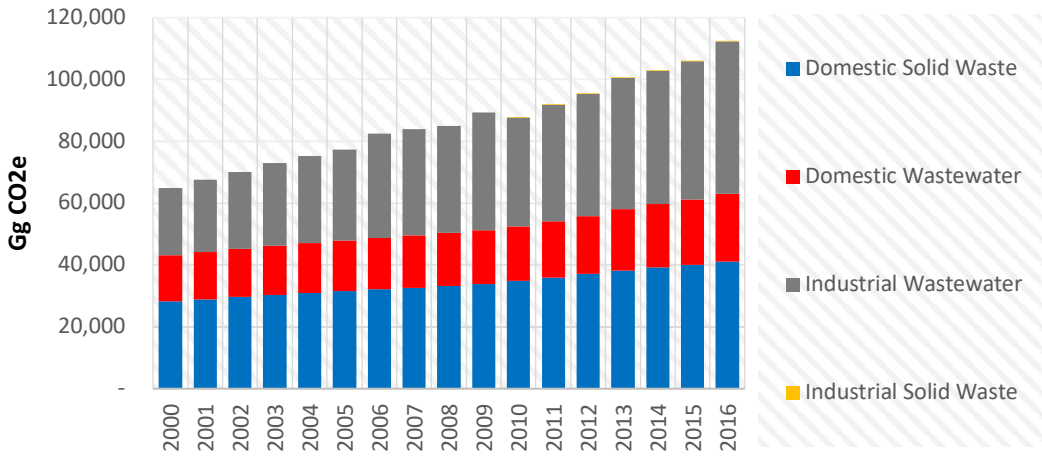


Figure 2-22. GHG Emissions from Waste Sector, 2000-2016

GHG emission from waste sector in 2016 was 112,073 Ggram CO_2e, dominated by emissions from industrial wastewater (42.55%), followed by MSW (37,60%), domestic wastewater (19.73%) and the least was industrial solid waste (0.11%). By type of gas, CH_4 was the main gas generated from this sector (94.52%). Distributions of GHG emissions from waste sector in 2016 by sources and type of gas are presented in Figure 2-23. In addition, common reporting format of GHG

emissions from waste sector is also presented in the following Table 2-16.

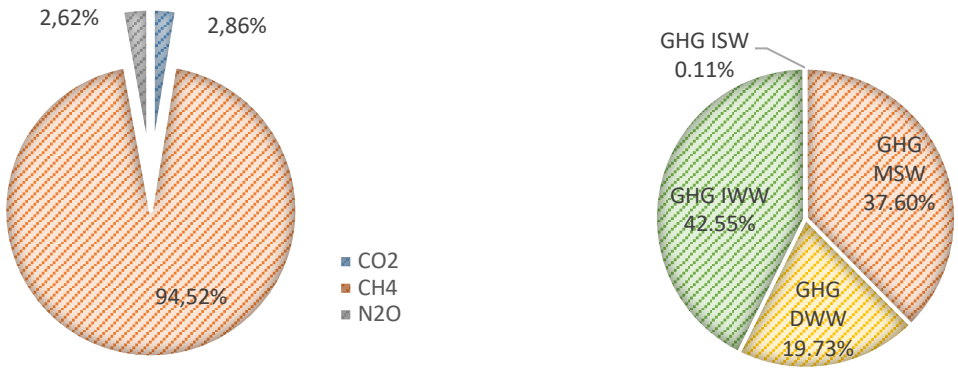


Figure 2-23. Distributions of GHG emissions in waste sector by type of gas (left) and by category of source (right)

Table 2-16. Common Reporting Format of GHG emissions from waste sector

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2016			
	CO_2 (1)	CH_4	N_2O	CO_2-e
	(Ggram)			
Total waste	**2,940**	**5,058**	**10**	**112,351**
A. Solid waste disposal				
1.1 Managed Domestic Waste Disposal Sites				
1.2 Managed Industrial Waste Disposal		0.67		14
2. Unmanaged Domestic Waste Disposal Sites		1,714		36,002
3. Uncategorized waste disposal sites				
B. Biological treatment of solid waste				
1. Composting of Domestic Solid Waste		0.0007	0.0018	0.57
2. Composting of Industrial Solid Waste		0.0267	0.0016	1.06
3. Anaerobic digestion at biogas facilities				
C. Incineration and open burning of waste				
1. Waste incineration				
2. Open burning of domestic solid waste	2,939	89	1	5,146
D. Wastewater treatment and discharge				
1. Domestic wastewater		905	9	21,870
2. Industrial wastewater		2,343		49,211
3. Other (as specified in table 5.D)				
E. Other (please specify):				
1. Industrial Sludge Handling	1.04	5.00		106

Key Category Analysis

Based on the key category analysis, the main sources of emissions in waste sector are industrial wastewater, unmanaged solid waste disposal (MSW), and domestic wastewater (see Table 2-18).

Plan of Improvement for Waste Sector

In the waste sector, the planned improvements to be carried out are as follows:

1. To include more data on the composition of MSW dumped in the landfill by covering more landfills in the survey and to begin collecting results of research from the

Settlement Research Centre and other institutions related to MSW characteristics data (dry matter content and DOC).

2. To start collecting research results from the Settlement Development Research Centre and other institutions regarding data on BOD and domestic wastewater treatment (domestic WWTP) types related to domestic wastewater characteristics, MCF (methane correction factor) and/or emission factor. Necessarily also to add more data on BOD (domestic wastewater characteristics) by including more wastewater management types (centralized, bio-digester, etc.) in the survey.
3. To add necessary bio-digester data from activities in which the realization is greater than those collected by the Ministry of Environment and Forestry, such as those developed by the Ministry of Public Works and Housing, international cooperation (e.g. BORDA), NGOs (Clinton Program, Bali Focus), Islamic boarding schools, real estate settlements (e.g. BSD City), and sanitation programs equipped with bio-digesters.
4. To correct calculations, which previously are still based on all residents who utilize septic tanks, using the number of users that are already connected to centralized systems (integrated WWTP), the number of users of communal septic tanks equipped with bio-digesters, and the number of residents living in the real estate and apartment area equipped with centralized or communal treatment plants.

Table 2-17. Key Category Analysis for waste sector in 2016

Code	Category	Total GHG Emissions	Level/Rank	Cumulative
4 D 1	Industrial Wastewater Treatment and Discharge	49,211.27	43.80%	44%
4 A 2	Unmanaged Solid Waste Disposal	36,002.18	32.04%	76%
4 D 1	Domestic Wastewater	21,869.69	19.47%	95%
4 C	Open Burning of waste (MSW)	5,146.08	4.58%	100%
4 E 1	Sludge handling	106.02	0.09%	100%
4 A 1.2	Managed Industrial Solid Waste Disposal	14.01	0.01%	100%
4 B 2	Biological Treatment of Industrial Solid Waste	1.06	0.0009%	100%
4 B 1	Biological Treatment of Domestic Solid Waste	0.57	0.0005%	100%
TOTAL		**112,351**	**100%**	

5. To add the data of emission level from the domestic waste treatment above in to the calculation of emissions from domestic waste processors in the industrial area, area of businesses (offices, malls, markets, schools / universities, etc.) and others.
6. To improve sludge recovery data on industrial wastewater treatment plant collected by the Ministry of Environment and Forestry (Directorate of MSW Management and Hazardous Waste MoEF / PSLB3 KLHK), by completing the annual factory production data (real production level - not installed capacity and the type of product).
7. To incorporate the GHG emissions data from the WWTP industrial estate.
8. To include the GHG emissions data from landfills or WWTP sludge treatment from industries other than paper. Addition of data on sources of emissions originating from industrial solid waste piles / landfills (other than sludge and paper).
9. To improve the parameters related to activity data, including industrial production data, with updated statistical data and/or plant data level.
10. To improve the use of data on septic tank utilization, which has been sourced from Ministry of Health (MoH) and Welfare Statistics (*SKR BPS*), through monitoring and development by the Ministry of Public Works and Housing (MoPWH)

2.3.4 Emission Trend

In 2016, the national GHG emissions reached 1,461,367 Gg CO_2e for 5 gases (CO_2, CH_4, N_2O, CF_4, and C_2F_6) or 1,457,774Gg CO_2e for 3 gases (CO_2, CH_4, N_2O). This figure was 432,152 Gg CO_2e higher than emissions in 2000 and significantly lower than in 2015, which was at the level of 2,372,509 Gg CO_2e. While in 2015 there was a 76% increase compared to 2013's emission level (1,349,801 Gg CO_2e). The highest emissions in 2015 compared to other years were due to the high emission of peat fires that occurred in the 2015 El Nino year. Trend of national GHG emission 2000-2016 is given in Table 2-24.

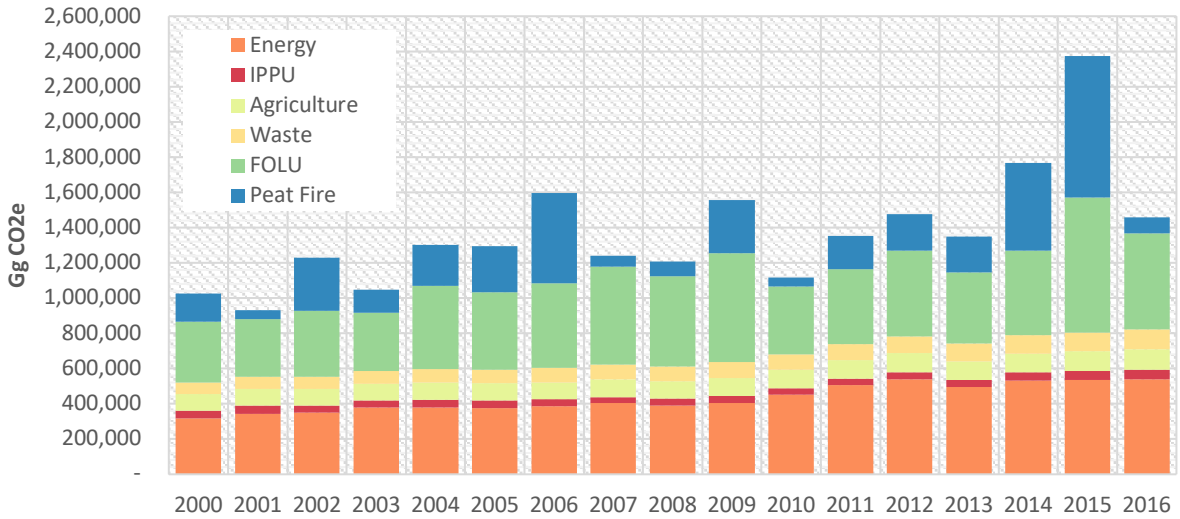


Figure 2-24. National GHG Emissions Trend without FOLU, 2000 – 2016

In the period of 2000 – 2016, the national GHG emissions increased with an average rate of 4.98% per year with AFOLU, and 2.96% per year without FOLU. This showed that land-based sectors, especially forestry, had significant contributions to the national GHG emissions (Table 2-18).

Table 2-18. Annual increase of emissions by sector

Sector	Increase (%)
Energy	3.48
IPPU	2.00
Agriculture	1.30
Waste	3.52
FOLU	11.22

2.3.5 Key Category Analysis and Uncertainty Analysis

Key Category Analysis

By using 1 approach to all emission sources with inclusion of AFOLU sector, 17 key source categories were identified in Table 2-19, which were dominated by AFOLU sector (including peat fire). The first four main categories were (i) peat decomposition, (ii) forest land, (iii) cropland, and (iv) energy industries with cumulative emissions as much as 56% of the total emission of all sectors in 2016. Meanwhile for key category analysis with exclusion of FOLU sector (including peat fire), there were 16 key sources that had been identified (

Table 2-20). The first three main categories were (i) energy industries, (ii) transportation, and (iii) manufacturing industries and construction, with cumulative emissions as much as 57% of the total emissions excluded FOLU including peat fire in 2016.

2.3.6 Uncertainty Analysis

Uncertainty of the 2016 activity data and emission factors are the same as the ones reported in the TNC. Result of the uncertainty analysis showed that overall the uncertainty of the Indonesian National GHG inventory with AFOLU (including peat fire) for 2000 and 2016 were approximately 17.3% and 16.7% respectively. A better level of uncertainty, 10.2% for 2000 and 13.1% for 2016, were generated when the FOLU was excluded from the analysis.

Table 2-19. Key Category Analysis for National GHG Invntory (three gases) with AFOLU including peat fire.

Code	Category	Total GHG Emissions	Level/Rank	Cumulative
Other	Peat Decomposition	357,896	17%	17%
3B1	Forest Land	295,852	14%	32%
3B2	Cropland	254,943	12%	44%
1 A 1	Energy Industries	246,851	12%	56%
3B6	Other Land	136,483	7%	63%
1 A 3	Transportation	136,405	7%	70%
Other	Peat Fire	90,267	4%	74%
1 A 2	Manufacturing Industries and Construction	87,933	4%	78%
3B3	Grassland	56,380	3%	81%
4.D.2	Industrial Wastewater treatment and Discharge	49,211	2%	84%
3 C 7	Rice Cultivation	42,606	2%	86%
4.A.2	Unmanaged Municipal Solid Waste Disposal	36,002	2%	87%
3B5	Settlements	35,331	2%	89%
3 C 4	Direct N_2O Emissions from Managed Soils	33,416	2%	91%
1 A 4 b	Residential	33,164	2%	92%
2 A 1	Cement Production	28,710	1%	94%
4.D.1	Domestic Wastewater treatment and Discharge	21,870	1%	95%

Table 2-20. Key Category Analysis for National GHG Inventory (three gases) without FOLU including peat fire

Code	Category	Total GHG Emissions	Level/Rank	Cumulative
1 A 1	Energy Industries	246,851	30%	30%
1 A 3	Transportation	136,405	17%	47%
1 A 2	Manufacturing Industries and Construction	87,933	11%	57%
4.D.2	Industrial Wastewater treatment and Discharge	49,211	6%	63%
3 C 7	Rice Cultivation	42,606	5%	68%
4.A.2	Unmanaged Municipal Solid Waste Disposal	36,002	4%	73%
3 C 4	Direct N_2O Emissions from Managed Soils	33,416	4%	77%
1 A 4 b	Residential	33,164	4%	81%
2 A 1	Cement Production	28,710	3%	84%
4.D.1	Domestic Wastewater treatment and Discharge	21,870	3%	87%
1 B 2	Oil and Natural Gas	19,912	2%	90%
3A1	Enteric Fermentation	13,303	2%	91%
3 C 5	Indirect N_2O Emissions from Managed Soils	8,988	1%	92%
1 A 5	Other/Non-Specified	8,853	1%	93%
2 C 1	Iron and Steel Production	8,196	1%	94%
2 B 1	Ammonia Production	7,395	1%	95%

CHAPTER 3. MITIGATION ACTIONS AND THEIR EFFECTS

3.1 Introduction

The current mitigation actions in Indonesia are implemented under the framework of Paris Agreement (PA). Indonesia has ratified the PA following the Act No. 16/2016 and has submitted the Nationally Determined Contribution (NDC) in October 2016, with commitments of reducing the GHG emission by 29% unconditionally and up to 41% conditionally from the BAU emission by 2030. This 2nd BUR document, reports the progress of the implementation of mitigation policies and programmes and their impacts in GHG emissions reduction within the context of achieving the NDC target. The progress report covers updates of data related to the implementation of mitigation policies and programmes for all sectors, specifically those occurring in 2015 and 2016. The updates were previously been reported by the TNC in meeting the voluntary emission reduction target for pre-2020 as mandated by the Presidential Regulation No. 61 of 2011.

3.2 Mitigation Programmes in Indonesia

3.2.1 Emission Reduction Target

The commitment endorsed in the Indonesian NDC to meet the emission reduction target by 2030 is presented in Table 3-1. Similar to the pre-2020 commitment, Indonesia focuses its programme on the reduction of GHG emissions 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 accounts for 811 MTonne CO_2e or 28.2% below the 2030 baseline, while the rest are fulfilled by agriculture, IPPU and waste. Figure 3-1 indicates the GHG emissions reduction target for all sectors compared to the base year (2010) and baseline emissions (2030) under the conditional mitigations scenario.

Table 3-1. GHG emissions level in the BAU and GHG emissions reduction in 2020 and 2030

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	453.2	904	834	807	1,669	1,355	1,271	314	398	11%	14%
2	IPPU	36	59	57	57	69.6	66.85	66.35	2.75	3.25	0.1%	0.11%
3	AFOLU	757	873	549	346	835	327	180	506	655	18%	23%
3.a	Agriculture	110.5	115.9	111.5	114.1	119.66	110.39	115.86	9	4	0.32%	0.13%
3.b	Forestry*2	647	758	437	232	714	217	64	497	650	17.2%	23%
4	Waste	88	143	141	141	296	285	270	11	26	0.38%	1%
	Total	1,334	1,980	1,581	1,351	2,869	2,035	1,787	834	1,082	29%	38%

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 for further reductions by 2030, by outlining the emission reduction plans using an evidence-based and inclusive approach. The commitments will be implemented through land-based and non-land based sectors. The land-based sectors comprised of agriculture and forestry sectors, 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, encompassed the enhancement of energy conservation, the

promotion of clean and renewable energy sources, the improvement of IPPU and improvement of waste management nationwide using the landscape and ecosystem management approaches for both adaptation and mitigation efforts through building and strengthening of sub-national jurisdictional capacities.

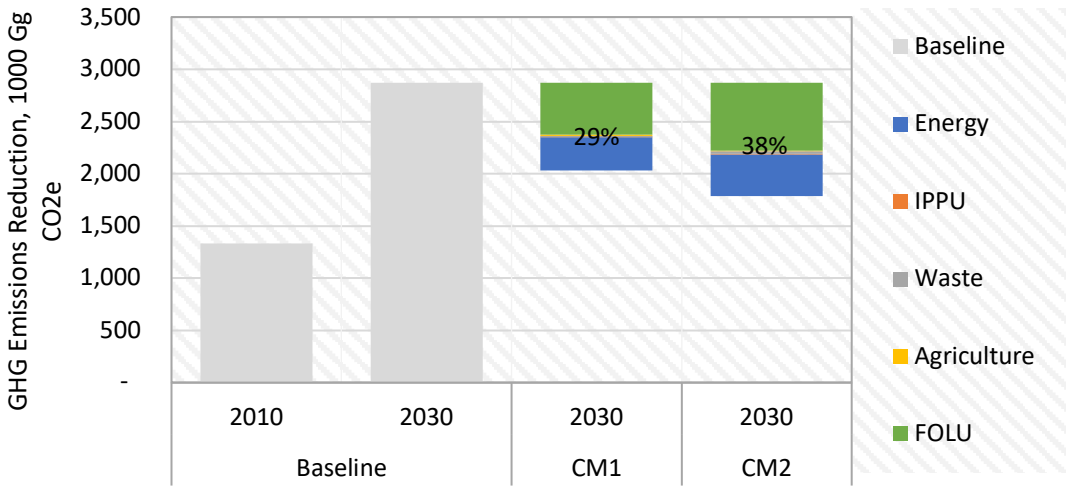


Figure 3-1. GHG emissions reduction target for all sectors compared to the base year (2010) and baseline emissions (2030) under the conditional mitigation scenario

3.2.2 National Mitigation Programmes

To achieve the GHG emissions reduction target in the NDC, the mitigation actions in Indonesia are classified into sectors and implemented by the party stakeholder (PS) involving related ministries. After the Government of Indonesia (GoI) has ratified the Paris Agreement, the roles of non-party stakeholders (NPS) would be encouraged to support the achievement of the NDC target. NPS comprises of local governments (provinces, regencies, and cities), business, and communities. The PS national mitigation action plans are categorised into energy, IPPU, AFOLU, and waste sectors as presented in Figure 3-2.

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

Energy
1. Energy efficiency in final demand
2. Clean coal technology in power
3. Renewable energy in power
4. Biofuel in transportation sector
5. Additional gas distribution lines
6. Additional CNG fuel station

Waste
1. Enhanced LFG recovery
2. Enhanced Composting and 3R
3. Enhanced RDF Utilization
4. Management of Domestic WWT
5. Management of Industrial WWT

IPPU
1. Reduction of Clinker to Cement ratio
2. Feedstock utilization and CO2 recovery in primary reformer in petrochemical industry
3. Other actions in steel industry and aluminum smelter

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

LULUCF
1. Reduction unplanned deforestation
2. Rehabilitation of land & forest in watershed
3. Development of community forest & village forest
4. Establishment of timber plantation and private forest
5. Restoration of production forest ecosystem
6. Development of partnership forest
7. Fire management & combatting illegal logging
8. Establishment Forest Management Unit
9. Conversion of forested peatland, issued moratorium policies for peatland
10. Development Fire early warning system
11. Strengthening community based fire fighting system
12. Improving of peatland management

Source: Indonesia first NDC and other sources

Figure 3-2. Mitigations under Indonesia NDC for energy, IPPU, AFOLU, and waste sectors

3.2.3 Mitigation Policy

Indonesia has strong legal bases in developing, issuing and implementing the climate change mitigation policies and programmes for each sector at both the national and local levels. In addition to legislations and regulations, some sectors have also issued policies that are directly and indirectly affecting the climate change mitigation actions. The direct policies are issued to provide the environment that support the implementation of the mitigation programmes, while the indirect policies encourage the formation of enabling conditions. The legal instruments discussed in the 2nd BUR document, covers all the legislations and regulations, the direct policies, as well as the enabling policies that were not covered in the TNC Report due to relatively new and/or released right after Paris Agreement was ratified.

3.2.3.1 Energy Sector

GoI has issued a number of new policies and regulations for the enhancement of mitigation actions that could directly and indirectly encourage the implementation of climate change mitigation. One of the important policies in energy sector that supports climate change mitigation actions and would eventually put Indonesia on the path to de-carbonization is the Government Regulation No. 79/2014 on Indonesia National Energy Policy. This regulation sets out the ambition targets to transform the primary energy supply mix favourable to climate change mitigation by 2025 and 2050:

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

In addition to the National Energy Policy, the GoI has also issued other policies in support of climate change mitigation actions. List of these policies is provided in Table 3-2, which is an update of those previously reported in the TNC Report.

Table 3-2. Policy instruments for supporting mitigation actions in energy sector (additional to the list by TNC)

Mitigation Measures	Policy Instruments	Description/remarks
Enhancement of renewable energy in building sub-sector	MEMR Ministerial Regulation No.49/2018 on Rooftop Solar Cell.	Regulate the Rooftop Solar Cell utilization business
	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 Utilization of Biodiesel and Palm Oil Plantation Fund	Regulate the supply and utilization 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 Utilization of Palm Oil Plantation Fund.	Regulate the collection and utilization 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 utilization	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 utilization and energy conservation	MEMR Ministerial Regulation No.12 /2018 on the Revision of Ministerial Regulation No 39/2017 on The Implementation of Renewable Energy Utilization and Energy Conservation	Revised version of provisions that regulate the implementation of renewable energy utilization and conservation, including the purchase of renewable electricity
	MEMR Ministerial Regulation No.39/2017 on The implementation of Renewable Energy Utilization and Energy Conservation.	Provisions of the implementation of renewable energy utilization 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

3.2.3.2 IPPU and Energy in Industry Sector

In supporting and to facilitating the enhancement of mitigation actions in industries, the GoI through its Ministry of Industry (MoI) has developed and issued policies that could directly and indirectly encourage the implementation of climate change mitigation actions. The policies were issued in the form of ministerial regulations that are intended to encourage the two groups of mitigation actions, i.e. the increased use of alternative energy and material, and as an enhancement in energy efficiency measures that could reduce GHG emissions from the energy and IPPU categories. Table 3-3 presents the additional legal instruments for energy and IPPU related mitigation actions in the industry sector to those listed in the TNC document.

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

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 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 utilizations, 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 is committed to a further reduction of the emissions from waste management by 2020 and beyond. This would be done through developing a comprehensive and coherent policy development, institutional strengthening, improved financial/funding mechanisms, technology innovation, and social-cultural approaches, which are directed to improve the policies and institutional capacities at national and local levels, enhancement of management capacity of urban waste water, reduction of landfill waste through Reduce-Reuse-Recycle approach, and utilization of waste for energy production. Additional core actions and relevant legal instruments to the TNC List are given in Table 3-4.

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

Mitigation Measures	Policy Instruments	Description/remarks
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

Mitigation Measures	Policy Instruments	Description/remarks
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, programs, and targets for reducing and handling of household waste and wastes similar to household waste at national level.
Policy on waste management for Sub National	Ministerial Regulation No. P.10/ MENLHK/SETJEN/PLB.0/4/2018 on the Guideline of Policy Formulation and Sub National 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 sub national 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, none of the forest in Indonesia is open accessed, which normally expose to high risk of illegal activities causing uncontrolled deforestation and forest degradation. Government has well-implement this policy. About 531 KPHs have been established covering a total area of about 84 million hectares. Thus, almost all of the forested areas are under the management of KPHs. Nevertheless, the management capacity of the KPHS still required much strengthening. In addition, the GoI has also enacted a number of new policies and regulations in supporting the implementation of climate change mitigation actions, as presented in Table 3-5.

Table 3-5. Policy instruments for supporting mitigation actions in AFOLU sector (additional to the TNC List)

Measures	Policy Instrument	Description/remarks
Peat ecosystem management	Presidential Regulation No. 57/2016 on the Revision to the Presidential Regulation No. 71/2014	A more rigid policy regulate 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
Moratorium	Presidential Instruction No. 6/2017	Regulate the moratorium/suspension of new licenses and the improvement of primary forest governance and peatlands
Enhancement of Land and Forest Fire Management	Presidential Instruction No. 11/2015	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.
Social Forestry	Minister of Environment and Forestry Regulation No. 83/2016	Policy on forest management system employed by the community to improve their livelihoods and life quality as well as developing the forest potentials.
Guidance and Support/Incentive on Forest and Land Rehabilitation	Minister of Environment and Forestry Regulation No. 39/2016 on the Revision to the Ministerial Regulation No. 9/2013	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.

Measures	Policy Instrument	Description/remarks
Mandatory Certification for 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.
Estate crop management	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 follow several stages from planning, implementing, monitoring, reporting, verification and/or registering as shown in Figure 3-3.

The institutions responsible for Indonesia's climate change mitigation actions are MoEF, Bappenas, and related ministries, i.e. ministries whose activities are directly related to the sector generating GHGs. Mitigation action plan is prepared by the relevant ministries and coordinated by MoEF, making the mitigation action an integral part of the national development. Planning stage is developed based on mitigation scenarios prepared and coordinated by MoEF and Bappenas. Implementation, monitoring and reporting of the mitigation actions are undertaken by related ministries and the reports are submitted to Bappenas, MoEF, as well as to the Ministry of Home Affairs (MoHA). Mitigation actions reported by each ministry are then verified by the MoEF, and subsequently recorded in the National Registry System managed by MoEF. Responsibility for the implementation of climate change mitigation actions for each sector would fall under each related ministry in accordance with the mandates stated in the Presidential Regulation No. 61/2011, and reinforced by the Ministerial Regulations/Decrees as listed below in Table 3-6.

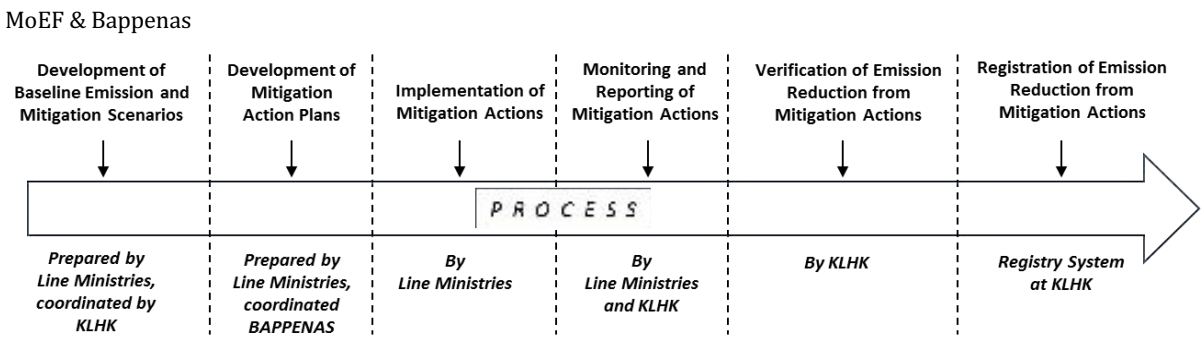


Figure 3-3. Institutional arrangement for the implementation of climate change mitigation at national level

Table 3-6. Institution for implementing of mitigation actions and reporting of each sector

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

Sector	Ministry	Responsible Unit
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	Ditjen 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

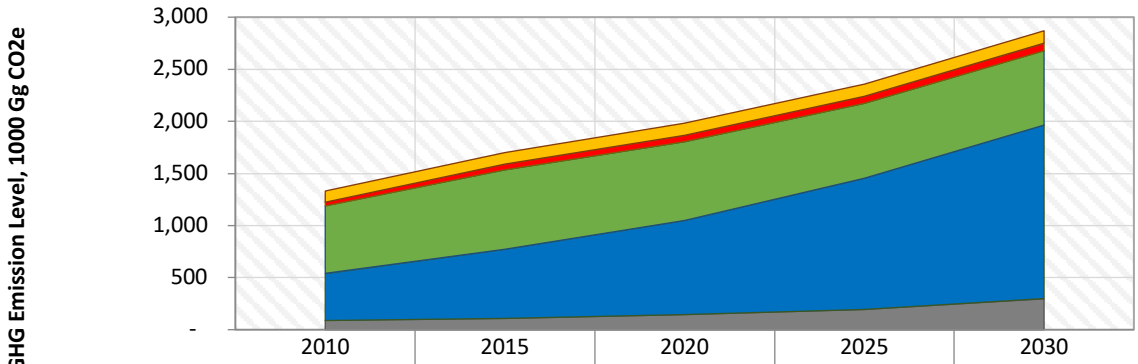
3.3 Implementation of National Mitigation Programs and Their Effects

GHG emission reductions are defined based on the difference between 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 the implementation of development do not take into consideration the aspects associated with climate change mitigation efforts. The baseline emission is subjected to the definition of "business as usual (BAU)" development, the calculation methodology and the assumptions of variables used in the estimation of emissions.

3.3.1 Baseline Emissions

Depending on the purpose of emission reduction calculation, there are two types of baseline namely project baseline and sectoral baseline. **Project baseline** is the baseline emission used in calculating the emission reduction of a project-scale mitigation action while **sectoral baseline** is the baseline emission used in determining the emission reduction achieved from a sector-wide mitigation activity. Project-scale emission reduction is to be recorded in the National Registry System that registers the achievement of GHG emission reductions. The achievement og the sector wide emission reduction is to be reported to UNFCCC within the context of Indonesian commitment in GHG emission reduction, i.e. Indonesia NDC under the Paris Agreement. National baseline emissions can be established either using an integrated model covering all sectors of national development, or developing sectoral modelling of all sectors and summed up the results to produce the national baseline emission. In the case for Indonesia, the country's baseline emission projection used the second approach, where the baseline emission is an aggregation of four sectors' baseline emissions, i.e. energy, IPPU, AFOLU (Agriculture, Forestry and Land Use) and waste.

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



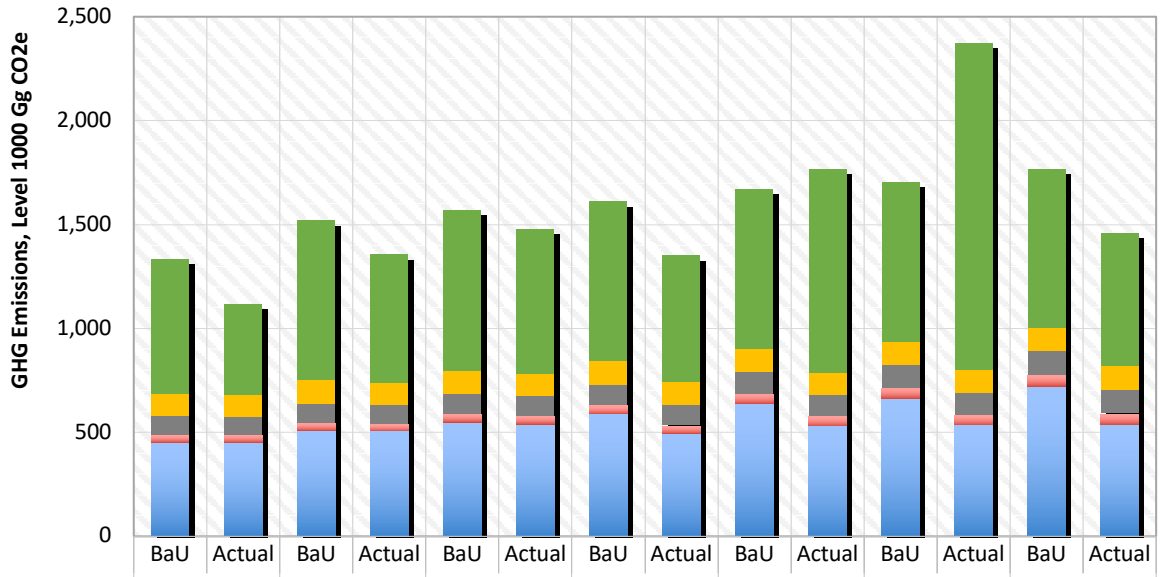
	2010	2015	2020	2025	2030
Agriculture	111	114	116	117	120
IPPU	36	53	59	65	69.6
Forestry	647	765	758	721	714
Energy	453	664	904	1,258	1,669
Waste	88	106	143	196	296
Total	1,334	1,702	1,980	2,357	2,869

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

3.3.2 Progress of National Mitigations

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

The calculation results of the 5 sectors (energy, IPPU, forestry, agriculture, and waste) showed that there were no reduction in GHG emissions in 2014 and 2015 (Figure 3-5). In 2015, the estimated emission increased much higher from the baseline by about -670 Gg CO2e. This was mainly due to the significant increase in emission from forest and other land use (FOLU) sectors. In 2015, the increase in emission was mainly from large fires occurred across the country. However, in 2016, the emission level decreased again to below the baseline by about 311,000 Gg CO2e (Figure 3-6).



	BaU	Actual	BaU	Actual	BaU	Actual	BaU	Actual	BaU	Actual	BaU	Actual	BaU	Actual
	2010		2011		2012		2013		2014		2015		2016	
FOLU	647	435	769	616	771	695	768	607	766	979	765	1,569	764	635
Agriculture	111	105	111	103	111	107	112	107	113	107	114	112	114	117
Waste	88	88	92	92	96	96	101	101	103	103	106	106	113	112
IPPU	36	36	37	36	41	40	41	39	49	47	53	49	56	55
Energy	453	453	511	507	550	540	590	496	639	531	664	536	723	538

Figure 3-5. National GHG emissions (by sector) and the corresponding baseline, 2010 - 2016

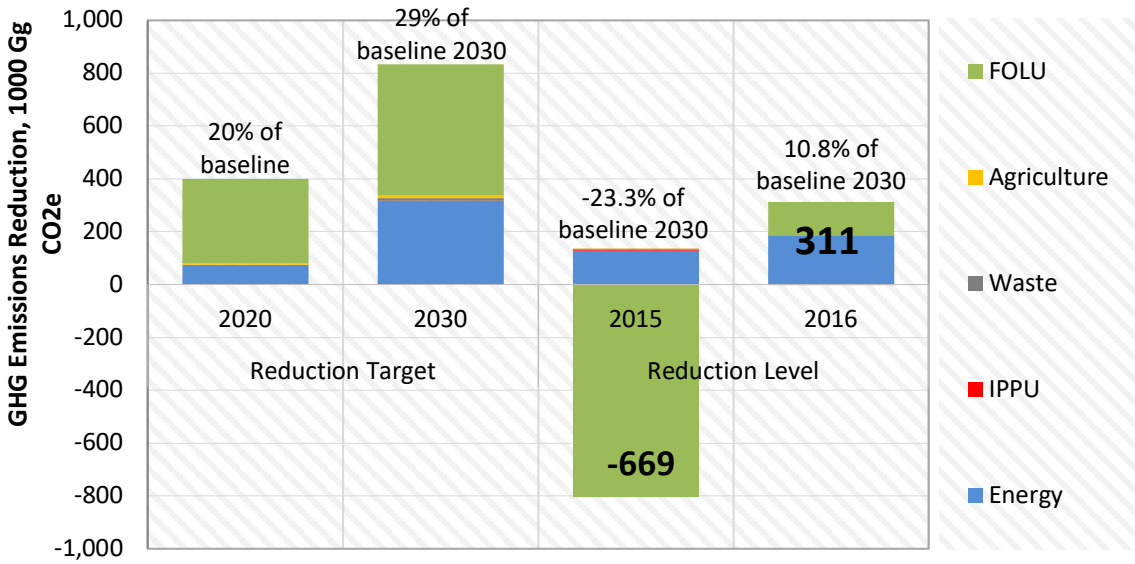
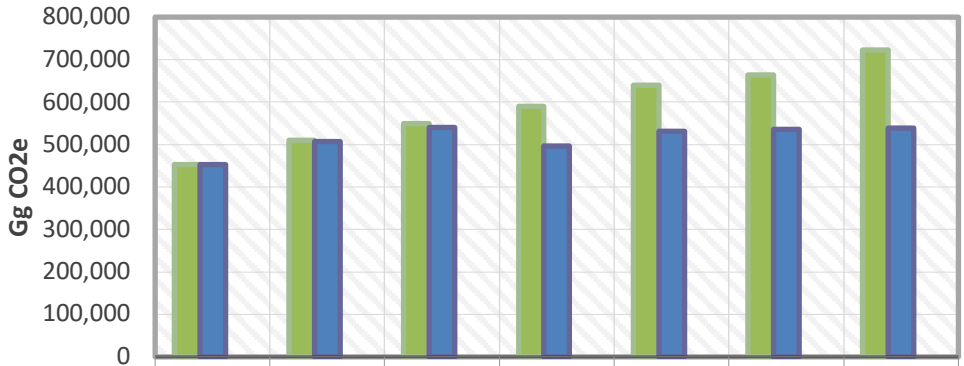


Figure 3-6. GHG emissions reduction by type of mitigation sector in 2015 and 2016 compared to GHG emissions reduction target of each sector under the NDC in 2030

3.3.3 Progress of Mitigations in Energy Sector

GHG emissions reduction targets of mitigation actions under unconditional and conditional scenarios of the NDC in energy sector category are 11% and 14% of the baseline emission level in 2030 respectively (see Table 3-1). The impacts of the implementation of mitigation actions have resulted in the reduction of emissions from the baseline. The magnitude of the impacts of the mitigation actions on emission reduction showed an increased by year (Figure 3-7). In 2015 and 2016, the emission reduction have reached about

128,076 and 184,509 Gg CO2e respectively (Figure 3-6). These reductions were equivalent to about 4.46% and 6.43% below the NDC baseline emissions in 2030 respectively.



	2010	2011	2012	2013	2014	2015	2016
Baseline	453,235	510,771	550,010	590,270	639,193	664,382	722,534
GHG Emissions Level	453,235	507,357	540,419	496,030	531,142	536,306	538,025
% Reduction to BaU 2030	0.00%	0.12%	0.33%	3.28%	3.77%	4.46%	6.43%

Figure 3-7. GHG emissions level of energy sector and the corresponding baseline emissions in 2010 – 2016

Based on the emission reduction report of the Ministry of Energy and Mineral Resources (MoEMR), the impacts of mitigation from the energy sector towards the emission reduction were about 32,154 Gg CO2e (2015) and 36,962 Gg CO2e in 2016. The breakdown of the achievement of GHG emissions reduction from each type of mitigation in some sub-sectors under the energy category in 2015 and 2016 is presented in Figure 3-8. It shows that the reduction of emission from the energy sector is mainly resulted from the final energy efficiency through activities related to energy conservation and audits, followed by ow carbon fuels used in residential, deployment of Clean Coal Technology (CCT), renewable energy, and low carbon emitting fuels in power generation and transportation. It should be noted, that the emissions reduction through energy conservation and audit were also carried out and reported by the Ministry of Industry (MoI), particularly in 13 cement industries. The GHG emissions reduction from these activities achieved an amount of 2,199 Gg CO2e (2015) and 1,418 Gg CO2e (2016). By including these achievements, the energy sector was able to reduce as much as 34,353 Gg CO2e (2015) and 38,380 Gg CO2e (2016) of emissions.

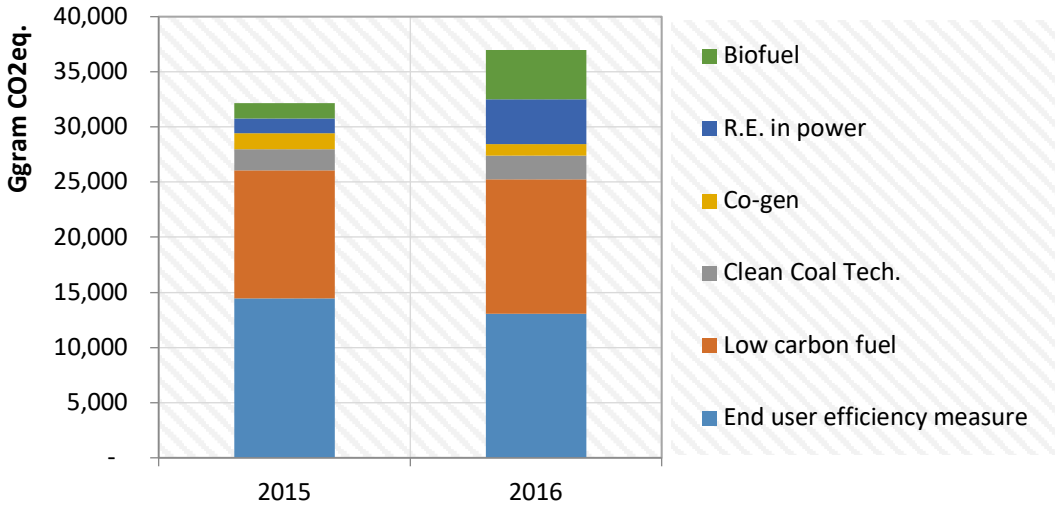


Figure 3-8. GHG emissions reduction in energy sector by type of mitigation actions in 2015 and 2016

Based on the emission reduction report of the Ministry of Transportation (MoT), the sector has reduced the emissions by 2,546 Gg CO2 and 2,939 Gg CO2 in 2015 and 2016 respectively (Figure 3-8). The mitigations activities in this sector are affected by the enhancement of energy efficiency and the increased use of zero and/or low emitting alternative fuels.

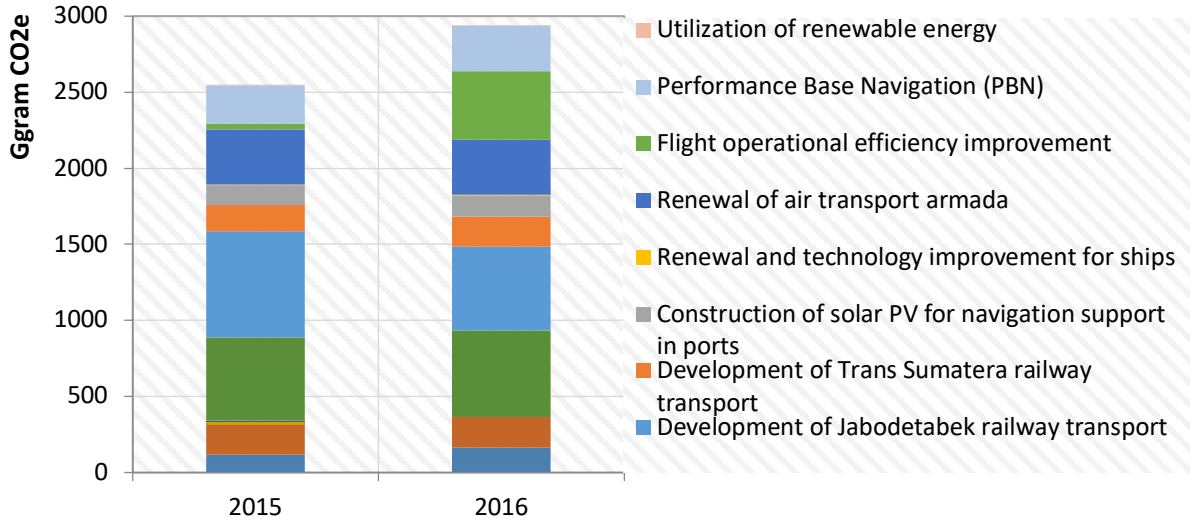


Figure 3-9. GHG emissions reduction in transport sector by type of mitigation actions in 2015 and 2016

In addition to the mitigation activities that are given in Figure 3-8 and Figure 3-9, there are other mitigations activities that have significant impacts in reducing the GHG emissions level in the energy sector that have not been reported (Figure 3-7). If the total emissions reduction reported by the MoEMR, MoI and MoT in 2015 was compared to the emissions reduction calculated from the comparison of GHG emissions level (inventory) with the corresponding baseline emission of the NDC, there is a discrepancy of about 91,176 Gg CO2e or 71%%. For the year 2016, the discrepancy was 143,189 Gg CO2e or 78% (Table 3-7). The discrepancy is considered as the emissions reduction from others, i.e. mitigations that were not reported by the MoEMR, MoI, and MoT as well as emissions reduction due to other factors such as economic situation, change in fuels price, etc. Brief information on the implemented mitigation activities for the energy and transportation sectors is presented in Appendixes 1 and 2.

Table 3-7. Summary of the achievement of GHG emissions reduction record 2015 – 2016

No	GHG emissions reduction	GHG Emissions Reduction, Gg CO2e	
		2015	2016
A	Comparison of actual GHG emission with the corresponding baseline emissions	128,075	184,508
B	GHG Emissions Reduction Activities		
1	MoEMR	32,154	36,962
2	MoI	2,199	1,418
3	MoT	2,546	2,939
4	Others	91,176	143,189
	Sub-Total	128,075	184,508

3.3.4 Progress of Mitigations in Industrial Process and Product Use

GHG emissions reduction target in the NDC under the unconditional and conditional scenarios (CM1) from industrial process and product use (IPPU) categories are 0.10% and 0.11% of the baseline emission level in 2030 respectively (see Table 3-1). Types of mitigation measures to be implemented to achieve the targets include: (a) enhancement on the use of alternative materials (blended cement program) for the replacement of clinker by decreasing the "clinker to cement ratio" from 80% in 2010 to 75% in 2030, (b)

efficiency improvement of ammonia production plant to reduce the use of natural gas as feedstocks as well as energy supply in the ammonia plant and CO_2 recovery in primary reformer of fertiliser industry, (c) improvement of processing system in the smelter industries, (d) use of secondary catalyst in nitric acid production and (e) claim of GHG emission reduction potential in aluminium smelter from CDM project of PFCs reduction in PT Inalum after the CDM project is completed (phase out). Figure 3-10 presents the GHG emissions reduction targets from IPPU sector in 2020 and 2030.

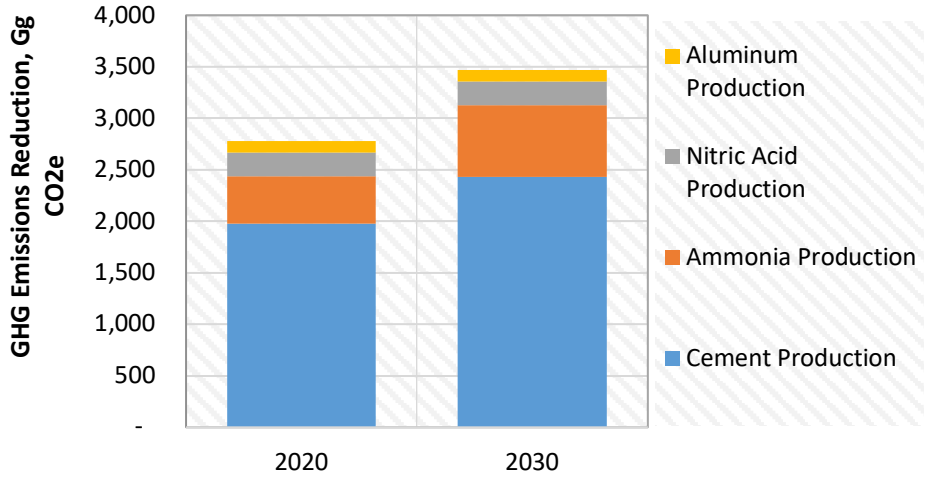
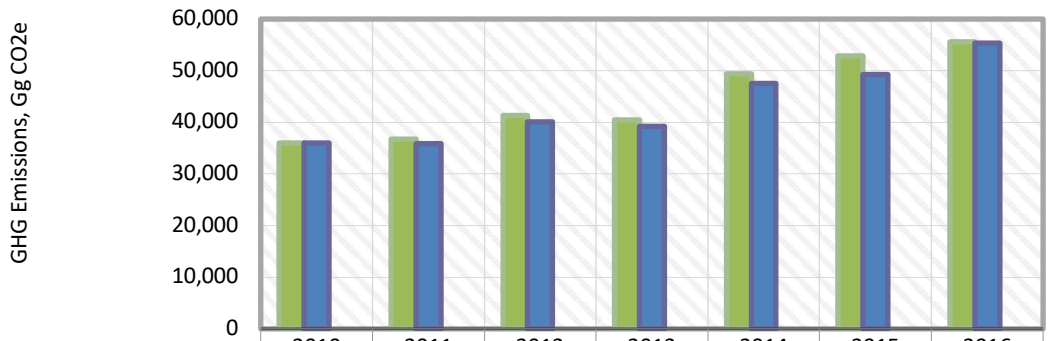


Figure 3-10. GHG emission reduction targets of IPPU sector in 2020 and 2030

Evaluation of the achievement of mitigations in IPPU categories, indicates that the GHG emissions reduction potential of the IPPU sector was 4,199 Gg CO2e in 2015 and 971 Gg CO2e in 2016 (Figure 3-11). At this level of reduction, the mitigation of IPPU sector has achieved 0.16% (2015) and 0.22% (2016) from the baseline emissions in 2030.



	2010	2011	2012	2013	2014	2015	2016
Baseline	36,033	36,723	41,376	40,522	49,442	52,922	55,637
Level of Inventory Emission	36,033	35,910	40,078	39,164	47,489	49,297	55,307
% Reduction to BaU 2030	0.007%	0.040%	0.058%	0.059%	0.080%	0.161%	0.222%

Figure 3-11. GHG emissions of IPPU sector and the corresponding baseline emissions 2010 – 2016

Under the project-based calculation, the achieved emission reduction was 1,426 Gg CO2e in 2015 and 971 Gg CO2e in 2016. The 2016 emission reduction accounted for 1.7 % of the baseline emissions of the NDC in 2016 (see Figure 3-12). If the GHG emissions reduction in 2016 is compared to the NDC reduction target in 2030, this reduction accounts for 35% of the reductions target in IPPU sector under the unconditional scenario. The brief information on implemented mitigation activities for this sector is presented in Appendix 3.

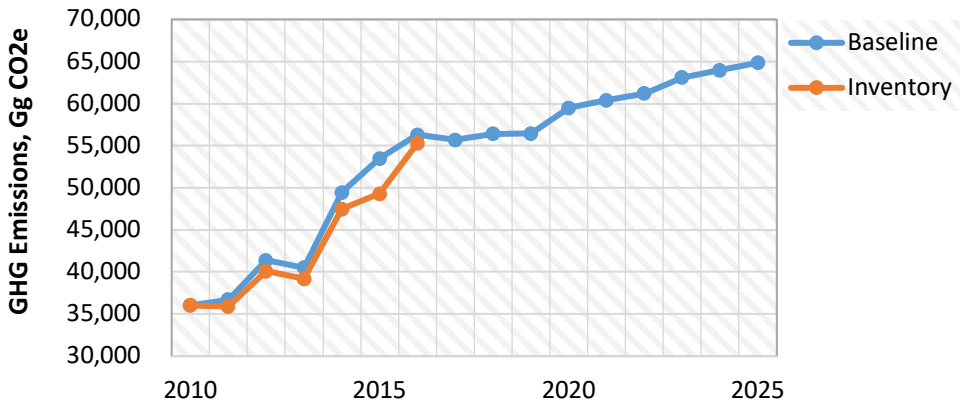
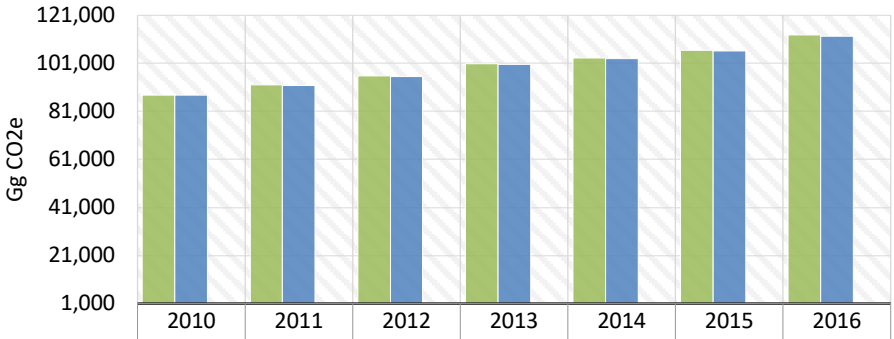


Figure 3-12. GHG emissions level of IPPU in 2015 and 2016 vs the baseline emissions

3.3.5 Progress of Mitigations in Waste Sector

Under unconditional scenario (CM1) of NDC, the GHG emissions reduction targets of mitigation actions from waste sector in 2020 and 2030 are 0.5% and 0.4% of the baseline emissions level respectively (see Table 3-1). To meet these targets, there are four types of waste treatment categories implemented, i.e. MSW, industrial solid waste, domestic wastewater, and industrial wastewater treatments. Each treatment category comprises of several mitigation actions.

The emissions reduction potential in 2015 and 2016 reached a total of 402 Gg CO2e and 396 Gg CO2e respectively, which accounted for 0.014 % of the NDC baseline emissions in 2030 (see Figure 3-13). If it is compared to the NDC reduction target in 2030, the 2016 reduction only accounts for 0.02% (Figure 3-14). Type of mitigation actions that contribute the most to the emission reduction are altering the open dumping to sanitary landfill and Landfill gas recovery and operation of WWTP (Figure 3-15). Similar to the energy sector, the low emission reduction achieved in 2015 and 2016 did not represent the real GHG emissions reductions since not all GHG emissions reduction from implemented mitigation actions are well recorded due to limited monitoring capacity. Summary of information on the implemented mitigation activities for waste sector is presented in Appendix 4.



	2010	2011	2012	2013	2014	2015	2016
Baseline	87,729	91,973	95,746	100,731	103,161	106,463	112,747
GHG Emissions Level	87,670	91,852	95,530	100,514	102,834	106,061	112,351
% Reduction to BaU 2030	0.002%	0.004%	0.008%	0.008%	0.011%	0.014%	0.014%

Figure 3-13. GHG emissions of waste sector and the corresponding baseline in 2010 – 2016

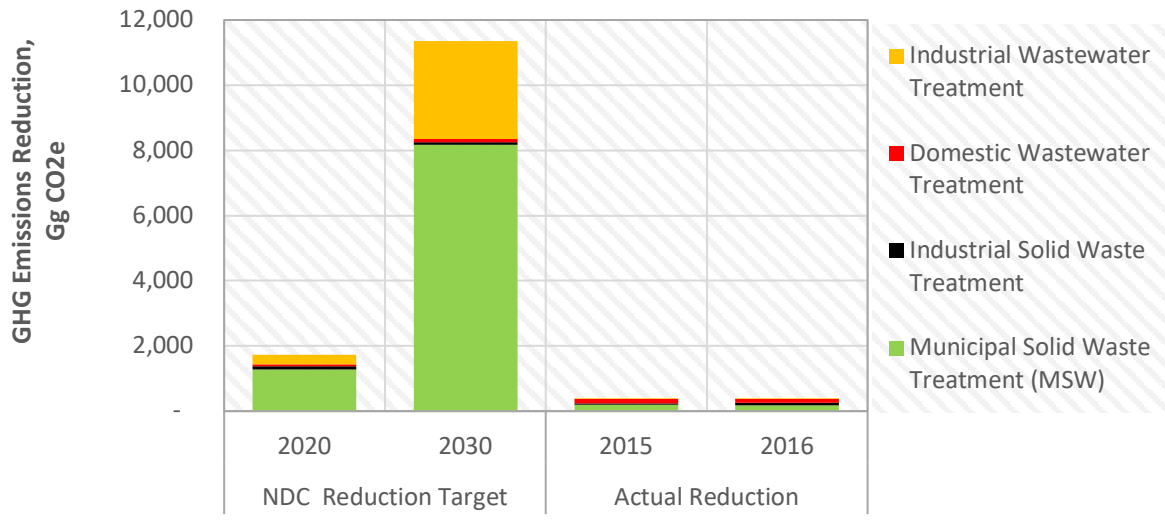


Figure 3-14. The GHG emissions reduction vs the NDC target of 2020 and 2030

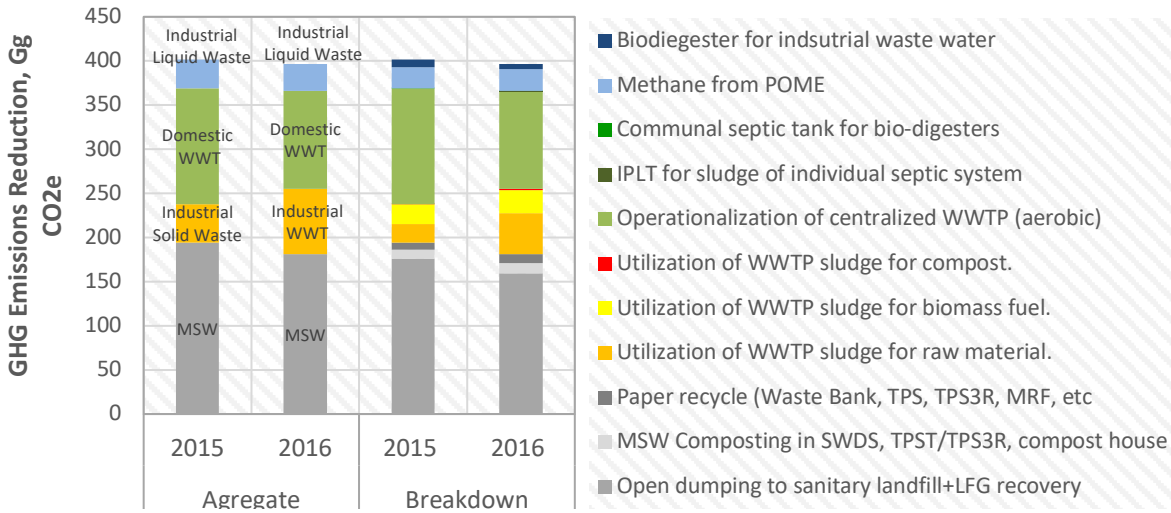


Figure 3-15. GHG emission reduction of waste sector by type of mitigation actions

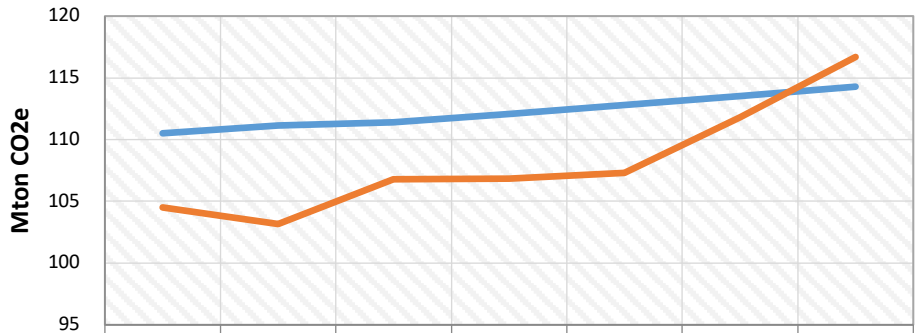
3.3.6 Progress of Mitigations in Agriculture Sector

Under the unconditional scenario (CM1) of NDC, the level of emission from agriculture sector are expected to reach 112 Mton CO_2e and 110 Mton CO_2e by 2020 and 2030 respectively. Mitigation actions to meet these targets were mainly implemented through five activities (i) optimising the use of land, (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) utilization of organic fertiliser and bio-pesticide (Organic Fertiliser Management Unit- *UPPO*) and (v) utilization of manure/ urine livestock and agricultural wastes for biogas (*BATAMAS*).

Evaluation results of the mitigation impacts on emission reduction potential (Figure 3-16) suggests that there were reduction of emission in 2010 to 2015, although in 2016, the actual emission increased above the baseline. The increase of emission in 2016 was largely due to the discontinuity of mitigation activities, i.e. BATAMAS and SLPTT. It should be noted that in the base year, the emission level from the inventory and the NDC is different by about 6.0 million tonnes CO2e (Figure 3-16), whereas this is not the case for non-AFOLU sector. In the case of agriculture sector, the mitigation activities have been implemented before 2010. Under the baseline, it is assumed that all rice cultivations apply water flooding and used IR64 variety. There is no manure management for the livestock. In

2010, some farmers have already applied the low emission rice variety and conducted manure management.

The emission reduction estimation from agriculture sector might be underestimated since the mitigation actions that have been reported were those implemented by the Party Stakeholder (Ministry of Agriculture/MoA). There are mitigation activities undertaken by non-party stakeholders (NPS), in which the impacts of their implementation on the emission reduction could not be measured due to lack of institutional mechanisms in data collection for such activities.



	2010	2011	2012	2013	2014	2015	2016
BAU NDC	111	111	111	112	113	114	114
GHG Inventory	105	103	107	107	107	112	117

Figure 3-16. Baseline and actual emission for agriculture sector

Based on the emission reduction report of the MoA, the implemented agriculture mitigation activities in 2015 and 2016 have reached 1.88 million tonnes CO_2 and 6.95 million tonnes CO_2 respectively. Nevertheless, after the estimates were verified, the emission reductions were further increase to 7.43 and 9.17 M tonnes CO2e respectively. The detail information on the implemented mitigation activities of agriculture sector is presented in Appendix 5.

There is discrepancy between the estimation of the emission reduction reported by the sector and the calculated one based on the difference between the NDC baseline emission and GHG inventory. This discrepancy occurred because of the difference in the activity data of the baseline projection with the actual activity data from the statistic office. In the NDC model, the estimation of rice area for example, is affected by the assumption used in the baseline. The area required for meeting the production targets would depend on the assumption used for land productivity and cropping intensity for that baseline and assumption of conversion of rice paddy area. If under the baseline, the assumption used for the rate of rice area conversion is higher than the actual rate, the projected rice paddy area might be lower than the actual one and this will result in lower emission under the baseline. If the decrease in rice paddy area under the baseline is much higher than the actual rate, then the implementation of the actions cannot be considered, if the emission reduction calculation was derived by comparing the baseline of NDC with the GHG Inventory.

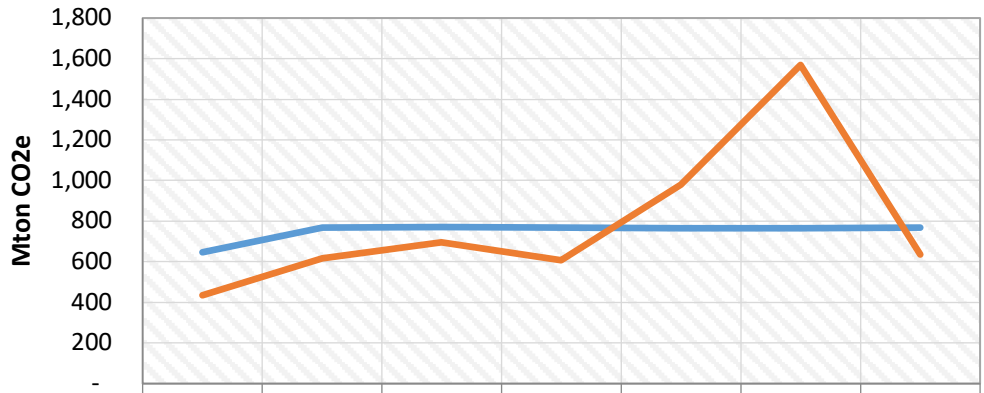
3.3.7 Progress of Mitigations in Forestry Sector

Under the unconditional scenario (CM1) of NDC, the levels of emission of the FOLU sector by 2020 and 2030 are expected to reach 437 Mtonne CO_2e and 217 Mtonne CO_2e respectively. To meet this target, the main mitigation activities to be implemented should include (i) reducing deforestation, (ii) increasing the implementation of sustainable forest management practices, (iii) rehabilitation of degraded land, (iv) peat restoration and (v) suppression/prevention land and forest fire.

Based on the difference in emission levels between NDC baseline and GHG Inventory, it is shown that emissions from this sector in 2010-2016 were below the baseline, except for the years of 2014 and 2015 (Figure 3-17). The resulted increase of emission in 2015 from this

sector significantly above the baseline was mainly due to the increase of emissions from peat fires. In 2015, the extreme drought due to the El Nino event had caused the occurrence of large fire across the country. The total area of the affected peat lands due to the fire was 869,754 ha, which is responsible for a total emission of about 549.4 million tonnes CO2e. Deforestation also increased from the baseline rate, i.e. up to 1.09 million ha. In 2016, with the implementation of fire prevention programmes, and avoiding deforestation, the peat fires have reduced significantly to 97,787 ha and deforested area also decreased to 0.63 million ha. Overall, forestry sector in 2016 was able to reduce the emission by about 132,256 M tonnes CO2e.

The activity data for the calculation of GHG inventory for the FOLU sector are derived from satellite. Some of the mitigation activities under the FOLU might not be able to be captured by the satellite especially when the scale of the implemented area is relatively small, such as land rehabilitation programmes. In addition, the estimation of emission in the GHG inventory does not fully capture the impacts of the implementation of peat restoration. Therefore, emission reduction achievement of 132,256 M tonnes CO2e might be under estimated. Information on the impacts of peat restoration on the emission factors change must be used in the inventory. However, this has not been applied as the system for monitoring changes of emission factors under different peat management has not been established. Summary of information on the implemented mitigation for the FOLU sector is presented in Appendix 6.



	2010	2011	2012	2013	2014	2015	2016
BAU NDC	647	769	771	768	766	765	768
GHG Inventory	435	616	695	607	979	1,569	635

Figure 3-17. Baseline and actual emissions for forest and other land use sector

3.4 Implementation of Mitigation Actions by NPS and Their Effects

In meeting the NDC target for the emission reduction, Non-Party stakeholders (NPS) have also implemented several mitigation actions. As reported in the TNC, the provinces as mandated by the Presidential Regulation No. 61/2011 are obligated to develop local mitigation plan (RAD). They have developed the plans and implemented some of the programme. However, only a few have reported the impacts of the mitigation actions on reducing the emissions.

One of the provinces that has reported the result of implementation of mitigation activities on emission reduction is DKI Jakarta with emission reduction of about 144,275 ton CO2 per year in the period 2015-2016 (Table 3-8).

Table 3-8. Emission reduction estimation for DKI Jakarta (ton CO2e)

Mitigation	2015	2016	Average
Bus Rapid Transport (BRT)	35,005	104,356	69,681
Green Building	13,504	13,684	13,594
LFG-Bantar Gebang	74,000	48,000	61,000
Total			144,275

At the city level, the implementation of mitigation programmes is facilitated through Clean City Program (ADIPURA). As reported in the TNC, the ADIPURA encourages each municipality to maintain urban cleanliness as an indicator of the environment quality. One of the criteria of Adipura is municipal waste management. The GHG mitigation actions that might be implemented are the reduction of municipal solid waste entering the landfills through composting activities, reduce-reuse-recycle or 3R, Waste Bank (Bank Sampah) and improvement of green open space and forest fire prevention. Cities participated in Adipura must have urban infrastructure and facilities such as urban forest, city park, waste landfill, Waste Bank or other waste treatment model and municipal solid waste treatment facility.

Based on the report from ADIPURA Secretariat (2016), the total number of cities that have received the ADIPURA rewards in 2016 totalled to 57 cities achieving Buana grade, 39 cities Kirana grade and 3 cities Paripurna grade (the highest grade). One of the cities that received Paripurna grade is the City of Malang. From the implementation of soil waste management (LFG and 3R) in the final dumpsites of Supit Urang and Talang Agung, the emission reduction have reached about 65 and 19 tonnes CO2e per year respectively. However, cities that report their emission reduction due to urban improvement (waste, green space etc.) are still limited.

The implementation of Climate Village Programme (Proklim) as reported in the TNC, also sees an increase. In 2012-2017, the number of mitigation activities that were implemented under the PROKLIM across the 30 provinces have reached to 447 activities. The estimated emission reductions from the implementation of the programme based on verification in 5 villages in 4 provinces during the period 2015-2016 was 161.35 tonnes CO2 (Table 3-9).

The contribution of emission reduction from the implementation of mitigation activities by the NPS in meeting the NDC target has not been included. The Government of Indonesia is still in the process of improving the National Registry System and MRV to ensure that all mitigation activities are implemented by the associated PS and NPS and be reported. Contribution of the NPS in meeting the NDC emission reduction target will be included in the next submission, if applicable.

Table 3-9. Estimation of GHG Emission Reduction from Proklim Areas in 2015-2016

Provinces	No. of Village	Sector	GHG Emission Reduction (ton CO2e)
Bali	2	Waste, energy	88.25
Riau	1	Forestry, agriculture	500.63
Central Java	1	Forestry, agriculture, energy	932.26
West Java	1	Forestry, Agriculture, energy	110.36

3.5 Supported Mitigation Actions

As reported in the TNC, Indonesia has already received supported mitigation actions from the Nationally Appropriate Mitigation Actions (NAMAs) programs for Sustainable Urban Transport Programme Indonesia (SUTRI NAMA). This NAMA is implemented together with the Indonesian Bus Rapid Transit Corridor Development Project (INDOBUS). The Government of Indonesia had signed the international agreement for the implementation of this project in December 2017.

3.6 International Market

As reported in the TNC, the mitigation actions under international market are CDM projects. As of November 2016, there were 147 CDM projects registered at the CDM EB. Of the 147 projects, 37 have produced CERs with a total of more than 19.6 million tonnes of CO_2e. Most of the Indonesian CDM projects are related to waste management and alternative energy generation activities, particularly from methane avoidance in agro-industry waste treatment. There are 6 additional CDM projects registered at the CDM EB of which three, i.e. cement industry, biogas and hydropower projects, have issued CER equivalent to about 0.332 million tonnes CO_2.

CHAPTER 4. DOMESTIC OF MEASUREMENT, REPORTING, AND VERIFICATION

4.1 Institutional Arrangement

Implementation of MRV in Indonesia follows the international guidance for domestic MRV framework, with several adjustments according to national circumstances. Guideline for the implementation of MRV is promulgated through the Ministry of Environment and Forestry (MoEF) regulation No 72/2017. The guideline regulates mechanism and system for measuring, reporting and verifying impact of climate actions (mitigation and adaptation) including financial resources, technology and capacity building. With the guideline, it is expected that measured impact of the implementation of the climate actions are reliable. The scope of domestic MRV for mitigation action is limited to 5 (five) sectors i.e. energy and transport, IPPU, AFOLU (agriculture, forestry and land use) and waste sector. Framework of the domestic MRV process is presented in Figure 4-1.

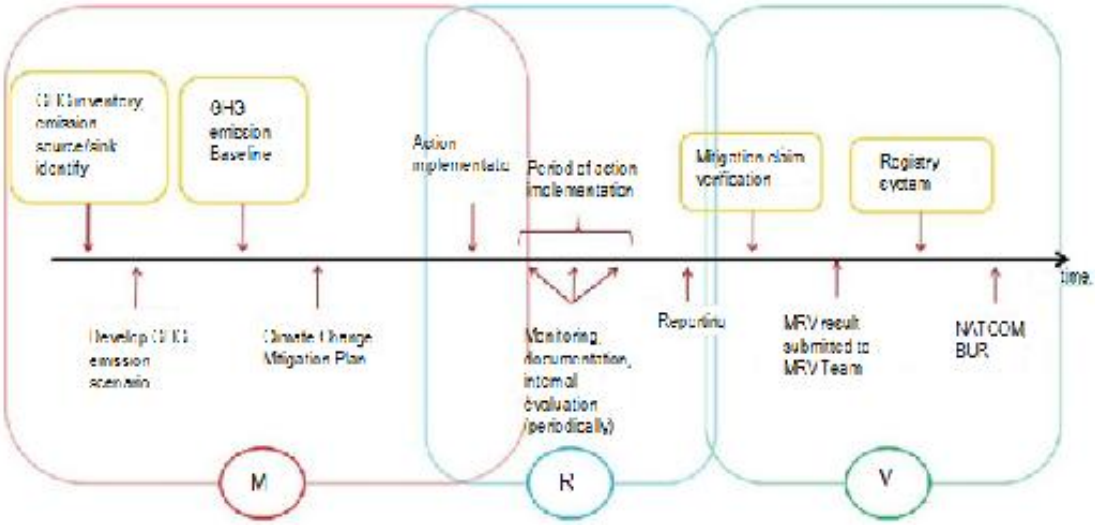


Figure 4-1. Framework of Domestic MRV Process

The implementation of the MRV is coordinated by the MoEF (c. q. Directorate General of Climate Change or DGCC) which engage all sectors that implements the climate actions, i.e. governments, private, as well as public. Methodology Panel has been formed to support the implementation of MRV consisting of experts from universities, research institutions and sectoral ministries. The function of the Panel is to identify, analyze, and asses methodologies developed by parties to measure the emission reduction and also to formulate recommendations for policy makers in making and planning climate action programs. The panel was established based on MoEF Regulation No.22/PPI/IGAS/PPI.2/6/2017.

4.2 Verification Process

The process of verifying mitigation actions starts from party who is responsible for the actions submitting report of the planning, implementation and achievement of mitigation activities to the DGCC. Further, the DGCC through the MRV committee verify the results of emission reductions and report to the DGCC the result of verification for approval. Before the approval,

the verification report is communicated to the sectors and the sectors can provide clarification and their view in meetings the report to reach an agreement. After reaching the agreement, the sectors register the actions in SRN and DGCC of the MoEF will publish the report. In brief, the process of the verification in each sectors is described below:

a. Mitigation action for Forestry

The achievement of emission reduction in forestry sectors are reported by technical Directorate Generals within Ministry of Environment and Forestry. The DGCC will verify the reports through the MRV team. In the case of REDD+, the MRV process follows two schemes as implementation of REDD+ uses national approach with sub-national implementation (provinces). The first scheme is designed for provinces that have not established the institutional system for REDD. In this case, report on emission reduction achievement is submitted by the Forest Management Units (FMU) in the provinces to the DGCC. The FMU will be responsible for coordinating the implementation of REDD+ activities in their management units. If there are REDD+ activities implemented outside the FMUs, the achievement report should be submitted directly by the REDD+ implementers to the MRV Team of the DGCC. The second scheme is designed for provinces that have established the institutional system for REDD. In this regard, the Province appoints an agency in the province to be responsible for coordinating and managing all REDD+ activities in its jurisdiction. The assigned agency (most cases the appointed agency is Provincial Environmental Office or Provincial Forest Office) will report the MRV team of the DGCC. For detail description about MRV REDD+ is presented in the Indonesian report in REDD+ performance (MoEF, 2018).

b. Mitigation action for Agriculture

The report of the emission reduction in agriculture sector is reported by Ministry of Agriculture (MoA) to MoEF via the MRV Team of the DGCC. In this ministry, the measurement of the emission reduction is conducted by Research and Development Agency of the MoA. The MRV Team of the DGCC together with the Methodology Panel will verify the emission reduction report. The Methodological Panel is formed with task to evaluate methodologies for defining baseline and monitoring emission proposed by sectors or actors that implement mitigation actions. The panel consists of experts from universities and sectoral research agencies.

c. Mitigation action for Energy

The MRV in Energy sector starts form submission the report for reduction emission from fuel use in 3 (three) main categories that carried out by 3 three related Ministries. First is reduction in fuel use for electricity, commercial, residential, and others activities that reported by Ministry of Energy and Mineral Resources (MoEMR), second is reduction in fuel use for manufacture and industry reported by Ministry of Industry (MoI), and third is reduction in fuel use for transportation activities reported by Ministry of Transportation (MoT). All the reports will be verified by the MRV Team of the DGCC together with the Methodology Panel.

d. Mitigation action for IPPU

The emission reduction from IPPU is reported by The Ministry of Industry (MoI) and it covers only mitigation actions for clinker ratio at cement industries. Similar to other sector, all the emission reduction reports will be verified by the MRV Team of the DGCC together with the Methodology Panel.

e. Mitigation action for Waste

There are 3 (three) agencies reporting emission reduction from the implementation of mitigation actions in waste sector. First is Ministry of Public Works and Public Housing (MoPWPH) for domestic waste, and MoI for industrial waste. The measurement in reduction of emission from domestic waste is perfomed by technical Directorates of the MoEF with support from the Ministry of Public Work and Public Housing (MoPWPH) that provide the mitigation data.

Verification of emission reduction consist of two processes. First is desk review by MRV Team together with Methodology Panel, and the second site visit. In the desk review, the MRV team will verify the completeness of all documents, appropriateness of methods used in defining the baseline and monitoring and calculation of the emission reduction following the guideline developed by the DGCC.

4.3 National Registry System for Climate Change (NRS – CC)

As part of the implementation of transparency framework in Article 13, and to translate the Paris Agreement into national context, the MoEF as National Focal Point (NFP) for UNFCCC has developed National Registry System of Climate Change (NRS CC) and launched nationally at October 2016. In November 2016, Indonesia launched NRS-CC internationally in COP 22 in Marrakech.

Set by MoEF Regulation No 71/2017, the NRS-CC aims to collect information of actions and sources of resources used for the implementation of the actions. With the presence of the NRS-CC all sectors and any entities who want to contribute to the implementation mitigation actions should register their mitigation activities through this system before being verified. This will avoid duplication, overlapping, double reporting, and double counting. The NRS-CC system is designed as web platform to accommodate all users and multi-platform devices accessible by public and individual/entity who wants to register or searching information related to climate change. The NRS-CC is accessible through web link: http//ditjenppi.menlhk.go.id/srn/. The NRS CC Indonesia workflow explained further in Figure 4-2.

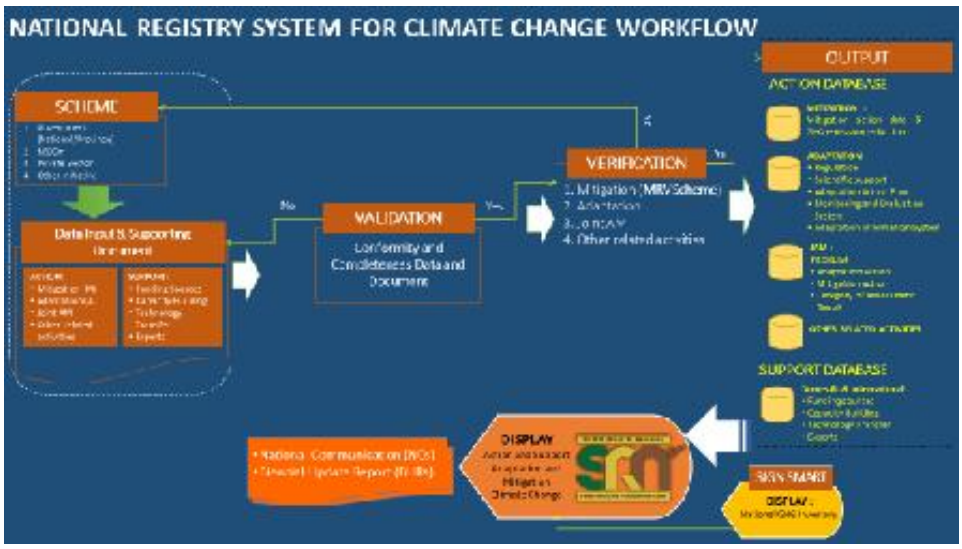


Figure 4-2. National Registry System for Climate Change (NRS CC) Workflow

4.4 Constraints and Plan of Improvement

MRV implementation encounter several constraints. Among others, key constraints are that many of mitigation actions implemented by non-Party actors including impact of mitigation policies on emission reduction cannot be captured or measured well. In addition, mechanism for reporting the mitigation activities through NRS-CC have not been used widely by all sectors and parties. The dissemination and capacity building for sectors and stakeholders on the use of NRS-CC still need to be enhanced that required a lot of financial support. On the other hand, emission reduction reports from parties and stakeholders have not properly explained assumption, data source, validity, methodology, etc. following the guideline as described in

regulation No 72/2017. Many activity data affected by the implementation of mitigations actions are not managed centrally or not connected to the national data and information system.

To overcome the above constraints, the DGCC of the MoEF has set up a number of activities for capacity building for the sectors and non-party actors, Some of key activities include (i) implementation of capacity building and technical assistance for parties that implement or responsible for reporting mitigation actions on the use of the MRV guideline and proper methodology for measuring and calculating emission reduction; (ii) improvement of current data management system for strengthening the linkage between GHG inventory data and mitigation actions, and (iii) establishment of linkage between sectoral data management systems and NRS-CC to support validation and verification process and (iv) implementation of research or survey activities to improve local emission factors and activity data for reducing uncertainty of GHG emission estimates.

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

Finance and technology support and capacity building in the field of climate change are instrumental for supporting developing countries in the implementation of climate change actions. Indonesia has identified a number of support needs from the assessment on the capacity needs in implementing the country's commitment to improve its resilience from the chatastrophic impacts of climate change and to shift toward a low carbon and climate change-resilient development pathway. This section describes financial, technology and capacity building needs to assist Indonesia to meet its emission reduction target up to 41% by 2020, and also supports received from domestic and international sources. Data sources used were gathered from official data particularly from BAPPENAS and the Ministry of Finance. Period of reporting on support received that is reported in this chapter only cover the period of 2015-2016

5.1 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, Government of Indonesia has committed voluntarily to reduce its emission by 29% in 2030. Indonesia definitely needs support to meet the targets, i.e. financial, technology and capacity building needs.

5.1.1 Financial Needs

Government of Indonesia has made an estimation on financial needs to meet the emission reduction target as defined in the NDC. To meet the conditional target by 2030, the financial needs from 2018-2030 is estimated to be about USD 247 billion (IDR 3,461 trillion using IDR 14,000/USD exchange rate). This is a conservative estimation on financial need to meet the Counter Measure 2 (CM2) Scenario or conditional targets (Table 5-1). The estimation is based on projected financial needs using existing public climate financing (government expenditure) added with estimated financial needs for specific interventions in waste and IPPU sectors which would normally be done by the private sectors. These combined estimation builds the baseline numbers which is used to estimate the projected unit cost of emission reduction in each sector.

The financial needs are partially developed from disbursed government expenditure from 2012 to 2016 which is filtered for climate specific (MoEF, 2017; MEMR, 2018). The definition of climate specific finance is taken from the definition developed by the Ministry of Finance (MoF) which takes into account both mitigation and adaptation activities, as well as indirect costs such as financing for policy making process, developing standards, research, and monitoring and evaluation activities. Financial needs for interventions in the specific industries is estimated using the marginal abatement cost for emission reduction in a specific industry (DNPI, 2009) and put against its emission reduction target. This method had been applied by others, i.e. DNPI (2009) and Ministry of Finance (Wahyudi 2012). The estimate of financial needs presented in this report are close to the estimates of two studies.

Table 5-1. Estimated financial needs to meet the unconditional target for period 2018-2030

Sector	Financial needs (billion IDR)	Financial needs (billion USD)	Mitigation policies and programs
Forest and Land use	77,824	5.557	Forest conservation/protection programs and forest and land fire prevention and suppression[1]. Expected emission reduction in 2030 from the BAU is 650 million tons CO_2
Energy & transportation	3,307,197	236.214	Mainly for the development of 48.9 GW renewable energy power plant and investments in clean technologies. Expected emission reduction in 2030 from the BAU is 398 million tons CO_2
IPPU	40,774	0.379	Mostly for cement and steel industries (80% by private investment). Expected emission reduction in 2030 from the BAU is 398 million tons CO_2
Waste	30,339	2.907	Solid and liquid waste management at household and industrial level. About 25% of the investment is by private particularly for liquid waste management. Expected emission reduction in 2030 from the BAU is 26 million tons CO_2
Agriculture	5,175	2.164	Low-emission rice varieties, improving efficient irrigation, biogas utilization, and improved feed additives. Expected emission reduction in 2030 from the BAU is 4 million tons CO_2
Total	**3,461,309**	247.221	

[1]/Cost of emission reduction per timber life-cycle is not included as well as cost of new technology that may occur at any stage of life cycle, and cost of peat management technologies.

Accuracy of the current government expenditure for climate actions (baseline) is important since it will affect projected financial needs. In order to improve the baseline accuracy, in the future baseline estimation may need to consider elaborating the capital expenditure and operational expenditure of projects relevant to NDC targets. Relevant projects are mostly found in the energy, IPPU, and waste sectors, which typically have such cost structures with different project financiers. Dividing capital and operational expenditure will also provide clarity whose money is being invested in the intervention, public or private. Moreover, projected financing need for capital and operational expenditure will be different. Another important improvement to be done in the future is to update the current government climate specific financing. This is due to changes in government expenditure codes which occasionally happen after new government administration.

5.1.2 Technology Needs

5.1.2.1 Energy

From the technology need assessment, Indonesia has identified technology needs to meet the NDC target. As described in Chapter 3, this target is to be achieved through six categories of mitigation actions, namely energy efficiency measures of final energy consumption, application of clean coal technology in power generation, renewable energy power generation, use of biofuel in transport sector, increase use of natural gas through expansion of natural gas pipeline network and construction of additional CNG stations. As the preparation for implementing NDC, technology needs for achieving the NDC targets can be grouped into four sub-sectors namely transport, power generation, industry and building (Table 5-2).

Table 5-2. 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 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; Green Chiller; Efficient Electric Motors; Gas pipeline network; Solar PV; Solar Water Heater

5.1.2.2 IPPU Sector

GHG emissions from industrial process are those released due to chemical or physical transformation of raw material into products. Indonesia's IPPU sector mitigation actions are carried out in 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 reduction target of Indonesia's NDC in IPPU sector are to be achieved by continuing and enhancing the above mentioned mitigation actions. Thus, the technologies that are needed by Indonesia's IPPU sector are those technologies associated with the mitigation actions listed above.

5.1.2.3 Waste sector

Waste sector is the fourth largest contributor to Indonesia's GHG emissions. Mitigation actions in waste sector currently implemented 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). Waste sector mitigation actions in Indonesia's NDC will 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 mitigation in the domestic liquid waste will include treatment of the wastes using aerated, centralized liquid waste treatment facilities (IPAL) and treatment of sludge recovered from septic tanks in integrated liquid waste treatment facilities (IPLT). To meet the NDC target, the technology needs for waste sector are associated with the above mentioned mitigation actions plan presented in Table 5-3.

Table 5-3. 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: 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 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 fire. Thus, significance emission reduction from this sector will depend on level of successful in reducing deforestation and degradation in both mineral and peat forests and improving management of peat land and preventing/supressing land and forest fires. The main challenge to accurately measure the achievement of the implementation mitigation actions in this sector is reliability of monitoring system to detect the change of land covers and to measure emission from peat. Government of Indonesia considered that the key technology needs for 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 methodology for determining area peat affected by fires including estimate of depth of peat burn (the burnt area and peat depth with an accuracy 5 cm).

On the other hand, reducing deforestation in the future will also depend on the capacity in reducing the expansion of commercial agriculture, such as cash crops, biofuel and livestock production. This will relate to capacity in implementing integrated landscape approach/land use planning, sustainable intensification of commercial crop production, sustainable intensification of livestock system, sustainable biofuel initiatives, intensification of smallholder system and livelihood diversification, using degraded land for agriculture expansion and increasing agriculture production in degraded land. Government of Indonesia considered that some of key technology needs for this sector are technology for sustainable intensification practices, technology for developing high yielding varieties, balanced fertilizer application, technology for restoring soil fertility and technology for increasing grassland productivity for animal feed.

5.1.1. Capacity Needs

For effective implementation of the mitigation actions sectoral ministries (party actors), and privates and also communities (non-party actors) required capacity building. Capacity is needed not only to strengthen the skills for implementation of the technologies, but also to monitor GHG emissions, and to measure the achievement in emission reduction. In addition, awareness rising activities need to be implemented in an integrated way not only for the sectoral government 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 different level of stakeholder are the following:

1. 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. Each sectoral ministry should be able to develop mitigation roadmap to meet the NDC/global target and integrated mitigation actions among sectors. Among other, the key capacity needs include (i) capacity in developing baseline/reference emission level as the basis for measuring the achievement of mitigation actions following the guideline developed by the Government; (ii) capacity for collecting and understanding data and in developing templates to facilitate data collection; and (iii) capacity for developing functional database for tracking information on GHG emissions, effects of mitigation actions, financial flows from donor countries/funds, and capacity building and technology transfer activities.
2. Capacity of local governments and private (non-Party actors) in integrating climate change actions into their long term plan and programs. Local governments at the provincial, district and city levels are institutions that play an important role in the success of the national climate change agenda and therefore require continuous capacity building. The Regional Government is the spearhead of 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 in adaptation and mitigation actions. Project planning capabilities, as well as technical writing of proposals for various sources of funds, as well as capacity for the calculation of GHG emissions also need to be improved.
3. Capacity of private sectors to implement mitigation actions. Type of capacity building for the private sectors should be adjusted to the fields condition, For example:

(i) mining companies will focus more on the use of renewable energy, as well as the processing industry, procurement of energy and raw water, and waste management,
(ii) Construction and real estate companies will focus more on green building designs that can absorb energy and be resilient to the threat of flooding,
(iii) trading companies will limit the use of plastic, while transportation companies will cultivate eco-driving as well as 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 and non-government agencies to carry out GHG inventory and MRV including collecting reliable activity data, developing and determining appropriate emission factors, selecting appropriate methodologies, carrying out uncertainty analysis of activity data, emission factors and GHG estimates, implementing quality control from the entire process of GHG inventory, understanding the quality assurance process, understanding the data and information filing system related to the GHG inventory.
5. Awareness and knowledge of agent of changes (religious leaders or ulama, young generation, extension services, journalist etc). The good knowledge of agent of changes is very important to accelerate the change and to motivate stakeholders in making changes. In community organizations, the role of figures is quite important in making an impact with a wide range of people. Although the 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 in general include understanding of climate change, related to causes, impacts, and how adaptation and mitigation actions must be carried out. Specifically, capacity building needs are adjusted to their respective roles. For religious leaders, capacity building is directed to increase their knowledge in climate change

communication, and to review the relevance of climate change issues with verses in the scriptures. Journalists, capacity building for writing climate change news. Politicians, capacity building in climate change issues in general. Young people, capacity building related to climate change communication, social media, and climate change campaigns.

6. Education, more higher graduate study overseas for field related to climate change and research related to climate change. At the level of primary and secondary education, the integration of climate change into the curriculum in general through subject matter. Meanwhile, the problems faced in implementing capacity building related to climate change include the limited access to teaching and learning materials, lack of competency of teaching staff in the scope of cross-disciplinary climate change, and limited integration of climate change into the curriculum. At the university level, the issue of climate change has become the object of study by many researchers and academics. In the context of current teaching and learning in higher education, climate change is integrated into a part of the course. Research related to climate change adaptation and mitigation has also been carried out, but scientific meeting forums to exchange knowledge and information still need to be improved

5.2 Support Received

5.2.1 Financial

5.2.1.1 Support for the development of 2nd BUR

Indonesia has received support fund from the GEF for the development of 1st Biennial Update Report (1st BUR) and Third National Communication (TNC; MoEF, 2017b) at the amount of 4.5 million USD. Additional support from GIZ, JICA were also received at the amount of 150,000 and USD 6,122,040 respectively to support various activities for the development of BUR and TNC. Government of 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). The 1st BUR and TNC documents have been submitted to the UNFCCC at the end of 2016 and mid of 2017 respectively. For the completion of the 2nd BUR, Government of Indonesia provided additional funding at the amount of about 40,000 USD which come from international partners.

5.2.1.2 Support received for supporting the implementation of mitigation actions

Government of Indonesia has received financial support for the implementation of climate actions from various countries and development agencies. In the period of 2015-2016, the financial support received reached 1.86 billion USD. About 99% of the support is for mitigation, i.e. 1.85 billion USD (Table 5-4). The financial supports are mostly in the form of concessional loan and only small amount as grant. Sectors that mostly received the financial support are energy and transportation sectors. These two sectors received more than 97% of the support. Based on source of fund, most of the support from bilateral agreement are from Japan (JICA), which amounted to about 885,11 million USD (48%) and followed by ADB about 403 million USD (22%), by Germany (KfW, GIZ) about 215 million USD (12%) and by France about 124.6 million USD (6.7%; Table 5-5). Financial supports from Japan are for supporting climate change mitigation investment, particularly for transportation, energy and waste management. Among others the supports are for building infrastructure, mainly for public transportation (MRT) and then for renewable energy (geothermal, hydropower) and sewerage. Germany provide financial supports for energy, transportation, forestry and waste sectors. France focus the support for sustainable and inclusive energy program.

Table 5-4. Financial support received for mitigation action in the period 2015-2016 (in million USD)

Financial instrument	Sector	Bilateral	Multilateral	Grand Total
Concessional Loan	Energy	377.00	534.30	911.30
	Transportation	890.53		890.53
	Waste	8.00	1.80	9.80
Sub-Total		**1,275.53**	**536.10**	1,811.63
Grant	Agriculture		0.07	0.07
	Multi sector	16.84	0.01	16.84
	Forestry	9.92	6.71	16.63
	Transportation	0.70	1.25	1.95
	Waste	1.24		1.24
Sub-Total		**28.70**	**8.03**	**36.73**
TOTAL		**1,304.23**	**544.13**	**1,848.36**

Source: MoF-Bappenas, data processed, 2018

Table 5-5. Financial support received for mitigation action in the period 2015-2016 by supporting agencies (in million USD)

	Funding sources	2015	2016	Total
Bilateral	JICA Japan	457.78	427.32	885.11
	KfW Germany	5.51	206.69	212.20
	EXIM Bank Korea	2.50	-	2.50
	China	-	60.04	60.04
	France	-	124.60	124.60
	Germany (GIZ)	-	1.34	1.34
	U K	-	2.71	2.71
	USA - MCC	-	15.73	15.73
Sub-Total		465.79	838.44	1,304.23
Multilateral	AIF		100.00	100.00
	Asian Development Bank	0.40	402.64	403.04
	European Union	-	2.00	2.00
	FAO		0.05	0.05
	GEF		6.25	6.25
	Research Council Norway	-	0.07	0.07
	UNDP	-	0.01	0.01
	World Bank	24.90	1.70	26.60
	World Bank	3.60	2.52	6.12
Sub-Total		28.90	515.23	544.13
TOTAL		494.69	1,353.67	1,848.36

Source: MoF-Bappenas, data processed, 2018

Meanwhile from multilateral, Indonesia received financial support in total 537.82 million USD, which is mainly from ADB, and followed by AIF and World Bank (Table 5-5). From ADB, the support mainly for energy, waste and forestry projects, while IAF and World Bank are for various sectors, e.g. forestry, energy, transportation and waste management. Some of multilateral fund such as FAI and UNDP also provide support for agriculture mitigations. In term of time of disbursement of the supports, there is significant increase in the amount of the support between this period, i.e. from 5% in 2015 to 95% in 2016.

Despite bilateral and multilateral, Indonesia also received support from other institution such as Murata Corporation for collaboration research

and development of innovative energy control technology with amount USD 0.12 million and from NEWRI Singapore for improving the quality of life Giriharja tofu production community through Biogas production from tofu wastewater USD 0.08 million.

5.1.2. Technology

In term of technology support received in the period of up to 2016, the Government of Indonesia has received technology supports from different countries and international organizations. The technology supports received through the implementation of pilot project for applying low carbon technologies and monitoring technologies in various sector. Some of the technology supports recorded in the supported NAMA (National Appropriate Mitigation Action) is presented in Table 5-6. There are other supports not reported in this 2nd BUR due to data limitation. More information of the supports will be provided in the next submissions.

Table 5-6. Some of technology transfer

No.	***Country-specific technology needs***	***Assistance received from developed country parties***	***Time Frame***	***Institution***
1.	• *Environmentally friendly, for example electric car* • *Renewable Energy Fuel, for example Bio-diesel* • *Low budget and environmentally friendly Carbon Capture Storage (CCS)*	*Asian Development Bank for CCS*	*2011-2012* *2016-2016*	*Centre For Research and Technology Development of Oil and Gas, Ministry of Energy and Mineral Resources (PPPTMGB LEMIGAS, KESDM)*
		World Bank for CCS	*2014-2015*	
		MHI and JCOAL Japan for CCS	*2011- 2012*	
		UK Government	*2013-present*	
	• *Smart Street Lighting Initiative (SSLI)*	*GIZ*	*2014*	*Ministry of Energy and Mineral Resources (KESDM, Indonesian Climate Change Trust Fund*
	• *Energy Efficiency Measures in City Hall/DPRD DKI Jakarta Office*	*UNDP*	*2015-present*	*BAPPENAS, ESDM*
	• *Efficient cooling and air conditioning in industry and business*	*BMUB/GIZ*	*2014 - 2018*	*Ministry of Energy and Mineral Resources (ESDM) Ministry of National Develoment Planning (BAPPENAS) Ministry of Environment (KLH), Ministry of Industry (KEMENPERIN)*
	• *Mine Reclamation for Rural Renewable Energy (MORRE)*	*GIZ*	*2016-present*	*East Kalimantan Provincial Government, Ministry of Energy and Mineral Resources (KESDM), Ministry of Environment and Forestry (KLHK)*
2.	*GHG mitigation technology on paddy field and paddy variety*	*USA; for research on paddy variety, testing of efficient nitrogen fertilizer for paddy field*	*2014-present*	*Environmental Research Center, The Ministry of Agriculture*
3.	*Amelioration and fertilizer utilization to improve efficiency and GHG emission reduction*	*Japan; for research on emission reduction technology with intermittent irrigation method from NIAES.*	*2013-present*	

Resources: TNC, NAMA Database for Indonesia (http://www.nama-database.org/index.php/Indonesia)

5.1.3. Capacity Building

Capacity buildings received by Indonesia related to climate change mitigation actions included (i) training activities for technical personnel and policy makers and (ii) pilot activities to strengthen the capacity of stakeholders for the development and implementation of mitigation actions. In the period of 2015-2016, at least 15 training and workshop activities have been implemented to Indonesia conducted in the country and overseas. In addition, many pilot projects have also been implemented to strengthen capacity of various stakeholders including local government in designing and implementing mitigation actions. One of the biggest supports received include demonstration activities for REDD+. At least 37 REDD+ demonstration activities have been implemented in various regions that provide good lesson learnt for Indonesia (Table 5-7).

Table 5-7. REDD+ Demonstration activities implemented in Indonesia

No.	Locations	Name of Activities	Implementing Agencies	Note
1.	A number of Provinces in Sumatera	Tropical Forest Conservation Act (TFCA) Sumatera	Kehati, WWF, TNC dan NGO lokal	Underway
2.	Sumatera Utara	Batang Toru REDD Project	Conservation international, OCSP, Australian mining concession, Yayasan Ecosystem Lestari	Completed
3.	Riau	Kampung Ring: A Sustainable Development Model Based on Peatland Sustainable Management	APRIL (Asia Pacific Resources International Holding, Ltd)	Underway
4.	Riau	REDD+ of Tesso Nilo Forest Complex	WWF Indonesia. Balai Taman Nasional Tesso Nilo, Kantor Balai TN Tesso Nilo, Pangkalan Kerinci, Palalawan, Riau	In process
5.	Riau	Korea Indonesia FMU/REDD+ Joint Project in Tasik Besar Serkap	Kementerian Kehutanan, Korea Forest Service, Dinas Kehutanan Provinsi Riau	Underway
6.	Riau	Giam Siak Kecil-Bukit batu Biosphere Reserve: REDD+ Pilot Project in Bengkalis and Siak	Sinarmas Forestry, Kemenhut, LIPI, Pemerintah Provinsi Riau	Underway
7.	Jambi	Berbak Carbon Initiative Project: A REDD Preparation in Berbak Ecosystem, Jambi	ZSL, MoF (PHKA-Berbak National Park), Darwin Initiative	Completed
8.	Sumatera Selatan	Merang REDD Project	Global Alam Lestari, Co., Ltd. Agrinergy, Co., Ltd	Underway
9.	Jambi dan Sumatera Selatan	DANIDA Support to Harapan Rain Forest (DSHRF)	Burung Indonesia, The Royal Society for the Protection of Birds (RSPB), Bird Life International, DANIDA	Underway
10.	Jambi, Kalbar, NTB	Community Forest Ecosystem Services Indonesia (CFES Indonesia)	FFI	Underway
11.	Jawa Tengah dan Jawa Timur	Project on Capacity Building for Restoration of	JICA, Kemenhut, FORDA, LIPI, Universitas Sriwijaya dan Universitas Kuningan	Completed

No.	Locations	Name of Activities	Implementing Agencies	Note
		Ecosyemtem in Conservation Areas (RECA)		
12.	Jawa Timur	Reforestation of Bromo Tengger Semeru National Park	Sumitomo Forestry Co Ltd., Kemenhut (TN Bromo-Tengger-Semeru)	Completed
13.	Jawa Timur	Tropical Forest Conservation for Reducing Emissions from Deforestation and Forest Degradation and Enhancing Carbon Stocks in Meru Betiri National Park, Indonesia	Puslitbang Kebijakan dan Perubahan Iklim, TNMB, LATIN	Completed
14.	Beberapa provinsi di Kalimatan	Tropical Forest Conservation Act (TFCA) Kalimantan	Kehati, WWF, TNC dan NGO lokal	Underway
15.	Kalimantan Barat	Reducing Emission from Deforestation Caused bt yhe Oil Palm Sector in West Kalimantan	Fauna dan FloraInternational and oil palm companies (PT. Kayong Agro Lestari and PT. Cipta Usaha Sejati)	Underway
16.	Kalimantan Barat	Rehabilitation of the Sungai Putri Peat Swamp Forest, Ketapang, Kalimantan	PT Wana Hijau Nusantara, FFI, Macquarie/BioCarbon	Completed
17.	Kalimantan Barat dan kalimantan Tengah	Indonesia Japan Project Development of REDD+ Implementation Mechanism (IJ-REDD+)	JICA, Kemenhut, Gunung Palung National Park	Completed
18.	Kalimantan Tengah	Community Carbon Project for Lamandau Wildlife Reserve	RARE, YAYORIN, Clinton Foundation, Orang Utan Foundation	Underway
19.	Kalimantan Barat	Danau Siawan-Belida Ecological Restoration Concession: Conservation of the Upper Kapuas Lake System	PT. Wana Hijau Nusantara supported by FFI/Macquarie	Completed
20.	Kalimantan Barat dan Timur	Forest and Climate Change Programme (FORCLIME) Financial Cooperation Modules	KfW, GIZ, Kemenhut, GFA, Pemkab dan Pemprov	Underway
21.	Kalimantan Tengah	The Rimba Raya Biodiversity Reserve REDD Project: Avoided (Planned) Deforestation in Central Kalimantan (Borneo) Indonesia	PT. Rimba Raya Conservation, Infinite-EARTH, Ltd., Orangutan Foundation International	Underway
22.	Kalimantan Tengah	Community Carbon Project for Lamandau Wildlife Reserve	RARE, YAYORIN, Clinton Foundation, Orangutan Foundation	Underway
23.	Kalimantan Tengah	Katingan Peat Restoration and Conservation Project	PT. Rimba Makmur Utama (RMU) Starling Resources	Underway
24.	Kalimantan Tengah	Sebangau Restoration Project	WWF, Taman Nasional Sebangau	Underway
25.	Kalimantan Tengah	Ecosystem Restoration Concession on Production Forest Concession to Release	PT. RHOI (Restorasi Habitat Orangutan Indonesia)	Underway

No.	Locations	Name of Activities	Implementing Agencies	Note
		Orang Utan Using REDD+ Scheme		
26.	Kalimantan Tengah	REDD in HoB: Leboyan Corridor, Bukit Baka – Bukit Raya National Park	WWF, BMU, MoF	-
27.	Kalimantan Timur	Berau Forest Carbon Programme (BFCP)	TNC, ICRAF, Universitas Mulawarman, Sekala Winrock International, University of Queensland	Underway
28.	Kalimantan Utara	Program Setapak (*Selamatkan Hutan dan Lahan melalui Perbaikan Sistem Tata Kelola* or Saving forest and land through improvement of governance system)	STABIL, PIONIR, TAF	-
29.	Kalimantan Timur	Community forest based management	Bioma	Underway
30.	Kalimantan Timur	Transforming Kutai Barat Spatial Planning Toward Forest Low Carbon: Kalimantan Timur Province	WWF, Bebsic, Bioma, Kemenhut (Kutai Barat Regional Office)	-
31.	Kalimantan Timur	Management of peat conservation forest	Pokja TKLH-LK REDD, Bioma, Disbunhut	-
32.	Papua	Preparation of REDD+ Involving Community in Jayapura District: Papua Province	WWF, Kemenhut	-
33.	Papua	The Memberamo Basin Carbon and Community Conservation Project	Conservation Interantional, Pemprov Papua CSIRO, CIFOR, PT Mamberamo Alasmandiri	-
34.	Papua	Papua Avoided Deforestation Initiatives	Sekala, PCSSF, WRI, Telapak	-
35.	Nusa Tenggara Timur	Toward Enabling Mitigation of Climate Change Through Promotion of Community-Based Economic Growth (TEBE Project)	KYEEMA Foundation, AusAID, Yayasan Peduli Sanlima, Yayasan Timor Membangun (YTM)	-
36.	Gorontalo	Gorontalo REDD+ Project with Safeguard Program	Kanematsu, Panasonic Gobel	-
37.	Sulawesi Tengah	Indonesia UNREDD Programme	FAO, UNDP, UNEP, Dishut Sulteng	-

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APPENDIX

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 (concerning emission reduction, in tonne CO_2e)		Information on international market mechanisms
						2015	2016	
Efficiency in final energy consumption								
1.	Mandatory Energy Management Practices for Energy-Intensive Users	Baseline: the 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 tonne CO_2e/MWh; GHG emissions estimate: 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 and low cost): 10%.	Energy efficiency	The Government of Indonesia has issued a series of regulations and tools: i. Energy Act No. 30/2007; ii. Government Regulation No. 70/2009 concerning Energy Conservation; iii. Ministry of Labour Decree No. 321/MEN/XII/2011 concerning Energy Manager on Industry; iv. Ministry of Labour Decree No. 323/MEN/ XII/2011 concerning Energy Manager on Building; and v. Ministerial Regulation of MEMR no. 14/2012 concerning Energy Management.	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 – POME) in 2014 to 2016.	5,849,410.5	3,300,653.7	

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 (concerning emission reduction, in tonne CO_2e)		Information on international market mechanisms
						2015	2016	
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 tonne CO_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: i. Government Regulation No. 70/2009 concerning Energy Conservation; ii. Ministry of Labour Decree No. 321/MEN/XII/2011 concerning Energy Manager on Industry; iii. Ministry of Labour Decree No. 323/MEN/ XII/2011 concerning Energy Manager on Building; v. Ministerial Regulation of MEMR no. 14/2012 concerning Energy Management; and v. Indonesian National Standard (SNI) for Energy Efficient Buildings (SNI 03-6389-2011, SNI 03-6390-2011, SNI 03-6197-2011, SNI 03-6169-2011).		00.00	00.00	

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 (concerning emission reduction, in tonne CO_2e)		Information on international market mechanisms
						2015	2016	
3.	Energy efficiency improvement through the implementation of energy efficiency appliances	Energy saving estimate: the number of efficient appliances distributed in Indonesia and replacement of old technology (baseline). The estimation also considers the capacity of each appliance; Energy saving: the baseline minus the energy level after mitigation; GHG emissions estimates: Tier 1 of IPCC 2006 GLs; EF: electricity grid of all provinces; Assumption: The sold appliances will replace the old (inefficient) residential appliances; Working hours of appliances: typically 8 hrs (source: survey by the Indonesian Association of Luminaire and Electricity).	Energy efficiency	The Government of Indonesia has issued a series of regulations and tools: i. Energy Act No. 30/2007 Government Regulation No. 70/2009 concerning Energy Conservation; and ii. Ministerial Regulation of MEMR No. 6/2011 concerning The Labelling of Energy Efficient Appliances.		3,791,547.3	6,239,246.2	
4.	Installation of public solar street lighting		Implementation of new and renewable energy			1,783.8	2,325.6	
5.	Installation of public solar street lighting - LED lighting retrofits		Energy efficiency			3,466.9	7,662.5	
6.	Implementation of the Presidential Instruction	Energy saving estimate: the energy audit before	Energy efficiency	Presidential Instruction No. 13/2011		226,890.3	20,174.5	

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 (concerning emission reduction, in tonne CO_2e)		Information on international market mechanisms
						2015	2016	
	No.13/2011 on Energy and Water Saving	(baseline) and after the implementation. The associated GHG emissions: Multiplication of the potential energy consumption reduction with emissions factor ; Assumption: All partners will implement energy conservation programmes.						
7.	Utilisation 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 tonne CO_2e/MWh (Jamali) - The EF of fossil fuel will depend on fuel type Assumption: All partners	Utilisation of new and renewable energy	The Government of Indonesia has issued a series of regulations and tools: i. Energy Act 30/2007; Industry Act 3/2014 Govt. Regulation No. 70/2009: Energy Conservation; ii. President Regulation No. 14/2012: Energy Management; ii. President Instruction No.13/2011 on Water & Energy Saving; v. Presidential Decree No.5/2006 on National Energy Policy; v. MEMR Regulation No.14/2012 on	Constructed in 2013 and established with a total capacity of 0.82 MW.	2,199,702.00	1,417,927.62	

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 (concerning emission reduction, in tonne CO_2e)		Information on international market mechanisms
						2015	2016	
		will implement the energy efficiency potential (resulted from the energy audit)		Energy Management; vi. MEMR Regulation No.13&14/2010 on Competence Standard for Energy Manager on Buildings and Industries.				
Renewable energy in electricity generation								
8.	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 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	The Government of Indonesia has issued a series of regulations and tools: i. Energy Act No. 30/2007; ii. Ministerial Regulation of MEMR No 10/2012 Concerning The Development of Renewable Energy Project.		612,865.0	3,150,804.3	
9.	Electricity generation from mini-hydropower plants		Utilisation of new and renewable energy			15,040.1	34,706.5	
10.	Electricity generation from micro-hydropower plants		Utilisation of new and renewable energy			67,079.5	88,529.4	
11.	Electricity generation from solar power		Utilisation of new and renewable energy	The Government of Indonesia has issued a series of regulations and tools: i. Act No. 30 of 2009 concerning Electricity; ii. Government Regulation No. 14 of 2014 concerning		5,078.0	7,374.3	

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 (concerning emission reduction, in tonne CO_2e)		Information on international market mechanisms
						2015	2016	
				Electricity Supply Business; iii. Ministry of Energy and Mineral Resources Decree No.2026.K/20/ MEM/2010 of 2010; iv. Ministry of Energy and Mineral Resources Regulation No. 21 of 2013 concerning Electricity Supply Business Plan (RUPTL)				
12.	Electricity generation from hybrid power plants		Utilisation of new and renewable energy.			1,008.7	1,803.6	
13.	Electricity generation from biomass power plants		Utilisation of new and renewable energy.			574,690.0	654,319.0	
14.	Energy-Sufficient Village Programme		Utilisation of new and renewable energy.			31,096.0	31,096.0	
15.	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	Utilisation of new and renewable energy.	The Government of Indonesia has issued a series of regulations and tools: i. Energy Act No. 30/2007; ii. Ministerial Regulation of MEMR No 10/2012 concerning The		8,277.0	11,814.0	

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 (concerning emission reduction, in tonne CO_2e)		Information on international market mechanisms
						2015	2016	
		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.		Development of Renewable Energy Project.				
Additional compressed-natural gas fuel stations (SPBG)								
16.	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		109,825.9	132,895.9	
Additional gas distribution lines								
17.	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	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		38,249.0	42,135.0	

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 (concerning emission reduction, in tonne CO_2e)		Information on international market mechanisms
						2015	2016	
		residential (newly connected)						
18.	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		00.00	00.00	
19.	Mandatory biodiesel utilisation 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 (bio-fuel is carbon neutral). Assumption: biodiesel as substitute for petroleum diesel and bi-ethanol as substitute for gasoline.		The Government of Indonesia has issued a series of regulations and tools: i. MEMR regulation No. 32/2008 on Mandatory of Biofuels (biodiesel, bio-ethanol, and biogas) Utilisation; ii. MEMR Regulation No. 25/2013 Mandatory of Biofuels (biodiesel, bio-ethanol, and biogas) Utilisation (replacing the MEMR Regulation No 32/2008)		1,363,937.0	4,480,005.0	

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 (concerning emission reduction, in tonne CO_2e)		Information on international market mechanisms
						2015	2016	
Mitigation actions in power sub-sector, including Implementation of clean coal technology in power plant								
20.	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: i. Act No. 30 of 2009 on Electricity; ii. Government Regulation No. 14 of 2014 concerning Electricity Supply Business; iii. Ministry of Energy and Mineral Resources Decree No.2026.K/20/ MEM/2010 of2010; iv. 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	69,076.2	74,975.9	
21.	Construction and operation of supercritical boiler coal-fired 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	Obligation to build clean energy for fossil fuel power plant to achieve an environment-friendly power generation in Electricity sector	The Government of Indonesia has issued a series of regulations and tools: i. Act No. 30 of 2009 on Electricity; ii. Government Regulation No. 14 of 2014	Constructed in 2010/2011/2012/ 2013 and established with a total capacity of 1475 MW.	1,937,348.3	2,161,952.8	

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 (concerning emission reduction, in tonne CO_2e)		Information on international market mechanisms
						2015	2016	
		(i.e. condition without mandatory policy) with the resulted emission level.	or obligation to build renewable and alternative power plants into electricity grid interconnections (PLN Grid interconnection)	concerning Electricity Supply Business; iii. Ministry of Energy and Mineral Resources Decree No.2026.K/20/ MEM/2010 of 2010; iv. Ministry of Energy and Mineral Resources Regulation No. 21 of 2013 concerning Electricity Supply Business Plan (RUPTL)				
22.	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	The Government of Indonesia has issued a series of regulations and tools: i. Act No. 30 of 2009 on Electricity; ii. Government Regulation No. 14 of 2014 concerning Electricity Supply Business; iii. Ministry of Energy and Mineral Resources Decree No.2026.K/20/ MEM/2010 of2010	Constructed in 2013 and established with a total capacity of 2 MW.	1,402,872.7	1,026,356.4	

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 (concerning emission reduction, in tonne CO_2e)		Information on international market mechanisms
						2015	2016	
			interconnection PLN)	iv. Ministry of Energy and Mineral Resources Regulation No. 21 of 2013 concerning Electricity Supply Business Plan (RUPTL)				
23.	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		11,474,817.5	12,015,258.2	
24.	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.			1,701,050.7	1,959,615.4	

Appendix 2. Mitigation actions for transportation 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 envisaged	Results achieved (about emission reduction, ton CO_2e)		Information on international market mechanisms
						2015	2016	
Transportation sector								
Land-transportation sub-sector						**341.502**	**367.63**	
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.	BRT has been implemented in Jakarta (13 corridors), Bandung, Bogor, and Solo.	115.802	165.704	
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 unit ACTS) and Bandung (12 unit ACTS).	199.727	201.421	
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).	452	505	
4.	Implementation of traffic impact management on national main roads (ANDALLALIN)					19.005		

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 envisaged	Results achieved (about emission reduction, ton CO_2e)		Information on international market mechanisms
						2015	2016	
5.	Modernisation of public transports		Reducing fuel consumption, reducing GHG emissions and avoiding air pollution.			6.516		
Railways sub-sector						**1,418,000**	**1,317,000**	
6.	Construction of double-line railway crossings in the Northern Java		Reducing congestion, improving transportation services by shortening travel time and reducing consumer costs, saving energy, reducing GHG emissions and air pollution.			546	566	
7.	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.			698	551	
8.	Construction of Trans Sumatera railway lines.		Reducing congestion, improving transportation services by shortening travel time and reducing consumer costs, saving energy, reducing GHG emissions and air pollution.			174	200	
Maritime Transportation						**133.212**	**139.945**	

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 envisaged	Results achieved (about emission reduction, ton CO_2e)		Information on international market mechanisms
						2015	2016	
9.	Application of solar cell Shipment Navigation System for efficient harbour management through Sailing Navigation Support Facility (SBNP)					128.625	135.077	
10.	Modernisation of ships and ship technology for pioneer ship*	USEPA-ITF				4.587	4.868	
Air transportation						**662.109**	**1,123,434**	
11.	Modernisation of air navigation	ICAO Calculation				361.13	364.559	
12.	Completion of systems and procedures for the operation and maintenance of aircraft passengers	ICAO Calculation	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		38.463	449.14	
13.	Performance Based Navigation (PBN)					253.736	300.643	
14.	Implementation of new and renewable energy technologies					199	263	
15.	Revegetation of airports					8.581	8.829	

Appendix 3. Mitigation actions for IPPU 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 envisaged	Results achieved (about emission reduction, ton CO_2e)		Information on international market mechanisms
						2015	2016	
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 t CO_2/t clinker; EF total: 852 t CO_2/t cement; Mitigation target EF (t CO_2/t cement) - old technology 0.514 - 772 - new technology 0.491 – 488 - calcination 0.325 t CO_2/t clinker	Efficient use of raw materials, saving of production costs, reduction of GHG emissions.	The Government of Indonesia has issued the MoI Regulation No. 12/2012 concerning Roadmap of CO_2 Emission Reduction in Cement Industry in Indonesia	Application of clinker ratio reduction from 0.85 to 0.70 in all cement industries.	1,426,034.71	971,338.10	
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.	N/A	A new unit has been operated and retrofit in the ammonia plant			

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 envisaged	Results achieved (about emission reduction, ton CO_2e)		Information on international market mechanisms
						2015	2016	
3.	Utilisation of scrap (steel industries)	Emission reduction = ((GHG emissions from pig iron and DRI) + (BOF and EAF GHG 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))	Increase in production efficiency, savings of production cost and increase of company profits, feedstock supply security, reduction of GHG emissions.	N/A	Scrap was used as an alternative material (iron ore) in DRI and blasic oxygen furnace (BOF).			
4.	Reduction of PFCs emissions in aluminium smelter (aluminium industries).	Emission reduction = (emissions from aluminium smelter before the replacement of feeding systems and feeding system automation) - (emissions from aluminium 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.	N/A	Implemented at PT. Inalum since 2010.			

Appendix 4. Mitigation actions for agriculture 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 envisaged	Results achieved	Information on international market mechanisms
1.	Management of lowland rice: climate-smart cropping patterns and crop varieties that can resist dry or wet conditions. These activities will reduce the CH4 emissions. The emission reduction target for the 29% scenario in 2020 and 2030 will be more efficient with the implementation of rice-water irrigation system for 68.1 Gg CO_2e and 178 Gg CO_2e respectively Indicator of progress: reduced number of methane live-producing bacteria	Baseline: 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.	Increase 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).	In 2015, a national program, GPPTT (Implementation of Integrated Plant Management Movement, previously called SLPTT), was conducted in 2016 on an area of 356,950 ha and increased to 2,154,673 ha. Additionally, the increase in emissions was due to the use of low emission crop varieties in 7 Provinces, which were originally implemented nationally, i.e. the use of Ciherang variety was only 1,183,256.92 ha.	In 2016 national emission reduction from management of lowland rice: 8.63 ton CO_2e.	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.	In 2014 and 2015, UPPO mitigation actions were discontinued; In 2016 started at 575 units.	In 2016 national emission reduction from utilisation of organic fertilisers: 0.44 ton CO_2e.	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 envisaged	Results achieved	Information on international market mechanisms
3.	BATAMAS (*Biogas Asal Ternak Bersama Masyarakat*) - Utilisation of livestock biogas by the community through the 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 is 7.9 Gg CO_2e and 31.4 Gg CO_2e, respectively; Indicator of progress: The biogas is produced from community livestock.	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. 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.	Increase community income through the use of biogas and compost.	Development of Bio-digester of livestock manure.	Referring to the assumptions that the number of operational BATAMAS in 2016 was 76 units and that within the next 5 years it was estimated to be discontinued.	In 2016 sees national emission reduction from biogas: 0.01 tonne CO_2e.	N/A

Appendix 5. Mitigation actions for forest and other land use change 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 envisaged	Results achieved	Information on international market mechanisms
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 in 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: a). Moratorium on primary natural and peat forest policies that have been extended every 2 years. b). Development of a social forestry program to improve access to forest management by the community.	In period 2014-2015, 2015-2016, the rate of deforestation decreased from 1.09 million ha to 0.63 million ha. Target of social forestry scheme is 12.7 million ha, the social forestry area until 2016 amounted to 636,567.87 ha.	In 2015 and 2016: the national emission reduction from deforestation was 61,107,625 tonnes CO_2e and 14,365,053 tons CO_2e respectively.	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 comparing the NDC baseline with actual emissions due to peat fires.	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.	Starting from 2015 to 2017 the number has decreased by 70,971; 2,844 and 2,440. from 2016 to 2016 decreased by 61.8% and from 2015-2016 decreased by 93.6%	In 2015 and 2016 the achievement of national emission reductions from peat fire control amounted to-549,439,984 CO_2e and 163,131 tons CO_2e, respectively.	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 envisaged	Results achieved	Information on international market mechanisms
3.	Restoration of peatlands is the systematic attempt 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.	Until the end of 2016, peat restoration priorities covered a total of 2,492,527 hectares, which have been mapped; 36 concession holders have been assigned, across the Provinces of South Sumatra, Central Kalimantan, West Kalimantan, Riau and Jambi for peat restoration totalling to 650,389 hectares or 26% of the whole peat restoration area	In 2015 and 2016 national emission reduction achievements from peat restoration amounted to -24,293,823 tons CO_2e and -27,537,955 tons CO_2e respectively.	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: increase 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	The total forest and land rehabilitated in 2015, 2016 and 2017 were: 200,447 Ha, 198,346 Ha and 200,990 Ha, respectively: i. Land rehabilitation in Protection Forest in 2015 and 2016 were 10,516 Ha and 7,067 Ha respectively; ii. Urban forests in 2015 and 2016 were 240 Ha and 215 Ha respectively; iii. Mangroves in 2015 and 2016 were 481	In 2015 and 2016 national emission reduction achievements from forest and land rehabilitation amounted to 1,630,270 tons CO_2e 2,375,892 tons CO_2e	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 envisaged	Results achieved	Information on international market mechanisms
					ha and 497 ha respectively; iv. the seeds of the people in 2015 and 2016 were respectively 189,218 Ha and 28,569 Ha; v. agroforestry in 2015 and 2016: 7,624 ha and 13,416 ha 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 CO_2 emissions; Emission reduction targets for the scenario of 29% in 2020 and 2030 are -18.667 Gg CO_2e and -43.830 Gg CO_2e, 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)	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).	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 envisaged	Results achieved	Information on international market mechanisms
					Minister of Environment and Forestry Regulation Number P.30 / MenLHK / Setjen / PHPL.3 / 3/2016 concerning Assessment of Performance of Sustainable Production Forest Management and Verification of Timber Legality for License Holders, Management Rights, or in Private Forests		

Appendix 6. Mitigation actions for waste 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 envisaged	Results achieved (in relation to emission reduction, ton CO_2e)		Information on international market mechanisms
						2015	2016	
Domestic solid waste						**194.52**	**180.94**	
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 to 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.	Fertilisation of land, reduction of waste in landfills, and reduction of GHG emissions.	N/A	Implemented in several municipal landfills: - Balikpapan (Manggar), - Malang (Talangagung, Supit Urang), - DKI Jakarta (Bantar Gebang), - Surabaya (Benowo).	175.80	159.47	

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 envisaged	Results achieved (in relation to emission reduction, ton CO_2e)		Information on international market mechanisms
						2015	2016	
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). - 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.	Fertilizing land, reducing waste in the landfill, reducing GHG emissions.	The government of Indonesia has issued a series of regulations and tools: i. Waste Management Act No.18/2008; ii. Govt. Regulation No. 81/2012 on Domestic Waste Management; iii. Ministry of Public Works Regulation 03/PRT/M/ 2013 on Infrastructure for Domestic Waste Management; iv. MoE Regulation No. 13/2012 on Guideline for Implementationof 3R through Waste Bank		10.41	11.42	

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 envisaged	Results achieved (in relation to emission reduction, ton CO_2e)		Information on international market mechanisms
						2015	2016	
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: i. Managed Deep SWDS of all MSW SWDS with CH4 recovery (power and SRT); ii. Additional activities in composting and 3R after 2010; ii. 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 emissions.	The government of Indonesia has issued a series of regulations and tools: i. Waste Management Act No.18/2008; ii. Government Regulation No. 81/2012 on Domestic Waste Management; iii. Ministry of Public Works Regulation 03/PRT/M/2013 concerning Infrastructure for Domestic Waste Management; iv. MoE Regulation No. 13/2012 on Guideline for the Implementation of 3R through Waste Bank		8.31	10.05	

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 envisaged	Results achieved (in relation to emission reduction, ton CO_2e)		Information on international market mechanisms
						2015	2016	
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 to 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 CO_2 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 Environment-Friendly Electricity-Based Energy.	N/A	0.00	0.00	

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 envisaged	Results achieved (in relation to emission reduction, ton CO_2e)		Information on international market mechanisms
						2015	2016	
Industrial solid waste						**43.50**	**73.88**	
5.	Utilisation of wastewater sludge as materials.	Methodology: IPCC 2006, FOD (First Order Decay) for landfill, composting and waste 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.	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.	20.75	46.54	
6.	Utilisation of wastewater sludge for fuels by incineration.					22.17	26.55	
7.	Utilisation of wastewater sludge for compost.					0.58	0.79	
Domestic liquid waste						**130.97**	**111.48**	
8.	Development of wastewater treatment (off/on sites)	Methodology: IPCC 2006, Tier-1, default value Baseline: Domestic wastewater is septic tank (w/o CH4 recovery) common practice in 2010 (base year): - septic tank in rural 52%; - septic tank urban 79%, (source: *Statistik Kesejahteraan Rakyat*-BPS). Mitigation:	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: i. Govt. Regulation No. 82/2001 Water Quality Management and Water Pollution Control; ii. Govt. Regulation No. 16/2005 Improvement of SPAM; iii. Ministry of Public Works Regulation no.16/ PRT/M/ 2008 Waste Water Strategic Policy	Development of: i. Centralised WWT in 13 locations; ii. Communal septic tank in 82 locations (equipped with CH4 recovery) (implemented by local governments)	130.92	110.72	

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 envisaged	Results achieved (in relation to emission reduction, ton CO_2e)		Information on international market mechanisms
						2015	2016	
		Centralised domestic WWT is an aerobic sewage type; On-site WWT is a septic tank (CH4 recovery) Assumptions: - BOD: 40 gram BOD/day/person. - MCF septic tank: 0.3.						
9.	Extraction of domestic sewage (MCK) sludge to be processed in the integrated domestic liquid waste facility or IPLT (based on DKI Jakarta report only).	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, enhancement of the community's health and sanitation, reducing GHG emissions.	N/A	Implemented in several districts.	0	0.61	
10.	Operation of communal bio-digester wastewater treatment facility, for households.	Baseline: common practice in 2010 (base year) - rural septic tanks 52%; - urban septic tank 79%, (source: *Statistik Kesejahteraan Rakyat*-BPS). Assumptions: - BOD: 40 gram BOD/day/person, all gases have been utilized.	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.	0.05	0.15	

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 envisaged	Results achieved (in relation to emission reduction, ton CO_2e)		Information on international market mechanisms
						2015	2016	
		- Efficiency of bio-digester: 80%. - Equivalent: 12 kg LPG/month/household. - Heating value LPG: 46 MJ/kg. - Heating value methane gas: 50 MJ/kg.						
Industrial liquid waste						**32.70**	**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-paper industry.	24.29	24.29	
12.	Operation of bio-digester with methane recovery.					8.41	5.83	

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

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1. Introduction

Indonesia has submitted on a voluntary basis, the Forest Reference Emission Level (FREL), in accordance to Decision 13/CP.19 and within the context of result-based payments. FREL covers the activities that "reduce emissions from deforestation" and "reduce emissions from forest degradation", which are among the activities included in Decision 1/CP.16, paragraph 70. In this document, Indonesia uses the opportunity to submit a Technical Annex to its 2nd Biennial Update Report (BUR) in the context of result-based payments for REDD+ under the UNFCCC. Indonesia underlines that the submission of this Technical Annex with REDD+ results is voluntary and exclusively to obtain and receive payments for REDD+ actions, under Decisions 13/CP.19, paragraph 2, and 14/CP.19, paragraphs 7 and 8. The Indonesian government developed this submission with the support of the Working Group of Technical Experts commissioned by the Ministry of Environment and Forestry (MoEF) involving national experts contributed in the development of FREL and its technical assessment.

This Technical Annex presents the results of activities concerning reducing emissions from deforestation and degradation of natural forests and peatland decomposition in the entire national territory of Indonesia from 2013-2017 (MoEF, 2018), measured against the FREL presented by Indonesia to the UNFCCC on January 4th 2016. The focus areas of the Technical Annex are the forested areas in 2013 and forested peatlands in 1990 (hereafter will be called as *Performance Assessment Area*-PAA or *Wilayah Penilaian Kinerja-WPK* REDD+). The Technical Annex also presents the continuous progress of data and information production for the improvement of Indonesian's submissions.

The development of this Technical Annex for REDD+ followed the guidelines of the Decision 14/CP.19 that consisted of:

1. Summary of information from the final report containing each corresponding assessed forest reference emission level;
2. Results in tonnes of CO_2eq per year, consistent with the assessed FREL;
3. Demonstration that the methodologies used to produce the results are consistent with those used to establish the assessed the FREL;
4. Description of national forest monitoring systems and the institutional roles and responsibilities in measuring, reporting and verifying the results;
5. Necessary information that allows the reconstruction of results;
6. A description of how the elements contained in Decision 4/ CP.15, paragraph 1(c) and (d), have been taken into consideration

2. Summary Information from the Technical Assessment Report of FREL

Indonesia has started the development of its national forest baseline termed FREL in 2014. The FREL was designed as a baseline reference for assessing the results of REDD+ implementation in Indonesia, toward performance-based payment/result-based payment of REDD+. Indonesia National FREL was developed by a team of national experts representing various disciplines from cross-ministerial agencies and diverse organisations including NGOs and universities, commissioned and supervised under the Indonesian Ministry of Environment and Forestry of Indonesia, as the National Focal Point (NFP) for UNFCCC. The national experts ensured the sustainability of REDD+ implementation and the continuous improvement of the REDD+ monitoring and emissions calculation methods.

During the COP 21 in Paris on December 2015, Indonesia's NFP submitted the FREL and was officially accepted by UNFCCC Secretariat on January 4th 2016. Following the submission, the FREL undergone technical assessment by the UNFCCC Secretariat, and was completed in November 2016, as scheduled by the UNFCCC secretariat. Report of the technical assessment as well as the official document are available at the UNFCCC website (http://unfccc.int/resource/docs/2016/tar/idn.pdf) and the Directorate General of Climate Change of The Indonesia Ministry of Environment and Forestry (MoEF) website (http://ditjenppi.menlhk.go.id/reddplus/images/resources/frell/FREL-Submission-by-Indonesia-2016.pdf). The Ministerial Decree No. 70/2017 on REDD+ Implementation Guideline states that the current FREL will be effective until 2020, after which the next FREL will be submitted to UNFCCC. This would permit the Government of Indonesia to incorporate as much as possible, the various improvement plans provided during the FREL technical assessment, in line with the country capacities and capabilities.

The REDD+ included in the FREL covered activities related to deforestation and degradation of Indonesia natural forest, which accounted for 113.2 million hectares or about 60% of the country's land area. The first FREL incorporated the above-ground biomass (AGB) for both mineral and peatlands including soil carbon for peatlands as carbon pools, and only took into account the carbon dioxide (CO_2) emissions. The reference period used for the FREL assessment was 1990-2012 considering: (a) the availability of transparent, accurate, complete and consistent land-cover data, (b) reflection of the general condition of forest transition in Indonesia, and (c) sufficient length of time that reflected the national circumstances related to policy dynamics, socio-economic impacts, and climatic variations.

The average annual rate of deforestation during the reference period was 918,678 hectares, and 507,486 hectares for forest degradation rate, which amounted to the annual emissions of 293 $MtCO_2e\ yr^{-1}$ and 58 $MtCO_2e\ yr^{-1}$ respectively. Due to the nature of peat soil and its emission, when deforestation and forest degradation occurred on peat soils that would result in drained peat, emissions from peat decomposition contributed considerably. Emissions from peat decomposition increased over time from about 151.7 $MtCO_2e\ yr^{-1}$ in the initial period (1990) to about 226.1 $MtCO_2e\ yr^{-1}$ at the completion of the analysis period (end of 2012). The increased annual emissions was partly due to the expansion of drained peatlands, which progressively emitted CO_2 within the timeframe of this analysis, and because of the occurrence of inherited emissions. The peat emissions were calculated not only at the time of deforestation, but continued over more extended periods until the organic contents/ peats were fully decomposed. Emissions from peat decomposition were calculated in the areas that had been experiencing deforestation and degradation since 1990.

These annual emissions served as the forest reference emission level, on which the assessment of emissions reduction would be based. The annual historical emissions from deforestation, forest

degradation and (additional) associated peat decomposition (in $MtCO_2$) from 1990 to 2012 are presented in Figure 2-1.

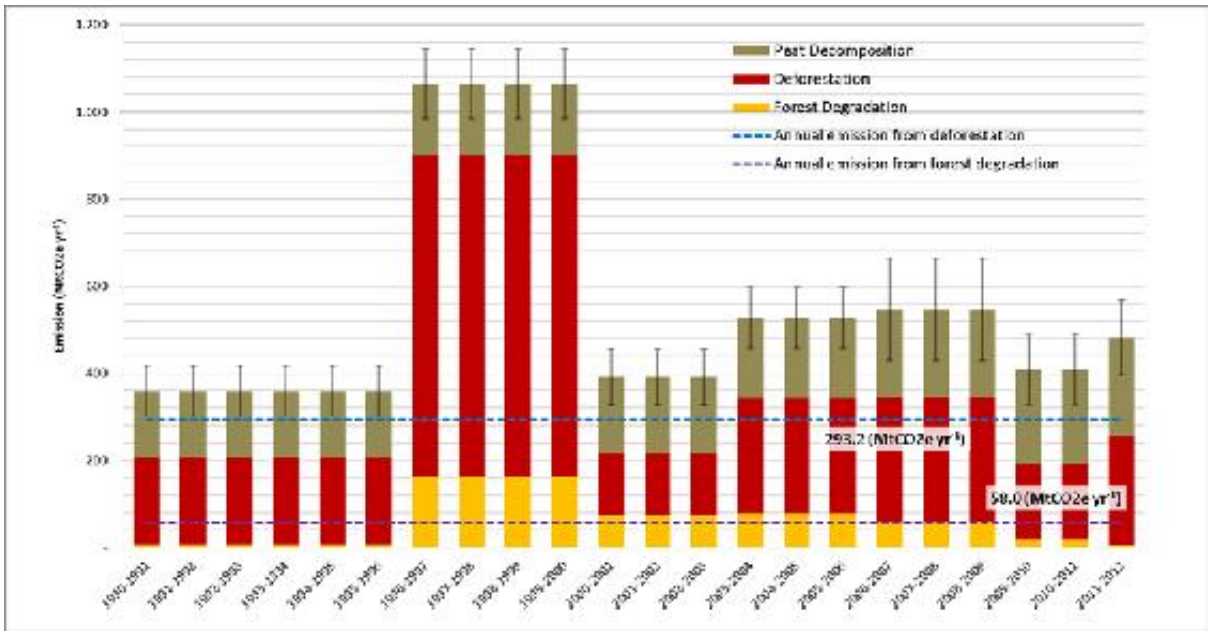


Figure 2-1. Annual and average annual historical emissions from deforestation, forest degradation and associated peat decomposition (in $MtCO_2$) in Indonesia from 1990 to 2012.

3. Results in Tonnes of CO_2-Equivalent per Year, Consistent with the Assessed FREL

The estimation of CO_2 emissions from deforestation, forest degradation and peat decomposition for the resulting phase, used the same emission factors, approaches and procedures presented in the FREL document (http://unfccc.int/resource/docs/2016/tar/idn.pdf). The performance of CO_2 emissions was calculated by subtracting the CO_2 emissions in the reference period with the actual CO_2 emission within the 2013 - 2017 period. Results are shown in Table 3-1.

Table 3-1. Annual emissions from deforestation, forest degradation and peat decomposition during 2013-2017. Values in bold depict higher emissions than the references.

No	Period (year period)	Emissions from Deforestation (CO_2-e)		Emission from Forest Degradation (CO_2-e)		Emission from Peat Decomposition (CO_2-e)	
		Reference	Actual	Reference	Actual	Reference	Actual
1.	2012 – 2013	293,208,910	**296,309,148**	58,002,762	20,401,580	217,648,209	**234,200,361**
2.	2013 – 2014	293,208,910	118,747,501	58,002,762	9,824,101	221,143,831	**240,813,389**
3.	2014 – 2015	293,208,910	239,501,493	58,002,762	**85,971,152**	224,639,453	**248,965,527**
4.	2015 – 2016	293,208,910	283,794,741	58,002,762	**78,649,415**	228,135,075	**255,706,927**
5	2016 - 2017	293,208,910	222,420,072	58,002,762	42,316,848	231,630,697	**256,741,233**
Average		293,208,910	232,154,591	58,002,762	47,432,619	224,639,453	**247,285,488**
Total		1,466,044,549	1,160,772,955	290,013,812	237,163,095	1,123,197,263	**1,236,427,438**

The CO_2 emissions reference from deforestation was derived from the historical emission from 1990 to 2012, which amounted to 293 million tCO_2-e.yr^{-1}. Assessment during 2013-2017 showed that the emissions from deforestation were mostly below the reference (except 2012-2013), with an average of about 232 million tCO_2-e. yr^{-1} (Table 3-1). Meanwhile, the average CO_2 emissions from forest degradation within a period of 2013 - 2017 (47.4 $MtCO_2$-e. yr^{-1}) was also lower than the reference emissions (58 $MtCO_2$-e. yr^{-1}). However, the annual emissions of 2014-2015 and 2015-2016 showed that the forest degradation were higher than the reference emissions. Similarly, from 2013 to 2017, the average emission from peat decomposition was also higher than the reference, i.e. from 224.6 $MtCO_2$-e. yr^{-1} to 247.3 $MtCO_2$-e. All annual emissions from peat decomposition were above the reference emissions.

The overall average emission from deforestation, forest degradation and peat decomposition during the period 2013 – 2017 (526.9 $MtCO_2$-e. $yr^{-}1$) was still below the overall average emission of the reference period (1990-2012) (575.8 $MtCO_2$-e. yr^{-1}) (see Figure 3-1). Only within the periods of 2015 to 2016, the overall emission was slightly above the reference, with an annual emission of 618 $MtCO_2$-e. yr^{-1}. It was apparent that the high emission value was mostly due to the impact of large fires in 2015 that increased the emission from forest degradation. The detailed trend of emission against baseline during the 2013 – 2017 period is given in Figure 3.1.

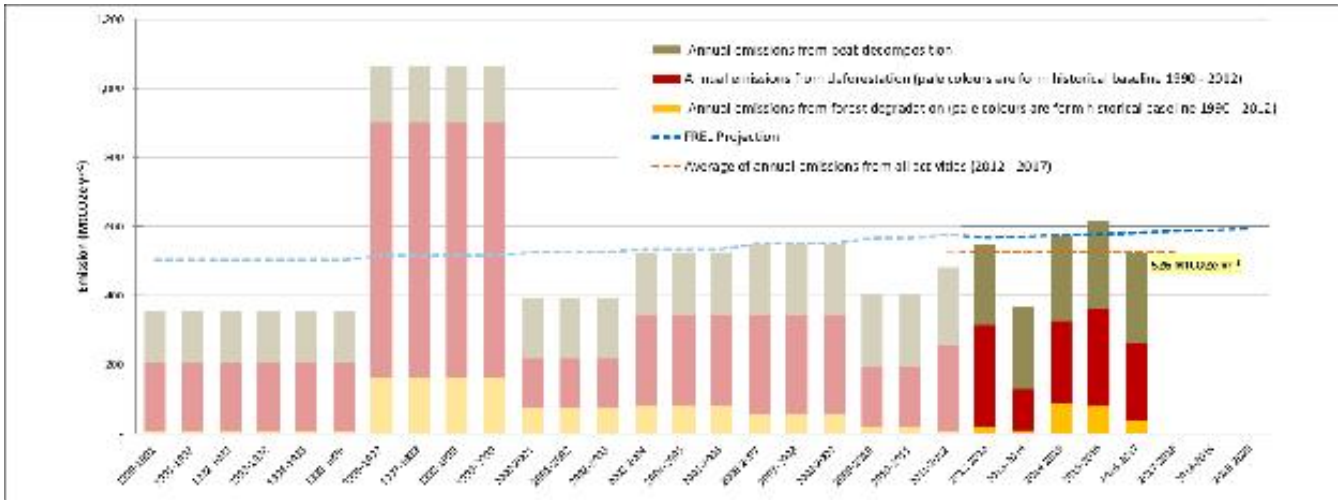


Figure 3-1. Annual emissions from deforestation, forest degradation and peat decomposition. The pale bars show historical data used for the baseline. Error bars depict uncertainties of total annual emissions.

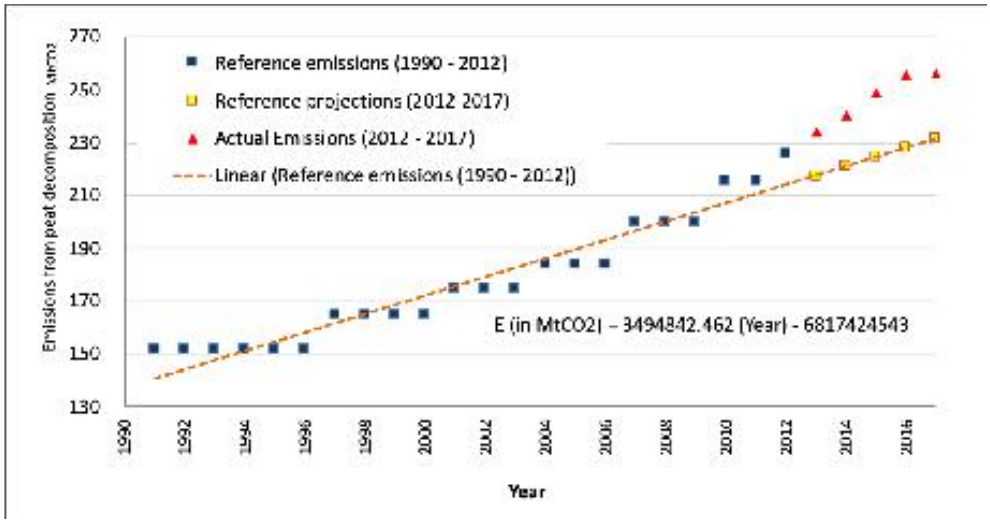
From 2013 to 2017, Indonesia has reduced 305 $MtCO_2$-e from avoiding deforestation against the 1990-2012 reference. The emission reduction from deforestation equals to 20.8 % from the reference emission. Avoidance of deforestation in 2013-2014 (Table 3-2) provided the most significant contribution of emission reductions. Total emission reduction from forest degradation during the period of 2013 – 2017 against the reference period was 53 $MtCO_2$e, or equals to 18.2% reduction from the reference emission. Altogether, Indonesia has reduced 358.1 $MtCO_2$-e emissions from avoiding deforestation and forest degradation, which equals to 20.4 % of the total emission in the reference period. However, emission from peat decomposition was in excess of 113.2 $MtCO_2$-e of the reference. Thus, the excess of the emissions from peat decomposition has reduced the total emission reduction from 358.1 $MtCO_2$-e to 244.9 $MtCO_2$-e. This resulted in 8.5 % emission reduction compare to reference emissions. The main reason for this was the caveat during the development of reference emission projection for peat decomposition (Box 3-1).

Table 3-2. Emissions reductions (in tCO_2e) from deforestation, forest degradation and peat decomposition activities from 2012 - 2017.

Year	Deforestation	Forest Degradation	Peat Decomposition	Total without Peat Decomposition	Total with Peat Decomposition
2012-2013	-3,100,238	37,601,183	-16,552,152	34,500,944	17,948,792
2013-2014	174,461,409	48,178,662	-19,669,559	222,640,071	202,970,512
2014-2015	53,707,417	-27,968,390	-24,326,074	25,739,027	1,412,953
2015-2016	9,414,169	-20,646,652	-27,571,853	-11,232,484	-38,804,337
2016-2017	70,788,838	15,685,914	-25,110,537	86,474,752	61,364,215
Average	**61,054,319**	**10,570,143**	**-22,646,035**	**71,624,462**	**48,978,427**
Total	**305,271,594**	**52,850,717**	**-113,230,175**	**358,122,311**	**244,892,135**
% of reduction from references	**20.8**	**18.2**	**-10.1**	**20.4**	**8.5**

BOX 3-1: Projection of emission from peat decomposition

The emissions from peat decomposition is progressive, due to inherited emissions from previous degraded peatlands. The emissions from peat decomposition will never decrease unless the degraded peatlands are changed into forests, which is unlikely to happen in this period of assessment. In the FREL, we developed linear equations from regression analysis using annual peat emissions from historical data. The emissions from peat decomposition were estimated based on the land cover maps. In some years, instead of yearly land cover map, we only have multi-years land cover maps, i.e. 6-yearly (1990 – 1996), 4-yearly (1997 – 2000) and 3-yearly (2001 – 2009). We generated annual emission from the average values of the mapping period. Each year has an estimated emission value to be regressed against year (Figure A). This resulted in an improper emission projection, where the reference emission in 2013 (218 $MtCO_2e$) was lower than 2012 baseline emission (226 $MtCO_2e$). Therefore, the reference emissions (yellow squares) will always be far below the actual emissions (red triangles).



4. Demonstration that the Methodologies Used to Produce the Results are Consistent with Those Used to Establish the Assessed FREL

This report undertook a technical analysis following the methods used in the construction of Indonesia FREL that has been technically assessed by UNFCCC secretariat (http://unfccc.int/resource/docs/2016/tar/idn.pdf). This includes consistencies in the methodologies used for generating activity data, emission factors, assumptions, definitions, and procedures for estimating CO_2 emissions from deforestation and forest degradation, and peat decomposition occurring on the deforested and degraded forest.

The analysis was carried out for the period of the implementation phase, i.e. 2013 – 2017, focusing on the areas that were still covered by natural forests by the end of 2012, of which are called the Performance Assessment Areas (PAA) or *Wilayah Penilaian Kinerja* (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 construction.

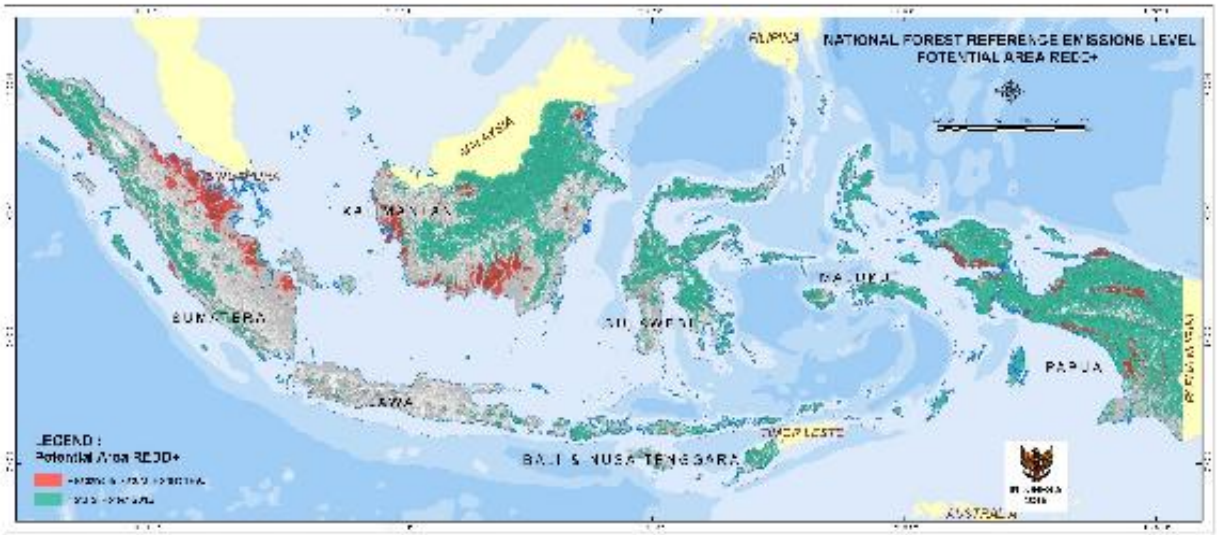


Figure 4-1. Performance Assessment Areas (PAA) or Wilayah Penilaian Kinerja (WPK) for REDD+, which includes natural (intact/primary and degraded/secondary) forests by the end of 2012 as well as peatland that was forested in 1990.

The focus of the current PAA/WPK (2013-2020) was only on activities related to: deforestation, forest degradation, and peat decomposition due to deforestation and forest degradation over peatland since 1990. Other "plus" activities under the REDD+ scheme were not included, and eventually not a subject of the current MRV system.

The emissions from deforestation, forest degradation and peat decomposition were calculated following the FREL methodology by multiplying the transition matrix of land cover change areas in the PAA with the transition matrix of emission factors associated with specific land cover changes. The above-ground biomass data originated from the national forest inventory, and emission factor for peat

decomposition was the IPCC defaults from "2013 supplement to the IPCC 2006 Guidelines for National GHG Inventory: Wetlands (2014)".

Deforestation and forest degradation emission was calculated using the following equation:

$$GE_{ij} = A_{ij} \times EF_j \times 3.67 \quad (1)$$

Where GE_{ij} = CO_2 emissions from deforested or forest degraded area-i at forest change class-j, in tCO_2e. A_{ij} = deforested or forest degradation area-i in forest change class j, in hectares (ha). EF_j = Emission Factor from the loss of carbon stock due to change of forest class-j, owing to deforestation or forest degradation; in tons carbon per ha (tC ha^{-1}). The 3.67 is conversion factor from tC to tCO_2e.

Emission from deforestation and forest degradation at period t (GE_t) was estimated using the following equation:

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

Where, GE_t written in tCO_2, GE_{ij} is emission from deforested or degraded forest area-i in forest class j expressed in tCO_2. 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, which meet natural forest criterion.

While calculation of emission from 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 (tCO_2 yr^{-1}) from peat decomposition occurring in peat forest area-*i* that changed 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 is the emission factor from peat decomposition of peat forest that changed into land-cover class-*j* (tCO_2 ha^{-1} yr^{-1}).

Consistent with deforestation and forest degradation activities, the emission from peat decomposition was calculated from 2013 to 2017. The base calculation for peatland emission is the area located on forested peatland in 1990. The emission baseline of peat decomposition for FREL was estimated using a linear equation approach. This estimate will be improved gradually through a stepwise process to produce a more accurate estimate for future implementation.

The decomposition process in organic soil will produce significant carbon emissions when organic soils are drained. The soils will be exposed to the aerobic condition, being oxidised and emit CO_2. In another hand, when forested peatland being converted to other land uses, the organic soils will continuously decompose for years. These emissions are inherited for years after the initial disturbance. Therefore, emissions from peat decomposition will always increase with an additional peatland being deforested.

Regarding consistency, the data, methodologies, and procedures used for calculating the results presented in this report are similar to those used when establishing the FREL. These are described as follows:

4.1. Activity Data

The activity data used for deforestation and forest degradation were land-cover data available from NFMS for 2013, 2014, 2015, 2016 and 2017. The data were generated from Landsat images to capture historical land-cover data for deforestation (defined as loss of natural forest cover below a certain threshold) and forest degradation (defined as a change from primary forest to disturbed secondary forest) using the same method and procedure as those used for land cover data of 1990-2012 in developing FREL. The land-cover maps that served as activity data were produced by the Ministry of Environment and Forestry, which had been manually digitised through visual interpretation. The minimum threshold for mapping area was 6.25 ha. The activity data used for peatland decomposition

were obtained from peatland spatial map provided by the Ministry of Agriculture, and several related maps, field surveys and ground checks.

4.2. Emission Factors

The primary source of data used to derive emission factors for deforestation and forest degradation were the National Forest Inventory (NFI) plots available throughout the country (by the Ministry of Environment and Forestry), complemented by additional research plots to fill information gaps for specific forest type (i.e. mangrove forest) that had no representative NFI plots at the time of data being assessed. Emission factors for peat decomposition were taken from the 2013 IPCC Wetlands Supplement, which were mostly generated from Indonesia data.

4.3. Carbon Pools

The carbon pools presented in this report were above-ground biomass and soil organic carbon, maintaining the consistency of the same pools as the assessed 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, litter and deadwood) were not included. Soil organic carbon on soil types other than peatlands was also not included.

4.4. Non-CO_2 Gases

The assessed FREL included only carbon dioxide (CO_2) emissions from deforestation and forest degradation. The results presented in this report did not incorporate other gases, maintaining the consistency with the assessed FREL. CO_2 was the most significant gas concerning emissions from forests.

4.5. REDD+ Activities

The REDD+ activities included in this report were consistent with the assessed FREL, i.e. the REDD+ activities with most significant emissions (deforestation and forest degradation), and, hence, did not include emissions from other REDD+ activities (the role of conservation, sustainable management of forests and enhancement of forest carbon stocks). These other REDD+ activities were considered in the area for improvement and will be included in future submissions.

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

5.1. The National Forest Monitoring System of Indonesia

In 1989, the Indonesian Ministry of Forestry (MoFor) developed forest resource monitoring through the National Forest Inventory (NFI) project of Indonesia, which was established in 1989. The NFI was initially designed to collect information on the distribution of forests, the forest cover types, and the standing stock volumes for each type of forest, including mangroves, peatlands, lowland forests and mountain forests. The NFI later had been adjusted to current national condition with four significant components, i.e. (a) forest resources (status) assessment; (b) forest resources (change) monitoring; (c) geographic information system (GIS); and (d) users' involvement (Sugardiman in Mora *et al.*, 2012, MoEF, 2018).

The component of forest resource (change) monitoring (component a) in later development was named National Forest Monitoring System (NFMS). The system is the monitoring system that based on the use of satellite imagery to produce series of land cover map. The satellite imagery used in the system was pre-dominantly Landsat data, which was introduced during the periods of NFI (Revilla and Liang 1989, 1992). After termination of the NFI project around 1998, operational land cover mapping was transferred into the Directorate General (DG) of Forestry Planning of the MoFor. Under the DG of Forestry Planning, more systematic monitoring approach was at first established in 2000. The system is now named NFMS, which is based on a regular production of a land cover map of Indonesia generated in three years interval, or less, and provided in 23 land cover classes including the class of cloud cover and no-data (MoFor 2012, SNI 7645-2010). The NFMS is available online at migrate to http://webgis.menlhk.go.id:8080/nfms_simontana/ for data display, viewing and simple analysis.

Detail information on the NFMS is described in FREL document (MoEF, 2016) (http://ditjenppi.menlhk.go.id/reddplus/images/resources/frell/FREL-Submission-by-Indonesia-2016.pdf) and the method used in NFMS is explained in Margono *et al.* (2016) (https://www.researchgate.net/publication/306233863_Indonesias_Forest_Resource_Monitoring). The design of NFMS and institutional arrangement for measuring, reporting and verification (MRV) process is given in REDD+ performance document (MoEF, 2018) (http://ditjenppi.menlhk.go.id/reddplus/images/adminppi/dokumen/Book_IRPR_KLHK_B5_revisi_4_opt.pdf).

5.2. NFMS: the Institutional roles and responsibilities for MRV

MRV requires credible data and information supported by the suitable system. In this context, the NFMS that provide continuous information on activity data and source of emission factor, plays essential roles. Besides the need of an active system, institution arrangement that describes relationship and authority sharing among institution in doing MRV, would also be imminent.

To ensure day-to-day activities and continuity of the NFMS to support the need of Indonesia MRV for the land-based sector, the system has been strongly supported by the government (under The MoEF or *Kementerian Lingkungan Hidup dan Kehutanan* (KLHK) of Indonesia). The Environment and Forestry Ministerial Regulation No 18/2015 gives the authority for forest resource monitoring to the Directorate General of Forestry Planning and Environmental Arrangement, while authority for MRV is within the Directorate General of Climate Change, another DG within the MoEF. Those two institutions are independent of each other but have to share and integrate the tasks. Illustration on arrangement

and sharing authority in dealing with NFMS for MRV purposes in Indonesia was elaborated in the document of REDD+ Performance (MoEF, 2018).

Regarding a transparent, accurate, consistent, comparative and comprehensive (TACCC) MRV implementation, Indonesia has established modalities for National MRV System, which includedNational 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. Indonesia's MRV scheme for REDD+ outlines the flow of general national MRV process with proper adjustments to accommodate alignment with REDD+ funding schemes and its requirements. Indonesia's MRV scheme for REDD+ is officially presented in the Annex of Ministerial Regulation on the guidance for implementing REDD+ in Indonesia. The detail guideline for the MRV for REDD+ is provided in Guideline for MRV REDD+ activities (http://ditjenppi.menlhk.go.id/reddplus/images/adminppi/dokumen/pedoman_mrv_redd.pdf). Within the above-mentioned regulations, the role of NFMS is imminent.

6. Necessary Information that Allows for the Reconstruction of the Results

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

1. The data of 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, are accessible online at http://webgis.menlhk.go.id:8080/nfms_simontana/
2. The peatland spatial data/map produced by the Ministry of Agriculture (MoA)in 2011 could be accessed at http://tanahair.indonesia.go.id. The data showed emission calculation from peat decomposition in deforested peatland of 1990.
3. Complete information on REDD+ purposes means the provision of data that allows for the reconstruction of the FREL and results of the REDD+ can be accessed by request.

The estimation of emission from deforestation and forest degradation from the loss of above-ground biomass between two years used the land use transition matrix (LUTM). Table 6-1 provides an example of LUTM transition matrix for the period 2012-2013. The emissions from the change of forest change class-j to non-forest classes were calculated using the equation (1). For example, to calculate the emissions from deforestation from primary dryland forest (class code 2001) (GE_{2001}) in tCO_2e, we used the equation (4):

$$GE_{2001} = AD * EF * 3.67 \quad (4)$$

Where *AD* is the change of primary dryland forests (code 2001) to non-forests in the period 2012-2013 in hectare; and *EF* is the emission factor for deforestation of the corresponding class in ton C/ha (see. Table 6-2 presents the sample of the emission matrix from deforestation of all forest classes in 2012-2013.

Emissions from the deforestation of other forest classes use similar equation with corresponding emission factors. Therefore the total emission from deforestation of all different forest classes is estimated using the equation (5):

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

Table 6-1. An example of land use transition matrix of deforestation in the period of 2012-2013 in hectares.

LC		LC 2012 (ha)						
		2001	2002	2004	2005	.20041	20051	Total
LC 2013	2006		12,253		85	671	39,285	52,294
	2007	12,120	182,408	0	242		2,175	196,945
	2010	177	26,411		858	104	35,245	62,795
	2012		220	46	0			265
	2014	8,690	183,816	169	2,405	8,035	144,190	347,303
	20071	76	753	741	4,254	3,768	92,907	102,499
	20091	188	11,553		677	47	1,725	14,190
	20092	9,005	121,818	0	28		1,246	132,098
	20093		283		873			1,156
	20094				1,672		1,454	3,127
	20121		93					93
	20122		330					330
	20141	301	3,985	34	268	4	1,321	5,912
	50011						241	241

	Total	**30,556**	**543,923**	**990**	**11,361**	**12,628**	**319,790**	**919,248**

Table 6-2. An example of CO_2 emission matrix from deforestation due to loss of above-ground biomass in the period 2012-2013 in tCO_2e.

LC Classes		LC 2012 (tCO2e)						
		2001	**2002**	**2004**	**2005**	**20041**	**20051**	**Total**
LC 2013	2006	-	4,178,506	-	28,287	233,445	10,794,481	15,234,720
	2007	5,560,995	62,203,571	0	80,370	-	597,544	68,442,479
	2010	81,178	9,006,342	-	285,338	36,153	9,684,551	19,093,562
	2012	-	74,909	20,825	0	-	-	95,734
	2014	3,986,975	62,683,426	76,931	799,633	2,795,735	39,619,980	109,962,679
	20071	34,773	256,747	337,179	1,414,599	1,311,084	25,528,741	28,883,123
	20091	86,073	3,939,799	-	225,107	16,241	474,084	4,741,304
	20092	4,131,907	41,541,623	0	9,248	-	342,373	46,025,152
	20093	-	96,588	-	290,157	-	-	386,745
	20094	-	-	-	556,083	-	399,583	955,666
	20121	-	31,768	-	-	-	-	31,768
	20122	-	112,529	-	-	-	-	112,529
	20141	137,911	1,358,785	15,547	89,137	1,255	363,087	1,965,723
	50011	-	-	-	-	-	66,353	66,353
	Total	**14,019,813**	**185,484,592**	**450,481**	**3,777,960**	**4,393,912**	**87,870,778**	**295,997,537 ***

*Note: The total of emission in this calculation is different from the actual emissions in 2013 (296,309,148 tCO_2e), because this example used the national EF values instead of island-grouping EF values (see FREL Document; MoEF, 2015)

Calculation of emissions from peat decomposition in particular year at the time of deforestation and forest degradation used the same basis as the one used in calculation of emissions from deforestation and forest degradation with the inclusion of inherited emission. As mentioned above, this is because once deforestation and forest degradation occurred in peat forests, there would be emissions from the loss of ABG at the time of conversion as described above, and additional subsequent emissions from peat decomposition at the time of deforestation and forest degradation. In addition, the deforested and degraded peat forests will release further CO_2 emissions in the following years, known as inherited emissions from peat decomposition. The emission from peat decomposition is calculated using Equation 3.

For example, in the land cover transition matrix of peatlands in the 2012-2013 period, the change of primary swamp forest (SPF) to swamp shrubs (SSr) was 3,379 ha (see Table 6-3 at column 5, line 10), which was considered as the activity data. The emission factor used for this land cover transition (Table 6-4 at column 5, line 10), was the mean of emissions factor of the two land cover types, in this case (0+19)/2 or equals to 9.5 tCO_2/year. Thus, the emission from the peat decomposition of this deforestation was 3,379 × 9.5 equals to 32,102 ton CO_2 (see table 6-5 at column 5, line 10). In the following years, the emission of peat decomposition from the swamp shrubs continues as inherited emission at a rate of 19 ton CO_2/year. This rate will change if the shrubs are converted to other land use that has different emission factor.

Table 6-3. Land cover transition matrix of peatlands in 2012-2013 period (in hectares)

LC		2012																							Grand Total
		PF	SF	PMF	SMF	PSF	SSF	TP	Sr	EP	SSr	AUA	MxUA	Rc	Sv	Po	Sw	Se	Ai	Tr	Br	Mn	WB	Ot	
2013	PF	372,446			1		16																		372,463
	SF	4,573	292,000				19																		296,592
	PMF			232,928																					232,928
	SMF			3,887	89,838																				93,724
	PSF		2			2,124,918																			2,124,920
	SSF		1,145		37	10,206	3,368,605	755	329	115	10,881		224									429			3,392,726
	TP		31		50	585	27,950	517,985	4,548	1,420	19,059	115	518									46,389			618,650
	Sr		1,121				1,068		106,438				13												108,641
	EP		105		10	15	19,188	2,226	2,092	992,893	42,555	89	35	6,467								26,090			1,091,765
	SSr		342	22	137	3,379	57,595	276	206	515	1,791,213						5,131					97			1,858,913
	AUA		8,890				1,186			598	1,884	87,988										238			100,784
	MxUA		2,103				490		55,956		4,378	2,787	120,391												186,105
	Rc										33			51,552											51,585
	Sv														31,703										31,703
	Po															1,555									1,555
	Sw																95,234								95,234
	Se																	5,014							5,014
	Ai																		72						72
	Tr																			669					669
	Br		959		33	6,104	93,206	28,124	1,077	4,153	11,531	5	86	109								320,660			466,046
	Mn		28				554				3										1,823				2,408
	WB																						824		824
	Ot																								-
Grand Total		**377,019**	**306,726**	**236,837**	**90,106**	**2,145,207**	**3,569,878**	**549,366**	**170,647**	**999,694**	**1,881,538**	**90,983**	**121,267**	**58,128**	**31,703**	**1,555**	**100,365**	**5,014**	**72**	**669**	**1,823**	**393,902**	**824**	**-**	**11,133,321**

Table 6-4. Matrix of emission factors for peat decomposition (in tCO_2/ha)

LC		T1																							
		PF	SF	PMF	SMF	PSF	SSF	TP	Sr	EP	SSr	AUA	MxUA	Rc	Sv	Po	Sw	Se	Ai	Tr	Br	Mn	WB	Ot
T0	PF	-	9.5	-	9.5	-	9.5	36.5	9.5	20.0	9.5	25.5	25.5	17.5	17.5	-	-	17.5	-		25.5	25.5	-	-
	SF	9.5	19.0	9.5	19.0	9.5	19.0	46.0	19.0	29.5	19.0	35.0	35.0	27.0	27.0	9.5	9.5	27.0	9.5	35.0	35.0	35.0	9.5	9.5
	PMF	-	9.5	-	9.5	-	9.5	36.5	9.5	20.0	9.5	25.5	25.5	17.5	17.5	-	-	17.5	-	25.5	25.5	25.5	-	-
	SMF	9.5	19.0	9.5	19.0	9.5	19.0	46.0	19.0	29.5	19.0	35.0	35.0	27.0	27.0	9.5	9.5	27.0	9.5	35.0	35.0	35.0	9.5	9.5
	PSF	-	9.5	-	9.5	-	9.5	36.5	9.5	20.0	9.5	25.5	25.5	17.5	17.5	-	-	17.5	-	25.5	25.5	25.5	-	-
	SSF	9.5	19.0	9.5	19.0	9.5	19.0	46.0	19.0	29.5	19.0	35.0	35.0	27.0	27.0	9.5	9.5	27.0	9.5	35.0	35.0	35.0	9.5	9.5
	TP	36.5	46.0	36.5	46.0	36.5		73.0	46.0	56.5	46.0	62.0	62.0	54.0	54.0	36.5	36.5	54.0	36.5	62.0	62.0	62.0	36.5	36.5
	Sr	9.5	19.0	9.5	19.0	9.5	19.0	46.0	19.0	29.5	19.0	35.0	35.0	27.0	27.0	9.5	9.5	27.0	9.5	35.0	35.0	35.0	9.5	9.5
	EP	20.0	29.5	20.0	29.5	20.0	29.5	56.5	29.5	40.0	29.5	45.5	45.5	37.5	37.5	20.0	20.0	37.5	20.0	45.5	45.5	45.5	20.0	20.0
	SSr	9.5	19.0	9.5	19.0	9.5	19.0	46.0	19.0	29.5	19.0	35.0	35.0	27.0	27.0	9.5	9.5	27.0	9.5	35.0	35.0	35.0	9.5	9.5
	AUA	25.5	35.0	25.5	35.0	25.5	35.0	62.0	35.0	45.5	35.0	51.0	51.0	43.0	43.0	25.5	25.5	43.0	25.5	51.0	51.0	51.0	25.5	25.5
	MxUA	25.5	35.0	25.5	35.0	25.5	35.0	62.0	35.0	45.5	35.0	51.0	51.0	43.0	43.0	25.5	25.5	43.0	25.5	51.0	51.0	51.0	25.5	25.5
	Rc	17.5	27.0	17.5	27.0	17.5	27.0	54.0	27.0	37.5	27.0	43.0	43.0	35.0	35.0	17.5	17.5	35.0	17.5	43.0	43.0	43.0	17.5	17.5
	Sv	17.5	27.0	17.5	27.0	17.5	27.0	54.0	27.0	37.5	27.0	43.0	43.0	35.0	35.0	17.5	17.5	35.0	17.5	43.0	43.0	43.0	17.5	17.5
	Po	-	9.5	-	9.5	-	9.5	36.5	9.5	20.0	9.5	25.5	25.5	17.5	17.5	-	-	17.5	-	25.5	25.5	25.5	-	-
	Sw	-	9.5	-	9.5	-	9.5	36.5	9.5	20.0	9.5	25.5	25.5	17.5	17.5	-	-	17.5	-	25.5	25.5	25.5	-	-
	Se	17.5	27.0	17.5	27.0	17.5	27.0	54.0	27.0	37.5	27.0	43.0	43.0	35.0	35.0	17.5	17.5	35.0	17.5	43.0	43.0	43.0	17.5	17.5
	Ai	-	9.5	-	9.5	-	9.5	36.5	9.5	20.0	9.5	25.5	25.5	17.5	17.5	-	-	17.5	-	25.5	25.5	25.5	-	-
	Tr	25.5	35.0	25.5	35.0	25.5	35.0	62.0	35.0	45.5	35.0	51.0	51.0	43.0	43.0	25.5	25.5	43.0	25.5	51.0	51.0	51.0	25.5	25.5
	Br	25.5	35.0	25.5	35.0	25.5	35.0	62.0	35.0	45.5	35.0	51.0	51.0	43.0	43.0	25.5	25.5	43.0	25.5	51.0	51.0	51.0	25.5	25.5
	Mn	25.5	35.0	25.5	35.0	25.5	35.0	62.0	35.0	45.5	35.0	51.0	51.0	43.0	43.0	25.5	25.5	43.0	25.5	51.0	51.0	51.0	25.5	25.5
	WB	-	9.5	-	9.5	-	9.5	36.5	9.5	20.0	9.5	25.5	25.5	17.5	17.5	-	-	17.5	-	25.5	25.5	25.5	-	-
	Ot	-	9.5	-	9.5	-	9.5	36.5	9.5	20.0	9.5	25.5	25.5	17.5	17.5	-	-	17.5	-	25.5	25.5	25.5	-	-

Table 6-5. Matrix of CO_2 emissions from peat decomposition (in $tC0_2e$)

LC		2012																							Grand Total
		PF	SF	PMF	SMF	PSF	SSF	TP	Sr	EP	SSr	AUA	MxUA	Rc	Sv	Po	Sw	Se	Ai	Tr	Br	Mn	WB	Ot	
2013	PF	-	-	-	5	-	150	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	155
	SF	43,442	5,548,000	-	-	-	358	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5,591,800
	PMF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SMF	-	-	36,924	1,706,913	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1,743,837
	PSF	-	16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16
	SSF	-	21,750	-	703	96,952	64,003,498	34,747	6,260	3,388	206,744	-	7,832	-	-	-	-	-	-	-	-	15,001	-	-	64,396,876
	TP	-	1,434	-	2,300	21,343	-	37,812,876	209,190	80,255	876,716	7,108	32,137	-	-	-	-	-	-	-	-	2,876,095	-	-	41,919,455
	Sr	-	21,306	-	-	-	20,297	-	2,022,327	-	-	-	447	-	-	-	-	-	-	-	-	-	-	-	2,064,376
	EP	-	3,094	-	308	306	566,045	125,761	61,716	39,715,730	1,255,384	4,051	1,592	242,497	-	-	-	-	-	-	-	1,187,080	-	-	43,163,564
	SSr	-	6,506	212	2,611	32,102	1,094,303	12,692	3,920	15,182	34,033,041	-	-	-	-	-	48,743	-	-	-	-	3,387	-	-	35,252,698
	AUA	-	311,140	-	-	-	41,523	-	-	27,222	65,957	4,487,368	-	-	-	-	-	-	-	-	-	12,127	-	-	4,945,338
	MxUA	-	73,599	-	-	-	17,159	-	1,958,469	-	153,225	142,115	6,139,945	-	-	-	-	-	-	-	-	-	-	-	8,484,512
	Rc	-	-	-	-	-	-	-	-	-	897	-	-	1,804,327	-	-	-	-	-	-	-	-	-	-	1,805,225
	Sv	-	-	-	-	-	-	-	-	-	-	-	-	-	1,109,621	-	-	-	-	-	-	-	-	-	1,109,621
	Po	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Sw	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Se	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	175,494	-	-	-	-	-	-	175,494
	Ai	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Tr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	34,130	-	-	-	-	34,130
	Br	-	33,552	-	1,147	155,650	3,262,211	1,743,714	37,684	188,941	403,577	267	4,373	4,688	-	-	-	-	-	-	-	16,353,669	-	-	22,189,474
	Mn	-	991	-	-	-	19,386	-	-	-	97	-	-	-	-	-	-	-	-	-	92,961	-	-	-	113,436
	WB	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Ot	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Grand Total		**43,442**	**6,021,388**	**37,137**	**1,713,987**	**306,353**	**69,024,931**	**39,729,791**	**4,299,566**	**40,030,718**	**36,995,639**	**4,640,910**	**6,186,325**	**2,051,513**	**1,109,621**	**-**	**48,743**	**175,494**	**-**	**34,130**	**92,961**	**20,447,359**	**-**	**-**	**232,990,006**

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 the most recent IPCC Guidance and Guidelines

The methods used in the calculation of the results presented in this Technical Annex were consistent with those used in the assessed FREL and complied with the methodologies described in the 2006 IPCC Guidelines for National Greenhouse Inventory (IPCC, 2006) and the 2013 Supplement to the 2006 Guidelines for National Greenhouse Inventory: Wetlands or Wetlands Supplement (IPCC, 2014). The 2006 IPCC Guidelines, particularly Volume 4 (Agriculture, Forestry and Other Land Use (AFOLU) Sector), was used as a basis for estimating emissions from deforestation and forest degradation. In the IPCC Guidelines, emissions from deforestation refer to changes in carbon stocks from forest land converted to other land uses; while emissions from forest degradation refer to changes in carbon stocks from forest land remaining forest land. The IPCC considers the carbon stock changes in the biomass immediately before and after the conversion. In the assessed FREL, the carbon stocks in biomass present shortly before the conversion of forests to other land uses were assumed to be lost after the conversion (gross emissions from deforestation).

The 2013 IPCC Wetlands Supplement was used as a basis for estimating emissions from peat decomposition due to deforestation and forest degradation occurring on peatlands. Emissions from peat decomposition refer to emissions occurred in drained organic soils of the IPCC Wetlands Supplement. In the assessed FREL, emissions from peat decomposition were calculated based on the land cover changes post-conversion, which determined decomposition rates. For example, the rate in peatlands with annual crops differed from that in peatlands with secondary forest or plantations. Although the Wetlands Supplement are intended to be applied only to “drained organic soils”, the assessed FREL did not distinguish areas with and without drainage, and all of the secondary forests were considered as drained forests.

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

The activity data used in the assessed FREL and for the calculation of the results presented in this Technical Annex were originated from land-cover data available from National Forest Monitoring System (NFMS) provided by the Ministry of Environment and Forestry. The NFMS includes an online-based integrated monitoring system that provides spatial forest data and summary reports. The existing NFMS offers comprehensive data on forest resources, consists of national forest/land cover dataset including forest/land fires (burn scar datasets), which are periodically updated in accurate, transparent and credible ways. The NFMS can be accessed online at http://webgis.menlhk.go.id:8080/klhk/home/mapview.

For the REDD+ scheme, Indonesia is emphasising the protection of its tropical natural forests, excluding plantation forest. Therefore, only deforestation and forest degradation occurred in natural forests were accounted in the REDD+ scheme. Indonesia current submission did not consider forest regrowth (both natural and human intervention), nor any carbon sequestration that was taken up by forest growth. This is different from the net deforestation that accounts re-growing secondary forests and plantations. However, the net-deforestation will be counted under GHG inventory and/or further development and elaboration on the “plus” of REDD.

Forest degradation refers to changes in carbon stocks as a result from the conversion of primary forests to secondary forests. In Indonesia, primary forests apply to all forest types that have not been disturbed, while secondary forests encompass all disturbed forest types. Emissions from forest degradation were calculated from the losses of biomass due to changes from primary forests to secondary forests.

For developing the emission factors, Indonesia primarily used the National Forest Inventory (NFI) plot data established for the whole area of Indonesia. The NFI plot data were also available and included in the NFMS as the primary source of emission factors. The uncertainties of the biomass stock estimates used in the current submission ranged from 3% to 50%, depending on the availability of NFI plots of each land cover stratum in each island (see Box 7-1). Thus, a re-design of the current NFI system is being initiated to ensure the sustainability of NFI data measurement, covering all vital land cover classes and reduction of uncertainties of the emission factors.

The most considerable uncertainty came from the estimates of the peatland emissions. Current estimates were based on the IPCC default values, which have 50% uncertainties. Thus, a Tier 3 emission factor for peatlands monitoring is crucial. Currently BRG and other donor organisations installed 66 groundwater level monitoring system (GWLMS) at various degraded peatlands (BRG, 2018). In addition, MoEF is compiling peatland GWLMS data from timber concessions. The GWLMS data will be available in the future and it will be used for estimating the CO2 emissions due to peat

Box 7-1: How to calculate uncertainties

Sources of uncertainties calculated in this submission included uncertainties from emission factors and activity data for all activities (deforestation, forest degradation and peat decomposition). Uncertainty for activity data derived from the values of overall mapping accuracy of forest and non-forest classification for each period. The uncertainty calculation of activity data for deforestation, forest degradation and peat decomposition applied the same values.

The uncertainties of emissions factor for deforestation (U_{Def}) were derived from the sampling error of AGB estimates for primary (U_{PF}) or secondary forests (U_{SF}), depending on where the deforestation occurs. Uncertainties of forest degradation (U_{Deg}) were calculated using theequation below:

$$U_{Deg} = \sqrt{U_{PF}^2 + U_{SF}^2}$$

All sampling error of the AGB estimates were derived from the NFI data analysis. Uncertainty for peat decomposition (U_{Peat}) derived from IPCC. Total uncertainty (U_{Tot}) was calculated using the following equation:

$$U_{Tot} = \sqrt{U_{Deg}^2 + U_{Def}^2 + U_{Peat}^2}$$

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