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# FIRST
# BIENNIAL UPDATE REPORT (BUR)

Under the United Nations Framework Convention on Climate Change

Republic of Indonesia

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# Preface

Combating climate change while ensuring national development in a sustainable manner is one of the greatest challenges of the 21st century. The importance of ambitious targets in reducing emissions and vulnerability have been recognized in the frameworks of the UNFCCC and respectively of the Rio+20 objectives *The Future We Want*. Furthermore, efforts to halt dangerous effects of climate change need to be done as soon as possible.

The Government of Indonesia has committed to ambitious emissions reduction target and is implementing a comprehensive nationwide response to climate change: reducing emissions, adapting to unavoidable climate change, and helping to shape a global response. These actions will safeguard our environment, sustain our society, and support our economy for the years ahead.

The mitigation voluntary commitment has been elaborated into a set of policies for climate change mitigation to achieve the national target of 26% emission reduction compare to business as usual in 2020 by national resources and up to 41% with international support. This target was articulated in Presidential Decree Number 61 and Number 71 in 2011 respectively. The supporting tools have been developed and operationalized, such as *National System on Greenhouse Gas Inventory* and National MRV system.

As a Party to the UNFCCC, Indonesia has obligation to report periodically through national communications, and to submit biennial update reports containing updates of national greenhouse gas inventories, including a national inventory report and information on mitigation actions, needs and support received, as mandated by the Conference of the Parties at its sixteenth session (COP 16).

This First Biennial Update Report (BUR) to the UNFCCC contains the national inventory of anthropogenic emissions by sources and removal by sinks of all greenhouse gases (GHGs) not controlled by the Montreal Protocol, including a national inventory report, as well as information on mitigation actions and their effects, as well as the associated methodologies and assumptions.

This First BUR also identified constraints and gaps related to financial, technical and capacity needs, information on domestic measurement, reporting and verification, and other information relevant to the achievement of the objective of the Convention.

**Dr. Siti Nurbaya**

Minister for Environment and Forestry
Republic of Indonesia

# Executive Summary

Indonesia continues the efforts and actions towards the implementation of its commitments as a Non-Annex I Party to the United Nations Framework Convention on Climate Change (UNFCCC). Indonesia presented its First National Communication in 1999 and the Second National Communication (SNC) in 2010 to the UNFCCC. Following Decision 2/CP.17, Indonesia has prepared its first Biennial Update Reports (BUR) containing updates of national greenhouse gas inventories, including a national inventory report and information on mitigation actions, needs and supports received.

This BUR was supported by the Global Environment Facility (GEF) through the United Nations Development Programme (UNDP), along with further funding from the Government of Indonesia. The preparation process of the first BUR included consultations with line ministries, academics and private sector, to seek their opinions and points of view about the elements of the updates that would require improvement in this first assessment.

As requested, Indonesia's first BUR was prepared in accordance with the UNFCCC reporting guidelines on BUR.

## 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 about 790 million hectares (ha) with a total coastline length of 95,181 km and land territory of about 200 million ha. Of the 200 million ha of land territory, about 50 million ha are devoted to various agricultural activities. There is nearly 20 million ha of arable land, of which about 40% is wetland (e.g., rice fields), 40% is dry land, and 15% is shifting cultivation. Since 2013, the Republic of Indonesia has been divided administratively into 35 provinces.

Indonesia's population in 2010 reached 238 million people, the fourth most populous nation in the world after China, India and the United States. In the period 1980-1990, the annual population growth rate was 1.98% and slightly decreased to 1.49% during 2000-2010. Indonesia's population is projected to exceed 300 million by 2030. Based on age composition, the current dominated population is 45 and below. Unemployment and underemployment are still relatively high, hence poverty remains a challenge. Nevertheless, employments in Indonesian has been improving in the past 8 years. Though the unemployment rate is still relatively high, it had been decreasing from around 10% in 2004 to around 6% in 2013. In 2014, about 27.7 million people (11% of the population) in Indonesia are considered poor. According to the country's Medium-term Development Plan (RPJMN 2015-2019), the government plans to implement various development and welfare programmes to reduce poverty rate to 6.5-8.0 % of the population by 2019.

Indonesia's economy has grown rapidly in the last 10 years. The Indonesia GDP price in 2013 was worth IDR 9,084 trillion (±USD 939 billion), which was much higher than it was nine years ago at only IDR 2,300 trillion (±USD 248 billion). In terms of per capita, Indonesia GDP grew from IDR 10.5 million (USD 1,132) in 2004 to IDR 33.3 million (USD 3,442) in 2012. During this period, the annual growths of Indonesian economy varied from 4.6% to 6.5%. The national RPJMN 2015-2019 has set the annual economic growth target to be 6% - 8% in the next five years.

## 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 2012, the total GHG emissions for the three main greenhouse

gases ($CO_2$, $CH_4$ and $N_2O$) without land use change and forestry (LUCF) and peat fire, amounted to 758,979 Gg $CO_2$-e. With the inclusion of LUCF and peat fires, the total GHG emissions from Indonesia become 1,453,957 Gg $CO_2$-e (Table 1). The main contributing sectors were LUCF (including peat fires (47.8%) followed by energy (34.9%), agriculture (7.8%), waste (6.7%), and IPPU (2.8%) (Table 2). The GHG emissions (in $CO_2$ equivalent) were distributed unevenly between the three gases at 84.1%, 11.9% and 4.1% for $CO_2$, $CH_4$ and $N_2O$ respectively.

Table 1. Summary of 2000 and 2012 GHG emissions for Three Main GHG ($CO_2$, $CH_4$ and $N_2O$) in Gg $CO_2$-e

| Sectors | | Year | | Percentage | |
|---|---|---|---|---|---|
| | | 2000 | 2012 | 2000 | 2012 |
| 1 | Energy | 298,412 | 508,120 | 29.8 | 34.9 |
| 2 | IPPU | 40,761 | 41,015 | 4.1 | 2.8 |
| 3 | Agriculture | 96,305 | 112,727 | 9.6 | 7.8 |
| 4 | LULUCF (incl. peat fire) | 505,369 | 694,978 | 50.5 | 47.8 |
| 5 | Waste | 60,575 | 97,117 | 6.0 | 6.7 |
| Total without LUCF & peat fire | | 496,053 | 758,979 | 100 | 100 |
| Total with LUCF & peat fire | | 1,001,422 | 1,453,957 | | |

Table 2. Summary of 2000 and 2012 GHG emissions by gas (in Gg $CO_2$-e)

| No | Sectors | Year | $CO_2$ | $CH_4$ | $N_2O$ | Total 3 Gases | $CF_4$ | $C_2F_6$ | CO | NOx | NMVOC | Sox | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | Energy | 2000 | 265,318 | 29,742 | 3,352 | 298,412 | NE | NE | NE | NE | NE | NE | 298,412 |
| | | 2012 | 477,805 | 25,188 | 5,127 | 508,120 | NE | NE | NE | NE | NE | NE | 508,120 |
| **2** | IPPU | 2000 | 40,425 | 70.67 | 265.28 | 40,761 | 250 | 22 | NE | NE | NE | NE | 41,033 |
| | | 2012 | 40,538.10 | 56.9 | 420 | 41,015 | 47 | NE | NE | NE | NE | NE | 41,062 |
| **3** | Agriculture (incl. livestock) | 2000 | 4,772 | 51,461 | 40,072 | 96,305 | NE | NE | 2,724.44 | 74.03 | NE | NE | 99,103 |
| | | 2012 | 6,625 | 55,650 | 50,452 | 112,727 | NE | NE | 3,370.83 | 91.6 | NE | NE | 116,189 |
| **4** | LULUCF (incl. peat fire) | 2000 | 505,369 | NE | NE | 505,369 | NE | NE | NE | NE | NE | NE | 505,369 |
| | | 2012 | 694,978 | NE | NE | 694,978 | NE | NE | NE | NE | NE | NE | 694,978 |
| **5** | Waste | 2000 | 1,783 | 56,591 | 2201 | 60,575 | NE | NE | NE | NE | NE | NE | 60,575 |
| | | 2012 | 2,207 | 91,913 | 2,997 | 97,117 | NE | NE | NE | NE | NE | NE | 97,117 |
| **Total ($CO_2$-eq)** | | 2000 | 817,667 | 137,864 | 45,890 | **1,001,422** | 0 | 0 | 2,724 | 74 | 0 | 0 | **1,004,492** |
| | | 2012 | 1,222,152 | 172,808 | 58,996 | **1,453,957** | 0 | 0 | 3,371 | 92 | 0 | 0 | **1,457,466** |
| **Percentage (%)** | | 2000 | 81.7 | 13.8 | 4.6 | | | | | | | | 100.0 |
| | | 2012 | 84.1 | 11.9 | 4.1 | | | | | | | | 100.0 |

Over the period of 2000-2012, the GHG emissions from all sectors tend to increase with the exception of industry (Figure 1). The emissions from energy, agriculture and waste, increased at the annual rates of 4.6%, 1.3% and 4.0% respectively, while those from industrial sector was relatively less than 1%. Overall, without LUCF, the annual emissions over the period of 2000-2012 increased consistently with a rate of about 3.6% per year. With LUCF, the annual emissions fluctuated considerably due to high inter-annual variability of emissions from LUCF sector (Figure 1). The average national GHG emissions in the period 2000-2012 were about 1,249,325 Gg $CO_2e$ (1.249 Gt $CO_2$). The contribution of LUCF (incl. peat fire) and energy sector to total emissions over the period of 2000-2012 were about 51% and 32%, respectively (Figure 2).

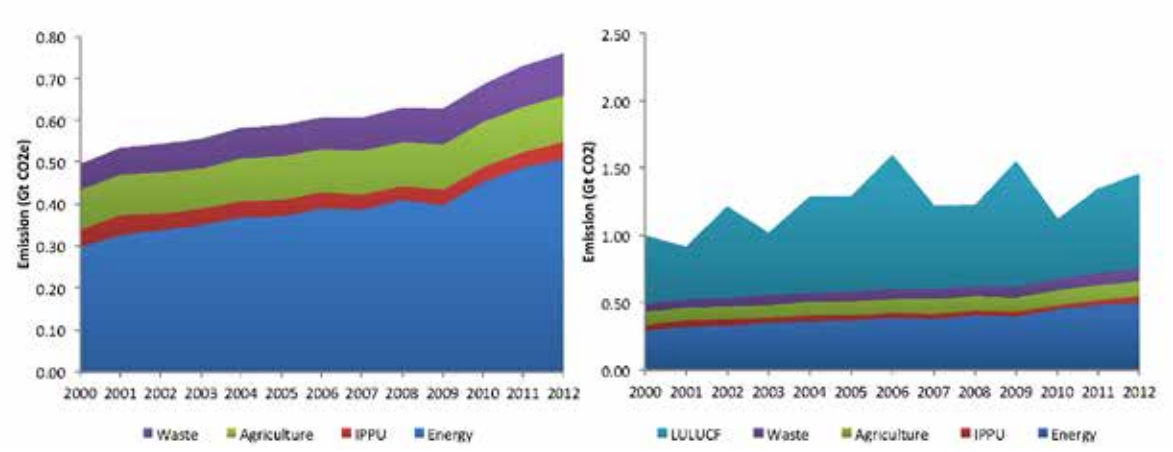


***Figure 1.*** Emission Trend without LUCF (left) and with LUCF (right)

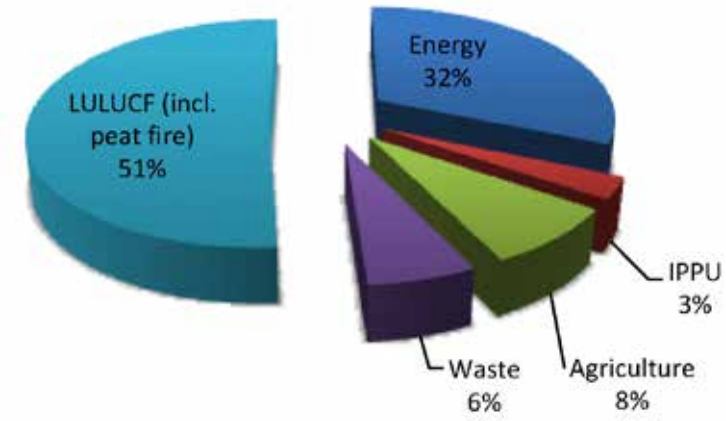


***Figure 2.*** Sectoral Emissions Contribution to the National emission over period 2000-2012

Key category analysis indicated that without LUCF, the two main emissions sources that have contributed to more than 50% of total emissions were (i) energy production (electricity, heat, oil & gas refining) and (ii) transportation. While with LUCF, there were three main emissions sources, namely (i) emissions and removals from soils (mainly from peat decomposition), (ii) peat fire and (iii) forest and grassland conversion.

## 1.3. Measures to Mitigate Climate Change and Effect

Responding to the global climate change challenge, in 2009, President of Indonesia has pledged to reduce GHG emissions level up to 26% below BAU by 2020, using domestic effort and further up to 41% with international support. Following this announcement, GoI issued Presidential Regulation (Perpres) No. 61 Year 2011 on National Action Plan for GHG Reduction (RAN GRK).

The regulation provided details of sectoral mitigation action plans for reducing GHG emissions. In total, there were more than 50 mitigation action plans under RAN GRK. Implementation of these plans, either through policy statements (policy-based mitigation action) or project activities (project-based mitigation actions) was intended to achieve the national GHG emissions reduction target. Perpres No. 61/2011 stated that the quantified emission reduction target of 26% by 2020 would be 0.767 Giga ton $CO_2$-e, and of 41% would be 1.189 Giga ton $CO_2$-e.

The sectoral ministries have reported the implementation of mitigation actions as defined in Perpres No. 61/2011 (Table 3). The total number of mitigation activities that have been implemented totalled to 45 actions. However, not all sectors reported the effects of the mitigation actions on emissions reduction (Table 4). Total reported emission reduction achieved in the period 2010-2012 was about 41.29 million ton $CO_2$-e (0.04129 Giga ton $CO_2$-e) or about 13.76 Mt $CO_2$e (0.01376 Gt $CO_2$-e) annually. In addition to Perpres No. 61/2011, there were other 27 mitigation actions in which 4 activities were supported by NAMA and 23 were non-Perpres. Similarly, very few activities have reported the effects of the actions on emissions reduction (Table 4). The resulted emissions reduction over that period was reported to be about 5.09 Mt $CO_2$-e (0.00509 Gt $CO_2$-e) or about 1.70 Mt $CO_2$e (0.00170 Gt $CO_2$e) annually. Most of the reported emissions reduction achievements have not been verified.

Table 3. Mitigation actions

| Category in FCCC/ AWGLCA/2011/ INF.1 | SECTOR/ACTIVITY | ER Target (GtCO2e) | REMARKS |
|---|---|---|---|
| | ENERGY SECTOR | 0.030 | Equivalent to 40 TWh or 4,651 MW capacity |
| D & E | Energy Conservation Programme in DSM (Demand Side Management):<br>- Development of standards<br>- Development of regulation/policy<br>- Labelling programme<br>- Energy manager training<br>- Energy audit (pilot)<br>- R&D<br>- Dissemination of activities in all sectors | | All energy conservation programme will be implemented by government, private sector and households through housekeeping, routine maintenance and repair and small investment |
| | TRANSPORT SECTOR | 0.008 | Equivalent to 24 MMBOE |
| G | - Standardization to achieve more energy efficient vehicles (higher fuels economy), i.e. passenger and freight transportation<br>- Enhance public transport infrastructure such as Bus Rapid Transit or city train system<br>- Improvement of transport management and planning<br>- Improvement in traffic demand management<br>- Integration of transport and land use plan | | All programmes will be implemented by government, private sector and community. Key actors:<br>- Ministry of Transport<br>- Ministry of Energy and Mineral Resources<br>- City Planning<br>- Public transport operators<br>- Private sector,<br>- Community |
| | INDUSTRIAL SECTOR | 0.001 | |
| D & E | - Process improvement<br>- Operation system improvement<br>- Technology change<br>- Raw material substitution<br>- Dissemination/Promotion Programme | | All programmes will be implemented by government, private sector and community. Key actors:<br>- Ministry of Industry<br>- Ministry of Energy and Mineral Resources<br>- City Planning<br>- Community |
| | AGRICULTURE SECTOR | 0.008 | |
| C | - Improvement of water management (increasing water use efficiency such as SRI, PTT)<br>- Introduction of new rice varieties with less methane emissions<br>- Feed quality improvement and food supplement for ruminants<br>- Biogas energy | | All programme will be implemented by government and private sector (CSR) |
| | FORESTRY SECTOR | 0.392 | |
| B & C | - Rehabilitation of land and forests in watershed<br>- Development of community forest and village forest<br>- Establishment of timber plantation and private forest<br>- Restoration of production forest ecosystem<br>- Development of partnership forest<br>- Fire management and combating illegal logging<br>- Avoidance of deforestation<br>- Empowerment of community | | The programmes have been implemented by government, private sector and community. Private sectors will dominate the efforts for establishing timber plantation, communities and CSR dominate the effort for establishing partnership forests, while government dominates land and forest rehabilitation programmes. |
| | WASTE SECTOR | 0.048 | |
| F | - Implementation of MSW management law<br>- Government programme for the improvement of<br>- existing solid waste landfill<br>- Domestic liquid waste management<br>- Industrial liquid waste management<br>- Capacity building for waste collection and transportation<br>- Programme to enhance 3R activities (reuse, recycle, recovery)<br>- Encouragment of private sector involvement in MSW treatment | | All programmes will be implemented by government, private sector and community. Key actors:<br>- Ministry of Environment<br>- Ministry of Public Works<br>- Local Government<br>- Private sector<br>- Community |

| Category in FCCC/ AWGLCA/2011/ INF.1 | SECTOR/ACTIVITY | ER Target (GtCO2e) | REMARKS |
|---|---|---|---|
| | PEAT EMISSIONS | 0.280 | |
| A | - Development of fire early warning system<br>- Strengthening community based fire-fighting team<br>- Improvement of peatland management<br>- Mapping of peat characteristics<br>- Empowerment of community<br>- Law enforcement for policy compliance<br>- Generating income activities for communities such as fishery management in peat water | | Most of programme will be implemented by government, national and international NGOs and private sectors (CSR).<br>Key actors:<br>Ministry of Environment<br>Ministry of Forestry<br>Ministry of Agriculture<br>Local Government<br>Private Sector |

Note: The mitigation actions categories documented in the FCCC/AWGLCA/2011/INF.1 as following: A:Sustainable peat land management; B: A reduction in the rate of deforestation and land degradation; C: The development of carbon sequestration projects in forestry and agriculture; D: The promotion of energy efficiency; E: The development of alternative and renewable energy sources; F: A reduction in solid and liquid waste; and G: Shifting to low-emission modes of transport

Table 4. Effect of the Implementation of Mitigation Activities on $CO_2$ Emission Reduction

| | Sector | Number Of Implemented Activities | Number Of Activities With Reported Emission | Emission Reduction Target/ Potential By 2020 (Mt CO2-e) | Emission Reduction Cumulative 2010-2012 (Mt CO2-e) | Emission Reduction Average Per Year (Mt CO2-e) |
|---|---|---|---|---|---|---|
| Perpres | Energy | 9 | 8 | 32.53 | 4.74 | 1.58 |
| | Transportation | 17 | 7 | 35.15 | 0.27 | 0.09 |
| | Industry | 2 | 2 | 4.81 | 0.79 | 0.26 |
| | Agriculture | 4 | 4 | 43.59 | 35.49 | 11.83 |
| | LUCF | 11 | 0 | 605.90 | n.a | n.a |
| | Waste | 2 | 2 | 48.00 | n.a | n.a |
| **Sub-total Perpres** | | **45** | **23** | **769.98** | **41.29** | **13.76** |
| NAMA | Energy | 2 | 0 | 4.12 | n.a | n.a |
| | Transportation | 1 | 0 | 1.50 | n.a | n.a |
| | Waste | 1 | 0 | 0.35 | n.a | n.a |
| **Sub-total NAMA** | | **4** | **0** | **5.97** | **n.a** | **n.a** |
| Non-Perpres | Energy | 6 | 6 | 0.15 | 0.84 | 0.28 |
| | Transportation | 5 | 5 | 9.97 | 4.25 | 1.42 |
| | Forestry | 10 | 0 | n.a | n.a | n.a |
| | Others | 2 | 0 | n.a | n.a | n.a |
| **Sub-Total Non-Perpres** | | **23** | **11** | **10.11** | **5.09** | **1.70** |
| **TOTAL** | | **72** | **34** | **786.06** | **46.38** | **15.46** |

## 1.4. Financial, Technology, Capacity Needs and Supports Received for Climate Change Activities

### Gaps and constrains

Development of GHG Inventory and the implementation of mitigation actions plan (RAN/RAD GRK) in Indonesia are regulated by Presidential Regulation No. 71/2011 and 61/2011 respectively. Roles and responsibilities of national and local institutions are clearly defined in the regulations. BAPPENAS leads the implementation of RAN/RAD GRK and coordinates the monitoring, evaluation and reporting (MER) of the implementation of mitigation actions. MOE leads the development of National GHG Inventory and also coordinates the verification process of the reported mitigation actions. Both agencies have developed guidelines for the implementation of the activities. The impacts of the implementation of mitigation actions on GHG emissions should be reflected in the GHG Inventory. Therefore, institutional process for linking activity data related to the mitigation activities and GHG inventory needs to be developed. Agencies responsible for collecting development data, i.e. Statistics Indonesia (BPS) and Centre for Data and Information (PUSDATIN) of each sector, would play important role, although currently, their involvement in data collecting process are still limited.

In terms of technical capacity in the development of GHG Inventory, there were gaps between national and local institutions, and among sectors. In most cases, provinces and districts had difficulties in calculating the emissions related to their development activities and also in defining the baseline emission as a reference for evaluating the effectiveness of mitigation actions in emissions reduction. Another challenge was in monitoring, including in tracking the budgets used to fund the activity.

### Financial needs

Needs for financial support were identified especially for the implementation of supported NAMAs activities. The fund was required particularly to support the achievement of national emissions reduction target of 41%. Using domestic budget, Government of Indonesia has committed voluntarily to reduce its emission to 26% by 2020. Thus the support was needed to increase the emissions reduction target by 15% from the unilateral target. Until 2014, six ministries and one local government have identified 15 mitigation activities requiring international financial supports, called known as supported NAMAs. Implementation of these activities was mostly scheduled between 2015 and 2020 with a

total investment of about US$ 870 million. Financial support required for implementing six of the 15 activities was about US$ 229 million, while the other 7 activities have not been assessed.

## Technology needs

There were technical supports required for the implementation of the supported NAMA. Two activities proposed to get the supports were Sustainable Urban Transport (SUTRI) and Smart Street Lighting Initiative (SSLI). Estimate cost for the technical support for these two activities is about USD 13 millions. Other sectors have identified small mitigation technology needs, however, further assessment on the technology is still required. The identified technology needs include the following:

1. Energy: solar photovoltaic (PV) and regenerative burner combustion system (RBCS)
2. Waste: mechanical-biological treatment (MBT), in vessel composting (IVC), low solid anaerobic digestion (LSAD)
3. Agriculture, forest and other land uses (AFOLU): Integrated forest-peat carbon measurement and monitoring technology, efficient peat depth mapping technology and peat water management technology including methodology for determining the activity data of burned peat (burned area and burned depth at least to the closest 5 cm peat depth precision).

With regard to the AFOLU, the technical support would cost about USD 22.5 millions, while for the energy and waste sectors the information on costs for the technical support were not communicated.

## Capacity Building Needs

Capacity buildings are required to enhance skills to implement technology, monitoring of GHG emissions, and calculation of emissions reduction through the implementation of policies and measures. Accordingly, capacity buildings should be directed towards: (i) increasing capacity of sector in developing sectoral and sub-sectoral baseline/reference emission level as the basis for measuring the achievement of mitigation actions; (ii) enhancing capacity of agencies responsible for collecting and understanding data and in developing templates to facilitate data collection; and (iii) 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. Institutions targeted to receive

capacity buildings include divisions or bodies within sectoral ministries and agencies (K/L) in charge of developing, coordinating and monitoring the implementation of sub-sectoral mitigation actions as well as agencies responsible for collecting data from the implementation of mitigation programme/activities. Capacity of local governments in developing low carbon development strategies should also be strengthened, including awareness rising activities directed not only for the government agencies but also for private sectors who have the potential to participate in the implementation of mitigation actions. For the implementation of NAMA activities, K/L has identified at least 13 capacity building needs. The estimated funding required for implementing seven of the 13 activities was about USD 35 millions.

## Supports received

In implementing mitigation activities, the Government of Indonesia has received supports from bilateral and multilateral agencies. Over the period 2008-2014, Government of Indonesia has received IDR 1.18 trillion (±USD 85.73 milion) of the IDR 3.04 trillion (±USD 247.44 million) commitment. Government of Indonesia only reported the supports that have been registered by the Government, i.e. supports that already have official agreement. In addition to international support, Indonesia has used its own funding to implement mitigation action and development of GHG Inventory following Precidential Regulation No. 61/2011 and 71/2011.

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# Glossary of Abbreviation

| | |
|---|---|
| ACM | Agriculture, Construction, and Mining |
| ADO/HSD | Automotive Diesel Oil or High Speed Diesel |
| AGB | Above Ground Biomass |
| APBD | *Anggaran Pendapatan dan Belanja Daerah* (Provincial/District/CityBudget) |
| APBN | *Anggaran Pendapatan dan Belanja Negara* (National Budget) |
| APL | *Area Penggunaan Lain* (Non-Forest Areas) |
| APPI | *Asosiasi Perusahaan Pupuk Indonesia* (Indonesian Fertilizer Producer Association) |
| ASI | *Asosiasi Semen Indonesia* (Indonesian Cement Association) |
| BAPPENAS | *Badan Perencanaan Pembangunan Nasional* (National Development Planning Agency) |
| BIG | *Badan Informasi Geospasial* (Geospatial Information Agency) |
| BPREDD+ | *Badan Pengelola* REDD+ (National Agency for REDD+) |
| BPPT | *Badan Pengkajian dan Penerapan Teknologi* (Agency of the Assessment and Application of Technology) |
| BPS | *Badan Pusat Statistik* (Statistics Indonesia) |
| BUR | Biennial Update Report |
| CFM | Community Forest Management Programme |
| $CH_4$ | Methane |
| CO | Carbon Monoxide |
| $CO_2$ | Carbon Dioxide |
| COP | Conference of Parties |
| COREMAP | Coral Reef Rehabilitation and Management Programme |
| CSR | Corporate Social Responsibility |
| DBH | Diameter at Breast Height |
| DEN | *Dewan Energi Nasional* (National Energy Council) |
| DNPI | *Dewan Nasional Perubahan Iklim* (National Council for Climate Change) |
| DJPPI | *Direktorat Jenderal Pengendalian Perubahan Iklim* (Directorate General of Climate Change) |
| EF | Emission Factor |
| ENSO | El Niño Southern Oscillation |
| FO | Fuel Oil |
| FORDA | Forestry Research and Development Agency |
| GDP | Gross Domestic Product |
| GEF | Global Environment Facility |

| | |
|---|---|
| GERHAN | *Gerakan Rehabilitasi Hutan dan Lahan* (Forest and Land Rehabilitation Movement) |
| GHG | Green House Gases |
| GRK | *Gas Rumah Kaca* (Green House Gases) |
| GWP | Global Warming Potential |
| HK | *Hutan Konservasi* (Conservation Forests) |
| HL | *Hutan Lindung* (Protection Forests) |
| HP | *Hutan Produksi* (Production Forests) |
| HPK | *Hutan Produksi Konversi* (Production Convertible Forests) |
| HPT | *Hutan Produksi Terbatas* (Limited Production Forests) |
| IAARD | Indonesian Agency for Agricultural Research and Development |
| IAERI | Indonesia Agricultural Environmental Research Institute |
| ICALRD | Indonesia Centre for Agricultural Land Resources Research and Development |
| IDO | Industrial Diesel Oil |
| IDR | Indonesia Rupiah |
| INC | First / Initial National Communication |
| IPCC | Intergovernmental Panel on Climate Change |
| IPP | Independent Power Producer |
| IPPU | Industrial Processes and Product Use |
| ITCZ | Inter-Tropical Convergence Zone |
| IUPHHK | (*Izin Usaha Pemanfaatan Hasil Hutan Kayu)* Permit on Utilization of Wood Forest Products |
| IUPHHK-RE | (*Izin Usaha Pemanfaatan Hasil Hutan Kayu – Restorasi Ekosistem*) Restoration Ecosystem Permit of Production Forest |
| JAMALI | Electricity grid of *Jawa, Bali, and Madura* Islands |
| K/L | *Kementerian/Lembaga* (Ministry/Institution) |
| KCA | Key Category Analysis |
| MOE | *Kementerian Lingkungan Hidup* (Ministry of Environment) |
| LAPAN | *Lembaga Antariksa dan Penerbangan Nasional* (National Institute of Aeronautics and Space) |
| LFG | Landfill Gas |
| LSAD | Vessel Composting, Low Solid Anaerobic Digestion |
| LUCF | Land Use Change and Forestry |
| LULUCF | Land Use, Land Use Change and Forestry |
| LUTM | Land Use Transition Matrix |

| | |
|---|---|
| MBT | Mechanical-Biological Treatment |
| MEMR | Ministry of Energy and Mineral Resource |
| MER | Monitoring, Evaluation and Reporting |
| MDO | Marine Diesel Oil |
| MoA | Ministry of Agriculture |
| MoE | Ministry of Environment |
| MoEF | Ministry of Environment and Forestry |
| MoFor | Ministry of Forestry |
| MoI | Ministry of Industry |
| MSW | Municipal Solid Waste |
| $N_2O$ | Nitrous Oxide |
| NAMA | Nationally Appropriate Mitigation Action |
| NFI | National Forest Inventory |
| NGHGI | Indonesian National Greenhouse Gas Inventory |
| NGOs | Non-Governmental Organizations |
| NPK | Nitrogen, Phosphorus and Potassium |
| PFC | Perfluorocarbons |
| PLN | *Perusahaan Listrik Negara* (National Electricity Company) |
| PPIHLH | *Pusat Pengkajian Industri Hijau & Lingkungan Hidup* (Centre for Assessment on Green Industry and Environment) |
| PSPs | Permanent Sampling Plots |
| PUSDATIN | *Pusat Data dan Informasi* (Data and Information Centre) |
| PV | Solar Photovoltaic |
| QA | Quality Assurance |
| QC | Quality Control |
| RAD | *Rencana Aksi Daerah* (Provincial/District/CityAction Plan) |
| RAN | *Rencana Aksi Nasional* (National Action Plan) |
| RBCS | Regenerative Burner Combustion System |
| RKTN | *Rencana Kehutanan Tingkat Nasional* (National Forestry Plan) |
| RPJMN | *Rencana Pembangunan Jangka Menengah Nasional* (National Medium-term Development Plan) |
| SC | Steering Committee |
| SIGN | *Sistem Inventarisasi Gas Rumah Kaca Nasional* (National GHG Inventory System) |
| SLPTT | *Sekolah Lapang Pengelolaan Tanaman Terpadu* (Integrated Crop Management Field School) |

| | |
|---|---|
| SNC | Second National Communication |
| SRI | System of Rice Intensification |
| SSLI | Smart Street Lighting Initiative |
| SST | Sea-Surface Temperature |
| SUSENAS | *Survei Sosial-Ekonomi Nasional* (National Socio-Economic Survey) |
| SUTRI | Sustainable Urban Transport Indonesia |
| SWDS | Solid Waste Disposal Site |
| SWG | Sectoral Working Groups |
| TGHK | *Tata Guna Hutan Kesepakatan* (Forest Land Use by Consensus) |
| TNA | Technology Needs Assessment |
| TOE | Tonne Oil Equivalent |
| UNDP | United Nations Development Programme |
| UNFCCC | United Nations Framework Convention on Climate Change |
| WD | Wood Density |

# Chapter 1.

# National Circumstances

## 1.1. Geography

Indonesia lies in 6°08′ North and 11°15′ South latitude, and from 94°45′ to 141°05′ East longitude, between the Pacific and the Indian Oceans and bridges two continents: Asia and Australia. The country covers approximately 790 million hectares (ha), with a total coastline length of about 95,181 km (Statistik Sumber Daya laut dan Pesisir 2014, BPS) and land territory of about 200 million ha. It consists of approximately 13,466 islands, of which only six thousands are inhabited, including the five main islands of Sumatera, Java, Kalimantan, Sulawesi and Papua. Extensive coastal plains and mountainous areas of 1,000 meters above sea level characterize the Islands of Sumatra, Kalimantan and Papua. Of the 200 million ha of land territory, about 50 million ha are devoted to various agricultural activities. There is nearly 20 million ha of arable land, of which about 40% is wetland (e.g., rice fields), 40% is dry land, 15% is shifting cultivation and 5% other cover. Since 2013, the Republic of Indonesia has been divided administratively into 35 provinces (Figure 1.1).

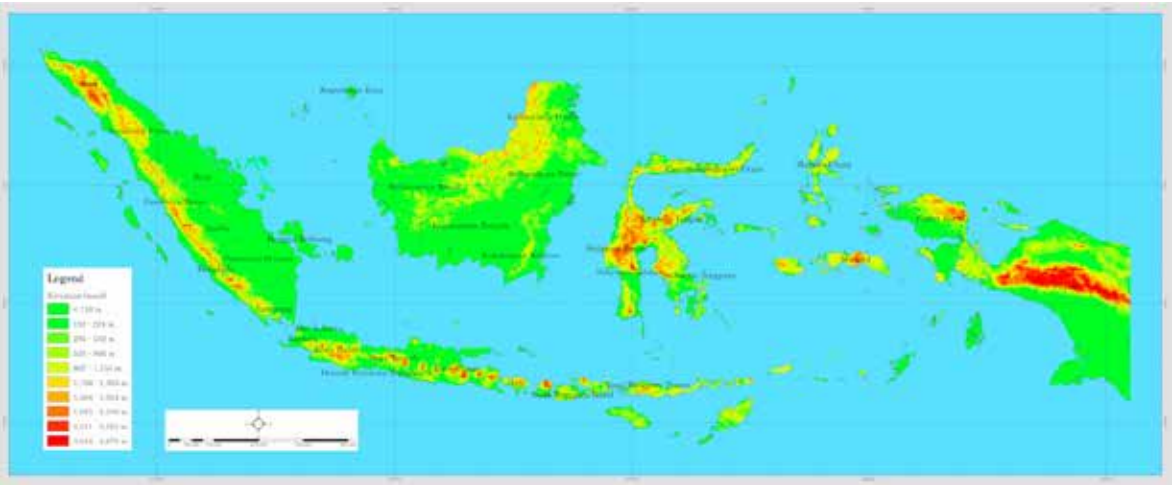


**Figure 1.1.** Map of Indonesia (Source: Geospatial Information Agency)

## 1.2. Climate

Indonesia's climate is dominated by monsoons, which give a degree of homogeneity across the region. Indonesia lies across the range of the Inter-Tropical Convergence Zone (ITCZ) where the northeast and southeast trade winds penetrate the doldrums. Strong ascending motion, overcast skies, strong squalls, heavy rainfall and severe local thunderstorms with variable intensities are characteristics of this zone. There are three types of rainfall pattern in Indonesia (Boerema, 1938): (1) The first type is a monsoon rainfall with a monthly rainfall peak in December; (2) The second is a more localized rainfall pattern in the eastern equatorial part of the country with a monthly rainfall peak in July-August; (3) The third type is an equatorial rainfall characterized by two monthly rainfall peaks, in March and October. Overall, these three types of rainfall result in a wet season that varies in length from as long as 280 to 300 days toas short as 10 to 110 days, with rainfall varying from 4,115 mm to as low as 640 mm.

Rainfall variability in Indonesia is influenced by many large-scale climate phenomena. Many of these phenomena are imposed by sea-surface temperature (SST) variability. El Niño Southern Oscillation (ENSO) is one that strongly influences Indonesian rainfall variability. Many studies on ENSO influences on inter-annual rainfall variability in Indonesia, reveal the following seasonal patterns (e.g. Yoshino *et al*., 2000; Kirono and Partridge, 2002; Aldrian and Susanto, 2003): (i) end of dry season occurs later than normal during El Niño and earlier during La Niña years, (ii) the onset of the wet season is delayed during El Niño and advanced during La Niña years, (iii) a significant reduction of dry season rainfall could be expected during El Niño and a significant increase during La Niña years, (iv) long dry spells occur during the monsoon period, particularly in Eastern Indonesia.

ENSO is one of the natural phenomena that resulted in devastating consequences on climate and causes disasters. In Indonesia, El Niño is often related to drought and La Niña to floods. Of the total 43 drought events occurred over the period of 1844-1998, only six events were not associated with El-Niño (Quinn *et al*., 1978; ADB and BAPPENAS, 1999; Boer and Subbiah, 2005). Moreover, El Nino is considered as one of the overriding control 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 connected to these phenomena (Gagnon *et al*., 2001; Hopp and Foley, 2003).

A number of research findings indicate that global warming would bring more frequent and perhaps intense ENSO events in the future (Timmerman *et al.,* 1999; Tsonis *et al*., 2005; Hansen *et al*., 2006; McGregor *et al*., 2013). Recent findings indicate that the variability of ENSO within 30 years period between 1590 and 1880 was lower than those between 1979 and 2009 (McGregor *et al*., 2013). The variability of sea surface temperature in Pacific Ocean (NINO3.4) has also increased in this century compare to the past century (Gergis and Fowler, 2009; and Li *et al.,* 2013). The frequency of strong El Nino tends to increase

while the strong La Nina tendsto decrease (Figure 1.2). The global warming is likely to expose Indonesia to more and frequent extreme climate events.

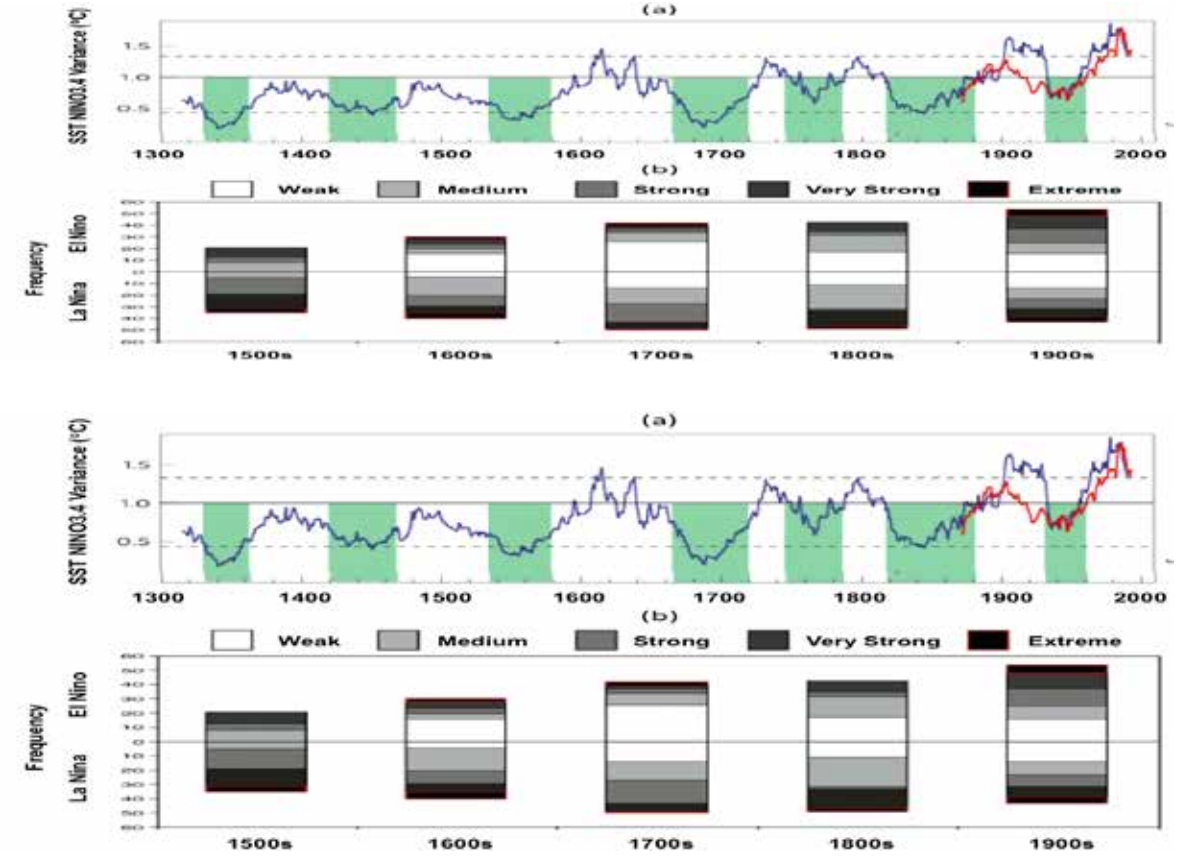



**Figure 1.2.** (a) Variance of sea surface temperature at NINO3.4 from 1300-2000 based on reconstructed data (blue) and observation (red) (Li *et al*., 2013), and (b) frequency of ENSO events from 1500s to 1900s (Gergis and Fowler, 2009)

## 1.3. Population

In the past four decades, Indonesia's population has been continuously increasing from 119.21 million in 1971 to 238.52 million in 2010 (Source: Population Census 1971 and 2010, Statistics Indonesia (BPS), 2014). However, its annual growth rate appears to be decreasing, from 1.98% (1980-1990) to 1.49% (2000-2010). It is projected that the population will exceed 300 million by 2030. The distribution of the population follows the distribution of the country's economic activity that is concentrated in the western part of Indonesia i.e. on the islands of Java and Sumatera. In 2010, almost 60% (more than 136 million) of the population were living in the Island of Java, and around half inhabited urban areas. Provinces with more than 50% of their inhabitants living in urban areas are DKI Jakarta (100%), Riau (83%), Banten, Yogyakarta, and West Java (more than 60%).Based on age composition, the population is dominated by age 45 and below (Figure 1.3).

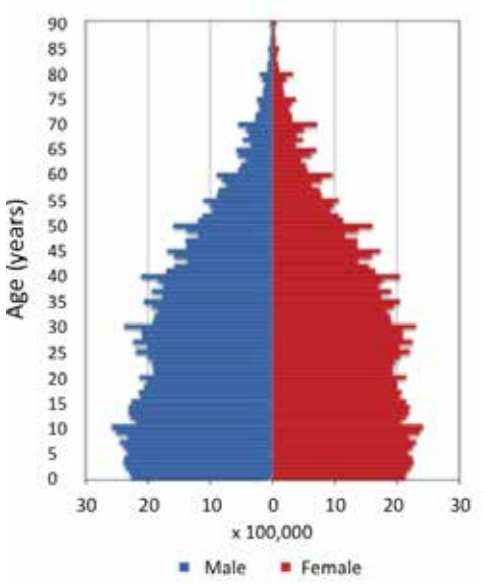



**Figure 1.3.** Population distribution pyramid by age (BPS-Statistics Indonesia, 2010)

## 1.4. Economic and Social Development

Indonesia life expectancy at birth has improved significantly in the past four decades from only 47.9 years in 1970 to 69.7 years in 2011[1]. For the period 2010-2015, BPS estimates that Indonesia life expectancy at birth would increase to 70.1 years[2]. In education sector, as the result of sustained efforts, Indonesia adult literacy in 2011 was 95%, which is significantly higher than it was in 1970, which was only 79%[3].

Prior to 1999, Indonesia had been successful to alleviate poverty. In 1970, 60% of the population (70 million people) was living in absolute poverty. By 1990, the number had dropped to 27 million or 15% of the population and continued to improve up to 1997, when the figure decreased to 20 million. However, in 1999, for the first time in years, Indonesia experienced a severe 18-month drop in the country's social and economic condition, resulting in over 100 million people living below the poverty line. Despite successful recovery following the country's economic and political reforms since 2000, some people are still living below poverty line. In 2014, Indonesian poor to talled to about 27.7 million people (11% of the population).

[1] www.worldlifeexpectancy.com
[2] http://www.bps.go.id/
[3] http://www.unesco.org

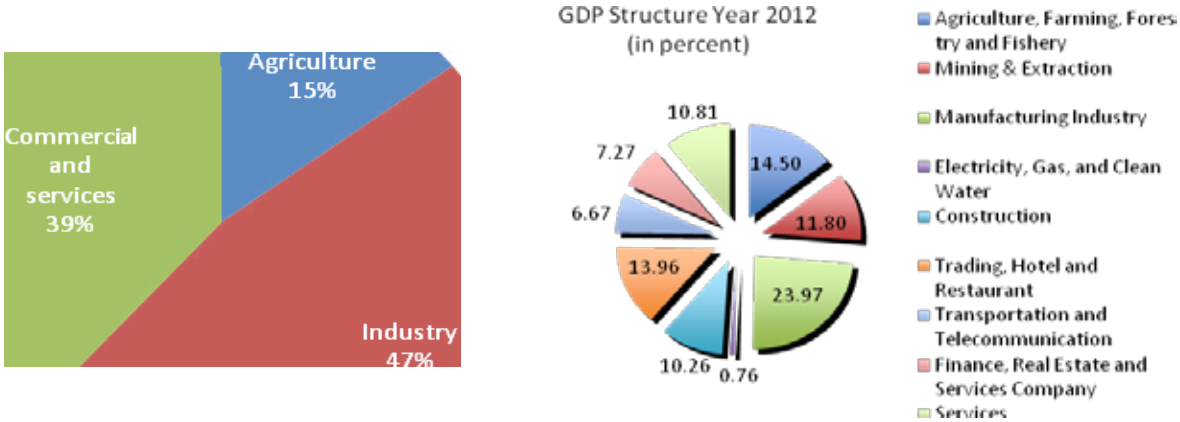
Table 1-1). According to the National Medium-term Development Plan (RPJMN 2015-2019), the government plans to implement various development and welfare programmes to reduce poverty rate to 6.5- 8.0% of the population by 2019.

**Table 1-1.** Indonesian Poverty and Inequality Statistics

| | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Relative Poverty (% of population) | 16.7 | 16.0 | 17.8 | 16.6 | 15.4 | 14.2 | 13.3 | 12.4 | 11.7 | 11.5 | 11.0 |
| Absolute Poverty (in millions) | 36.2 | 35.1 | 39.3 | 37.2 | 35.0 | 32.5 | 31.0 | 29.9 | 28.6 | 28.6 | 27.7 |
| Gini Coefficient (Gini Ratio) | - | 0.363 | - | 0.364 | 0.35 | 0.37 | 0.38 | 0.41 | 0.41 | 0.41 | 0.41 |

*Sources: Based on data from BPS-Statistic Indonesia*

Employment rate of Indonesian workforce has been improving in the past 8 years. Though the unemployment rate is still relatively high, it has been decreasing from about 10% in 2004 to about 6% in 2013[4]. Compared to the sixties, Indonesia's economy has experienced structural transformation from agricultural economy to industrial and services economy. Figure 1.4 shows the aggregate economic structure (GDP) in 2012. It also shows that the share of industry and service account for 85% of the economy. Major contributors in the industrial sectors are manufacturing, mining and extraction, and construction; while trading, hotels, restaurant, finance, real estate, transport and telecommunication are the major contributors in commerce and service sectors.




(a) (b)

**Figure 1.4.** Distribution of Indonesia GDP in 2013 by (a) sector; (b) structure (*BPS-Statistics Indonesia)*

[4] http://www.bps.go.id/

In 2013, the Indonesia GDP price was worth IDR 9,084 trillion (±USD 745 billion), which was much higher than it was nine years ago at IDR 2,300 trillion (±USD 248 billion) in 2004. In terms of per capita, the GDP grew from IDR 10.5 million in 2004 (USD 1,132) to IDR 36.5 million (USD 2,994) in 2013. Table 1-2 shows the development of Indonesia GDP in current price as well as constant price in 2000. For the past ten years, the national economy has been growing with varying annual growth rates from 4.6% to 6.5%. The RPJMN 2015-2019 has set the annual economic growth target of 6% - 8% within the next five years.

Table 1-2. Development of Indonesian GDP and exchange rate

| | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|---|---|---|---|
| GDP (current price), Trillion IDR | 2,296 | 2,774 | 3,339 | 3,951 | 4,949 | 5,606 | 6,447 | 7,419 | 8,229 | 9,084 |
| GDP/cap in million IDR (current price) | 10.5 | 12.6 | 14.9 | 17.4 | 21.4 | 23.9 | 27.1 | 30.8 | 33.3 | 36.5 |
| GDP (constant price 2000), Trillion IDR | 1,657 | 1,751 | 1,847 | 1,964 | 2,082 | 2,179 | 2,314 | 2,465 | 2,619 | 2,770 |
| GDP/cap in million IDR constant price 2000 | 7.60 | 7.93 | 8.24 | 8.63 | 9.01 | 9.30 | 9.74 | 10.23 | 10.59 | 11,13 |
| GDP Growth | 5.0% | 5.7% | 5.5% | 6.3% | 6.0% | 4.6% | 6.2% | 6.5% | 6.3% | 5.8% |
| Exchange rate, 000 Rp/USD | 9.27 | 9.83 | 8.99 | 9.39 | 10.9 | 9.4 | 8.99 | 9.06 | 9.67 | 12.19 |

*Sources: Based on data from BPS - Statistics Indonesia (2015)*

## 1.5. Sectoral Conditions

### 1.5.1. Energy Sector

The energy sector is an important sector as it provides the energy needed to support daily activity and to fuel the economic activity. This sector also generates government revenues from sales of natural resources to domestic and exports markets royalties and various taxes. Energy is consumed in transport, industrial, agricultural and building sectors. The types of final energy consumed in these sectors include oil fuels, coal, electricity, natural gas, LPG and biomass. The primary energy used includes coal, natural gas, crude oil, diesel oil, hydropower and geothermal. The final energy consumption has been growing in line with economic and population growth. Between 2000 and 2012, the total final energy demand grew on average 2.7% annually, from 709 million to 1050 million BOE (Barrel of Oil) (MEMR, 2014). Industrial, residential and transport sectors dominated the final energy consumption (Figure 1.5). High consumption growth occurred in transport (6.9% per year) and commercial (4.6% per year) sectors. The growth was much higher

than that of industrial (1.8% per year) and residential (0.9% per year) sectors. By fuel type (Figure 1.6), energy demand is still dominated by oil that account for around 32.2% of the total consumption, followed by biomass (26.9%), coal (11.7%), electricity (10.2%) and gas (9.2%). High demand growth occurred in coal (10.8% per year), electricity (6.8% per year), and gas (4.8% per year). High growth in gas demand was due to government policy that switched kerosene subsidy to LPG subsidy in residential sector. Coal consumption as a final energy was used solely in industrial sector. The high growth in coal was due to the removal of industrial diesel subsidy resulting in the industries to switch from diesel to coal.

Between 2000 and 2012, primary energy supply grew at a rate of 3.4% per year, from 996 million to 1,566 million BOE. As shown in Figure 1.7, the primary energy supply has been dominated by oil, followed by coal and natural gas. Ever since the domestic oil production capacity continued to decline, for energy security reason, the government has been attempting to move away from oil by promoting energy that are abundantly available in the country i.e. coal, natural gas and renewable energy. These attempts have resulted in high growth in coal supply (11.5% per year), much higher than growth in oil (2.8% per year) and natural gas (3.9% per year). These growths have resulted in decreased oil share in supply mix, from 44% in 2000 to 35% in 2012, and increased coal share, from 9.4% in 2000 to 24.1% in 2012.

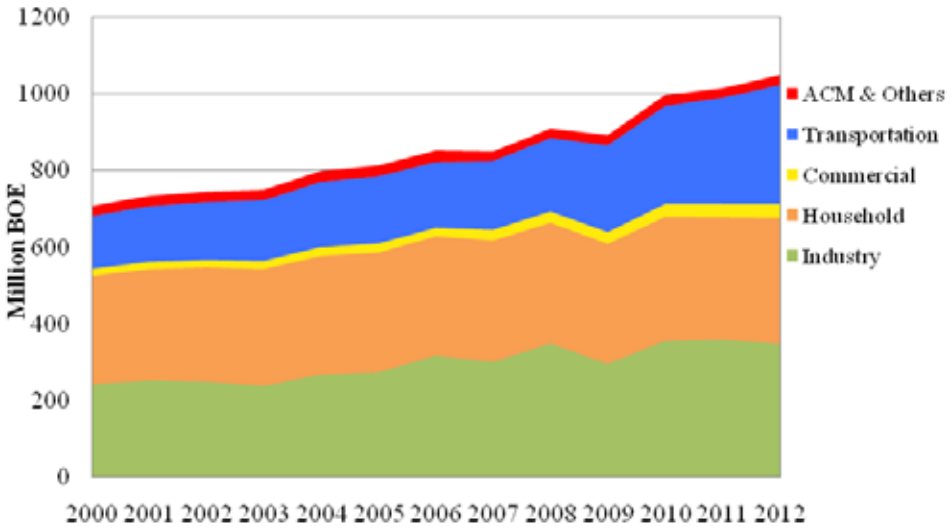



**Figure 1.5.** Development of Final Energy Demand (including biomass) by Sector (Centre of Data and Information-MEMR, 2014)

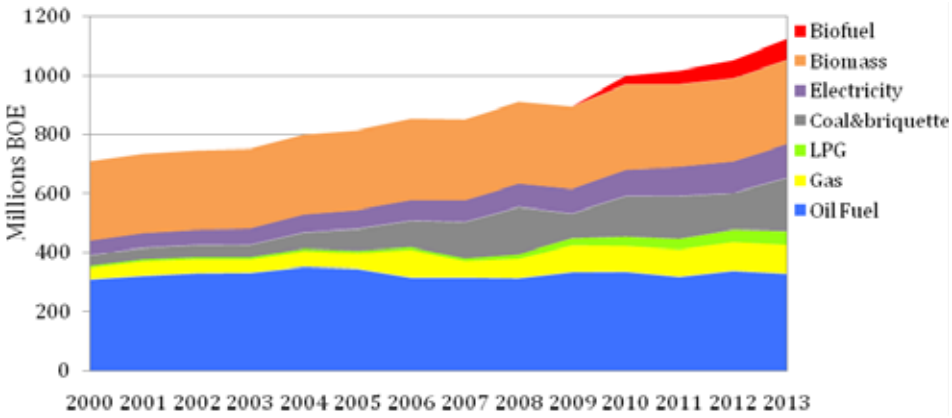



**Figure 1.6.** Development of Final Energy Demand by fuel Type
(Centre for Data and Information-MEMR, 2014)

Around 10% of final energy consumption was in the form of electricity. The electricity demand was fulfilled by different types of power plants, i.e. coal, gas, hydropower, geothermal and oil fuels. Figure 1.8 shows the development of power generation by types of energy source where coal plant was the dominant source. In the past twelve years, the plants that experienced high annual growths were geothermal (10%) and coal (9%). The high growth rate of coal plant had pushed the share of coal in the power generation mix to increase from 37% in 2000 to 51% in 2012. Despite the high growth, the share of geothermal in power mix was still small, i.e. 4.8% in 2012 (Figure 1.8).

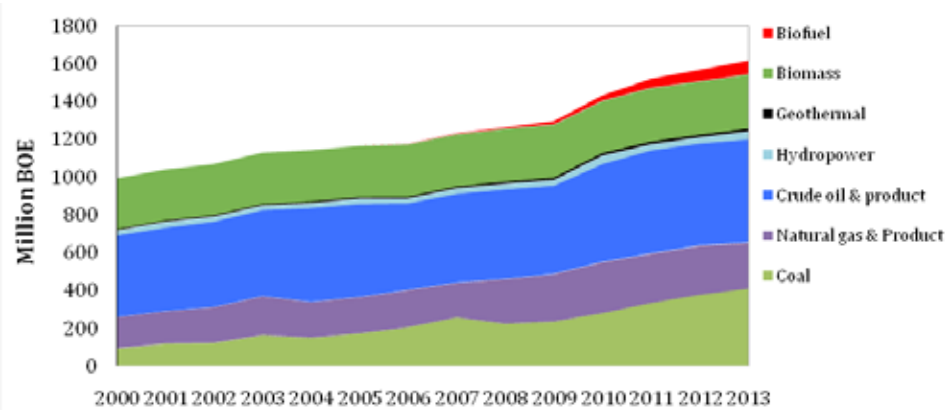



**Figure 1.7.** Development of Primary Energy Supply (Centre for Data and Information MEMR, 2014)

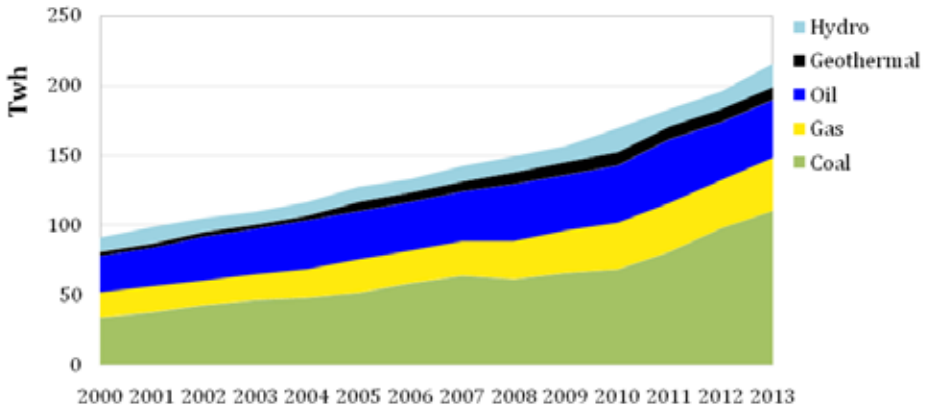



**Figure 1.8.** Development of Power Generation Mix
(Centre for Data and Information- MEMR, 2014)

The future challenge in energy sector is to utilize limited energy resources to supply an increasing demand to support daily lives and economic activities. Through the National Energy Council (DEN), the GOI has released national energy policy that provides guidance to the country's future energy development. The main features of the energy policy are as follows:

- Strive for energy security (move away from oil - reduced to 25% of supply in 2025, promotes more abundantly available resources such as natural gas and coal)
- Increase energy efficiency (targeting energy elasticity to be less than one in 2025)
- Promote the development of renewable energy (targeting 23% of supply mix in 2025)

### 1.5.2. Industrial Sector

As previously mentioned, industry has been playing an important role in Indonesian economy. Since the past decades, industry has contributed around 40% - 46% to the GDP formation. The important sub-sectors are mining and manufacturing, which together account for about 78% of the industrial sector GDP. In terms of production volume, large manufacturing industries are pulp and paper, cement, iron/steel and ammonia/urea. In the past decade, the developments of these industries were fluctuating but tend to slightly declining except for pulp and paper industry that slightly grew at 1.5% per year. Table 1-3 shows the development of industrial production in 2000-2012.

Table 1-3. Development of Industrial Products (000 ton) in 2000-2012

| Industry | Year | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
| **Mineral** | | | | | | | | | | | | | |
| Cement | 30,119 | 33,880 | 33,248 | 32,629 | 34,886 | 34,004 | 34,970 | 35,914 | 37,630 | 35,599 | 34,515 | 37,491 | 41,077 |
| Lime | 4,918 | 9,382 | 2,770 | 2,745 | 2,820 | 2,828 | 3,089 | 3,349 | 2,286 | 1,222 | 1,222 | 1,222 | 1,222 |
| Glass | 571 | 341 | 311 | 389 | 365 | 422 | 157 | 124 | 93 | 96 | 106 | 85 | 85 |
| Ceramics | 12 | 12 | 15 | 12 | 15 | 13 | 9 | 10 | 11 | 11 | 11 | 13 | 13 |
| Other Soda Ash | 4,760 | 4,760 | 2,616 | 2,616 | 7,214 | 7,214 | 1,775 | 1,774 | 1,774 | 1,774 | 1,774 | 1,774 | 1,774 |
| Other Carbonate Consumption | 14,524 | 14,524 | 14,524 | 11,216 | 9,852 | 5,324 | 4,827 | 2,937 | 2,952 | 2,852 | 2,845 | 2,851 | 2,851 |
| **Chemical** | | | | | | | | | | | | | |
| Ammonia | 4,785 | 4,407 | 4,771 | 4,860 | 4,546 | 5,125 | 4,910 | 4,070 | 4,197 | 4,580 | 4,528 | 4,182 | 4,239 |
| Nitric Acid | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 102 | 146 |
| Carbide | 22 | 70 | 76 | 76 | 20 | 20 | 35 | 33 | 31 | 29 | 27 | 26 | 21 |
| Methanol | 794 | 931 | 785 | 792 | 788 | 846 | 676 | 675 | 848 | 685 | 496 | 510 | 457 |
| Ethylene | 499 | 398 | 428 | 476 | 465 | 487 | 490 | 532 | 488 | 455 | 567 | 467 | 531 |
| EDC | 761 | 788 | 782 | 799 | 800 | 728 | 31 | 31 | 29 | 21 | 21 | 11 | 32 |
| VCM | | | | | | | 493 | 403 | 391 | 404 | 419 | 390 | 409 |
| Carbon Black | 95 | 98 | 91 | 96 | 110 | 123 | 123 | 123 | 129 | 130 | 129 | 88 | 242 |
| **Metal** | | | | | | | | | | | | | |
| DR Iron | 1,356 | 1,918 | 859 | 2,212 | 2,425 | 2,270 | 1,817 | 1,365 | 1,304 | 941 | 1,084 | 1,014 | 1,166 |
| Pig Iron | 0 | 0 | 2 | 3 | 3 | 33 | 33 | 33 | 33 | 1,533 | 1,533 | 1,533 | 1,533 |
| Sinter | 241 | 741 | 646 | 621 | 589 | 590 | 590 | 590 | 590 | 590 | 590 | 590 | 590 |
| Aluminium | 240 | 240 | 240 | 240 | 240 | 240 | 250 | 241 | 242 | 241 | 237 | 240 | 241 |
| Lead | 37 | 32 | 24 | 27 | 25 | 27 | 36 | 45 | 87 | 54 | 22 | 25 | 25 |
| Zinc | 72 | 99 | 55 | 57 | 41 | 62 | 44 | 30 | 19 | 16 | 16 | 12 | 9 |
| **Non-Energy Products from Fuels and Solvent Use** | | | | | | | | | | | | | |
| Lubricant Use* | 15 | 14 | 10 | 12 | 13 | 13 | 15 | 16 | 17 | 15 | 11 | 17 | 15 |
| Paraffin Wax Use* | 42 | 41 | 40 | 58 | 47 | 49 | 59 | 62 | 72 | 158 | 98 | 141 | 212 |
| **Others** | | | | | | | | | | | | | |
| Pulp and Paper | 188 | 188 | 188 | 188 | 188 | 188 | 188 | 188 | 177 | 196 | 211 | 214 | 225 |
| Food & Beverages | 34 | 13 | 6.6 | 2.6 | 8.6 | 2 | 5 | 2.5 | 4,6 | 1.9 | 1 | 2.6 | 1.2 |

(*unit in thousand TJ)

*Source: (a) Statistics of Large and Medium Industry/ISIC – BPS, Indonesia (b) Centre for Assessment of Green Industry (PPIH-LH) MoI (c) Indonesian Cement Association*

## 1.5.3. Forestry Sector

Indonesia possesses diverse forest ecosystems spreading from the coast to the mountain areasand as high as 4800 m above sea level (Table 1.4). The forests are not only large in area, but also high in biodiversity. Therefore, Indonesia is known as one of the mega-biodiversity countries in the world. It has recorded to contain 1500 species of algae, 80,000 species

plants with spora (such as Cryptogam) is in the form of herbal medicine, 595 species of lichens, 2,197 species of Pteridophyta, and 30000-40000 of flora species (15.5% of the total number of flora in the world). As for fauna, Indonesia harbours 8,157 species of vertebrate (mammals, birds, herpetofauna, and fish), 1,900 species of butterfly (10% of the world's species). Moreover, the uniqueness of geology of Indonesia has caused high number of endemic flora, fauna and microbes species.

Indonesia even has the world's highest endemicity number of fauna species including birds, mammals and reptiles, where there are 270 endemic species of mammals, 386 species of birds, 328 species of reptiles, with additional 204 species of amphibians, and 280 species of fish[5].

Forests support the livelihood of 48.8 million people (Ministry of Forestry, 2010), of which 60% is directly dependent on shifting cultivation, fishing, hunting, gathering, logging, and selling wood and non-wood forest products (Nandika, 2005). About 3.4 million people work in the private forestry sector, of which 205,300 people are directly working in wood-processing industries (Ministry of Forestry, 2010).

Table 1-4. Main forest ecosystems in Indonesia

| Climate | Soil Water | Soils | Elevation | Forest formation |
|---|---|---|---|---|
| Seasonally dry | Strong annual shortage | Podsol, Renzina, Latosol | 0–(750) 1000 m, | Lowland Monsoon forest (seasonal forest) |
| | | Red yellow podsolic, latosol, andosol | 1000–3000 m | Montane monsoon forest |
| Ever-wet (perhumid) | Dryland | Zonal (mainly oxisols, ultisols) | Lowland | Lowland evergreen rain forest |
| | | | Mountains (750) 1200–1500 m | Lower montane rain forest |
| | | | (1500) 2500–3300 m | Upper montane rain forest |
| | | | (3350) m | |
| | | | 3000 (3350) m to tree-line | Subalpine forest |
| | | Podozolized sands | 0–(750) 1000 m | Heath forest |
| | | Renzina, Latosol | 0–(750) 1000 m | Forest over limestone |
| | | Soils with high Mg, Fe, and Si content | 0–(750) 1000 m | Forest over ultrabasic |
| | Water table high (at least periodically) | | | |
| | Coastal salt-water | Regosol, Red yellow podsolic | 0–(750) 1000 m | Beach forest |
| | | Alluvial | <0 m | Mangrove forest |
| | Inland fresh water | Oligotrophic peats | 0–(750) 1000 m | Peat swamp forest |
| | | Eutrophic (muck and minerals) soil | 0–(750) 1000 m | Freshwater swamp forest |

*Source: Kartawinata (2005)*

With the purpose of administering the use of forest resources, in 1980s, the Ministry of Forestry has developed a national forestland use based on forest functions (conservation,

5 Indonesia Biodiversity Outlook 2014, LIPI

protection, and production), which was termed TGHK (*Tata Guna Hutan Kesepakatan*) or Forest Land Use by Consensus. Land under TGHK referred to forestlands (*kawasan hutan*), while forests for other land uses referred to non-forest areas (*areal penggunaan lain*/APL). The 1980s TGHK was the first forestland use applied in Indonesia. It was simply established by scoring three main geo-physical characteristics, i.e., soil type (sensitivity to soil-erosion), slope, and rainfall, and provided a general scale (1:500.000). With the absent of land cover and other important information such as centre of development etc., TGHK could not keep up with the rapid development. For that, the synchronization of TGHK to the provincial spatial planning was performed in 1999/2000. The broad classes of forest functions (Conservation Forest/HK, Protection Forest/HL and Production Forest/HP) were maintained, adjusted and legalized under the Forestry Act No. 41/1999. The production forest, which was disaggregated into Regular Production Forests (HP), Limited Production Forests (HPT) and Convertible Production Forests (HPK), was also legalized under the Government Regulation 44/2004. All forestland classes that were released from forestlands, were labelled APL.

Each class of forestland use (HK, HL, HP, HPT and HPK) has specific applied management practices that preserve the forests, or consequently disturb the forests that resulted in planned and unplanned deforestation. Therefore, referring to its functions, forest clearing is completely forbidden within HK and HL, thus deforestations were likely occurred from illegal logging, forest encroachments, and forest fires. These types of disturbances are categorized as unplanned deforestation. On the contrary, forest clearings were permitted within HP and HPT, especially over unproductive forested areas (secondary or degraded forests) (number of parent trees with dbh >20 cm is less than 25 trees/ha, number of parent tree is less than 10 trees/ha, and insufficient/very few regeneration). Tree removal over such areas is categorized as planned deforestation. To simplify, any forest clearing activity and or forest degradation occurring within HP and HPT without a legal permit are considered as unplanned deforestation and or uncontrolled forest degradation. As with HPK, since it is a production forest classification that is legally designed for other uses, mainly for agriculture, transmigration, plantations, and settlements, thus all forest clearing activities within HPK are categorized as planned deforestation.

The total forestland in 2013 was approximately 128.4 million ha (including inland water, marine and coastal ecosystems) and the rest is non-forestland (APL) (MoFor, 2014a). Of the 128.4 million ha, 17% has been classified as conservation forest (HK), 23.7% protection forest (HL), 21.7% limited production forest (HPT), 23.5% production forest (HP) and 13.9% convertible production forest (HPK; Figure 1.9). The total area assigned as HPK by the Ministry of Forestry amounted to about 17.9 million hectares. Of the 17.9 million ha of HPK, based on the Landsat 7 ETM+ interpretation of 2012, about 46% (8.25 million ha) was still covered by natural forests. On the other hand, about 7.13 million ha of natural forests were located in APL. The total area of natural forests in HPK and APL reached about 15.4 million ha. Most of the forested lands of HPK and APL are foundin Papua and Kalimantan, i.e. 9.6 million ha (Figure 1.10) and by law, they are permitted for conversion to other land uses.

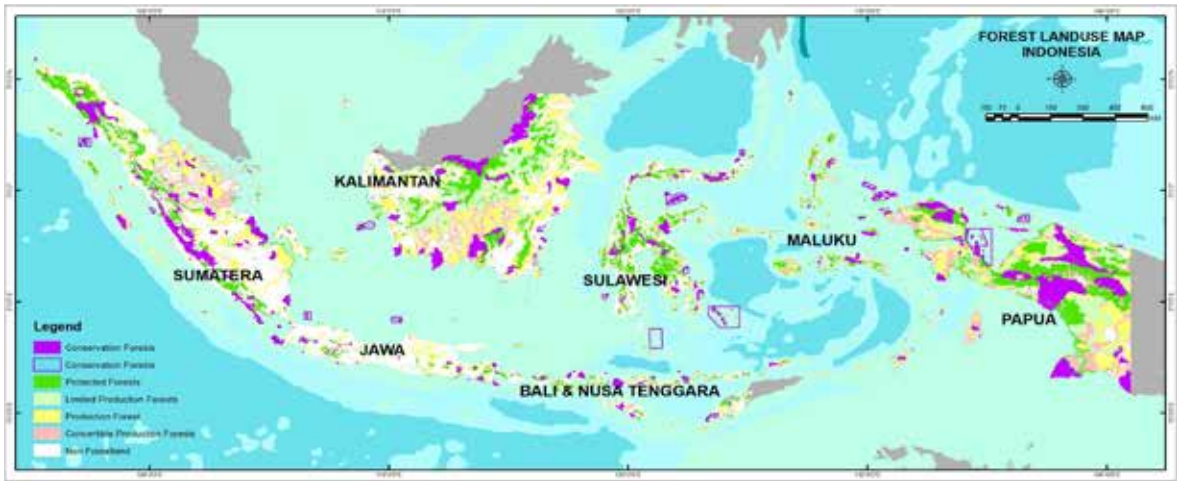



**Figure 1.9.** Map of Forestland Designation based on Minister of Forestry Decree on Marine and Ecosystem Areas and TGHK for all Provinces by December 2012 (MoFor, 2014a)

The main drivers of deforestation and degradation varied among islands. In the early 1980s, the main driver of deforestation in Sumatra was the establishment of settlement through transmigration programme, while in Kalimantan it was mainly due to excessive timber harvesting (MoE, 2003). It is believed that logging is not responsible for the deforestation of Indonesian forests. However, road network systems that have been developed during timber harvesting, have opened the access of capital to the forest area. Attractiveness of timber products, high agriculture income and open access market, have increased the insecurity of the forest. Combination of high logging extraction coupled with capital investment for agroindustrial production has caused high rates of forest degradation and deforestation. By 2012, more than half of the remaining Indonesia forests were secondary forests with various levels of degradation (Figure 1.11).


**Figure 1.10.** Distribution of Natural Forests in the HPK and APL (MoFor, 2014a)

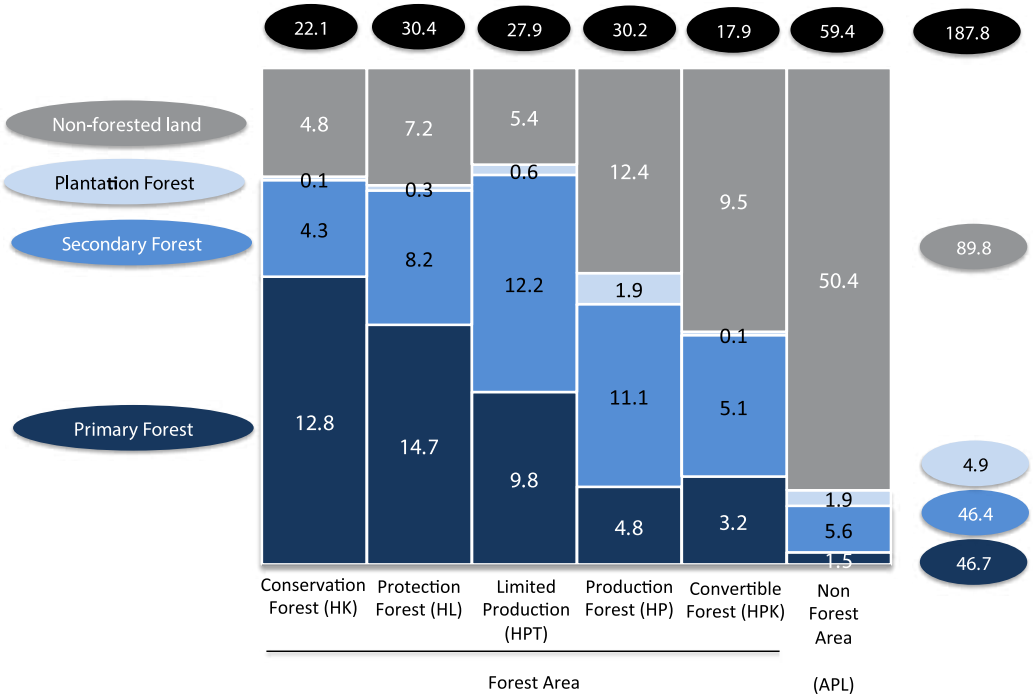



**Figure 1.11.** Area and Condition of Forest Cover in Various Forest Lands and Non-Forestland (MoFor, 2014a) in Million Hectare

Estimations of deforestation rates (both planned and unplanned) in Indonesia varied considerably among studies. FAO estimated that the annual rate of deforestation in the early 1970s was about 300,000 ha/year, in the early 1980s was about 600,000 ha/year and in the early 1990s, it had reached a level of 1 million ha/year (FAO and MoFor, 1990). Other estimation such as by the World Bank, stated that deforestation was caused by small holder conversion, development projects, poor logging practices and losses through fires which for the early 1990s was commonly quoted to account for between 700,000 ha/year to 1.2 million ha/year, while MoFor and FAO (1990) arrived at a figure of 1.3 million ha/ year from the total natural forest.

Recent study by Margono *et al*. (2014) published online in the Journal of Nature Climate Change, estimate the loss of natural forest from 2000 to 2012. The lost of natural forests over the years 2000-2006 was about 0.32 million ha per year and increased to 0.65 million hectare per year between 2006-2012. Meanwhile, Ministry of Forestry (MoFor, 2013) suggests that deforestation rate during 2000-2006 was 1.125 million ha per year. Both results indicated a large discrepancy between the figures for the annual deforestation rate during 2000-2006. These might be due to differences in methodology, forest definition used, and level of interpretation. In 2014, Ministry of Forestry has re-analyzed deforestation rate for the period between 1996-2012. The result of the analysis showed that the rate of deforestation of natural forest between 2006-2006 was 0.544 million ha

per year and increased to 0.599 million ha per year between 2006-2012. The revised data from the Ministry of Forestry is quite consistent with data of Margono *et al*. (2014) and also with study of Romijn et al.(2013).

In the efforts to reduce the rate of deforestation and forest degradation, and reduce the area of degraded land and forest, the Government of Indonesia has established five priority policies namely (i) combating illegal logging and forest fire, (ii) restructuring forestry sector industries including enhancement of plantation development, (iii) forest rehabilitation and conservation, (iv) promoting sustainable forest area, and (v) strengthening the local economies. Development of Forest Management Units (FMUs), particularly in the open access areas, has been prioritized as a key programme for supporting the implementation of the policies. Open access area is defined as forest areas that have not been granted to concessionaires and have no management status. These open-access areas are highly risky in illegal activities. The presence of on-site management unit could improve the management of forest area and increase the success of implementation for programmes under the five policies. The total number of FMUs that will be established throughout Indonesia is about 600 FMUs. In the 2010-2014 Strategic Plan of Ministry of Forestry, the Government of Indonesia has targeted to establish 60 FMUs in 5 years (12 units per year). However, this target is doubled to 120 FMUs following the emission reduction commitment (Precidential Regulation No. 61/2011). During the period 2009-2013, as many as 120 FMU models have been established (MoFor, 2014b).

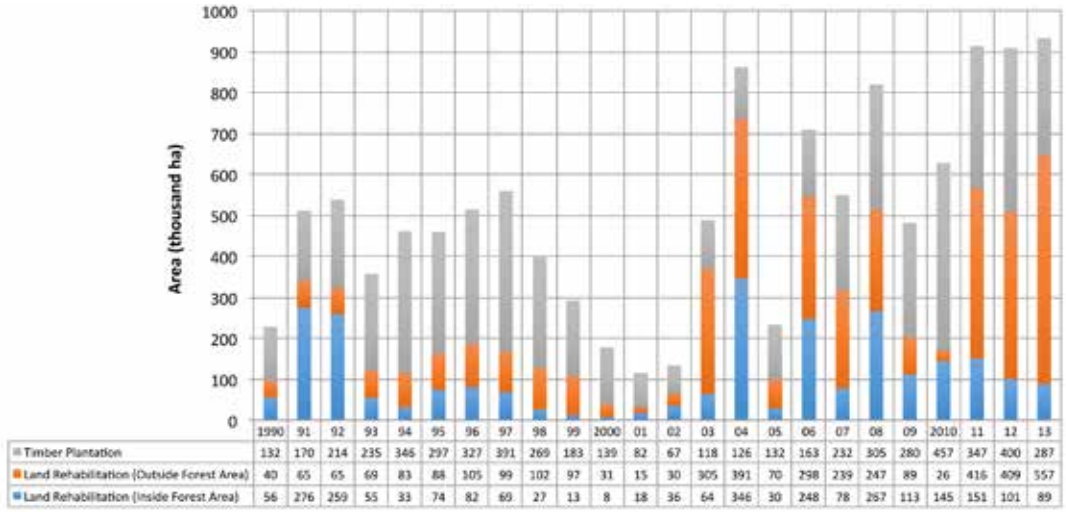
Secondary forest or degraded forests are not homogeneous. It consists of various degradation levels, depending on the degree of disturbances. Under proper treatments, lightly to medium degraded forests are able to recover to reach climax forests. On the other hand, due to insufficient field control and strict law enforcement, degraded forests may continue to be disturbed and degraded, resulting in severely degraded forests that fit the criteria of unproductive forests as given by Ministry of Forestry Decree No. 200/1994 and No. 18/2004. Unproductive forests comprised of forest areas withless than 25 parent tress/ha with dbh of 20 cm up; less than 10 parent trees/ha; and insufficient/very few regeneration (numbers of seedling is less than 1000/ha, sapling less than 240/ha and poles less than 75/ha). Therefore, it is thus obvious that not all degraded forests could be converted into plantation forests. In this case, the Government of Indonesia has allocated severely degraded forests (unproductive forested areas) to be established for plantation forests (including HTI).

Until 2013, Government of Indonesia had issued permits to establish plantation forest in production forest area with a total area of about 10.29 million hectares (MoFor, 2014b). Of this, about 10.1 million ha were granted to private sectors as Industrial Timber Plantation (IUPHHK-HTI) and 0.19 million ha to community as Community Timber Plantation (IUPHHK-HTR). However as indicated in Figure 1.11, less than 5 million ha of this area have been planted by the concession holders. In addition, Government of Indonesia also

issued permits for restoring production forest ecosystem (IUPHHK-RE). These permits allowed privates or entities to restore degraded production forests and later be harvested to produce woods (IUPHHK-RE). The total areas that have been granted with IUPPHK-RE until 2012 was only 0.398 million ha, while there were about 20 million hectares of degraded production forest that require restoration.

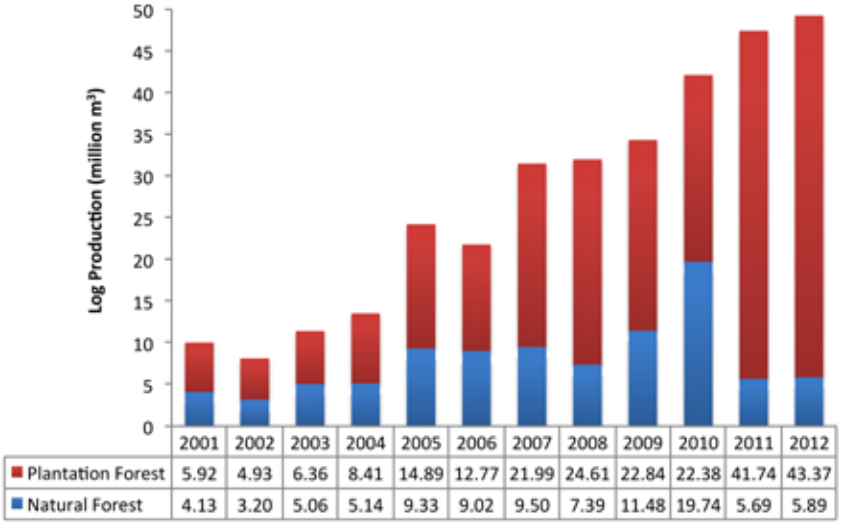
Lands inside and outside forest areas were severely damaged due to lost of vegetation cover and critical conditions. Forests functions such as water retention, erosion control, nutrient cycling, micro climate regulator and carbon retention were completely depleted. Ministry of Forestry has classified critical lands into 5 categories, i.e. very critical, critical, rather critical, potentially critical, and not critical. Furthermore, the Directorate General of Watershed Management has prioritized lands with critical and very critical condition for rehabilitation purposes. By 2011, the total area of critical lands had reached 27.3 million ha, comprised of 22.0 million ha critical and 5.3 million very critical. Government of Indonesia has implemented land rehabilitation programmes to restore, maintain and improve forests and lands area so that their carrying capacity, productivity and roles in supporting life system are sustained. After 2011, Government of Indonesia has accelerated the rate of land rehabilitation from 300 thousand to 580 thousand hectares annually (Figure 1.12). The programme is expected to rehabilitate about 11.6 million ha of degraded land until 2030. Despite such efforts, successes of land rehabilitation programmes were still low. Based on the 2006/07 evaluation report assessment on land rehabilitation programme implementation in West Java by PT. Equality Indonesia (2007), it was found that the survival rate of the planted trees was only about 20% (Boer, 2012). Considering this, to increase the survival rates, GoI prioritizes land rehabilitation programme to be implemented in areas where KPH (FMU) has been established.

Government policy to accelerate the establishment of timber plantation on degraded land is expected to reduce the reliance on natural forest in meeting future wood demands. Based on data from 2001-2012 (MoFor 2001, 2002, …, 2013), it was noted that log production from natural forest has decreased quite significantly between 2010 (Figure 1.13). Total log production in 2001 was only about 10 million $m^3$, and in 2012 it reached almost 50 million $m^3$. The growth rate of log production between 2001 and 2012 was about 15% per year. The 2011-2030 National Forestry Plan (RKTN) (MoFor, 2011) states that by 2030, the targeted annual log production capacity would be 362.5 million $m^3$ from a total of 14.5 million ha plantation forests and an annual log production of about 14 million $m^3$ from a total of 24.8 million ha concession forest (natural forest).




| | 1990 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 2000 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 2010 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Timber Plantation | 132 | 170 | 214 | 235 | 346 | 297 | 327 | 391 | 269 | 183 | 139 | 82 | 67 | 118 | 126 | 132 | 163 | 232 | 305 | 280 | 457 | 347 | 400 | 287 |
| Land Rehabilitation (Outside Forest Area) | 40 | 65 | 65 | 69 | 83 | 88 | 105 | 99 | 102 | 97 | 31 | 15 | 30 | 305 | 391 | 70 | 298 | 239 | 247 | 89 | 26 | 416 | 409 | 557 |
| Land Rehabilitation (Inside Forest Area) | 56 | 276 | 259 | 55 | 33 | 74 | 82 | 69 | 27 | 13 | 8 | 18 | 36 | 64 | 346 | 30 | 248 | 78 | 267 | 113 | 145 | 151 | 101 | 89 |

**Figure 1.12.** Rate of Land Rehabilitation Inside and Outside Forest Areas and HTI Development (Based on data from Forest Statistics 2001-2013; MoFor, 2002, ...,2014b)[6]




| | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Plantation Forest | 5.92 | 4.93 | 6.36 | 8.41 | 14.89 | 12.77 | 21.99 | 24.61 | 22.84 | 22.38 | 41.74 | 43.37 |
| Natural Forest | 4.13 | 3.20 | 5.06 | 5.14 | 9.33 | 9.02 | 9.50 | 7.39 | 11.48 | 19.74 | 5.69 | 5.89 |

**Figure 1.13.** Total Log Productions Based on Sources (Based on data from Forest Statistics 2001-2013; MoFor, 2002, ..., 2014b). The data shown in the figure only for log from the forest concessionaire.

## 1.5.4. Agricultural Sector

During the period 2005-2009, agricultural development continued to record various successes. One notable success was that Indonesia has achieved self-sufficiency in rice since 2008 (BAPPENAS, 2013a). The stable production of rice as the main staple food for

[6] http://www.dephut.go.id/index.php/news/statistik_kehutanan

most Indonesians, had helped to stabilize domestic food prices to avoid food crisis that occurred in many countries during this period. However, the long-term trend indicated a steady decline in *sawah* (paddy field) area, as much as 14,000 ha annually (Figure 1.14). This is primarily due to conversions of paddy fields to urban areas and settlement developments (Agus *et al.,* 2006). If this were to continue, rice self-sufficiency would not be sustained. On the contrary, plantation area has drastically increased at a rate of 571,000 ha annually. The annual total areas of upland and idle lands (including *Imperata* grass and bush lands) fluctuated, but the trend was increasing over the last six years. The increased in plantations, upland farming and idle lands postulated decreasing forest area.

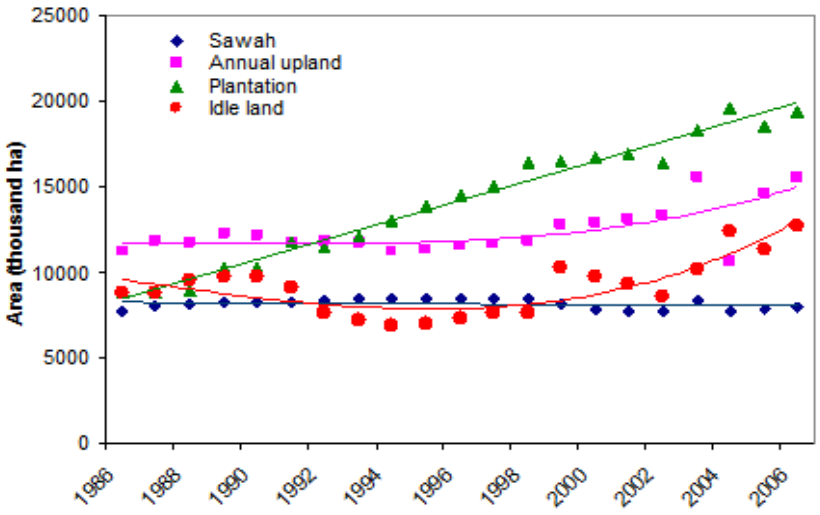



**Figure 1.14.** Development of Main Agricultural Systems from 1986 to 2006
(*Data taken from Statistics Indonesia*)

Meanwhile, there was a small increase in the overall harvested area and production of paddy area. Between the years 2000-2012, there was an annual increase of rice harvested area and production at a rate of 1% and 2% respectively (Figure 1.15).

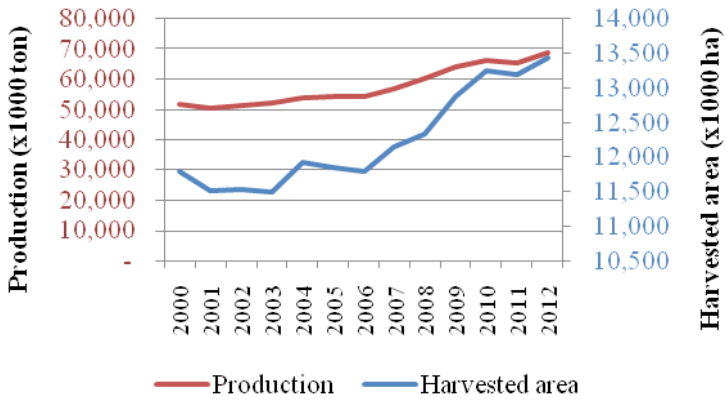



**Figure 1.15.** Development of Paddy Cultivation from 2000 to 2012 *(Data taken from the Ministry of Agriculture)*

Rapid increased in agricultural plantation areas was mainly due to the high growth of palm oil plantation, which increased exponentially over the last decade (Figure 1.16). Between 1980 and 2013, the average increased was 12% annually from about 0.3 to 10.5 million ha. The rapid increased in palm oil plantations was driven by the increasing demands of domestic and international markets, including demand for biodiesel. Areas of cacao and coffee plantations have also increased, although not as drastically as that of palm oil.

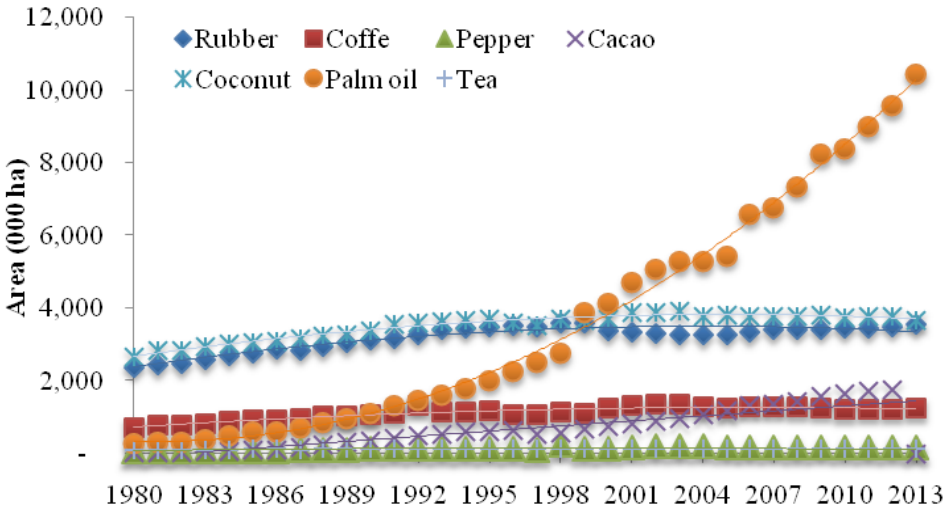



**Figure 1.16.** Development of the Main Plantation Areas from 2000 to 2013
*(Data taken from the Ministry of Agriculture)*

To increase productions of the main agricultural commodities, particularly palm oil, Indonesia has targeted to expand palm oil plantation to 1.375 million ha between 2010 and 2015 (Ministry of Agriculture, 2008). The target provinces for the expansion of palm oil plantations were East Kalimantan, West Kalimantan, Central Kalimantan, Jambi and South Sumatra.

To secure future rice production, Indonesia will allocate 15 million ha of land permanently for cropland by 2030. In 2012, the total area of paddy field was approximately 13.4 million ha, meaning that an additional 1.6 million ha was still required to meet this target. However, due to high demands for housings and urban developments, land use competitions had converted potential arable lands to meet such demands, resulting in less available paddy field areas.

Concerning livestock, overall there were increases in the number of populations, especially for poultry. Swine and cattle were also experiencing increases of 4% and 3% per year, respectively (Figure 1.17).

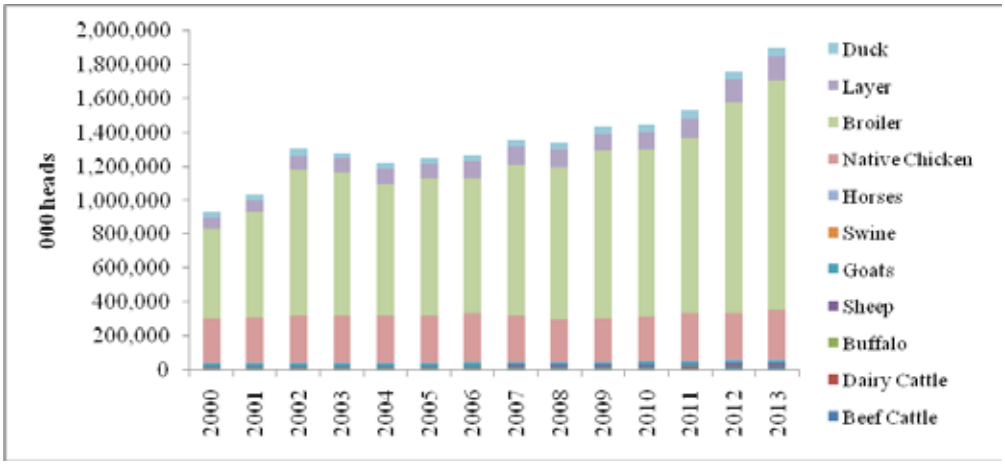



**Figure 1.17.** Development of Livestock Population (Source: Ministry of Agriculture)

## 1.5.5. Water Sector

In general, Indonesia holds about 6 % of the world's fresh water reserve or approximately 21% in the whole Asia-Pacific region. The high availability of water in Indonesia is indicative of the high level of rainfall and the potential availability of surface water and groundwater. However, in recent years, many areas were experiencing difficulties in obtaining available supplies of usable water. Java (with its high population and high industrial activities), Bali and East Nusa Tenggara were already experiencing water deficits (Ministry of Public Works, 2007). The current total water demand for irrigation, domestic, municipal and industrial

usages amounts to 1,074 $m^3$/sec; however, the available flow during a normal climatic year is only about 790 m3/sec or approximately 76% of the total water demand. Water deficits would continue to increase following the increases of population and economic activities.

A great deal of factors have caused the reduction of water both in quantity and quality. The first factor is the declining carrying capacity of upstream water catchment areas as the result of uncontrolled forest clearing. This was indicated by the increased in the number of critical catchments areas of river basins, from 22 river basins in 1984 to 39 river basins in 1992 and to 62 catchment areas in 1998 (MoE, 2007). The second factor is uncontrolled land clearing within flood-prone areas, water catchment areas and riverbanks that has resulted in reduced infiltration capacity, changes in river morphology, and reduced carrying capacity of streams, hence expanding the risk and increasing flood frequency. The third factor is uncontrolled extraction of freshwater that has resulted in increased saltwater intrusion and land subsidence. The fourth factor is degradation of river beds in Java, Bali and West Nusa Tenggara due to exploitation of sand which in turned has caused infrastructural and structural damages along the rivers. The fifth and final factor is the increased sedimentation of river beds resulting from household solid waste disposal and mining.

Efforts for water resources management have been carried out by the government through instrumentation of regulation and programmes executed by various related sectors. In general, the efforts focused on two activities, i.e., water conservation and water pollution control.

### 1.5.6. Coastal and Marine Sector

Indonesia is an archipelagic country with approximately 5.8 million $km^2$ of ocean. Coastal areas, small islands, marine life and fisheries play important roles in supplying food energy, supporting natural cycles, and regulating global climate. From an economic standpoint, Indonesia's fishery resources equate to 6.65 million tonnes per year consisting of 4.35 million tonnes in territorial and 2.3 tonnes in the Executive Economic Zone (MoE, 2007). About 140 million people or 60% of the total population spread across 42 cities and 182 districts are living within 50 km of the shoreline.

Indonesian marine ecosystem is also home of coral reefs. Each coral reef area contains at least 2,500 species of fish, although at present, only 30% of these reefs are in good or excellent condition. Several areas of the oceans have been damaged due to non-environmental friendly practices. The coral reefs damage level in Indonesia reached 40%,with 24% of all reefs considered to be damaged and medium damaged condition while only 6% remained in very good condition. It has been estimated that 90% of Indonesia's coral reefs have been

damaged by a combination of unsustainable fishing practices, over-fishing, sedimentation and land-based pollution, and coral mining (MoE, 2007).

Similar conditions were also found with mangrove ecosystems. In 1993, Indonesia's mangrove forest was around 3.7 million ha, dispersed throughout the coasts, from the Island of Sumatra, Kalimantan, Java, Sulawesi, West Nusa Tenggara, East Nusa Tenggara, all of Maluku Islands, and Papua. However, by 2005, the remaining mangrove forest was only 1.5 million ha. Mangrove forest has significantly decreased between 2% (the lowest) in East Java to 100% (the highest) in East Nusa Tenggara due to illegal cuttings of mangrove wood, area clearing for shrimp breeding and also wet and dry farming (MoE, 2007).

Many initiatives have already being carried out by various parties including the government, environmental non-governmental organizations (NGOs) and communities related to coastal and marine management, such as the Coral Reef Rehabilitation and Management Programme (COREMAP), including mapping of priority areas for rehabilitation and utilization in marine and coastal areas, mangrove rehabilitation management as well as the Coral Triangle Initiative. The latter initiative conserve marine region that spans along parts of Indonesia, Malaysia, New Guinea, the Philippines, the Solomon Islands, and Timor Leste with at least 500 species of reef-building corals, which in turned providing incomes and food security to more than 120 million people living in the area.

# Chapter 2.

# National Greenhouse Gas Inventory

## 2.1. Introduction

The Indonesia National Greenhouse Gas Inventory provided estimations of emissions by sources and sinks for the period 2000-2012. It was drawn up in line with Articles 4 and 12 of the United Nations Framework Convention on Climate Change (UNFCCC) and the Guidelines for National Communications of non-Annex I Parties of the UNFCCC, adopted in decision 17/ CP.8, which stated that non-Annex I Parties should include information on a national inventory of anthropogenic emissions by sources and absorption by sinks of all greenhouse gases (GHGs) not controlled by the Montreal Protocol, within the limits of their possibilities, using the methodologies promoted and approved by the Conference of Parties (COP).

The calculations for GHG emissions were made for the six emissions categories defined by the Intergovernmental Panel on Climate Change (IPCC) following the 2006 IPCC Guidelines, namely Energy, Industrial Processes, Solvents, Agriculture, Land Use Change and Forestry and Waste. The Inventory 2000-2012 reports on the three main GHGs included in Appendix A of the Kyoto Protocol: carbon dioxide ($CO_2$), methane ($CH_4$), and nitrous oxide ($N_2O$). Information on three other minor gases (CO, $NO_X$ and perfluorocarbons [PFC]) were also provided.

## 2.2. Institutional Arrangements

In the development of Indonesia's first Communication (INC) and Second National Communication (SNC) to UNFCCC, the preparation of national GHG Inventory was conducted by a consulting team consisted of universities and research agencies. The involvement of related line ministries and national agencies was very limited. In the INC, the involvement was only in the consultation processes during the development of the report, while in developing SNC, these institutions were more actively engaged in providing activity data and in the process of developing the inventory. Under such process, the production of the

GHG Inventory might not be sustainable in the long term. Therefore, high involvement of these institutions in the development of the regular inventory system is critical to better facilitate the process to improve the quality of the inventory, to facilitate the development of QA/QC (*quality assurance and quality control*) process for improving the quality of activity data, and to document and archive the data and information.

Concerning this, the Government of Indonesia has issued the Precidential Regulation 71/2011 (Perpres No 71/2011) on the Implementation of National GHG Inventory. This Precidential Regulation 71/2011 mandated all sectors and local governments under the coordination of the Minister of Environment to develop annual report on the implementation of GHG inventory to the Coordinating Minister for People's Welfare. The inventory reports will be published periodically in compliance with the needs of national and international reporting (e.g. National Communication and Biennial Update Report). It will further be used to formulate policy and evaluate the national mitigation action plans to reduce GHG emissions.

The MoE has established Centre for National GHG Inventory System (called the *SIGN Centre*) to facilitate and to coordinate line ministries/national agencies and local governments in developing GHG Inventory. The SIGN Centre is directed by a Steering Committee (SC) consisted of Echelon 1 from related ministries and supported by the Sectoral Working Groups (SWG) for the Inventory representing by Echelon 2 from related sectors that have been assigned for developing GHG Inventory (Figure 2.1). The SG and SWG of SIGN centre were established through the Minister of Environment Decree Number 463/2013 on the Coordination Team of the Implementation of National GHG Inventory. Each line ministry has been assigned a certain unit/institution within the ministry to perform the task. The units are supported by certain parties responsible for data collection and calculation of GHG Emissions. The units in each line ministry are responsible for the development of National GHG Inventory as listed in Table 2.1.

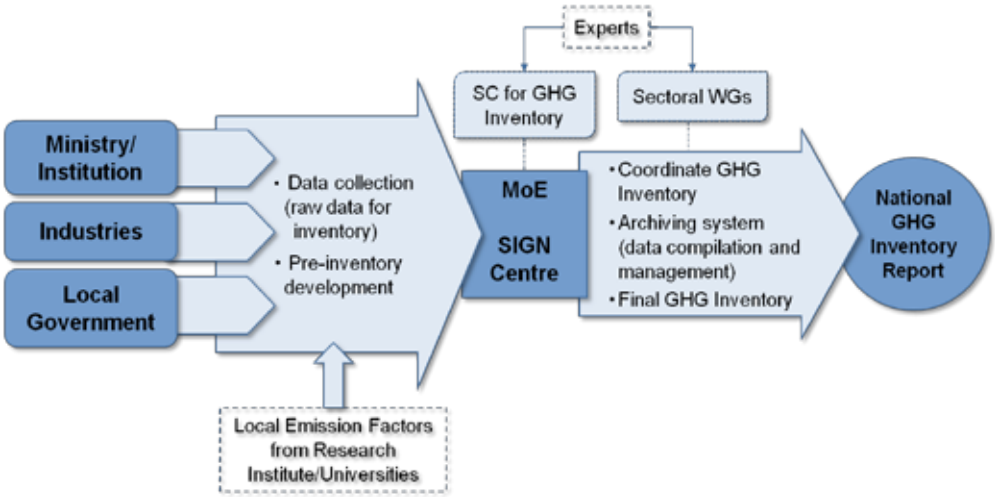



**Figure 2.1.** Institutional Mechanism for National GHG Inventory System (SIGN)

Table 2-1. Related Institution for the Development of National GHG Inventory

| Sectors (Sources of GHG ) | Related Institution | Responsible Units Within the Institutions |
|---|---|---|
| ***Coordinator of National GHG Inventory: SIGN Centre, Ministry of Environment*** | | |
| ***GHG from Energy Activity:*** | | |
| **Reference Approach** | Ministry of Energy and Mineral Resources (MEMR) | Centre for Data and Information |
| **Power Generation Plant** | MEMR | Centre for Data and Information |
| | National Electricity Company (PLN) and IPP | |
| **Oil and Gas (Fuel + Fugitive)** | MEMR | Centre for Data and Information |
| | Oil/Gas Companies (Pertamina & Production Sharing Contract) | |
| **Coal Mining (Fuel + Fugitive)** | MEMR | Centre for Data and Information |
| | Coal Companies | |
| **Transportation** | MEMR | Centre for Data and Information |
| | Ministry of Transportation (MoT) | Centre for Assessment of Transportation Services and Partnership |
| **Energy in Industry** | MEMR | Centre for Data and Information |
| | Ministry of Industry (MoI) | Centre for Assessment of the Environment and Green Industry; Centre for Data and Information |
| | Statistics Indonesia (BPS) | Directorate for Industrial Statistics |
| | Large industries/companies | - |
| **Energy in Commercial Areas** | MEMR | Centre for Data and Information |
| **Energy in Residential Areas** | MEMR | Centre for Data and Information |
| ***GHG from IPPU*** | | |
| **Industrial Process** | MoI | Centre for Assessment of the Environment and Green Industry; Centre for Data and Information |
| | BPS | Directorate for Industrial Statistics |
| | Large industries/companies/association | - |
| **Product Use** | MoI | Centre for Assessment of the Environment and Green Industry; Centre for Data and Information |
| | BPS | Directorate for Industrial Statistics |
| ***GHG from Waste Treatment*** | | |
| **Municipal Solid Waste (MSW)** | Ministry of Environment (MoE) | Assistant Deputy for Solid Waste Management (ADIPURA Unit of Deputy IV) |
| | Ministry of Public Work | Directorate for Development of Settlement Sanitation and Environment<br>Center for Research and Development of Settlement Sanitation and Environment; |
| **Domestic Liquid Waste** | MoE | Assistant Deputy for the Pollution Control of Manufacture, Service, and Infrastructure |
| | Ministry of Public Work | Directorate for Development of Settlement Sanitation and Environment;<br>Research Centre for Water Resources<br>Center for Research and Development of Settlement Sanitation and Environment; |
| | BPS | Directorate for Industrial Statistics |

| Sectors (Sources of GHG ) | Related Institution | Responsible Units Within the Institutions |
|---|---|---|
| **Industrial Solid Waste (includes medical/ pharmaceutical waste)** | MoE | Assistant Deputy for Verification of Hazardous Waste Management |
| | MoI | Centre for Assessment of the Environment and Green Industry, Centre for Data and Information |
| **Industrial Liquid Waste** | MoE | PROPER Units of Deputy II:<br>Assistant Deputy for the Pollution Control of Mining, Energy, Oil, and Gas;<br>Assistant Deputy for the Pollution Control of Agro-industry and Small Scale Enterprises; Assistant Deputy for the Pollution Control of Manufacture, Service, and Infrastructure |
| | MoI | Centre for Assessment of the Environment and Green Industry; Centre for Data and Information |
| | Large industries/companies/associations | |
| ***GHG from Agriculture*** | | |
| **Rice Cultivation** | Ministry of Agriculture (MoA) | Indonesian Agency for Agricultural Research and Development (IAARD); Indonesia Centre for Agricultural Land Resources Research and Development (ICALRD); Indonesia Agricultural Environmental Research Institute (IAERI); Bureau for Planning; Centre for Data and Information; Directorate General for Food Crops |
| | BPS | Directorate for Agricultural Statistics |
| **Livestock** | MoA | IAARD; IAERI; Bureau for Planning; Centre for Data and Information; Directorate General for Livestock and Animal Husbandry |
| **Agriculture Soils** | MoA | ICALRD; IAARD; IAERI; Centre for Data and Information |
| | Association | Indonesian Fertilizer Producer Association (APPI) |
| **Prescribed Burning Savanna** | MoA | IAARD; IAERI |
| | Ministry of Forestry (MoFor) | Forestry Research and Development Agency (FORDA) |
| **Field Burning of Agriculture Residues** | MoA | IAARD, IAERI |
| ***GHG for Forest and Land Use Change*** | | |
| **Agriculture Plantation** | MoA | IARRD; Centre for Data and Information; Directorate General for Estate Crops |
| **Land use change and forestry** | MoFor | Directorate for Forestry Resources Inventory and Monitoring;<br>Centre for Environmental Standardization; Research and Development Centre for Climate Change and Policy; Research and Development Centre for Conservation and Rehabilitation |
| | MoA | ICALRD |
| | Geospatial Information Agency (BIG) | Deputy for Thematic Geospatial Information |
| | National Institute of Aeronautics and Space (LAPAN) | Deputy for Remote Sensing |

As mandated by Presidential Regulation No. 71/2011, the development of National GHG Inventory should involve the active participation from sub-national governments (provincial and city/regency). However, at present, development of National GHG Inventory mainly involves national agencies (see Table 2.1). In the development of GHG Inventory, the roles of sub-national government (provincial and city/regency) should be constantly strengthened. Thus, in the future, development of GHG Inventory would need touse both top-down and bottom-up approaches (Figure 2.2) to compare the GHG emissions estimated at national level with the total GHG emissions estimated at sub-national level. This should increase the consistencies between GHG emissions estimates at national and sub-nationallevels. Ideally, the difference between the two estimations, as in the case of reference and sectoral approaches in energy sector, should not exceed 5%.

The use of bottom-up approach will require capacity building for regional/sub-national government, particularly the capacity in using IPCC methodology for the development of GHG inventory. This will require many resources. To address this issue, the Ministry of Environment has established a data collection system called SIGN SMART[7] system. The system will only require regional/sub-national government to collect and report activity data, while estimation of emission will be performed by the system (Figure 2.3).

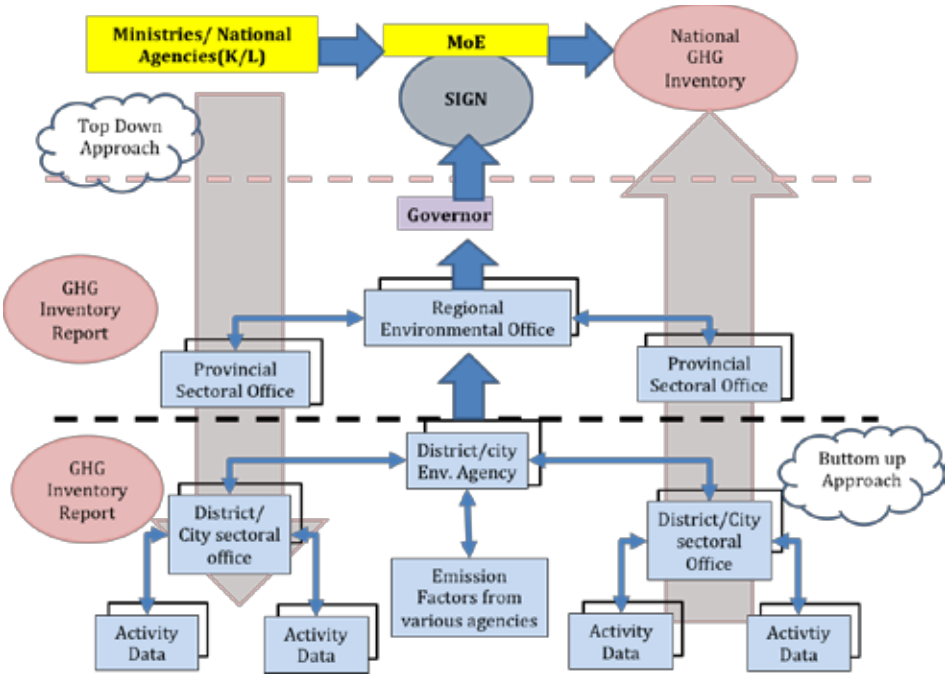



**Figure 2.2.** Institutional Arrangements for the Implementation of Presidential Regulation No. 71/2011

7 "SMART" comes from abbreviation of Indonesian words for "simple, easy, accurate, concise, and transparent"

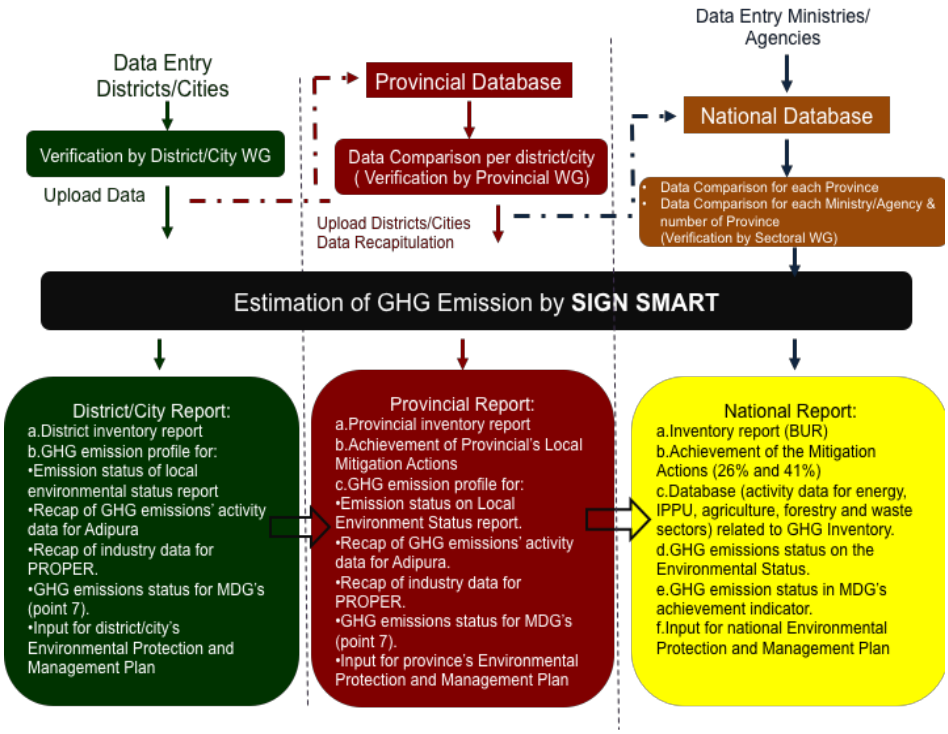



**Figure 2.3.** Flows for SIGN-SMART

## 2.3. Overview of Source and Sink Category Emission Estimates for 2012

### 2.3.1. Methodology

The estimation of source and sink category in the National GHG Inventory for the period 2000-2012 was carried out by using the 2006 IPCC Guidelines (GLs) with Tier 1 and Tier 2, similar to that of the Second National Communication. However, the use of this methodology was not in line with the Guidelines for National Communications of non-Annex I Parties of the UNFCCC, adopted in decision 17/ CP.8 where it was stated that the non-Annex 1 countries should used the revised 1996 IPCC GL to develop their inventory. The decision to adopt the 2006 IPCC GL was made since it covered source categories that were not available in the revised 1996 IPCC GL.

The Global Warming Potential (GWP) values used for converting GHG emissions data for non-$CO_2$ into units of carbon dioxide equivalent ($CO_2$-e) followed the 4th AR of IPCC with 100 years time horizon (Table 2.2). Thus it is different from the SNC, which used GWPs values from the TAR.

Table 2-2. GWPs Values of Second Assessment Report (SAR) for 100 years Time Horizon

| No. | Gases | GWP ($CO_2$-e) |
|---|---|---|
| 1 | $CO_2$ | 1 |
| 2 | Methane ($CH_4$) | 21 |
| 3 | Nitrous Oxide ($N_2O$) | 310 |
| 4 | PFC-14 ($CF_4$) | 6,500 |
| 5 | PFC-116 ($C_2F_6$) | 9,200 |
| 6 | Sulphur hexafluoride ($SF_6$) | 23,900 |

## 2.3.2. National Emissions

In 2012, the total GHG emissions for the three main greenhouse gases ($CO_2$, $CH_4$ and $N_2O$) excluding land use, land use change and forestry (LULUCF) and peat fires was 758,979 Gg $CO_2$-e. With the inclusion of LULUCF, the total GHG emissions from Indonesia become 1,453,957 Gg $CO_2$-e (Table 2.3). The GHG emissions (in $CO_2$ equivalent) were distributed unevenly between the three gases namely 84.1%, 11.9% and 4.1% for $CO_2$, $CH_4$ and $N_2O$ respectively. The main contributing sectors in LUCF included peat fire (47.8%), followed by energy (34.9%), agriculture (7.8%), waste (6.7%) and industry (2.8%) (Figure 2.4). Without LUCF, the energy sector contributed to 66.9% of the total emission, followed by agriculture (14.9%), waste (12.8%) and industry (5.4%). Summary of the GHG emissions for 2012 is presented in Table 2.4 and Table 2.5.

Table 2-3. GHGs Emissions by Sectors in 2000 and 2012 (Gg $CO_2$-e)

| No | Sectors | Year | $CO_2$ | $CH_4$ | $N_2O$ | Total 3 Gases | $CF_4$ | $C_2F_6$ | CO | NOx | NMVOC | Sox | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Energy | 2000 | 265,318 | 29,742 | 3,352 | 298,412 | NE | NE | NE | NE | NE | NE | 298,412 |
| | | 2012 | 477,805 | 25,188 | 5,127 | 508,120 | NE | NE | NE | NE | NE | NE | 508,120 |
| 2 | IPPU | 2000 | 40,425 | 70.67 | 265.28 | 40,761 | 250 | 22 | NE | NE | NE | NE | 41,033 |
| | | 2012 | 40,538.10 | 56.9 | 420 | 41,015 | 47 | NE | NE | NE | NE | NE | 41,062 |
| 3 | Agriculture (incl. livestock) | 2000 | 4,772 | 51,461 | 40,072 | 96,305 | NE | NE | 2,724.44 | 74.03 | NE | NE | 99,103 |
| | | 2012 | 6,625 | 55,650 | 50,452 | 112,727 | NE | NE | 3,370.83 | 91.6 | NE | NE | 116,189 |
| 4 | LULUCF (incl. peat fire) | 2000 | 505,369 | NE | NE | 505,369 | NE | NE | NE | NE | NE | NE | 505,369 |
| | | 2012 | 694,978 | NE | NE | 694,978 | NE | NE | NE | NE | NE | NE | 694,978 |
| 5 | Waste | 2000 | 1,783 | 56,591 | 2201 | 60,575 | NE | NE | NE | NE | NE | NE | 60,575 |
| | | 2012 | 2,207 | 91,913 | 2,997 | 97,117 | NE | NE | NE | NE | NE | NE | 97,117 |
| **Total ($CO_2$-eq)** | | 2000 | 817,667 | 137,864 | 45,890 | **1,001,422** | 0 | 0 | 2,724 | 74 | 0 | 0 | **1,004,492** |
| | | 2012 | 1,222,152 | 172,808 | 58,996 | **1,453,957** | 0 | 0 | 3,371 | 92 | 0 | 0 | **1,457,466** |
| **Percentage (%)** | | 2000 | 81.7 | 13.8 | 4.6 | | | | | | | | 100.0 |
| | | 2012 | 84.1 | 11.9 | 4.1 | | | | | | | | 100.0 |

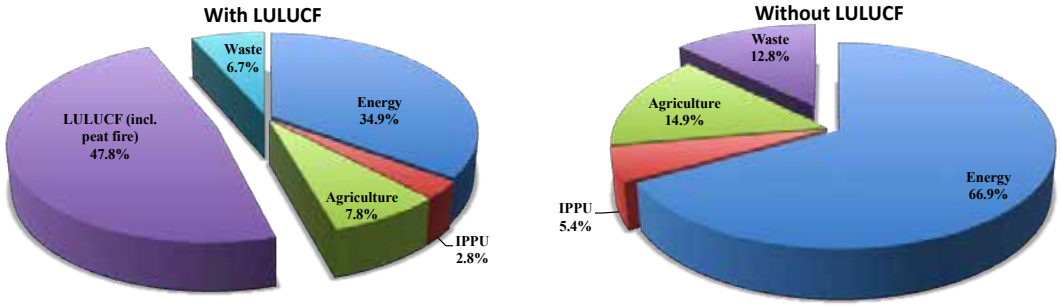



**Figure 2.4.** National Emissions Contributions by Sector in 2012

## Table 2-4. Summary of National GHG Emissions in 2012 (in $CO_2e$)

| No | Source and sink Categories | CO2 removal | CO2 emission | CH4 | N2O | CO | NOx | NMVOC | SOx |
|---|---|---|---|---|---|---|---|---|---|
| | | (Gg) | (Gg) | (Gg) | (Gg) | (Gg) | (Gg) | (Gg) | (Gg) |
| **Total National Emission and Removals** | | **-53,403.65** | **1,275,556** | **172,809** | **58,996** | **3,371** | **92** | **NE** | **NE** |
| **1. Energy (without Biomass)** | | | **477,804.65** | **25,188.44** | **5,127.14** | **-** | **-** | **-** | **-** |
| **A** | **Fuel Combustion Activity** | | **471,326** | **10,094** | **5,115** | **-** | **-** | **-** | **-** |
| 1 | Energy production (electricity, heat, oil & gas refining) | | 186,881 | 62 | 688 | NE | NE | NE | NE |
| 2 | Manufacturing Industries and Construction | | 122,683 | 339 | 716 | NE | NE | NE | NE |
| 3 | Transportation | | 128,807 | 738 | 1,912 | NE | NE | NE | NE |
| 4 | Commercial/Institutional | | 3,465 | 59 | 17 | NE | NE | NE | NE |
| 5 | Residential | | 18,249 | 8,863 | 1,753 | NE | NE | NE | NE |
| 6 | Non Specified | | 11,241 | 32 | 28 | NE | NE | NE | NE |
| **B.** | **Fugitive Emissions** | | **6,478** | **15,095** | **12** | **-** | **-** | **-** | **-** |
| 1 | Solid Fuels | | | 1,871 | | NE | NE | NE | NE |
| 2 | Oil and Natural Gas | | 6,478.45 | 13,224 | 12 | NE | NE | NE | NE |
| **2. Industrial Processes and Product Use** | | | **40,538.10** | **56.90** | **420.00** | **-** | **-** | **-** | **-** |
| **A. Mineral** | | | **24,358.12** | | | **NE** | **NE** | **NE** | **NE** |
| 1 | Cement Production | | 21,360 | | | NE | NE | NE | NE |
| 2 | Lime Production | | 916 | | | NE | NE | NE | NE |
| 3 | Glass Production | | 39 | | | NE | NE | NE | NE |
| 4a | Ceramic production | | 6 | | | NE | NE | NE | NE |
| 4b | Other Process Uses of Carbonates | | 2,037 | | | | | | |
| **B. Chemical** | | | **9,336.23** | **56.04** | **420.00** | **-** | **-** | **-** | **-** |
| 1 | Ammonia Production | | 7,182 | NE | NE | NE | NE | NE | NE |
| 2 | Nitric Acid Production | | NE | NE | 420 | NE | NE | NE | NE |
| 3 | Caprolactam, Glyoxal dan Glyoxylic Acid | | NE | NE | - | NE | NE | NE | NE |
| 4 | Carbide Production | | 23 | | | NE | NE | NE | NE |
| 5 | Petrochemical and Carbon Black Production | | | | | | | | |
| | - Methanol | | 175.89 | 22.07 | NE | NE | NE | NE | NE |
| | - Ethylene | | 1,194.32 | 33.46 | NE | NE | NE | NE | NE |
| | - Ethylene Dichloride and VCM | | 126.52 | 0.21 | NE | NE | NE | NE | NE |
| | - Carbon Black | | 634.89 | 0.31 | NE | NE | NE | NE | NE |
| **C. Metal** | | | **3,419.16** | **0.87** | **0.00** | **-** | **-** | **-** | **-** |
| 1 | Iron and Steel Production | | 3,004.06 | 0.87 | NE | NE | NE | NE | NE |
| 2 | Ferroalloys Production | | NE | NE | NE | NE | NE | NE | NE |
| 3 | Alumunium Production | | 386.13 | NE | NE | NE | NE | NE | NE |
| 4 | Lead Production | | 13.03 | NE | NE | NE | NE | NE | NE |
| 5 | Zinc Production | | 15.94 | NE | NE | NE | NE | NE | NE |

| No | Source and sink Categories | CO2 removal | CO2 emission | CH4 | N2O | CO | NOx | NMVOC | SOx |
|---|---|---|---|---|---|---|---|---|---|
| | | (Gg) | (Gg) | (Gg) | (Gg) | (Gg) | (Gg) | (Gg) | (Gg) |
| **D. Others** | | | **3,425** | **-** | **-** | **-** | **-** | **-** | **-** |
| 1 | Lubricant Use | | 222 | NE | NE | NE | NE | NE | NE |
| 2 | Paraffin Wax Use | | 3,108 | NE | NE | NE | NE | NE | NE |
| 3 | Others - natrium carbonate in pulp&paper industry | | 94 | NE | NE | NE | NE | NE | NE |
| 4 | Others - natrium carbonate in food&beverages industry | | 0.50 | NE | NE | NE | NE | NE | NE |
| **3. Solvent and Other Product Use** | | | **NE** | | **NE** | | | **NE** | |
| **4. Agriculture** | | | **6,624.68** | **55,650.07** | **50,452.38** | **3,370.83** | **91.60** | | |
| A | Enteric Fermentation | | | 16,828 | | | | | |
| B | Manure Management | | | 2,103 | | | | | |
| C | Rice Cultivation | | | 34,641 | NE | | | | |
| D | Agriculture Soils | | | | | | | | |
| 1 | Direct N2O Soils | | | NE | 32,646 | | | | |
| 2 | Indirect N2O Soils | | | NE | 8,479 | | | | |
| 3 | Direct N2O from manure | | | NE | 7,371 | | | | |
| 4 | Indirect N2O from manure | | | NE | 1,162 | | | | |
| E | Prescribed Burning of Savanna/ grassland | | | 804 | 308 | 1,304.42 | 35.45 | | |
| F | Prescribed burining of Agiruclture Residues | | | 1,274 | 487 | 2,066.42 | 56.15 | | |
| G | Others | | | | | | | | |
| 1 | Liming | | 1,771.44 | NO | NE | NO | NO | NO | NO |
| 2 | Urea Fertilization | | 4,853.24 | NO | IE | NO | NO | NO | NO |
| **5. Land Use Change and Forestry** | | **- 53,404** | **748,382** | **-** | **-** | **-** | **-** | | |
| A | Changes in forest and other woody biomass stocks | - 16,327 | | | | | | | |
| B | Forest and grassland conversion | | 214,225.93 | | | | | | |
| C | Abandonment of croplands, pastures, plantation forests, or other managed lands | -37,076 | | | | | | | |
| D | CO2 emissions and removals from soils | NE | 327,106 | | | | | | |
| E | Others: | | | | | | | | |
| | - Forest Burning | | NE | NE | NE | NE | NE | | |
| | - Peat Fire* | | 207,050 | NE | NE | NE | NE | | |
| **6. Waste** | | | **2,206.86** | **91,913.17** | **2,996.53** | **-** | **-** | | |
| A1 | Unmanaged Waste Disposal Sites | | NE | 27,584 | NE | NE | NE | NE | |
| A2 | Unmanaged Dumpsite | | NE | NE | NE | NE | NE | NE | |
| B | Biological Treatment of Solid Waste | | NE | 129 | 114 | NE | NE | NE | NE |
| C | Open Burning Waste | | 2,206.86 | 1,744 | 307 | NE | NE | NE | NE |
| D1 | Domestic Wastewater Treatment and Discharge | | | 11,547 | 2,575 | NE | NE | NE | |
| D2 | Industrial Wastewater Treatment and Discharge | | | 47,250 | NE | NE | NE | NE | |
| E | Untreated, estimated using SWDS unmanaged shallow | | | 3,659 | NE | NE | NE | NE | |
| **7. Others** | | | **183,619.57** | **-** | **-** | **-** | **-** | **-** | **-** |
| | International bunkers | | NE | NE | NE | NE | NE | NE | NE |
| | Aviation | | NE | NE | NE | NE | NE | NE | NE |
| | Marine | | NE | NE | NE | NE | NE | NE | NE |
| | Biomass | | 183,620 | | | | | | |

Notes: NE = not estimated, NO = not occurred

Table 2-5. Summary of National GHG Emissions in 2012 (in $CO_2e$)

| No | Source and Sink Categories | HFCs | | | | Others | PFCs | | $SF_6$ |
|---|---|---|---|---|---|---|---|---|---|
| | | HFC-32 | HFC-125 | HFC124 | HFC143 | (Gg) | $CF_4$ | $C_2F_6$ | |
| **Total National Emission and Removals** | | | | | | | **47** | | |
| **1. Energy (without Biomass)** | | | | | | | | | |
| **A** | **Fuel Combustion** | | | | | | | | |
| 1 | Energy production (electricity, heat, oil & gas refining) | | | | | | | | NE |
| 2 | Manufacturing industries and Construction | | | | | | | | |
| 3 | Transportation | | | | | | | | |
| 4 | Commercial/Institutional | | | | | | | | |
| 5 | Residential | | | | | | | | |
| 6 | Non Specified | | | | | | | | |
| **B** | **Fugitive Emissions** | | | | | | | | |
| 1 | Solid Fuels | | | | | | | | |
| 2 | Oil and Natural Gas | | | | | | | | |
| **2. Industrial Processes and Product Use** | | | | | | | | | |
| **A. Mineral** | | | | | | | | | |
| 1 | Cement Production | | | | | | | | |
| 2 | Lime Production | | | | | | | | |
| 3 | Glass Production | | | | | | | | |
| 4a | Ceramic | | | | | | | | |
| 4b | Other Process Use of Carbonates | | | | | | | | |
| **B. Chemical** | | | | | | | | | |
| 1 | Ammonia Production | | | | | | | | |
| 2 | Nitric Acid Production | | | | | | | | |
| 3 | Caprolactam, Glyoxal and Glyoxylic Acid | | | | | | | | |
| 4 | Carbide Production | | | | | | | | |
| 5 | Petrochemical and Carbon Black Production | | | | | | | | |
| | - Methanol | | | | | | | | |
| | - Ethylene | | | | | | | | |
| | - Ethylene Dichloride and VCM | | | | | | | | |
| | - Carbon Black | | | | | | | | |
| **C. Metal** | | | | | | | 47 | - | |
| 1 | Iron and Steel Production | | | | | | NE | NE | |
| 2 | Ferroalloys Production | | | | | | NE | NE | |
| 3 | Aluminum Production | | | | | | 47 | - | |
| 4 | Lead Production | | | | | | NE | NE | |
| 5 | Zinc Production | | | | | | NE | NE | |
| **D. Others** | | | | | | | | | |
| 1 | Lubricant Use | | | | | | | | |
| 2 | Paraffin Wax Use | | | | | | | | |
| 3 | Others – Natrium carbonate in pulp&paper industry | | | | | | | | |
| 4 | Others – Natrium carbonate in food&beverages industry | | | | | | | | |
| **3. Solvent and Other Prooduct Use** | | | | | | | | | |
| **4. Agriculture** | | | | | | | | | |
| **5. Land Use Change and Forestry** | | | | | | | | | |
| **6. Waste** | | | | | | | | | |
| A1 | Unmanaged Waste Disposal Sites | | | | | | | | |
| A2 | Unmanaged Dumpsite | | | | | | | | |
| B | Biological Treatment of Solid Waste | | | | | | | | |
| C | Open Burning Waste | | | | | | | | |
| D1 | Domestic Wastewater Treatment and Discharge | | | | | | | | |
| D2 | Industrial Wastewater Treatment and Discharge | | | | | | | | |
| E | Untreated, estimated using SWDS unmanaged shallow | | | | | | | | |
| **7. Others** | | | | | | | | | |

## 2.4. Sectoral Emissions

This sub-chapter presents a summary of Indonesia National Greenhouse Gas (GHG) Inventory in 2012 and the trends between 2000 and 2012. The national GHG inventory includes a breakdown of the country's anthropogenic emissions by sources and removals by sinks, which was developed using IPCC-2006 Guidelines for National GHG Inventories. It covers the following sectors: (a) Energy, (b) Industrial Process and Product Use (IPPU), (c) Agriculture, Forestry and Land Use (AFOLU); and (d) Waste (see Figure 2.5).

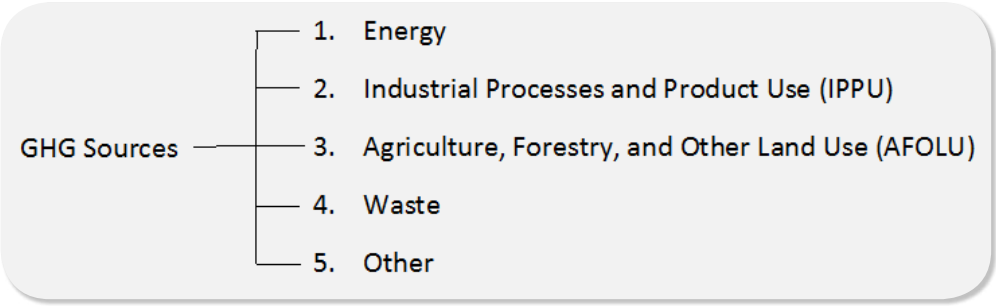
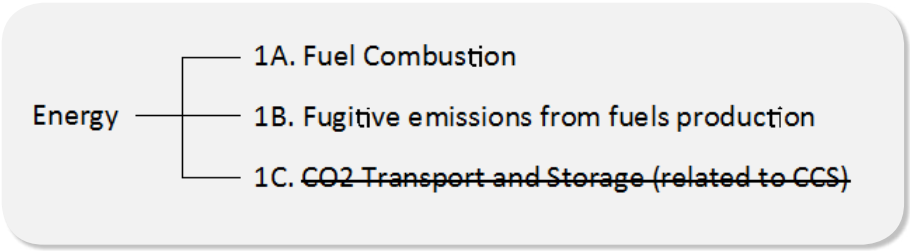



**Figure 2.5.** Main Sources of GHG Emissions [IPCC-2006 GLs)

### 2.4.1. Energy

#### a. Source Category of GHG Emissions from Energy Sector

Under the IPCC-2006 Guidelines, the sources of these emissions were classified into three categories, i.e. (a) fuel combustion, (b) fugitive emissions from fuels productions, and (c) activities of transporting, injecting, and storage of $CO_2$ (related to CCS or carbon capture storage). Since CCS has not been implemented in Indonesia, this report will only cover the first two sources. The coverage of GHG emissions sources from energy sector is presented in Figures 2.6.

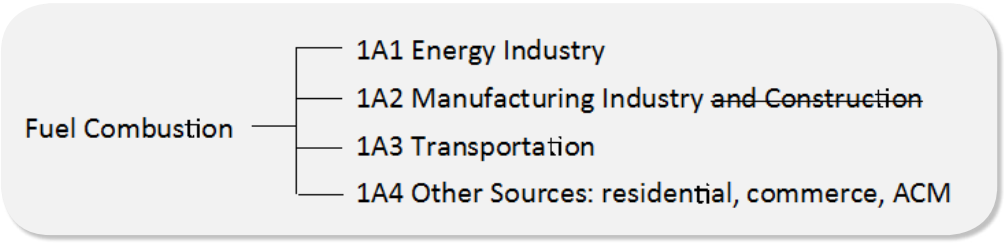



Notes: Strikethrough means not occurred (NO)

**Figure 2.6.** The Coverage of GHG Emissions Sources from Energy Sector

## Fuel Combustions

GHG emissions from fuel combustion (Figure 2.7) would include those emitted by energy industries (producers), manufacturing industries (not including fuel combustion emissions in construction activities), transportations, and other sources such as households, commercials, and ACM (Agricultures, Construction, and Mining). Fuel combustions in construction sub-sector are covered in ACM sub-sector (1A4 Other Sources).

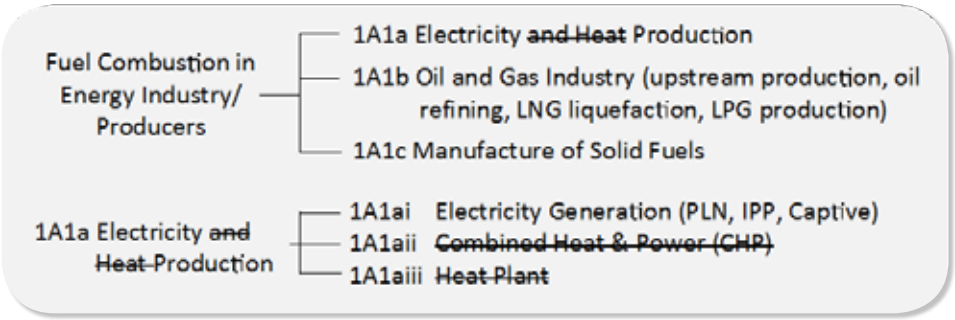



Notes: Strikethrough (construction) means including elsewhere (IE) in 1A4 ACM

**Figure 2.7.** Breakdown of Source Category of GHG Emissions from Fuel Combustions

- **Fuel Combustions in Energy Industries**

GHG emissions from this category include emissions during fuel combustions in electricity and heat productions, petroleum industries, and manufacturing of solid fuels (Figure 2.8). The electricity production includes electricity generated by state utility (PLN), independent power producers (IPP), and captive power from private power utility (PPU). The GHG emissions from the combined heat and power (CHP) and heat production, often occurring in industry were covered in GHG emissions from fuel combustions in manufacturing industries. The petroleum industry includes up stream oil and gas, oil refining, LNG liquefaction, and LPG production.

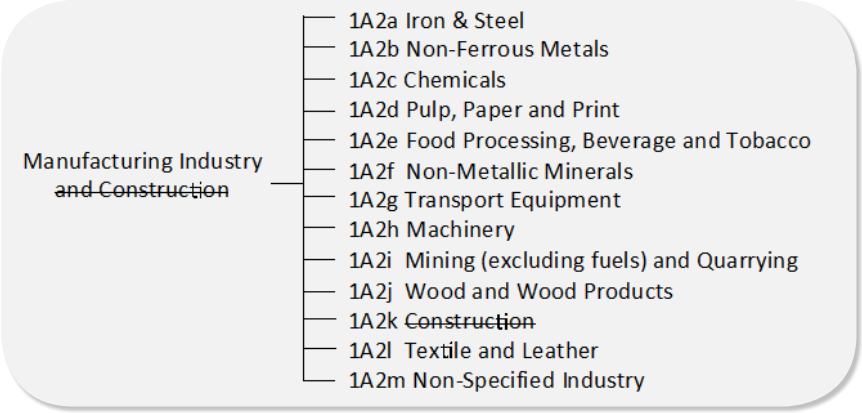



Notes: Strikethrough means not estimated (NE)

**Figure 2.8.** Coverage of GHG Emissions Sources from Fuel Combustion in Energy Industries

- **Fuel Combustions in Manufacturing Industries**

The manufacturing industries include all types of industries known to use fuel combustions as their energy sources (Figure 2.9). Practically, almost all industries fall within this category. In Indonesia, data onfuel consumption in these industries were collected from fuel sales data to these industries, which were aggregated. The GHG emissions from fuel combustions in manufacturing industries were calculated from this aggregated fuel consumption data. It should be noted that the GHG emissions from fuel combustions in non-fuel mining and quarry is included in the manufacturing industries category. However, GHG from fuel combustions in fuel mining activities is covered in ACM that will be discussed later.



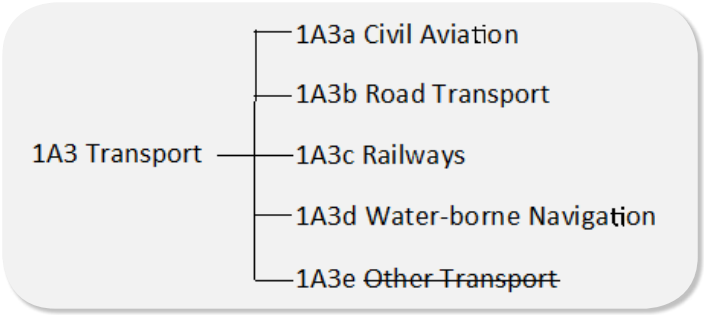

Notes: Strikethrough means IE (included in ACM sub-sector)

**Figure 2.9.** Coverage of GHG Emissions Sources from Fuel Combustions in Manufacturing Industries

- **Fuel Combustions in Transportation**

Under the IPCC 2006 GL, GHG emissions from transportation consisted of emissions during fuel combustions in civil aviation, road transportation, railways, water-borne navigation, and other transportation (pipe-line and off-road; Figure 2.10). The GHG emissions inventory of energy sector reported in the first BUR was estimated using aggregate fuel consumptions data. For transportation sector, the consumption data were grouped according to the type of fuels instead of the type of utilization. However, since a particular fuel is used for specific purpose, the groupings of GHG emissions couldbe used to estimate the type of fuels. For example, avgas (aviation gasoline for aircraft propeller) and avtur (fuels for jet aircraft) are only used in civil aviation. Therefore, GHG emissions from civil aviation can be estimated using avgas and avtur consumption data.

Further distinction between domestic and international aviation (as requested by IPCC 2006 breakdown) could not be made since the consumption data were aggregated from both domestic and international. All types of motor gasoline (RON88, RON92, RON95, Bio-RON88, and Bio-RON 92) were used only for road transport (cars and motor cycles). For multi user fuels, such as gas oil or diesel oil, the estimation of GHG emissions cannot be disaggregated base on the type of transportation (roads, railways, or water borne navigations) because the diesel fuel consumption data is aggregated for all types of transportation that used diesel. The diesel fuels include diesel 51 (diesel oil with cetane number 51), ADO/HSD (automotive diesel oil or high-speed diesel), IDO (industrial diesel oil), marine diesel oil, and Bio-solar (bio-diesel mix with diesel oil). Transportation of materials through pipelines such as oil, gas and industrial materials transfer within industries, are included in the corresponding industries.




Notes: Strikethrough means IE (embedded in transport sector and corresponding industries-for pipelines transportation

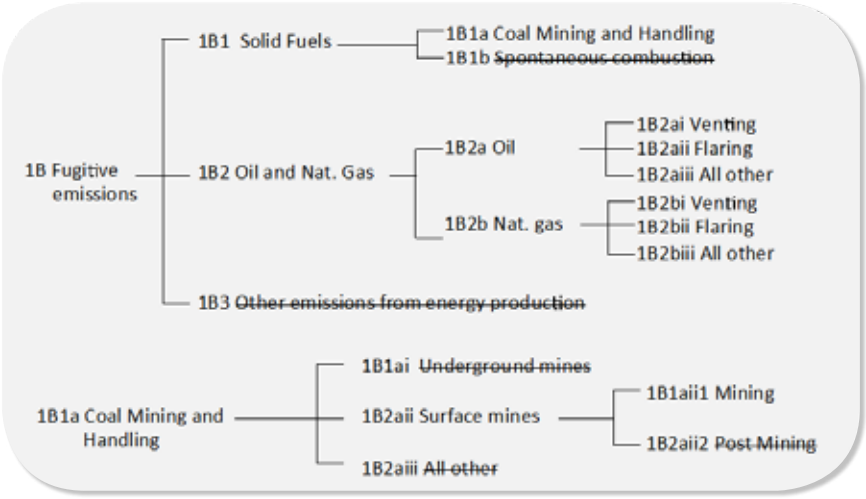
**Figure 2.10.** Coverage of GHG Emissions Sources from Fuel Combustions in Transportation

- **Fuel Combustions in Other Sectors**

GHG emissions from this category included emissions during fuel combustions in residential, commercials, and ACM (Agriculture, Construction, and Mining). GHG emissions from residential as well as from commercial are generated from combustions of LPG, pipe gas, and kerosene. GHG emissions from ACM cannot be disaggregated according to those sub-sectors, i.e. agriculture (including fisheries), construction, and mining but can be disaggregated according to type of fuels, i.e. motor gasoline, ADO, IDO, kerosene, and fuel oil (FO). Motor gasoline, ADO, and kerosene are used in motorized equipment for agriculture activities including fisheries. FO is used in fisheries. ADO and IDO are used in construction and mining sub-sectors.

- **Fugitive Emissions from Fuel Productions**

Fugitive emissions from fuel productions only included $CH_4$ gas released from coal mining and GHG emissions released from oil and gas production facilities (up-stream), refining and processing, and distributions (Figure 2.11). All Indonesian coal mining are either surface or open mining, therefore fugitive emissions from coal mining only limited during mining activities.




Notes: Strikethrough means NO (not occurred)

**Figure 2.11.** Coverage of Fugitive Emissions from Fuel Productions

## b. Type of Gases

Under IPCC-2006 GLs, the types of GHG emissions from energy sector comprised of $CO_2$, $CH_4$ and $N_2O$.

## c. Methodology

GHG emissions level presented in the GHG emissions inventory of energy sectors estimated using Tier 1 method of IPCC 2006 GLs with default value emission factor and activity data in energy unit (boe, barrel oil equivalent) collected from Energy Balance Table in Handbook of Energy and Economic Statistics of Indonesia, published by PUSDATIN MEMR. Recently, the Ministry of Energy and Mineral Resources (MEMR) has prepared Indonesian fuel characteristics, particularly the heating values. These characteristics could not be used in the GHG inventory inthe first BUR because they have not been officially approved by

MEMR. Therefore, the GHG inventory team of MEMR decided not to use the results of fuel characterization but to use default value of IPCC2006 GLs. Results of fuel characterization will be used in the next 2nd BUR and 3rd NATCOM.

As guided by the IPCC-2006 GLs, the GHG emissions is estimated using both approaches (sectoral and reference). The two approaches often showed different results because the reference approach is a top-down approach calculated using country's aggregate data of national primary energy supply while sectoral approach is a bottom-up approach calculated using final energy demand data, energy transformation data, and fugitives related data. The discrepancy of GHG emissions level between the two approaches is usually not more than 5%. The discrepancy is most likely due to the GHG from fugitives and stock change at consumers.

## d. Time Frame

GHG inventory reported in this first BUR covered GHG emissions generated from the year 2000 until 2012. The GHG emissions inventory for 2000 – 2005 were taken from the SNC document with some revisions, i.e. the refinery fuel combustions data has been corrected using revised figures. The GHG emissions inventory for 2006 – 2012 is current.

## e. Data Sources

All data and information related to GHG emissions inventory of energy sector were collected from single publication source, i.e. Energy Balance Table (2000 – 20012) available in the Handbook of Energy and Economic Statistics of Indonesia 2006 – 2014 published by PUSDATIN MEMR.

## f. GHG Emissions Estimates

### Reference versus Sectoral Approaches for Estimating the $CO_2$ Emissions Level

As expected, the estimate of GHG emissions showed that $CO_2$ estimation using sectoral approach was slightly higher than estimation using reference approach due to fugitive emissions (Figure 2.12). This discrepancy of GHG emissions level (2000-2012) estimated by both approaches is about 1.3% to 10.7%. Detail results of the GHG estimates using both approaches is given in Table 2.6.

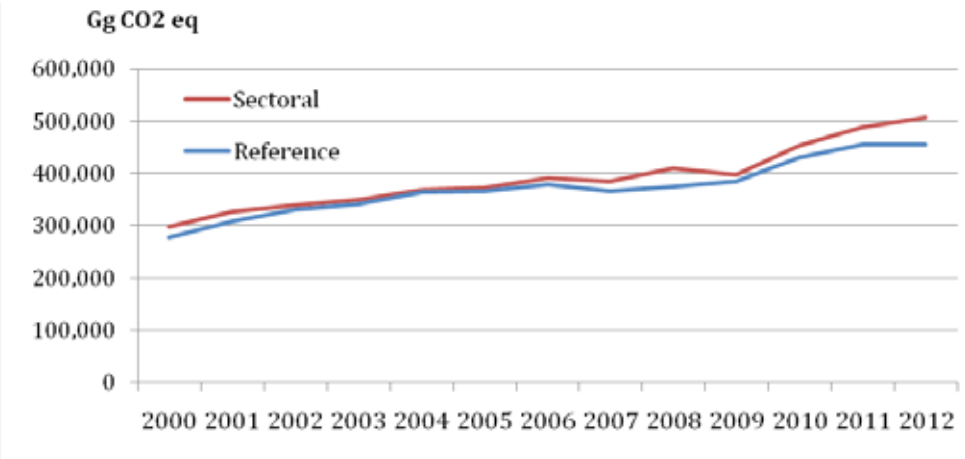



**Figure 2.12.** $CO_2$ Emissions Level of Energy Sector using Reference and Sectoral Approaches

Distribution of GHG emissions based on the type of fuels is shown in Figure 2.13 while detail results of GHG estimates of reference approaches is presented in Appendix A1. Figure 2.13 indicates significant changes in the distribution. During 2000-2005, large fractions of the GHG emissions came from liquid fuels combustions. Beginning of 2010, fraction of GHG emissions from solid fuels began to increase at the expense of GHG emissions from liquid fuels. This GHG emissions development trend correlated with the pattern of fuel supply in the country.

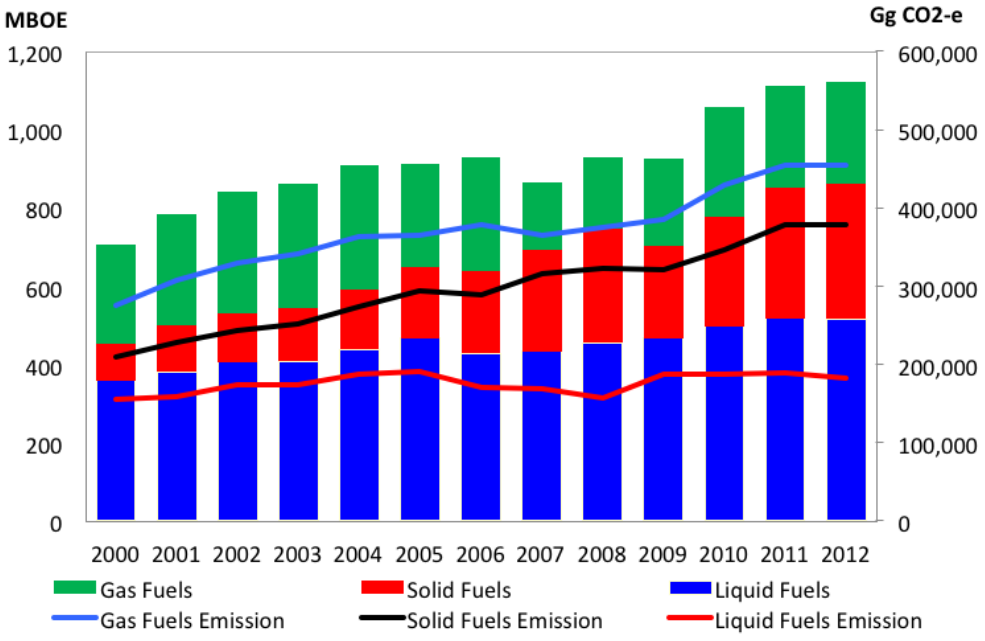



**Figure 2.13.** GHG Emissions Level of Energy Sector by Fuel Type, 2000-2012

Table 2-5. GHG Emissions Estimates of Energy Sector using Reference and Sectoral Approach (Gg $CO_2$-e)

| Source of GHG Emissions | Emission (Gg $CO_2$e) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
| **By Type of Fuel** | | | | | | | | | | | | | |
| 1. Liquid Fuels | 155,515 | 159,934 | 174,080 | 173,785 | 188,172 | 191,501 | 170,507 | 170,041 | 158,206 | 188,034 | 187,820 | 189,793 | 183,282 |
| 2. Solid Fuels | 52,998 | 67,474 | 69,393 | 77,206 | 85,518 | 101,838 | 117,410 | 145,686 | 163,786 | 133,421 | 158,793 | 188,555 | 194,682 |
| 3. Gas Fuels | 67,748 | 79,664 | 86,497 | 89,883 | 89,971 | 72,003 | 90,821 | 49,182 | 52,524 | 63,433 | 82,855 | 76,427 | 76,019 |
| Total by type of fuel | 276,262 | 307,071 | 329,971 | 340,874 | 363,661 | 365,341 | 378,738 | 364,910 | 374,516 | 384,889 | 429,467 | 454,775 | 453,983 |
| **By Sector/Sorces** | | | | | | | | | | | | | |
| 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 |
| 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 |
| 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 |
| 1.A.1.c Coal Processing | - | - | - | - | - | - | 115 | 119 | 103 | 146 | 192 | 44 | 86 |
| 1.A.2 Manufacturer | 72,300 | 77,379 | 77,393 | 74,019 | 88,365 | 94,005 | 108,118 | 111,441 | 134,824 | 99,255 | 132,306 | 133,226 | 123,738 |
| 1.A.3 Transportation | 58,916 | 62,158 | 64,636 | 67,601 | 72,841 | 74,947 | 73,120 | 76,219 | 81,367 | 96,352 | 108,745 | 117,518 | 131,458 |
| 1.A.4.a Commercial | 3,489 | 3,483 | 3,572 | 3,632 | 3,819 | 3,271 | 3,979 | 3,946 | 3,732 | 3,668 | 3,798 | 3,438 | 3,541 |
| 1.A.4.b Residential | 33,167 | 34,381 | 35,836 | 36,730 | 36,930 | 36,449 | 34,340 | 34,699 | 32,397 | 29,379 | 28,299 | 27,842 | 28,865 |
| 1.A.5 Non-Specified | 11,421 | 11,742 | 11,996 | 12,120 | 12,286 | 12,276 | 11,372 | 10,828 | 10,787 | 11,423 | 12,496 | 10,743 | 11,301 |
| 1.A Fuel Combustion | 269,009 | 299,907 | 313,227 | 324,291 | 343,759 | 348,764 | 368,023 | 361,158 | 387,591 | 376,676 | 430,171 | 466,571 | 486,534 |
| **1.B Fugitives** | **29,404** | **28,031** | **27,096** | **25,753** | **24,749** | **24,127** | **23,401** | **25,435** | **22,145** | **21,963** | **23,007** | **22,365** | **21,586** |
| 1.B.1 Fugitives Solid Fuels Mining | 374 | 449 | 501 | 554 | 642 | 738 | 940 | 1,054 | 1,110 | 1,242 | 1,334 | 1,713 | 1,871 |
| 1.B.2 Fugitives Oil/Gas | 29,030 | 27,582 | 26,595 | 25,199 | 24,107 | 23,389 | 22,461 | 24,381 | 21,034 | 20,721 | 21,673 | 20,652 | 19,714 |
| **Total Sectoral** | **298,412** | **327,938** | **340,323** | **350,044** | **368,508** | **372,891** | **391,424** | **386,593** | **409,736** | **398,639** | **453,178** | **488,936** | **508,120** |
| **Discrepancy of Reference to Sectoral Approach (%)** | **7.4%** | **6.4%** | **3.0%** | **2.6%** | **1.3%** | **2.0%** | **3.2%** | **5.6%** | **8.6%** | **3.4%** | **5.2%** | **7.0%** | **10.7%** |

## Sectoral Approach: GHG Emissions Level by Sector

The GHG emissions released from energy sector in Indonesia is dominated by $CO_2$ (Figure 2.14). Detail data of this emission type is presented in Appendix A2. This emission level correlates with the sources of emissions, which is dominated by GHG emissions from fuel combustion (Figure 2.15). By sector, the GHG emissions of energy sector can be broken down into energy producers, manufacture, and transport (Figure 2.16). The sectoral GHG emissions from energy activity in 2012 are summarized in Table 2.8, while data detailing sectoral GHG emissions is presented in Appendix A3.

The above GHG emissions level was determined by the development pattern of final energy demand (see Figures 1.5 and 1.6). As shown in Figure 1.5, the final energy demand was dominated by industry, transport, and residential sectors (see Appendix A4 for detail). The energy demand from residential sector included electricity and biomass energy, therefore the GHG emissions from residential is not significant. The GHG emissions associated with electricity consumption in residential is given in energy producers/industries (electricity generation). Biomass consumptions in residential and industrial sectors reported in this first BUR were obtained from $CO_2$ neutral biomass waste.

Referring to Figure 1.6, some fractions of final energy demand is in the form of electricity. In the past five years, the energy supply mix of power sector was dominated by coal, followed by natural gas and oil (see Figure 1.7). This supply mix development has significantly increased GHG emissions from energy producers/industries as shown in Figure 2.16. In terms of primary energy, Indonesia energy supply has been dominated by fossil fuels, i.e. oil, coal and natural gas (see Figure 1.7 and Appendix A5). Although various renewable energy have been growing significantly during the past five years, the current shares of these renewable energy are still very small due to the low starting point.

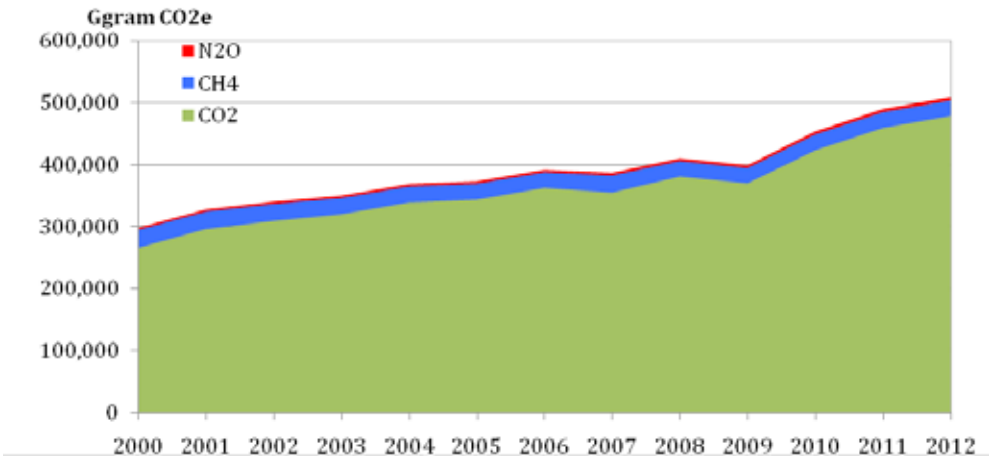



**Figure 2.14.** GHG Emissions Level of Energy Sector by Type of GHG Emissions, 2000 – 2012

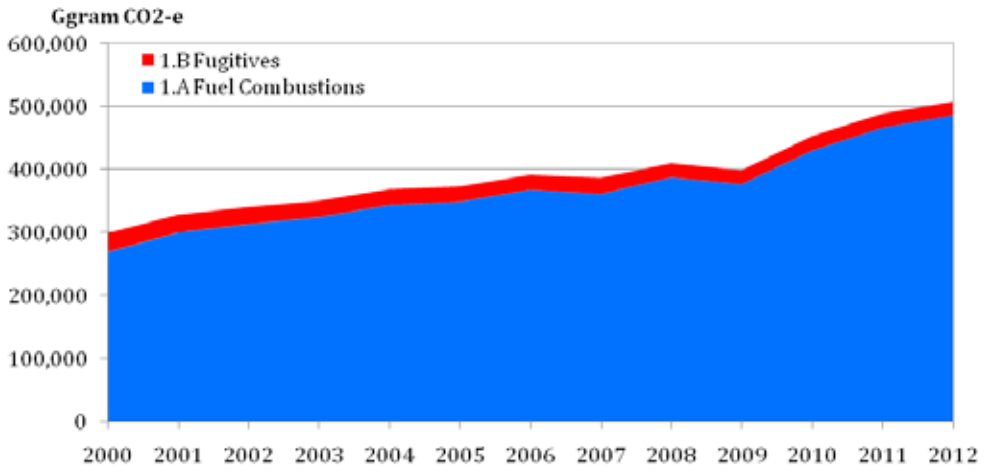



**Figure 2.15.** GHG Emissions Level of Energy Sector by Sources, 2000 – 2012

GHG emissions from this sector in 2012 was 508,120 Gg CO2e (Table 2.7). About 96.69% were derived from fuel combustion and the remainings from fugitive emission. Key category analysis showed that the main contributors of the emissions from fuel combustion were dominated by electricity and heat production activities followed by transportation, manufacturing industries and construction, residential, fugitive from oil/natural gas, and own energy use in petroleum refining (Table 2.7). The contribution of GHG emissions from fuel combustions in other sectors (ACM and commercial), fugitive from solid fuel mining, and own energy use for coal processing were not significant.

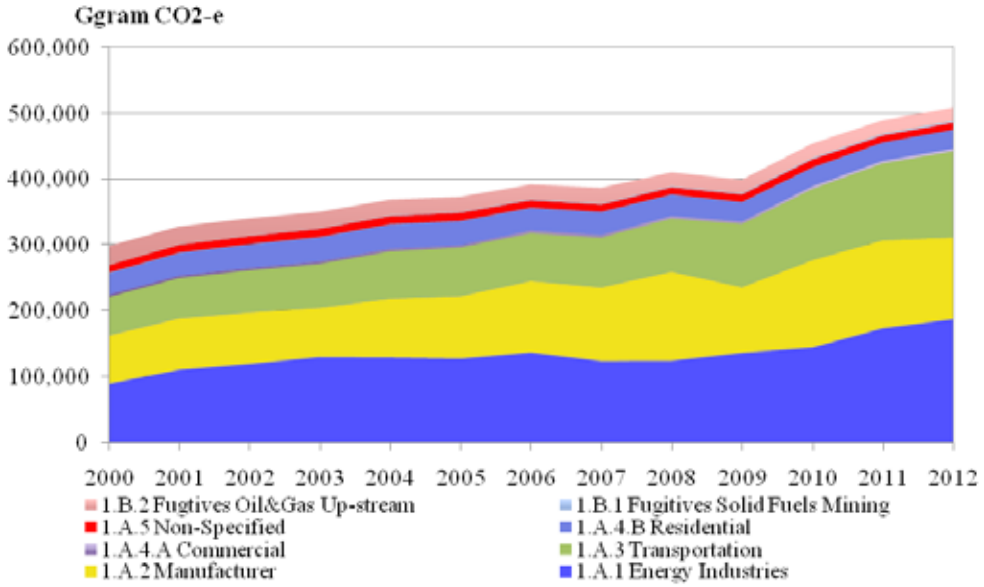



Figure 2.16. GHG Emissions Level of Energy Sector by Sub-sector Activity, 2000 – 2012

Table 2-6. GHG Emissions from Energy Activity in 2012

| Code | Categories | 2012 | | | |
|---|---|---|---|---|---|
| | | CO2 (Gg CO2) | $CH_4$ (Gg $CH_4$) | $N_2O$ (Gg $N_2O$) | Total $CO_2e$ |
| | **Sectoral Approach** | | | | |
| **Energy** | **Energy** | 477,805 | 1,199 | 17 | **508,120** |
| 1.A | **Fuel Combustion** | 471,326 | 481 | 16 | **486,534** |
| 1.A.1 | Energy Industries | 186,881 | 3 | 2 | **187,631** |
| 1.A.1.a | Main activity electricity and heat production | 174,135 | 3 | 2 | **174,873** |
| 1.A.1.b | Petroleum refining | 12,660 | 0 | 0 | **12,672** |
| 1.A.1.c | Coal Processing | 85 | 0 | 0 | **86** |
| 1.A.2 | **Manufacturing Industries and Construction** | 122,683 | 16 | 2 | **123,738** |
| 1.A.3 | **Transport** | 128,807 | 35 | 6 | **131,458** |
| 1.A.4 | **Other Sectors** | 32,955 | 426 | 6 | **43,707** |
| 1.A.4.a | Commercial/Institutional | 3,465 | 3 | 0 | **3,541** |
| 1.A.4.b | Residential | 18,249 | 422 | 6 | **28,865** |
| 1.A.5 | Other | 11,241 | 2 | 0 | **11,301** |
| 1.B | **Fugitive emissions** | 6,478 | 719 | 0 | **21,586** |
| 1.B.1 | **Solid Fuels** | - | 89 | - | **1,871** |
| 1.B.1.a | Underground coal mining | | | | **-** |
| 1.B.1.b | Surface coal mining | - | 89 | | **1,871** |
| 1.B.2 | **Oil and Natural Gas** | 6,478 | 630 | 0 | **19,714** |
| 1.B.2.a | Oil | 2,284 | 556 | 0 | **13,970** |
| 1.B.2.b | Natural gas | 4,194 | 74 | 0 | **5,744** |

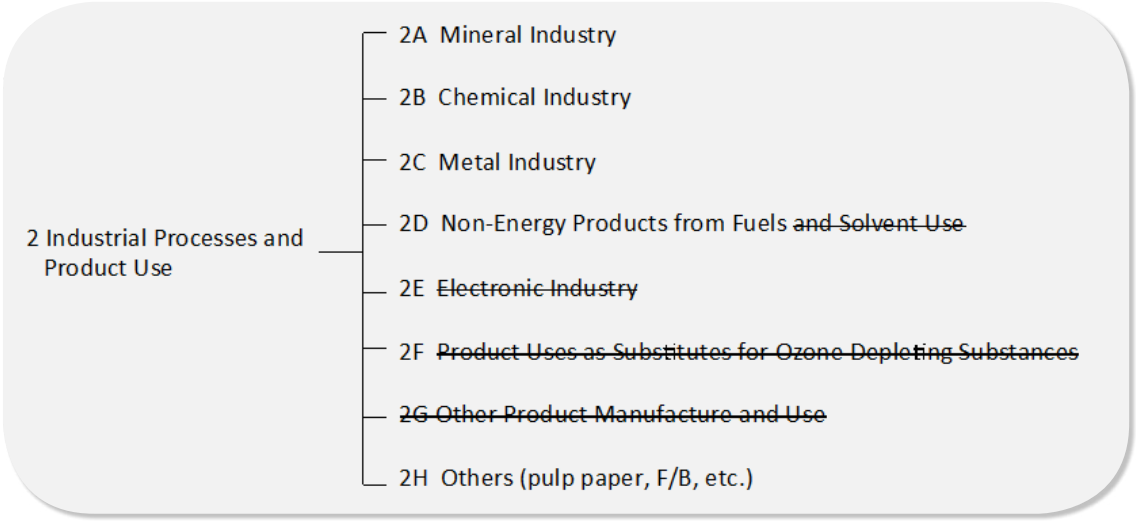
Table 2-7.Key Category Analysis of the GHG Emissions from Energy Activity, 2012

| Code | Category | Total GHG Emissions | Level/Rank | Cumulative |
|---|---|---|---|---|
| 1.A.1.a | Main activity electricity and heat production | 174,873 | 34.42% | 34.42% |
| 1.A.3 | Transport | 131,458 | 25.87% | 60.29% |
| 1.A.2 | Manufacturing industries and construction | 123,738 | 24.35% | 84.64% |
| 1.A.4.b | Residential | 28,865 | 5.68% | 90.32% |
| 1.B.2 | Fugitive from Oil/Natural Gas | 19,714 | 3.88% | 94.20% |
| 1.A.1.b | Petroleum refining | 12,672 | 2.49% | 96.69% |
| 1.A.5 | Other (ACM) | 11,301 | 2.22% | 98.92% |
| 1.A.4.a | Commercial/Institutional | 3,541 | 0.70% | 99.61% |
| 1.B.1 | Fugitive from solid fuels | 1,871 | 0.37% | 99.98% |
| 1.A.1.c | Coal processing | 86 | 0.02% | 100.00% |
| Total | | 508,120 | | |

## 2.4.2. Industrial Processes and Product Use (IPPU)

### a. Source Category of GHG Emissions from IPPU

The sources of GHG emissions from industrial sector included GHG emissions from industrial process and product use (IPPU) activity, that classified into 8 main categories (Figure 2.17) namely: (a) mineral industries, (b) chemical industries, (c) metal industries, (d) non-energy products from fuels and solvent use, (e) electronic industries, (f) product uses as substitutes for Ozone Depleting Subtances (ODS), (g) production of other products and utilizations, (h) other industries.




Notes: Strikethrough means NE (Not Estimated)

**Figure 2.17.** The coverage of IPPU emissions sources

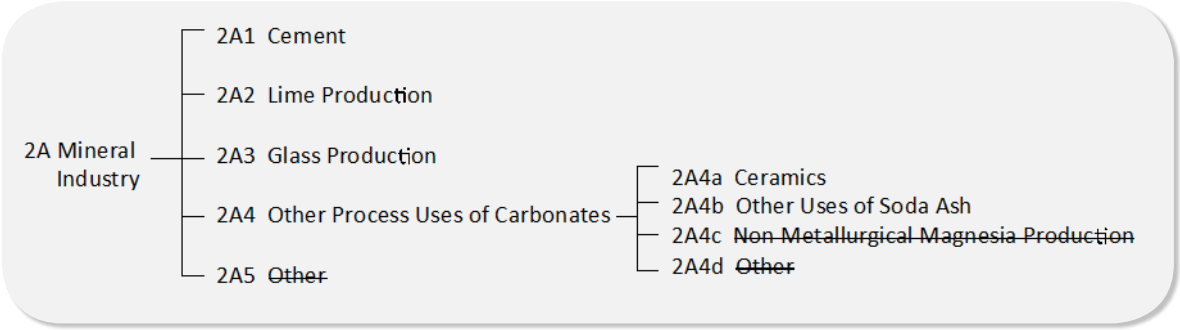
IPPU emissions reported in the first BUR comprised of emissions related to industrial process during conversion processes (usually involved chemical processes) and selected product manufacture and use. All industries (except electronic industry) in Indonesia that fall within the IPPU category were covered in this report. However, due to limited data, GHG emissions related to product manufacture and use in this report will only report the non-energy product use, i.e. lubricants and paraffin wax. While emissions related to the product uses as substitutes for ODS have not been reported.

Industrial process emissions from electronics industries are currently difficult to estimate because data cannot be disaggregated between those emitting GHG emissions from their production processes and those non GHG-emitting electronic industries (mostly involves simple electronic assembling activities). GHG emissions related to the Ozone Depleting

Substance (ODS) substitute products are currently difficult to estimate because ODS stock data is not available; although import ODS data can be traced, however the fate of those imported ODS is not known. Currently, the government is recording data of the imports of (ODS) substitute products. This data can be used as the basis for estimating the GHG emissions reduction but cannot be used to determine GHG inventory.

## Mineral Industries

IPPU emissions from mineral industries include those emissions related to chemical processes activities in cement (clinker production), lime, glass production activities and industries that use carbonates in their processes. Figure 2.18 presents the coverage of GHG emissions sources from mineral industries that are reported in this First BUR document. It shows that the coverage does not include non-metallurgical magnesia and 'other' industrial production activities, which are not available in Indonesia.

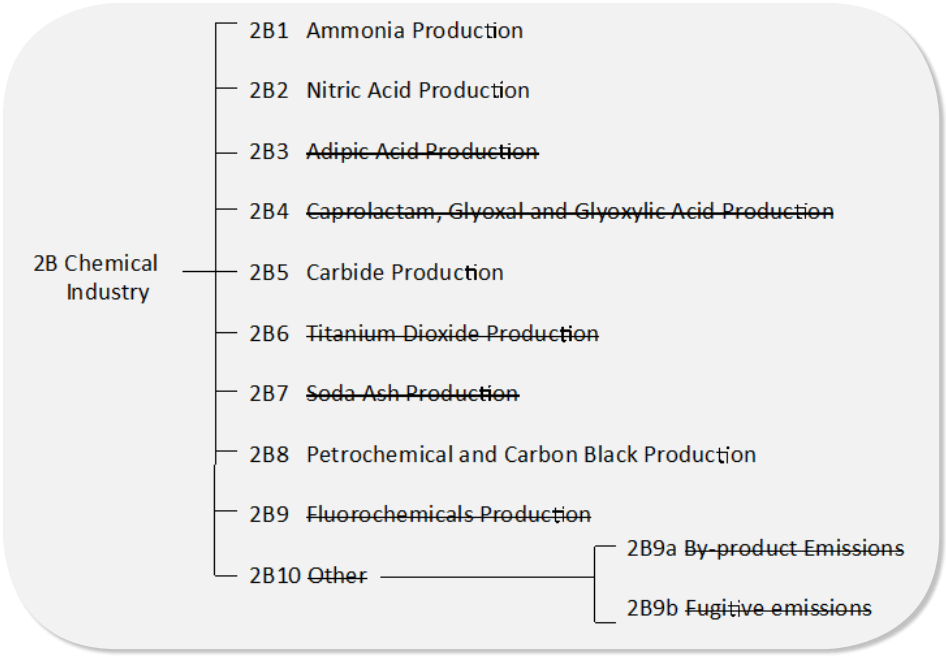



Notes: Strikethrough means NO (not occurred)

**Figure 2.18** Coverage of IPPU Emission Sources in Mineral Industries

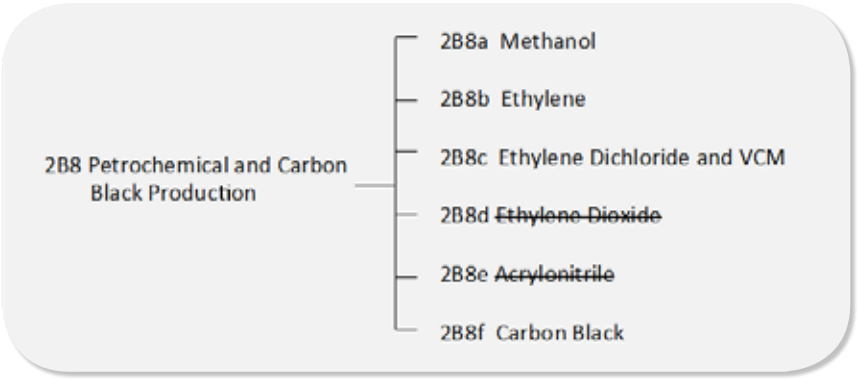
## Chemical Industries

GHG emissions from chemical industries include those emissions related to chemical processes activities in ammonia, nitric acid, carbide, petrochemical and carbon black productions. All industries in Indonesia that fall within those categories are covered in this report. However, for emissions related to adipic acid, caprolactam, glyoxal, glyoxylic acid, $TiO_2$, soda ash, Fluoro-chemicals, and 'other' chemical industries are excluded since they are not available in Indonesia (Figure 2.19 and 2.20).




Notes: Strikethrough means NE (Not Estimated)

**Figure 2.19.** Coverage of GHG Emissions Sources from IPPU in Chemical Industries

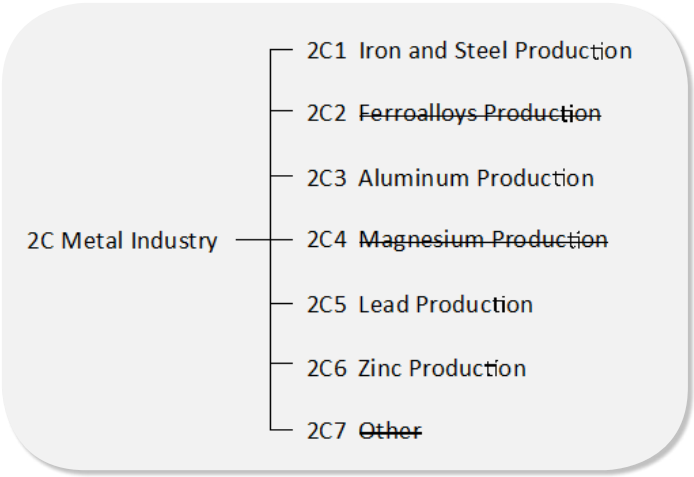



Notes: Strikethrough means NE (Not Estimated)

**Figure 2.20.** Coverage of IPPU Emissions in Petrochemical and Carbon Black industries

## Metal Industries

GHG emissions from metal industries include those emissions related to chemical processes activities in iron and steel, aluminium, lead, and zinc productions (see Figure 2.21). Some of the industries under this category are not included since they are not available in Indonesia, i.e. ferro alloys, magnesium, and other production industries.

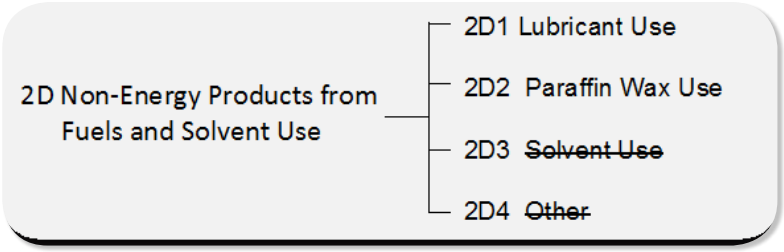



Notes: Strikethrough means NE (Not Estimated)

**Figure 2.21.** Coverage of the Sources of IPPU Emissions in Metal Industries

## Non-Energy Products from Fuels and Solvent Use

The products covered here comprise of lubricants, paraffin waxes, and solvents. Figure 2.22 presents the coverage of GHG emissions sources from products uses that are reported in this document.

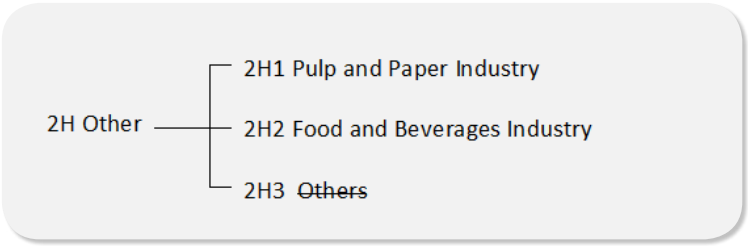



Notes: Strikethrough means NE (Not Estimated)

**Figure 2.22.** Coverage of IPPU GHG Emissions of Non-fuel Refinery Product and Solvents

## Other Industries

IPPU emissions from other industries include GHG emissions related to carbonate utilization during production activities in pulp/paper and food/beverage industries. In pulp/paper industries, the carbonate used as chemical make-up during recausticizing process. Although the amount of carbonate form is not significant, yet the process will release GHG emissions.




Notes: Strikethrough means NE (Not Estimated)

**Figure 2.23.** Coverage of GHG emissionssources from other industries

## b. Type of Gases

Type of GHG from IPPU consists of $CO_2$, $CH_4$, $N_2O$, HFC, per-fluorocarbon (PFCs), and $SF_6$. In industrial sector, $CO_2$is usually released from fuel combustion activities. However, in some industries, these emissions were generated during the processes and utilization of products. Referring to IPCC-2006 GL, GHG emissions released from fossil fuel combustions in industries are not reported under IPPU category but under energy category (see Sub-chapter 2.4.1). Therefore, this sub-chapter only discusses GHG emissions from IPPU category.

## c. Methodology

Almost all GHG emissions levels in GHG inventory of IPPU sector were estimated using Tier 1 methods of IPCC-2006 with default value emission factor except for cement (clinker production) and aluminium industries (after June 2010). For cement industry, the IPPU GHG emissions was estimated using plant level activity data (measured in all cement industries operating in Indonesia) and local EF developed by cement industries supported by AFD (Agence Francaise de Development) study in 2010. It should be noted that local EF of cement industry in Indonesia was developed within the framework of the development of cement industry roadmap to reduce GHG emissions.

**d. In aluminium industry,** IPPU GHG emissions were calculated based on plant level activity data measured by PT. Inalum. EF used for calculating the IPPU GHG emissions from this industry is the default value of IPCC-2006 (for estimating GHG emissions of 2000 – 2010) and local EF (after 2010), since in 2010 this industry started to implement mitigation actions for reducing GHG emissions under CDM project. This local EF is already approved by CDM board as reported in the project monitoring report of GHG emissions (CDM MR PFC Emission Reduction at PT. Inalum Kuala Tanjung, Indonesia, February 2011). Since PT. Inalum is the only aluminium industry operating in Indonesia. Therefore, the IPPU emissions calculated/measured will represent the national IPPU emissions from aluminium industry in Indonesia.

## e. Time Frame

The GHG inventory reported in this First BUR covers GHG emissions generated in the year of 2000 until 2012. The GHG emissions inventory for 2000 – 2005 was taken from the SNC document with some revisions, i.e. data has been improved using new figures of activity data as well as emission factors (particularly cement industry). The GHG emissions inventory for 2006 – 2012 is current.

## f. Data Sources

Data and information related to GHG emissions inventory of IPPU category (Table 2.8) and the list of AD and EF of each IPPU category (Table 2.9) were collected from several publications:

- Data and information related to activity data were collected from Statistics of Large and Medium Industry published by Statistics Indonesia (2000 – 2014), data from Association (Indonesian Cement Association or ASI), and MoI (Centre for Assessment of Green Industry and Environment or PPIHLH). It should be noted that all of those industrial activity data have been consolidated and verified through several meetings and discussions coordinated by Ministry of Environment and supported by UNDP (2013-2014).
- Data and information related to emission factors and other relevant parameters were collected from IPCC-2006 GLs, PPIHLH-MoI.

Table 2-8. Data Sources and Documents used by Each Category of IPPU

| Code | Category | Data Sources |
|---|---|---|
| Mineral | | |
| 2A1 | Cement | ASI through PPIHLH MoI |
| 2A2 | Lime | Statistics of Large and Medium Industry BPS/ ISIC |
| 2A3 | Glass | |
| 2A4 | Other process using carbonate: | |
| 2A4a | Ceramic | Statistics of Large and Medium Industry BPS/ ISIC |
| 2A4b | Other use of soda ash | |
| Chemical | | |
| 2B1 | Ammonia | PPIHLH MoI |
| 2B2 | Nitric acid | |
| 2B5 | Carbide | Statistics of Large and Medium Industry BPS/ ISIC |
| 2B8 | Petrochemical and Carbon Black: | |
| 2B8a | Methanol | PPIHLH MoI |
| 2B8b | Ethylene | |
| 2B8c | Ethylene dichloride & VCM | |
| 2B8f | Carbon Black | Statistics of Large and Medium Industry BPS/ ISIC |

| Code | Category | Data Sources |
|---|---|---|
| Metal | | |
| 2C1 | Iron & steel | PPIHLH MoI |
| 2C3 | Aluminium | |
| 2C5 | Lead | Statistics of Large and Medium Industry BPS/ ISIC |
| 2C6 | Zinc | |
| Non-Energy Product & Solvent Use | | |
| 2D1 | Lubricants | Handbook of Energy and Economic Statistics of Indonesia Pusdatin – MEMR |
| 2D2 | Paraffin | |
| Others | | |
| 2H1 | Pulp & paper | Statistics of Large and Medium Industry BPS/ ISIC |
| 2H2 | Food & beverages | |

Table 2-9. List of Activity Data and Emission Factor used for Estimating GHG in IPPU

| IPCC Code &Category | Type of Data | | Year | Data Sources |
|---|---|---|---|---|
| **2A. Mineral Industry** | | | | |
| 2A1 Cement | AD | Total domestic production of clinker | 2000-2013 | ASI through PPIHLH MoI |
| | EF | EF: 0.52 t $CO_2$/t clinker | | IPCC default |
| 2A2 Lime | AD | Lime production | 2000-2012 | Statistics of Large and Medium Industry BPS/ ISIC |
| | EF | Default High Calcium Lime: 0.75 t $CO_2$/t Lime | | IPCC 2006 GLs |
| 2A3 Glass | AD | Carbonate used in glass production | 2000-2012 | |
| | EF | Limestone ($CaCO_3$): 0.23971 t $CO_2$/t Carbonate | | IPCC2006 GLs |
| | | Dolomite $CaMg(CO_3)_2$: 0.47732 t $CO_2$/t Carbonate | | |
| | | Sodium carbonate ($Na_2CO_3$): 0.41492t $CO_2$/t Carbonate | | |
| 2A4a Ceramics | AD | Carbonate used in ceramic production | 2000-2012 | Statistics of Large and Medium Industry BPS/ ISIC |
| | EF | Limestone ($CaCO_3$): 0.23971t$CO_2$/t Carbonate | | IPCC 2006 GLs |
| | | Dolomite $CaMg(CO_3)_2$: 0.47732 t$CO_2$/t Carbonate | | |
| | | Sodium carbonate ($Na_2CO_3$): 0.41492 t$CO_2$/t Carbonate | | |
| 2A4b Other utilization of $Na_2CO_3$ | AD | Carbonate consumption except for glass, ceramic, pulp/paper,F/B production | 2000-2012 | Statistics of Large and Medium Industry BPS/ ISIC |
| | EF | Limestone ($CaCO_3$): 0.23971t $CO_2$/t carbonate | | IPCC 2006 GLs |
| | | DolomiteCaMg$(CO_3)_2$: 0.47732 t $CO_2$/t carbonate | | |
| | | Sodium carbonate ($Na_2CO_3$): 0.41492 t $CO_2$/t carbonate | | |
| 2B. Chemical Industry | | | | |
| 2B1 Ammonia | AD | Real data of ammonia production in fertilizer production plants/facilities | 2000-2013 | PPIHLH MoI (data from 5 fertilizer plants, 2 other plants do not report data) |

| IPCC Code &Category | Type of Data | | Year | Data Sources |
|---|---|---|---|---|
| | EF | Conventional gas reforming: 1.694 t $CO_2$/t $NH_3$ | | IPCC 2006 GLs |
| 2B2 Nitric Acid | AD | Nitric acid productions | 2000-2013 | SNC document and PPIHLH MoI (PT. Pupuk Kujang and PT. Multi Nitrotama Kimia). |
| | EF | High pressure plants: 9 Kg $N_2O$/t product | | IPCC 2006 GLs |
| 2B5 Carbide | AD | Production data ofcalsium carbide ($CaC_2$) dan Silikon Carbide (SiC) | 2000-2011<br>2012-2013 | Statistics of Large & Medium Industry BPS/ ISIC (2000-2011)<br>PPIHLH MoI (2012-2013) |
| | EF | Calsium carbide: 1.09 t $CO_2$/t product<br>Silicon Carbide: 2.62 t $CO_2$/t product and 11.6 kg $CH_4$/ton product | | IPCC 2006 GLs |
| 2B8a Methanol | AD | Domestic production of methanol | 2000-2012 | PPIHLH MoI (PT. Kaltim Methanol Industri (Bontang) and /or Methanol Bunyu) |
| | EF | Lurgi conventional process:<br>0.39 t $CO_2$/t methanol<br>2.3 kg $CH_4$/t methanol | | IPCC 2006 GLS |
| 2B8b Ethylene | AD | Ethylene Production | 2000-2013 | PPIHLH Kemenperin (PT. Chandra Asri) |
| | EF | Naphtha:<br>1.73 ton $CO_2$/ton ethylene<br>3 kg $CH_4$/ ton ethylene | | IPCC 2006 GLs |
| 2B8c Ethylene Dichloride (EDC) and VCM | AD | EDC and VCM production | EDC: 2000-2005; 2007-2012<br>VCM: 2006-2012 | PPIHLH MoI |
| | EF | 0.196 t $CO_2$/t EDC<br>0.0226 kg $CH_4$/t EDC | | IPCC 2006 GLs |
| 2B8f C – Black | AD | Production data of Carbon Black | 2000-2012 | |
| | EF | Black Furnace Process: 2.62 t $CO_2$/t C-black<br>Thermal treatment: 0.06 kg $CH_4$/t C-black | | IPCC 2006 GLs |
| 2C. Metal Industry | | | | |
| 2C1 Iron&Steel | AD | DRI (Direct Reduction Iron), Sinter, BOF (Basic Oxygen Furnace), Pig Iron production | DRI: 2000-2013<br>Sinter: 2000-2012<br>Pig Iron: 2000-2013 | PPIHLH MoI<br>DRI: PT. Krakatau Steel<br>Sinter: 2000-2005 production; 2006-2012 (same as 2005)<br>Pig Iron:2000-2008 PT. KS; 2009-2013 PT. KS & PT. Indo-ferro (Pig Iron & Nickel Pig Iron)<br>BOF: PT. Krakatau Posco (start from 2014) |
| | EF | BOF: 1.46 t $CO_2$/t product<br>DRI: 0.7 t $CO_2$/t product<br>Pig Iron: 1.35 t $CO_2$/t product<br>Sinter: 0.2 t $CO_2$/t product | | IPCC 2006 GLs |
| 2C3Aluminum | AD | Aluminium production | 2000-2012 | PPIHLH MoI (PT. INALUM) |
| | EF | 2000-2009 → 1.122 t CO2-eq/t Al<br>2010-2012 → 0.216 t CO2-eq/t Al | | CDM document of PT. INALUM |
| 2C5 Lead | AD | Lead Production | 2000-2012<br>2013 | Statistics of Large and Medium Industry BPS/ ISIC PPIHLH (*Pusat Pengkajian Industri Hijau dan Lingkungan Hidup*) MoI |
| | EF | Default Emission Factor:<br>0.52 t $CO_2$/t production | | IPCC 2006 GLs |

| IPCC Code &Category | Type of Data | | Year | Data Sources |
|---|---|---|---|---|
| 2C6 Zinc | AD | Zinc production | 2000-2012 2013 | Statistics of Large and Medium Industry BPS/ ISIC PPIHLH MoI |
| | EF | 1.72 t $CO_2$/t production | | IPCC 2006 GLs |
| 2D Utilization of fossil carbon for non-energy use and solvents | | | | |
| 2D1 Utilization of Lube Oil | AD | Domestic Utilization of Lube Oil (Production – Export + Import) | 2000-2012 | Handbook of Energy, MEMR |
| | EF | Default: 0.2 | | IPCC 2006 GLs |
| 2D2: Utilization of Paraffin Wax | AD | Domestic Utilization of Paraffin Wax | 2000-2012 | Handbook of Energy, MEMR (other products) |
| | EF | Default: 0.2 | | IPCC 2006 GLs |
| 2H Others | | | | |
| 2H1Pulp &Paper | AD | Domestic consumption of $Na_2CO_3$(sodium carbonate) 3% ofpulpproduction | 2000-2012 | Statistics of Large and Medium Industry BPS/ ISIC |
| | EF | 0.41492 t $CO_2$/t carbonate | | IPCC 2006 GLs |
| 2H2 Food and Beverage | AD | Domestic consumptionof sodium carbonate ($Na_2CO_3$) | 2000-2012 | Statistics of Large and Medium Industry BPS/ ISIC |
| | EF | Sodium carbonate ($Na_2CO_3$): 0.41492 t $CO_2$/tonne carbonate | | IPCC 2006 GLs |

## g. GHG Emissions Estimates

Similar to energy sector, GHG emissions from IPPU was dominated by $CO_2$. Table 2.10 presents GHG emission level of various type of GHG from 2000-2012. The total GHG emissions during this period varied between years but tend to increase. In 2012 the total emission of IPPU, including $CF_4$ and $C_2F_6$ is 41,062 Gg $CO_2$-e.One can see from Table 2.10 that $CF_4$ and $C_2F_6$ emissions decrease significantly since 2011. This happened due to the application of new technology for CDM project in aluminum production.

Table 2-10. IPPU GHG Emissions Level by Type of Gas in Gg $CO_2$-e, 2000 – 2012

| GHGs | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $CO_2$ | 40,425 | 45,379 | 38,898 | 38,659 | 40,642 | 39,293 | 36,853 | 34,962 | 35,364 | 36,967 | 35,640 | 36,914 | 40,538 |
| $CH_4$ | 71 | 72 | 66 | 70 | 69 | 73 | 65 | 67 | 73 | 63 | 61 | 55 | 57 |
| $N_2O$ | 265 | 265 | 265 | 265 | 265 | 265 | 265 | 265 | 265 | 265 | 265 | 295 | 420 |
| $CF_4$ | 250 | 250 | 250 | 250 | 250 | 250 | 260 | 251 | 252 | 250 | 130 | 47 | 47 |
| $C_2F_6$ | 22 | 22 | 22 | 22 | 22 | 22 | 23 | 22 | 22 | 22 | 22 | 0 | 0 |
| Total | 41,033 | 45,987 | 39,501 | 39,266 | 41,248 | 39,903 | 37,445 | 35,567 | 35,977 | 37,568 | 36,118 | 37,311 | 41,062 |

Out of 20 IPPU emission sources, seven sources contributed almost 95% of the total IPPU emissions (Figure 2.24). This seven sources are cement productions (52%), ammonia production (17.5%), paraffin wax use (7.6%), iron and steel production (7.3%), other use of

carbonate and soda ash (5.0%), ethylene production (3.0%), and lime production (2.2%). The development of each type of GHG emission during 2000-2012 is shown in Figure 2.25 (see Appendix A6 for detail).

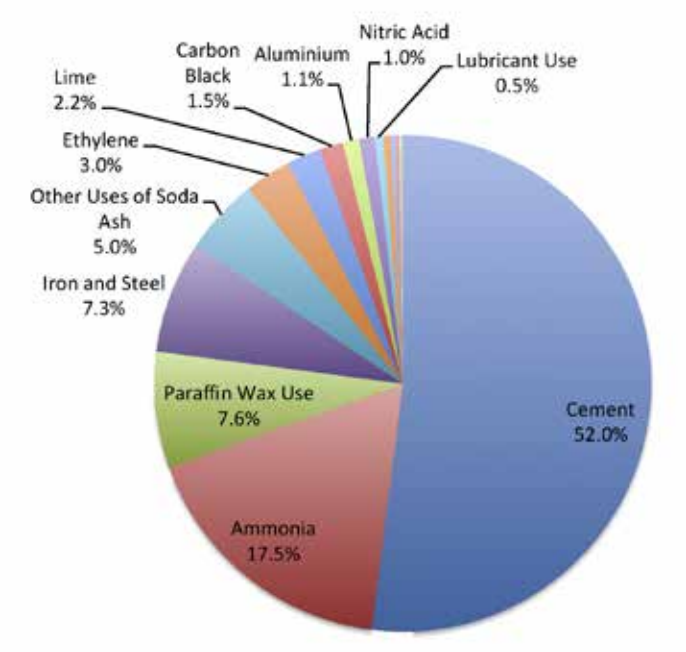



**Figure 2.24.** The Share of GHG Emissions in IPPU Sector in 2012

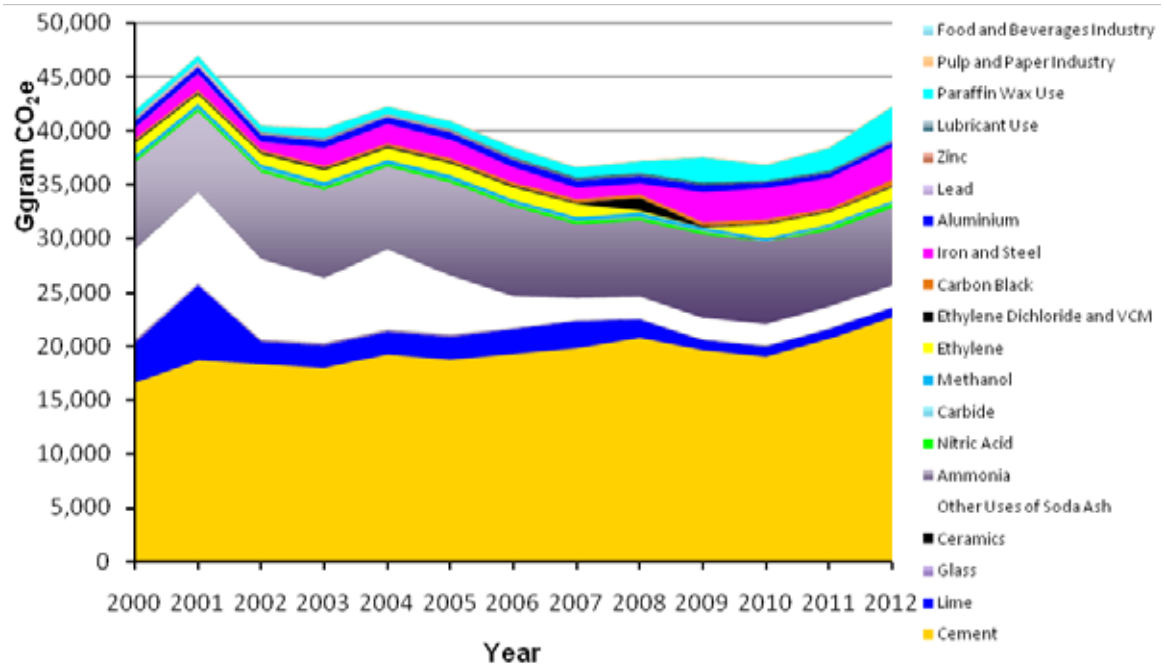



**Figure 2.25.** GHG Emissions Level from Industrial Processes and Product Use, 2000 – 2012

Data on the production development of each industrial sub-sector during 2000 – 2012 and the corresponding IPPU emissions are given in Figures 2.26 to 2.30. These figures indicate that IPPU emissions from cement industries have slightly gone up as a consequence of increasing clinker production (Figure 2.26), while those from lime production tend to decrease due to a decline in production (Figure 2.27). Similar trend is also observed in IPPU emissions from carbonate consumption in glass industry (Figure 2.28), while IPPU emissions from ceramic production tend to be constant, in line with its production (Figure 2.29). IPPU emission from other uses of carbonate and soda ash activities decreases as a consequence of falling production in this industry group (Figure 2.30).

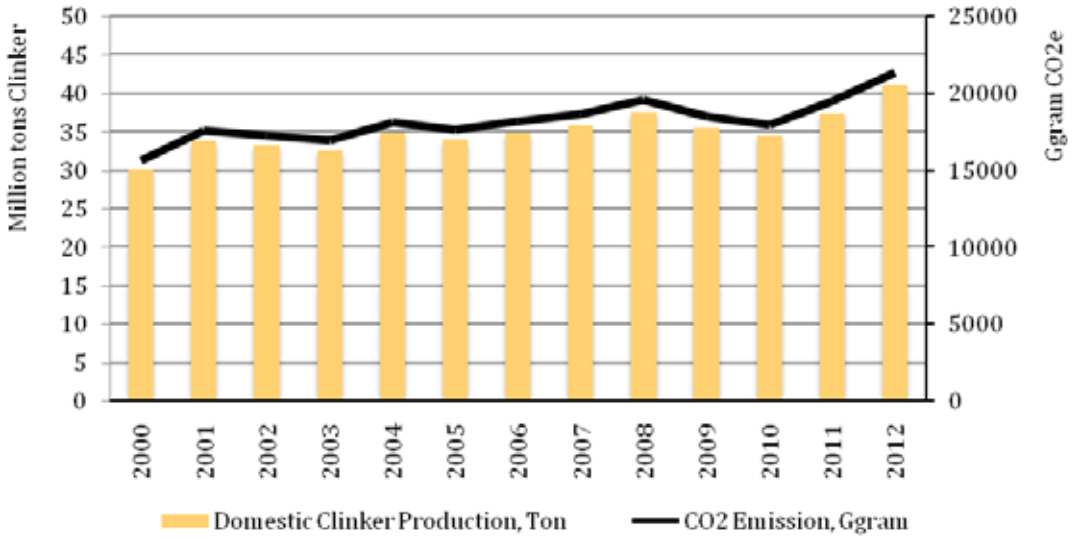



**Figure 2.26.** IPPU Emission from 2.A.1- Cement Production, (based on clinker production)

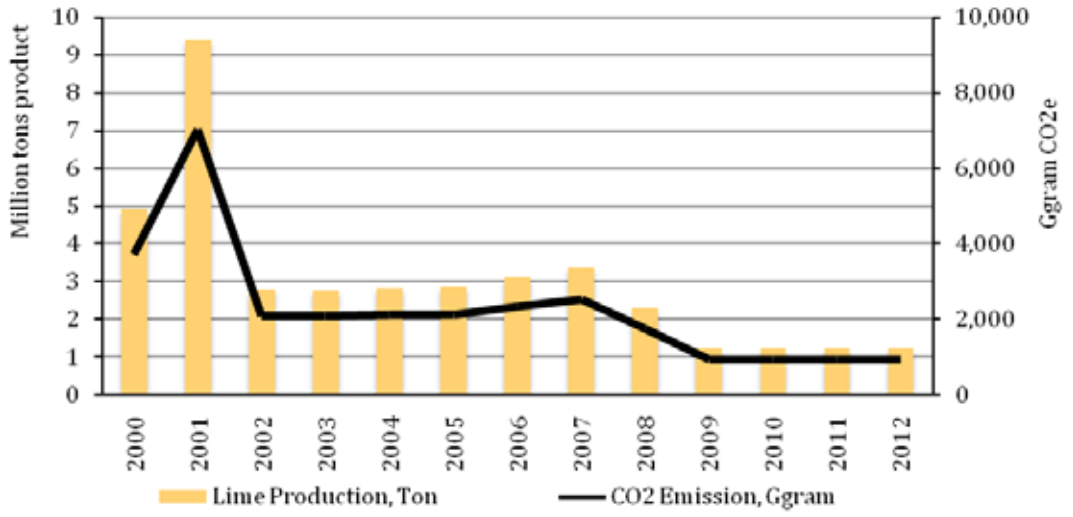



**Figure 2.27.** IPPU Emission from 2.A.2-Lime Production

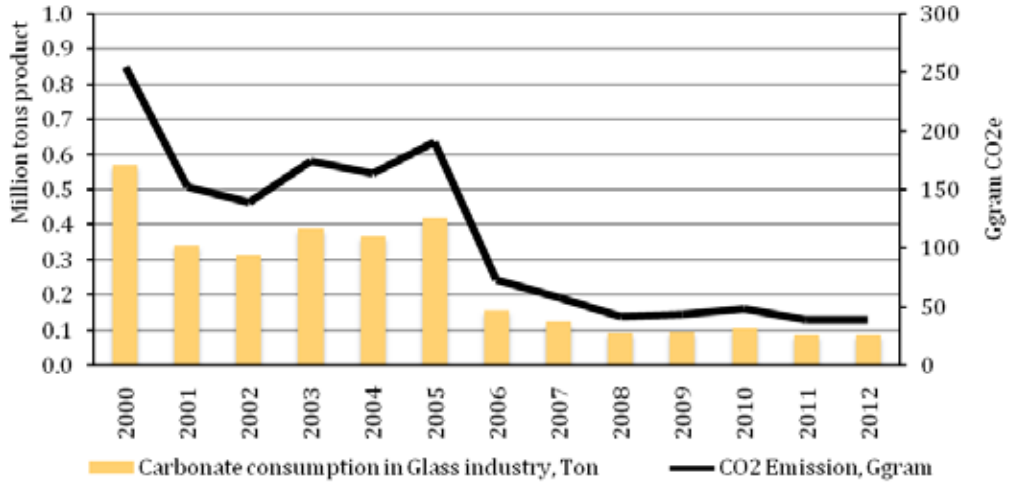



Figure 2.28. IPPU Emissions from 2.A.3-Carbonate Consumption in Glass Industry

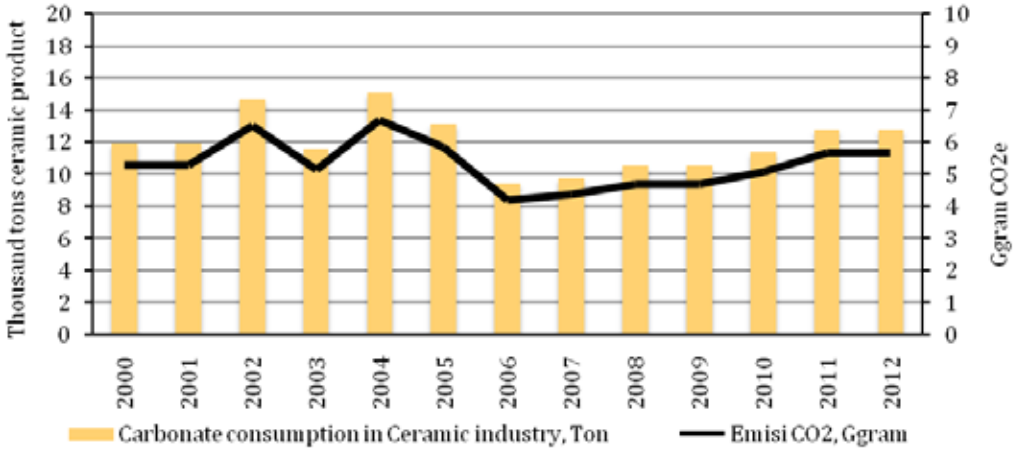



**Figure 2.29.** IPPU Emission from 2.A.4.a-Ceramic Industry

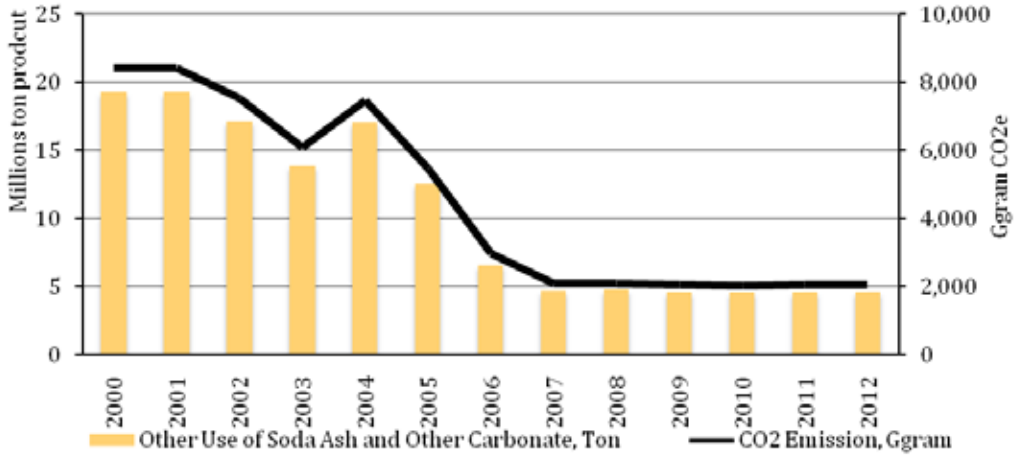



**Figure 2.30.** IPPU Emissions from 2.A.4.b-Other Industries using Soda Ash

The developments of IPPU emissions from chemical production activities are presented in Figures 2.31 to 2.33. IPPU emissions from ammonia industries tend to be constant along with its production level (Figure 2.31), and those from nitric-acid production are relatively constant except for during 2011- 2012, which showed significant increase due to new nitric acid plant development in those years (Figure 2.32). IPPU emissions from carbide production are fluctuating, particularly in 2001 – 2003 (Figure 2.33).

The development of IPPU emission from petrochemical production activity is presented in Figure 2.34. As indicated by the figure, IPPU emissions from most petrochemical production activity tend to decrease except in 2012 where emissions from carbon black slightly increase due to significant increase in carbon black production.

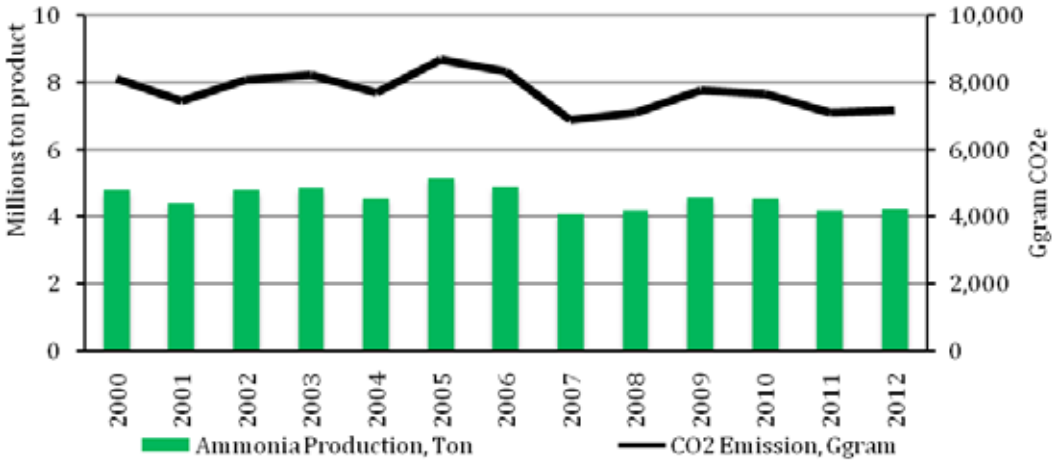



**Figure 2.31.** GHG Emissions from 2.B.1-Ammonia Industry

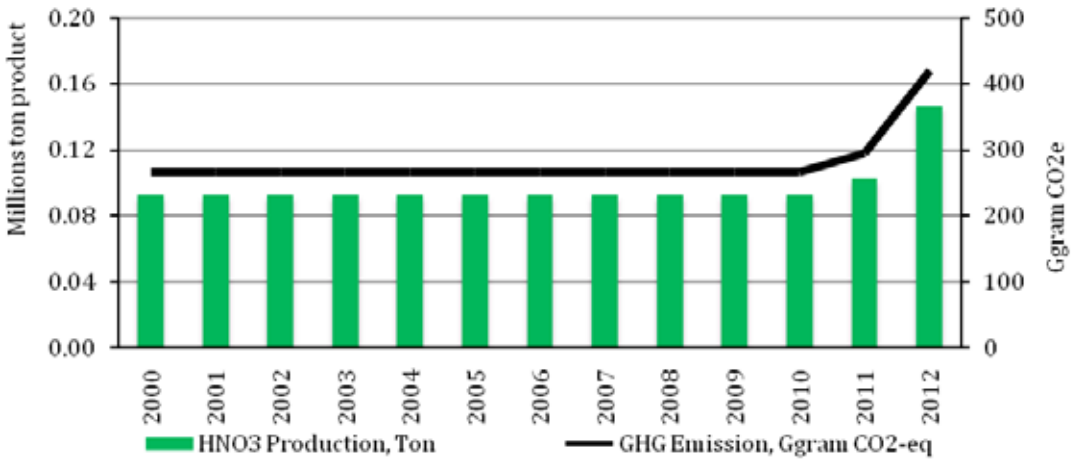



**Figure 2.32.** GHG Emissions from 2.B.2-Nitric Acid Production

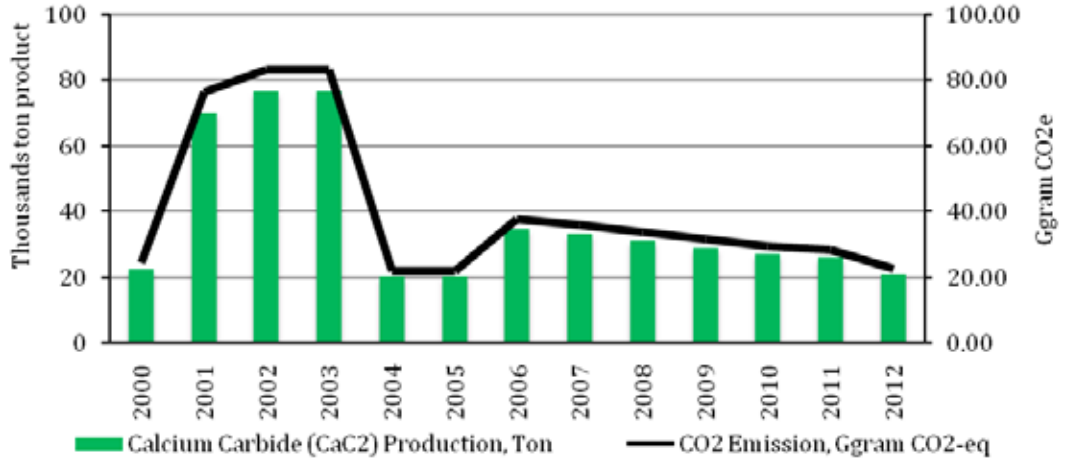



**Figure 2.33.** IPPU Emission from 2B5-Carbide Production

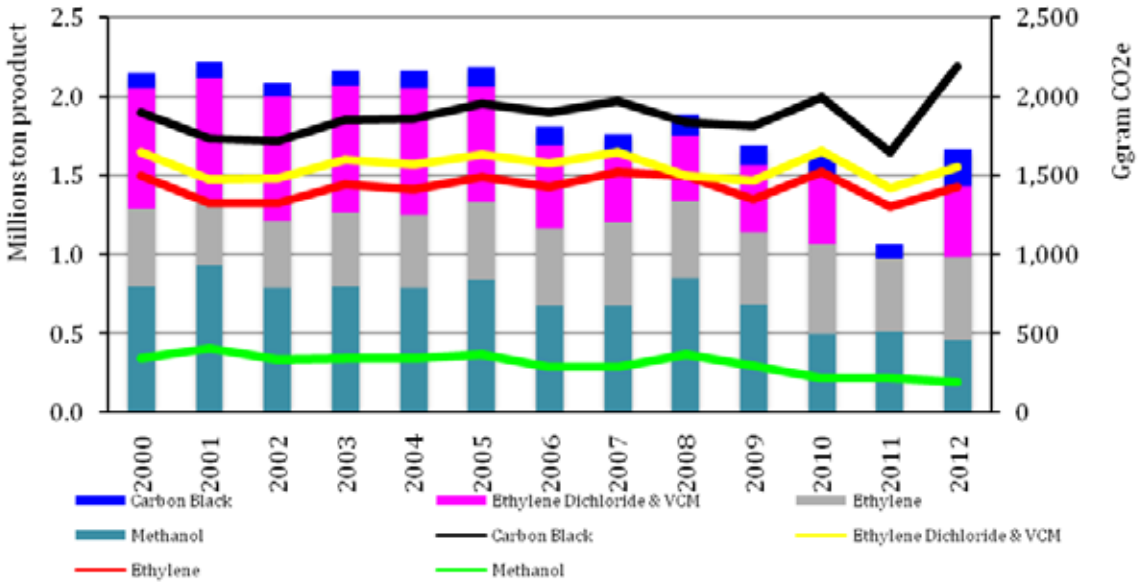



**Figure 2.34.** IPPU Emission from 2B8-Petrochemical Industries

The development of IPPU emissions from Iron and Steel production activities are presented in Figure 2.35. The figure showed that the IPPU emissions derived from this activity were fluctuating during 2000–2008 in line with the fluctuation of the DRI production in those periods. Since 2009, the IPPU emission has significantly increased due to the newly introduce Pig Iron production.

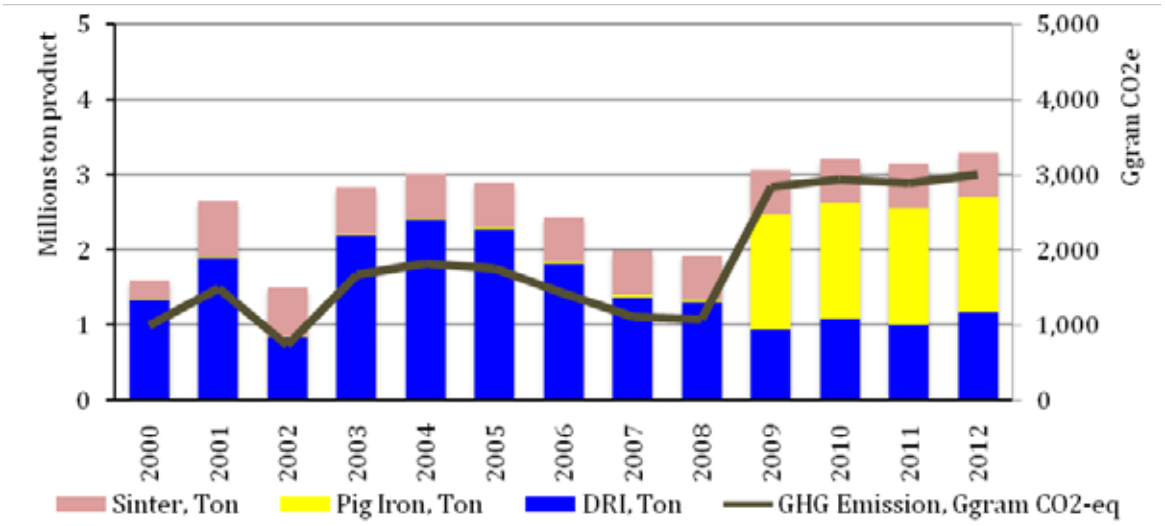



**Figure 2.35.** IPPU Emissions from 2C1-Iron and Steelproduction

The development of aluminium production during 2000 – 2012 and the corresponding IPPU emissions are presented in Figure 2.36. This aluminium production data represented the production data of PT. Inalum, i.e. the only aluminium producer in Indonesia. Referring to IPCC-2006 GLs, IPPU emissions in this category include $CO_2$, $CF_4$, $C_2F_6$ emissions released during the productions. As e seen in Figure 2.36, during 2000 – 2012, the $CO_2$ emissions tend to be constant. However, since 2010, there was a significant decrease in PFC due to the deployment of new technology for efficiency improvement of their production system and PFC emission mitigation under the CDM project in PT. Inalum.

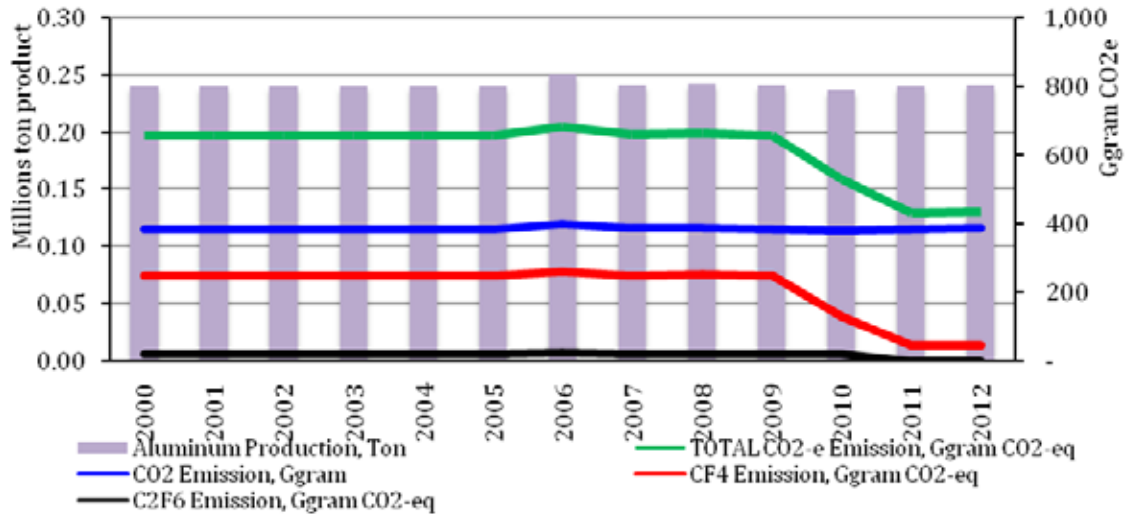



**Figure 2.36.** IPPU Emission from 2C3-Aluminium Industry

The development of Zinc production and Lead production l during 2000 – 2012 and the corresponding IPPU emissions are presented in Figure 2.37 and 2.38 respectively. Figure 2.37 shows that $CO_2$ emissions during 2000-2005 were fluctuating in line with the production level of Zinc industry in Indonesia. However, since 2006 the emissions have been decreasing significantly. Figure 2.38 shows that $CO_2$ emission level from lead production is fluctuating, especially during 2007 – 2009 where the emission level was very high.

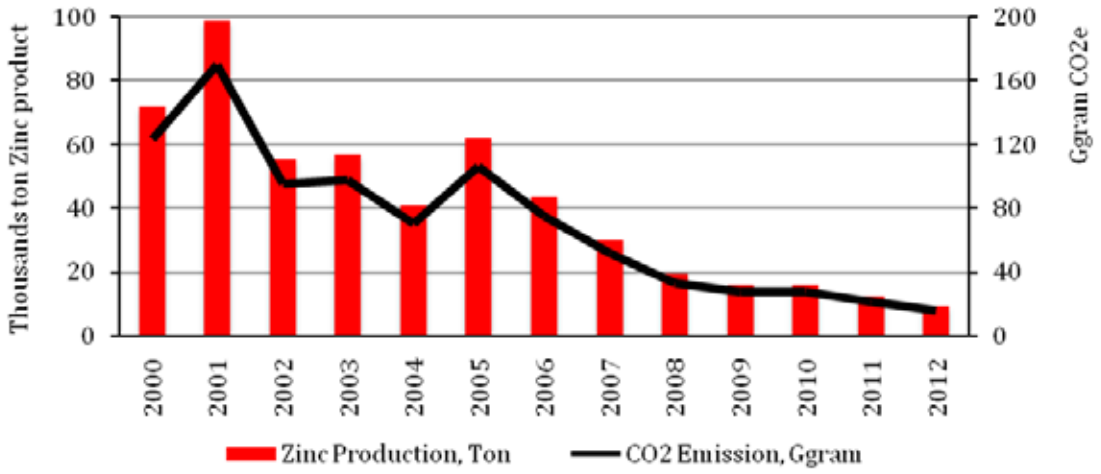



**Figure 2.37.** IPPU Emission from 2C5-Zinc Production

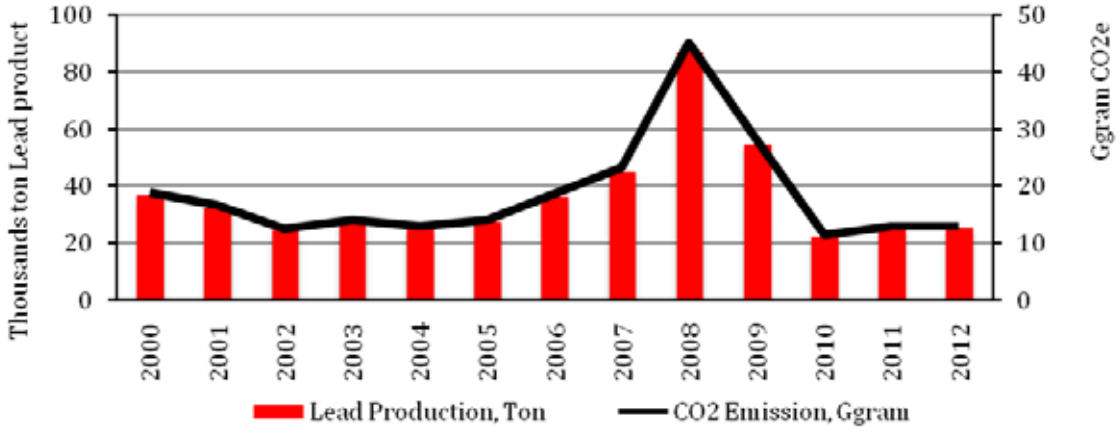



**Figure 2.38.** IPPU Emission from 2C5-Lead Production

The development of IPPU emissions from product utilization activities of lubricant and paraffin wax are presented in Figures 2.39 and 2.40 respectively. Emissions from lubricant utilization tend to be constant along with the amount of lubricant use, except in 2010, when the emission had decreased due the decreased of lubricant use (Figure 2.39). IPPU emissions from paraffin wax use tend to increase gradually along with paraffin wax utilization (Figure 2.40).

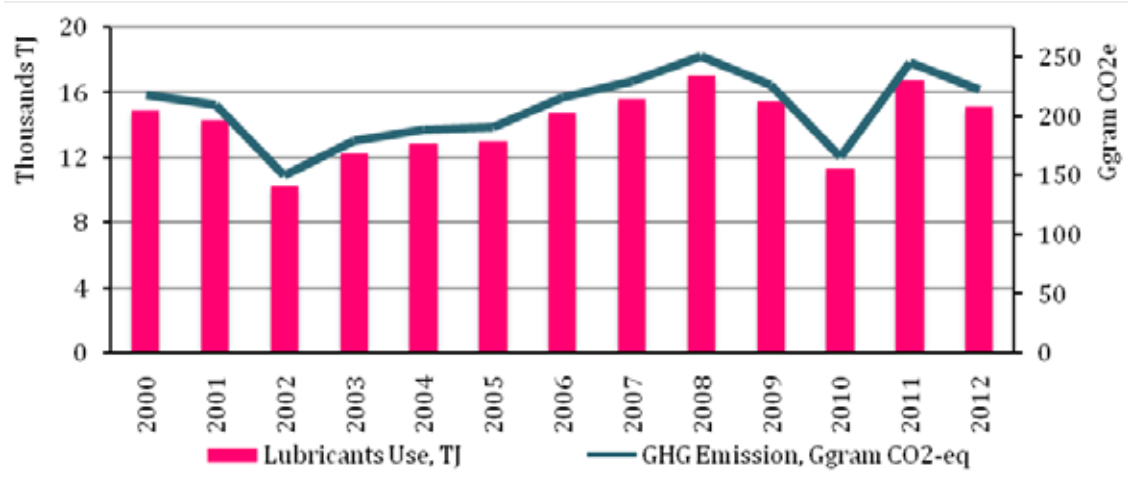



**Figure 2.39.** IPPU Emission from 2D1-Lubricants Consumption

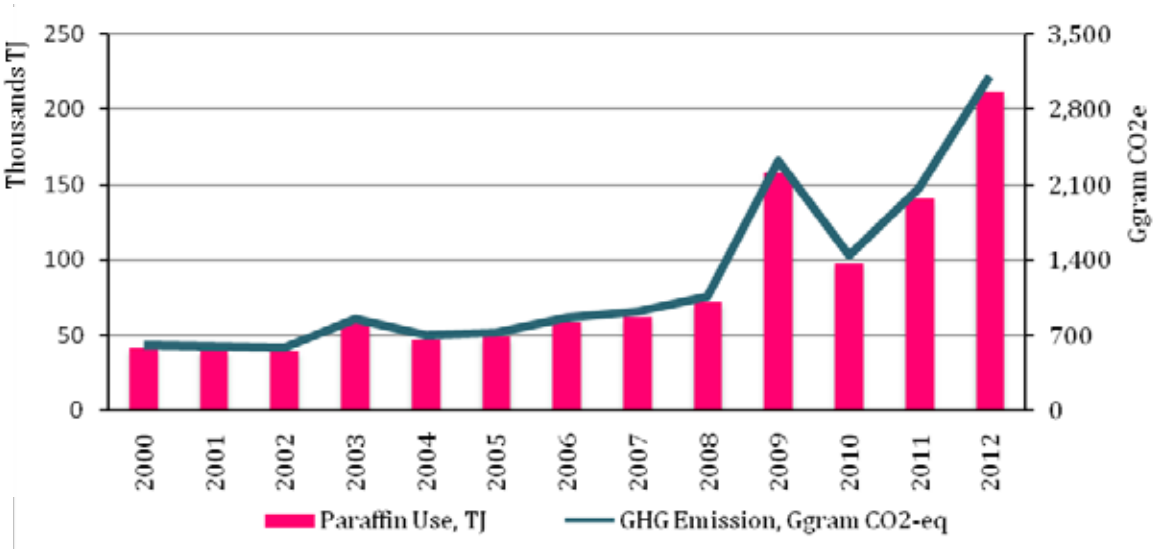



**Figure 2.40.** IPPU Emission from 2D2-Paraffin wax use

The development of IPPU emissions from the use of $Na_2CO_3$ in pulp and paper industry and food and beverage industry are given in Figure 2.41 and 2.42 respectively. IPPU emissions from $Na_2CO_3$ use in pulp and paper industry tend to be constant during 2000-2008. The emission was slightly decreased in 2009 and then slightly increased since 2010 following the decreasing or increasing use of $Na_2CO_3$ use in the production of pulp and paper (Figure 2.41). Where as IPPU emissions from $Na_2CO_3$ use in Food and Beverage industries tend to decrease in line with the declining use of $Na_2CO_3$(Figure 2.42).

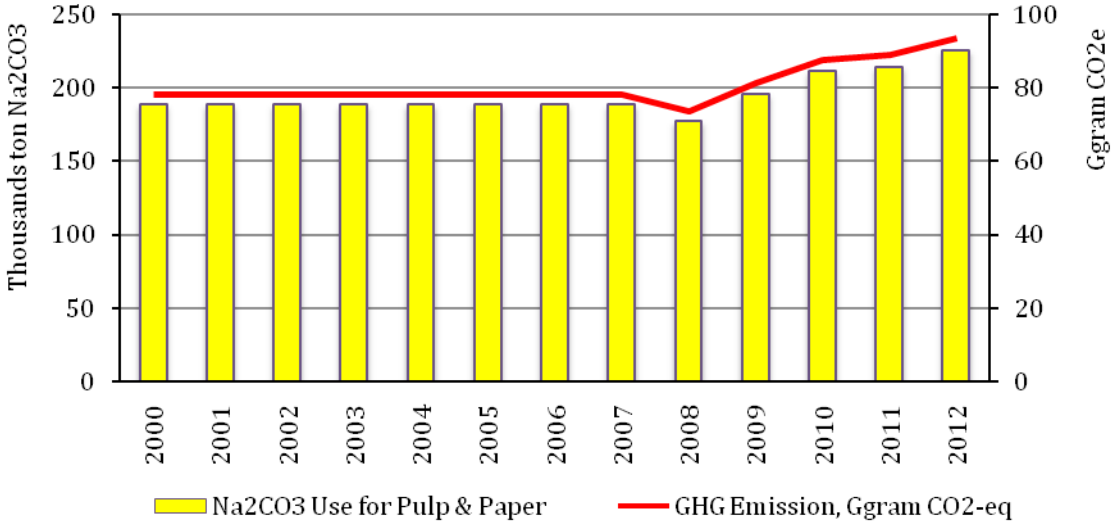



**Figure 2.41.** IPPU Emissions from Carbonate use in 2H1-Pulp & Paper Industries

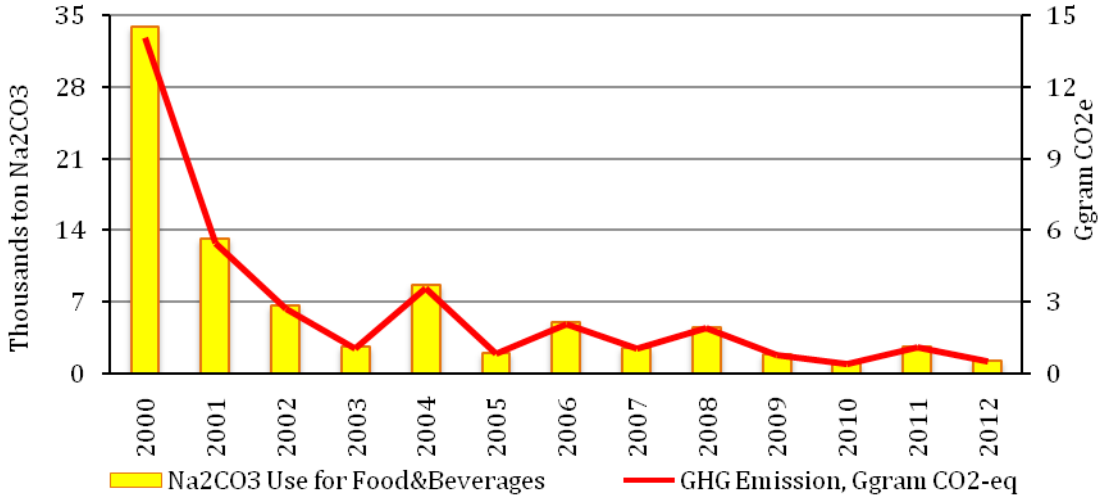



**Figure 2.42.** IPPU Emission from Carbonate use in 2H2-Food and Beverages Industries

GHG emissions for IPPU sector in 2012 reached 41,062 Gg $CO_2$e (Table 2.11). Out of the 22 IPPU emission sources, seven sources contributed total most 95% of the total IPPU emissions, namely cement productions (52%) followed by ammonia production (17.5%), paraffin wax use (7.6%), iron and steel production (7.3%), other use of carbonate and soda ash (5.0%), ethylene production (3.0%), and lime production (2.2%; Table 2.11).

Table 2-11. GHG Emissions from IPPU, Gg $CO_2$-e (2012)

| Code & Category | | $CO_2$ | $CH_4$ | $N_2O$ | HFCs | $CF_4$ | $C_2F_6$ | $SF_6$ | Total |
|---|---|---|---|---|---|---|---|---|---|
| | | (Gg) | (Gg) | (Gg) | (Gg) | (Gg) | (Gg) | (Gg) | (Gg Coe) |
| 2A1 | Cement production | 21,360 | | | | | | | 21,360 |
| 2A2 | Lime production | 916 | | | | | | | 916 |
| 2A3 | Glass production | 39 | | | | | | | 39 |
| 2A4a | Ceramic production | 6 | | | | | | | 6 |
| 2A4b | Other use of carbonate and soda ash | 2,037 | | | | | | | 2,037 |
| 2B1 | Ammonia production | 7,182 | | | | | | | 7,182 |
| 2B2 | Nitric acid production | | | 1.35 | | | | | 420 |
| 2B5 | Carbide production | 23 | | | | | | | 23 |
| 2B8 | Petrochemical & carbon black | | | | | | | | |
| | 2B8a Methanol | 176 | 1.05 | | | | | | 198 |
| | 2B8b Ethylene | 1,194 | 1.59 | | | | | | 1,228 |
| | 2Bbc Ethylene dichloride &VCM | 127 | 0.01 | | | | | | 127 |
| | 2B8f Carbon black | 635 | 0.01 | | | | | | 635 |
| 2C1 | Iron & steel production | 3,004 | 0.04 | | | | | | 3,005 |
| 2C3 | Aluminium production | 386 | | | | 0.007 | - | | 433 |
| 2C5 | Lead production | 13 | | | | | | | 13 |
| 2C6 | Zinc production | 16 | | | | | | | 16 |
| 2D1 | Lubricants use | 222 | | | | | | | 222 |
| 2D2 | Paraffin wax use | 3,108 | | | | | | | 3,108 |
| 2H1 | Sodium carbonate use in pulp/ paper industry | 94 | | | | | | | 94 |
| 2H2 | Sodium carbonate use in food & beverages | 0.5 | | | | | | | 0.5 |
| | Total | 40,538 | 57 | 420 | - | 46 | - | - | 41,062 |

Table 2-12. KCA for year 2012

| Category | Total GHG Emissions, Ggram $CO_2$-e | Level/Rank | Cumulative |
|---|---|---|---|
| Cement production | 21,360 | 52.0% | 52.02% |
| Ammonia production | 7,182 | 17.5% | 69.51% |
| Paraffin wax use | 3,108 | 7.6% | 77.08% |
| Iron & steel production | 3,005 | 7.3% | 84.40% |
| Other use of carbonate and soda ash | 2,037 | 5.0% | 89.36% |
| Ethylene | 1,228 | 3.0% | 92.35% |
| Lime production | 916 | 2.2% | 94.58% |
| Carbon black | 635 | 1.5% | 96.13% |
| Aluminium production | 433 | 1.1% | 97.18% |
| Nitric acid production | 420 | 1.0% | 98.20% |
| Lubricants use | 222 | 0.5% | 98.75% |
| Methanol | 198 | 0.5% | 99.23% |
| Ethylene dichloride and VCM | 127 | 0.3% | 99.54% |
| Others –sodium carbonate in pulp&paper industry | 94 | 0.2% | 99.76% |
| Glass production | 39 | 0.1% | 99.86% |
| Carbide production | 23 | 0.1% | 99.91% |
| Zinc production | 16 | 0.0% | 99.95% |
| Lead production | 13 | 0.0% | 99.98% |
| Ceramic production | 6 | 0.0% | 100.00% |
| Others –sodium carbonate in food & beverages industry | 0.5 | 0.0% | 100.00% |
| Total | 41,062 | | |

## 2.4.3. AFOLU (Agriculture Forestry and Other Land Use)

Sources of emissions from AFOLU are classified into four categories, i.e. (a) livestock, (b) land (c) aggregate sources and non-CO2 emissions sources on land, (d) others. Since data on harvested wood products in other category is not available, only the first three sources are reported in this First BUR. The coverage of GHG emissions sources from AFOLU sector is presented in Figures 2.43.

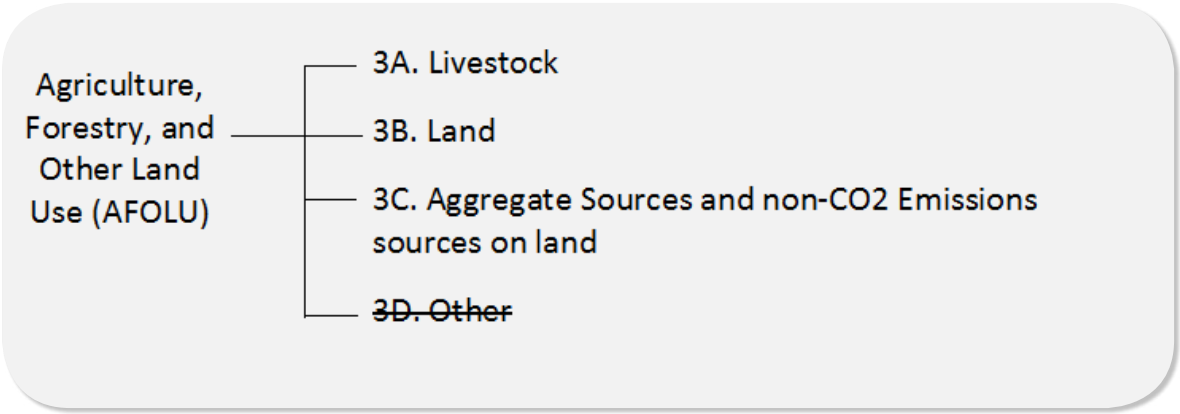



**Figure 2.43.** The Coverage of GHG Emissions Sources from AFOLU sector

### 2.4.3.1. Livestock

#### a. Source Category of GHG Emissions from Livestock

The sources of GHG emissions of livestock sector include GHG emissions from enteric fermentation and manure management (Figure 2.44). The emission of both sources are categorized based on livestock populations, i.e. dairy cows, other cattle, buffalo, sheep, goats, camels, horses, mules and asses, swine, and poultry (Figure 2.45). Methane emissions from camel, mules and assess are not estimated due to limited data.

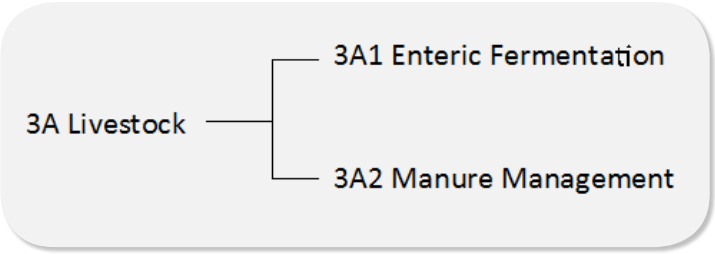
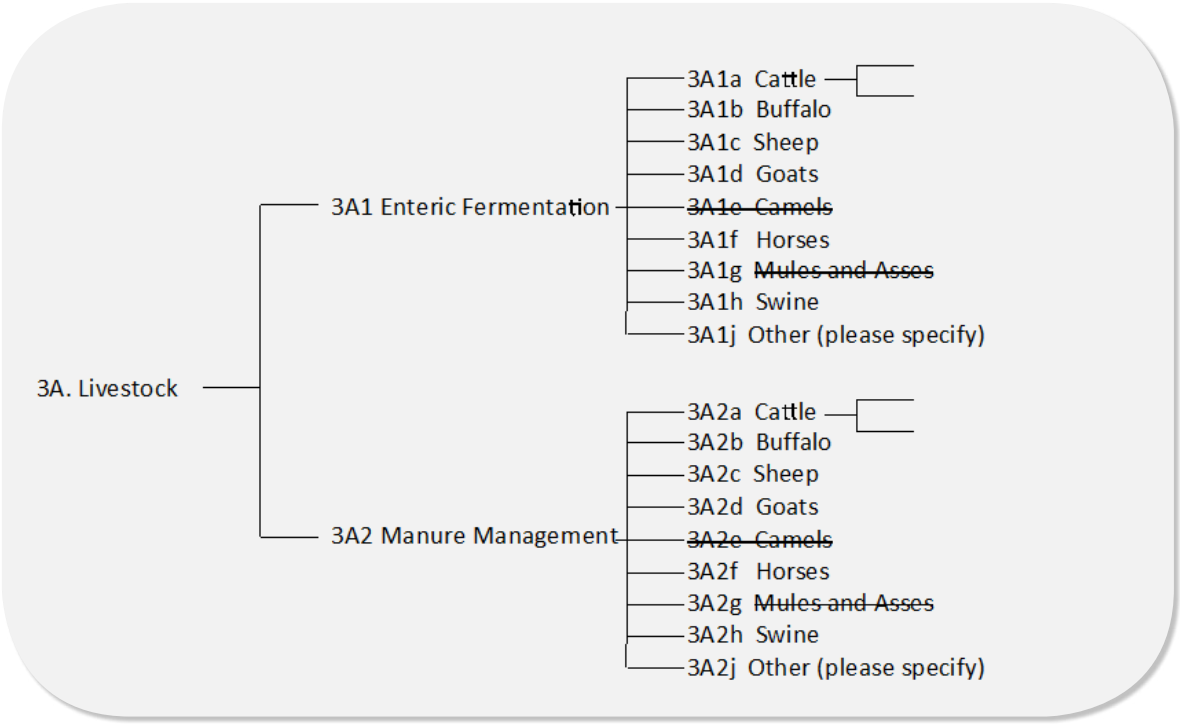



**Figure 2.44.** The Coverage of GHG Emissions Sources from Livestock sector




Notes: Strikethrough means NO (Not Occurred)

**Figure 2.45.** The Coverage of GHG Emissions Sources from Enteric Fermentation and Manure Management

## Methane emission from enteric fermentation

Livestocks produce methane as a by-product of enteric fermentation, a digestive process by which carbohydrates are broken down by micro-organisms into simple molecules to be absorbed into the bloodstream. The major sources of methane are ruminant livestocks (e.g., cattle, sheep) with moderate amounts produced from non-ruminant livestock (e.g., pigs, horses).

## Manure management

Methane is produced during the storage and treatment of manure, and from manure deposited on pasture. The decomposition of manure under anaerobic conditions (i.e., in the absence of oxygen) during storage and treatment produces $CH_4$. These conditions occur most readily when large numbers of animals are managed in a confined area (e.g., dairy farms, beef feedlots, and swine and poultry farms), and where manure is disposed in liquid-based systems.

In addition, during treatment of manure, $N_2O$ could be emitted before applying to the land (Figure 2.46). The $N_2O$ emissions generated by manure in the 'pasture, range, and paddock'

systems could occur directly and indirectly from the soil. The indirect $N_2O$ emission was therefore reported under the category of $N_2O$ Emissions from Managed Soils (3C6). The direct $N_2O$ emission occurred through the combination of nitrification and denitrification of nitrogen contained in the manure. The indirect $N_2O$ emission resulted from volatile nitrogen losses that occurred primarily in the forms of ammonia and NOx.

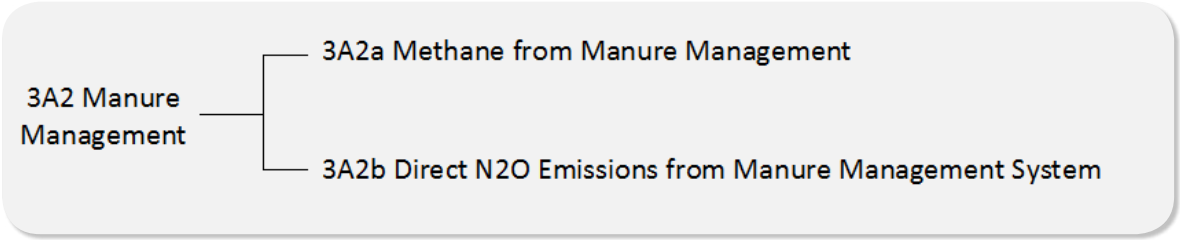



**Figure 2.46.** The Coverage of GHG Emissions Sources from Manure Management

### b. Type of Gases

According to IPCC-2006 GLs, the types of GHG emissions from livestock sector are $CH_4$ and $N_2O$.

### c. Methodology

The GHG emissions from livestock presented in the GHG emissions inventory were estimated using Tier 1 methods of IPCC-2006 with default value emission factor. Indonesia has yet the higher tier, however the Ministry of Agriculture is preparing local emission factor and mapping detailed characteristics of livestock. Unfortunately, the country specific or the local emission factors are not available. The estimation of livestock emissions was determined through emission calculations by multiplying an activity data (e.g. number of population) by default emission factor.

### d. Time Frame

The GHG inventory reported in this First BUR covers GHG emissions generated in the year of 2000 until 2012. The GHG emissions inventory for 2000 – 2005 is available from the SNC document with revisions on the updated activity data and improved supporting activity data. The GHG emissions for 2000 – 2005 are therefore a result of recalculation using updated and improved activity data, while for 2006 – 2012 used current activity data.

### e. Data Sources

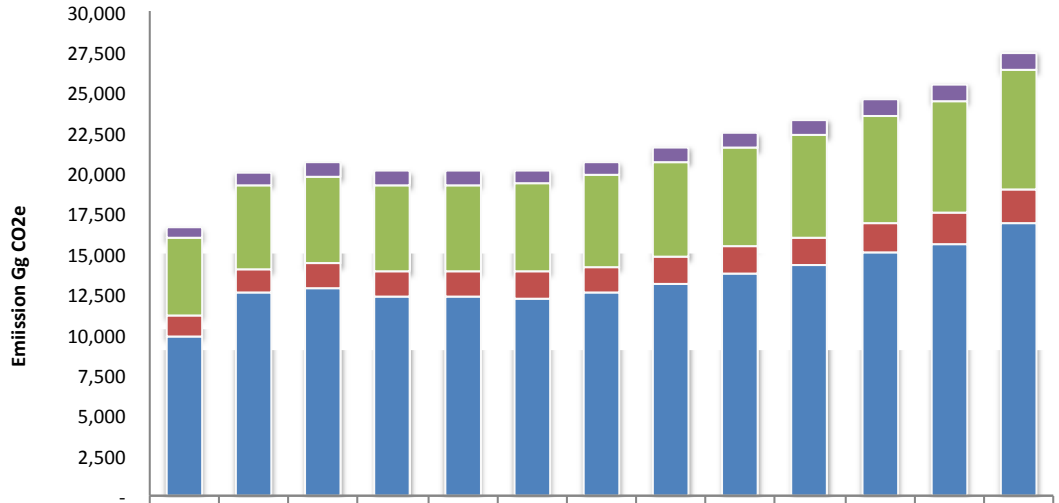
The livestock population and information related to GHG emissions inventory are collected from single publication source, i.e. Agriculture Statistic (2000 – 2012) from PUSDATIN (Data and Information Centre) of the Ministry of Agriculture (MoA). As level of emission of the livestock with different age is not the same, while the statistic data does not differentiate the age structure, correction factors (k(T)) was developed to accommodate this age structure. The correction factor was developed based on survey on animal population structure conducted by BPS in 2006. The correction factors (k(T)) for beef cattle, dairy cattle, and buffalo are 0.72, 0.75 and 0.72 respectively.

### f. GHG emissions Estimates

Livestock populations in Indonesia increase from year to year and consist of eleven livestock species: beef cattle, dairy cattle, buffalo, sheep, goats, swine, horses, native chicken, broiler, layer and duck. The highest number of livestock species is broiler and the lower one is dairy cattle, which is 1,244 million and 0.347 million heads respectively (Table 2.13). In 2012, total emissions of livestock amounted to 27,465 Gg $CO_2$-eq, while emission in 2000 was much lower, i.e. 16,595 Gg $CO_2$-eq (Figure 2.47). Contribution of enteric fermentation to the total emission of livestock in 2010 accounts to 61.1%, followed by direct $N_2O$ (27.0%), manure management (7.8%) and indirect $N_2O$ (4.1%).

Table 2-13. Livestock Population in Indonesia from 2000-2012 (in 1000 heads)

| Year | Beef Cattle | Dairy Cattle | Buffalo | Sheep | Goats | Swine | Horses | Native Chicken | Broiler | Layer | Duck |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2000 | 8,122 | 266 | 1,766 | 7,415 | 12,613 | 5,247 | 413 | 261,132 | 534,811 | 69,703 | 29,674 |
| 2001 | 11,138 | 347 | 2,333 | 7,401 | 12,464 | 5,369 | 422 | 268,039 | 621,870 | 70,254 | 32,068 |
| 2002 | 11,298 | 358 | 2,403 | 7,641 | 12,549 | 5,927 | 419 | 275,292 | 865,075 | 78,039 | 46,001 |
| 2003 | 10,504 | 374 | 2,459 | 7,811 | 12,722 | 6,151 | 413 | 277,357 | 847,744 | 79,206 | 33,863 |
| 2004 | 10,533 | 364 | 2,403 | 8,075 | 12,781 | 5,980 | 397 | 276,989 | 778,970 | 93,416 | 32,573 |
| 2005 | 10,569 | 361 | 2,128 | 8,327 | 13,409 | 6,801 | 387 | 278,954 | 811,189 | 84,790 | 32,405 |
| 2006 | 10,875 | 369 | 2,167 | 8,980 | 13,790 | 6,218 | 398 | 291,085 | 797,527 | 100,202 | 32,481 |
| 2007 | 11,515 | 374 | 2,086 | 9,514 | 14,470 | 6,711 | 401 | 272,251 | 891,659 | 111,489 | 35,867 |
| 2008 | 12,257 | 458 | 1,931 | 9,605 | 15,147 | 6,838 | 393 | 243,423 | 902,052 | 107,955 | 39,840 |
| 2009 | 12,760 | 475 | 1,933 | 10,199 | 15,815 | 6,975 | 399 | 249,963 | 1,026,379 | 111,418 | 40,676 |
| 2010 | 13,582 | 488 | 2,000 | 10,725 | 16,620 | 7,477 | 419 | 257,544 | 986,872 | 105,210 | 44,302 |
| 2011 | 14,824 | 597 | 1,305 | 11,791 | 16,946 | 7,525 | 409 | 264,340 | 1,177,991 | 124,636 | 43,488 |
| 2012 | 15,981 | 612 | 1,438 | 13,420 | 17,906 | 7,900 | 437 | 274,564 | 1,244,402 | 138,718 | 44,357 |




| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Indirect N2O From Manure | 682 | 773 | 850 | 824 | 826 | 836 | 861 | 915 | 931 | 978 | 1,007 | 1,084 | 1,162 |
| Direct N2O from Manure | 4,719 | 5,259 | 5,378 | 5,331 | 5,348 | 5,448 | 5,611 | 5,876 | 6,046 | 6,292 | 6,630 | 6,821 | 7,371 |
| Manure Management | 1,300 | 1,429 | 1,549 | 1,575 | 1,545 | 1,659 | 1,595 | 1,693 | 1,758 | 1,811 | 1,910 | 1,995 | 2,103 |
| Enteric fermentation | 9,894 | 12,585 | 12,813 | 12,351 | 12,339 | 12,239 | 12,597 | 13,129 | 13,697 | 14,212 | 15,024 | 15,590 | 16,828 |
| Total | 16,595 | 20,045 | 20,591 | 20,080 | 20,058 | 20,182 | 20,664 | 21,613 | 22,432 | 23,294 | 24,570 | 25,490 | 27,465 |

**Figure 2.47.** Trend in CO2-e Emission of Livestock for the Period 2000 to 2012

## Methane Emissions from Livestock

Enteric fermentation is the most important source of methane emissions (Figure 2.48), which were largely produced by beef cattle (67.5%), goat herds (11.2%), sheep (8.4%), and buffalo (7.1%) as depicted in Figure 2.48, while for other livestock, the contribution was less that 5%. The emission of enteric fermentations in 2012 was 16,828 Gg $CO_2$-e.

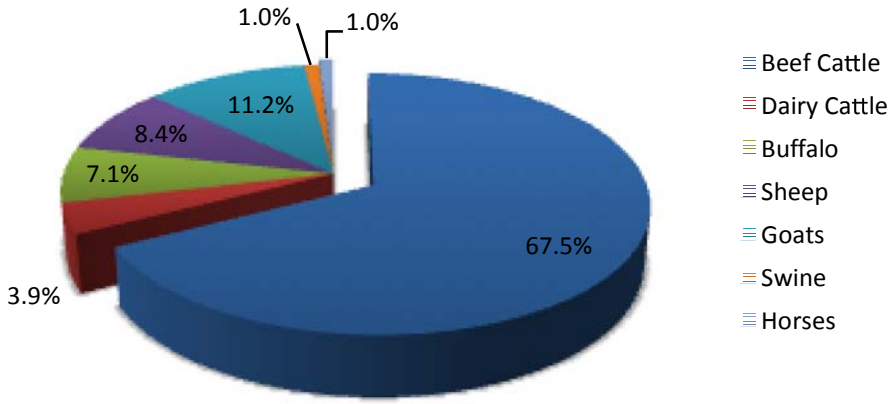



**Figure 2.48.** Contribution to Emissions of Enteric Fermentation by Species Type

Meanwhile, methane emission from manure management in 2012 was 2,103 Gg $CO_2$-e and dominated by swine, contributing 55.2%, followed by dairy cattle (14.2%) and beef cattle, which contributed the third largest emissions (11.4%) as presented in Figure 2.49. Methane emissions from manure management were small compared to enteric fermentation, comprising of only 8% of the total emissions from livestock.

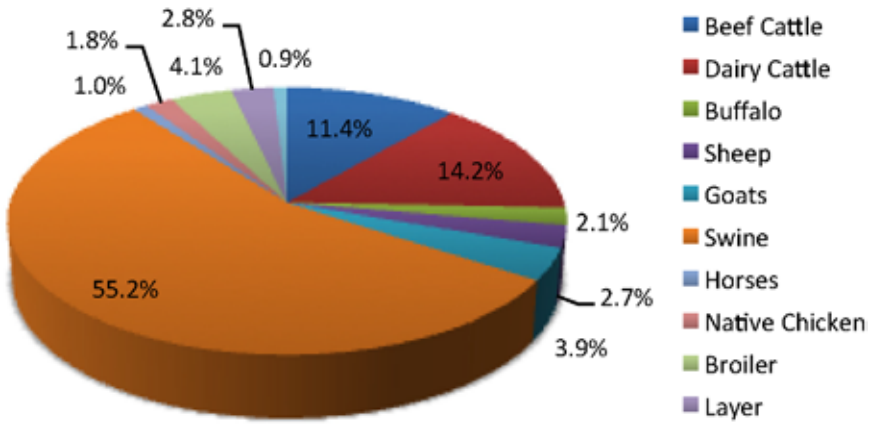
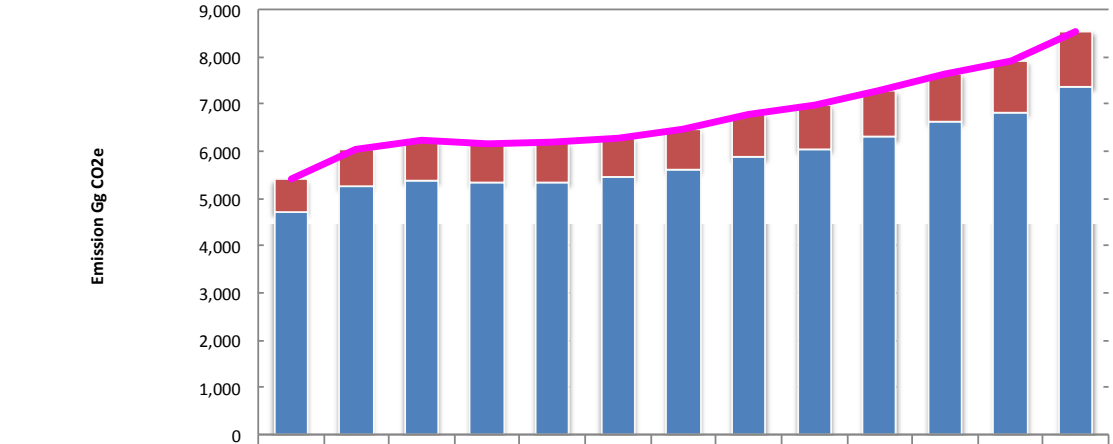



**Figure 2.49.** Contribution to Emissions of Manure Management by Species Type

## $N_2O$ Emissions from Manure Management

The direct $N_2O$ emissions were the main source of $N_2O$ emissions from manure management. In 2012, the annual direct $N_2O$ emissions amounted to 7,371 Gg $CO_2$-e, while the annual indirect $N_2O$ emissions were 1,621 Gg $CO_2$-e. Beef cattle contributed most to the $N_2O$ emissions. The total $N_2O$ emissions from manure management were therefore 8,533 Gg $CO_2$-e (Figure 2.50).



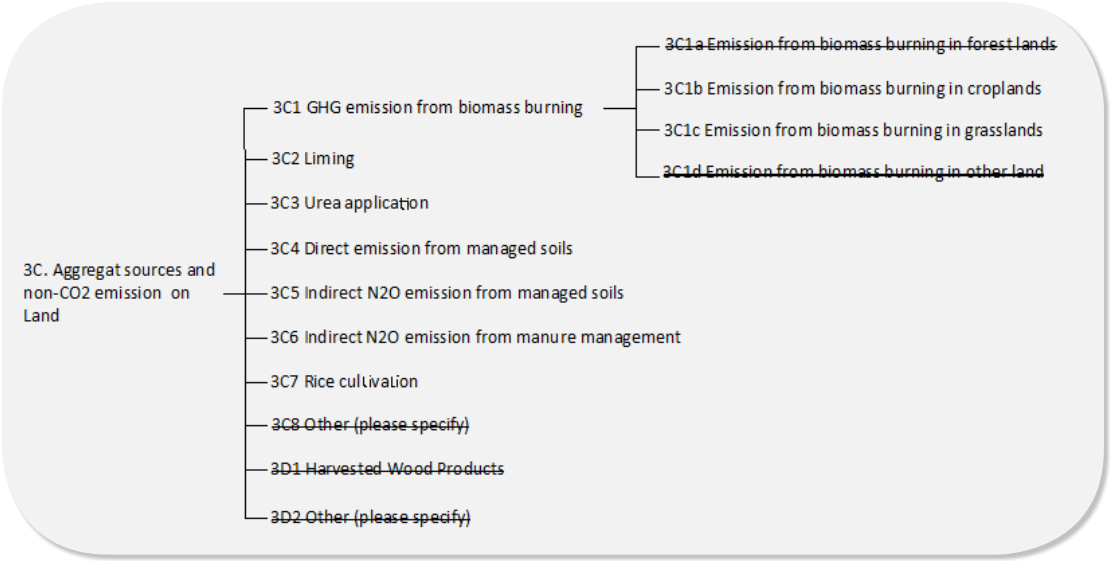

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Indirect N2O From Manure | 682 | 773 | 850 | 824 | 826 | 836 | 861 | 915 | 931 | 978 | 1,007 | 1,084 | 1,162 |
| Direct N2O from Manure | 4,719 | 5,259 | 5,378 | 5,331 | 5,348 | 5,448 | 5,611 | 5,876 | 6,046 | 6,292 | 6,630 | 6,821 | 7,371 |
| Total | 5,401 | 6,031 | 6,228 | 6,154 | 6,174 | 6,284 | 6,472 | 6,791 | 6,978 | 7,271 | 7,636 | 7,906 | 8,533 |

**Figure 2.50.** Trend of $N_2O$ Emission from Manure Management in $CO_2$-eq for the Period 2000 to 2012

## 2.4.3.2. Aggregate Sources and Non-$CO_2$ Emissions Sources on Land

### a. Source Category of GHG Emissions from Aggregate Sources and Non-$CO_2$ Emissions Sources on Land

Under this sector, sources of emissions were classified into six categories, i.e. (a) GHG emissions from biomass burning, (b) liming, (c) urea application, (d) direct $N_2O$ emission from managed soil, (e) indirect N2O emission from managed soil, (f) indirect $N_2O$ emission from manure management, and (g) rice cultivation (Figure 2.51). In this first BUR, the emissions from biomass burning in forest land and other land were not calculated, because the activity data presenting burnt forest area and other land types were not available.




Notes: Strikethrough means NE (Not Estimated)

**Figure 2.51.** The Coverage of GHG Emissions Sources from Aggregate Sources and non-$CO_2$ Emissions Sources on Land

#### The GHG Emissions from Biomass Burning

Emissions from biomass burning included not only $CO_2$, but also other GHGs, or precursors, due to incomplete combustion of the fuel, including carbon monoxide (CO), methane ($CH_4$), non-methane volatile organic compounds (NMVOC) and nitrogen (e.g., $N_2O$, NOx). Non-$CO_2$ greenhouse gas emissions were estimated for all land use categories. In the first BUR, only emissions from biomass burning in cropland and grassland were estimated.

### Liming

Under the IPCC 2006 GL, liming is used to reduce soil acidity and improve plant growth in managed systems, particularly agricultural lands and managed forests. Adding carbonates to soils in the form of lime (e.g., calcic limestone ($CaCO_3$), or dolomite ($CaMg(CO_3)_2$) led to $CO_2$ emissions as the carbonate limes dissolved and released bicarbonate ($_2HCO_3$-), which evolved into $CO_2$ and water ($H_2O$).

### Urea Application

Adding urea to soils during fertilization would lead to a loss of $CO_2$ that was previously fixed in fertilizer during industrial production process that manufactured it. Urea ($CO(NH_2)_2$) was converted into ammonium ($NH_4^+$), an hydroxyl ion ($OH^-$) and bicarbonate ($HCO_3^-$), in the presence of water and urease enzymes. Similar to the soil reaction following the addition of lime, the bicarbonate that was formed evolved into $CO_2$ and water.

### $N_2O$ emission from Managed Soil

The emissions of $N_2O$ that resulted from anthropogenic N inputs or N mineralisation occurred through direct pathway (i.e., directly from the soils to which the N is added/released), and through two indirect pathways: (i) following volatilisation of $NH_3$ and NOx from managed soils and from fossil fuel combustion and biomass burning, and the subsequent redeposition of these gases and their products $NH_4^+$ and $NO_3^-$ to soils and waters; and (ii) after leaching and runoff of N, mainly as $NO_3$-, from managed soils.

### Rice Cultivation

Anaerobic decomposition of organic material in flooded rice fields produced methane ($CH_4$), which escaped to the atmosphere primarily by transport through the rice plants. The annual amount of $CH_4$ emitted from a given area of rice is a function of the number and duration of crops grown, water regimes before and during cultivation period, and organic and inorganic soil amendments. Soil type, temperature, and rice cultivar also affected $CH_4$ emissions.

## b. Type of Gases

Under the IPCC-2006 GL, types of GHG emissions from the aggregate sources and non-$CO_2$ emissions sources on land were $CO_2$, $CH_4$ and $N_2O$.

## c. Methodology

The GHG emissions from the aggregate sources and non-$CO_2$ emissions sources on land in the GHG emissions inventory estimated using Tier 1 methods of IPCC 2006 with default value emission factor and Tier 2 method. Methane emissions from rice cultivation were calculated using country specific emission factor, which was summarized from the local values of rice field in Indonesia. The emission factor from Indonesia rice field ranged between 0.67-79.86 g $CH_4/m^2$/season with the average default value of 160.9 kg $CH_4$/ha/season. The soil scale factor was modified, because several studies conducted in Indonesia found that different soil properties obtained different potential $CH_4$ production (Table 2.14). In addition, the scale factor for water regime and rice variety used the country specific scale factor as presented in Table 2.15 and 2.16.

Table 2-14. Revised Scale Factor of different soil types of Indonesia

| Soil Type | Adjusted soil SF |
|---|---|
| Alfisols | 0.84 (0.32-1.59) |
| Andosols | 1.02 |
| Entisols | 1.02 (0.94-1.09) |
| Histosols | 2.39 (0.92-3.86) |
| Inceptisols | 1.12 (1.0-1.23) |
| Mollisols | - |
| Oxisols | 0.29 (0.1-0.47) |
| Ultisols | 0.29 |
| Vertisols | 1.02 (0.94-1.09) |

Table 2-15. Adjusted Scale Factor from Rice Ecosystem and Water Regime of Indonesia

| Category | Sub-category | | | SF (adapted from IPCC Guidelines 1996) | Adjusted SF (based on current studies in Indonesia) |
|---|---|---|---|---|---|
| Upland | None | | | 0 | |
| Lowland | Irrigated | Continuously Flooded | | 1.0 | 1.00 |
| | | Intermittently Flooded | Single Aeration | 0.5 (0.2-0.7) | 0.46 (0.38-0.53) |
| | | | Multiple Aeration | 0.2 (0.1-0.3) | |
| | Rainfed | Flood Prone | | 0.8 (0.5-1.0) | 0.49 (0.19-0.75) |
| | | Drought Prone | | 0.4 (0-0.5) | |
| | Deep Water | Water Depth 50-100 cm | | 0.8 (0.6-1.0) | |
| | | Water Depth < 50 cm | | 0.6 (0.5-0.8) | |

Table 2-16. Scaling Factor of Different Rice Varieties in Indonesia

| No | Variety | Average emission (kg/ha/session) | SF |
|---|---|---|---|
| 1 | Gilirang | 496.9 | 2.46 |
| 2 | Aromatic | 273.6 | 1.35 |
| 3 | Tukad Unda | 244.2 | 1.21 |
| 4 | IR 72 | 223.2 | 1.10 |
| 6 | Cisadane | 204.6 | 1.01 |
| 5 | IR 64* | 202.3 | 1.00 |
| 7 | Margasari | 187.2 | 0.93 |
| 8 | Cisantana | 186.7 | 0.92 |
| 9 | Tukad Petanu | 157.8 | 0.78 |
| 10 | Batang Anai | 153.5 | 0.76 |
| 11 | IR 36 | 147.5 | 0.73 |
| 12 | Memberamo | 146.2 | 0.72 |
| 13 | Dodokan | 145.6 | 0.72 |
| 14 | Way Apoburu | 145.5 | 0.72 |
| 15 | Muncul | 127.0 | 0.63 |
| 16 | Tukad Balian | 115.6 | 0.57 |
| 17 | Cisanggarung | 115.2 | 0.57 |
| 18 | Ciherang | 114.8 | 0.57 |
| 19 | Limboto | 99.2 | 0.49 |
| 20 | Wayrarem | 91.6 | 0.45 |
| 21 | Maros | 73.9 | 0.37 |
| 22 | Mendawak | 255 | 1.26 |
| 23 | Mekongga | 234 | 1.16 |
| 24 | IR42 | 269 | 1.33 |
| 25 | Fatmawati | 245 | 1.21 |
| 26 | BP360 | 215 | 1.06 |
| 27 | BP205 | 196 | 0.97 |
| 28 | Hipa4 | 197 | 0.98 |
| 29 | Hipa6 | 219 | 1.08 |
| 30 | Rokan | 308 | 1.52 |
| 31 | Hipa 5 Ceva | 323 | 1.60 |
| 32 | Hipa 6 Jete | 301 | 1.49 |
| 33 | Inpari 1 | 271 | 1.34 |
| 34 | Inpari 6 Jete | 272 | 1.34 |
| 35 | Inpari 9 Elo | 359 | 1.77 |
| 36 | Banyuasin | 584.8 | 2.49 |
| 37 | Batanghari | 517.8 | 2.20 |
| 38 | Siak Raya | 235.2 | 1.00 |
| 39 | Sei Lalan | 152.6 | 0.65 |
| 40 | Punggur | 144.2 | 0.61 |
| 41 | Indragiri | 141.1 | 0.60 |
| 42 | Air Tenggulang | 140.0 | 0.60 |
| 43 | Martapura | 125.7 | 0.53 |

Based on variety data used by farmers in the period 2009-2011 (about 70% of total rice planting area), it was found that the weighted average of scaling factor for rice variety under continuous flooding was 0.74. This value was used to estimate emission from irrigated areas with no information on rice variety. For non-irrigated rice, the SF for rice variety would be equal to 1.0, since the effect of water condition on reducing methane emissions would be much more dominant than that of variety. Thus the effect of changing varieties in reducing emissions would not be significant in non-irrigated area, therefore the SF was set back to 1.0 for the non-irrigated area.

Other sources of emissions, i.e. biomass burning, liming, urea application, direct $N_2O$ emissions from managed soil, indirect $N_2O$ emissions from managed soil, and indirect $N_2O$ emissions from manure management used the default IPCC values as the emission factor.

### e. Time Frame

The GHG emissions inventory reported in this first BUR covers GHG emissions year of 2000 to 2012. The GHG emissions inventory for 2000 – 2005 is taken from the SNC document with a revision, i.e. the updated activity data and improved supporting activity data. The GHG emissions for 2000 – 2005 is therefore as a result of recalculation using the updated and improved activity data, while for 2006 – 2012 used new activity data.

### f. Data Sources

Activity data used for the GHG emissions of the aggregate sources and non-$CO_2$ emissions sources on land were obtained from various publication sources. The activity data for estimation of GHG emissions from biomass burning and liming sourced from PUSDATIN Ministry of Agriculture; urea application, direct and indirect $N_2O$ emission from managed soil, and indirect $N_2O$ emissions from manure management applied activity data obtained from PUSDATIN Ministry of Agriculture and APPI (Indonesian Fertilizer Producer Association). While, activity data for estimating methane emissions from rice cultivation were obtained from PUSDATIN Ministry of Agriculture (MoA) and BPS.

### g. GHG emissions Estimates

Unlike other sectors, some estimates of national emissions from aggregate sources and non-CO2 emissions sources were based on aggregation of emissions in provinces. For rice cultivation and biomass burning (cropland and grassland), data were gathered from provincial level, while for urea and liming application as well as managed soil, data were

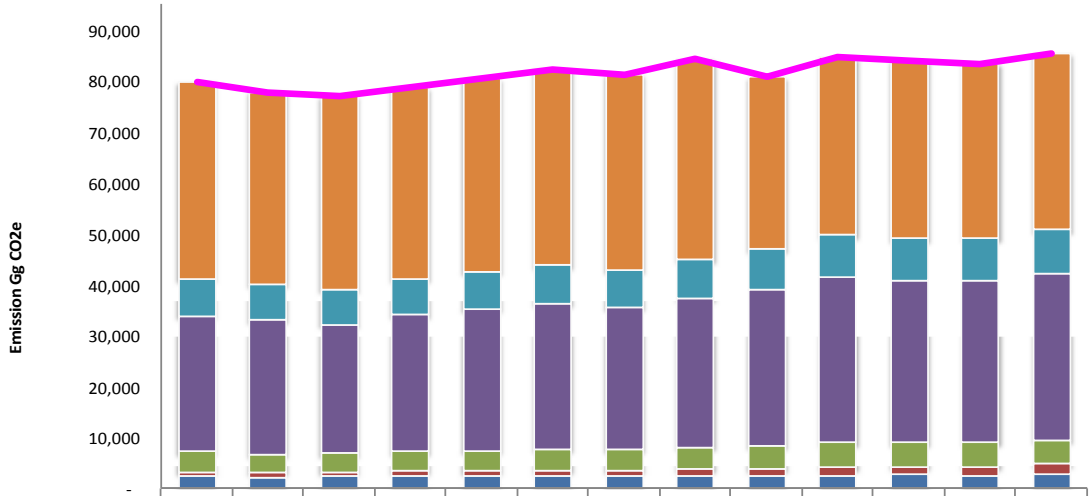
gathered from national level. Because of this, variation in biophysical conditions between provinces was taken into consideration in defining emissions factors.

From the analysis it was found that in 2000, total emissions of the three main GHGs ($CO_2$, $CH_4$ and $N_2O$) from this sector was 79,709 Gg $CO_2$-e and in 2012, they had increased by 5% to 85,263 Gg $CO_2$-e (Table 2.17). Methane contributed to approximately 48% of the total emissions, while $N_2O$ contributed 44% and $CO_2$ contributed 8% to the total emissions.

Table 2-17. GHG emissions from the Agricultural Sector from 2000 to 2012 by Gas (in Gg $CO_2$-e)

| Year | $CO_2$ | $CH_4$ | $N_2O$ | Total |
|---|---|---|---|---|
| | ---------- Gg $CO_2$e ---------- | | | |
| 2000 | 4,772 | 40,266 | 34,671 | 79,709 |
| 2001 | 4,495 | 39,300 | 33,950 | 77,744 |
| 2002 | 4,523 | 39,429 | 32,936 | 76,889 |
| 2003 | 4,810 | 39,021 | 34,636 | 78,467 |
| 2004 | 5,113 | 39,333 | 35,796 | 80,241 |
| 2005 | 5,301 | 40,221 | 36,715 | 82,237 |
| 2006 | 5,269 | 39,978 | 35,908 | 81,156 |
| 2007 | 5,639 | 41,065 | 37,439 | 84,144 |
| 2008 | 5,855 | 35,465 | 39,278 | 80,598 |
| 2009 | 6,305 | 36,607 | 41,527 | 84,439 |
| 2010 | 6,225 | 36,898 | 40,794 | 83,917 |
| 2011 | 6,444 | 35,970 | 40,814 | 83,228 |
| 2012 | 6,625 | 36,719 | 41,919 | 85,263 |

By source, the major emissions were from rice cultivation, direct $N_2O$ emissions and indirect $N_2O$ emissions. These three sources accounted for approximately 90% of the total GHG emissions from this sector (Figure 2.52).




| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rice Cultivation | 38,587 | 37,720 | 37,813 | 37,374 | 37,679 | 38,510 | 38,283 | 39,272 | 33,679 | 34,776 | 34,990 | 34,134 | 34,641 |
| Indirect N2O Soils | 7,254 | 7,108 | 6,951 | 7,167 | 7,405 | 7,514 | 7,383 | 7,651 | 7,953 | 8,372 | 8,333 | 8,331 | 8,479 |
| Direct N2O Soils | 26,775 | 26,237 | 25,366 | 26,839 | 27,758 | 28,546 | 27,876 | 29,102 | 30,641 | 32,454 | 31,731 | 31,780 | 32,646 |
| 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 |
| Liming | 872 | 933 | 976 | 1,001 | 1,057 | 1,091 | 1,146 | 1,200 | 1,275 | 1,441 | 1,515 | 1,631 | 1,771 |
| 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 |
| Total | 79,709 | 77,744 | 76,889 | 78,467 | 80,241 | 82,237 | 81,156 | 84,144 | 80,598 | 84,439 | 83,917 | 83,228 | 85,263 |

**Figure 2.52.** GHG Emissions from Agricultural Sector from 2000-2012 by Source

By source category, GHG emissions from aggregate sources and non-$CO_2$ emissions sources on land are reported below.

## Emission from Biomass Burning

**Prescribed Savannah Burning (Grassland Burning).** Emissions from grassland burning were calculated based on the harvested area of upland rice in the period 2000 to 2012, which were derived from MoA. The emissions of $CH_4$, CO, $N_2O$ and $NO_x$ from grassland burning are shown in Table 2.18.

Table 2-18. Distribution of GHG Emissions from Grassland Burning from 2000-2012 (in Gg)

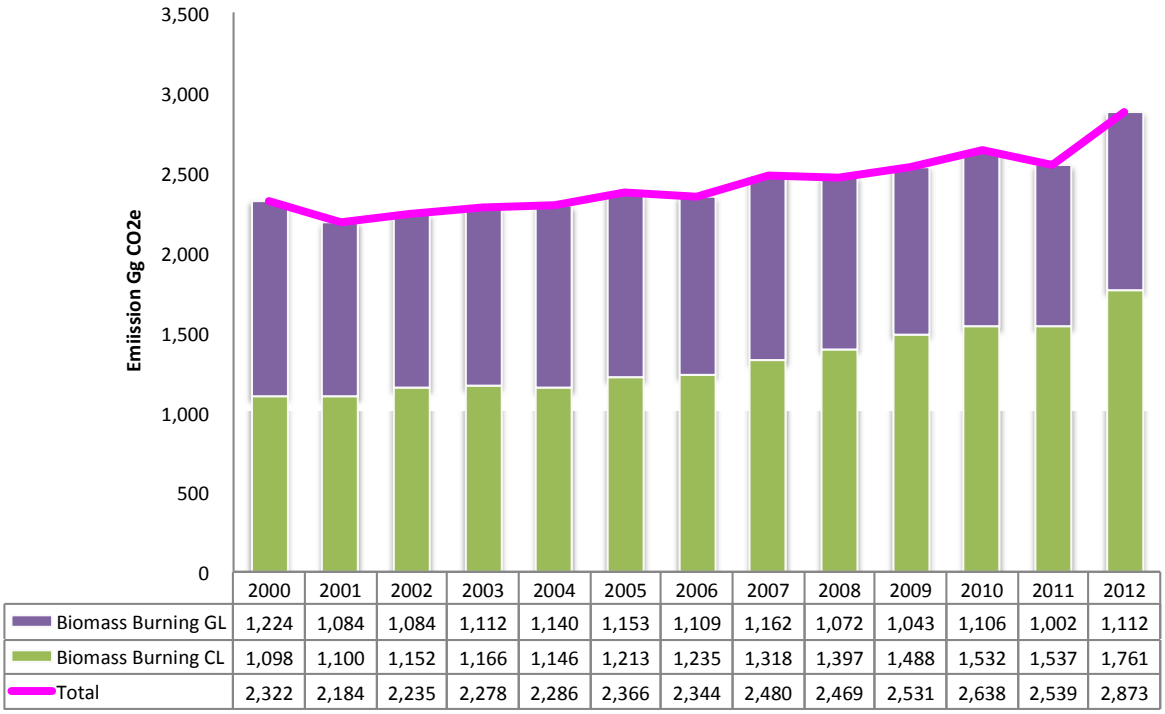
| GHG's emission | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Gg CH4 | 42.1 | 37.3 | 37.3 | 38.3 | 39.3 | 39.7 | 38.2 | 40.0 | 36.9 | 35.9 | 38.1 | 34.5 | 38.3 |
| Gg CO | 1,436.0 | 1,272.0 | 1,271.7 | 1,304.8 | 1,337.6 | 1,353.2 | 1,301.8 | 1,363.9 | 1,257.8 | 1,224.3 | 1,297.9 | 1,175.4 | 1,304.4 |
| Gg N20 | 1.1 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 0.9 | 1.0 | 0.9 | 1.0 |
| Gg Nox | 39.0 | 34.6 | 34.6 | 35.5 | 36.3 | 36.8 | 35.4 | 37.1 | 34.2 | 33.3 | 35.3 | 31.9 | 35.4 |
| Gg CO2-e | 1,224 | 1,084 | 1,084 | 1,112 | 1,140 | 1,153 | 1,109 | 1,162 | 1,072 | 1,043 | 1,106 | 1,002 | 1,112 |

**Field Burning of Agriculture Residue (Cropland burning).** Emissions from cropland burning were calculated based on data of the harvested area of rice and production, derived from MoA. The emissions of $CH_4$, CO, $N_2O$ and $NO_x$ from cropland burning are shown in Table 2.19.

Table 2-19. Distribution of GHG Emissions from Cropland Burning from 2000-2012 (in Gg)

| GHG's emission | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Gg CH4 | 37.8 | 37.9 | 39.7 | 40.1 | 39.5 | 41.8 | 42.5 | 45.4 | 48.1 | 51.2 | 52.7 | 52.9 | 60.6 |
| Gg CO | 1,288.5 | 1,290.9 | 1,351.3 | 1,368.0 | 1,345.3 | 1,423.2 | 1,449.2 | 1,546.6 | 1,639.5 | 1,746.1 | 1,797.4 | 1,803.6 | 2,066.4 |
| Gg N20 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.1 | 1.1 | 1.2 | 1.2 | 1.3 | 1.4 | 1.4 | 1.6 |
| Gg Nox | 35.0 | 35.1 | 36.7 | 37.2 | 36.6 | 38.7 | 39.4 | 42.0 | 44.6 | 47.4 | 48.8 | 49.0 | 56.2 |
| Gg CO2-e | 1,098 | 1,100 | 1,152 | 1,166 | 1,146 | 1,213 | 1,235 | 1,318 | 1,397 | 1,488 | 1,532 | 1,537 | 1,761 |

Results showed slight decrease of grassland burning annualy, while emissions from cropland burning increased (Figure 2.53). The total emissions from biomass burning in 2000 were 2,322 Gg $CO_2$-eq and increased slightly to approximately 24% to be 2,873 Gg $CO_2$-eq.




| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Biomass Burning GL | 1,224 | 1,084 | 1,084 | 1,112 | 1,140 | 1,153 | 1,109 | 1,162 | 1,072 | 1,043 | 1,106 | 1,002 | 1,112 |
| Biomass Burning CL | 1,098 | 1,100 | 1,152 | 1,166 | 1,146 | 1,213 | 1,235 | 1,318 | 1,397 | 1,488 | 1,532 | 1,537 | 1,761 |
| Total | 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 |

**Figure 2.53.** Emissions from Biomass Burning in the Period 2000 – 2012

## Liming

The $CO_2$ emissions from liming were determined from the recommended dose of lime for palm oil plantations, rubber and cocoa, which were planted on acid sulphate and organic soils. Liming food crops was rarely applied by farmers. Using this method, the $CO_2$ emissions from liming in 2000 to 2012 are shown in Figure 2.54. Lime consumption in Indonesia increased consistently with the expansion of peatlands for palm oil plantation after the year 2000. In 2000, the $CO_2$emission from liming was 872 Gg $CO_2$ and increased more than 100% to 1,771 Gg $CO_2$ in 2012.


**Figure 2.54.** $CO_2$ Emissions from Liming in Agriculture

## Urea Fertilization

Activity data on urea consumption for the years 2000-2012 were derived from fertilizer consumption in domestic market from APPI (Indonesian Fertilizer Producers Association). In addition, urea application was also estimated from oil palm plantation (excluding smallholder plantation) by multiplying the recommended dose of the urea. The $CO_2$ emissions from urea application in agricultural sector are given in Figure 2.55, giving a figure of 3,900 Gg CO2 in 2000 and 4,853 Gg $CO_2$in 2012. The increased emission in adding the urea followed the increased in crop production especially rice, where the harvested area of rice paddy expanded consistently from year to year.

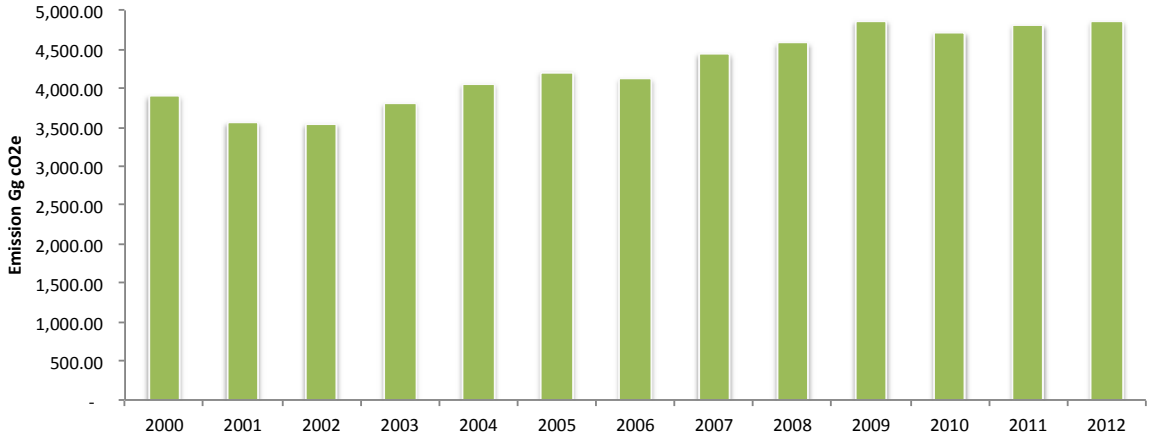



**Figure 2.55.** $CO_2$ Emissions from Urea Fertilization from 2000-2012

## $N_2O$ Emissions from Managed Soils

***Direct $N_2O$ Emissions.*** Urea, Ammonium Sulphate (AS) and nitrogen, phosphorus and potassium (NPK) are the general types of inorganic nitrogen (N) fertilizers that are most commonly used in agricultural sector of Indonesia. Urea and AS are the most common nitrogen-based inorganic fertilizers used in large plantations (APPI, 2008) and crops. In addition, these types of fertilizer are applied to fruits, vegetables and other perennial crops with high economic values. The concentration of N in urea, AS and NPK is 46%, 21% and 15% respectively (Petrokimia Gresik, 2008). Data were obtained on Urea, AS and NPK fertilizer consumption from Indonesian Fertilizer Producer Association (APPI).

Direct $N_2O$ emissions on managed soil and flooded rice were calculated from the levels of application of N fertilizer and animal manure. $N_2O$ emissions from flooded rice paddies were calculated based on harvested area of rice and from managed soil (i.e., maize, soybean and palm oil). The direct $N_2O$ emissions from 2000-2012 on managed soil are shown in Figure 2.56. Fluctuation of $N_2O$ direct emissions from managed soil could be attributed to the consumption of urea and AS in Indonesia agriculture. In 2000, the $N_2O$ direct emissions were 26,775 Gg $CO_2$-e and increased to 32,647 Gg $CO_2$-e in 2012.

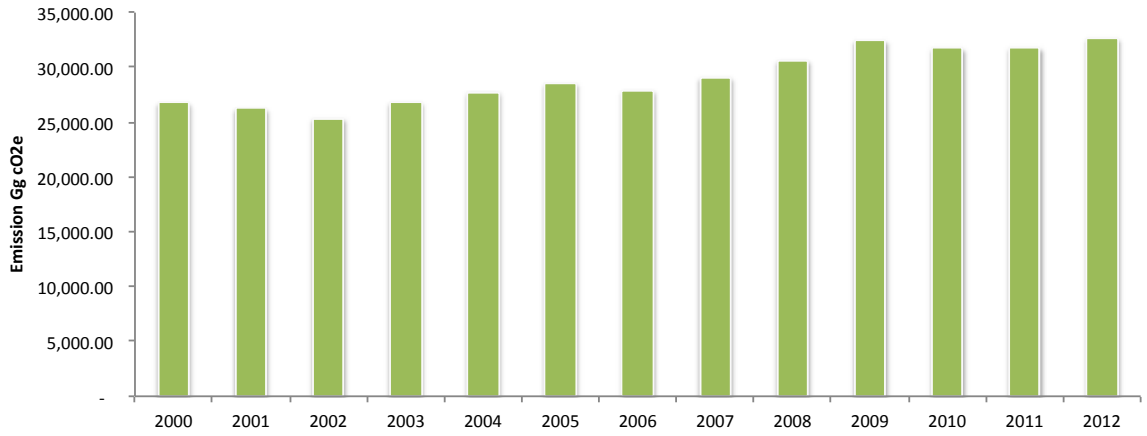



**Figure 2.56.** Direct $N_2O$ Emissions from N Applied to Soils

***Indirect $N_2O$ Emissions.*** Indirect $N_2O$ emissions from soil were also calculated based on the consumption of N fertilizer (urea, AS, NPK and animal manure) in agriculture. The indirect $N_2O$ emissions from N fertilizer for perennial and estate crops were based on the N fertilizer consumption data from 2000 to 2012 and the use of animal manure for agricultural crops. The emissions of indirect $N_2O$ from adding N onto managed soil is depicted in Figure 2.57. In general, the figure showed an increased trend of the indirect $N_2O$ emissions. The emission in 2012 was 8,479 Gg CO2-e.

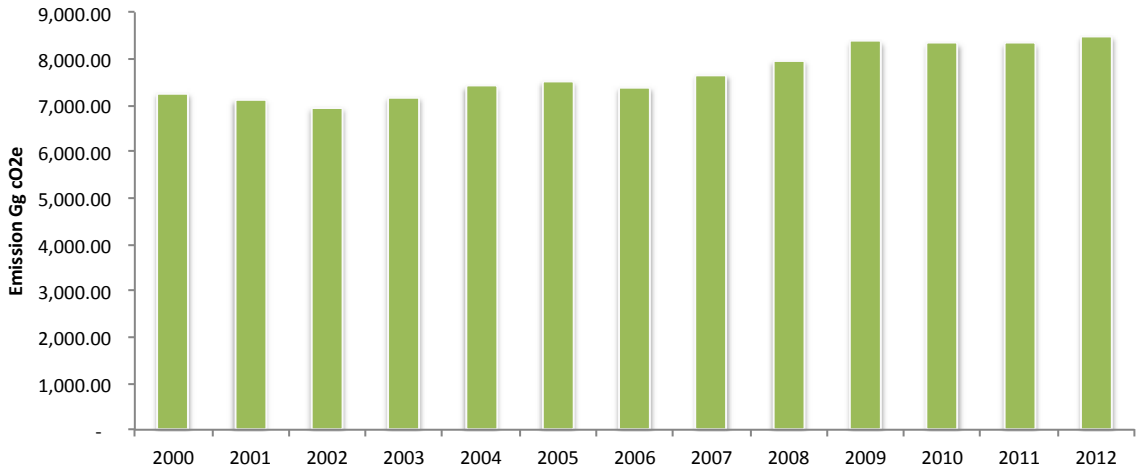



Figure 2.57. Indirect $N_2O$ Emissions from N Applied to Soils

## 2.4.4. Rice Cultivation

Activity data used to calculate the emissions from rice cultivation were based on data of rice field area and planting intensity taken from BPS 2000-2012. Scaling factor for soil was weighted based on proportion of soil type at provincial level. Similar method was used to determine the national scale factor of rice variety, which was calculated by considering a proportion of land area of all rice variety utilized at provincial level. This value was applied for an inventory year, where there was no available information on rice variety utilization or scale factor of certain rice variety. The total $CH_4$ emissions from Indonesia rice fields in 2000 and 2012 were 38,587 and 34,641 Gg $CO_2$-eq, respectively (Figure 2.58). A decrease of 10% in 2012 from emissions in year 2000 could be attributed to mitigation measures, especially the application of low emission rice variety, SRI (System Rice Intensification) and SLPTT (integrated crop management field school).

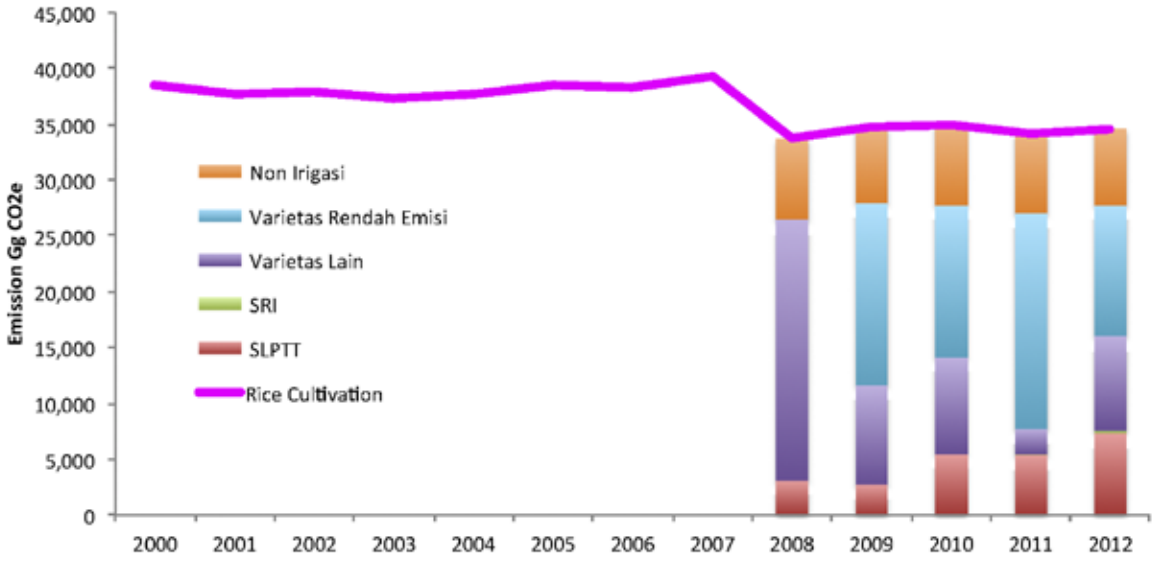



**Figure 2.58.** Methane Emissions from Rice Cultivation from 2000-2012

## 2.4.5. Land (Land Use Change and Forestry/LUCF)

LUCF is one main sector that needs to be considered in developing the inventory, especially its role in carbon cycle. A greater part of carbon exchange between atmosphere and terrestrial biosphere occur in forest. The status and management of forest would determine whether a terrestrial biosphere is a net sink or net source of carbon.

Huge uncertainties in LULUCF inventory have been stated in many country reports. The variation was due to the differences in activity data and emission factors, methodology and assumptions used in the analysis. Types of activity data and emission factors that required to be improved, to obtain reliable estimates of changes in C stocks in terrestrial ecosystems, were the annual biomass increment and forest above ground biomass.

All studies indicated that in 1990, Indonesian forest was still a net sink. However, in the First National Communication, Indonesia has become a net emitter country (INC, 2000) and the SNC report stated that it contributes about 47% of total emissions. Change of status from net sinker into net emitter was primarily due to the change in carbon emissions and removal estimates from LULUCF. Therefore, accurate and reliable activity data and emission factors are very critical in the preparation of good quality national GHG inventories.

### a. Source Category of GHG Emissions from LUCF

Under this sector, sources of emissions were categorized based on six main land uses, in which land is categorized to lands remaining in a land use category and lands converted to a new land use category. The emission/removal from LUCF is therefore classified into 12 category, i.e. (1) forest land remained forest land, (2) land converted to forest land, (3) cropland remained crop land, (4) land converted to cropland, (5) grassland remained grassland, (6) land converted to grassland, (7) wetlands remained wetlands, (8) land converted to wetlands, (9) settlements remained settlements, (10) land converted to settlements, (11) other land remained other land, (12) land converted to other land (Figure 2.59). The total $CO_2$ emissions/removals from C stock changes for each LU category is the sum of those from these all subcategories by considering the five carbon pools: living biomass (above and below), dead organic matters (dead wood and litter), and soil.

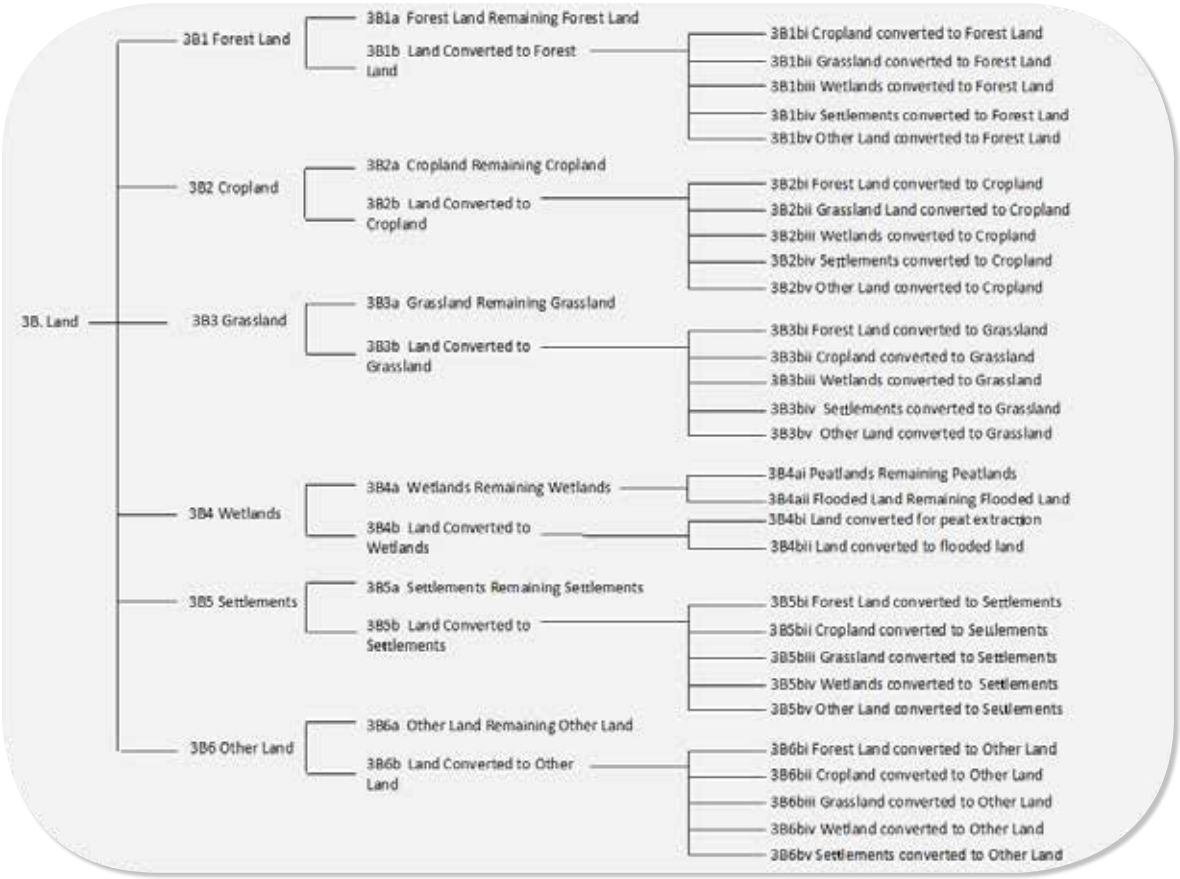



**Figure 2.59.** The Coverage of GHG Emissions Sources from LUCF

## b. Type of Gases

Under the IPCC-2006 GLs, the type of GHG emissions from LUCF was only $CO_2$.

## c. Methodology

The method used to estimate GHG emissions from the LUCF is the IPCC 2006 methodology by combining local emission factors and IPCC default value emission factors. The equation for estimating carbon stock change for the entire land use category is as follows:

$$\Delta C_{AFOLU} = \Delta C_{FL} + \Delta C_{CL} + \Delta C_{GL} + \Delta C_{WL} + \Delta C_{SL} + \Delta C_{OL}$$

Where, ΔC = carbon stock change; AFOLU = Agriculture, Forestry and Other Land Use; FL = Forest Land; CL = Cropland; GL = Grassland; WL = Wetlands; SL = Settlements; and OL = Other Land.

Estimation of carbon stock changes considered subdivisions of land area (e.g., climate zone, ecotype, soil type, management regime etc.) chosen for a land-use category:

$$\Delta C_{LU} = \sum \Delta C_{Lui}$$

Where, $\Delta C_{LU}$ = carbon stock changes for a land-use (LU) category as defined in above equation; I = denotes a specific stratum or subdivision within the land-use category (by any combination of species, climatic zone, ecotype, management regime etc.); and I = 1 to n

Within a land use category, carbon stock changes are estimated for five carbon pools by adding up changes in all pools as in below equation.

$$\Delta C_{Lui} = \Delta C_{AB} + \Delta C_{BB} + \Delta C_{DW} + \Delta C_{LI} + \Delta C_{SO}$$

Where $\Delta C_{Lui}$ = carbon stock changes for a stratum of a land-use category; AB = above-ground biomass; BB = below-ground biomass; DW = deadwood; and LI = litter; SO = soils.

The emission from peat decomposition is estimated for each land use category on peat land by multiplying the area of peat lands with the emission factor.

$$L_{LU\ Organic} = \sum (A \bullet EF)$$

Where $L_{LU\ Organic}$=the $CO_2$ emission from peat decomposition ofa land use category on peatland; A= area of a land use category; and EF = the emission factor from peat decomposition of a land use category.

Emissions from peat fires were estimated following method developed by the National Agency for REDD+ (BPREDD+, 2014). The equation for estimation of emissions from peat fires is following the 2006 IPCC Supplement for Wetland (IPCC, 2013):

$$L_{fire} = A \times MB \times CF \times G_{ef}$$

Where, $L_{fire}$= emission from peat fires; A = burned peat area; MB = mass of fuel available for combustion; CF = combustion factor (default factor = 1.0); and $G_{ef}$ = emissions factor.

The BPREDD+ generated the burned peat area based on MODIS hotspots data using confidence level of more than 80%. The hotspots data overlaid with a raster map with 1×1 km grid (pixel size) and hotspots within pixels which representing burned area of about 75% of 1×1 km grid (i.e. 7,500 ha). This rule applies for each pixel regardless the amount of hotspots within that particular pixel (BPREDD+, 2014). The mass of fuel available for combustion (MB) is estimated from multiplication of mean depth of burned peat (D) and bulk density (BD). It assumes that average peat depth burned by fire is 0.33 m (Ballhorn *et*

*al*., 2009) and bulk density is 0.153 ton/$m^3$ (Mulyani et al., 2012). The emission factor ($G_{ef}$) is estimated indirectly from organic carbon content ($C_{org}$, % of weight), CO2 emission factor ($G_{ef}$) can be indirectly estimated from organic carbon content ($C_{org}$, % of weight), which is equal to $C_{org}$x 3.67.

### d. Time Frame

The GHG emissions inventory reported in this first BUR provided GHG emissions for the period 2000 to 2012 using current activity data.

### e. Data Sources

Land cover map produced by the Ministry of Forestry was used as the basis for generating activity data to estimate emissions from LUCF. The available land cover map data sets used to complete the GHG inventory for these categories were 2000, 2003, 2006, 2009, 2011 and 2012. Overlay process between the land cover data sets of 2000 and 2003 produce land-cover change (LCC) from 2000 to 2003, where the period of land cover transition is 3 years. To determine the annual basis for land-cover change (LCC), such as 2000-2001, 2001-2002,..., 2011-2012, the annual loss of primary (natural) forest and other land use generated by Margono *et al*. (2014) was used as a reference proportion to partitioning the original data sets (2000-2003) into annual data sets (2000-2001, 2001-2002, 2002-2003) and so on. This process produced annual land cover change (LCC), i.e. 2000-2001, 2001-2002, ..., 2011-2012. These set of data allowed for the calculation of emissions from the LUCF annually. The estimated emissions obtained from LCC for 2000-2001 was treated as the emissions inventory for 2001 and so on. The emissions inventory of LUCF in 2000 was derived by averaging the emissions for the years from 2001 to 2003. This approach used the annual LCC of 2000-2001, 2001-2002 and 2002-2003 that were derived from satellite data on 2000 and 2003. This approach was different from that of the SNC (Second National Communication) where the emission estimates derived from land use change in 2000-2001 was treated as the emission inventory of 2000.

In addition, the SNC did not used LCC in the development of GHG Inventory but it used deforestation data from Forest Statistics Reports 2000-2007 (MoFor, 2000-2007). Similar to this report, deforestation data provided in the Forest Statistics Reports was also averaged to arrive at the annual deforestation rate for the period 2000-2003 and 2003-2006. The SNC produced the annual deforestation rate based on this average data and develop crop lands data from the Ministry of Agriculture. It should be noted that the annual rate of deforestation data provided in the Forest Statistic Reports of 2000-2007 were not the same as that calculated from the LCC, since this report used image processing data that has been revised by the Directorate General of Forest Planology.

The main data set of land-cover map was interpreted manually/visually from satellite images into 23 classes of land cover including 6 natural forest classes, and validated by ground checking and high-resolution images. The minimum area of delineated polygon was 0.25 $cm^2$ at 1: 50,000 of scale that equal to 6.25 ha. The common problems in satellite images, such as SLC-off and cloud cover in the tropical region, were compensated by combining multi-temporal Landsat satellite images.

Since land categories in the 2006 IPCC GL consisted of 6 main land use categories, land cover categories by Ministry of Forestry were grouped following the 2006 IPCC GL as shown in Table 2.20. To ensure the variations among regions in the calculation of emissions from LUCF, 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 2-20. Adjustment of Land Cover Category Produced by Ministry of Forestry to the 2006 IPCC GL categories

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

The emission/removal factors used for the calculation of GHG emissions were taken from country-specific studies. The annual growth rate of different land use categories was taken from BAPPENAS (2010) and MoFor (1998; Table 2.21). Carbon stock for various land cover particularly forest cover is available from different parts of Indonesia which was measured from permanent sampling plots (PSPs) of the National Forest Inventory (NFI) of the Ministry of Forestry. Therefore, data were stratified to seven islands of Indonesia. The diameter at breast height (DBH) and wood density (WD) of individual trees in the PSP were converted into above ground biomass (AGB) data using generalized allometric model of Chave *et al.* (2005) for tropical forests. This generalized model was used since the availability of the local allometric models specific for six forest types were not all represented in the seven islands of Indonesia. This model was found to perform equally well as local models in the Indonesian tropical forests (Rutishauser *et al.*, 2013; Manuri *et al.*, 2014). The average carbon stock data of the ABG for different forest types in the seven islands is provided in Table 2.22.

For loss of wood due to wood removal, the activity data of wood removal are taken from Statistical Forestry Report (MoFor, 2001-2012; see Figure 1.13). However, as the official data did not include the wood harvesting from illegal logging, thus the data may need to be adjusted to take into account the illegal wood. So far there is no precise estimate of illegal wood. Based on a number of studies in early 2000, it was suggested that the illegal wood ranged between 17 and 30 million m3 (FAO, 2002). This illegal logging activities was driven mainly by the big deficits between the demand and wood supply. MoFor (2002) estimated that illegal logging might close to 40 million m3 since the round wood demand was around 63.48 million m3, while production was only 23.98 million m3. To cover the figure of wood removal due to illegal logging, the official figure is adjusted with the assumption that the illegal wood in 2000 was about 40 million $m^3$ and in the period 2001 and 2012 decreased linearly with rate of 2.45 million $m^3$ per year as the wood production from timber plantation increased (see Figure 1.13).

Table 2-21. Annual Growth Rate of Different Land use Categories

| Land use/cover | IPCC Category | MAI (tC/ha/year) | Source |
|---|---|---|---|
| Shrubs | GL | 0.2 | BAPPENAS 2010 |
| Swamp Shrubs | GL | 0.6 | BAPPENAS 2010 |
| Dry land Primary Forest | FL | 0 | BAPPENAS 2010 |
| Dry land secondary forest | FL | 1.075 | Mean of MoFor 1998 |
| Mangrove Primary Forest | FL | 0 | BAPPENAS 2010 |
| Mangrove Secondary Forest | FL | 2.8 | MoFor 1998 |
| Swamp Primary Forest | FL | 0 | BAPPENAS 2010 |
| Swamp Secondary Forest | FL | 1.075 | Mean of MoFor 1998 |
| Plantation Forest | FL | 4.8 | BAPPENAS 2010 |

| Land use/cover | IPCC Category | MAI (tC/ha/year) | Source |
|---|---|---|---|
| Settlement | SL | 0.2 | BAPPENAS 2010 |
| Agriculture Plantation | CL | 2.52 | BAPPENAS 2010 |
| Mining | OL | 0 | BAPPENAS 2010 |
| Dry land agriculture | CL | 0.2 | BAPPENAS 2010 |
| Dry land agriculture mixed with shrubs | CL | 0.6 | BAPPENAS 2010 |
| Swamp | WL | 0.1 | BAPPENAS 2010 |
| Savannah/ grassland | GL | 0.2 | BAPPENAS 2010 |
| Rice paddy | CL | 0 | BAPPENAS 2010 |
| Ponds | OL | 0 | BAPPENAS 2010 |
| Open land | OL | 0.1 | BAPPENAS 2010 |
| Transmigration (Tr) | CL | 1.32 | BAPPENAS 2010 |

The emission factors for peat decomposition were taken from the 2013 Supplement to the 2006 IPCC Guidelines for National GHG Inventory: Wetlands (IPCC, 2013) and from available studies across Indonesia. Most of emission factors for peat decomposition from the 2013 Supplementary Report were developed in Indonesia. The emission factors for peat decomposition are presented in Table 2.23.

Table 2-22. The Estimates of Carbon Stocks of the AGB in Each Forest Type

| Forest type | Main island | Mean AGB (t $ha^{-1}$) | 95% Confidence Interval (t $ha^{-1}$) | | N of plot measurement |
|---|---|---|---|---|---|
| *Primary Dryland Forest* | Bali Nusa Tenggara | 274.4 | 247.4 | 301.3 | 52 |
| | Jawa | nd | nd | nd | nd |
| | Kalimantan | 269.4 | 258.2 | 280.6 | 333 |
| | Maluku | 301.4 | 220.3 | 382.5 | 14 |
| | Papua | 239.1 | 227.5 | 250.6 | 162 |
| | Sulawesi | 275.2 | 262.4 | 288.1 | 221 |
| | Sumatera | 268.6 | 247.1 | 290.1 | 92 |
| | Indonesia | 266.0 | 259.5 | 272.5 | 874 |
| *Secondary Dryland Forest* | Bali Nusa Tenggara | 162.7 | 140.6 | 184.9 | 69 |
| | Jawa | 170.5 | na | na | 1 |
| | Kalimantan | 203.3 | 196.3 | 210.3 | 608 |
| | Maluku | 222.1 | 204.5 | 239.8 | 99 |
| | Papua | 180.4 | 158.5 | 202.4 | 60 |
| | Sulawesi | 206.5 | 194.3 | 218.7 | 197 |
| | Sumatera | 182.2 | 172.1 | 192.4 | 265 |
| | Indonesia | 197.7 | 192.9 | 202.5 | 1299 |

| Forest type | Main island | Mean AGB (t ha$^{-1}$) | 95% Confidence Interval (t ha$^{-1}$) | | N of plot measurement |
|---|---|---|---|---|---|
| *Primary Swamp Forest* | Bali Nusa Tenggara | na | na | na | na |
| | Jawa | na | na | na | na |
| | Kalimantan | 274.8 | 269.2 | 281.9 | 3 |
| | Maluku | na | na | na | na |
| | Papua | 178.8 | 160.0 | 197.5 | 67 |
| | Sulawesi | 214.4 | -256.4 | 685.2 | 3 |
| | Sumatera | 220.8 | 174.7 | 266.9 | 22 |
| | Indonesia | 192.7 | 174.6 | 210.8 | 95 |
| *Secondary Swamp Forest* | Bali Nusa Tenggara | na | na | na | na |
| | Jawa | na | na | na | na |
| | Kalimantan | 170.5 | 158.6 | 182.5 | 166 |
| | Maluku | na | na | na | na |
| | Papua | 145.7 | 106.7 | 184.7 | 16 |
| | Sulawesi | 128.3 | 74.5 | 182.1 | 12 |
| | Sumatera | 151.4 | 140.2 | 162.6 | 160 |
| | Indonesia | 159.3 | 151.4 | 167.3 | 354 |
| *Primary Mangrove Forest*[a,b,c] | Kalimantan | 263.9 | 209.0 | 318.8 | 8 |
| *Secondary Mangrove Forest*[b,c] | Kalimantan and Sulawesi | 201.7 | 134.5 | 244.0 | 12 |

Notes: [a] Murdiyarso *et al*., 2009; [b] Krisnawati *et al*., 2014; [c] Donato *et al*., 2011; nd = no data; na = not applicable

## f. GHG emissions Estimates

The emissions of LUCF sector from 2000-2012 were summarized using the 2006 IPCC GLs and the 1996 IPCC GLs and are shown in the Table 2.24 and 2.25 respectively. The emission in 2000 was 505,369 Gg $CO_2$e, while in 2012 694,978 Gg $CO_2$e. Table 2.24 showed that on average, during the period 2000-2012, forest lands sequestered $CO_2$e at a rate of about 24,454 Gg per year, while for others, i.e. crop land, grassland, settlement and other land emissions, the GHGs rate were 36,553 Gg, 33,428 Gg, 1,512 Gg and 56,588 Gg $CO_2$e per year respectively. Whereas, $CO_2$ emissions from peat decomposition occurring in these lands totalled to about 290,285 Gg $CO_2$e per year and from peat fires about 195,367 Gg $CO_2$e per year. Thus in total, the average net emissions from LUCF amounted to 49,091 Gg $CO_2$ annually.

Table 2-23. Emission Factors of Peat Decomposition from Various Land Cover and Land use Types

| No. | Land cover | Emission (t CO2 $ha^{-1}$ $th^{-1}$) | 95% confidence interval | | Sources |
|---|---|---|---|---|---|
| 1. | Primary forest | 0 | 0 | 0 | IPCC (2006) |
| 2. | Secondary forest | 19 | -3 | 35 | IPCC (2013) |
| 3. | Plantation forest | 73 | 59 | 88 | IPCC (2013) |
| 4. | Estate crop | 40 | 21 | 62 | IPCC (2013) |
| 5. | Pure dry agriculture | 51 | 24 | 95 | IPCC (2013) |
| 6. | Mixed dry agriculture | 51 | 24 | 95 | IPCC (2013) |
| 7. | Dry shrub | 19 | -3 | 35 | IPCC (2013) |
| 8. | Wet shrub | 19 | -3 | 35 | IPCC (2013) |
| 9. | Savannah and Grasses | 35 | -1 | 73 | IPCC (2013) |
| 10. | Paddy Field | 35 | -1 | 73 | IPCC (2013) |
| 11. | Open swamp | 0 | 0 | 0 | Waterlogged condition, assumed zero CO2 emission |
| 12. | Fish pond/aquaculture | 0 | 0 | 0 | Waterlogged condition, assumed zero CO2 emission |
| 13. | Transmigration areas | 51 | 24 | 95 | Assumed similar to mixed upland agriculture |
| 14. | Settlement areas | 35 | -1 | 73 | Assumed similar to grassland |
| 15. | Port and harbour | 0 | 0 | 0 | Assumed zero as most surface is sealed with concrete. |
| 16. | Mining areas | 51 | 24 | 95 | Assumed similar to bare land |
| 17. | Bare ground | 51 | 24 | 95 | IPCC (2013) |
| 18. | Open water | 0 | 0 | 0 | Waterlogged condition, assumed zero CO2 emission |
| 19. | Clouds and no-data | Nd | nd | nd | |

Referring to Table 2.25, the main source of emissions from LUCF in addition to peat decomposition and peat fire are forest and grassland conversion. The average emission in the period 2000-2012 from these three sources amounted to 638,189 Gg $CO_2$e per year comprised of 45.5% from peat decomposition, 30.6% from peat fireand 23.9 % from forest and grassland conversions. Where as the abandoned managed lands sequestered carbon at a rate of 39,904 Gg $CO_2$e annually. Nevertheless, the inter-annual variability of emission from this sector is very high (Figure 2.60).

Table 2-24. Summary of Emission from LUCF Sector using the 2006 IPCC Guideline

| Code | Source Categories | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 |
| 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 |
| 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 |
| 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 |
| 3B3a | Grassland remaining Grassland | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 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 |
| 3B4a | Wetland remaining Wetland | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3B4b | Non-Wetland to Wetland | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3B5a | Settlement remaining Settlement | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3B5b | Non-Settlement to settlement | 1,864 | 2,200 | 1,777 | 1,615 | 1,482 | 971 | 1,348 | 1,252 | 943 | 1,406 | 1,370 | 1,677 | 1,753 |
| 3B6a | Otherland remaining Otherland | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 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 |
| | Other: | | | | | | | | | | | | | |
| | - Peat Decomposition | 283,223 | 267,531 | 268,545 | 269,650 | 274,431 | 280,818 | 286,289 | 292,825 | 297,349 | 303,567 | 312,968 | 322,595 | 328,567 |
| | - 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 |
| | Total | **505,369** | **380,129** | **674,943** | **461,035** | **707,870** | **698,525** | **989,956** | **616,562** | **595,468** | **920,501** | **434,788** | **616,335** | **694,978** |

Table 2-25. Summary of Emission from LUCF Sector using the 1996 IPCC Reporting Format

| | Source Category | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5A | Changes in forest & other woody biomass stocks | 20,892 | 18,186 | 37,191 | 7,299 | 46,041 | 24,978 | 40,052 | 61,045 | 28,014 | 66,727 | -17,877 | 647 | -16,327 |
| 5B | Forest and grassland conversion | 96,320 | 85,405 | 109,539 | 94,015 | 197,784 | 175,637 | 194,552 | 241,457 | 228,823 | 290,039 | 126,076 | 141,440 | 214,226 |
| 5C | Abandonment of managed lands | -41,632 | -41,671 | -41,590 | -41,634 | -41,511 | -41,265 | -40,835 | -39,963 | -38,974 | -37,816 | -37,626 | -37,156 | -37,076 |
| 5D | $CO_2$ emissions and removals from soils | 268,218 | 267,324 | 268,050 | 269,280 | 273,537 | 280,289 | 285,477 | 291,276 | 295,861 | 301,632 | 312,831 | 322,379 | 327,106 |
| 5E | Others: | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | - Forest Burning | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | - 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 |
| | **TOTAL** | 505,369 | 380,129 | 674,943 | 461,035 | 707,870 | 698,525 | 989,956 | 616,562 | 595,468 | 920,501 | 434,788 | 616,335 | 694,978 |

Figure 2.60 suggests that high variability of emission in the LUCF sectors are mainly due to high fluctuation of emission from peat fires, forest and grassland conversion, changes in forest and other woody biomass stocks. In Indonesia, big peat fires often coincided with El Nino events. Deforestation rate was also fluctuated from year to year. Between 2000 and 2012, the annual rate of deforestation varied from 0.335 million ha/year up to 1.106 million ha/year.


**Figure 2.60.** GHG Emissions from LUCF Sector from 2001-2012 by Source Category

Compare to the Second National Communication (SNC), the reported emission of LUCF sector in this 1st BUR was lower (Table 2.26). As previously mentioned, these differences were mainly due to the significant change in activity data (deforestation rate). Table 2.27 presents the rate of deforestation data of SNC and BUR. It is clear that deforestation data used in SNC was much higher than that of BUR.

Table 2-26. Comparison of Emissions Estimates from LUCF between SNC and BUR

| Emission | NC | 2000-01 | 2001-02 | 2002-03 | 2003-04 | 2004-05 | 2005-06 |
|---|---|---|---|---|---|---|---|
| Emissions (Gg $CO_2$-eq) | SNC | 649,254 | 560,546 | 1,287,495 | 345,489 | 617,423 | 674,828 |
| | BUR | 343,798 | 329,244 | 373,190 | 328,960 | 475,851 | 439,638 |
| Differences (SNC-BUR) | | 305,456 | 231,302 | 914,305 | 16,529 | 141,572 | 235,190 |

Table 2-27. Comparison of Deforestation Rate in SNC and BUR

| | | 2000-01 | 2001-02 | 2002-03 | 2003-04 | 2004-05 | 2005-06 |
|---|---|---|---|---|---|---|---|
| Deforestation Rate (million ha) | SNC | 1.0182 | 0.9263 | 1.898 | 0.635 | 0.958 | 1.001 |
| | BUR | 0.336 | 0.426 | 0.363 | 0.866 | 0.801 | 0.852 |
| Differences (SNC-BUR) | | 0.682 | 0.500 | 1.535 | -0.231 | 0.157 | 0.149 |

## 2.4.6. Waste Sector

### a. Main Source Category of GHG Emissions

Under the IPCC-2006 Guidelines, the main source of GHG emissions from waste sector was waste treatment activities. The sources were classified in four categories (see Figure 2.61), i.e. (a) municipal solid waste (MSW) treatments in solid waste disposal site (SWDS) or landfill, biological treatment/composting unit, open burning site, and incinerator, (b) domestic liquid waste treatment (collected and treated in centralized domestic WWT as well as un-collected such as septic tank, latrine, etc.), (c) industrial waste water treatment, and (d) industrial solid waste treatment. Due to the difficulties in data collection and identification, not all GHG emissions from these waste treatment activities could be reported in this first BUR, i.e. industrial solid waste (including sludge from waste water treatment plant), clinical waste, hazardous waste, etc. However, compared to the SNC, the coverage of GHG emissions of the waste sector reported in this first BUR is wider, i.e. by including several types of industries that were not covered in the SNC.

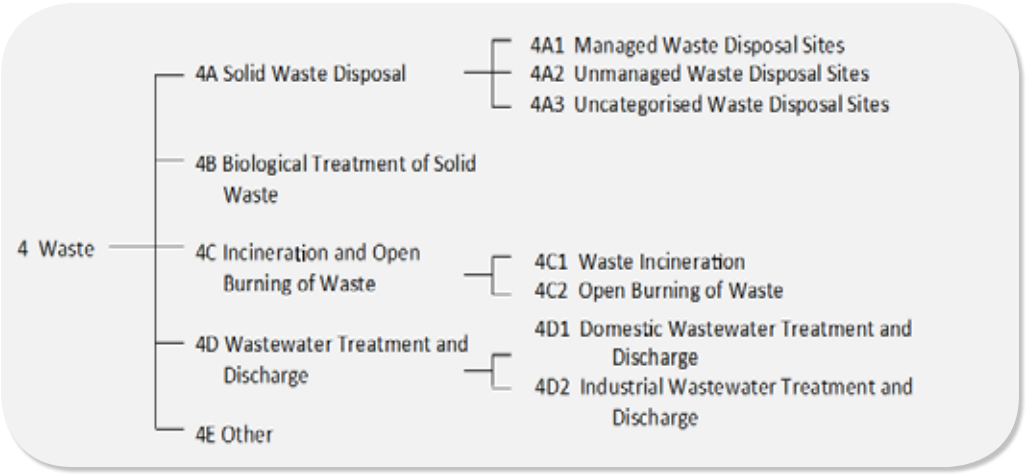



**Figure 2.61.** Main Source of GHG Emissions from Waste Sector

## b. Type of Gases

Based on IPCC 2006 GLs, the types of GHG from waste sector included $CO_2$, $CH_4$, and $N_2O$. In waste sector, $CO_2$was released from incineration, open burning, and composting processes. $CH_4$was mainly released from an-aerobic digestion processes, i.e. at solid waste disposal site or SWDS (landfill), waste water treatment plant, etc. $N_2O$ was mainly released from biological process in composting activity and municipal wastewater treatment facilities.

## c. Methodology

GHG emissions level of waste sector was dependent on the amount of waste to be treated and characteristics of the wastes and the treatment processes. The calculated GHG emissions, however, dependent on the methodology used to estimate the GHG emissions level. In this first BUR report, almost all GHG emissions level in GHG inventory of waste sector were estimated using the same methodology as that used in the SNC, i.e. Tier 1 methods of IPCC-2006 GLs, in which regional default values and other relevant parameters of IPCC 2006 GLs were used.

Some improvements have been made in estimating GHG emissions level from MSW treatment in SWDS. Instead of mass balance method, which was used in the SNC, the GHG emissions from SWDS reported in this first BUR was estimated using FOD (First Order Decay) method. In addition, local parameters related to emission factor have been used in this FOD method. The local parameters were waste composition and dry matter contents.

Improvement has also been made in the estimation of GHG emissions from industrial wastewater treatment. Instead of using the default values of IPCC 2006 GLs, GHG emissions

level was estimated using parameters collected from industries, i.e. wastewater flow rate, wastewater COD level and also the types of wastewater treatment facilities.

### d. Time Frame

The GHG inventory reported in this first BUR covered GHG emissions generated in the year 2000 to2012. GHG emissions level reported in the SNC for 2000 – 2005 have been revised due to changes in methodology and revision of activity data and related parameters.

### e. Data Sources

Data and information related to GHG emissions inventory of waste category were collected from several publications (see Table 2.28), namely:

- ADIPURA data for the amount of MSW to be dumped at SWDS;
- PROPER data for industrial liquid waste (influent flow rate, COD content of influent, and type of wastewater treatment plant).
- BPS and economic and social national surveys (SUSENAS) for population (for estimating the amount of domestic waste water to be treated), characteristics of domestic waste water treatment;
- Others relevant data and parameters were referred to the default value of IPCC 2006 GLs.

ADIPURA is an annual reward granted by the Ministry of Environment (MoE) for cities that showed well managed environmental quality. One of ADIPURA criteria is the management of municipal solid waste. During the ADIPURA process, every city must submit reports concerning the state of their environmental quality and management. Data concerning the amount of MSW generation and their treatment were retrieved from ADIPURA documents.

PROPER is an annual assessment system by MoE for industries to evaluate their environmental compliance level. Industries with high quality environmental compliance were granted with GOLD status while industries with lesser compliance level were granted with GREEN, BLUE, RED and BLACK (worst). Data collected during PROPER assessment process included industrial wastewater and solid waste. Data concerning the amount of industrial wastewater and solid waste and their treatment facilities were collected from PROPER document.

In addition, inputs from industries, associations, and Ministry of Industry (MoI) gathered in several focus group discussions related to the preparation of the GHG inventory were also used in the estimation of GHG emissions reported in this first BUR.

Table 2-28. Sources of Data

| IPCC Category | Type of Data | | Data Year | Data Sources |
|---|---|---|---|---|
| 4A SWDS,<br>4B Composting,<br>4C Open burning | AD | Waste generation | 2000-2010 actual data<br>2011-2012 extrapolation<br>1990-1999 back-casting | ADIPURA |
| | | Bulk Density: 0,347ton/$m^3$ | | Pilot Project JICA SP3 North & South Sumatera |
| | | Waste Composition | | |
| | | Dry Matter Content | | |
| | | Waste stream (by fraction)<br>To SWDS : 60%<br>Open burning : 35%<br>Composting : 2%<br>3R : 2%<br>Other (untreated waste) : 1% | | Expert judgment of ADIPURA (2012)<br>Survey of SLHI 2000-2005<br>Judgment from ADIPURA Programme 2012 Compiled from various sources |
| | EF | MCF: 0,8 (open dumping SWDS)<br>DOC: default | | IPCC GL 2006 |
| 4D1 Domestic Wastewater | AD | Population | 2000-2012 | BPS |
| | | BOD: 40 g/person/day | | IPCC GL 2006 |
| | | Protein consumption/capita/year | | BPS |
| | EF | Default | | IPCC GL 2006 |
| 4D2 Industrial Wastewater | AD | Total Production | 2000-2012 | Statistik Industri Manufaktur, BPS<br>Statistik Deptan |
| | | Wastewater flow rate | | PROPER, Industries, MoEF regulation, and Association |
| | | COD Inlet | | |
| | EF | Default | | IPCC GL 2006 |

## f. Activity Data and Parameters for Estimating GHG Emissions Level

Activity data and other relevant parameters used in estimating GHG emissions level were classified based on the source category of IPCC 2006 GLs, i.e. MSW treatment, domestic liquid waste treatments, and industrial wastewater treatment. Activity data and other relevant parameters of each type of this treatment are discussed.

### MSW Treatment

The amount of annual MSW generation was collected from ADIPURA documents that were submitted by all cities in Indonesia. The document provided information on the average fraction of waste brought to landfill (SWDS). Based on this information, the fraction of MSW dumped to SWDS was on average 60%. This figure was used in estimating GHG emissions level of MSW treatment in SWDS.

The amount of MSW that was brought to open burning site was estimated using the assumption that 35% (pfrac=0.35) of MSW was brought to open burning site with burning fraction of the waste of 60% (bfrac=0.6). In addition, ADIPURA data showed that most cities in Indonesia started to treat their wastes through composting and 3R in 2006. The average amount of MSW to be composted and 3R were each 2% of total MSW generated in the city. Type of waste treatment for the rest of the waste generated in the city was considered as untreated. The activity data (amount of MSW to be treated) of each treatment facility is presented in Figure 2.62 and Appendix A7.

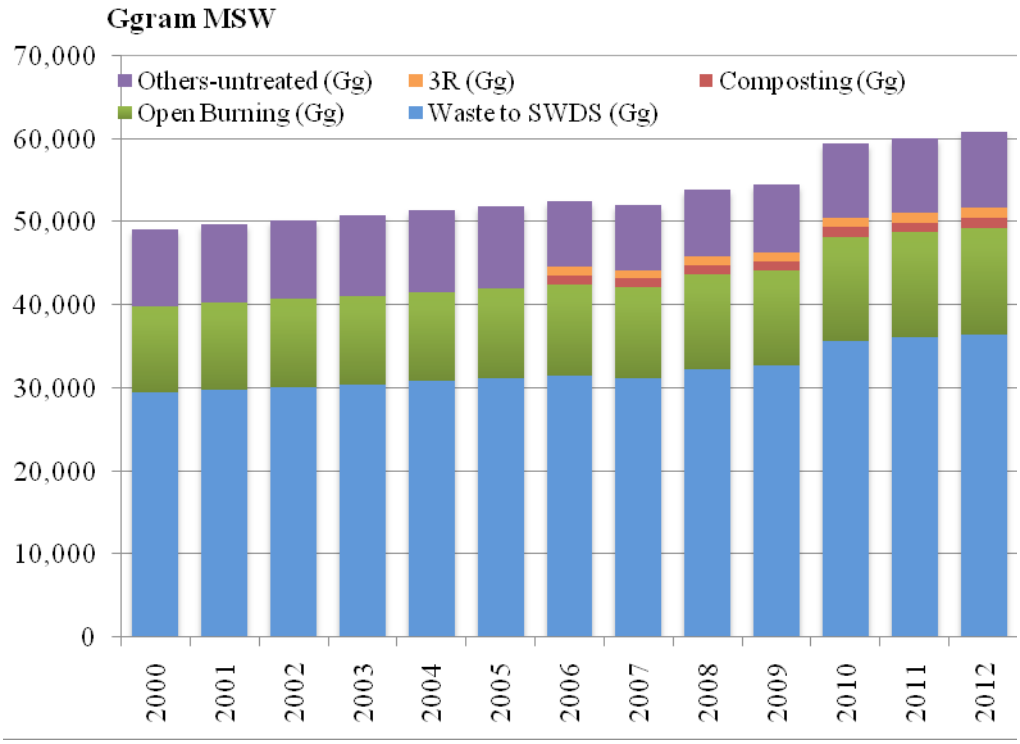



**Figure 2.62.** The Amount of MSW to be treated, by Type of Treatment Facilities

As mentioned previously, the GHG emissions level is dependent on the characteristics of the wastes. The characteristics consisted of waste composition, dry matter content, and DOC (Degradable Organic Carbon). In this first BUR, the local characteristics, i.e. waste composition and dry matter content were used to estimate GHG emissions from waste sector while the DOC characteristics of the waste was the default value of IPCC 2006 GLS.

The local MSW characteristics were developed by the Ministry of Environment and Forestry (MoEF) which referred to the result of the study on waste characterization carried out in South Sumatera and North Sumatera. The study was carried by Institut Teknologi Bandung supported by JICA, BLH North Sumatera, BLH South Sumatera, Universitas Sriwijaya, and

Universitas Sumatera Utara. Table 2.29 shows the waste composition, while Table 2.30 shows the dry matter contents. In several SWDS, landfill gas (LFG) has been recovered for electricity generation or for cooking gas in residential (household). The assumption of methane recovery activity in several SWDS is provided in Appendix A8.

Table 2-29. MSW Composition at SWD (landfill)

| Component | | Waste composition (% wet weight) | | | |
|---|---|---|---|---|---|
| | | South Sumatera | North Sumatera | Average | IPCC 2006 GL (South East Asia Region) |
| a. | Food waste | 59% | 50% | 54.5% | 43,5% |
| b. | Paper + cardboard + nappies | 15% | 13% | 14% | 12,9% |
| c. | Wood and garden waste | 3% | 14% | 8.5% | 9,9% |
| d. | Textile | 2% | 3% | 2.5% | 2,7% |
| e. | Rubber & Leather | 0% | 1% | 0.5% | 0,9% |
| f. | Plastic | 19% | 10% | 14.5% | 7,2% |
| g. | Metal | 0% | 0% | 0% | 3,3% |
| h. | Glass | 1% | 1% | 1% | 4,0% |
| i. | Other (inert) | 0% | 7% | 3.5% | 16,3% |

***Source:*** *Ministry of Environment, 2012*

Table 2-30. Dry Matter Content of MSW Dumped at SWDS (landfill)

| Component | | Waste composition (% wet weight) | | | |
|---|---|---|---|---|---|
| | | South Sumatera | Sumatera Utara | Average | IPCC2006 (South East Asia Region) |
| a. | Food waste | 23% | 59% | 46% | 40% |
| b. | Paper + cardboard + nappies | 51% | 44% | 48% | 90% |
| c. | Wood and garden waste | 50% | 57% | 55% | 85% |
| d. | Textile | 56% | 73% | 64% | 80% |
| e. | Rubber & Leather | 84% | 89% | 90% | 84% |
| f. | Plastic | 76% | 57% | 68% | 100% |
| g. | Metal | 100% | 97% | 97% | 100% |
| h. | Glass | 92% | 66% | 79% | 100% |
| i. | Other (inert) | 85% | 95% | 92% | N/A |

*Source: Ministry of Environment, 2012*

## Domestic Liquid Waste

GHG emissions from domestic liquid waste were estimated based on the quantity of waste to be treated, waste characteristics and wastewater treatment. Parameters (BOD/capita/year) used to estimate TOW (annual total organics in municipal wastewater, kg BOD/yr and EF (EF = Bo* MCF, kg $CH_4$/kg BOD) were the default values given in IPCC 2006. Table 2.31 presents waste generation and characteristics while Table 2.32 presents waste treatment characteristics. Table 2.33 presents the number of population and estimated TOW of domestic wastewater treatment and the corresponding generated GHG emissions.

Table 2-31 Waste Generation and Characteristics of Domestic Liquid Waste

| Parameters | Characteristics |
|---|---|
| BOD of wastewater | 40.00 Gram/cap/day<br>14.60 kilo Gram/cap/year |
| Max $CH_4$ prod capacity | 0.60 kg $CH_4$/kg BOD |
| Methane Emission Factor | 0.15 kg $CH_4$/kg BOD |
| Protein consumption per capita per year * | Year / Protein: 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; 2009 19.84; 2010 20.08; 2011 19.96; 2012 19.58 (Consumption, Kg/cap/year) |
| Fraction of N in protein | 0.16 kg N/kg protein |
| F non-consume protein | 1.10 |
| F industrial and commercial co-discharged protein | 1.25 |
| N removed with sludge (default is zero) | 0 kGram |
| Emission factor | 0.005kg $N_2O$-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/year |

*Source: Default value IPCC 2006 GLs, *BPS*

Table 2-32. Domestic Wastewater Treatment Characteristics

| | | Fraction | Degree of utilization | EF (MCF*EF wwt) | Av-EF |
|---|---|---|---|---|---|
| Rural | Septic tank | 0.54 | 0.00 | 0.30 | 0 |
| | Latrine | 0.54 | 0.47 | 0.07 | 0.0168 |
| | Other | 0.54 | 0.00 | 0.06 | 0 |
| | Sewer | 0.54 | 0.10 | 0.30 | 0.0162 |
| | None | 0.54 | 0.43 | 0.00 | 0 |
| Urban high income | Septic tank | 0.12 | 0.18 | 0.30 | 0.0065 |
| | Latrine | 0.12 | 0.08 | 0.42 | 0.0040 |
| | Other | 0.12 | 0.00 | 0.06 | 0 |
| | Sewer | 0.12 | 0.74 | 0.30 | 0.0266 |
| | None | 0.12 | 0.00 | 0.00 | 0 |
| Urban low income | Septic tank | 0.34 | 0.14 | 0.30 | 0.0143 |
| | Latrine | 0.34 | 0.10 | 0.42 | 0.0143 |
| | Other | 0.34 | 0.03 | 0.06 | 0.0006 |
| | Sewer | 0.34 | 0.53 | 0.30 | 0.0541 |
| | None | 0.34 | 0.20 | 0.00 | 0 |
| | | | | | 0.1533 |

*Source: IPCC Guidelines, 2006*

Table 2-33. Population and Estimated TOW of Domestic Wastewater Treatment and Corresponding Generated GHG Emissions in Ggram

| Year | Population | TOW | $CH_4$ | | Nitrogen in effluent (NEFFLUENT) | $N_2O$ | | Ggram $CO_2$-eq |
|---|---|---|---|---|---|---|---|---|
| | (BPS Data*) | (KGram BOD/ year) | Ggram | Ggram $CO_2$-e | (kg N/year) | Ggram | Ggram $CO_2$-e | |
| 2000 | 205,132,500* | 2,994,934,500 | 459 | 9,644 | 801,699,042 | 6.30 | 1,953 | 11,596 |
| 2001 | 208,250,500 | 3,040,457,300 | 466 | 9,790 | 813,884,812 | 6.39 | 1,982 | 11,773 |
| 2002 | 211,415,900 | 3,086,672,140 | 473 | 9,939 | 924,381,139 | 7.26 | 2,252 | 12,191 |
| 2003 | 214,629,400 | 3,133,589,240 | 480 | 10,090 | 954,287,599 | 7.50 | 2,324 | 12,415 |
| 2004 | 217,891,800 | 3,181,220,280 | 488 | 10,244 | 956,195,286 | 7.51 | 2,329 | 12,573 |
| 2005 | 221,203,700 | 3,229,574,020 | 495 | 10,399 | 981,742,058 | 7.71 | 2,391 | 12,791 |
| 2006 | 224,566,000 | 3,278,663,600 | 503 | 10,557 | 967,451,662 | 7.60 | 2,356 | 12,914 |
| 2007 | 227,979,400 | 3,328,499,240 | 510 | 10.718 | 1,055,566,964 | 8.29 | 2,571 | 13,289 |
| 2008 | 231,444,700 | 3,379,092,620 | 518 | 10,881 | 1,068,452,191 | 8.39 | 2,602 | 13,483 |
| 2009 | 234,962,700 | 3,430,455,420 | 526 | 11,046 | 1,025,448,886 | 8.06 | 2,498 | 13,544 |
| 2010 | 238,518,800** | 3,482,374,480 | 534 | 11,213 | 1,053,609,811 | 8.28 | 2,566 | 13,780 |
| 2011 | 241,990,700 | 3,533,064,220 | 542 | 11,377 | 1,062,728,052 | 8.35 | 2,589 | 13,965 |
| 2012 | 245,425,200 | 3,583,207,920 | 549 | 11,538 | 1,057,118,001 | 8.31 | 2,575 | 14,113 |

*Source: Indonesia Population Projection 2010-2035, Statistics Indonesia, 2013*

* The result of the 2000 Population census;
**Indonesia mid year population of 2014 (June)

### Industrial Wastewater

GHG emissions from industrial wastewater were estimated based on the quantity of the waste to be treated, waste characteristics, and wastewater treatment. Parameters (COD/$m^3$ and wastewater flow rate) used to estimate TOW (annual total organics degradable material in wastewater for each industry sector, kg COD/yr) in this first BUR were collected from industries and associations, PROPER data, research studies (BPPT and universities), and regulation of Ministry of Environment, etc. From discussions with industry association, it was found that pulp and paper industry has used processing technology that produced less effluent and low COD content, and therefore emitted less GHG compared to technology that was assumed in the SNC (default value of IPCC 2006 Guideline) report.

Coverage of industries in this first BUR included CPO mills effluent, which was not covered in the SNC.

Parameters related to emission factor, EF = Bo* MCF, kg $CH_4$/kg COD were the default value of IPCC 2006.

Table 2.34 and 2.35 shows production rate data of each type of industry that was used to estimate the quantity of wastewater being treated. Wastewater characteristics and wastewater treatment characteristics are given in Table 2.36 respectively.

## g. GHG Emissions Estimates

GHG emissions inventory of waste sector included GHG emissions from municipal solid waste (MSW), domestic wastewater, and industrial waste water treatment activities. The characteristics of wastewater treatment are summarized in Table 2.37, while the summary of the GHG emissions from waste sector (2000 -2012) is presented in Figure 2.63. This figure indicated that GHG emissions level of MSW and domestic wastewater treatments were relatively constant while the GHG emissions level of industrial wastewater treatment was increasing significantly.

Table 2-34. Production Rate of Each Type Industry in Tonne Product/year

| Industry Type | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|---|---|
| Alcohol refining | 38,105 | 38,257 | 38,410 | 38,564 | 38,729 | 38,970 | 38,970 |
| Beer & Malt | 154,519 | 155,601 | 156,690 | 157,787 | 158,891 | 159,769 | 204,792 |
| Coffee | 108,548 | 112,564 | 116,729 | 121,048 | 125,505 | 129,880 | 682,158 |
| Dairy Products | 387,621 | 410,878 | 435,530 | 461,662 | 489,362 | 516,536 | 516,536 |
| Fish Processing | 870,114 | 900,840 | 932,744 | 965,874 | 1,000,279 | 1,036,011 | 1,036,011 |
| Meat & Poultry | 2,513,003 | 2,741,931 | 3,177,618 | 3,329,360 | 3,522,802 | 3,362,254 | 3,766,860 |
| Organic Chemicals | 963,379 | 963,379 | 963,379 | 963,379 | 963,379 | 963,379 | 1,110,398 |
| Petroleum Refineries* | 52,593,872 | 52,763,816 | 52,263,766 | 52,343,774 | 53,440,818 | 52,217,776 | 46,290,957 |
| Plastics & Resins | 2,511,350 | 2,511,350 | 2,511,350 | 2,511,350 | 2,511,350 | 2,511,350 | 2,511,350 |
| Pulp & Paper (combined) | 10,842,008 | 11,357,152 | 11,896,822 | 12,462,190 | 12,888,500 | 13,675,160 | 14,868,789 |
| Soap & Detergents | 1,348,785 | 1,355,562 | 1,362,373 | 1,369,220 | 1,420,479 | 1,435,293 | 1,435,293 |
| Starch Production | 16,089,020 | 17,054,648 | 16,913,104 | 18,523,810 | 19,424,707 | 19,321,183 | 19,986,640 |
| Sugar Refining | 233,689 | 303,039 | 392,971 | 509,590 | 660,818 | 856,924 | 1,100,000 |
| Vegetable Oils (except CPO) | 8,300,000 | 9,200,000 | 10,300,000 | 11,970,000 | 13,560,000 | 15,560,000 | 16,600,000 |
| Vegetable, Fruits & Juices | 15,476,355 | 16,571,533 | 18,288,203 | 21,003,536 | 22,899,680 | 23,657,087 | 23,657,087 |
| Wine & Vinegar | 56,466 | 56,466 | 56,466 | 56,466 | 56,466 | 96,646 | 116,809 |
| CPO | 8,300,000 | 9,200,000 | 10,300,000 | 11,970,000 | 13,560,000 | 15,560,000 | 16,600,000 |

Table 2-35.Production Rate of Each Type Industry in Tonne Product/year (continued)

| Industry Type | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|
| Alcohol refining | 17,725 | 20,439 | 14,802 | 11,160 | 66,356 | 66,356 |
| Beer & Malt | 249,815 | 222,904 | 221,396 | 205,346 | 205,346 | 205,346 |
| Coffee | 676,475 | 698,016 | 682,591 | 686,921 | 633,991 | 691,163 |
| Dairy Products | 2,476,447 | 1,760,309 | 1,942,516 | 826,976 | 801,668 | 4,641,745 |
| Fish Processing | 1,036,011 | 1,036,011 | 3,318,584 | 2,089,809 | 2,089,809 | 2,089,809 |
| Meat & Poultry | 3,773,519 | 3,840,727 | 3,908,786 | 4,070,100 | 4,220,291 | 4,341,881 |
| Organic Chemicals | 1,257,416 | 1,056,951 | 2,743,573 | 1,480,312 | 1,724,488 | 1,724,488 |
| Petroleum Refineries* | 45,858,946 | 44,906,686 | 45,659,128 | 43,285,636 | 44,604,876 | 41,861,346 |
| Plastics & Resins | 2,511,350 | 2,511,350 | 2,511,350 | 2,511,350 | 2,511,350 | 2,511,350 |
| Pulp & Paper (combined) | 14,963,134 | 14,162,388 | 15,833,324 | 17,565,401 | 19,586,627 | 20,998,978 |
| Soap & Detergents | 1,435,293 | 1,435,293 | 1,439,735 | 1,690,247 | 1,940,760 | 2,665,335 |
| Starch Production | 19,988,058 | 21,756,991 | 22,039,145 | 23,918,118 | 24,044,025 | 24,177,372 |
| Sugar Refining | 1,350,000 | 1,256,000 | 1,256,000 | 1,256,000 | 2,600,000 | 2,600,000 |
| Vegetable Oils (except CPO) | 18,000,000 | 20,500,000 | 22,000,000 | 23,600,000 | 26,200,000 | 28,500,000 |
| Vegetable, Fruits & Juices | 23,657,087 | 23,657,087 | 23,657,087 | 23,657,087 | 30,971,324 | 30,971,324 |
| Wine & Vinegar | 125,355 | 114,308 | 96,383 | 103,654 | 53,976 | 100,837 |
| CPO | 18,000,000 | 20,500,000 | 22,000,000 | 23,600,000 | 26,200,000 | 28,500,000 |

Table 2-36. Wastewater Characteristics of Each Industry

| Industry | Wastewater Flow rate, $m^3$/t product | Source of Data | Chemical Oxygen Demand, $kgCOD/m^3$ | Source of Data |
|---|---|---|---|---|
| Alcohol refining | 24 | IPCC2006 default value | 11 | IPCC2006 default value |
| Beer & Malt | 6 | Ministerial Decree 51/1995 | 2.9 | |
| Coffee | 30 | Ministerial Regulation 5/2014 | 9 | |
| Dairy Products | 5 | Ministerial Decree 51/1995 | 2.7 | |
| Fish Processing | 10 | Ministerial Regulation 5/2014 | 2.5 | |
| Meat & Poultry | 13 | IPCC 2006 default value | 4.1 | |
| Organic Chemicals | 67 | | 3 | |
| Petroleum Refineries | 0.6 | | 1 | |
| Plastics & Resins | 0.6 | | 3.7 | |
| Pulp & Paper (combined) | 60 | Ministerial Decree 51/1995 and Ministry Regulation 5/2014 | 5 | Pulp/Paper Industry & APKI (Pulp/Paper Assc) |
| Soap & Detergents | 8 | Ministerial Decree 51/1995 and Ministerial Regulation 5/2014 | 0.85 | IPCC2006 Default value |
| Starch Production | 30 | Ministerial Regulation 5/2014 | 10 | |
| Sugar Refining | 9 | IPCC 2006 default value | 3.2 | |
| Vegetable Oils (except CPO) | 25 | Ministerial Regulation 5/2014 | 1.2 | |
| Vegetable, Fruits & Juices | 20 | IPCC 2006 default value | 5 | |
| Wine & Vinegar | 23 | | 1.5 | |
| CPO | 3 | Ministerial Decree 51/1995 and Ministerial Regulation 5/2014 | 50 | Average from typical Proper Data and Direct measurement in typical WWT |

Table 2-37. Wastewater Treatment Characteristics

| Type of treatment or discharge | Maximum Methane Producing Capacity $B_0$, kg $CH_4$/kg COD | Methane Correction Factor for the Treatment System ($MCF_j$) | Emission Factor $EF_j$, kg $CH_4$/kg BOD |
|---|---|---|---|
| **Untreated** | | | |
| Sea, river, and lake discharge | 0.25 | 0.1 | 0.25 |
| **Treated** | | | |
| Aerobic treatment plant (well managed) [MCF =0 - 0.1] | 0.25 | 0.1 | 0.025 |
| Aerobic treatment plant (not well managed) | 0.25 | 0.3 | 0.075 |
| Anaerobic digester for sludge | 0.25 | 0.8 | 0.200 |
| Anaerobic reactor (e.g. UASB, Fixed Film Reactor) | 0.25 | 0.8 | 0.200 |
| Anaerobic shallow lagoon | 0.25 | 0.2 | 0.050 |
| Anaerobic deep lagoon | 0.25 | 0.8 | 0.200 |

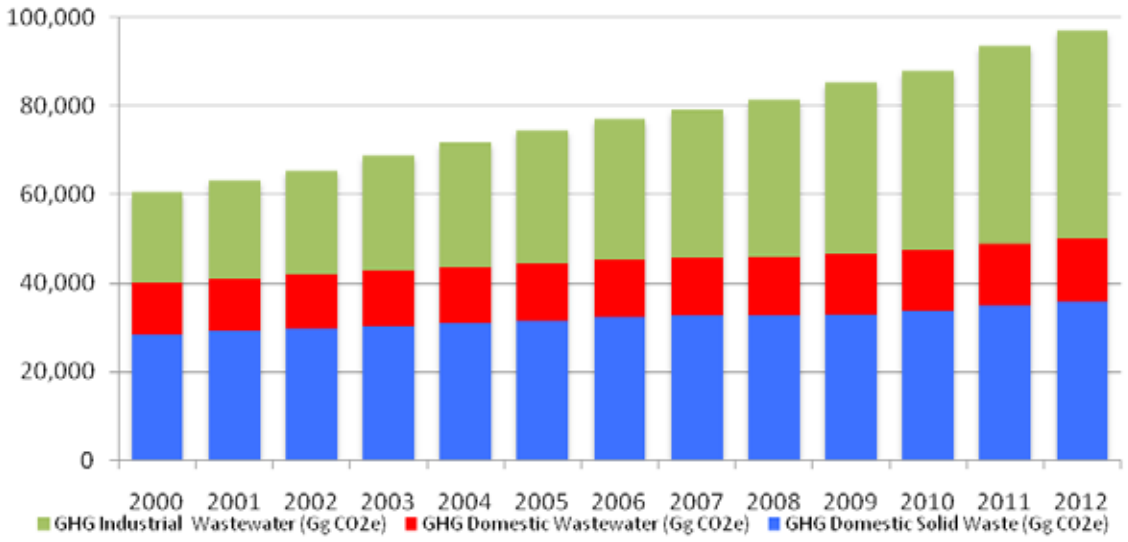



**Figure 2.63.** Summary of GHG Emissions from Waste Sector, 2000-2012

Distribution of GHG emissions from waste sector by sources and by type of gases in 2010 is presented in Figure 2.64. It can be clearly seen that emissions from waste sector are dominated by GHG emissions from industrial wastewater and MSW treatment.

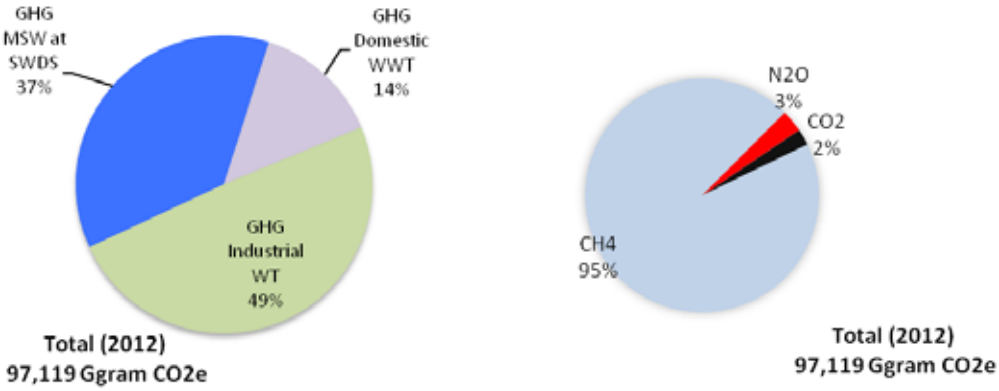



**Figure 2.64.** Distribution of GHG Emissions from Waste Sector, 2012

## Municipal Solid Waste Disposal/Treatments

GHG emissions reported in this first BUR covered emissions generated from MSW treatment at SWDS (landfill), open burning sites, biodigestion/composting and 3R (reuse, recycle, and recovery) facilities, and un-treated sites (see Figure 2.65). It can be summarized that emissions from MSW treatment is dominated by emission generated from MSW treatment in SWDS.

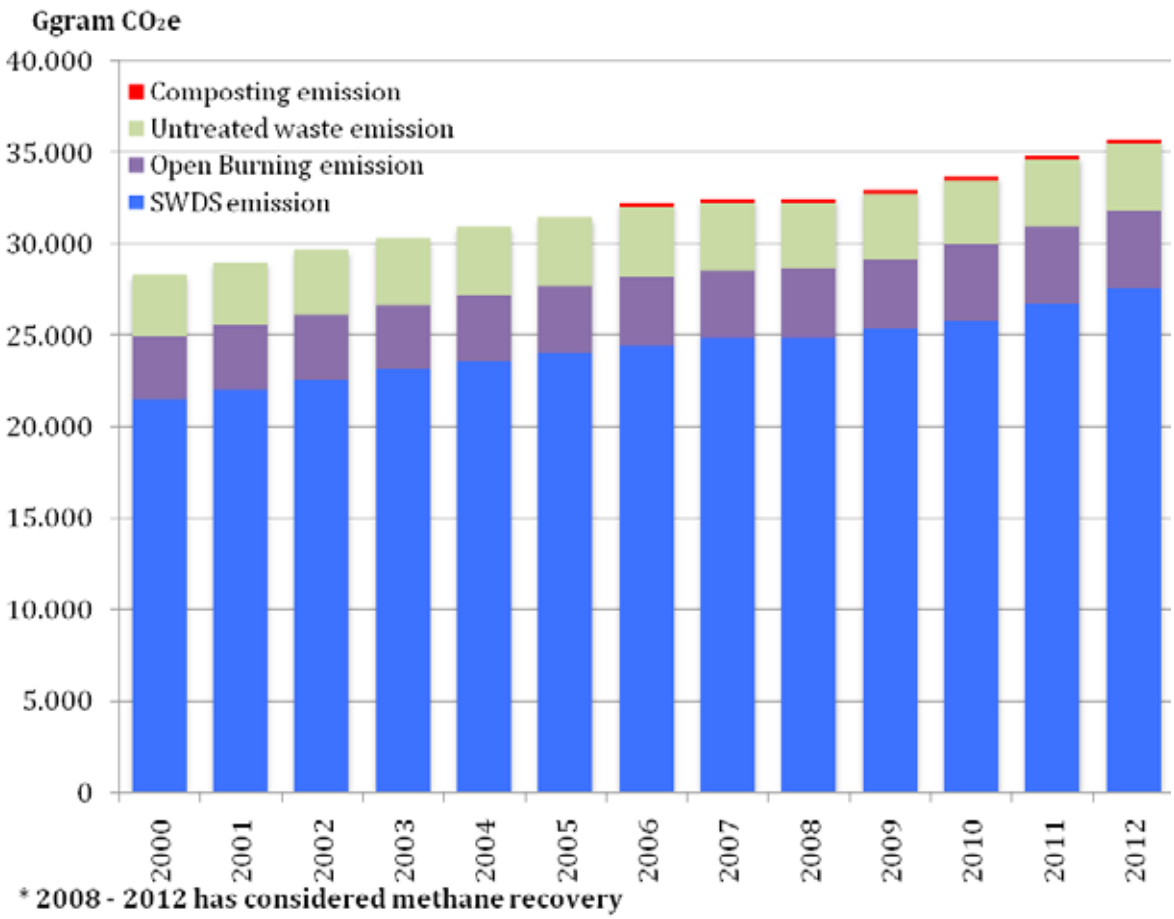



**Figure 2.65.** GHG Emissions from MSW Treatment Activities by Type of Treatment, 2000-2012

The GHG emissions report is also classified into type of gases, i.e. $CO_2$, $CH_4$, and $N_2O$. By type of gases, emissions from MSW treatment activities were dominated by $CH_4$(Figure 2.66). Detail of emissions from MSW treatment by type of treatment activity and type of gas is presented in Appendix A9.

## GHG Emissions Inventory from Domestic Wastewater Treatments

GHG emissions from domestic wastewater treatment by type of gas are shown in Figure 2.67. The emission was dominated by $CH_4$.

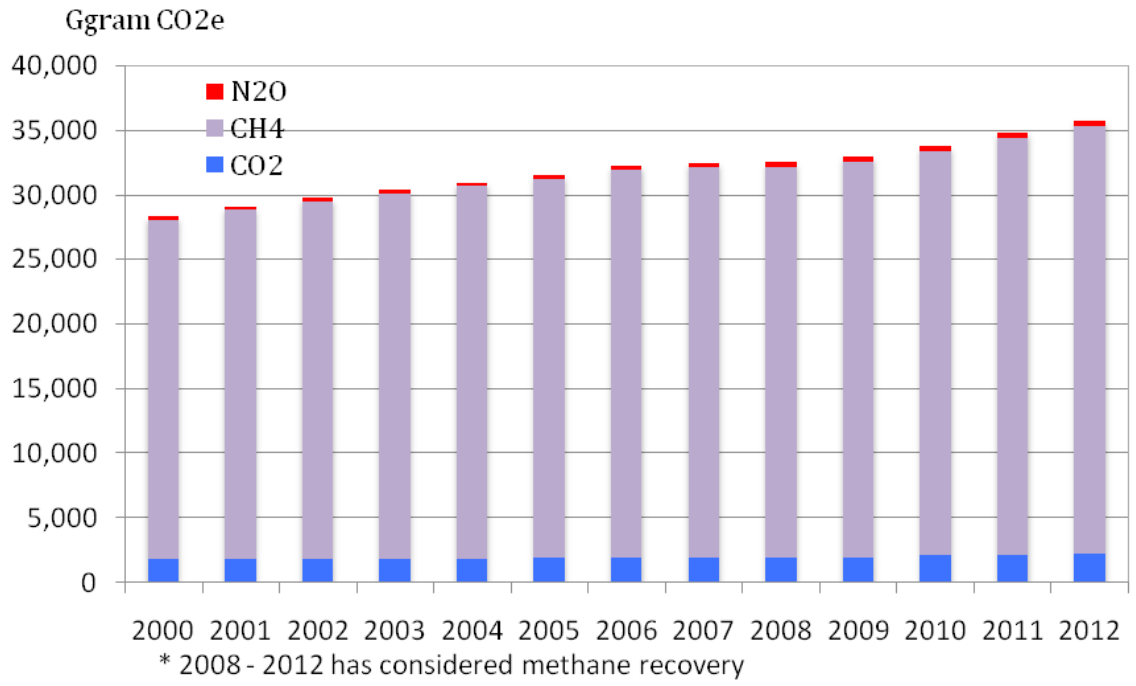



**Figure 2.66.** GHG Emissions from MSW Treatment Activities by Type of Gas, 2000 – 2012

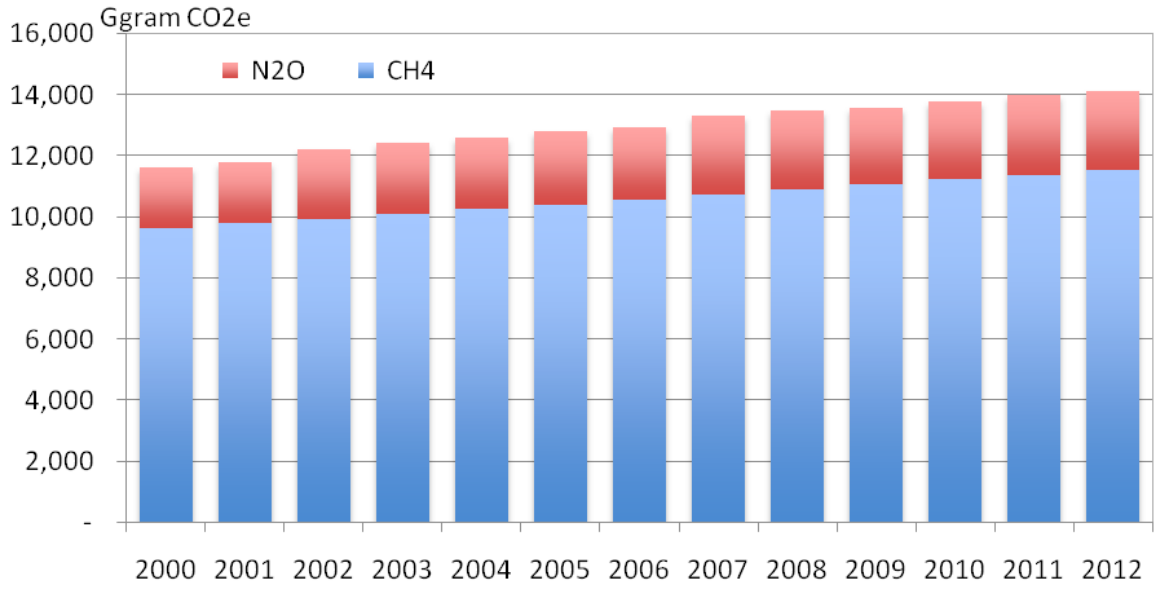



**Figure 2.67.** GHG from Domestic Liquid Waste Treatments by Type of Gas, 2000 - 2012

## GHG Emissions from Industrial WasteWater Treatment by Type of Industry

GHG emissions from industrial wastewater treatment by industrial sub-sector are shown in Figure 2.68, while detail data of the industrial wastewater emissions for each industry is given in Appendix A10. It can be seen from the figure, the GHG emissions from industrial wastewater treatment are dominated by emissions from CPO industry followed by pulp and paper industry (combined), starch industry, vegetable/fruits/juices processing, and vegetable oil. The share of emissions from sugar refining was not significant. It should be noted that sugar refining in this inventory only include sugar refining industry while emissions from state own sugar refining industry with much larger capacities were not covered due to lack of data. It should be noted these state own industries are covered under Ministry of Agriculture.

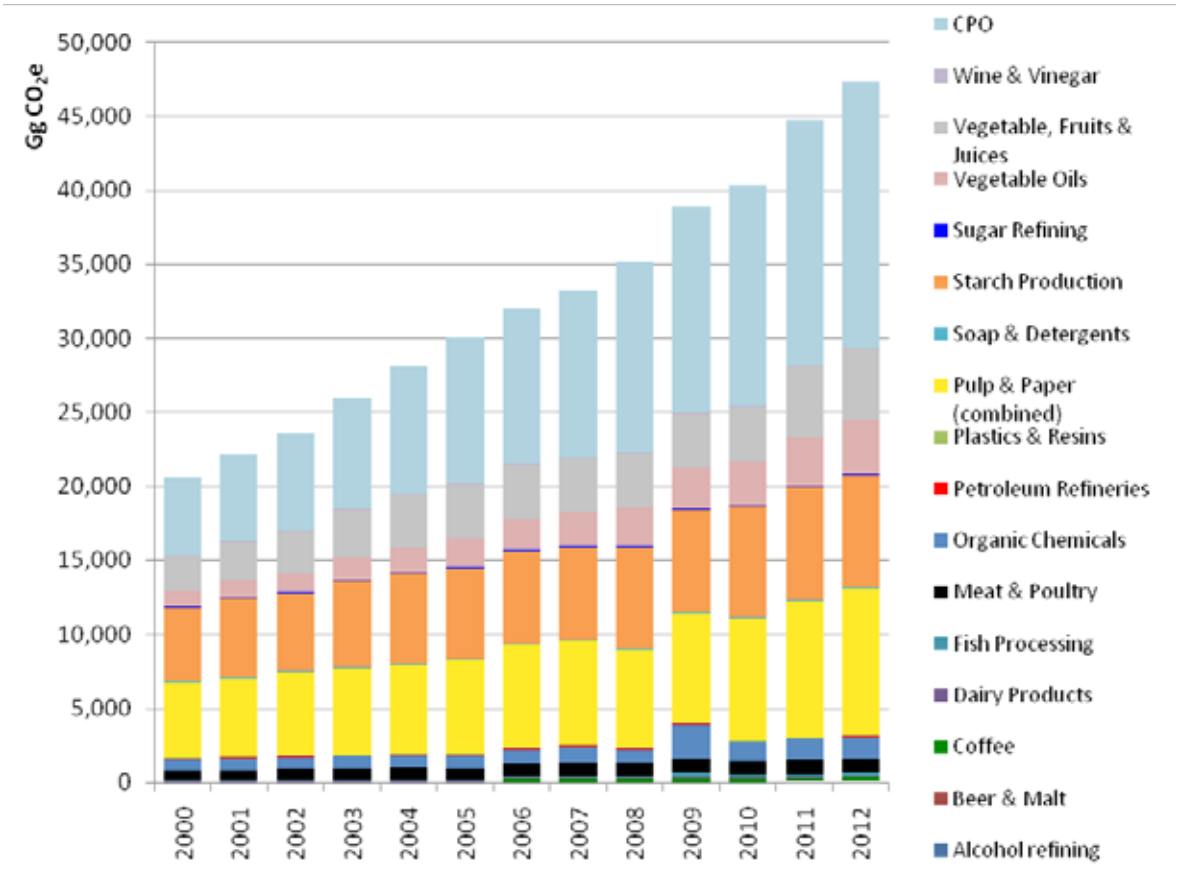



**Figure 2.68.** GHG Emissions from Industrial Waste Water Treatment by Type of Industry

The GHG emissions from waste sector by type of GHG and treatment are summarized in Table 2.38, while its KCA for 2012 is showed in Table 2.39.

Table 2-38. GHG Emissions from Waste Sector by Type of GHG and Treatment, 2012

| GREENHOUSE GAS SOURCE AND SINK CATEGORIES | $CO_2$ (1) | $CH_4$ | $N_2O$ | $CO_2$-e |
|---|---|---|---|---|
| **Total waste (Ggram)** | **2,207** | **4,377** | **10** | **97,119** |
| **A. Solid waste disposal** | | | | |
| 1. Managed waste disposal sites | | | | |
| 2. Unmanaged waste disposal sites | | 1,314 | | 27,584 |
| 3. Uncategorized waste disposal sites | | | | |
| **B. Biological treatment of solid waste** | | | | |
| 1. Composting | | 6 | 0.37 | 243 |
| 2. Anaerobic digestion at biogas facilities | | | | |
| **C. Incineration and open burning of waste** | | | | |
| 1. Waste incineration | | | | |
| 2. Open burning of waste | 2,207 | 83 | 1 | 4,258 |
| **D. Wastewater treatment and discharge** | | | | |
| 1. Domestic wastewater | | 549 | 8 | 14,113 |
| 2. Industrial wastewater | | 2,251 | NE | 47,262 |
| 3. Other (as specified in table 5.D) | | | | |
| **E. Other (please specify)** | | | | |
| 1. Untreated, assumed SWDS unmanaged shallow | | 174 | | 3,659 |

Table 2-39. KCA for GHG Emissions from Waste, 2012

| Category | Total GHG Emissions | Level/Rank | Cumulative |
|---|---|---|---|
| Industrial wastewater | 47,262 | 48.7% | 48.7% |
| Unmanaged waste disposal sites | 27,584 | 28.4% | 77.1% |
| Domestic wastewater | 14,113 | 14.5% | 91.6% |
| Open burning of waste | 4,258 | 4.4% | 96.0% |
| Others is assumed as untreated at SWDS (unmanaged shallow) | 3,659 | 3.8% | 99.7% |
| Composting | 243 | 0.3% | 100.0% |
| Total | 97,119 | | |

## 2.4.7. Emission Trend

Based on sectoral emissions from 2000 to 2012 with exclusion of LUCF, the GHG emissions of the sectors tend to increase with the exception of industry. The emissions from energy, agricultural and waste sectors increased at rate of 4.6 %, 1.3 % and 4.0% per year respectively, while those from industry was relatively constant (Table 2.40). Overall, the emissions of

these sectors increased consistently with rate of about 3.6 % per year, while emissions of LUCF fluctuated considerably (Figure 2.69). As previously discussed, high inter-annual variability of LUCF emissions was mainly due to high variability of deforestation and peat fire emissions.

Table 2-40. Sectoral Emission from 2000-2012

| Year | Energy | IPPU | Agriculture | Waste | LULUCF | Peat Fire | Total |
|---|---|---|---|---|---|---|---|
| 2000 | 298,412 | 40,761 | 96,305 | 60,575 | 343,798 | 161,571 | 1,001,422 |
| 2001 | 327,938 | 45,715 | 97,789 | 62,893 | 329,244 | 50,885 | 914,465 |
| 2002 | 340,323 | 39,229 | 97,479 | 65,399 | 373,190 | 301,753 | 1,217,373 |
| 2003 | 350,044 | 38,994 | 98,547 | 68,757 | 328,960 | 132,075 | 1,017,377 |
| 2004 | 368,508 | 40,976 | 100,299 | 71,548 | 475,851 | 232,018 | 1,289,201 |
| 2005 | 372,891 | 39,631 | 102,419 | 74,274 | 439,638 | 258,887 | 1,287,740 |
| 2006 | 391,424 | 37,162 | 101,819 | 77,152 | 479,246 | 510,710 | 1,597,513 |
| 2007 | 386,593 | 35, 294 | 105,757 | 79,015 | 553,815 | 62,747 | 1,223,221 |
| 2008 | 409,736 | 35,812 | 103,030 | 81,130 | 513,724 | 81,744 | 1,225,176 |
| 2009 | 398,639 | 36,245 | 107,733 | 85,336 | 620,581 | 299,920 | 1,548,455 |
| 2010 | 453,178 | 35,966 | 108,487 | 87,787 | 383,405 | 51,383 | 1,120,206 |
| 2011 | 488,936 | 37,264 | 108,718 | 93,469 | 427,310 | 189,026 | 1,344,721 |
| 2012 | 508,120 | 41,015 | 112,727 | 97,117 | 487,928 | 207,050 | 1,453,957 |

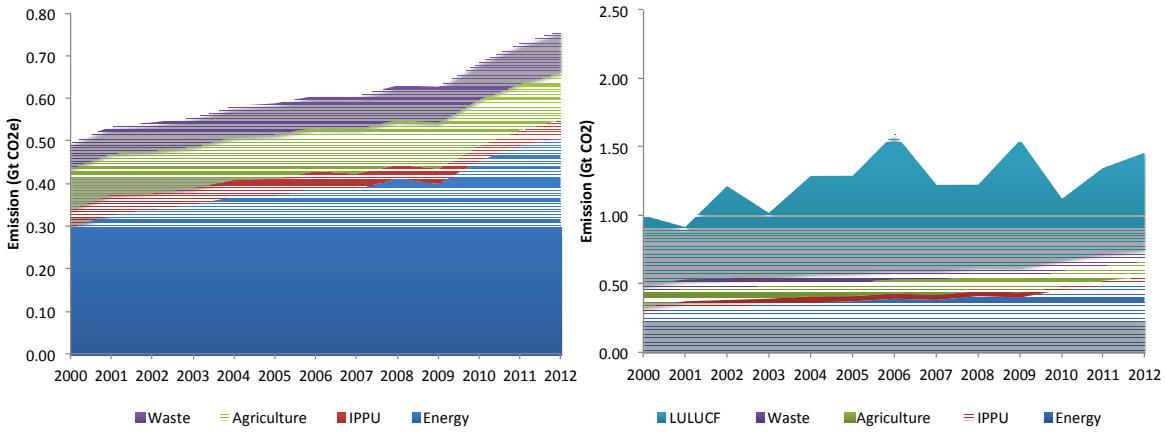



**Figure 2.69.** Trend of Emissions without LUCF (left) and with LUCF (right)

Referring to Figure 2.69, the contribution of LUCF and peat fires to the total national emission varied by year due to high inter-annual variability of emissions from these sources. The average national GHG emissions from 2000-2012 was about 1,249,365 $GgCO_2e$ (1.249 $GtCO_2e$). Contribution of the LUCF (incl. peat fire) and energy sector to the total emissions over the period 2000-2012 were about 51% and 32%, respectively (Figure 2.70).

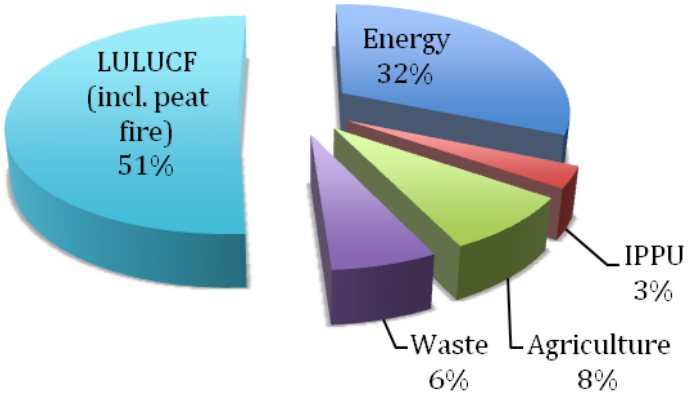



**Figure 2.70.** Sectoral Emission Contribution to National Emission Over the Period 2000-2012

## 2.5. Key Category Analysis

Based on the 2012 GHG emissions using Tier 1 approach, there are 20 key source categories without LUCF and 18 key source categories with LUCF. Without LUCF, the first three main categories (i) energy production (electricity, heat, oil & gas refining), (ii) transportation, and (iii) manufacturing industries and construction, contributed to more than 50% of the total emissions (Table 2.41). With LUCF, the three main categories contributed more than 50% of the total emissions were (i) emissions and removals from soils (mainly from peat decomposition), (ii) peat fire and (iii) forest and grassland conversion.

## 2.6. Uncertainty Analysis

Uncertainty analysis was conducted (Tier 1) following the IPCC 2006. The levels of uncertainty for activity data and emission factors for GHG emission from energy, IPPU, waste were taken from related ministries while for LUCF was based on recent data from the Ministry of Forestry and National Forest Inventory (NFI).The NFI system plots covered the whole area of forests across Indonesia. The improvement of NFI system plots has contributed significantly to the improvement of the GHG emission estimates from this sector.

The result of the analysis showed that the overall uncertainties of the Indonesian National GHG inventory without LUCF for 2000 and 2012 were approximately 19.1% and 14.9% respectively. With the inclusion of LUCF, the level of uncertainty increased for both years, i.e. 19.8% and 17.4% respectively, however the increase was not very significance (Table 2.42). This is a result of improvement of activity data and emissions factors of LUCF that have been made in the last few years. Further improvement is still possible following the MoEF plans to provide land cover map on annual basis, which is derived from satellite data using medium and high resolutions. Emissions/removal factors could further be improved by optimizing the use of NFI.

Table 2-41. Key Category Analysis

| No. | Sector | Source category | Cumulative Contribution (%) |
|---|---|---|---|
| **Without LULUCF** | | | |
| 1 | Energy | CO2 Energy production (electricity, heat, oil & gas refining) | 25% |
| 2 | Energy | CO2 Transportation | 42% |
| 3 | Energy | CO2 Manufacturing Industries and Construction | 58% |
| 4 | Waste | CH4 Industrial Wastewater Treatment and Discharge | 64% |
| 5 | Agriculture | CH4 Emissions from Rice Production | 68% |
| 6 | Agriculture | N2O Direct Soils | 73% |
| 7 | Waste | CH4 Emissions from Solid Waste Disposal Sites | 76% |
| 8 | Industrial Process | CO2 Emissions from Cement Production | 79% |
| 9 | Energy | CO2 Residential | 82% |
| 10 | Agriculture | CH4 Emissions from Enteric Fermentation in Domestic Livestock | 84% |
| 11 | Energy | CH4 Oil and Natural Gas | 86% |
| 12 | Waste | CH4 Domestic Wastewater Treatment and Discharge | 87% |
| 13 | Energy | CO2 Other (Energy)- | 89% |
| 14 | Energy | CH4 Residential | 90% |
| 15 | Agriculture | N2O Indirect Soils | 91% |
| 16 | Agriculture | N20 Direct from manure | 92% |
| 17 | Industrial Process | CO2 Ammonia Production | 93% |
| 18 | Energy | CO2 Oil and Natural Gas | 94% |
| 19 | Agriculture | CO2 Urea Fertilization | 94% |
| 20 | Waste | CH4 Untreated, estimated using SWDS unmanaged shallow | 95% |
| **With LULUCF** | | | |
| 1 | LULUCF | CH4 emissions and removals from soils | 21% |
| 2 | LULUCF | CO2 Forest and grassland conversion | 35% |
| 3 | LULUCF | CH4 Peat Fire* | 48% |
| 4 | Energy | CO2 Energy production (electricity, heat, oil & gas refining) | 60% |
| 5 | Energy | CO2 Transportation | 68% |
| 6 | Energy | CO2 Manufacturing Industries and Construction | 76% |
| 7 | Waste | CH4 Industrial Wastewater Treatment and Discharge | 79% |
| 8 | LULUCF | CO2 Abandonment of croplands, pastures, plantation forests, or other managed lands | 81% |
| 9 | Agriculture | CH4 Emissions from Rice Production | 84% |
| 10 | Agriculture | N2O Direct Soils | 86% |
| 11 | Waste | CH4 Emissions from Solid Waste Disposal Sites | 87% |
| 12 | Industrial Process | CO2 Emissions from Cement Production | 89% |
| 13 | IPPU | CO2 Residential | 90% |
| 14 | Agriculture | CH4 Emissions from Enteric Fermentation in Domestic Livestock | 91% |
| 15 | LULUCF | CO2 Changes in forest and other woody biomass stocks | 92% |
| 16 | Energy | CH4 Oil and Natural Gas | 93% |
| 17 | Waste | CH4 Domestic Wastewater Treatment and Discharge | 94% |
| 18 | Energy | CO2 Other (Energy)- | 94% |

Table 2-42. Level of Current Uncertainty of Indonesian National GHG Inventory for 2000 and 2012 and its Trend

| GHG Inventory | Year | | Trend |
|---|---|---|---|
| | 2000 | 2012 | 2000-2012 |
| Without LUCF | 19.1% | 14.9% | 21.7% |
| With LUCF | 19.8% | 17.4% | 16.5% |

# Chapter 3.

# Mitigation Actions and Their Effects

## 3.1. Introduction

Mitigation actions can be seen from various perspectives. Based on the nature of action, GHG mitigations are framed in terms of goal-based actions and non-goal based actions. Goal-based actions are mitigation actions that are implemented within the framework to achieve a certain national target of GHG emissions reduction. It can be implemented in the form of policy measures or in the form of project activities. Non-goal based actions are not intended to meet national target but they are carried out as credited or voluntary bases. Most non-goal based actions are project mitigation activities, although in very view cases, there are some actions that are implemented in the form of policy measures. Both types of actions can also be grouped according to level/scope of implementation, source of funding, and method of measurement (see Figure 3.1).

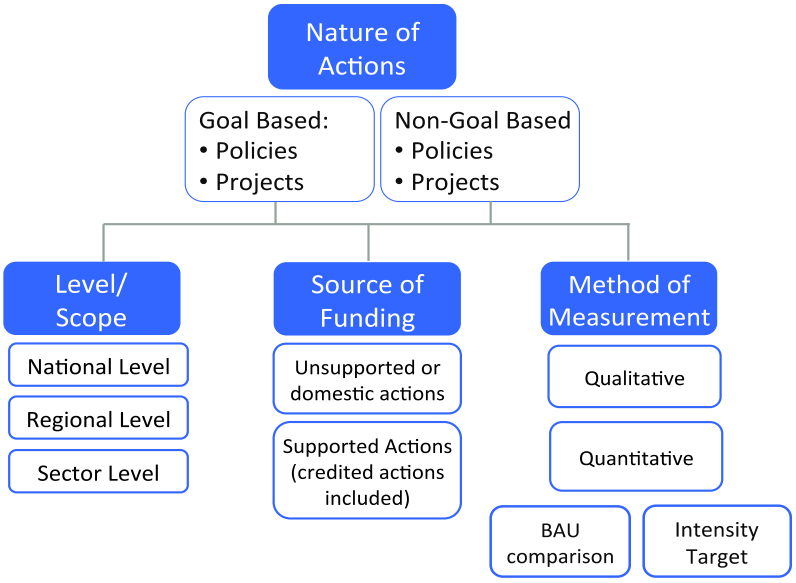



**Figure 3.1** Mitigation Actions Grouping (Author's figure, 2015)

Based on the level/scope of implementation, mitigation actions are categorized into national, sectoral, regional, and organization/company levels. In estimating the impacts (GHG emissions reduction) of these mitigation activities, different categories will require different GHG emissions baseline, i.e. sectoral baseline or project baselines.

Based on source of funding, mitigation actions are classified into unilateral, supported, and credited (carbon market) mechanisms. Unilateral mitigation actions are activities that are implemented using domestic budget, while supported and credited mitigation actions are implemented using international support. The classification based on source of funding also implies the party that will claim the GHG emissions reduction. Mitigation can also be categorized according to approach used to measure the impacts, i.e. quantitative or qualitative measures. Most of mitigation actions are assessed using quantitative approaches. The quantitative category is differentiated in terms of measurement indicators, i.e. BAU comparison or intensity target.

Most of mitigation actions that are recently carried out in Indonesia fall under category of Goal-based mitigation since they are intended to achieve the national GHG emissions reduction target. Additionally, there are also mitigation actions categorizedas non-goal based, such as REDD+, credited mitigations, and voluntary actions (i.e. PROKLIM, Green Building). This chapter covers both Goal-based and Non-goal based mitigation actions.

## 3.2. Mitigation Actions in Indonesia

### 3.2.1. GHG Emissions Reduction Target

In response to global climate change challenge, in 2009, the President of Indonesia has pledged to reduce GHG emissions level up to 26% below BAU by 2020 using domestic budget and further up to 41% with international support. Following this announcement, GoI issued Presidential Regulation No. 61/2011 concerning National Action Plan for GHG Emissions Mitigation (abbreviated as RAN GRK) in 2011. The regulation provides detail of sectoral mitigation action plans for reducing GHG emissions. In total, there are more than 50 mitigation action plans under RAN GRK. Implementation of these plans, either through policy statements (policy-based mitigation action) or project activities (project-based mitigation actions), is intended to meet the national GHG emissions reduction target.

Perpres No. 61/2011 stated that the quantified emission reduction target of 26% in 2020 is 0.767 Gt $CO_2$-e, and of 41% is 1.189 Giga ton $CO_2$-e. In achieving this target, mitigation actions are allocated to five different sectors, i.e., forestry and peat-land, waste, energy and transport, agriculture, and industry, as shown in Table 3.1. This grouping is slightly different

with that of GHG inventory, which classifies GHG sources into energy IPPU (industrial process and product use), AFOLU, and waste sectors.

Table 3-1. Target in reducing the GHG emissions under RAN GRK in 2020

| Sector of Activity | Emission Reduction (Giga Ton $CO_2e$) | | Total (41%) |
|---|---|---|---|
| | 26% | 15% | |
| Forestry and Peatland | 0.672 | 0.367 | 1.039 |
| Waste | 0.048 | 0.030 | 0.078 |
| Energy and Transport | 0.038 | 0.018 | 0.056 |
| Agriculture | 0.008 | 0.003 | 0.011 |
| Industry | 0.001 | 0.004 | 0.005 |
| **Total** | 0.767 | 0.422 | 1.189 |

*Source: Presidential Regulation no.61/2011*

The distribution of the target is determined by considering the contribution of each sector in the national GHG emissions (see Chapter 2, National GHG Inventory) and the reduction potential within that sector. The highest mitigation target is found within Forestry and Peatland since this sector is the highest contributor (± 70% of total national emission) and has many opportunities/options for mitigation actions. The magnitude (tonne $CO_2e$) of the total emission reduction target was determined based on the GHG emissions baseline reported in the SNC. Achievements of each sectoral target are to be evaluated by comparing the actual emission after the implementation of mitigation activity with baseline emission level.

Parallel to RAN GRK, which is implemented at the national level and allocated to sectors, the government has also requested the 33 provinces to formulate Provincial Action Plans for GHG Emissions Reduction (called RAD GRK) to encourage their participations in implementing mitigation actions.

## 3.2.2. Implementation of Mitigation Action

Policy-based actions are mitigation actions of RAN GRK that resulted from the implementation of government policies. These policies include newly introduced policy that are intentionally developed for mitigations or existing government policies. To facilitate the implementation of these policy statements, GoI applies either new or existing policy instruments (i.e. regulations, incentive-disincentive tools). Although there is no specific methodology to estimate GHG reduction potential from policy-based actions, RAN-GRK provides lists of GHG emissions reduction target for each policy-based action. Activity-

based actions, on the other hand, are mitigation actions in the form of specific activities, programmes, or projects. Installation or construction of biogas plants, LED street lighting, energy conservation in industries are some examples of these activity-based actions.

The implementation of mitigation actions in Indonesia is funded by domestic budget and international funding. The domestic budget comprises of government and private/public budgets. The government budget is used to fund activities under RAN GRK and RAD GRK while private/public budget is used to fund voluntary or private initiatives. The government budget consists of national budget (APBN) and provincial budget (APBD). Some of the mitigation actions are supported by international funds (donor countries) where the generated GHG emissions reduction will not be claimed by the donor country. Examples of this kind of activity are REDD and supported NAMA. In addition, international funds are also used to finance credited mitigation actions for carbon market mechanism where the generated emission reduction will be claimed by the funding party and/or transferred to other party through trading platform.

Mitigation actions reported in the First BUR cover national level actions under RAN GRK (Goal-based mitigation) and credited and voluntary mitigation actions (Non-Goal Based). The progress of mitigation actions under RAN GRK are described in Sub-chapter 3.3. The progress covered in this report includes status of the each action, impact of the mitigations, achievement of actions with respect to the targets, and implementation budget.

### 3.2.3. Institutional Arrangement

The current GHG mitigation actions in Indonesia are implemented under a well coordinated institutional arrangement. According to Perpres No 61/2011, BAPPENAS is mandated to coordinate mitigation actions in Indonesia, in which all sectors in the RAN GRK are responsible for the implementation of these actions relevant to each sectors. In response to this, BAPPENAS issued decree No. 38/M.PPN/HK/03/2012 on the establishment of Coordination Team on Climate Change (CT-CC). The CT-CC consisted of a steering committee (SC) and six working groups (WG). The SC comprised of 40 members (Echelon 1 from 23 government institutions) and is chaired by the Vice Minister of BAPPENAS with two Secretaries: (i) Deputy Minister of BAPPENAS for Natural Resource and Environment who is in charge for coordinating the implementation of Perpres No. 61/2011, and (ii) Deputy Minister of Environment for Control of Environmental Degradation and Climate Change who is in charge for coordinating the implementation of Perpres No. 71/2011).

The six working groups are Agriculture (as WG1), Forestry and Peatland (WG2), Energy, transportation and Industry (WG3), Waste Management (WG4), Supporting and Cross Sectoral (WG5), and Climate Change Adaptation (WG6). The WGs are chaired by Echelon 1b (Director General Level) who were assigned the tasks for coordinating the implementation of climate change programmes by the respective line ministry and agency (K/L). The six WGs are assisted by two secretaries (echelon 2 level), one from related sectors and one from BAPPENAS, and with members representative of related sectors who are assigned to coordinate the implementation of the climate change programme within the sector (BAPPENAS, 2012). A secretariat was also formed to support the tasks of CT-CC in handling technical issues related to mitigation.

The tasks and responsibilities of the SC are to: (i) establish policy/strategy recommendations in addressing climate change (mitigation and adaptation); (ii) provide general directions to the working groups in the implementation of RAN/RAD GRK, and (iii) submit the result of climate change mitigation and adaptation programmes/adaptations to the Minister of National Development Planning/Chief of National Development Planning Agency. The Working Groups tasks and responsibilities are to: (i) coordinate the implementation of climate change activities and programmes in the respective sector; (ii) synchronize the working plan both internally within a Ministry or among line Ministries/Agencies; (iii) conduct monitoring of the implementation of climate change mitigation and adaptation actions; and (iv) prepare quarterly and annual reports on the results of programme implementation/actions reports to the Chair of SC of the CT-CC.

## 3.3. Baseline Emission

GHG emissions baseline is a very important parameter in evaluating mitigation actions since it is used to determine the achievement of a mitigation action. Due to the different levels/scopes of mitigation actions, different levels of baseline would be required to conduct evaluation. These comprised of National Baseline, Provincial Baseline, Sectoral Baseline, and Project/Technology Baseline, where national baseline is technically the sum of sectoral baselines.

Sectoral mitigation actions requires sectoral GHG emissions baseline while mitigation action at project level requires project/technology baseline. Mitigation actions at national level requires national-sectoral baseline because these actions are implemented in sectors relevant to the type of each action. Mitigation actions at provincial level requires local-sectoral baseline (baseline of a sector, e.g. energy sector, at local level). For example, national programme for energy efficiency is implemented in energy sector. Therefore, GHG emissions baseline of this national programme (energy sector) is sectoral.

In this First BUR, sectoral baseline and project baseline are used to estimate the potential GHG emissions reduction. The project baseline is used to evaluate the achievement of a mitigation project in reducing GHG emissions. The sectoral baseline is used to evaluate the achievement of national (sectoral) mitigations actions. The achievement of national mitigation actions is evaluated based on aggregate achievement at sector level.

### 3.3.1. National Baseline

It is stated in Perpres 61/2011 that the projection of emission under BAU follows the second national communication (SNC). It is projected that by 2020, the emission under the BAU will be about 2.95 $GtCO_2$eq. By 2020, Indonesia is targeting to reduce its emission by 26% from the BAU emission (equivalent to about 0.767Gt CO2-e) through unilateral actions and to reduce further to 41% with international support (additional emission reduction of about 0.422 Gt).

After the issuance of the Perpres 61/2011, several governmental sectors have made revisions to their baseline emission, since the development of sectoral baseline emission in the SNC was not integrated. The government has made plan to revise the baseline that integrates all sectors. It is intended that in the submission of the second BUR and the Third National Communication, Indonesia will provide the updated baseline that may use dynamic modelling.

The following sections summarized the sectoral baselines used for measuring the mitigation impacts. Sectors that have already made revisions to their baseline emissions were agriculture and waste sectors. Since revisions of the baselines for energy, transportation, and IPPU sectors are still underway, the baselines reported in this First BUR for these sectors are the same as those reported in the SNC.

### 3.3.2. Sectoral Baseline

#### 3.3.2.1. Energy Sector

The current national baseline emission scenario for energy sectors are still the same as that of the national baseline emission scenario of energy sectors reported in the SNC. The agency responsible for developing baseline emission of this sector is ministry/ institution responsible in the development of road map or plan in energy sector. All data and information related to energy demand (including transportation and industrial sectors) were collected and maintained by Ministry of Energy and Mineral Resources (MEMR). As the capability and capacity in developing energy projection scenarios have

been established in MEMR, the revision of the baseline emission scenario was conducted by MEMR with intensive consultation with the Ministry of Industry (MoI), Ministry of Transportation (MoT), etc. The vision process is still ongoing.

### 3.3.2.2. Industrial Process and Product Use (IPPU)

GHG emissions baseline for IPPU category covers GHG emissions from industrial process and product use activities. As discussed earlier in Chapter 2 on GHG Inventory, the coverage of IPPU category has been updated since the SNC, with some additional industrial process categories as well as product use categories. This requires some improvements for the current baseline that would cover all additional categories of IPPU. The baseline of GHG emissions from IPPU sector as reported in the SNC was calculated based on estimates (projection) of industry production capacity. The agency responsible for developing the baseline emission scenario for IPPU sector is the Ministry of Industry. Revision of the baseline emission for this sector is still underway.

### 3.3.2.3. Agriculture, Forest and other Land Uses (AFOLU)

The agencies responsible for developing baseline emission scenario for AFOLU sectors were the Ministry of Agriculture (MoA) and Ministry of Forestry (MoFor). In the SNC, the projections of baseline emissions from these sectors were only formulated for four key categories, i.e., carbon emissions from (i) rice cultivation, (ii) livestock, (iii) deforestation and (iv) carbon removal from land rehabilitation. In this First BUR, the source category would still include the four key categories, however with modifications for the assumption used in making emission projection under BAU scenario. The methodology and projection of the BAU emissions from the four categories are described in the following sections.

### 3.3.2.4. Rice Cultivation

The change in assumptions used for projecting BAU emission under SNC and First BUR, was on the method for projecting rice growing area and planting intensity. In the SNC, rice growing area was projected based on the available literatures related to conversion rate of rice growing area in Java and new rice area establishment rate outside Java, while for planting intensity was based on government target (MoE, 2010). In the First BUR, the methodology used by the Ministry of Agriculture to estimate the emission under the BAU scenario has been revised. The emission under the BAU scenario was estimated using factual data on harvesting area and planting intensity using the assumption that management practices have not changed. Under the BAU scenarios, it is assumed that farmers apply continuous flooding in their rice cultivation and similar varieties from the 2009-2011 condition (see Chapter 2). These imply that the emission reduction would

occur when water management practices is changed from continuous flooding to other land use practices that would lower the emissions (e.g. intermittent, or non-flooding practices), or under the condition of similar water management practices, the emission reduction would occur only when new varieties with lower emission were used. The magnitude reduction of the emission would depend on the extent of the management practices being applied. The wider the area applying the new management practices, the higher is the emission reduction.

### 3.3.2.5. Livestock

Similar to rice cultivation, the Ministry of Agriculture has also changed the method for estimating the emission from livestock under the BAU scenario. The method is very similar to that of rice cultivation. Emission under the BAU scenario was estimated using actual population data with the assumption that manure management was absence and feed composition remained the same as that of the historical condition.

### 3.3.2.6. Deforestation

In the SNC, the Ministry of Forestry developed projection of emission from deforestation based on historical deforestation data between 2000 and 2006. Under the BAU, it is assumed that deforestation rate until 2020 was the same as the deforestation rate between 2000 and 2006. It was found that emission from biomass removal was projected to be constant at a rate of about 0.898 Gt $CO_2$e per year. The Ministry of Forestry has recently issued the Minister of Forestry Decree Number 633/2014 on new forest reference emission level (FREL) for deforestation. The decree stated that the FREL is 0.816 Gt $CO_2$e. This figure is slightly lower than that of SNC despite the same data activity and reference period (2000-2006) used in the estimation. The difference in the estimated FREL between SNC and the decree is merely due to the difference in carbon pools used for calculation of FREL. The SNC considered both the above and below ground biomasses while the decree only considered the above ground biomass.

After the issuance of the decree, the Ministry of Forestry revisited the deforestation data and recalculated it using the newly launched Landsat 8 OLI and placed the Landsat 7 ETM+ as a substitution in cloud elimination process. Variation of sensors and methods used after the year 2000 were significant contributors in providing better illustration of national land-cover, compared to that prior to 2000 when land-cover map was mostly derived from various data formats (hardcopy, softcopy, analog, digital). Up to now, land-cover data is available for the years of 2000, 2003, 2006, 2009, 2011, 2012 and 2013. The revised deforestation data is presented in Table 3.2, which showed consistency the data set published by Margono *et al*. (2014).

Table 3-2. Comparison of estimates of deforestation rates before and after recalculation

| Deforestation | 2000-03 | 2003-06 | 2006-09 | 2009-11 | 2011-12 | 2012-13 |
|---|---|---|---|---|---|---|
| Before recalculation* | 1.080 | 1.170 | 0.832 | 0.451 | 0.613 | 0.727 |
| After recalculation** | 0.348 | 0.741 | 0.865 | 0.341 | 0.471 | 0.727 |
| Difference (%) | -67,778 | -36,667 | 3,966 | -24,390 | -23,165 | 0,000 |

*Source: *Minister of Forestry Decree No. 633/2014; ** Presentation of Directorate IPSDH on 2 March 2015*

With the presence of new data post re-calculation, Indonesia re-calculated and published the Forest Reference Emission Level (FREL) on September 18, 2015. Detail FREL calculation explained in FREL document.

### 3.3.2.7. Land Rehabilitation

Sequestration of carbon occurs as a result of regeneration of secondary forests, land rehabilitation (afforestation and reforestation), and regrowth of woody vegetation (e.g. perennial crops and shrubs). Based on various studies, the mean annual growth rate of secondary forest is assumed to be about 5.32 $tCO_2$/ha, forest plantation is about 20 tonnes Biomass/ha, and other perennial crops/shrubs about 3.67 tonnes C/ha/yr. Based on aerial assessments between 1996 and 2006, it was found that the growth rate of forest plantation was about 198 thousand ha per year. In the SNC, it was assumed that under the BAU scenario, the planting rate between 2000-2006 would continue until 2020. Using this assumption, the rate of sequestration (carbon removal) under the BAU (also called as reference level) would increase from 0.505 Gt $CO_2$-e per year in 2005 to 0.753 Gt $CO_2$-e in 2020. The First BUR used similar assumption. However, as new data on growth rates are available and thus can better represent the national condition, the reference level must also be revised. Similar to deforestation, this revision is still underway and will soon be available. Likewise, it is also expected to be used as the basis for monitoring the impacts of REDD+ activities on forest sink enhancement.

### 3.3.2.8. Waste

GHG emissions baseline for waste category covers GHG emissions derived from activities in (a) municipal solid waste treatment, (b) domestic wastewater treatment, and (c) industrial wastewater treatment. GHG emissions from industrial solid waste treatment will not be covered. Each of these waste treatment types has their own GHG emissions baseline. As discussed previously in Chapter 2, the methodology used for calculating GHG emissions from waste category has been changed from mass balance approach to FOD

(first order decay) approach. However, the current available national baseline emission for waste category is still the same with that of the SNC, in which mass balance approach was used. Therefore, the current baseline for this category needs to be revised using this new approach. The agency responsible for developing baseline emission scenario for waste sector is the Ministry of Environment. The revision of the baseline emission of this sector is in progress.

## 3.4. Progress of Mitigation Actions and Their Effects

Prior to the issuance of Perpres 61/2011, the government has submitted its mitigation activities under seven categories that were documented in the FCCC/AWGLCA/2011/INF.1 as follow:

A: Sustainable peat land management;

B: Reduction in the rate of deforestation and land degradation;

C: Development of carbon sequestration projects in forestry and agriculture;

D: Promotion of energy efficiency;

E: Development of alternative and renewable energy sources;

F: Reduction in solid and liquid wastes;

G: Shifting to low emission modes of transport

Details of mitigation actions for each category defined above are given in Table 3.3 and 3.4. Brief description and status of the implementation of each mitigation action are presented in the sub-sections 3.3.1 below.

Table 3-3. Programme Activity of Each Sector for 26% Reduction Scenario

| Category in FCCC/ AWGLCA/2011/ INF.1 | SECTOR/ACTIVITY | ER Target ($GtCO_2e$) | REMARK |
|---|---|---|---|
| | ENERGY SECTOR | 0.030 | Equivalent to 40 TWh or 4,651 MW capacity |
| D & E | Energy Conservation Programme in DSM (Demand Side Management):<br>Development of standards<br>Development of regulation/policy<br>Labelling programme<br>Energy manager training<br>Energy audit (pilot)<br>R&D<br>Dissemination of activities in all sectors | | All energy conservation programme will be implemented by government, private sector and households through housekeeping, routine maintenance and repair and small investment |
| | TRANSPORT SECTOR | 0.008 | Equivalent to 24 MMBOE |
| G | Standardization to achieve more energy efficient vehicles (higher fuels economy), i.e. passenger and freight transportation<br>Enhance public transport infrastructure such as Bus Rapid Transit or city train system<br>Improvement of transport management and planning<br>Improvement in traffic demand management<br>Integration of transport and land use plan | | All programmes will be implemented by government, private sector and community.<br>Key actors:<br>Ministry of Transport<br>Ministry of Energy and Mineral Resources<br>City Planning<br>Public transport operators<br>Private sector,<br>Community |
| | INDUSTRIAL SECTOR | 0.001 | |
| D & E | Process improvement<br>Operation system improvement<br>Technology change<br>Raw material substitution<br>Dissemination/Promotion Programme | | All programmes will be implemented by government, private sector and community.<br>Key actors:<br>Ministry of Industry<br>Ministry of Energy and Mineral Resources<br>City Planning<br>Community |
| | AGRICULTURE SECTOR | 0.008 | |
| C | Improvement of water management (increasing water use efficiency such as SRI, PTT)<br>Introduction of new rice varieties with less methane emissions<br>Feed quality improvement and food supplement for ruminants<br>Biogas energy | | All programme will be implemented by government and private sector (CSR) |
| | FORESTRY SECTOR | 0.392 | |
| B & C | Rehabilitation of land and forests in watershed<br>Development of community forest and village forest<br>Establishment of timber plantation and private forest<br>Restoration of production forest ecosystem<br>Development of partnership forest<br>Fire management and combating illegal logging<br>Avoidance of deforestation<br>Empowerment of community | | The programmes have been implemented by government, private sector and community. Private sectors will dominate the efforts for establishing timber plantation, communities and CSR dominate the effort for establishing partnership forests, while government dominates land and forest rehabilitation programmes. |
| | WASTE SECTOR | 0.048 | |
| F | Implementation of MSW management law<br>Government programme for the improvement of<br>existing solid waste landfill<br>Domestic liquid waste management<br>Industrial liquid waste management<br>Capacity building for waste collection and transportation<br>Programme to enhance 3R activities (reuse, recycle, recovery)<br>Encouragment of private sector involvement in MSW treatment | | All programmes will be implemented by government, private sector and community.<br>Key actors:<br>Ministry of Environment<br>Ministry of Public Works<br>Local Government<br>Private sector<br>Community |

| Category in FCCC/ AWGLCA/2011/ INF.1 | SECTOR/ACTIVITY | ER Target ($GtCO_2e$) | REMARK |
|---|---|---|---|
| | PEAT EMISSIONS | 0.280 | |
| A | Development of fire early warning system<br>Strengthening community based fire-fighting team<br>Improvement of peatland management<br>Mapping of peat characteristics<br>Empowerment of community<br>Law enforcement for policy compliance<br>Generating income activities for communities such as fishery management in peat water | | Most of programme will be implemented by government, national and international NGOs and private sectors (CSR).<br>Key actors:<br>Ministry of Environment<br>Ministry of Forestry<br>Ministry of Agriculture<br>Local Government<br>Private Sector |

*Source: Perpres No. 61/2011 and MoE (2010)*

## Table 3-4. Programme Activity of each Sector for the Additional 15% Emission Reduction Target

| Category in FCCC/ AWGLCA/2011/ INF.1 | SECTOR/ACTIVITY | Additional ER Target (Gt CO2e) | REMARK |
|---|---|---|---|
| C, D & E | ENERGY SECTOR | 0.010 | Equivalent to 13 TWh or 1550 MW capacity |
| | Energy Conservation Programme in demand side<br>• Energy conservation for minor investment<br>• Overhaul for maintenance and repair | | Energy Efficiency will be achieved through minor investment in industry, building/ commercial sector, etc |
| | Deployment of clean coal technology | | Supercritical or Fluidized Bed coal Power plant (350 MW) |
| | Accelerated Geothermal (1000 MW) | | Additional 1000 MW to the existing government plan |
| | Biofuel | | Additional to achieve the government target (mandatory) |
| | TRANSPORT SECTOR | 0.008 | Equivalent to 24 MMBOE |
| | Further Improvement in Transportation Sector<br>• Enhance public transport infrastructure such as Bus Rapid Transit or city train system<br>• Integration of transport and land use plan | | The programme will further improve more efficient public transport infrastructure (road, pedestrian, public transport vehicle, information system for public transport management |
| D | INDUSTRIAL SECTOR | 0.004 | - |
| | Further improvement of industrial processes | | More investment to reduce GHG emissions in industrial processes |
| C | AGRICULTURE SECTOR | 0.003 | |
| | Up-scaling and expanding the improved water management programmes (SRI, SLPTT), introduction of new rice varieties with less methane emissions, feed quality improvement and food supplement, and biogas energy. | | More investment for conducting long-term breeding programme for livestock and introduction of other technologies for reducing methane and nitrous oxide emission from rice cultivation and irrigation |
| C | FORESTRY SECTOR | 0.031 | |
| | Up-scaling and expanding ofland and forest rehabilitation, timber plantation, and community empowerment | | REDD+ implementation, establishment of MRV system |
| F | WASTE SECTOR | 0.030 | - |
| | Wider coverage of the waste management improvement | | More investment for new land fill and other waste management infrastructure |
| A | PEAT EMISSIONS | 0.057 | |
| | Further improvement of peat land management and enhancement of institutional and community capacity in managing peat fire | | Improve peat land management and monitoring system |

*Source: Perpres No. 61/2011 and MoE (2010)*

### 3.4.1. National Mitigation Action

Information on mitigation actions at national level conducted by government and private sector is presented in Appendix B. This includes (i) name of actions, (ii) brief description of the actions, (iii) methodology and assumption in measuring the impact, (iv) status of implementation, (v) policy or supported regulations, (vi) co-benefits and (viii) administering agencies that implement the actions. An example of the information on mitigation action is given in Box 1. The following sub-chapters describe the summary of the implementation of mitigation actions under RAN GRK and their impacts. Most of the reported emission reduction achievement provided in this BUR have not been verified, thus they may change after verification process. However, verifications of the emission reduction achievement have been conducted for mitigation activities implemented by energy and agricultural sectors.

In the period 2010-2012, sectoral ministries have reported the implementation of mitigation actions as defined in Perpres No. 61/2011 (Table 3.3 and 3.4). The total number of mitigation activities being implemented amounted to 45 actions, although not all of the impacts of the mitigation actions were reported (Table 3.5). The reported emission reduction achievement in this period reached about 41.29 Mt $CO_2$-e (0.04129 Gt $CO_2$-e) or about 13.76 Mt $CO_2$-e (0.01376 Gt $CO_2$-e) annually. In addition to Perpres No. 61/2011, there were other 27 mitigation actions comprised of 4 activities supported NAMA and 23 non-Perpres. Similar to Perpres, only a few activities have reported the effects of the actions on emission reduction (Table 3.5). The resulted emission reduction in that period was reported to be about 5.09 Mt $CO_2$-e (0.00509 Gt $CO_2$-e) or about 1.70 Mt $CO_2$e (0.00170 Gt $CO_2$e) annually.

The following sub-sections provide a more detail description on the information of mitigation actions that have been implemented, as required by the COP decision, namely description of the mitigation actions, methodology and assumption, progress on the implementation, and result achieved.

Box 1. Example of Mitigation Actions Summary

**Name of actions:**
Mandatory to Implement Energy Management in Large Energy Consumers

**Description:**
GoI declares that mandatory to implement energy management in large energy consumers (i.e. industry, hotel/commerce, office building) is one of mitigation actions of energy sector in RAN GRK. This action is categorized as policy-based mitigation. The policy states that large energy users with certain electricity consumption are mandated to have energy manager and implement energy efficiency measures. The targeted number of companies that will be able to comply with this mandatory during

2010-2014 is 200 companies and in 2015 – 2020 would be 200 companies. The GHG emissions reduction that will be obtained from energy efficiency in these companies are 2.2 million ton $CO_2e$ (2010-2014) and 7.92 million ton $CO_2e$ (2015-2020). The total GHG emissions reduction target is 10.16 MTon $CO_2$-e in 2010-2020.

According to UNFCCC/AWGLCA/2011/INF.1, this type of mitigation actions falls within Category D.

**Methodology in Estimating the Mitigation Impacts and Assumptions:**
Mitigation impacts of energy efficiency policy implementation in Indonesia can be measured by comparing baseline GHG emissions with emission of the sector after the implementation of this mitigation. The baseline is the projected GHG emissions that would occur in large companies in the absence of energy efficiency measures. Methodology for estimating GHG emissions level is Tier 1 of IPCC 2006 GLs.

Assumptions: The target of energy efficiency achieved if 400 energy manager simplement required measures in the form of electricity consumption reduction. Large-energy-consumers use 6000 toe per year and energy efficiency potential (no and low cost) is 10% (Ministerial Regulation ofMEMR14/2012). EF JAMALI electricity grid is 0.814 ton $CO_2e$/MWh.

**Current Status of Implementation:**
During 2010-2012, four companies that have implemented energy efficient measures with average reduction of energy consumption of 459.6 GWh per year, which is equivalent to the GHG emissions reduction of 0.374 Mt $CO_2e$ per year.

**Policy Instruments and Enabling Policies/Regulations:**
Regulations and policies that have been issued and expected to support the implementation of this mitigation action: (a) Energy Act 30/2007, (b) Government Regulation 70/2009 concerning Energy Conservation, (c) Ministerial Regulation of MEMR 13 and 14/2010 concerning standard of competency of energy manager in building and industry, and (e) Ministerial Regulation of MEMR no. 14/2012 concerning Energy Management.

**Co-benefits:**
Co-benefits of this mitigation include energy cost saving at the company side, better energy utilization plan, capacity building for energy operators, stimulate innovation in energy efficiency activities, national energy security, less pollutants in the consumers and/or in the power plants.

**Name of Administering Government Agencies/Actors**: MEMR

Table 3-5. The Effect of Implementation of Mitigation Activities on $CO_2$ Emission Reduction

| | Sector | No of Implemented Activities | No of Activities with reported emission | Emission Reduction target/potential by 2020 (Mt $CO_2$-e) | Emission Reduction Cumulative 2010-2012 (Mt $CO_2$-e) | Emission Reduction Average per year (Mt $CO_2$-e) |
|---|---|---|---|---|---|---|
| **Perpres** | Energy* | 9 | 8 | 32.53 | 3.39 | 1.13 |
| | Transportation | 17 | 7 | 35.15 | 0.27 | 0.09 |
| | Industry | 2 | 2 | 4.81 | 0.79 | 0.26 |
| | Agriculture** | 4 | 4 | 43.59 | 35.49 | 11.83 |
| | LUCF | 11 | 0 | 605.90 | n.a | n.a |
| | Waste | 2 | 2 | 48.00 | n.a | n.a |
| **Sub-total Perpres** | | 45 | 23 | 769.98 | 41.29 | 13.76 |
| **NAMA** | Energy | 2 | 0 | 4.12 | n.a | n.a |
| | Transportation | 1 | 0 | 1.50 | n.a | n.a |
| | Waste | 1 | 0 | 0.35 | n.a | n.a |
| **Sub-total NAMA** | | 4 | 0 | 5.97 | n.a | n.a |
| **Non Perpres** | Energy | 6 | 6 | 0.15 | 0.84 | 0.28 |
| | Transportation | 5 | 5 | 9.97 | 4.25 | 1.42 |
| | Forestry | 10 | 0 | n.a | n.a | n.a |
| | Others | 2 | 0 | n.a | n.a | n.a |
| **Sub-Total Non-Perpres** | | 23 | 11 | 10.11 | 5.09 | 1.70 |
| **TOTAL** | | 72 | 34 | 786.06 | 45.03 | |

Note: Emission reduction achievement up to 2013 has been reported to reach 4.74 MtCO2e or 1.185 MtCO2 per year

### 3.4.1.1. Energy and Transport

Mitigation actions of energy and transport sector include policy-based and projects-based activities. Policy-based actions are carried out by implementing policies/regulations that will eventually lead to GHG emissions reduction, for example energy efficiency regulations and renewable energy promotions. Project-based mitigation actions are carried out by utilizing efficient energy technology, renewable technology, less carbon emitting fuels and energy technology, etc. To facilitate the implementation of policy-based and project-based mitigations, GoI employed policy instruments and/or enabling regulations in the form of regulation, incentives, and disincentives.

The mitigation actions reported under 'energy and transport' sector covered all mitigation actions in energy and transportation activities but excluding mitigation related to energy use in industry, which is reported under the industry sector. The rationale to organize the mitigation actions in this way is to ensure the success of the implementation of mitigation actions; although the emission from transportation is due to the use of energy in this sector, it is reasonable that the mitigation actions are implemented and controlled

under institutions responsible to the development of transportation sector, i.e. MoT[8] not MEMR[9]. Similarly, as industrial development is regulated and controlled by MoI[10], mitigation actions in industries including energy-related mitigations are implemented and controlled by MoI.

Most of mitigation actions in energy sector are activity-based, thus the impacts of mitigation actions were measured using project activity approach. The baseline used in evaluating the impacts of these mitigation activities was GHG emissions level that would occur in the absence of mitigation actions. Table 3.5 depicts current mitigation activities and its achievements. The number of mitigation activities implemented in the energy sectors was nine activities with emission reduction target of about 32.53 million tonnes $CO_2$-eq. Up to 2013, only eight activities have reported their achievements that reached about 4.74 Mt $CO_2$-eq. Transportation has implemented 17 activities with emission reduction target of 35.15 Mt$CO_2$-eq. In that sector, total reported emission reduction achievement from 2010-2012 was only 0.27 Mt $CO_2$-eq. The detail information of this implementation is presented in Appendix B1 and B2 respectively.

As defined above, the Government of Indonesia has employed policy instruments and/or enabling regulations in the form of regulation, incentives, and disincentives to facilitate the implementation of mitigation actions. Different from mitigation actions, measuring impact of the policies implementation on emission reduction is difficult. The common way of measuring the impact is by comparing the baseline emission with the actual emission of the GHG inventory. The difference between the baseline emission and the actual GHG emission in 2010, 2011 and 2012 were 7, 16 and 52 Mt $CO_2$e respectively (Figure 3-2). However, it should be noted that the emission difference occurred not only due to the effect of the mitigation policies implementation and the mitigation measures but also other factors such as economic growth, increase of energy price that will reduce the fossil fuel consumption, and delay of new coal power plant constructions planned in the baseline (this makes GHG emission level from coal power plant is lower than GHG emission level if the constructions were not delayed).

[8] Ministry of Transportation
[9] Ministry of Energy and Mineral Resources
[10] Ministry of Industry

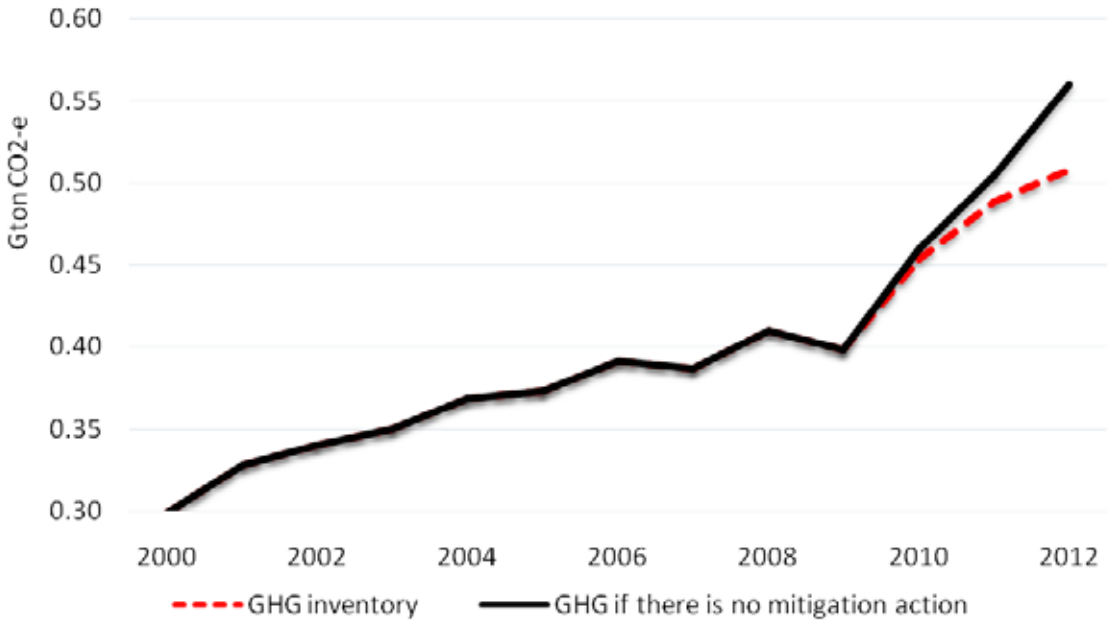



**Figure 3.2.** Baseline vs Actual GHG Emissions of Energy Sector, the difference between the red line and the black line indicates performance of mitigation action

### 3.4.1.2. Industry (Energy and IPPU)

Mitigation actions in industrial sector included efficiency improvement of energy utilizations and processes, which were policies and projects-based measures. The policy-based actions were carried out by issuing policies/regulations that would eventually lead to GHG emissions reduction. Energy efficiency regulations were some examples of policies-based actions. The project-based mitigation actions were carried out by installing energy efficient technology in industry. Comparing the baseline emission and actual emission from IPPU, it was found that there is a slight decrease in GHG emission compare to the baseline from 2010 to 2012. The reduction of emission for 2010, 2011 and 2012 were 0.12, 0.23 and 0.23 Mt $CO_2$e respectively (Figure 3-3) or cumulatively about 0.57 Mt $CO_2$e. This reduction is recorded from mitigation action in aluminum production (Figure 3-4). It can be seen from this figure, after 2009 the amount of $CO_2$ released for producing one ton of aluminium product decreased significantly. The effort for reducing this emission is part of CDM project. It should be noted there are several mitigation activities in cement industries. However, the GHG emission reduction from this activities are not reported in this BUR due to lack of data.

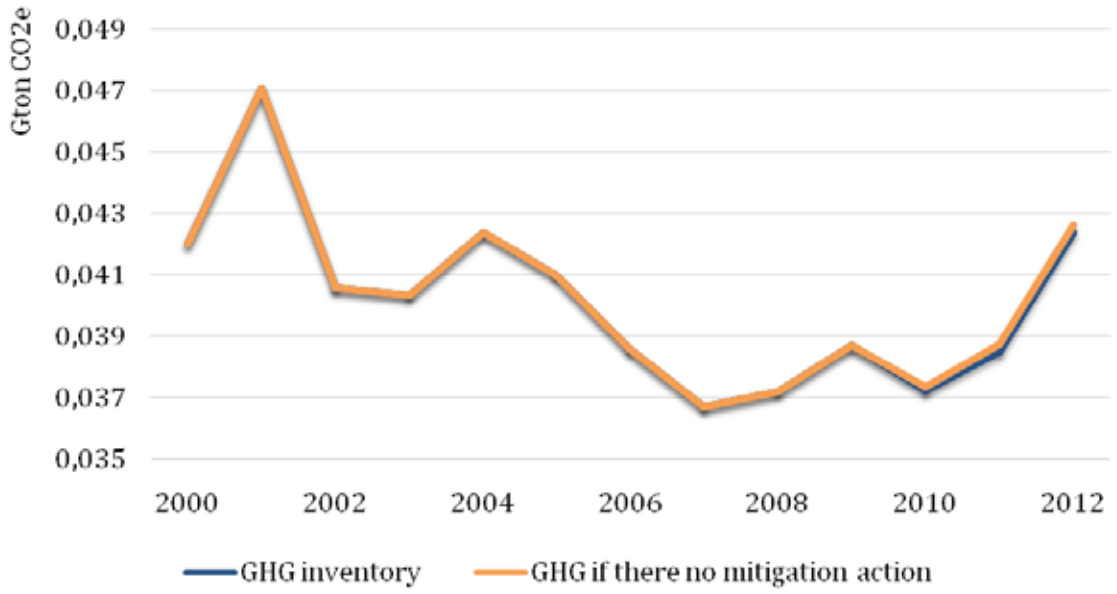



**Figure 3.3.** Baseline vs Actual GHG Emissions of IPPU Sector

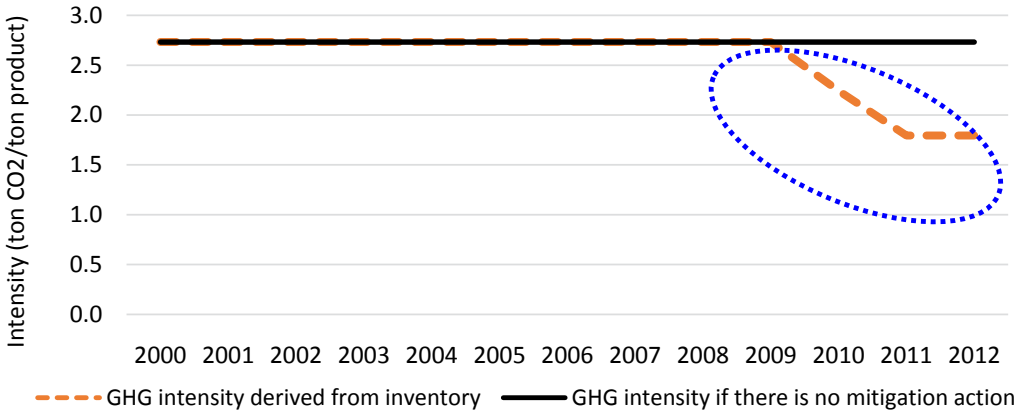



**Figure 3.4.** Emission Intensity from Aluminum Product

Beside targeting energy efficiency, the industries was also targeting IPPU in the mitigation actions. Efficiency improvement in industrial processes resulted in the reduction of consumption of materials in industrial processes that generated GHG emissions as well as the preparation of the materials. There were two mitigation actions implemented by this sector with emission reduction target of about 4.81 Mt $CO_2$-e. The reported emission reduction achievement was only 0.79 Mt $CO_2$-eq. Detail information of this implementation is presented in Appendix B3.

### 3.4.1.3. Agriculture

Implementations of mitigation actions in agriculture sectors only cover the improvement of water management in rice paddy that would reduce the emission of methane. The improved practices were Integrated Farming Practices and System Rice Intensification (SRI). While for livestock, include the use of manure for producing biogas. Different from energy and transportation sectors, the impacts of mitigation were measured against the sectoral baseline. There were four mitigation activities that have been implemented in this sector that were expected to reduce emission by about 34.60 Mt $CO_2$-eq. In 2012, the reported achievement of emission reduction was about 35.49 Mt $CO_2$-eq.

For this sector, the Ministry of Environment with the Ministry of Agriculture have evaluated the methodology and assumption used in measuring the emission reduction. Using the revised methodology and assumption, the previous emission reduction achievement that was reported to be about 35.49 Mt $CO_2$-eq has changed to 11.42 Mt $CO_2$-eq (Figure 3.5). Detail of this implementation is presented in Appendix B4.

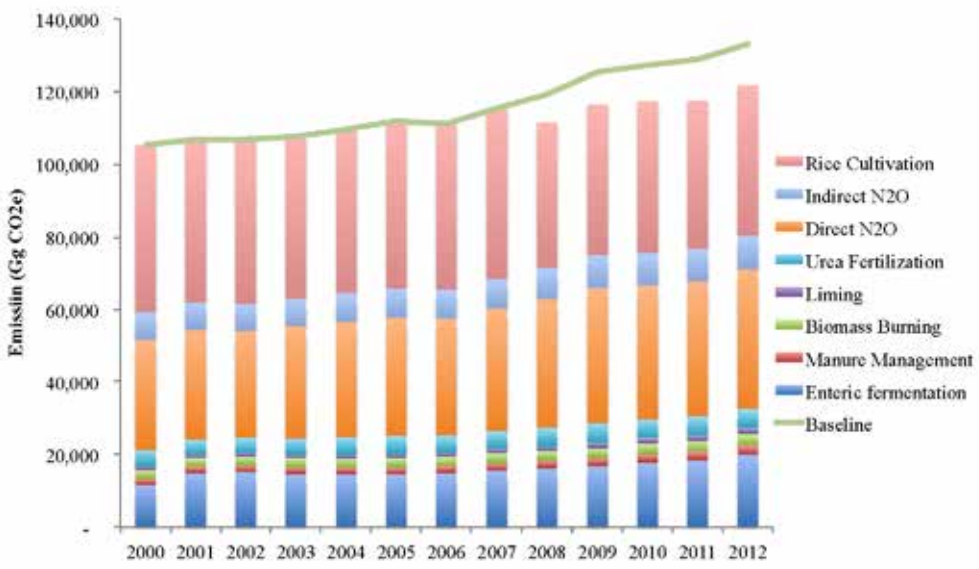



**Figure 3.5.** Baseline vs Actual GHG Emissions of Agriculture Sector

### 3.4.1.4. Forest and Other Land Use

The implementation of mitigation policies and measures in forest and land use has wide impact. It was difficult to measure emission reduction from the implementation of certain actions. The emission reduction from deforestation and degradation would be the result of the impacts from the implementation of a number of policies and measures. In this regards, the emission reduction would be measured against the emission of baseline without looking at a single measure. Thus the impacts of mitigation were measured using sectoral baseline and not activity-based baseline. Since the baseline emission of this sector is still under revision (see sections 3.3.26 and 3.3.27), the achievement of emission reduction from this sector has not been reported. Detail information on the implementation of mitigation actions for LUCF sector is presented in Appendix B5.

### 3.4.1.5. Waste

Mitigation actions in waste sector reported in this first BUR covered the management of municipal solid waste (MSW) treatments and landfill gas (LFG) utilization for power generation and residential cooking. The impact of mitigation actions in this waste sector can be seen by comparing baseline emission and GHG inventory shown in Figure 3.6. It should be noted that emission reduction achieved from other mitigation actions implemented by the national government as part of the Perpres No. 61/2011 for this sector has not reported yet (see Appendix B6 for detail information) and therefore is not included in Figure 3.6.

The nature of all mitigation actions is project-based, voluntarily iniated by several local governments. The average emission reduction resulted from these actions is 805 Ggram $CO_2$-e/year, which is composed of 407 Ggram $CO_2$-e/year from MSW management improvement (implementing 3R and composting, reducing open burning etc.), 395 Ggram $CO_2$-e/year from methane avoidance in LFG for power plant and 2.9 Ggram $CO_2$-e/year from methane avoidance related to the use of LFG for residential cooking. In addition these activities also reduced emissions from substitution of fossil fuels used for residential cooking and substitution of electricity from PLN grid by utilizing electricity generated by LFG power plant (renewable energy source). The achievement of emission reduction associated with this substitution is: 24 Ggram $CO_2$-e/year for electricity substitution and 0.14 Ggram $CO_2$-e/year for cooking fuel substitution. It should be noted these reduction has to be recorded in energy sector. Detailed information (methodology, assumption, emission reduction) regarding this voluntary mitigation action is presented in Appendix B7.

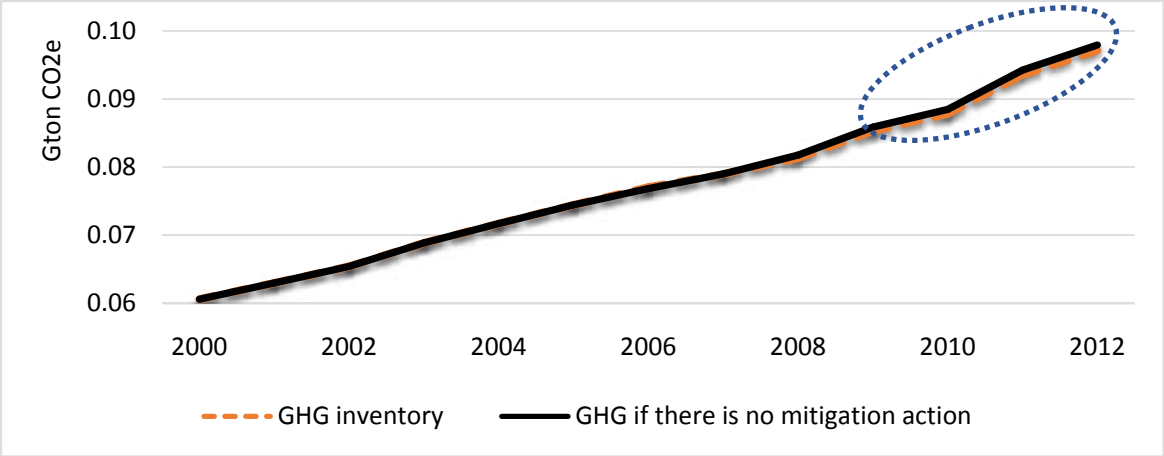



**Figure 3.6.** Baseline vs Actual GHG Emissions of Waste Sector

### 3.4.2. Province Mitigation Actions

Based on Article 6 of the Perpres No. 61/2011, local governments are required to develop local action plan called "*Rencana Aksi Daerah Pengurangan Emisi Gas Rumah Kaca*" (RAD GRK) based on RAN GRK and development priorities. As of the end of 2013, all 33 provinces have submitted their RAD GRK documents. In their RAD GRK documents, most provinces follow the national emission reduction target of 26% and 41%. An exception is the Province of Jakarta that targeted a 30% reduction by 2020, higher than the national target.

### 3.4.3. Supported Mitigation Actions

Activities falling under this category might not be purely supported in nature. In the case of Sustainable Transportation Programme, it was developed as part of RAN GRK, but some of the implementation would be supported by international funding. Similar to this is REDD+ activities, where there was a possibility that the activity would later involve trading mechanism.

#### 3.4.3.1. Supported NAMAs

Until December 2014, Indonesia has registered two mitigation activities as NAMAs at the UNFCCC. The programmes are known as Sustainable Urban Transportation in Indonesia (SUTRI) developed by the Ministry of Transportation and Smart Street Lighting Initiative

(SSLI) developed by Ministry of Energy and Mineral Resources. These two programmes were estimated to reduce as much as 0.7-1.5 MtCO2-eq in 2030 from NAMA SUTRI and 0.425 MtCO2-eq in 2020 from NAMA SSLI. Additionally, other activities are currently being proposed as NAMAs.

#### 3.4.3.2. REDD+

REDD+ in Indonesia is marked by the involvement of various types of financing schemes, namely market mechanism and bilateral cooperation, private sector support, and some of them through voluntary market mechanism. Up to early 2015, there are around 35 Demonstration Activities (DAs) being developed of which some were developed using voluntary carbon mechanism, such as Voluntary Carbon Standard (VCS) and Plan Vivo.

It was noted that DAs developed under bilateral cooperation might become part of trading mechanism if the developers were not interested to be part of the voluntary emission reduction target initiated by the government. As for bilateral cooperation, in May 2010, Indonesia signed an agreement with Norway in which the Norwegian agreed to provide a USD 1 billion support depends on the performance.

### 3.4.4. International Market (trading)

Various mitigation actions were developed under carbon trading mechanism such as CDM. As per 31st January 2015, 242 projects were approved by the Indonesian DNA. As many as 146 projects have been registered in UNFCCC and 21 projects are currently under going validation processes. Of the registered projects, about 13.5 million CERs were issued while the expected annual CERs were 17.8 million.

These projects were mostly initiated by private companies, indicating their willingness and interest to participate in mitigation actions. However, in practice, they still face some limitations, such as technical support and training, as well as incentives that might attract more companies to participate, which the government has not been able to provide.

### 3.4.5. Other Mitigation Actions and Their Effects

There were approximately 19 mitigation actions outside the RAN GRK which are funded by governments, privates and/or community funds. The emission reduction target was

about 18.29 Mt $CO_2$e. Out of the 19 mitigation activities, 12 activities have reported the emission reduction achievement. In 2012, the total emission reduction achievement was 6.75 Mt $CO_2$e. Further information on the implementation of other mitigation actions and their impacts is presented in Appendix B7.

## 3.5. Development of Monitoring, Reporting, and Verification (MRV) System

### 3.5.1. Institutional Arrangement

MRV in Indonesia was set based on Perpres 61/2011 on National Action Plan for the Reduction of GHG Emissions, Perpres 71/2011 on Implementation of GHG Inventory, and MoE Regulation 15/2013 on MRV of Mitigation Actions. There are different arrangements for MRV depending on criteria required by each mitigation schemes. Mitigation actions funded through domestic sources were subject to domestic verification and follow domestic standard such as the MER and the MoE Regulation on MRV, whereas activities financed by international source must comply with international guidelines and were subject to international verification. The following sub-chapters described MRV settings for National and Local Action Plan, REDD+, international trading, and other mitigation actions.

#### 3.5.1.1. For RAN GRK and RAD GRK activities

Under Perpres 61/2011, National Action Plan is divided into National Action Plan called RAN-GRK, and Local Action Plan called RAD-GRK. For these activities, the Government of Indonesia has established a system called PEP (*Pemantauan, Evaluasi, dan Pelaporan* – Monitoring, Evaluation, and Reporting/MER) to monitor the achievement of the activities. The procedure is shown in Figure 3.7.

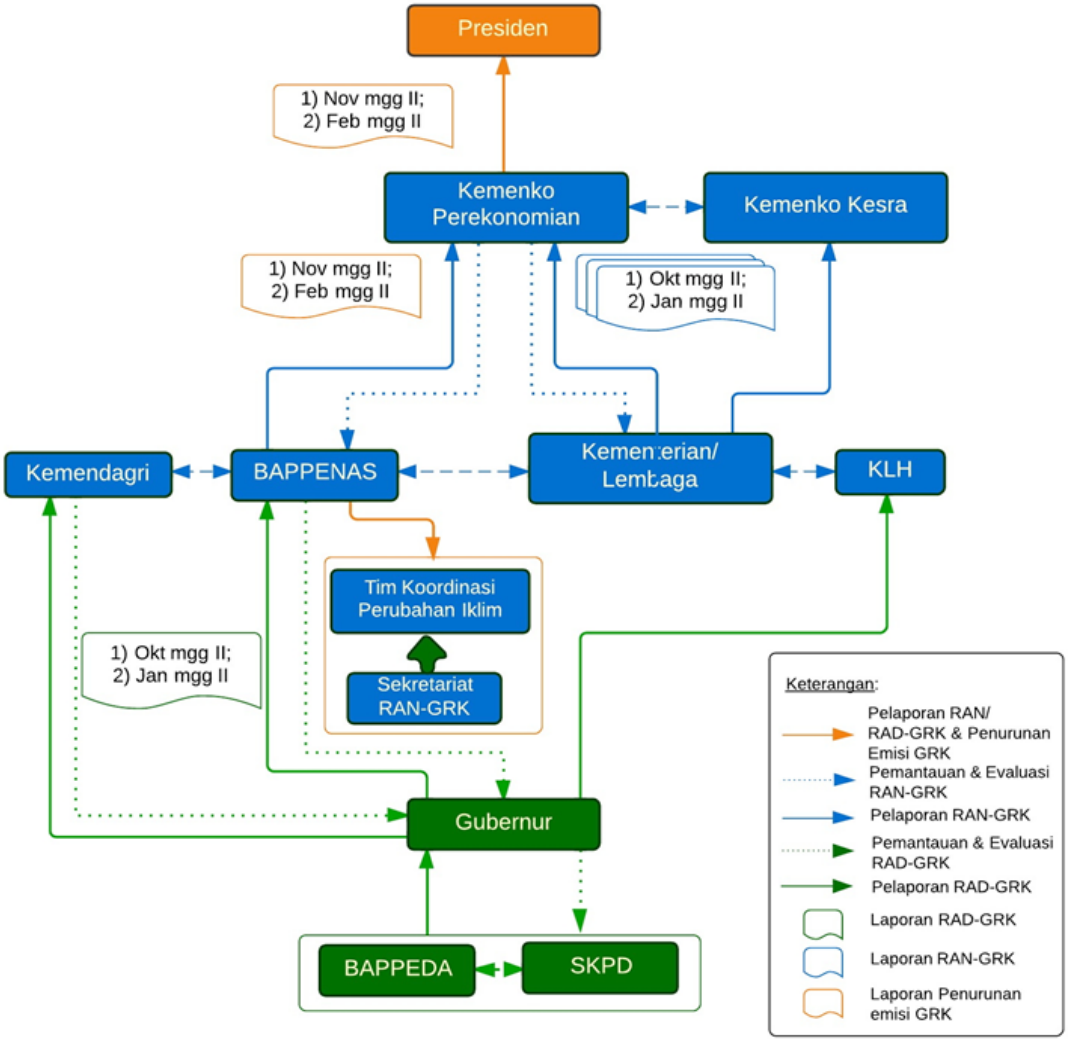



**Figure 3.7.** Mechanism for Monitoring, Evaluation, and Reporting the Achievement of RAN-GRK and RAD-GRK (BAPPENAS, 2014)

Under the new Government Structure, a new Directorate General in charge for Climate Change has been formed, which is Directorate General for Climate Change Control (Direktorat Jenderal Pengendalian Perubahan Iklim; DJPPI) under the Ministry of Environment and Forestry (MoEF). The role and function of the DJPPI as defined in the President Regulation Number 16/2015 is to formulate and implement policies related to climate change. Furthermore, the Minister Environment and Forestry has issued Minister Regulation Number P.18/MenLHK-II/2015 on Organization and Working Mechanism under the Ministry as mandated by the President Regulation. in which DJPPI now includes other agencies which are DNPI and BPREDD+. Climate Change Focal Point previously held by the head of DNPI is also now transferred to the Director General of Climate Change.

Under the DJPPI, there are five Directorates in charge for climate change, namely (i) Directorate Climate Change Adaptation, (ii) Directorate Climate Change Mitigation, (iii) Directorate

GHG Inventory and MRV, (iv) Directorate Sectoral and Regional Resource Mobilization and (v) Directorate Forest Fire Management. With the formation of these Directorates, the institutional arrangement for the MER as shown in Figure 3.7 will be adjusted accordingly.

### 3.5.1.2. For REDD+

Implementers of REDD+activities are also responsible of carrying out monitoring and development of report for the activities. At present, there is no yet a defined procedure for evaluation and verification of REDD+ activity outside those developed by carbon trading scheme. The DJPPI under the process of developing the MRV procedure for REDD+ activities.

### 3.5.1.3. For activities under trading mechanism

Carbon trading schemes such as CDM and VCS have already established their modalities and procedures, including for MRV. While the government of Indonesia, through the Indonesian DNA, has records on the number of CDM projects being registered at the UNFCCC and the number of CERs issued, there was no registry existed for activities under voluntary carbon scheme such as the VCS with the exception in forestry sector. REDD+ activities, by law of Ministry Regulation No. 30/2009, were obligated to submit information on their activities to the Ministry of Forestry.

With the change of institutional structure under the new government, this process will change. In regard with mitigation activities under the international carbon market schemes, the verification of the mitigation activities and its emission reduction achievement will follow the international procedures. However, the responsible parties/project proponents also have to submit the result of the verification report from the accredited verifier to the Minister of Environment and Forestry for registration at the National Registry System, so that Government of Indonesia could report this information to the UNFCCC Secretariat as part of BURs and National Communications.

### 3.5.1.4. For other mitigation activities

For mitigation activities that are implemented in Indonesia without international support and activities that received support from international fund, the procedure of Measurement and Reporting process will be accordingly to own scheme, while the

Verification process will be under Indonesia domestic MRV System. For activities that received international support, the verification process could be open to additional agreement between Indonesia and supporting party.

### 3.5.2. Verification Process

Following the MoE Regulation No. 15/2013 on MRV of Mitigation Actions and considering the new government structure, the Indonesia domestic MRV system is defined in Figure 3.8. Responsible Party in conducting mitigation activities has to submit a report on the planning, implementation and achievement of mitigation activities to the Minister of Environment and Forestry (MoEF; Part 1).

In line with the mandate as defined in the President Regulation Number 16/2015 and Minister Regulation Number P.18/MenLHK-II/2015, the Director General of Climate Change Control (DJPPI) will be responsible to conduct the verification (Part 2). The DJPPI forms Verification Team who will conduct verification to the report submitted by the responsible party (Part-3). If the result of the emission reduction is not approved it will be returned to the responsible party for revision, while if it is approved, the Verification Team will report to the DJPPI to get recommendation from the Minister of Environment and Forestry for issuing the certificate of emission reduction (Part 4). The DJPPI will register the mitigation activity and its achievement in National Registry System (Part 5).

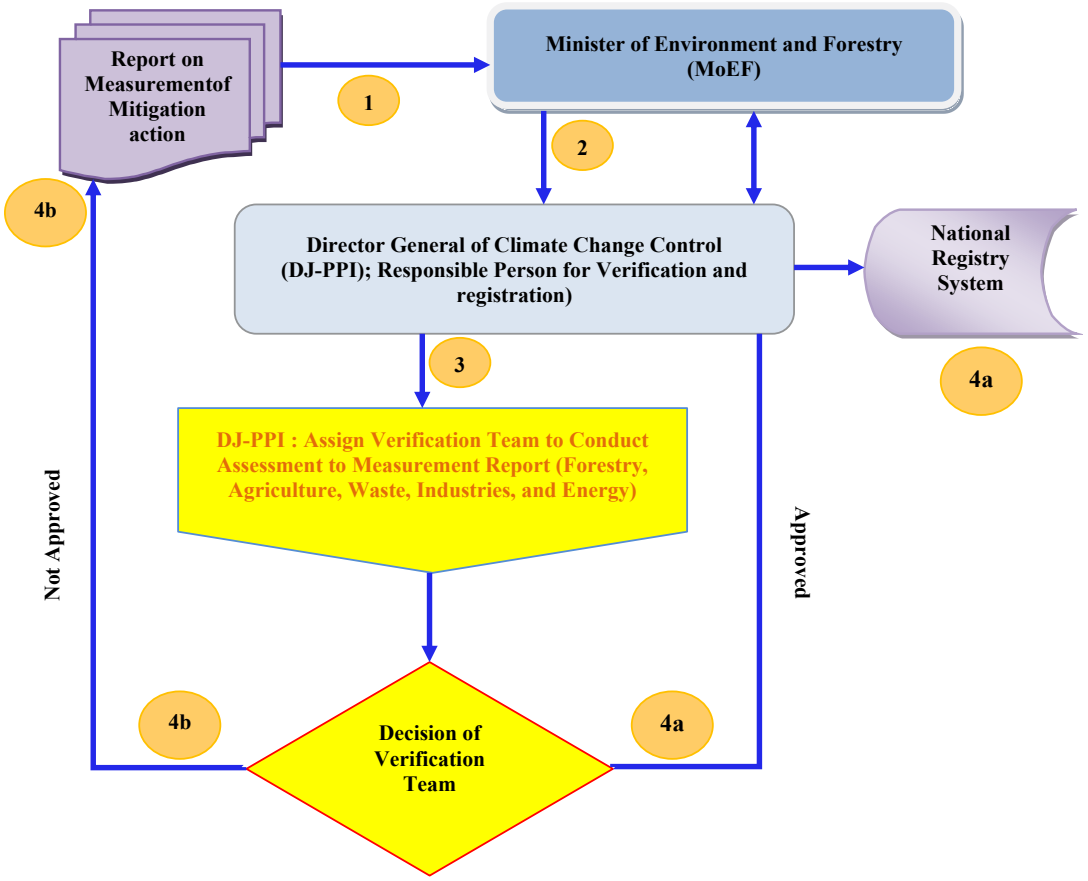



**Figure 3.8.** Procedure for the evaluation of Measurement Report

There are several instruments being developed to ensure the accuracy, consistency, transparency and quality of verification result. The instruments include of verification checklist which consists of:

1. Baseline that includes base year, indicator, projection year, and methodology
2. Activity data and year
3. Emission reduction calculation includes methodology and emission factor
4. Monitoring that includes parameter, period, schedule, instruments and documentation
5. Managerial system of Party in Charge
6. Source of fund

The other instrument is criteria for evaluating data quality and accuracy. The criteria used for assessing the data quality include the availability of Standard Operating Procedure (SOP), structure of organization for data collection and documentation system. For data accuracy, the criteria used include emission factors used for calculating the emission (local or default values), source of activity data and reliability of other supporting parameters used in the calculation of the emission. Currently pilot MRV is implemented in RAN GRK energy sector with Ministry of Energy and Mineral Resources as Party in Charge (see Box 1).

# Chapter 4.

# Financial, Technology, Capacity Needs and Support Received for Climate Change Activities

This chapter provides information on gaps and constraints that are facing the development of national GHG inventory and the implementation of mitigation actions, identification of 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. The last section describes the information on funding support for the development of BUR. Data sources used in this chapter 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 those after Cancun Agreement (2010).

## 4.1. Gaps and Constraints

Development of GHG Inventory and implementation of mitigation actions plan (RAN/RAD GRK) in Indonesia are regulated by the Presidential Regulation No. 71/2011 and 61/2011 respectively. Roles and responsibilities of national and local institutions are clearly defined in these regulations. BAPPENAS leads the implementation of RAN/RAD GRK, while MOE leads the development of National GHG Inventory. Both agencies have developed guidelines for the implementation of both activities. However, the linkage between the two activities can be improved, particularly on harmonization of data collection, and that the impact of the implementation of mitigation actions should be reflected in the GHG Inventory. Moreover, institutional process for linking activity data related to the mitigation activities and the GHG inventory needs to be developed which includes significant involvement of agencies responsible for collecting development data, i.e. Bureau of Statistics (BPS) and Centre for Data and Information (PUSDATIN) in each sector.

In terms of technical capacity in the development of GHG Inventory, there is gap between national and local institutions, and between sectors. In most cases, provinces and districts are facing difficulties in calculating the emissions related to their mitigation activities and

also in defining the baseline emission as reference for evaluating the effectiveness of mitigation actions in reducing the emission. Another challenge is in monitoring activities implementation including tracking budget used to fund the activity. This gap hinders the upcoming plan of having both top-down and bottom-up approaches in developing National GHG Inventory (see sub-chapter 2.2). Other constraint in the implementation of mitigation activities among others are (i) access to financing, (ii) limited skill in applying low carbon technology, and (iii) limited incentives especially to attract private sectors' participation.

## 4.2. Financial, technology and capacity needs

### 4.2.1. Financial needs

The Government of Indonesia requires financial supports, particularly for achieving the national emission reduction target of 41%. Using domestic budget, Government of Indonesia has committed voluntarily to reduce its emission by 26% in 2020. Thus supports are necessary to increase emission reduction target by 15% from the unilateral target.

Up to 2014, six ministries and one local government have identified 15 mitigation activities required international financial supports, called as supported NAMAs (Bappenas, 2014b). Implementation of the activities is scheduled mostly from 2015-2020 with total investment of USD 1,299.7 millions. The overall financial support required is only for six activities, i.e. USD 229.2 millions (Table 4.1). The detail information of the 15 activities is presented in Appendix C1.

Table 4-1.Number of Supported NAMAs Proposed by Ministries and Local Government

| No | Agencies | No. of Activities | Total Investment | Required supports |
|---|---|---|---|---|
| 1 | Ministry of Energy and Mineral Resources | 3 | 560.3 | 203.2 |
| | | 1 | NC | NC |
| 2 | Ministry of Environment and Forestry | 1 | 198.0 | NC |
| 3 | Local Government (Bogor-West Java) | 1 | 40.0 | NC |
| 4 | Ministry of Agriculture | 5 | 20.2 | NC |
| 5 | Ministry of Industry | 1 | 2.4 | 2.4 |
| 6 | Ministry of Public Works and Housing | 1 | 11.7 | 7.3 |
| | | 1 | NC | NC |
| 7 | Ministry of Transportation | 1 | 467.1 | 16.3 |
| **TOTAL** | | 15 | 1299.7 | 229.2 |

Note: NC = Not communicated

### 4.2.2. Technology needs

Some sectors which implement supported NAMA activities required technical support, namely Ministry of Transportation on Sustainable Urban Transport (SUTRI) NAMA and Ministry of Energy and Mineral Resources on Smart Street Lightning Initiative (SSLI) NAMA. Estimated cost for the technical support needed for these two activities is USD 13.9 million. Other sectors have also identified mitigation technology needs (BAPPENAS, 2014b; DNPI, 2012):

1. Energy: solar photovoltaic (PV) and regenerative burner combustion system (RBCS)
2. Waste: mechanical-biological treatment (MBT), in vessel composting (IVC), low solid anaerobic digestion (LSAD)
3. Agriculture, forest and other land uses (AFOLU): Integrated forest-peat carbon measurement and monitoring technology, peat re-mapping technology and peat water management technology including methodology for determining the activity data of burned peat (the burnt area and peat depth with an accuracy 5 cm).

For the AFOLU, the technical support would cost about IDR 50.5 Billion (USD 3.66 million), while for the energy and waste sectors the information on cost for technical supports were not communicated (see Appendix C2 for more detail information).

### 4.2.3. Capacity needs

For implemention of the mitigation actions including supported NAMAs, sectoral ministries, privates and also communities 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. Therefore, capacity building ought to be directed towards: (i) increasing sectoral capacity in developing sectoral and sub-sectoral baseline/reference emission level as the basis for measuring the achievement of mitigation actions; (ii) enhancing the capacities of agencies responsible for collecting and understanding data and in developing templates to facilitate data collection; and (iii) 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. Targets for this capacity building are divisions or bodies within K/L who are in charge of developing, coordinating and monitoring the implementation of sub-sectoral mitigation actions as well as agencies responsible for collecting data from the implementation of mitigation programme/activities. In addition, awareness rising activities need to be implemented in an integrated way not only for the government agencies but also for private sectors who have the potential to participate in the implementation of mitigation actions.

The sectoral ministries have identified the types of capacity building activities necessary for the implementation of NAMA activities. The activities spanned from strengthening the capacity for developing mitigation strategies and supported regulations, application of mitigation technologies, and development of MRV system. At least there were 13 capacity building activities required by the sectoral ministries (see Appendix C3 for detail) of which seven had funding estimates. The estimated funding required for the seven activities is about USD 25 millions (Table 4.2).

Table 4-2. Number of Capacity Building Activities and Support Needs for their Implementation

| Types of capacity building | No. of Activities | Total funding (million USD) | Support required (Million USD) |
|---|---|---|---|
| Development of mitigation strategies including supporting regulations | 4 | 18.25 | 18.25 |
| Application of mitigation technologies | 1 | 2.54 | NC |
| | 4 | NC | NC |
| Development and implementing MRV system | 2 | 4.25 | 4.25 |
| | 2 | NC | NC |
| Total | 13 | 25.04 | 22.50 |

Note: NC = Not communicated

## 4.3. Support Received

Based on Government Regulation 10/2011 on procedure for obtaining loans and grants, all grants should be recorded by BAPPENAS. This BUR only reports the supports received in accordance with the regulations. As Government of Indonesia has committed voluntarily to reduce its emission using domestic sources, this report also includes information on funding used for the implementation of the mitigation actions.

### 4.3.1. Domestic Source and Institutional Arrangement

For the implementation of mitigation action and development of National GHG inventory as regulated under the Presidential Regulations 61/2011 and 71/2011, Indonesia has significantly increased its expenses for implementing mitigation actions especially after 2012 (Figure 4.1). All of the funds originated from National Budget (APBN), of which some were channelled through Government Investment Agency (PIP), the Indonesia Climate Change Trust Fund (ICCTF), and the Millennium Challenge Account Indonesia (MCAI).

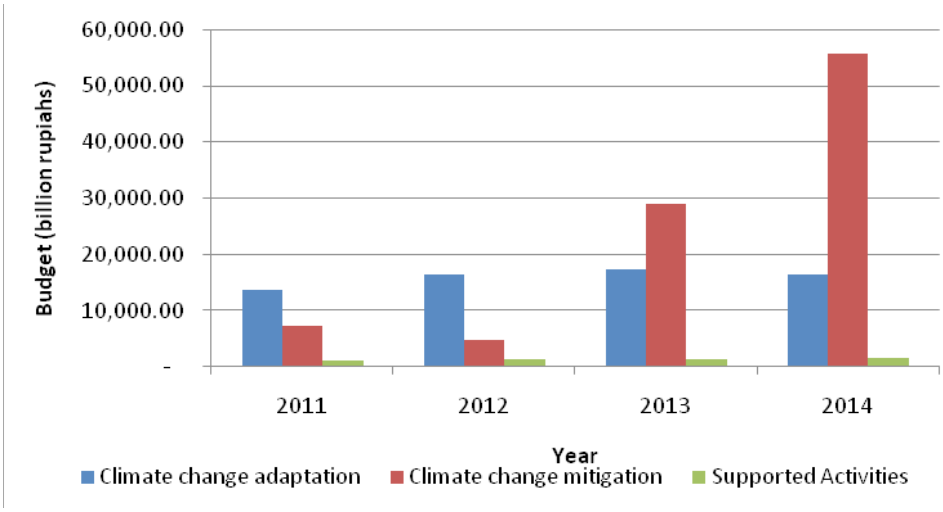



**Figure 4.1.** Budget Realization related to Climate Change in 2011-2014 (BAPPENAS, 2014a)

In addition to National Budget (APBN), the implementation of mitigation actions at local level also used Local Budget (APBD). Similar to APBN, the expense of local governments for the implementation of mitigation action in various sectors also increased very significant after 2011 (Table 4.3). According to BAPPENAS (2014a), in 2012, most of the funds were used by forestry sector (Table 4.4). The Ministry of Finance (2012) had estimated the amount of funding needed to achieve the voluntary emission reduction target in 2020, including possible contributions from private sector. It was estimated that the amount of funding to support the implementation of mitigation actions in forest, peat land, energy, and transportation sectors would reach IDR 140 billion annually (Table 4.4).

Table 4-3. Number of Activity for GHG emissions Reduction and Budget Realization for RAD-GRK

| Sector | 2010 | | 2011 | | 2012 | | TOTAL | |
|---|---|---|---|---|---|---|---|---|
| | | | | ***Core Activities*** | | | | |
| | Number of Activity | Budget (Billion Rupiahs) | Number of Activity | Budget (Billion Rupiahs) | Number of Activity | Budget (Billion Rupiahs) | Number of Activity | Budget (Billion Rupiahs) |
| **Forestry** | 150 | 123 | 143 | 150 | 163 | 2,701 | 456 | 2,974 |
| **Agriculture** | 55 | 33 | 101 | 76 | 142 | 43 | 298 | 151 |
| **Energy** | 59 | 70 | 72 | 104 | 78 | 143 | 209 | 317 |
| **Transportation** | 37 | 62 | 32 | 60 | 37 | 240 | 106 | 362 |
| **Waste Management** | 37 | 128 | 209 | 216 | 276 | 589 | 522 | 934 |
| **TOTAL** | 338 | 417 | 557 | 606 | 696 | 3,716 | 1,591 | 4,738 |
| | | | | ***Supporting Activities*** | | | | |
| All Sectors | 236 | 80 | 314 | 4 | 249 | 118 | 899 | 4,205 |

Source: BAPPENAS (2014a)

Table 4-4. Budget Contribution for Emission Reduction and Indicative Cost (Ministry of Finance, 2012)

| Sources of emission reduction | Emission reduction ($tCO_2$) in 2020 | Indicative cost (billion IDR/year) | | |
|---|---|---|---|---|
| | | Public | Private | Total |
| Maintain RAN GRK expenditures on the year 2012' level | 116 | 16 | 0 | 16 |
| Additional expenditure for RAN GRK according to GDP | 31 | 4 | 0 | 4 |
| Improvement of budget's effectiveness from the existing expenditures | 78 | 1-2 | 0 | 1-2 |
| Emissions from power plant s 26% lower, including geothermal | 104 | 15-45 | 15-45 | 40-70 |
| Policy to limit deforestation up to 450,000 ha/year | 260 | 1-2 | 20-30 | 21-32 |
| Emission reduction needed from new initiative | 121 | 6 | 11 | 17 |
| RAN GRK target for forest, peat land, energy and transportation | 710 | 45-75 | 45-85 | 100-140 |
| Emission reduction from agriculture, industry, and waste | 57 | Is not included yet in the report | | |
| RAN GRK's total target | 767 | | | |

Source: Ministry of Finance (2012)

To create a conducive atmosphere for the financing of climate change-related activities, the Ministry of Finance (2014b) has developed several fiscal policies, among others are: 1) Government investment through SOEs to support geothermal development; 2) Revolving fund to support geothermal exploration; 3) Provision of grants to the National Electricity Company (PLN) to accelerate the construction of 10,000 megawatt power plants, which are mainly powered by renewable energy sources; 4) Feed in-tariff for renewable energy sources; 5) Funding for green investment by the Government Investment Centre (PIP); 6) Energy efficiency revolving fund for small- and medium-scale enterprises (the process of finalizing in October 2013).

Financial support from international communities came in various forms, e.g. grant, soft loan, and mix of grants and performance-based grant. The latter is currently applied for REDD+ activities under bilateral cooperation with Norway. To manage the support received, Government of Indonesia has established institutional arrangement such as ICCTF and PIP. Aside from these, there are also direct bilateral arrangement between donors and sectors.

## ICCTF (Indonesia Climate Change Trust Fund)

In responding to the demand for coordination and harmonization climate financing in Indonesia, in 2009, the Government of Indonesia established Indonesia Climate Change Trust Fund (ICCTF). ICCTF is a national trust fund dedicated to climate finance equipped with a governmental mandate to support the implementation of Indonesia's mitigation and adaptation goals. ICCTF's missions are to mobilize, allocate and manage funds that are invested in projects and programmes in compliant with national and international fiduciary standards; and to contribute to efficient and effective actions in GHG emissions reduction and increasing resilience of the country inline with sustainable development principles. Thus, ICCTF is a key instrument of the GoI in achieving its mitigation and adaptation targets, supporting both the implementation of National Mitigation Action Plan (RAN-GRK, including RAD-GRK) as well as National Adaptation Action Plan (RAN-API).

With regards to organizational development, ICCTF has established Board of Trustees (MWA) for Indonesia Climate Change Trust Fund through the Minister of National Development Planning/Head of the National Development Planning Agency Decree No. KEP.33/M.PPN/HK/03/2014. In 2014, the MWA has approved a By laws and Fundraising Strategy & Business Plan (2014–2019) of the ICCTF and has signed an MoU with Bank Mandiri who will act as manager for the ICCTF fund. ICCTF is also preparing for accreditation of ISO 9001 Quality Management System. Central to the long-term strategy of the ICCTF, is the financing and implementation of NAMAs in cooperation with public and private institutions. In this regard, ICCTF is encouraging partnerships and cooperations with development partners and private sector.

ICCTF focuses on three areas of programmes namely Land-based Mitigation, Energy, and Adaptation and Resilience Windows. **The Land-based Mitigation Window** aims to reduce GHG emissions by supporting afforestation/reforestation activities along with sustainable agriculture and forest management. Finance activities focused on strengthening the institutional setting and capacities as well as reforming forest governance. **The Energy Window** is expected to significantly reduce GHG emissions linked to energy supply and demand, encompassing the financing of low-carbon energy supply technologies and implementation of energy conservation and efficiency measures. **Resilience and Adaptation Window** strives for preparing Indonesia's national and local institutions, and vulnerable communities, for the current and future impacts of climate change by enhancing the dissemination of climate information, developing and improving the design of adaptation strategies, utilizing appropriate technology and knowledge, and establishing favourable policies for supporting adaptation activities change.

Since its establishment, ICCTF has funded a total of 12 Climate Change Projects (Six Projects implemented by Line Ministries, and Six Projects Implemented by University, National NGOs, and Civil Society Organizations). In addition, ICCTF has also implemented

communication and outreach activities to promote ICCTF, such as the Climate and Development Investment Forum held in September 12th of 2014 in collaboration with BMUB-ICCTF, GIZ, CDKN and line ministries. The forum aimed to correspond national sustainable policies and programmes (NAMAs) with international climate and clean energy finance from international donors and other investors.

### PIP (Government Investment Center)

Government Investment Agency (PIP) was established to mobilize climate finance. PIP is an extensionof the Ministry of Finance that manages sovereign wealth fund in partnership with the private sector. PIP can undertake portfolio investment as well as direct investment. PIP offers finance with interest in return based on the interest rate of lending institution. From PIP, it will then be forwarded to project contractors with interest in return. The return paid to PIP is categorized as non-tax state income (*Penerimaan Negara Bukan Pajak*- PNBP). To fund government activities related to low carbon development, PIP established a clean technology fund, together with the Qatar Investment Authority (QIA). In this regard, the government has allocated IDR 1.5 trillion rupiahs for initial financing of this cooperation, with approval from the Committee overlooking assumption of the National Budget (APBN) (CER Indonesia, 2012).

## 4.3.2. International Sources

Indonesia received international financial support in the form of grants to improve environmental quality and for climate change activities, from several countries and development partners (BAPPENAS, 2014a). From 2008 to 2014, total of the grants was IDR 1.178 trillion. This amount is much less than that announced at global level that reached 249.79 million USD (IDR 3.04 trillion). This discrepancy may be because the donor announced the support globally prior to entering agreement with Government of Indonesia. In addition, funding from donors might go to non-government organizations that were not recorded by the GoI. Various funding sources either from multilateral or bilateral institutions including the type of the funds received by Government of Indonesia are given in Table 4.7.

The challenges in reporting international supports were tracking the fundings that flows to non-government agencies. Money transferred through the Indonesian Treasury became part of comprehensive reporting requirements while the Ministry of Finance's ability to track the remaining was often impaired. The Ministry of Finance has already commenced to develop a system to 'tag' climate finance within the state budget. A budget tagging system would be an important step to improve reporting and tracking, strengthening the ability of policy makers to manage and target domestic finance resources more effectively.

In addition to the grants, international funding agencies provided loans to support the implementation of climate change activities. It was reported that the amount of loans allocated for Indonesia amounted to 323 million USD (www.climatefundsupdate.org/data). However, this BUR does not include such information, as the GoI does not consider loan as a support since the government has the obligation to pay back the loans.

Table 4-5. Financial support to Government of Indonesia

| Funding Sources | Description of Support (USD) | | | Implementing Agency | Description |
|---|---|---|---|---|---|
| | Reporting Period | Financial | | | |
| | | Approved | Disbursed | | |
| 1) ADB | 2014-2017 | 700 Thousand | NA | BAPPENAS | Implementing Effective Climate Change Adaption Policy<br>Technical assistance (TA) aims to support the strategic efforts to help develop climate change adaptation policy agenda and to provide guidance to catalyse implementation of effective adaptation. TA has two components activities:<br>(1) improving policy development, planning, and coordination related to adaptation to climate change and<br>(2) improve knowledge management and information management |
| 2) UNDP, DFID/ UKCCU, SIDA, AUSAID | 2010-2013 | 11.4 Million | 6.4 Million | BAPPENAS | Support to Preparation Arrangement for ICCTF-Full Size<br>Grant support from development partners, channelled through UNDP. This grant aims to provide support to initiatives in the field of climate change, which is a government priority, providing support for the establishment of ICCTF bodies, and provide capacity building to the Government of Indonesia to improve the efficiency and effectiveness of ICCTF |
| 3) Japan | 2012 | 11.2 Million | 6.4 Million | BAPPENAS, Ministry of Environment and BMKG | Project of Capacity Development for Climate Change Strategies in Indonesia (Climate Change Policy – Natural Resource)<br>This grant aims to improve the capacity of ministries and local governments to devise strategies to climate change mitigation policies are integrated with national development planning |
| 4) United Kingdom | 2009-2015<br>(7 Activities) | £ 54.8 Million | £14.7 Million | BAPPENAS, DNPI, PIP<br>BAPPENAS, DNPI, PIP<br>Ministry of Finance<br>Ministry of HA | • Development Cooperation to Support Poverty Reduction through National Responses to Climate Change (2009-2011) : Approved 1 Million £ and Disbursed 0.6 Million £.<br>Grant of GBP 1 million is the initial stage of the total grant up to GBP 10 million for mitigation and adaptation to climate change. The initial phase is targeted for the establishment of a multi-donor trust fund (ICTTF), long-term investment framework and climate change strategy planning framework including programmes related to economic and poverty reduction (reduction aspects of vulnerability to climate change). Grant of GBP 179.5 thousand transferred to ICCTF.<br>• Support to BAPPENAS, DNPI, PIP (2009-2011) : Approved 1.3 Million £ and Disbursed 0.7 Million £.<br>• Support to MOFOR I & II (2010-2015) : Approved 6.3 Million £ and Disbursed 1.7 Million £.<br>The project goal is to create an environment conducive to investmentin Indonesia; -Provision of advice that affect policy change pro environmentally friendly, such as the reduction of import taxes on goods that have environmentally friendly technology, FIT for electricity produced from biomass and litter.<br>• Support to Papua (2011-2013) : Approved 10.6 Million £ and Disbursed 0.4 Million £.<br>The project's objectives to support the implementation of Spatial Planning and development Papua Low Carbon Strategy. |

| Funding Sources | Description of Support (USD) | | | Implementing Agency | Description |
|---|---|---|---|---|---|
| | Reporting Period | Financial | | | |
| | | Approved | Disbursed | | |
| | | | | Ministry of Forestry<br><br>Ministry of Forestry<br><br>AFD | • Multistakeholder Forestry Programme 1 &2 (2008-2013) : 8.3 Million £ and Disbursed 6.1 Million £.<br>This grant aims to support the Government of Indonesia in implementing timber licensing system.<br>• Multistakeholder Forestry Programme 3 (2013-2015) : Approved 10 Million £ and Disbursed 0.<br>This grant aims to support the Government of Indonesia in implementing timber licensing system.<br>• Promoting Low Carbon I & II (2011-2015) : Approved 17 Million £ and Disbursed 5 Million £.<br>The project goal is to create an environment conducive to investment in Indonesia; -Provision of advice that affect pro environmentally friendly policy change, such as the reduction of import taxes on goods that have environmental friendly technology, FIT for electricity produced from biomass and litter. |
| 5) Germany | 2010-2016<br>(8 Activities) | € 44.7 Million | € 24.5 Million | BAPPENAS and Ministry of Trade<br><br>Ministry of Forestry<br><br>Ministry of Forestry<br><br>Ministry of Environment /Bappedal<br><br>Ministry of Environment /Bappedal | • Sustainable Urban Transport Improvement Project - SUTIP (TC) (2008-2012) : Approved 4.8 Million € and Disbursed 4.3 Million €.<br>Based on the national urban transport policy, Indonesian city urban transport plan compatible, energy-efficient and climate-friendly<br>• Forest and Climate Protection (Forclime I)-TC (2008-2013) : Approved 9.9 Million € and Disbursed 9.9 Million €.<br>Involving the public and private sectors involved in implementing the framework of institutional improvement, methods and services for forest management, biodiversity conservation, and reduction of green house gas emissions from forest degradation and deforestation and to improve living conditions in rural communities. –Providing advice, strategy development and support for the implementation of the form of the forestry sector.<br>• Forest and Climate Protection (Forclime II)-TC (2012-2014) : Approved 7.5 Million € and Disbursed 2.9 Million €.<br>Involving the public and private sectors involved in implementing the framework of institutional improvement, methods and services for forest management, biodiversity conservation, and reduction of green house gas emissions from forest degradation and deforestation and to improve living conditions in rural communities. –Providing advice, strategy development and support for the implementation of there form of the forestry sector.<br>• Environment and Climate Change-Paklim (TC) (2008-2015) : Approved 7.9 Million € and Disbursed 4 Million €.<br>The national government, provinces, municipalities, industry and civil society organizations that have the best models and structures for the implementation and expansion of mitigation and adaptation measures.<br>• Paklim (TC) via AusAID (2008-2013) : Approved 0.8 Million € and Disbursed 0.2 Million €. |

| Funding Sources | Description of Support (USD) | | | Implementing Agency | Description |
|---|---|---|---|---|---|
| | Reporting Period | Financial | | | |
| | | Approved | Disbursed | | |
| | | | | | The national government, provinces, municipalities, industry and civil society organizations that have the best models and structures for the implementation and expansion of mitigation and-adaptation measures. |
| | | | | BMKG | • Dataclim (TC) (2010-2014) : Approved 2 Million € and Disbursed 1.8 Million €.<br>BMKG Indonesian climate services on adaptation to climate change is significantly enhanced through the introduction of web-based information systems. |
| | | | | Aceh Province | • Seulawah Agam Geothermal (FC) (2011-2014) : Approved 7.7 Million € and Disbursed 0.9 Million €.<br>The loan is to allow private sector participation in the development of geothermal resources in Indonesia to build a geothermal area Seulawah in order to meet the needs of communities electricity that are environmentally friendly |
| | | | | South Sumatra Province | • Biodiversity and Climate Change (BIOCLIME-TC) (2012-2016) : Approved 3.8 Million € and Disbursed 0.020 Million €.<br>Supporting the Provincial Government and district/ city in South Sumatra in making the concept of the protection and sustainable forest management in order to maintain biodiversity and carbon storage. This project involves the public, private and government. |
| 6) South Korea | 2010-2015<br>(2 Activities) | 6.5 Million | 3 Million | BAPPENAS | • Coastal Protection and Management Policy in Indonesia addressing Climate Change in Indonesia (2010-2011) : Approved 3 Million and Disbursed 3 million.<br>This grant aims to protect the coastal zone of Indonesia and infrastructure, offshore forests and ecosystems in it from the impact of disasters and climate change |
| | | | | BAPPENAS and Geospatial Information Agency | • Construction of Spatial Database System on Coastal Protection and Water Resources Management Policy for Adaptation to Climate Change Impact in Indonesia (2013-2015) : Approved 3.5 and Disbursed 0.<br>This grant is a continuation of the grant "Coastal Protection and Management Policy in Indonesia Adressing Climate Change in Indonesia" by stages include the preparation of a master plan for coastal areas involving work programme priorities and activities of the relevant K / L and local government, as well as the provision of equipment, databases systems and training. |
| 7) Denmark | 2008-2017<br>(2 Activities) | 490 Million Danish Krone | 149.7 Million Danish Krone | BAPPENAS, Ministry of Environment, and Ministry of Energy and Mineral Resource | • Environmental Support Programme Phase II (2008-2012) : Approved 220 Million Dannish Kronne and Disbursed 149.7 Million Dannish Kronne.<br>• Environmental Support Programme Phase III (2013-2017) : Approved 270 Million Dannish Kronne and Disbursed 0.<br>• Improving cross-sector cooperation between central and regional governments in ensuring the use of the consideration of environmental issues in all the planning and implementation of development activities; Improving energy efficiency in the field of trade and the public sector. |

Source: BAPPENAS (2014a)

### 4.3.3. Funding support for the development of BUR (GEF and others)

In the development of *Biennial Update Report* (BUR) and Third National Communication (TNC), Government of Indonesia has received funding support from the *Global Environment Facility* (GEF) about 4.5 Million USD. GoI would co-financ about 21 Million USD for the three years period from 2014 until 2016 (Table 4.6). In addition, on behalf of Germany and Japan's government, GIZ and JICA also provide support funding as much as USD 150,000 and USD 6,122,040 respectively to support various activities for the development of BUR and TNC.

Table 4-6. Financial Support for the Development of *Biennial Update Report* (BUR)

| | **Amount Year 1/2014 (USD)** | **Amount Year 2/2015 (USD)** | **Amount Year 3/2016 (USD)** | **Total (USD)** |
|---|---|---|---|---|
| GEF | 1,559,558 | 1,506,182 | 1,434,260 | 4,500,000 |
| GoI (incl co finance) | 7,000,000 | 7,022,040 | 7,000,000 | 21,022,040 |
| **Total** | 8,559,558 | 8,528,222 | 8,434,260 | 25,522,040 |

Funding support from GIZ is mainly used the three activities from 2013-2016 namely (i) Development of concept and guideline for measurement, reporting and verification (MRV) for Nationally Appropriate Mitigation Actions (NAMAs), (ii) Further development and updating of city GHG inventory and risk profile in a number of cities in Central Java, DIY Yogyakarta and East Java, including activities related to enhancing the capacities of city, district and provincial administrations and ensuring communication to province, national and wider stakeholders, and (iii) Development of baseline for industrial sectors (other than cement) and relevant mitigation scenarios. While JICA will support activities from 2010-2015 related to (i) the development capacity of key ministries and local governments to formulate nationally appropriate mitigation actions in a measureable, reported and verifiable manner and to integrate mitigation and adaptation to long-term development plan, (ii) development capacity for conducting vulnerability assessment and (iii) development capacity of key ministries and local government in developing GHG Inventory.

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# Appendix A

**Appendix A1.** GHG emissions estimates using reference approach

| Year | National Energy Consumption MBOE | | | | GHG Emission (Reference), Gg $CO_2$-e | | | |
|---|---|---|---|---|---|---|---|---|
| | Liquid Fuels | Solid Fuels | Gas Fuels | Total | Liquid Fuels Emission | Solid Fuels Emission | Gas Fuels Emission | Total |
| **2000** | 359,556 | 93,919 | 251,420 | 704,895 | 155,515 | 52,998 | 67,748 | 276,262 |
| **2001** | 380,210 | 119,572 | 283,080 | 782,862 | 159,934 | 67,474 | 79,664 | 307,071 |
| **2002** | 406,805 | 122,973 | 310,209 | 839,987 | 174,080 | 69,393 | 86,497 | 329,971 |
| **2003** | 407,750 | 136,818 | 318,872 | 863,440 | 173,785 | 77,206 | 89,883 | 340,874 |
| **2004** | 438,567 | 151,549 | 318,593 | 908,709 | 188,172 | 85,518 | 89,971 | 363,661 |
| **2005** | 467,120 | 180,469 | 265,488 | 913,077 | 191,501 | 101,838 | 72,003 | 365,341 |
| **2006** | 428,289 | 209,325 | 292,652 | 930,266 | 170,507 | 117,410 | 90,821 | 378,738 |
| **2007** | 433,464 | 258,174 | 174,105 | 865,743 | 170,041 | 145,686 | 49,182 | 364,910 |
| **2008** | 455,611 | 290,249 | 183,254 | 929,114 | 158,206 | 163,786 | 52,524 | 374,516 |
| **2009** | 467,341 | 236,439 | 220,930 | 924,710 | 188,034 | 133,421 | 63,433 | 384,889 |
| **2010** | 496,886 | 281,400 | 279,814 | 1,058,100 | 187,820 | 158,793 | 82,855 | 429,467 |
| **2011** | 518,752 | 334,142 | 260,361 | 1,113,255 | 189,793 | 188,555 | 76,427 | 454,775 |
| **2012** | 516,955 | 345,000 | 259,070 | 1,121,025 | 183,282 | 194,682 | 76,019 | 453,983 |

**Appendix A3.** GHG emissions by sectoral, Ggram $CO_2$-e

| GHG Emission Sources | Emission (Gg CO2-e) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
| 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** |
| 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 |
| 1.A.1.b Oil and Gas Refineries | 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 |
| 1.A.1.c Coal Processing | - | - | - | - | - | - | 115 | 119 | 103 | 146 | 192 | 44 | 86 |
| 1.A.2 Manufacturer | 72,300 | 77,379 | 77,393 | 74,019 | 88,365 | 94,005 | 108,118 | 111,441 | 134,824 | 99,255 | 132,306 | 133,226 | 123,738 |
| 1.A.3 Transportation | 58,916 | 62,158 | 64,636 | 67,601 | 72,841 | 74,947 | 73,120 | 76,219 | 81,367 | 96,352 | 108,745 | 117,518 | 131,458 |
| 1.A.4.A Commercial | 3,489 | 3,483 | 3,572 | 3,632 | 3,819 | 3,271 | 3,979 | 3,946 | 3,732 | 3,668 | 3,798 | 3,438 | 3,541 |
| 1.A.4.B Residential | 33,167 | 34,381 | 35,836 | 36,730 | 36,930 | 36,449 | 34,340 | 34,699 | 32,397 | 29,379 | 28,299 | 27,842 | 28,865 |
| 1.A.5 Non-Specified | 11,421 | 11,742 | 11,996 | 12,120 | 12,286 | 12,276 | 11,372 | 10,828 | 10,787 | 11,423 | 12,496 | 10,743 | 11,301 |
| 1.A Fuel Combustions | **269,009** | **299,907** | **313,227** | **324,291** | **343,759** | **348,764** | **368,023** | **361,158** | **387,591** | **376,676** | **430,171** | **466,571** | **486,534** |
| 1.B Fugitives | **29,404** | **28,031** | **27,096** | **25,753** | **24,749** | **24,127** | **23,401** | **25,435** | **22,145** | **21,963** | **23,007** | **22,365** | **21,586** |
| 1.B.1 Fugitives Solid Fuels Mining | 374 | 449 | 501 | 554 | 642 | 738 | 940 | 1,054 | 1,110 | 1,242 | 1,334 | 1,713 | 1,871 |
| 1.B.2 Fugitives Oil and Gas Up-stream | 29,030 | 27,582 | 26,595 | 25,199 | 24,107 | 23,389 | 22,461 | 24,381 | 21,034 | 20,721 | 21,673 | 20,652 | 19,714 |
| Total | **298,412** | **327,938** | **340,323** | **350,044** | **368,508** | **372,891** | **391,424** | **386,593** | **409,736** | **398,639** | **453,178** | **488,936** | **508,120** |

**Appendix A4.** Fossil fuel used by sector of activity in Indonesia (MBOE), 2000 - 2012

| Sector | Consumption (MBOE) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
| 1.A.1 Energy Industries Consumption | 218,114 | 263,772 | 285,374 | 305,988 | 302,124 | 286,340 | 307,190 | 253,010 | 257,078 | 281,123 | 311,697 | 364,720 | 390,315 |
| 1.A.1.a Main Activity Electricity Consumption | 134,465 | 160,348 | 168,263 | 187,652 | 192,973 | 207,712 | 222,135 | 246,321 | 249,607 | 279,794 | 271,048 | 325,385 | 351,946 |
| 1.A.1.b Oil and Gas Refining Consumption | 83,649 | 103,424 | 117,111 | 118,336 | 109,151 | 78,425 | 84,845 | 6,508 | 7,213 | 991 | 40,571 | 39,184 | 38,216 |
| 1.A.1.c Coal Processing Consumption | - | - | - | - | - | 203 | 210 | 181 | 258 | 338 | 78 | 151 | 153 |
| 1.A.2 Manufactures Consumption | 220,574 | 230,330 | 226,488 | 215,920 | 242,783 | 247,568 | 288,772 | 272,536 | 319,441 | 267,310 | 324,503 | 326,139 | 310,249 |
| 1.A.3 Transport Consumption | 137,413 | 144,967 | 150,888 | 158,060 | 170,266 | 175,506 | 171,500 | 179,084 | 191,207 | 226,510 | 255,776 | 277,352 | 310,554 |
| 1.A.4.A Commercial Consumption | 9,686 | 9,644 | 9,861 | 10,003 | 10,424 | 9,158 | 10,680 | 10,619 | 10,089 | 9,979 | 10,324 | 9,593 | 9,903 |
| 1.A.4.B Residential Consumption | 265,417 | 271,625 | 278,787 | 284,409 | 287,621 | 288,584 | 286,057 | 289,566 | 286,039 | 281,079 | 288,829 | 280,455 | 286,846 |
| 1.A.5 Non-Specified Consumption | 26,138 | 26,868 | 27,460 | 27,787 | 28,168 | 28,208 | 26,127 | 24,910 | 24,845 | 26,311 | 28,746 | 24,791 | 26,076 |

**Appendix A5.** Fossil fuel used by type of fuel in Indonesia (kiloton), 2000 - 2012

| Year | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Primary Fuels** | | | | | | | | | | | | | |
| Crude Oil | 51,068 | 50,007 | 49,623 | 50,340 | 50,735 | 53,560 | 46,572 | 44,859 | 41,915 | 47,026 | 41,841 | 34,770 | 38,829 |
| **Secondary Fuels** | | | | | | | | | | | | | |
| Gasoline | 351 | 0 | 1 | 1,309 | 1,741 | 4,047 | 4,322 | 5,231 | 6,343 | 7,595 | 9,089 | 11,284 | 13,040 |
| Jet Kerosene | 0 | 0 | 172 | 246 | 483 | 599 | 645 | 953 | 623 | 139 | 467 | 661 | 573 |
| Other Kerosene | 2,143 | 1,944 | 2,242 | 1,954 | 2,050 | 2,237 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Gas/Diesel Oil | 5,351 | 5,595 | 8,114 | 6,838 | 7,047 | 12,486 | 9,349 | 10,667 | 10,613 | 7,338 | 9,175 | 8,439 | 10,736 |
| Residual Fuel Oil (Incl. LSWR) | -3,952 | -3,738 | -3,897 | -4,389 | -5,275 | -3,598 | 1,598 | 2,055 | 2,444 | 1,814 | 521 | 948 | 399 |
| LPG | -1,306 | -1,485 | -1,268 | -990 | -1,001 | -993 | -324 | -314 | 153 | 735 | 1,283 | 1,921 | 2,538 |
| Naphtha (HOMC) | -256 | -200 | 1,134 | 824 | 1,511 | 1,368 | 832 | 82 | -1 | 995 | 1,174 | 120 | 402 |
| Lubricants | -85 | -22 | -57 | -93 | -71 | -9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Petroleum Coke | -264 | -264 | -225 | -372 | -340 | -26 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Other Oil | -491 | -411 | -33 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Solid Fossil** | | | | | | | | | | | | | |
| Sub-bit. Coal | 16,786 | 30,449 | 32,527 | 34,084 | 45,920 | 51,248 | 48,605 | 51,575 | 43,585 | 55,287 | 65,800 | 78,133 | 80,245 |
| **Gaseous Fossil** | | | | | | | | | | | | | |
| Natural Gas (Dry) | 26,676 | 27,753 | 28,717 | 30,063 | 28,395 | 28,798 | 45,031 | 41,986 | 47,530 | 48,673 | 54,157 | 50,995 | 47,775 |

**Appendix A6.** Development of GHG emissions of IPPU by industrial sub-sector from 2000 – 2012

| Code | Categories | Year | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
| **Mineral** | | | | | | | | | | | | | | |
| 2.A.1 | Cement | 16,626 | 18,702 | 18,353 | 18,011 | 19,275 | 18,770 | 19,303 | 19,824 | 20,772 | 19,650 | 19,052 | 20,695 | 22,675 |
| 2.A.2 | Lime | 3,688 | 7,037 | 2,078 | 2,059 | 2,115 | 2,121 | 2,316 | 2,512 | 1,714 | 916 | 916 | 916 | 916 |
| 2.A.3 | Glass | 255 | 153 | 139 | 175 | 163 | 190 | 73 | 58 | 42 | 43 | 48 | 39 | 39 |
| 2.A.4.a | Ceramics | 5.30 | 5.30 | 6.51 | 5.16 | 6.70 | 5.84 | 4.20 | 4.37 | 4.70 | 4.70 | 5.09 | 5.69 | 5.69 |
| 2.A.4.b | Other Uses of Soda Ash | 8,410 | 8,410 | 7,521 | 6,066 | 7,445 | 5,453 | 2,978 | 2,075 | 2,082 | 2,038 | 2,035 | 2,037 | 2,037 |
| **Chemical** | | | | | | | | | | | | | | |
| 2.B.1 | Ammonia | 8,107 | 7,466 | 8,084 | 8,235 | 7,702 | 8,683 | 8,319 | 6,896 | 7,111 | 7,759 | 7,671 | 7,085 | 7,182 |
| 2.B.2 | Nitric Acid | 265 | 265 | 265 | 265 | 265 | 265 | 265 | 265 | 265 | 265 | 265 | 295 | 420 |
| 2.B.5 | Carbide | 24 | 76 | 83 | 83 | 22 | 22 | 38 | 36 | 34 | 32 | 30 | 28 | 23 |
| 2.B.8.a | Methanol | 344 | 404 | 340 | 343 | 341 | 366 | 293 | 293 | 368 | 297 | 215 | 221 | 198 |
| 2.B.8.b | Ethylene | 1,154 | 919 | 990 | 1,101 | 1,075 | 1,126 | 1,133 | 1,230 | 1,128 | 1,051 | 1,311 | 1,081 | 1,228 |
| 2.B.8.c | Ethylene Dichloride &VCM | 150 | 155 | 154 | 157 | 157 | 143 | 151 | 125 | 121 | 123 | 128 | 117 | 127 |
| 2.B.8.f | Carbon Black | 248 | 257 | 238 | 251 | 288 | 322 | 322 | 322 | 337 | 342 | 337 | 231 | 635 |
| **Metal** | | | | | | | | | | | | | | |
| 2.C.1 | Iron and Steel | 998 | 1,492 | 735 | 1,678 | 1,820 | 1,752 | 1,436 | 1,119 | 1,076 | 2,847 | 2,947 | 2,898 | 3,005 |
| 2.C.3 | Aluminium | 656 | 656 | 656 | 656 | 656 | 656 | 683 | 659 | 662 | 658 | 531 | 431 | 433 |
| 2.C.5 | Lead | 19 | 17 | 13 | 14 | 13 | 14 | 19 | 23 | 45 | 28 | 12 | 13 | 13 |
| 2.C.6 | Zinc | 124 | 170 | 95 | 97 | 70 | 106 | 75 | 51 | 33 | 28 | 28 | 21 | 16 |
| **Non-Energy Products from Fuels and Solvent Use** | | | | | | | | | | | | | | |
| 2.D.1 | Lubricant Use | 218 | 209 | 150 | 179 | 189 | 191 | 216 | 229 | 250 | 226 | 166 | 245 | 222 |
| 2.D.2 | Paraffin Wax Use | 613 | 594 | 585 | 855 | 696 | 722 | 859 | 915 | 1,060 | 2,315 | 1,439 | 2,062 | 3,108 |
| **Others** | | | | | | | | | | | | | | |
| 2.H.1 | Pulp and Paper Industry | 78 | 78 | 78 | 78 | 78 | 78 | 78 | 78 | 74 | 81 | 88 | 89 | 94 |
| 2.H.2 | Food and Beverages Industry | 14.05 | 5.48 | 2.74 | 1.08 | 3.57 | 0.82 | 2.07 | 1.03 | 1.89 | 0.81 | 0.40 | 1.08 | 0.50 |

**Appendix A7.** Activity data used for calculating of GHG emissions level from MSW Treatment, Ggram

| Year | Waste Generation, Ggram | MSW to SWDS, Ggram | Open Burning, Ggram | Untreated, Ggram | Composting, Ggram | 3R, Ggram |
|---|---|---|---|---|---|---|
| **2000** | 49,156 | 29,493 | 10,323 | 9,340 | - | - |
| **2001** | 49,702 | 29,821 | 10,437 | 9,443 | - | - |
| **2002** | 50,255 | 30,153 | 10,554 | 9,548 | - | - |
| **2003** | 50,814 | 30,488 | 10,671 | 9,655 | - | - |
| **2004** | 51,379 | 30,828 | 10,790 | 9,762 | - | - |
| **2005** | 51,951 | 31,170 | 10,910 | 9,871 | - | - |
| **2006** | 52,522 | 31,513 | 11,030 | 7,878 | 1,050 | 1,050 |
| **2007** | 52,054 | 31,232 | 10,931 | 7,808 | 1,041 | 1,041 |
| **2008** | 53,908 | 32,345 | 11,321 | 8,086 | 1,078 | 1,078 |
| **2009** | 54,501 | 32,700 | 11,445 | 8,175 | 1,090 | 1,090 |
| **2010** | 59,500 | 35,700 | 12,495 | 8,925 | 1,190 | 1,190 |
| **2011** | 60,162 | 36,097 | 12,634 | 9,024 | 1,203 | 1,203 |
| **2012** | 60,831 | 36,499 | 12,775 | 9,125 | 1,217 | 1,217 |

Source: ADIPURA and SLHI (Indonesian Environment Status)

**Appendix A8.** Assumption of landfill Gas Recovery for Electricity Generation and Cooking Gas

| Data from SWDS (Landfill) | | Instaled Capacity | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|
| Operating Hours | 8,760 | hours/year | | | | | |
| LFG for Power Generation | | | | | | | |
| a. MW Installed Capacity | | | | | | | |
| DKI (Bantar Gebang) | 10 MW | 2010-2012 | 4 | 4 | 4 | 4 | 4 |
| Sumur Batu (Bekasi) | 10 MW | After 2014 | | | | | |
| Palembang, 0.5 MW | 0.12 MW | After 2012 | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 |
| Air Dingin Padang | 0.12 MW | After 2015 | | | | | |
| Kendari | 0.12 MW | After 2015 | | | | | |
| Benowo (Surabaya) | 10 MW | After 2012 | | | | | |
| Suwung Denpasar (pilot) | 4 MW | 2010-2012 | | | | | |
| Singaraja (pilot) | 2 MW | After 2012 | | | | | |
| **Total** | | **MW** | **4.12** | **4.12** | **4.12** | **4.12** | **4.12** |
| b. MWh Production Capacity per year | | MWh/year | 36,091 | 36,091 | 36,091 | 36,091 | 36,091 |
| HHV 3.5-5.5 kWh/Nm3 (55% CH4) | 0.0055 | MWh/M3 | | | | | |
| Gas density (0.9 kG/m3) | 9.E-07 | Ggram/m3 | | | | | |
| LFG for Power (efficieny 25%) | | Ggram/year | 23.62 | 23.62 | 23.62 | 23.62 | 23.62 |
| | | | | | | | |
| LFG for Cooking Gas | | | | | | | |
| Malang | | Households | | | | | 300 |
| Kendari | | Households | | | | | |
| Total | | Households | | | | | 300 |
| LPG Consumption/Households/year | 144 | KG LPG/HH/year | | | | | |
| | 46 | MJ/kG | | | | | |
| HHV 3.5-5.5 kWh/Nm3 (35-55% CH4) | 22 | MJ/kG | | | | | |
| LFG for cooking gas/household/year | 3.E-04 | Ggram/HH/year | | | | | |
| LFG for cooking gas | | Ggram/year | | | | | 0.09 |
| | | | | | | | |
| Total LFG Recovery | | Ggram/year | 23.62 | 23.62 | 23.62 | 23.62 | 23.71 |
| Methane recovery from landfill, 55% CH4 in LFG | | Ggram/year | 12.99 | 12.99 | 12.99 | 12.99 | 13.04 |
| | | % | 1.1% | 1.1% | 1.0% | 1.0% | 1.0% |

**Appendix A9.** GHG emissions of MSW treatment, 2000 – 2012

| Tahun | SWDS | | Composting | | | | | Open Burning | | | | | | Untreated | | TOTAL (Dry Base), Gg $CO_2$-e | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gg $CH_4$ | Gg $CO_2$-e | Gg $CH_4$ | Gg $CO_2$-e | Gg $N_2O$ | Gg $CO_2$-e | Gg $CO_2$-e | Gg $CO_2$ | Gg $CH_4$ | Gg $CO_2$-e | Gg $N_2O$ | Gg $CO_2$-e | Gg $CO_2$-e | Gg $CH_4$ | Gg $CO_2$-e | $CO_2$ | $CH_4$ | $N_2O$ | Gg $CO_2$-e |
| **2000** | 1,023 | 21,476 | - | - | - | - | - | 1,783 | 67 | 1,409 | 0.80 | 248 | 3,441 | 162 | 3,400 | 1,783 | 26,285 | 248.35 | 28,317 |
| **2001** | 1,051 | 22,075 | - | - | - | - | - | 1,803 | 68 | 1,425 | 0.81 | 251 | 3,479 | 166 | 3,495 | 1,803 | 26,995 | 251.11 | 29,049 |
| **2002** | 1,077 | 22,621 | - | - | - | - | - | 1,823 | 69 | 1,441 | 0.82 | 254 | 3,518 | 171 | 3,582 | 1,823 | 27,643 | 253.90 | 29,721 |
| **2003** | 1,101 | 23,127 | - | - | - | - | - | 1,843 | 69 | 1,457 | 0.83 | 257 | 3,557 | 174 | 3,662 | 1,843 | 28,245 | 256.73 | 30,346 |
| **2004** | 1,124 | 23,602 | - | - | - | - | - | 1,864 | 70 | 1,473 | 0.84 | 260 | 3,596 | 178 | 3,737 | 1,864 | 28,812 | 259.58 | 30,935 |
| **2005** | 1,145 | 24,053 | - | - | - | - | - | 1,885 | 71 | 1,489 | 0.85 | 262 | 3,636 | 181 | 3,808 | 1,885 | 29,350 | 262.47 | 31,498 |
| **2006** | 1,166 | 24,485 | 5 | 111 | 0.32 | 99 | 210 | 1,905 | 72 | 1,506 | 0.86 | 265 | 3,676 | 185 | 3,877 | 1,905 | 29,979 | 364.09 | 32,248 |
| **2007** | 1,186 | 24,901 | 5 | 110 | 0.32 | 98 | 208 | 1,888 | 71 | 1,492 | 0.85 | 263 | 3,644 | 177 | 3,716 | 1,888 | 30,220 | 360.84 | 32,469 |
| **2008** | 1,186 | 24,897 | 5 | 114 | 0.33 | 101 | 216 | 1,956 | 74 | 1,545 | 0.88 | 272 | 3,773 | 171 | 3,600 | 1,956 | 30,157 | 373.69 | 32,486 |
| **2009** | 1,208 | 25,359 | 6 | 116 | 0.33 | 102 | 218 | 1,977 | 74 | 1,562 | 0.89 | 275 | 3,815 | 169 | 3,552 | 1,977 | 30,589 | 377.81 | 32,944 |
| **2010** | 1,228 | 25,793 | 6 | 126 | 0.36 | 112 | 238 | 2,159 | 81 | 1,706 | 0.97 | 301 | 4,165 | 168 | 3,531 | 2,159 | 31,155 | 412.46 | 33,727 |
| **2011** | 1,275 | 26,776 | 6 | 128 | 0.36 | 113 | 241 | 2,183 | 82 | 1,725 | 0.98 | 304 | 4,211 | 171 | 3,598 | 2,183 | 32,227 | 417.05 | 34,826 |
| **2012** | 1,314 | 27,584 | 6 | 129 | 0.37 | 114 | 243 | 2,207 | 83 | 1,744 | 0.99 | 307 | 4,258 | 174 | 3,659 | 2,207 | 33,116 | 421.69 | 35,744 |

**Appendix A10.** GHG emissions of industrial wastewater treatment, Ggram $CO_2$-e

| Category | Year | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
| Alcohol refining | 42 | 42 | 43 | 43 | 43 | 43 | 43 | 20 | 23 | 16 | 12 | 74 | 74 |
| Beer & Malt | 12 | 12 | 12 | 12 | 12 | 12 | 16 | 19 | 17 | 17 | 16 | 16 | 16 |
| Coffee | 6.2 | 6.4 | 6.6 | 6.9 | 7.1 | 7.4 | 39 | 38 | 40 | 39 | 39 | 36 | 39 |
| Dairy Products | 12 | 12 | 13 | 14 | 15 | 15 | 15 | 74 | 52 | 58 | 25 | 24 | 138 |
| Fish Processing | 34 | 35 | 37 | 38 | 39 | 41 | 41 | 41 | 41 | 131 | 82 | 82 | 82 |
| Meat & Poultry | 211 | 230 | 267 | 279 | 296 | 282 | 316 | 317 | 322 | 328 | 342 | 354 | 364 |
| Organic Chemicals | 813 | 813 | 813 | 813 | 813 | 813 | 937 | 1,062 | 892 | 2,316 | 1,250 | 1,456 | 1,456 |
| Petroleum Refineries | 133 | 133 | 132 | 132 | 135 | 132 | 117 | 116 | 113 | 115 | 109 | 112 | 105 |
| Plastics & Resins | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 23 |
| Pulp & Paper (combined) | 4,269 | 4,472 | 4,684 | 4,907 | 5,075 | 5,385 | 5,855 | 5,892 | 5,576 | 6,234 | 6,916 | 7,712 | 8,268 |
| Soap & Detergents | 14.4 | 14.5 | 14.6 | 14.7 | 15.2 | 15.4 | 15.4 | 15.4 | 15.4 | 15.4 | 18.1 | 20.8 | 28.5 |
| Starch Production | 6,082 | 6,447 | 6,393 | 7,002 | 7,343 | 7,303 | 7,555 | 7,555 | 8,224 | 8,331 | 9,041 | 9,089 | 9,139 |
| Sugar Refining | 13 | 16 | 21 | 27 | 36 | 46 | 59 | 73 | 68 | 68 | 68 | 140 | 140 |
| Vegetable Oils | 16 | 17 | 19 | 23 | 26 | 29 | 31 | 34 | 39 | 42 | 45 | 50 | 54 |
| Vegetable, Fruits, Juices | 2,438 | 2,610 | 2,880 | 3,308 | 3,607 | 3,726 | 3,726 | 3,726 | 3,726 | 3,726 | 3,726 | 4,878 | 4,878 |
| Wine & Vinegar | 0.51 | 0.51 | 0.51 | 0.51 | 0.51 | 0.88 | 1.06 | 1.14 | 1.04 | 0.87 | 0.94 | 0.49 | 0.91 |
| CPO | 6,536 | 7,245 | 8,111 | 9,426 | 10,679 | 12,254 | 13,073 | 14,175 | 16,144 | 17,325 | 18,585 | 20,633 | 22,444 |
| **TOTAL** | **20,654** | **22,131** | **23,471** | **26,070** | **28,163** | **30,129** | **31,862** | **33,180** | **35,317** | **38,785** | **40,297** | **44,699** | **47,250** |

# Appendix B

## **Appendix B1.** Energy sector mitigation actions

| No | Name of Action | Description | Category in FCCC/ AWGLCA/ 2011/INF.1 | Methodology and Assumptions for Estimating the Mitigation Impacts | Current Status of Implementation | Policy Instruments and Enabling Policies/ Regulations | Emission reduction (Mt CO2e) | | Co-benefit | Administering Government Agencies/ Actor |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Potential/ Target | Achievement | | |
| 1 | Mandatory to Implement Energy Management in Energy Intensive Users | GoI declares that mandatory to implement energy management in large energy consumers (industry, office building hotel/commerce,) is one of mitigation actions of energy sector in RAN GRK. This action is categorized as policy-based mitigation. The policy states that large energy users with certain electricity consumption are mandated to have energy manager and implement energy efficiency measures. | D | Baseline: projected GHG emissions that would occur in large companies in the absence of energy efficiency measures, EF JAMALI electricity grid in 2012 is 0.814 ton CO2e/MWh.<br>GHG emissions estimates: Tier 1 of IPCC 2006 GLs.<br>Assumptions:<br>400 large energy consumers will implement energy efficiency measures (electricity consumption reduction).<br>Large energy consumers: larger than 6000 TOE per year,<br>Energy efficiency improvement potential (no and low cost): 10% | 2010-2013:<br>4 companies have implemented energy efficient measures;<br>Savings:<br>Electricity: 183 GWh<br>Nat Gas: 6,824 TJ | Energy ActNo. 30/2007<br>Government Regulation No. 70/2009 concerning Energy Conservation,<br>Ministry of Labour Decree No. 321/MEN/XII/2011 on energy manager in industry and Ministry of Labour Decree No. 323/MEN/XII/2011 on energy manager in building<br>Ministerial Regulation of MEMR no. 14/2012 concerning Energy Management. | 10.16 | 0.31 | Energy cost saving, better energy utilization plan, capacity building for energy operators, stimulate innovation in energy efficiency activities, national energy security, less pollutants in the consumers and/ or in the power plants | MEMR |
| 2 | Implementation of energy conservation partnership programme | National action to conduct energy conservation partnership programme with private parties/communities.<br>Target:<br>2010-2014: 1003 objects<br>2015-2020: 300 objects (building and industry) | D | Baseline: Projected GHG emissions that would occur in the absence of energy efficiency measures. Baseline is estimated based on energy audit before mitigations.<br>Energy saving: baseline minus energy level after mitigation<br>EF:<br>For electricity, EF Jamali grid in 2012 is 0.814 ton CO2e/MWh<br>GHG emissions estimates: Tier 1 of IPCC 2006 GLs<br>Associated emissions reduction is calculated from energy savings and relevant emissions factor. | 2010-2013:<br>Energy audit and conservation measures in 611 objects.<br>(building and industry).<br>Electricity Saving:<br>364 GWh | Energy ActNo. 30/2007<br>Government Regulation No. 70/2009 concerning Energy Conservation,<br>Ministry of Labour Decree No. 321/MEN/XII/2011 on energy manager in industry and Ministry of Labour Decree No. 323/MEN/XII/2011 on energy manager in building<br>Ministerial Regulation of MEMR no. 14/2012 concerning Energy Management.<br>Indonesian National Standard (SNI) for energy efficient buildings<br>(SNI 03-6389-2011, SNI 03-6390-2011, SNI 03-6197-2011, SNI 03-6169-2011) | 2.11 | 0.781 | Energy cost saving, better energy utilization, capacity building in energy-efficient culture, stimulate innovation in energy efficiency activities,<br>national energy security, less pollutants in the consumers and/ or in the power plants | MEMR |

| No | Name of Action | Description | Category in FCCC/ AWGLCA/ 2011/INF.1 | Methodology and Assumptions for Estimating the Mitigation Impacts | Current Status of Implementation | Policy Instruments and Enabling Policies/ Regulations | Emission reduction (Mt CO2e) | | Co-benefit | Administering Government Agencies/ Actor |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Potential/ Target | Achievement | | |
| 3 | Energy efficiency improvement-through imple-mentation of energy efficiency appliances | Application of energy efficient appliances in residential in all provinces (through labelling standards programme)<br>Saving<br>2010-2014: 7.9 million kWh<br>2014-2020: 13.53 million kWh | D | Energy saving is estimated from the number of efficient appliances distributed in Indonesia and the equivalent old technology replaced (baseline). Capacity of each appliance is also used in the estimation. Energy saving is baseline minus energy level after mitigation<br>GHG emissions estimates: Tier 1 of IPCC 2006 GLs<br>EF: electricity grid of all provinces<br>Assumption: the sold appliances are used in residential to replace old (inefficient) technology; working hours of appliances: 8 hrs typical (from survey of Indonesian Association of Luminaire and Electricity/)<br>Number of appliances is collected through MEMR monitoring and reporting system mandated by Ministerial Regulation. | 2010-2013:<br>Production of 168,839,709 units of Compact Lamp (CFL) | Energy ActNo. 30/2007<br>Government Regulation No. 70/2009 concerning Energy Conservation,<br>Ministerial Regulation of MEMR No. 6/2011 concerning labelling of energy efficient appliances | 9.75 | 1.38 | Energy cost saving, better energy utilization plan, stimulate innovation in energy efficiency manufactures, national energy security, less pollutants in the power plants | MEMR |
| 4 | Development and Management of New-Renewable Energy (NRE) and Energy Conservation | 2010 – 2014<br>Construction & operation: 46.17 MW micro-hydro, 182 MW mini-hydro, 102.1 MW Solar PV, 21.67 MW Wind, 0.4 MW Biomass PP,<br>Establish 250 energy self-sufficient village (DME)<br>2015-2020<br>Construction & operation:<br>82.23 MW micro-hydro, 510 MW mini-hydro, 224.68 MW Solar PV, 16.5 MW Biomass PP,<br>Establish 450 energy self-sufficient village (DME) | E | Baseline: Projected GHG emissions that would occur in the absence of energy efficiency measures, it is estimated based on technology commonly used in a region in the absence of mitigations (i.e. baseline for micro-hydro is diesel).<br>RE generation (substituted fossil energy): MW load x working hrs.<br>GHG reduction:<br>Baseline emission minus zero<br>Baseline emission: substituted fossil energy x specific fuel consumption x EF<br>For fossil fuels, EF depend on type of fuels in baseline (diesel) | 2010-2013:<br>0.22 MW micro-hydro,<br>99.6 MW mini-hydro,<br>0.38 MW Solar PV,<br>64.2 MW Biomass PP<br>92 DME has been constructed. | Energy Act No. 30/2007<br>Ministerial Regulation of MEMR No 10/2012 concerning development of renewable energy project | 4.4 | 0.957 | Energy security, poverty alleviation, job creation, discourage urbanization, rural empowerment | MEMR |

| No | Name of Action | Description | Category in FCCC/ AWGLCA/ 2011/INF.1 | Methodology and Assumptions for Estimating the Mitigation Impacts | Current Status of Implementation | Policy Instruments and Enabling Policies/ Regulations | Emission reduction (Mt CO2e) | | Co-benefit | Administering Government Agencies/ Actor |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Potential/ Target | Achievement | | |
| | | | | Energy self-sufficient villages (DME) use energy from RE project.<br>Therefore, GHG reduction of DME = GHG reduction from NRE Power plant<br>GHG emissions estimates: Tier 1 of IPCC 2006 GLs | | | | | | |
| 5 | Biogas Utilization | National action to install and operate biogas unit.<br>2010 - 20014: 10,000 units 2015 - 2020: 21,400 units | E | Baseline: Projected GHG emissions that would occur in the absence of biogas units;<br>Assumption: biogas substitute kerosene stoves.<br>Methodology: measurement of biogas utilization in household; biogas utilization corresponds with fossil fuel (kerosene) substitution.<br>Associated GHG is from volume of biogas utilization multiply by emission factors of kerosene/LPG.<br>Assumption: Biogas substitutes kerosene/LPG. | New biogas installation<br>2011: 3164 units, gas production: 2.1 million Nm3/year<br>2012: 3643 units, gas production: 2.5 million Nm3/year<br>2013: 6969 units, gas production: 4.6 million Nm3/year<br>Cumulative in 2013: 13776 units, 9.22 million Nm3/year | Energy Act No. 30/ 2007<br>Ministerial Regulation of MEMR No 10/2012 concerning development of renewable energy project | 0.13 | 0.02 | Cooking cost saving, energy supply security, waste utilization, rural empowerment, job creation | MEMR |
| 6 | Use of natural gas as city public transportation fuel | Pilot project to improve the use of natural gas as city transportation fuel in 9 cities (Palembang, Surabaya, Denpasar, Medan, Jabodetabek, Cilegon, Cirebon, Balikpapan, Sengkang).<br>Initial target in 2010-2014 are 29.33 MMSCFD of natural gas is used as fuel by city public transportation in 3 cities and 10.58 ton/day of LGV is used during 2 years as city public transportation fuel particularly in Denpasar.<br>Initial target in 2015-2020 are 628.5 MMSCFD of | E | Baseline: GHG emissions from using liquid fossil fuels<br>Project emission:<br>GHG emissions after substitution to natural gas<br>Emission estimates: IPCC 2006 GLs;<br>Verification data needed:<br>Annual gas sales data<br>Annual LGV sales data | 2010-2013 in progress<br>30 MMSCFD of natural gas used as city transportation fuel. | Energy Act No. 30/ 2007<br>Presidential Decree No.5/2006 concerning Energy Policy | 3.07 | 0.09 | Less city air pollution, energy security, | MEMR |

| No | Name of Action | Description | Category in FCCC/ AWGLCA/ 2011/INF.1 | Methodology and Assumptions for Estimating the Mitigation Impacts | Current Status of Implementation | Policy Instruments and Enabling Policies/ Regulations | Emission reduction (Mt CO2e) | | Co-benefit | Administering Government Agencies/ Actor |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Potential/ Target | Achievement | | |
| | | natural gas is used as fuel by city public transportation in 6 cities and 10.58 ton/ day of LGV is used as city public transportation fuel, particularly in Balikpapan | | | | | | | | |
| 7 | Enhancement of the pipe connection of natural gas to houses | Pilot project to increase the utilization of gas in 24 locations.<br>Initial target in 2010-2014 is 94.500 home connections | E | Baseline: GHG emissions from household using LPG or kerosene<br>Project emission:<br>GHG emissions after substitution to natural gas<br>Note: EF natural gas is slightly lower than LPG<br>Emission estimates: IPCC 2006 GLs;<br>Verification data needed:<br>Annual gas sales data to residential (newly connected) | 2010-2013: in progress.<br>73,111 new connections | Energy Act No. 30/ 2007<br>Presidential Decree No.5/2006 concerning Energy Policy | 0.15 | 0.004 | Less city air pollution, energy security, | MEMR |
| 8 | Construction of Liquid Petroleum Gas (LGP) mini plants | Pilot project in Musi Banyuasin to increase the LPG mini plant construction.<br>Initial target in 2010-2014 is 2.2 MMSCFD LPG mini plant is performed | E | Assumption: availability of LPG plant will contribute to kerosene to LPG conversion programme<br>Baseline: GHG emissions from the use of kerosene<br>Project emission: emission after substitution from kerosene to LPG<br>Emission estimates: IPCC 2006 GLs;<br>Verification data needed:<br>Annual LPG sales (from the mini plant) | Planning | Energy Act No. 30/ 2007<br>Presidential Decree No.5/2006 concerning Energy Policy | 0.03 | Not yet imple-mented | Less air pollution, energy security, | MEMR |
| 9 | Post-mining land reclamation | National policy for planting trees in post mining land. Initial target in 2010-2020 is planting trees on area of 72,500 ha of post mining land | C | IPCC 2006 | In progress up to 2014, 25,352 ha has been reforested | Act No. 4/2009. Government Regulation in line with Act NO. 78/2010 on post mining reclamation. Minister Regulation of MEMR No. 7/2014 on implementation of reclamation and post mining on mineral and coal mining | 2.73 | 1.2 | | MEMR |

**Appendix B2.** Transportation sector mitigation actions

| No | Name of Action | Description | Category in FCCC/ AWGLCA/ 2011/INF.1 | Methodology and Assumptions for Estimating the Mitigation Impacts | Current Status of Implementation | Policy Instruments and Enabling Policies/ Regulations | Emission reduction (Mt CO2e) | | Co-benefit | Administering Government Agencies/ Actor |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Potential/ Target | Achievement | | |
| 1 | Development of Intelligent Transport System (ITS) | Pilot project to reduce traffic jam level, enhance coordination between intersections, provide bus priority system and shift from private to mass transportation. Mitigation target in 2010-2020 is the development of 13 packages of ITS in Jabodetabek and 12 cities | G | Methodology:<br>MER 2013. Assumption:<br>Length of Corridor/road (Km)<br>Average Speed (km/hour)<br>Average Number of Vehicle in the corridor (Unit Vehicle/ day)<br>Vehicle Category: Truck, Bus, Motorcycle, Car | On going. In 2010-2013 ATCS (Area Traffic Control System) installed in 8 cities, not fully Intelligent Transport System (ITS) yet. | Government Regulation No.32 year 2011 on Traffic engineering, Impact Analysis and Transport Demand Management. | 1.77 | 0.177 | - Reduce Congestion<br>- Increase speed at intersection<br>- Reduce emission of local air pollution | MoT |
| 2 | Application of Traffic Impact Control (TIC) | Pilot project to reduce traffic jam level. Initial target in 2010-2020 is 12 packages of Traffic Impact Control are applied in 12 cities | G | Methodology: traffic impact assessment of building development. Assumptions: number of vehicle, number of trip/day, trip length | On going. In 2010-2013, 16 packages of traffic impact control document are applied in specific infrastructure development (bus station, housing, mall, factory) | Government Regulation No.32 year 2011 on Traffic engineering, Impact Analysis and Transport Demand Management. | 0.24 | 0.00008732 | - Reduce Congestion<br>- Increase traffic flow surround project area | MoT |
| 3 | Application of parking management | Pilot project to reduce mode share in downtown and reduce private car use. Initial target in 2010-2020 is application of parking management is applied in 12 cities | G | N/A | N/A | Government Regulation No.32 year 2011 on Traffic engineering, Impact Analysis and Transport Demand Management. | 1.07 | N/A | N/A | MoT |
| 4 | Application of Congestion Charging and Road Pricing (combined with mass rapid transport) | Pilot project to reduce mode share in downtown and reduce congestions in traffic limited areas. Initial target in 2010-2020 is application of congestion charging and road pricing are applied in 2 cities | G | N/A | N/A | Government Regulation No. 97 year 2012 on Congestion Charging as Retribution and Retribution of permit extension to employ foreign institution | 0.41 | N/A | N/A | MoT |
| 5 | Reformation of transit system - Bus rapid Transit (BRT)/ Semi BRT | Pilot project to supply and distribution BRT system. Initial target in 2010-2020 is 43 BRTs/ year is distributed in 12 cities | G | Methodology:<br>MER 2013 Assumption: Bus Capacity, mode Shift (%), Average Trip/day, Average distance trip/day (Km) | On going. In 2010-2013 BRTs is distributed to 10 cities | Ministerial of Transportation Decree No. 10 year 2012 on Minimum Standard of Service of Road Public Transport | 0.69 | 0.052963 | - Reduce congestion<br>- Increase fuel saving from shifting modes | MoT |

| No | Name of Action | Description | Category in FCCC/ AWGLCA/ 2011/INF.1 | Methodology and Assumptions for Estimating the Mitigation Impacts | Current Status of Implementation | Policy Instruments and Enabling Policies/ Regulations | Emission reduction (Mt CO2e) | | Co-benefit | Administering Government Agencies/ Actor |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Potential/ Target | Achievement | | |
| 6 | Rejuvenation of public transport fleets | Pilot project to have low emission design of public transport. Initial target in 2010-2020 is rejuvenation with 6,000 units of public transport fleets based on low emission design in 12 cities are performed | G | N/A | N/A | N/A | 0.36 | N/A | | MoT |
| 7 | Installation of converter Kit (public transport gasification) | Pilot project to reduce CO2 up to 25% by substituted fossil fuel with gas fuel for taxi and other public transportation. Initial target in 2010-2020 is installation of converter kit on 1,000 units of gasoline-fuelled taxi and public transportation per year in 9 cities is performed | G | N/A | N/A | N/A | 0.04 | N/A | | Administering agencies is MoI |
| 8 | Smart driving (eco-driving) training and socialization | Pilot project to reduce emission by held training and socialization on smart driving. Initial target in 2010-2020 is 50,000 person/ year from 12 cities are joined the training | G | Methodology:<br>Initiative by Urban Transport System Directorate of MoT. Assumption: Emission reduction from smart driving is 10% fuel saving of training participant | On going. In 2010-2013, 678 person have participated in eco driving training | Act Number 22/2009 concerning inland transport traffic | 0.002 | 0.00087 | - Increase fuel saving<br>- Increase safety driving on the road | MoT |
| 9 | Building of non-motorized transport (pedestrian and bicycle lines) | Pilot project for improving the non-motorized transport in particularly pedestrian and bicycle lines. Initial target in 2010-2020 is NMT built in 12 cities | G | Methodology:<br>Initiative by Urban Transport System Directorate of MoT. Assumption:length of pedestrian and bicycle line | On going. In 2010-2013, NMT is built in 4 cities | Act Number 22/2009 concerning inland transport traffic | 0.21 | 0.001736 | - Improve of access for mobility<br>- improve of city structure | MoT |
| 10 | Development of Bandung's city railways | Pilot project to improve public transport particularly in city railways. Initial target in 2010-2020 is developing Bandung's city railways of 42 km | G | N/A | Planning | | 4.56 | N/A | Not available | MoT |
| 11 | Construction of double-double track (including electrification) | Pilot project to improve public transport particularly in city railways. Initial target in 2010-2020 is to construct double track of 35 km in DKI Jakarta Province | G | N/A | Construction Process | | 21.21 | N/A | Not available | MoT |

| No | Name of Action | Description | Category in FCCC/ AWGLCA/ 2011/INF.1 | Methodology and Assumptions for Estimating the Mitigation Impacts | Current Status of Implementation | Policy Instruments and Enabling Policies/ Regulations | Emission reduction (Mt CO2e) | | Co-benefit | Administering Government Agencies/ Actor |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Potential/ Target | Achievement | | |
| 12 | Procurement of new electric rail car (KRL) | Pilot project to improve public transport particularly in Electric Rail Car. Initial target in 2010-2020 is to procure new KRL as many as 1,024 units in Jabodetabek , 640 units in East Java and 256 units in West Java | G | Methodology:<br>Initiative by DG Railway of MoT. Assumption:<br>fuel efficiency (L/person/ Km) from private vehicle to train | On going. In 2010-2013, the GHG reduction is estimated by comparing baseline (passengermultiply by private car fuel consumption) with emission level (passenger multiply by KRL fuel consumption) | Act No 23/2008 concerning Railways | 0.0035 | 0.0377 | Congestion reduction | MoT |
| 13 | Modification of Diesel Rail Train (KRD) into Electric Diesel Rail Train (KRDE) | Pilot project to improve public transport and reduce fuel consumption by modification of diesel rail train to electric diesel rail train. Initial target in 2010-2020 is 25 units of diesel rail train modified to electric diesel rail train in DKI Jakarta Province | G | | Planning | | 0.00005 | N/A | | MoT |
| 14 | Construction of North South Mass Rapid Transport (MRT) Phase I and Phase II | Pilot project to improve public transport and reduce fuel consumption by construct MRT. Initial target in 2010-2020 is the construction of MRT Phase I and II in DKI Jakarta Province are performed | G | | Planning | Local Government Regulation No 7 year 2013 on amendment of local government regulation No. 3/2008 on MRT state owned Company in Jakarta. | 2.77 | N/A | | MoT, Government of DKI Jakarta |
| 15 | Construction of Soekarno-Hatta Airport railway track | Pilot project to improve public transport and reduce fuel consumption by construct airport railway. Initial target in 2010-2020 is the construction of Soekarno-Hatta airport railway track of 33 km is performed | G | | Planning | | 0.19 | N/A | | MoT |
| 16 | Construction of Jakarta Monorail | Pilot project to improve public transport and reduce fuel consumption by construct monorail in Jakarta. Initial target of 2010-2020 is the construction of Jakarta monorail Blue line and Green line are performed | G | | Suspended | | 0.52 | | | MoT, Government of DKI Jakarta |
| 17 | Road construction/ improvement and preservation | National policy to reduce the fuel consumption by improves the road capacity. Initial target of 2010-2014 is enhancement of the capacity of the 19,370 km national road and preservation of the national road of 168,999 km | G | Enhancement of road should be priority to provide access for mobility in the rural/ isolated area, which has lack of infrastructure or to manage freight in the metropolitan area (i.e., outer ring road for freight to avoid trucks passing through the city). | | Government Regulation no 34 year 2006 on Road | 1.1 | 0.0043 | - Improve access of mobility<br>- Increase economic benefit (trading and business) | Ministry of Public Works |

## **Appendix B3.** Industrial sector mitigation actions

| No | Name of Action | Description | Category in FCCC/ AWGLCA/ 2011/INF.1 | Methodology and Assumptions for Estimating the Mitigation Impacts | Current Status of Implementation | Policy Instruments and Enabling Policies/ Regulations | Emission reduction (Mt CO2e) | | Co-benefit | Administering Government Agencies/ Actor |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Potential/ Target | Achievement | | |
| 1 | Application of Process and Technology Modification | Development of guidelines for biomass utilization and other technologies in cement industry as blended cement (AFR) | D, E, IPPU | 1.1.1.1.1.1 GHG emissions estimates: Tier 1 of IPCC 2006 GLs<br>Baseline: GHG emissions that would occur in the absence of AFR measures. It is estimated based on GHG intensity of current technology used in industry in the absence of mitigation actions (existing plants & new plants in 2009)<br>EF calcination: 0.552 t $CO_2$/t clinker<br>EF total: 852 t $CO_2$/t cement<br>Mitigation target EF (t $CO_2$/t cement)<br>- old technology 0.514 - 772<br>- new technology 0.491 – 488<br>- calcination 0.325 t $CO_2$/t clinker | AFR (blended cement and alternative fuels) has been implemented in cement industries<br>On going, have implemented usage of alternative materials to reduce clinker in cement production | MoI Regulation No 12/2012 concerning Roadmap of $CO_2$ emission reduction in Cement Industry in Indonesia | 2.75 | 0.070 | Resources efficiency, cost saving, waste management, industry performance improvement | PPIHLH/ MoI |
| 2 | Energy conservation and audit | 2010 – 2014<br>Establishment of energy management system in:<br>9 cement industries<br>35 iron/steel<br>15 pulp /paper<br>2015 - 2020<br>Establishment of energy management system in: glass and ceramic, fertilizer, petrochemical, food and beverage, textile, and basic chemical industries | D | 1.1.1.1.1.2 GHG emissions estimates: Tier 1 of IPCC 2006 GLs<br>Baseline: Projected GHG emissions that would occur in the absence of energy efficiency measures. Baseline is estimated based on energy audit before mitigations (2010-2011)<br>Energy saving: baseline minus energy level after mitigation | 2010 - 2012<br>Establishment of energy management system in:<br>35 Steel Industry<br>15 Pulp/Paper Industry | Energy Act 30/2007;<br>Industry Act 3/2014<br>Govt. Regulation No. 70/2009: Energy Conservation;<br>President Reg. No. 14/2012: Energy Management;<br>President Instruction No.13/2011: water & energy saving; | 2.06 | 0.722 | Energy cost saving, better energy utilization plan, capacity building for energy operators, stimulate innovation in energy efficiency activities, national energy | MoI |

| No | Name of Action | Description | Category in FCCC/ AWGLCA/ 2011/INF.1 | Methodology and Assumptions for Estimating the Mitigation Impacts | Current Status of Implementation | Policy Instruments and Enabling Policies/ Regulations | Emission reduction (Mt CO2e) | | Co-benefit | Administering Government Agencies/ Actor |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Potential/ Target | Achievement | | |
| | | | | Associated emissions reduction is calculated from energy savings and relevant emissions factor.<br>EF (Emission Factor):<br>- For electricity, EF grid in 2012 is 0.814 ton CO2e/MWh (Jamali)<br>- For fossil fuels, EF depend on the type of fuels<br>Assumption: All partners will implement energy efficiency potential (resulted from energy audit) | | Presidential Decree No.5/2006: National energy policy;<br>MEMR Regulation No.14/2012: Energy Management;<br>MEMR Regulation No.13&14/2010: Competency standard of energy manager in building & industry | | | security, less pollutants in the consumers and/ or in the power plants | |

## **Appendix B4.** Agriculture Sector

| No | Name of Action | Description | Category in FCCC/ AWGLCA/ 2011/INF.1 | Methodology and Assumptions for Estimating the Mitigation Impacts | Current status of implementation | Policy Instruments and Enabling Policies/ Regulations | Emission reduction (Mt CO2e) | | Co-benefit | Administering Government Agencies/ Actor |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Potential | Achievement | | |
| 1 | Improvement and maintenance of irrigation network | National mitigation action for optimizing water resources, stabilizing water level elevation, and developing uninterrupted circulation of water in irrigation network. Initial target in 2010-2014 is to repair 1.34 million ha of irrigation network and maintain 2.32 million ha of irrigation network | n/a | Methodology: IPCC 2006 on agriculture; assumption: stabilize water elevation and uninterrupted circulation of water irrigation to be able to implement intermittent system with less water flooding intensity which later will lead to less methane emission | On going, up to 2013, Ministry of Public Work has finished maintenance of 246,601 ha of irrigation network and start initial operation on 2.29 million ha of new irrigation network | Government Regulation no. 20/2006; Ministry of public Work Regulation no. 32/ PRT/M/2007 | 0.16 | 0.042 | Improvement of paddy field production; water efficient can be used for other plantation | Ministry of Public Work |
| 2 | Application of plant farming technologies by SLPTT, SRI and the use of low emission species | National mitigation action to promote the use of low carbon farming practices through organic fertilizer, efficient water use, and minimum tillage which will be applied between 2010-2014 in 2.03 million ha of agricultural area. | n/a | Methodology: IPCC 2006. Assumption: Methane emission decrease due to the increase of water use efficiency (e.g. intermittent irrigation), increase use of organic fertilizer, and minimizing tillage. | Ongoing. From 2008-2012, SLPTT has total harvested area of 5,974,045 hectares , SRI has total harvested area of 68,880 hectare from 2010 to 2012, and 25 low emission varieties have been introduced and implemented in 6,740,951 hectares area | General Director of Agricultural Crop Regulation number 6/ HK.310/C/1/2013 on Technical Guidelines of SLPTT rice and maize 2013 | 32.42 | 30.05 | Improve land productivity; Increase organic products | Ministry of Agriculture |
| 3 | Utilization of organic fertilizers and bio-pesticides by UPPO | Promote the use of organic fertilizers and bio pesticides in 250,000 ha area during 2010-2014 | n/a | Methodology: IPCC 2006. Assumption: Amount of manure and organic waste being decomposed anaerobically decreased. | Ongoing. since 2009 to 2012, MoA has been distributing 3,433 units of UPPO | Technical Guideline for Development of Organic Fertilizer Units (UPPO) 2012 | 10.00 | 0.379 | improve land fertility, increase community income by promoting agro-pasture system | Ministry of Agriculture |
| 4 | BATAMAS (Utilization of manure/urine of cattle and agricultural wastes for biogas) | National action to promote Cattle-based Biogas (BATAMAS) in rural area with high population of cattle. This action is expected to cover 1,500 community groups during 2010-2014. | E | Methodology: IPCC 2006. Assumption: All BATAMAS plants are fully operated during reporting period | On going, until 2012 4,352 units of BATAMAS has been distributed to community | Technical guideline for implantation of BATAMAS | 1.01 | 5.024 | | Ministry of Agriculture |

**Appendix B5.** Forest and Other Land Use Sector (include peatland management)

| No | Name of Action | Description | Category in FCCC/ AWGLCA/ 2011/INF.1 | Methodology and Assumptions for Estimating the Mitigation Impacts | Current status of implementation | Policy Instruments and Enabling Policies/ Regulations | Emission reduction (Mt CO2e) | | Co-benefit | Administering Government Agencies/ Actor |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Potential | Achievement | | |
| 1 | Establishment of a Forest Management Unit (KPH) | National action on improving efforts to apply sustainable forest management by establishing 120 units of FMUs in 2010-2014. | B | Methodology: n/a. Assumption: The present of KPH will improve forest management leading to lower deforestation and forest degradation, and higher survival rate of reforestation. | completed, target to establish 120 units is achieved and 119 units has formally started to operate. | Act number 5/1990 on Natural Resource and Ecosystem Conservation; Act number 41/1999 on Decentralization; Government Decree number 6/2007 jo. 3/2008 on Forest Management; Regulation of MoFor number 43, 46, 47/2013; MoFor Regulation P.6/2009 on FMU establishment; MoFor Regulation number 41 and 42/2011 on Standard and Infrastructure of FMU | 31.15 | N/A | Development of forest neighbouring communities to improve community livelihood and income from sustainable use of non forest products and PES | Ministry of Forestry |
| 2 | Planning for forest area utilization and business improvement | National policy on granting Business License for Utilization of Timber Forest Products-National Forest/Ecosystem Restoration (IUPHHK-HA/RE) on 2.5 million ha of Logged Over Area (LOA) and improving non-timber forest product/environmental services between 2010-2014 | C | Methodology:IPCC 2006. Assumption: Degradation of logged over area can be halted to allow for regeneration. | Completed, with targeted 2.5 million ha utilization achieved: Total area of IUPHHK-HA/RE until 2014: 2.65 million ha Total production of non-timber forest product until 2014: 1.09 million ton | Regulation of MoFor number 3143/20143; MoFor Regulation number P.26/2012 on Granting Permission for IUPHHK, IUPHHK-RA or IUPHHK HTI;<br>MoFor Regulation of MoFor number 36/2008 on Granting Permission for IUPHHBK; number P.29 on Regulating Wood Product from Plantation and P.30/2012 on Regulating Wood Product form Community Forest<br>MoFor Decree number 5984/2014 on Allocation of Potential Area for Forestry Investment (updated every 6 months) | 24.32 | N/A | Water and land conservation, job creation | Ministry of Forestry (*Dir. Bina Rencana Pemanfaatan dan Usaha Kawasan*) |

| No | Name of Action | Description | Category in FCCC/ AWGLCA/ 2011/INF.1 | Methodology and Assumptions for Estimating the Mitigation Impacts | Current status of implementation | Policy Instruments and Enabling Policies/ Regulations | Emission reduction (Mt CO2e) | | Co-benefit | Administering Government Agencies/ Actor |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Potential | Achievement | | |
| 3 | Development of the utilization of environmental services | Demonstration activities in Berbak national Park Jambi. Registered at Ministry of Forestry in 2013 (SK No.549/Menhut-II/2013)<br>Demonstration activities in Sebangau National Park, Central Kalimantan. Registered at MoFor in 2013 (SK.No.831/menhut-II/2013)<br>Demonstration activities in Meru Betiri National Park, registered at MoFor in 2014 (SK. No.86/ Menhut-II/2014) | B | Methodology: IPCC 2006 and Supplementary Guidelines 2013 for Wetland. Assumption: Rate of deforestation and forest degradation decreased from historical rate. | Ongoing activity in 142,750 ha area of Berbak National Park from 2013 to 2015<br>Ongoing activity in 74,167 ha area of Sebangau National Park which had received VCS certification for rewetting tropical peat swamp forest and gold level CCBA certification<br>From 2014, activities has been held in 58,000 ha area of Meru Betiri National Park t | MoFor Regulation number P.20/2012 on Forest Carbon Implementation | 3.67 | N/A | Water and land conservation, biodiversity improvement | Ministry of Forestry (*Dir. Pemanfaatan Jasa Lingkungan dan Kawasan Konservasi dan Hutan Lindung*) |
| 4 | Inauguration of forest areas | National action on inaguration of 25,000 km Forest Area Boundary | B | Methodology: IPCC 2006. Assumption: The present of clear forest boundary will reduce encroachment and illegal activities. Rate of deforestation and forest degradation decreased from historical rate. | ongoing, has been done for 16,336.07 km of forest boundary | Regulation of MoFor number 43/2013 | 123.41 | N/A | Clear land tenurial | Ministry of Forestry (*Dir. Pengukuhan dan Penatagunaan Kawasan Hutan*) |
| 5 | Improvement, rehabilitation, operation and maintenance of wetland reclamation network (including peatlands) | National actions on improving 10,000 ha of wetland reclamation network, rehabilitating 450,000 ha of wetland and maintaining 1.2 million ha of wetland reclamation network during 2010-2014 | A | Methodology: Supplementary Guidelines 2013 for Wetland. Assumption: The water level condition is improved and lead to lower decomposition rate. | N/A | Up to 2014, 429,739 hectare of irrigation amd 240,248 hectares of wetland networks has been established; 2,021,439 hectare of irrigation and 697,568 hectares of wetland networks have been rehabilitated; with 6 additional activity of development 122,766 hectare of fish ponds | 5.23 | N/A | Water and land conservation, biodiversity improvement | Ministry of Public Work |

| No | Name of Action | Description | Category in FCCC/ AWGLCA/ 2011/INF.1 | Methodology and Assumptions for Estimating the Mitigation Impacts | Current status of implementation | Policy Instruments and Enabling Policies/ Regulations | Emission reduction (Mt CO2e) | | Co-benefit | Administering Government Agencies/ Actor |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Potential | Achievement | | |
| 6 | Implementation of a forest and land rehabilitation and forest reclamation in the prioritized watersheds (DAS Prioritas) | National mitigation action by rehabilitation in 2,454,000 ha of priority watersheds, establishment of 6,000 ha of urban forest, and rehabilitation of 40,000 ha mangrove/coastal forest during 2010-2014 | C | Methodology: IPCC 2006. Assumption: Rate of forest rehabilitation and the survival is higher than the historical rate | On going. Until 2014, rehabilitation on 429,747 ha of priority watershed, 5,122 ha of urban forest, 1,828,471 ha critical area and 31,675 ha of mangrove forest had been conducted. | Act number 41/1999 on Forestry, MoFor Regulation number 20/Kpts-II/2001 on General Pattern, Standard, and Criteria on Forest and Land Rehabilitation; Government Regulation number 76/2008 on Forest Rehabilitation and Reclamation; MoFor Regulation number P/12/2012 on Guideline of Technical Plan of Forest and Watershed Rehabilitation; MoFor Regulation number P.14/2012 on Implementation Guideline of Forest and Land Rehabilitation 2012 | 91.75 | N/A | minimized erosion and land degradation, soil and water conservation, increase farmer income in downstream due to increasing of water availability | Ministry of Forestry (*Dir. Bina Rehabilitasi Hutan dan Lahan & Dir. Perencanan dan Evaluasi Pengelolaan DAS*) |
| 7 | Development of Social Forestry and Community Forest | National programme to facilitate designation of 2,500,000 ha of Social Forestry (HKm)/Village forest (HD) during 2010-2014 | C | Methodology: IPCC 2006. Assumption: rate of deforestation and forest degradation will be lowered compared to historical rate | On going until 2014, 2.56 million ha of HKM/HD has been designated | MoFor Regulation number 39/2013 on Community Empowerment through Partnership; MoFor Regulation number P.14/2012 on General guideline to Develop Conservation-based Social Forestry | 91.75 | N/A | water conservation, alternative income generation | Ministry of Forestry (*Dir. Bina Perhutanan Sosial*) |
| | | National programme on developing partnership of 250,000 ha of community forest (HR) during 2010-2014 | C | Methodology: IPCC 2006. Assumption: Carbon stock of land is lower than carbon stock of the timber plantation | On going until 2014, 292,592 ha of HR has been developed | MoFor Regulation no. P.3/2012 on Community Forest Working Plan; MoFor Regulation number P.19/2012 in lieu to MoFor Regulation number P.62/2008 on Working Plan fo Wood Products from Industrial and Community Plantation | 9.18 | N/A | | Ministry of Forestry (*Dir. Bina Perhutanan Sosial*) |

| No | Name of Action | Description | Category in FCCC/ AWGLCA/ 2011/INF.1 | Methodology and Assumptions for Estimating the Mitigation Impacts | Current status of implementation | Policy Instruments and Enabling Policies/ Regulations | Emission reduction (Mt CO2e) | | Co-benefit | Administering Government Agencies/ Actor |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Potential | Achievement | | |
| 8 | Forest fire control | National programme to reduce the number of hotspots by reducing hotspots incidents to 67.20 % from average incidents of year 2005-2009 or not to exceed limit of 19,316 hotspots inside forest area in Sumatera, Kalimantan and Sulawesi | B | Methodology: IPCC 2006. Assumption: Hotspots indicate fire incidences | Target is achieved. Until 29 December 2014, hotspots number in 11 provinces in 3 Islands (as in column 2) are 7384 spots, which means reduction by 87.46% | Act number 41/1999 on Forestry; Government Regulation number 45/2004 on Forest Protection; Presidential Instruction NO. 16/2011 on Improvement of Forest Fire Control; Regulation of MoFor No. P. 12/Menhut-II/2009 on Forest Fire Control | 21.77 | N/A | biodiversity and soil conservation | Ministry of Forestry (*Dir. Pengendalian Kebakaran Hutan*) |
| 9 | Forest investigation and protection | National programme to promote better enforcement of forest law by handling new cases of forest criminal acts (illegal logging, illegal mining and forest fire with at least 75 % of cases will be settled on 2010-2014. | B | Methodology : IPCC 2006; Assumption: with better enforcement, rate of deforestation and forest degradation will be lower than historical rate | ongoing. 59.24% cases has been processed until 2012 | Act number 41/1999 on Forestry, Government Regulation number 45/2004 on Forest Protection | 2.3 | N/A | law enforcement | Ministry of Forestry (*Dir. Penyidikan dan Pengamanan Hutan*) |
| 10 | Development of conservation and essential ecosystem areas and management of protected forests | National programme to improve management of essential ecosystems as life support by 10% and control conservation and protected forest in 17 location of essential ecosystem areas on 2010-2014<br>National programme to reduce 5% (25,000 ha) of conflict and stresses especially encroachment of protected forest in 12 priority province | B | Methodology : IPCC 2006; Assumption: Enhancement of conservation area management will prevent forest area from deforestation and forest degradation | Completed, target to establish 17 essential ecosystem areas is achieved<br>Target to reduce 26.559,80 ha of encroachment achieved | Government Regulation Number 28 / 2011 on management of nature reserves and conservation areas | 91.27 | N/A | water and biodiversity conservation, developing community empowerment, ensuring legal certainty, ensuring business certainty | Ministry of Forestry (*Dir. Kawasan Konservasi dan Bina Hutan Lindung*) |
| 11 | Enhancement of commercial forests | National action to increase establishment of plantation by promoting 3 million ha Industrial Plantation Forest and People's Forest (HTI and HTR) on 2010-2014 | C | Methodology: IPCC 2006. Assumption: Rate of establishment of timber plantation is higher than the historical rate | Ongoing.<br>Until early December 2014, 2.96 million ha area has been reserved for establishment of plantation forest. | Regulation of MoFor number P.15/2013 on MoFor Strategic Plan 2010-2014; Regulation of MoFor number 31/2014 on Granting Permission for IUPHHK-HA/ RE/HTI; MoFor Decree number 5984/2014 on Allocation of Potential Area for Forestry Investment (updated every 6 months). | 110.1 | N/A | income generation for community around forest | Ministry of Forestry (*Dir. Bina Usaha Hutan Tanaman*) |

**Appendix B6.** Waste sector mitigation actions

| No | Name of Action | Description | Category in FCCC/ AWGLCA/2011/ INF.1 | Methodology and Assumptions for Estimating the Mitigation Impacts | Current Status of Implementation | Policy Instruments and Enabling Policies/Regulations | Emission reduction (Mt CO2e) | | Co-benefit | Administering Government Agencies /Actor |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Potential/ Target | Achievement | | |
| 1 | Development of waste water treatment/ WWT (off site /on site) | National action for developing wastewater treatment plant:<br>a. Centralized domestic wastewater treatment (city scale) in 16 regencies/ cities.<br>b. On-site waste water treatment in 11,000 locations | F | **Methodology:**<br>IPCC 2006, Tier-1, default value<br>**Baseline:**<br>Domestic WWT is septic tank (w/o $CH_4$ recovery)<br>**Mitigation:**<br>a. Centralized domestic WWT is aerobic type<br>b. On-site WWT is septic tank (CH4 recovery) | Development of<br>a. Centralized WWT in 13 locations<br>b. Communal septic tank in 82 locations (equipped with CH4 recovery) | a. Govt. Regulation No. 82/2001 Water Quality Management and Water Pollution Control<br>b. Govt. Regulation No. 16/2005 Improvement of SPAM<br>c. Ministry of Public Works Regulation no.16/ PRT/M/ 2008 Waste Water Strategic Policy | 2.0 | N/A | Improve community health, water & soil pollution prevention | a. Ministry of Public Works and Housing,<br>b. Local Governments |
| 2 | Construction of Integrated MSW treatment in SWDS/ landfill with 3R | Quantitative goals (2010-2020)<br>a. Improvement of MSW treatment at SWDS in 210 locations<br>b. Integrated SWDS and 3R in 250 locations | F | Methodology: IPCC 2006, Tier-1, default EF, and local characteristics of MSW<br><br>Baseline: Un-managed SWDS (open dumping) of all MSW SWDS w/o CH4 recovery<br><br>Mitigation: Managed Deep SWDS of all MSW SWDS with CH4 recovery | Development of Sanitary SWDS for MSW treatment in 144 locations (by 2012)<br>Development of Integrated Sanitary SWDS and 3R in 250 locations (by 2012)<br>LFG Utilization for: a. Power Generation: Bantargebang 2 MW Palembang 0.12 MW<br>b. Cooking gas in Malang 408 HH Kendari 100 HH | a. Waste Management Act No.18/2008<br>b. Govt. Regulation No. 81/2012 Domestic Waste Management<br>c. Ministry of Public Works Regulation 03/PRT/M/ 2013 Infrastructure for Domestic Waste Management<br>d. MoE Regulation No. 13/2012 on Guideline for implementation 3R through waste bank | 46.0 | N/A | Improve community health, water & soil pollution prevention, good MSW management,3R, waste to energy, Job creation, community involvement | a. Ministry of Public Works and Housing,<br>b. Local Governments |

Source: MER-MoPWH, 2014

**Appendix B7.** Other mitigation actions (outside RAN GRK framework) and their impacts

| No | Name of Action | Description | Category in FCCC/ AWGLCA/ 2011/INF.1 | Methodology and Assumptions for Estimating the Mitigation Impacts | Current Status of Implementation | Policy Instruments and Enabling Policies/ Regulations | Emission reduction (Mt CO2e) | | Co-benefit | Administering Government Agencies/ Actor |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Potential/ Target | Achievement | | |
| 1 | REDD | National policy and demonstration activities to reduce emissions from deforestation and forest degradation in 11 pilot provinces. Forest moratorium as one of the policy aims to suspend the granting of new concession licenses for logging and conversion of primary natural forests and peatland which is located in conservation, protection, and production forests according to PIPIB. | B: A reduction in the rate of deforestation and land degradation | Methodology: calculating emission reduction from preventing deforestation and forest degradation.<br>Assumption: Providing alternative income generation for community inside and around forests and forest moratorium will prevent forest area from deforestation and forest degradation. | On going | Presidential Instruction Number 10/2011 on Forest Moratorium<br>Presidential Instruction number 6/2013 on Forest Moratorium | N/A | N/A | PES, Tenurial system, law enforcement, biodiversity | BP REDD |
| 2 | Establishment of Web-based Carbon Monitoring System | National action to establish WebGIS as source of spatial data and estimate potential forest resource and carbon stock from NFI database | N/A | Methodology/A<br>Assumption: Accurate measurement of forest resources will clarify forest value and reduce deforestation and degradation in high carbon stock forest | Achieved | Forestry Acts 41/199, Government Regulation 44/2004 on Forest Planning, Government Regulation 06/2007 on Forest Area Organization and Management; Ministerial Decree 67/2006 on the Criteria and Standards for Forest Planning | | | Transparency of spatial data | Ministry of Forestry (Directorate of Forest Resource Inventory and Monitoring) |
| 3 | Revision of Moratorium Map (*Peta Indikatif Penundaan Pemberian Ijin Baru*-PIPIB) | Revision of PIPIB to improve forest and peat land management in order to reduce emission from deforestation and forest degradation | A, B | Methodology/A<br>Assumption: Accurate map focused on forest moratorium will improve forest and peat land management which later can prevent forest area from deforestation and forest degradation | Achieved | Presidential Instruction number 10/2011, Presidential Instruction number 6/2013 on Forest Moratorium | | | Transparency of spatial data | Ministry of Forestry (Directorate of Forest Resource Inventory and Monitoring) |
| 4 | Demonstration Activity of REDD+ in Meru Betiri National Park Indonesia (ITTO Programme PD 519/08 Rev 1(F)) | National actions to develop methodology of carbon accounting and monitoring | B | Assumption: Accurate measurement of carbon stock will enhance forest planning and reduce deforestation and degradation in high carbon stock forest | Ongoing<br>(2010-2015) | | | | | Puspijak/ITTO |

| No | Name of Action | Description | Category in FCCC/ AWGLCA/ 2011/INF.1 | Methodology and Assumptions for Estimating the Mitigation Impacts | Current Status of Implementation | Policy Instruments and Enabling Policies/ Regulations | Emission reduction (Mt CO2e) | | Co-benefit | Administering Government Agencies/ Actor |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Potential/ Target | Achievement | | |
| 5 | Forest Carbon Partnership Facility REDD+ Readiness Preparation | National actions to set up MRV system and capacity building on REDD | B | Assumption: Well designed and strong MRV system will enhance transparency of REDD financial scheme to reduce deforestation and degradation | Ongoing<br>(2011-2015) | | | | | Puspijak/World Bank |
| 6 | Enhancing Smallholder Benefits from Reduced Emissions from Deforestation in Indonesia (ACIAR FST/2012/040) | Policy actions for the design of institutional arrangement and fiscal mechanism for REDD+ | B | Assumption: Well-designed fiscal mechanism will enhance benefit transfer scheme on reducing deforestation and degradation | Ongoing (2014-2017) | | | | | Puspijak/ACIAR |
| 7 | PROKLIM<br>(Climate Village Programme) | Appreciation certificate from MoE for local (village) initiatives in climate change mitigation and adaptation.<br>2012 – 2020:<br>1000 villages | A, B, C, D, E, F | Methodology: calculating emission reduction from local mitigation action initiatives (agriculture, waste, and energy). | 2012 - 2014:<br>412 village in 23 province (322 has been verified).<br>Village initiatives:<br>Biogas, Tree Planting , SW treatment, Substitution to Organic Fertilizer, Sustainable irrigation, 3R, MSW composting,<br>Adaptation | MoE Regulation Number 19 Year 2012 Regarding Climate Village (Programme Kampung Iklim) | - | N/A | Energy efficiency, community economic improvement, rise intensification, improvement of land productivity. | MoE |
| 8 | Green Building | Promote the development of Green Building to reduce GHG emissions in building sector (commercial and offices). | D, E, F | | 9 buildings have been certified as Green Building | MoE regulation Number 08/2010 concerning criteria/certification of Green Building, Regulation of Governor of DKI Jakarta No. 38/2012 concerning the obligation to apply Green Building standard<br>MEMR Regulation Number. 13/2012 concerning efficiency standard for electricity consumption in office building | 1.0 | N/A | Energy efficiency, Waste management, cost savings | MoE |

| No | Name of Action | Description | Category in FCCC/ AWGLCA/ 2011/INF.1 | Methodology and Assumptions for Estimating the Mitigation Impacts | Current Status of Implementation | Policy Instruments and Enabling Policies/ Regulations | Emission reduction (Mt CO2e) | | Co-benefit | Administering Government Agencies/ Actor |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Potential/ Target | Achievement | | |
| 9 | Mandatory of Biodiesel Utilization | Mandatory of Biodiesel Utilization in power plant, industry, and transport sectors | G | Methodology: IPCC 2006, Tier-1, default EF Baseline: GHG from the use of liquid fossil fuels in power plant, industry, transport.<br>Project emission: zero (bio-fuel is carbon neutral)<br>Assumption: biodiesel substitutes petroleum diesel and bi-ethanol substitutes gasoline | 2010-2012: biodiesel consumption is ±1.7 Million KLiter biodiesel. | MEMR regulation<br>Number 32/2008 Mandatory of Biofuels (biodiesel, bio-ethanol, and biogas) Utilization<br>MEMR Regulation No. 25/2013 Mandatory of Biofuels (biodiesel, bio-ethanol, and biogas) Utilization (replacement of MEMR regulation no 32/2008) | N/A | 0.46 | | MEMR |
| 10 | Implementation of Presidential Instruction No.13/2011 on Energy and Water Saving | Implementation of energy conservation in government office building | D | Methodology: energy audit before (baseline) and after implementation to estimate energy savings.<br>The associated GHG emissions are estimated by multiplying the reduction potential of energy consumption with emissions factor. Assumption: All partners will implement energy conservation programmes. | On going, in 2010-2012 total energy saving is 25,802 MWh | President Instruction Number 13/2011 | NA | 0.02 | Cost saving | MEMR |
| 11 | Construction and operational Hydro Power in medium and large scale to interconnection electricity grid. (Grid interconnection PLN) | Mandatory to build renewable energy and alternate energy for environment friendly in Electricity sector or mandatory to build renewable and alternate Power Plant into electricity interconnection grid (Grid interconnection PLN) | D | The method to estimate GHG emissions level is IPCC 2006, Tool to calculate the emission factor for an electricity system – UNFCCC ver 04.0 EB 75 Annex 15. The GHG reduction is estimated by comparing the baseline emissions level (i.e. condition without mandatory policy) with emission level that would be resulted. | Already constructed in 2010/2011/2012/ 2013 and established in total capacity 111.8 MW | Act No. 30 Year 2009 about Electricity, and Government Regulation No. 14 Year 2014 concern Electricity Supply Business, Ministry of Energy and Mineral Resources Decrees No.2026.K/20/ MEM/2010 Year 2010, and Ministry of Energy and Mineral Resources Regulation No. 21 Year 2013 concern Electricity Supply Business Plan ( *Rencana Usaha Penyediaan Tenaga Listrik-RUPTL*) | | 0.674 | Energy cost saving, because it substitutes petroleum Power Plant. | MEMR |

| No | Name of Action | Description | Category in FCCC/ AWGLCA/ 2011/INF.1 | Methodology and Assumptions for Estimating the Mitigation Impacts | Current Status of Implementation | Policy Instruments and Enabling Policies/ Regulations | Emission reduction (Mt CO2e) | | Co-benefit | Administering Government Agencies/ Actor |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Potential/ Target | Achievement | | |
| 12 | Construction and operational of Coal Bed Methane Generation into interconnection electricity grid. (Grid interconnection PLN) | Mandatory to build clean energy for fossil fuel Power Plant to obtain the environment friendly in Electricity sector or mandatory to build renewable and alternate Power Plant into electricity interconnection grid (Grid interconnection PLN) | D | The method to estimate GHG emissions level is IPCC 2006, Tool to calculate the emission factor for an electricity system – UNFCCC ver 04.0 EB 75 Annex 15. The GHG reduction is estimated by comparing the baseline emissions level (i.e. condition without mandatory policy) with emission level that would be resulted. | Already constructed in 2013 and established in total capacity 2 MW. | Act No. 30 Year 2009 about Electricity, and Government Regulation No. 14 Year 2014 concem Electricity Supply Business, Ministry of Energy and Mineral Resources Decrees No.2026.K/20/ MEM/2010 Year 2010, and Ministry of Energy and Mineral Resources Regulation No. 21 Year 2013 concern Electricity Supply Business Plan ( *Rencana Usaha Penyediaan Tenaga Listrik-RUPTL*) | 0.007 | 0.007 | Energy cost saving, because it is substituted petroleum Power Plant. | MEMR |
| 13 | Construction and operational of Photovoltaic Power Plant into interconnection electricity grid. (Grid interconnection PLN) | Mandatory to build clean energy to obtain the environment friendly in Electricity sector or mandatory to build renewable and alternate Power Plant into electricity interconnection grid (Grid interconnection PLN) | D | The method to estimate GHG emissions level is IPCC 2006, Tool to calculate the emission factor for an electricity system – UNFCCC ver 04.0 EB 75 Annex 15. The GHG reduction is estimated by comparing the baseline emissions level (i.e. condition without mandatory policy) with emission level that would be resulted. | Already constructed in 2013 and established in total capacity 0.82 MW. | Act No. 30 Year 2009 about Electricity, and Government Regulation No. 14 Year 2014 concem Electricity Supply Business, Ministry of Energy and Mineral Resources Decrees No.2026.K/20/ MEM/2010 Year 2010, and Ministry of Energy and Mineral Resources Regulation No. 21 Year 2013 concern Electricity Supply Business Plan (*Rencana Usaha Penyediaan Tenaga Listrik-RUPTL*) | 0.0012 | 0.0012 | Energy cost saving, because it is substituted petroleum Power Plant. | MEMR |
| 14 | Construction and operational of Super Critical Boiler for Coal-Fired Power Plant into interconnection electricity grid. (Grid interconnection PLN) | Mandatory to build clean energy for fossil fuel Power Plant to obtain the environment friendly in Electricity sector or mandatory to build renewable and alternate Power Plant into electricity interconnection grid (Grid interconnection PLN) | E | The method to estimate GHG emissions level is IPCC 2006, Tool to calculate the emission factor for an electricity system – UNFCCC ver 04.0 EB 75 Annex 15. The GHG reduction is estimated by comparing the baseline emissions level (i.e. condition without mandatory policy) with emission level that would be resulted. | Already constructed in 2010/2011/2012/ 2013 and established in total capacity 1475 MW. | Act No. 30 Year 2009 about Electricity, and Government Regulation No. 14 Year 2014 concem Electricity Supply Business, Ministry of Energy and Mineral Resources Decrees No.2026.K/20/ MEM/2010 Year 2010, and Ministry of Energy and Mineral Resources Regulation No. 21 Year 2013 concern Electricity Supply Business Plan ( *Rencana Usaha Penyediaan Tenaga Listrik-RUPTL*) | 0.138 | 0.138 | Energy cost saving, because it is substituted petroleum Power Plant. | MEMR |

| No | Name of Action | Description | Category in FCCC/ AWGLCA/ 2011/INF.1 | Methodology and Assumptions for Estimating the Mitigation Impacts | Current Status of Implementation | Policy Instruments and Enabling Policies/ Regulations | Emission reduction (Mt CO2e) | | Co-benefit | Administering Government Agencies/ Actor |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Potential/ Target | Achievement | | |
| 15 | Renewal air transport | Implementation of Ministry Transportation Regulation No 5/2006, about Rejuvenation of passenger aircraft | G | Methodology by ICAO Calculation | On going process. Report until 2014 activities | Act No. 1/2009 concerning flight<br>Minister Decree No. 201/2013 for action plan GHG | 4.478 | 1.718851 | | MoT |
| 16 | Completion of systems and procedures for the operationand maintenance of passenger aircraft | Adopting of improvements system, tingprocedures and maintenance of passengers air craft for fuel saving and spare parts saving | G | Methodology by ICAO Calculation | On going process. Report until 2014 activities | Act No. 1/2009 concerning flight<br>Minister Decree No. 201/2013 for action planGHG | 2.978 | 0.217 | | MoT |
| 17 | Create and implement of direct flight (Direct Routes, RNAV 5, RNP 10) | Flight with RNP-10 method<br>Flight with RNP-5 method | G | Methodology by ICAO Calculation | On going process. Report until 2014 activities | Act No. 1/2009 concerning flight<br>Minister Decree No. 201/2013 for action plan GHG | 1.269 | 0.605275 | | MoT |
| 18 | Making Navigation Procedure *Continous Climb and Descent Operations* (STAR-SID-RNAV1) | PBN-SID/STAR | G | Methodology by ICAO Calculation | On going process. Report until 2014 activities | Act No. 1/2009 concerning flight<br>Minister Decree No. 201/2013 for action plan GHG | 1.241 | 1.614083 | | MoT |
| 19 | Making *RNP Procedure Approach* (RNP 0.3, RNP 0.1) | Flight with PBN method | G | Methodology by ICAO Calculation | On going process. Report until 2014 activities | Act No. 1/2009 concerning flight<br>Minister Decree No. 201/2013 for action plan GHG | | 0.096845 | | MoT |
| 20 | NAMA-SUTRI (Sustainable Urban Transport) | Demonstration projects on transportation through promoting transportation shifting scenario and energy efficiency system for public transport vehicles | G | Methodology is varied e.g. improvement of public transport corridors (BRT), parking management and pedestrian programmes. Assumption: | Planning (2015-2019) | | 0.7 - 1.5 Mt CO2eq per year in 2030 | N/A | Equitable access, reduced air pollution and increased life quality | MoT, Ministry of National Development Planning, Ministry of Finance |
| 21 | NAMA- SSLI (Smart Street Lighting Initiative) | Demonstration projects on street lighting through promoting energy efficient lighting techonology | D | Methodology: measurement of LED in substitution of CFL bulbs.<br>Assumption: wattage saving from LED in substitution of CFL bulbs, baseline is projected GHG emissions that would occure if using CFL. | Planning (2015-2020) | | 0.425 Mt CO2 in 20102 | N/A | Energy security of supply and electrification, cost saving, improved life quality | MEMR |

| No | Name of Action | Description | Category in FCCC/ AWGLCA/ 2011/INF.1 | Methodology and Assumptions for Estimating the Mitigation Impacts | Current Status of Implementation | Policy Instruments and Enabling Policies/ Regulations | Emission reduction (Mt CO2e) | | Co-benefit | Administering Government Agencies/ Actor |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Potential/ Target | Achievement | | |
| 22 | NAMA- DEEP (Debottlenecking project finance for least cost renewables) | Demonstration projects on bioenergy techonology | E | Methodology:<br>Assumption | Planning (2016-2020) | | 3.7 Mt | N/A | | MEMR |
| 23 | VIMSWa-NAMA (Vertically Integrated Municipal Solid Waste NAMA) | Using vertical integrated approach between vertical government levels: national, provincial, and local (V-NAMA: Vertically Integrated NAMAs) supported by the GIZ, that fill identified gaps in the Indonesian MSWM-system to transform waste into valued products and a job-creating commodity that contributes its full share to GHG mitigation. Piloted in five locations with the view to establish mechanism that can be replicated national wide<br>Note:<br>V-NAMAs is a G to G cooperation between the Republic of Indonesia and the Federal Republic of Germany to reduce GHG emissions from the municipal solid waste sector using vertical integrated approach between government vertical levels: national, provincial, and local | E, F | | Plan of Implementation:<br>2017-2021 | - Act No.18/2008 on Waste Management<br>- Government Regulation No. 81/2012 on Domestic Waste Management | 350.000 tCO2eq per year in 2021<br>(after all investment measures are implement-ed) | | **Economic:**<br>- additional income for local budgets<br>- creating working opportunities,<br>- saving energy costs,<br>- extend the lifetime of the landfill,<br>- trigger economic growth<br>**Social:**<br>- community involvement,<br>- education and awareness raising,<br>- improving community health,<br>- improve working and living conditions for informal sector,<br>- safety, aesthetic aspect and cleanliness. | - Ministry of National Development Planning,<br>- Ministry of Public Works and Housing,<br>- Ministry of Environment and Forestry,<br>- Ministry of Home Affairs<br>- Ministry of Energy and Mineral Resources<br>- Provincial and Local Governments at the Pilot Locations,<br>- Private sectors and Other institutions |
| 24 | Development of Guidance on Methodological Aspects for Ground Based Forest Carbon Accounting | National Standard on Ground Based Forest Carbon Accounting (SNI 7724:2011, SNI 7725:2011) | B. A reduction in the rate of deforestation and land degradation | Methodology: IPCC 2006. | Published and used in national level | | | | Consistent, Comparable, Transparent Methods for Ground Based Forest Carbon Accounting | Ministry of Forestry (Centre for Standardization and Environment |

| No | Name of Action | Description | Category in FCCC/ AWGLCA/ 2011/INF.1 | Methodology and Assumptions for Estimating the Mitigation Impacts | Current Status of Implementation | Policy Instruments and Enabling Policies/ Regulations | Emission reduction (Mt CO2e) | | Co-benefit | Administering Government Agencies/ Actor |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Potential/ Target | Achievement | | |
| 25 | Development of Guidance on Methodological Aspects for Demonstration Activities (DA) REDD+ | National Standard on Demonstration Activities (DA) REDD+ | B. A reduction in the rate of deforestation and land degradation | Methodology: IPCC 2006. | Published and used in national level | | | | Consistent, Comparable, Transparent Methods for DA implementation | Ministry of Forestry (Centre for Standardization and Environment) |
| 26 | Development of Guidance on Methodological Aspects for Measurement of Forest Cover Change by Optical Remote Sensing Visual Interpretation | National Standard on Methods on Measurement of Forest Cover Change by Optical Remote Sensing Visual Interpretation | B. A reduction in the rate of deforestation and land degradation | Methodology: IPCC 2006. | Published and used in national level | | | | Consistent, Comparable, Transparent Methods for remote sensing interpretation | Ministry of Forestry (Centre for Standardization and Environment) |
| 27 | Monitoring of Demonstration Activities (DA) REDD+ | Monitoring of DA REDD+ to obtain latest progress and achievements | B. A reduction in the rate of deforestation and land degradation | Methodology: IPCC 2006. | In progress and published in several reports | | | | REDD+ lesson learned activities from various locations and levels | Ministry of Forestry (Centre for Standardization and Environment) |

## Voluntary Mitigation in Waste Waste Sector

| No | Name of Action | Description | Category in FCCC/ AWGLCA/ 2011/INF.1 | Methodology and Assumptions for Estimating the Mitigation Impacts | Current Status of Implementation | Policy Instruments and Enabling Policies/ Regulations | Emission reduction (Mt CO2e) | | Co-benefit | Administering Government Agencies/ Actor |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Potential/Target | Achievement | | |
| 28 | Utilization of Landfill Gas for Power | Voluntary action to utilize landfill gas for electric power generation | F | Methodology: calculating 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 power generation data.<br>Avoided methane potential is corrected by CO2 released from combustion of LFG (methane). Other GHG reduction is from the utilization of electricity from LFG power plant that substitutes electricity from PLN grid. This reduction is recorded in energy sector. | On-going | - | 3023 Ggram CO2-e/year<br>(based on installed capacity of power plant in several landfills; many other landfills are not yet equipped with power plant) | 395 Ggram CO2-e/year<br>(based on data of operational LFG power plants = 3.45 MW, 30,200 MWh/year) | Reduce demand of electricity from grid | Landfill operators |
| 29 | Utilization of Landfill Gas for Residential Cooking | Voluntary action to utilize landfill gas for residential cooking | F | Methodology: calculating 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 number of household utilizing the gas and the average cooking heat demand per household. The LFG is assumed to substitute LPG. | On-going | - | - | 2.9 Ggram CO2-e/year<br>(based on the number of household utilizing LFG for cooking i.e. 456 households) | Reduce demand for LPG | Landfill operators and households in the vicinity of the landfills |

## Voluntary Mitigation in Energy Sector

| No | Name of Action | Description | Category in FCCC/AWGLCA/ 2011/INF.1 | Methodology and Assumptions for Estimating the Mitigation Impacts | Current Status of Implementation | Policy Instruments and Enabling Policies/ Regulations | Emission reduction (Mt CO2e) | | Co-benefit | Administering Government Agencies/ Actor |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Potential/ Target | Achievement | | |
| 30 | Utilization of Landfill Gas for Power | Voluntary action to utilize landfill gas for electric power generation | E | Methodology: GHG reduction is from the utilization of electricity from LFG power plant that substitutes electricity from PLN grid. | On-going | - | 185 Ggram CO2-e/year (based on potential electricity generation of 231,000 MWh/ year, grid emission factor) | 24 Ggram CO2-e/year (based on data of operational LFG power plants = 3.45 MW, 30,200 MWh/year) | Reduce demand of electricity from grid | Landfill operators |
| 31 | Utilization of Landfill Gas for Residential Cooking | Voluntary action to utilize landfill gas for residential cooking | E | Methodology: calculating 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 number of household utilizing the gas and the average cooking heat demand per household. The LFG is assumed to substitute LPG. | On-going | - | - | 0.14 Ggram CO2-e/year (based on the number of household utilizing LFG for cooking i.e. 456 households and emission factor of LPG) | Reduce demand for LPG | Landfill operators and households in the vicinity of the landfills |

# Appendix C

**Appendix C1.** Financial support needs

| | Status (Identified /planned/ on-going /completed) | Total Budget | Overall financial support needed (a) | Financial Support received (b) | Additional financial support needed (c) |
|---|---|---|---|---|---|
| **1. SSLI NAMA**<br>**(Smart Street Lighting Initiative)**<br>**Concept:**<br>http://www.paklim.org/library/publications/?did=97<br>**Proposal:**<br>http://www4.unfccc.int/sites/nama/SitePages/Home.aspx<br>**Contact:**<br>Mrs. Maritje Hutapea, Director for Energy Conservation, Ministry of Energy and Mineral Resources, Directorate General of New and Renewable Energy, and Energy Conservation. Telephone +6221 31924590 Telefax +6221 31924590<br>Website: www.ebtke.esdm.go.id | On Going<br>(2015-2020) | USD 294 Million | USD 19 Million<br>(USD 11,5 million for investments) | USD 100,000 from USAID | Not communicated |
| **2. Scaling-up RE NAMA**<br>**(Scaling-up investment in small and medium scale renewable energy (RE))**<br>**Document:**<br>www.mitigationmomentum.org/partner_countries_indonesia.html<br>**Contact:**<br>Alihuddin Sitompul, Director, Directorate of Various New Energy and Renewable Energy, Directorate General of New and Renewable Energy, and Energy Conservation. Ministry of Energy and Mineral Resources (MEMR) Directorate General of New and Renewable Energy, and Energy Conservation (EBTKE) Telephone +62 213 192 4588. Postal Address Jalan PegangsaanTimur No. 1A, 10320 Jakarta,Indonesia.Website www.ebtke.esdm.go.id | On Going<br>(Phase I late 2014,<br>Phase II mid 2015) | USD 23-33 Million | **Public finance**<br>Mixed sources (Government and International support): USD $23-33 Million<br>**Private finance**<br>Private investors / banks: USD $150-200 Million | Not communicated | Not communicated |
| **3. Solid Waste Treatment and Final Disposal**<br>**(Greater Bandung Area and Bogor – Depok Area)**<br><br>**Contact:**<br>Provincial Government of West Java. Head of BPSR (Balai Pengelolaan Sampah Regional) West Java Province Jl. Kawaluyaan Indah No. 4 Bandung 40286 West Java. Phone : +62 22 7332078 Fax : +62 22 7332078 | On Going<br>**(Greater Bandung Area)**<br>Duration: 2012-2017<br>Project preparation: 2012-2013<br>Construction: 2014-2016<br>Preparation PPP service management: 2015-2016<br>Operation: 2017<br>**(Bogor)**<br>Duration:2012-2016<br>Project preparation: 2012<br>Tender : 2013<br>Construction : 2014-2015<br>Operation : 2016 | USD 100.00 Million by Government (Greater Bandung Area)<br><br>USD 40 Million (Bogor) | Government support maybe available | Not communicated | Not communicated |

| | Status (Identified /planned/ on-going /completed) | Total Budget | Overall financial support needed (a) | Financial Support received (b) | Additional financial support needed (c) |
|---|---|---|---|---|---|
| **4. SUTRI NAMA**<br>**(Sustainable Urban Transport)**<br>**Document:**<br>http://transport-namas.org/wpcontent/uploads/2014/05/Case-Study_Indonesia.pdf<br>**Proposal:**<br>http://www4.unfccc.int/sites/nama/_layouts/un/fccc/nama/<br>**Contact:**<br>Mr. Imam Hambali, Director of Centre for Partnership and Transportation Service –Pusat Kajian Kemitraan dan Pelayanan Jasa Transportasi. Ministry of Transportation. Phone: +6221 3811301 ,Fax: +6221 3852671. Website: http://www.dephub.go.id/ | Planned (2015-2019) | EURO 400 Million | EURO 14 million (EURO 8,5 million for investments) | Not communicated | Not communicated |
| **5. DEEP NAMA PROJECT**<br>**(Debottleneckingprojectfinancefor least costrenewablesinIndonesia)**<br><br>**Contact:**<br>Dr. Dadan Kusdiana, Director of Bioenergy, Directorate General of New and Renewable Energy, and Energy Conservation. Telephone +62-21-31924541 Telefax +62-21-31924541.Website:http://www.ebtke.esdm.go.id | Planned (2016-2020) | EURO 200 Million | EURO 13.6 Million | Not communicated | **Government (parallel):** EURO 30 Million Project Delivery<br>**Private investors / banks:** EURO 156 Million |
| **6. VIMSWa NAMA**<br>**(Vertically Integrated Municipal Solid Waste NAMA in Indonesia)**<br>**Contact**<br>Ir. Muhammad Maliki Moersid, MCP. (Director of Environmental Sanitation Development)<br>Postal Address : Jl. Pattimura No. 20 Jakarta Selatan, 12110, Indonesia Telephone : +62-21-72797175, Fax : +62-21-72797175 Email : persampahan_plp@yahoo.com Website:www.ciptakarya.pu.go.id\| www.pu.go.id | Planned (2017-2021) | EURO 10 Million | EURO 6.25 Million | Not communicated | Not communicated |
| **7. CEMENT NAMA**<br>**(Reducing CO2 and Closing the Waste Gap; Encouraging Waste-to-Energy in the Indonesian Cement sector)**<br>**Contact:**<br>Dr. NgakanTimurAntara, Head of Center for Assessment on Green Industry and Environment (PPIHLH). Telephone +62 21525 2746 Telefax +62 21 525 2746. Ministry of Industry (MoI). Agency for Industrial Policy, Business Climate and Quality Assessment (BPKIMI)<br>Website: http://www.kemenperin.go.id | Planned (2015-2018) | EURO 2.063 Million | EURO 2.063 Million EUR for technical assistance | Not communicated | Not communicated |

| | Status (Identified /planned/ on-going /completed) | Total Budget | Overall financial support needed (a) | Financial Support received (b) | Additional financial support needed (c) |
|---|---|---|---|---|---|
| **8. SWEET NAMA**<br>**(Sustainable Wood to Effective Energy Technology NAMAs)**<br>**Document**<br>Our website already have some info about the previous project and will be maintained and expanded for this project (www.greenmadura.or.id)<br>**Contact**<br>ICCTF Secretariat. Wisma Bakrie 2 Building, Fl. 20th. Jln. Rasuna Said, Kav. B-2, Kuningan, Jakarta.<br>Dr. Yetty Rusli. Sekretariat Pokja Perubahan Iklim Kemenhut. Gedung Manggala Wana Bhakti Blok VII, Lantai 6, Jalan Gatot Subroto Sunayan, Jakarta Pusat. | Planned<br>(2015-2020) | USD 38 Million for Phase 1<br>USD 160 Million for Phase 2 | Not communicated | Not communicated | Not communicated |
| **9. Technology prioritization for energy sector identified by TNA (2012)**<br>Photovoltaic (PV) industry,<br>Regenerative burner combustion system (RBCS) | planned | | Financing aid preferred is in the form of grant and / or soft loans from donor countries. The use of this aid is such as for:<br>**PV Technology**<br>Development of National PV Industry at 50 MWp capacity (minimum)<br>Increase of testing capacity of PLTS system<br>Improvement of PV cell manufacturing laboratories (crystalline)<br>**RBCS Technology**<br>Installation of RBCS in the selected steel industries.<br>Improved design of RBCS | Seeking Support | Not communicated |

| | Status (Identified /planned/ on-going /completed) | Total Budget | Overall financial support needed (a) | Financial Support received (b) | Additional financial support needed (c) |
|---|---|---|---|---|---|
| **10. Technology prioritization for waste sector identified by TNA (2012)**<br>Mechanical Biological Treatment (MBT),<br>In-Vessel Composting (IVC)<br>Low Solid Anaerobic Digestion (LSAD) | planned | | Grants and/or loans with low interest rate from foreign aid are needed. The use of this aid is such as for:<br>Pre-Installment cost: planning, FS and DED<br>Capital cost: construction and machineries installation.<br>Operation and maintenance cost: salaries, utility bills, tools and supplies, fuels of machines. Etc. | Seeking Support | Not communicated |
| **11. NAMA's Agriculture** identified by the letter of Planning Bureau of Agriculture (Sep 2014)<br>*Integrated Crops Management for Rice (PTT)*<br>Contact Person: Gatut Sumbogojati<br>Email: programme.tanamanpangan@gmail.com | planned | IDR 36.5 Billion | Not communicated | Not communicated | Not communicated |
| **12. NAMA's Agriculture** identified by the letter of Planning Bureau of Agriculture (Sep 2014)<br>*Community Based Organic Fertilizer Plan (UPPO)*<br>Contact : Edi Purnawan<br>Email: e_purnawan@yahoo.com | planned | IDR 25.65 Billion | Not communicated | Not communicated | Not communicated |
| **13. NAMA's Agriculture** identified by Research and Development Staff<br>Avoidance methane emission using Batamas (excluding fuel substitution)<br>**Contact:**<br>Joko Purwanto,<br>Email: kerjasama_nak@yahoo.co.id | planned | IDR 50 Billion | Not communicated | Not communicated | Not communicated |
| **14. NAMA's Agriculture** identified by Research and Development Staff<br>Rehabilitation of degraded land on APL (Other Land-Use)<br>**Contact:**<br>FahmudinAgus,<br>Email: fahmudin@yahoo.com | planned | IDR 100 Billion | Not communicated | Not communicated | Not communicated |

| | Status (Identified /planned/ on-going /completed) | Total Budget | Overall financial support needed (a) | Financial Support received (b) | Additional financial support needed (c) |
|---|---|---|---|---|---|
| **15. NAMA's Agriculture** identified by Research and Development Staff<br>Integrated Crop-Livestock management system<br>**Contact:**<br>Prihasto Setyanto | Planned | IDR 30.5 Billion | Not communicated | Not communicated | Not communicated |

Source: BAPPENAS (2014a)

**Appendix C2.** Technical support needs for Supporting NAMA activities

| | Status (Identified/ planned /on- going / planned / completed) | Total Budget | Overall technical Support needed (a) | Technical Support received (b) | Additional technical support needed (c) |
|---|---|---|---|---|---|
| **1. SSLI NAMA**<br>**(Smart Street Lighting Initiative)** | On Going (2015-2020) | USD 294 Million | USD 19 Million (and USD 7.5 million for technical assistance) | USD 100,000 from USAID | Not communicated |
| **2. SUTRI NAMA**<br>**(Sustainable Urban Transport)** | Planned (2015-2019) | EURO 400 Million | EURO 14 million (EURO 5.5 million for technical assistance) | Not communicated | Not communicated |
| **3. Technology:**<br>**PV technology:** *Development of National PV Industry at 50 MWp capacity (minimum);* Transfer technology of industrial PV cell (wafer to cell); *Testing capacity of PLTS system;* Transfer technology for the improvement of laboratory facilities according to standard IEC 61215, and addition of other components of equipment such as testing tools for batteries, inverters, and others; *Improvement of PV cell manufacturing laboratories (crystalline);* Transfer technology of industrial PV cell.<br>**RBCS Technology:** *Installation of RBCS in the selected steel industries;*Transfer technology on the RBCS and control room design. | Identified by TNA (2012) | Not communicated | Not communicated | Not communicated | Not communicated |

| | Status (Identified/ planned /on- going / planned /completed) | Total Budget | Overall technical Support needed (a) | Technical Support received (b) | Additional technical support needed (c) |
|---|---|---|---|---|---|
| **4. Technology for waste sector**<br>1. Mechanical Biological Treatment (MBT): MBT is heavy mechanized waste treatment facility. Actually, some equipment of the MBT can be possibly made in Indonesia, but some of complicated equipments have to be imported. This situation needs international support in technology transfer and IPR negotiation.<br>2. In-Vessel Composting (IVC)<br>3. Low Solid Anaerobic Digestion (LSAD) | Identified by TNA (2012) | Not communicated | Not communicated | Not communicated | Not communicated |
| **5. Technology Support Needs for Agriculture** identified by Research and Development Staff<br>Technology on activity data determination for peat fire area and peat fire depth (burned area and burned depth at least to the closest 5 cm peat depth precision<br>Contact Person: Prof. Dr. Fahmuddin Agus<br>Address: Indonesian Agency for Agricultural Research and Development<br>IAARD Jl. Ragunan 29 Pasar Minggu Jakarta Selatan 12540, Indonesia<br>Phone. (021) 7806202 Fax. (021) 7800644 E-mail: info@litbang.pertanian.go.id | Planned | IDR 30.5Billion | Seeking Support | Seeking Support | Not Communicated |

| | Status (Identified/ planned /on- going / planned / completed) | Total Budget | Overall technical Support needed (a) | Technical Support received (b) | Additional technical support needed (c) |
|---|---|---|---|---|---|
| **6. Technology Support Needs for Agriculture** identified by Research and Development Staff Technology on low methane emitting rice cultivars<br>Contact Person: Dr. Ir. Prihasto Setyanto, M.Agr.<br>Address: Balai Penelitian Lingkungan Pertanian (Balingtan) Jl. Raya Jakenan Km. 5 Kotak Pos 5Pati 59182 - Jawa TengahTelp: 0295 – 385215Fax: 0295 – 381592balingtan@litbang.pertanian.go.id, lolingtan@yahoo.com http://balingtan.litbang.pertanian.go.id/ | planned | NC | Seeking Support | Seeking Support | Not Communicated |
| **7. Technology and capacity building prioritization for Forest Resource Inventory and Monitoring by TNA**<br>1. Updating Annual Land Cover Map<br>2. Redesign and improving methodology for NFI (TSP/PSP), including using new technology and innovation<br>3. Improving capacity and access speed for Web GIS and NFMS<br>4. Peat detailed mapping and high resolution image for primary forest mapping<br>**Contact:**<br>Mr. Ruandha Agung Sugardiman, Director of Forest Resource Inventory and Monitoring, Ministry of Forestry. Phone: +6221 5730335 – 5730292 Fax: +6221 5730335 Website: http://www.dephut.go.id/ | Planned | IDR 20 Billion | Seeking Support | Seeking Support | Not Communicated |

Source: BAPPENAS (2014a) and DNPI (2012)

## **Appendix C3.** Capacity building needs

| Types of Capacity Building | Capacity Building Activities | Status (Identified /Planned /on-going /completed) | Cost for Overall capacity-building needed (a) | Support received (b) | Additional Support needed (c) |
|---|---|---|---|---|---|
| Development of mitigation strategies including supporting regulation | 1. Capacity building in NAMAs development for public and private sectors (strategy development, identification of NAMAs candidates, training in NAMAs development) | Planned (2015 – 2020) | 10 million US$ | - | 10 million US$ |
| | 2. Development of Low-Emission Development strategy in energy intensive industries | Planned (2015 – 2020) | 5 million US$ | - | 5 million US$ |
| | 3. Development of strategy for regulating GHG emissions from high-emitting entities (industries, commercial sector) | Planned (I2015 – 2020) | 2 million US$ | - | 2 million US$ |
| | **4. NAMA's Agriculture:** Capacity building on participatory planning for synergizing adaptation and mitigation action **Contact:** Fahmudin Agus Email: fahmudin@yahoo.com | Identified by Research and Development staff | IDR 15 Billion (USD 1.25 Million) | Seeking Support | IDR 15 Billion (USD 1.25 Million) |
| Application of mitigation technologies | **5. NAMA's Agriculture:** Capacity Building Programme on Indonesian Coffee Farmers Low Carbon Farming Empowerment | identified by the letter of Planning Bureau of Agriculture (Sep 2014) | IDR 30.5 Billion (USD 2.54 Million) | Seeking Support | Not communicated |
| | **6. Peat water management:** National Capacity Building onTechnology for Peatland Water Management Technology | Identified from TNA (2012) | Not communicated | Seeking Support | Not communicated |
| | **7. Photovoltaic (PV) Technology:** Capacity building to upgrading the human resources capability for: Development of National PV Industry at 50 MWp capacity (minimum) Increase of testing capacity of PLTS system Improvement of PV cell manufacturing laboratories (crystalline) | Identified from TNA (2012) | Not communicated | Seeking Support | Not communicated |
| | **8. Regenerative Burning Combustion System (RBCS) Technology:** Capacity building for improvement of human resources capabilities in the construction, operation, and maintenance of RBCS in selected steel industries, Capacity building for improvement of RBCS and control room design capability of local human resources. | Identified from TNA (2012) | Not communicated | Seeking Support | Not communicated |
| | **9. Technology for waste management**, i.e. Mechanical Biological Treatment (MBT), In-Vessel Composting (IVC), Low Solid Anaerobic Digestion (LSAD). Capacity building for improving the capacity of Indonesian researchers and users by foreign experts through training, tutoring and knowledge transferring during practical work at the plant. If there is a technology innovation aising during MBT operation it should be set an agreement, especially related to Intellectual Property Rights (IPR). | Identified from TNA (2012) | Not communicated | Seeking Support | Not communicated |

| Types of Capacity Building | Capacity Building Activities | Status (Identified /Planned /on-going /completed) | Cost for Overall capacity-building needed (a) | Support received (b) | Additional Support needed (c) |
|---|---|---|---|---|---|
| MRV (including mapping) | **10. Capacity building in MRV** (strategy development, benchmarking with other countries, training in MRV) | Planned (2015 – 2020) | USD 3 million | - | 3 million US$ |
| | **11. NAMA's Agriculture**<br>Capacity Building on agricultural carbon accounting at district level<br>**Contact**: Fahmudin Agus<br>Email: fahmudin@yahoo.com | identified by Research and Development staff | IDR 15 Billion (USD 1.25 Million) | Seeking Support | IDR 15 Billion (USD 1.25 Million) |
| | **12. Prioritized Technology on Forestry Sectors:**<br>National Capacity Building on Technology for Forest-Peat Carbon Measurement and Monitoring | Identified from TNA (2012) | Not communicated | Seeking Support | Not communicated |
| | 13. Prioritized Technology on Forestry Sectors identified: National Capacity Building on Technology for Forest Unified Peat Re-Mapping Technology | Identified from TNA (2012) | Not communicated | Seeking Support | Not communicated |