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Country Chapter

State of the 3Rs in Asia and the Pacific

The Republic of Indonesia

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Disclaimer

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ABBREVIATION

3Rs	Reduce, Reuse, Recycle
BPS	National Center for Statistics
BAPPENAS	Ministry of National Development Planning
ADIPURA	Program that measures the performance of city and regency in urban environment management including MSW management
EPR	Extended producer responsibility
FGD	Focus group discussion
GHG	Greenhouse gases
GR	Government Regulation
HW	Hazardous waste
ITB	Institut Teknologi Bandung
ICCSR	Indonesia Climate Change Sectoral Roadmap
JICA	Japan International Cooperation Agency
LD50	Lethal dose fifty
LUCF	Land use change, forestry and peat fire
MSW	Municipal Solid Waste
MEF	Ministry of Environment and Forestry
MH	Ministry of Health
MI	Ministry of Industry
MPWH	Ministry of Public Works and Housing
MRF	Material Recovery Facility
NGO	Non Governmental Organization
NAMAS	Nationally Appropriate Mitigation Action
PMA	Foreign capital investment
PROPER	Assessment of industry work performance program which includes water pollution control, air quality control, and hazardous waste management
RAD-GRK	Regional action plan for reducing GHG emissions
RAN-GRK	National action plan on GHG emissions reduction
RANPI	National action plan on climate change
SNI	Indonesia national standard
TPS	Transfer point for MSW
TPS-3R	Transfer point for MSW with recycling activity
TCLP	Toxicity Characteristics Leaching Procedure

CONTENTS

A: WASTE DEFINIITION AND CATEGORIZATION

In Indonesia, solid wastes are broadly classified into domestic waste and non-domestic waste. Non-domestic waste is further grouped into non-hazardous waste and hazardous waste. There are two laws that regulate waste management namely Law no. 18/2008 concerning Solid Waste Management, mainly focusing on municipal solid waste (MSW) management, and Law no. 32/2009 concerning Environment Protection and Management, regulating industry and HW.

Waste definitions vary by countries. Among developed countries, for instance, the definition of a MSW will encompass any goods that would be defined among developing countries as used goods that still have economic value. In developed countries, the elimination of used electronic appliances for examples should incur the cost of disposal. So will the other goods such as furniture and fixtures, used newspapers, used magazines, used clothes and so on. Among developed countries, these goods are defined as waste and require further handling. On the contrary, in developing countries, they would be regarded as valuable goods and could still be used after repairing them or otherwise by recovering their components in such a way that they would be reusable.

I. MSW Definition

Law no. 18/2008 defines solid waste as the residues of human daily activities and/or residues of natural processes in solid forms. Government Regulation (GR) no. 81/2012 explains more specifically regarding municipal solid waste management and its technical handling, 3Rs and EPR approach. Management of this type of waste is the responsibility of each municipality or other governmental authorities. Waste specified under this law includes:

- Domestic waste that is generated by daily activities performed within households, but does not include feces and specific waste;
- Domestic waste equivalents that are generated from commercial zones, industrial estates, special zones, social facilities, public facilities and any other facility;
- Specific waste is waste requiring special management due to its properties, concentrations and/or volumes, in the form of hazardous materials contained in the waste, HW, waste generated by disasters, demolition waste, un- processable waste due to availability of technology and non-periodical generated waste.

II. Hazardous Waste (HW) Definition

Waste may be considered hazardous for a number of reasons. For example, the potential for some waste to cause a toxic reaction in humans is the most fearful public concern. GR no. 101/2014 defines waste to be hazardous under legislation if it meets one or more of the following conditions:

- Exhibits characteristics such as being explosive, ignitable, reactive, toxic by Toxicity Leaching Characteristics Procedure (TCLP), infectious, corrosive, and/or toxicity by Lethal Doses-50

(LD50) tests;
- Is a non-specific source which includes generic wastes generated by a variety of general process;
- Is a specific source which is generated from specific industrial process; and
- Is a specific commercial chemical product or intermediate, discarded commercial chemical products, off-specification species, container residues, and spill residues.

III. Reduce-Reuse-Recycle (3Rs) Definition

The objective of Law no. 18/2008 is to increase public health and environmental quality as well as to utilize waste as a resource. Under the law there is a focus on the government's 3Rs policy. In conjunction with this, the law makes it clear that waste management is the shared responsibility of all parties: individual, community, business and government.

According to Law no. 18/2008, the management of MSW consists of waste reduction and waste handling. Waste reduction includes the activities of limitation of waste generation, recycling of waste and/or re-using of waste. In carrying out activities, all actors utilize materials for production that produced minimum waste, that is reusable, and recyclable, and/or is easy to be decomposed by natural process.

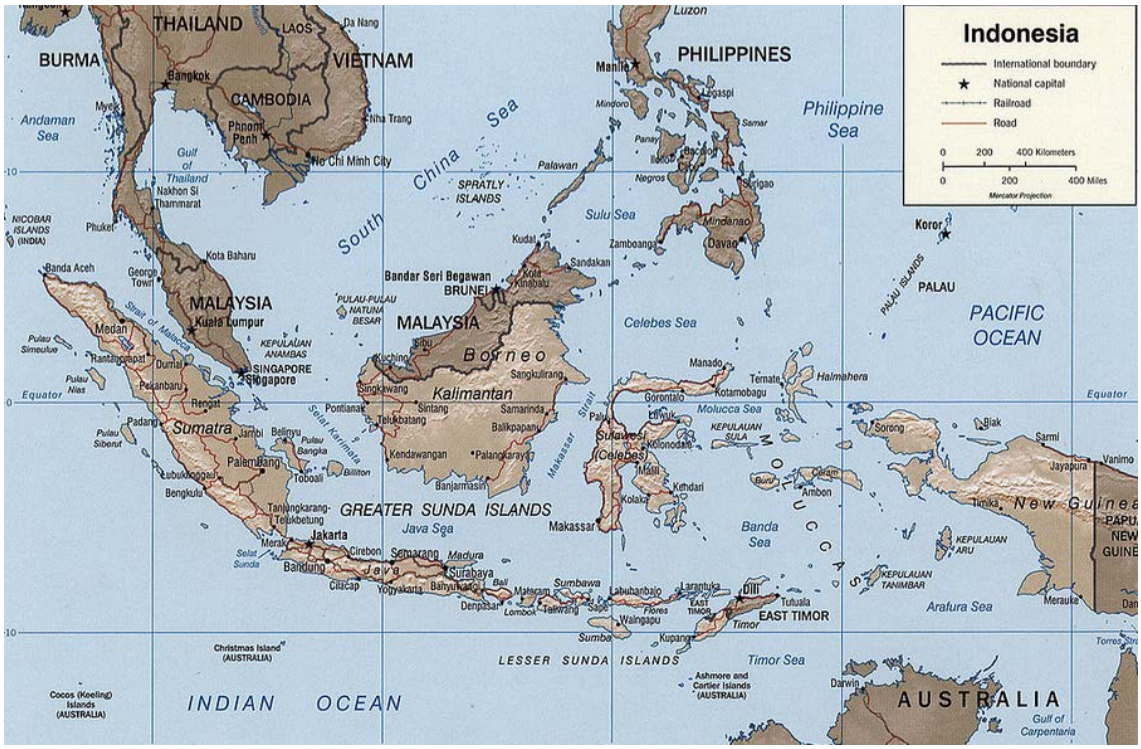
The government and regional governments are obliged to carry out the following activities:
- Determine the waste reduction target gradually within the limitation of time;
- Facilitate the application of environmental sound technology;
- Facilitate the labeling of environmental sound products;
- Facilitate the activities of re-using and recycling; and
- Facilitate the market of recycled products.

In terms of HW, GR no. 101/2014 defines that HW management is a series of activities including reduction, storage, collection, transportation, utilization, processing, landfilling and dumping in the sea. Hazardous waste reduction is an activity on the part of the waste generator to reduce the quantity and the hazard and toxic nature of waste prior to it being generated. While the utilization of waste is an act of recovery and/or reuse and/or recycle with a view to change the HW into a product or raw materials substitute for production processes, and/or into useful energy, it must also be safe for the environment and human health.

Furthermore, the Environmental Ministry Regulation no. 02/2008 states:
- Reuse: is reusing HW for the same purpose without any additional chemical, physical, biological, or thermal process;
- Recycle: is recycling valuable components through a chemical, physical, biological, and thermal process in order to produce the same or different product;
- Recovery: is recovering valuable components or energy through chemical, physical, biological, and thermal process.

B: COUNTRY'S BASIC POLICY DIRECTION PAST AND FUTURE

Indonesia is an archipelagic country extending 5,120 kilometers from east to west and 1,760 kilometers from north to south, consisting of more than 17,500 islands, only 6,000 of which are inhabited. Indonesia's total land area is 1,919,317 square kilometres. The additional surrounding sea areas bring Indonesia's recognized territory (land and sea) to about 5 million km^2 (Figure B-1).



Source: http://kubera.wikia.com/wiki/File: Peta-indonesia.jpg

Figure B-1 Map of the Republic of Indonesia

An inter census population survey in 2010 concluded that the total Indonesian population was 237.64 million persons with a population density of 127.6 people/km2 (www.bps.go.id). About 58.7% of the total population in 2005 inhabited Java, an island with an area covering only 6.95% of the total land area of the country (MH, 2007). The most populous province is West Java (with more than 43 million people), while the least populous province is that of West Papua in the far eastern region of Indonesia (having around 761,000 people). The annual national population growth rate of Indonesia between 2010 and 2015 was an average of 1.38%. This growth was highest in the province of East Kalimantan (2.64%), while the lowest figure came from East Java (0.67%).

Until the early twentieth century, the urban population in Indonesia was well distributed. Over the last forty years the country has experienced a process of rapid urbanization, resulting in the current situation in which over half of Indonesia's total population resides in urban areas. In 2012, the population of Indonesia increased to 245 million people, with about 50% of the population living in urban areas. It has been predicted that the population will increase to 285 million people in 2025, and urban population will be 67.5% of the total population *(BPS, 2013).*

Administratively, the country is comprised of 34 provinces, 502 cities and regencies, 6,543 districts and 75,244 villages. Since 1999, Indonesia has adopted the decentralization system in its governance, providing provincial and local governments with their own autonomy. With a population of 238 million in 2010, about 184,000 tonnes of waste is generated per day nationwide. Megacities generate 1,791 tonnes per day of solid waste, with other major cities producing 854 tonnes of solid waste a day. The figures tend to increase year by year as more people move to live in urban areas. Conversely, the coverage of a solid waste collection service in those cities is about 70% and even worse in other cities. Furthermore, more than 90% of final disposal still uses open dumping (RI, 2013).

As Indonesia grows rapidly and standards of living improve, waste is generated in ever higher quantities. With the advent of Law no. 32/2004 on Regional Governance, and Government Regulation no. 38/2007 on the Allocation of Governmental Affairs to National, Provincial and District/City Governments, the responsibility for handling MSW has shifted from the National Government to Local Governments (Mursito et al., 2013).

I. Recent and Future Policy Trends on 3Rs and Waste Management

Indonesia has three types of waste category related to recycling:

- Municipal solid waste is regulated by Law no. 18/2008 regarding MSW management. Under that regulation, 3Rs is the principle approach for waste management. The GR no. 81/2012 regulates more specific 3Rs and EPR as well as a technical approach for handling the waste. The EPR concept is being regulated under this GR on mandatory basis.
- HW is regulated by Law no. 32/2009 regarding environmental protection and management that takes into account the HW problems as first priority. The GR no. 101/2014 explains more specifically regarding HW management.
- Waste materials that are not listed in the regulation above such as non-hazardous industrial waste, agriculture waste, etc. still be considered for recycling.

1. Municipal solid waste (MSW)

On May 7, 2008 Indonesia introduced the Law of Solid Waste Management (Law no. 18/2008), which has been drafted since 2003. The finalization of this law saw major delays until it was revived after the incidence of a landslide at the Leuwigajah final disposal site in February 2005. This law is enforced by GR no. 81/2012 that mandates the implementation of the minimization of waste through a 3R approach and handling of waste must be done early as possible at the sources that can provide value and potential economic benefits. The regulation also mandates that local governments have to change the open dumping system to more environment-friendly dumping.

The implementation of MSW handling is responsibility of local government (city and regency). At the level of Central Government, there are three Ministries which are responsible for waste management, namely:

- Ministry of Environment and Forestry (MEF, before 2015: State Ministry for Environment): to

provide norms related to environmental standards;
- Ministry of Public Works and Housing (MPWH, before 2015: Ministry of Public Works): for providing regulations, standards, criteria as well as guidelines related to technical aspects;
- Ministry of Interior: for institutional aspects for local government.

One of the important mandates in Law no. 18/2008 is the implementation of waste separation, as an initial step of waste recycling. Every country recognizes the importance of recycling. In most countries, plastics, glasses, papers, and metals are properly collected by either the informal sector or municipalities, and these materials are recycled. In the case of MSW in Indonesia, there are two main recycling flows. In the first flow, collectors, including those in the informal sectors, collect recyclable materials at sources. In the second flow, these materials are separated and recycled by the municipality after MSW collection. Recycling activities in this context are all activities of reusing objects that were previously called "waste", either by directly self-reusing or by selling to waste traders.

Responding to policies and regulations on solid waste management, the MEF has been conducting some programmes related to solid waste management as follows (*RI, 2013*):
- Adipura Program, a program that measures the urban environment management performance of cities and regencies including MSW management performance; and beyond compliance toward a sustainable city (Adipura Kencana Program);
- Promote and Implement 3Rs, a program that develops 3Rs implementation both community-based 3Rs and city-scale 3Rs (365 cities as a pilot project) and city scale 3Rs;
- Bank Sampah or Waste Bank, a program that educates people to reduce their waste by conducting waste separation and waste saving for recycling purpose.
- PROPER Program, a program of assessment and performance rating of industry in environmental management.

The MEF is promoting recycling through the construction of Waste Banks that help communities make money through their waste recycling efforts. This is supported by Ministry Regulation no. 13/2012, which lays out guidelines for the 3Rs through Waste Banks. As of December 2012, the MEF has supported the construction of 1,195 Waste Banks. These are distributed across 55 regions and cities in Indonesia. According to MEF Report (*MEF, 2012a*), the Waste Bank initiative has shown a significant increase in the following areas:
- Has managed to engage around 471 individuals in February 2012, and increase to more than 96,200 individuals in December 2012;
- Collectively has generated around Rp. 1,65 billion (USD 183,000) by February 2012, increasing to around Rp 15.1 billion (USD 1.562 million)) by December 2012;
- Total of non-organic wastes processed in the Waste Banks was about 0.756 tonnes per month in February 2012, and reached approximately 2,262 tonnes per month by December 2012;

At the city level, the central government through the MPWH is also helping the local government in promoting waste reduction to be transported to final disposals through the implementation of Material Recovery Facility, known as TPS-3R (transfer point for MSW with recycling activity) on a sub-district scale and TPST (integrated MSW treatment) on a city scale. Central government

budget funds supported the construction of 595 TPS-3R and 3 TPST between 2007 and 2015. The MPWH will construct 47,329 TPS-3R by 2020. However, the last evaluation in 2015 of the existing function of 146 of TPS-3R located at Java, Sumatra and Kalimantan showed that only 12% of them were functioning, while 41% fell into the unused category.

The waste handling policy through the MPWH is that 50% of the MSW will be transported directly to landfill, while the remaining 50% is processed at the MRF. The target was to reduce waste up to 20%. For the category of small towns and medium cities, 50% of the MSW is processed in TPS-3R. For the category of large cities and metropolitan cities, 25% of the MSW is processed in TPS-3R and the other 25% is processed in TPST.

The Law no. 18/2008, *inter alia* requires that all landfills must be operated under sanitary conditions. Before that, the MPWH in 2006 issued regulation no.21/Prt/M/2006, outlining a number of policy and strategy measures for improving solid waste management systems during the planning period 2006-2015. Based on the Law no.18/2008, the central government oulined some targets for MSW management in the Medium Term National Development Plan 2010-2014, among others were to increase the waste collection coverage by 75%, optimizing and developing the municipal solid waste infrastructures, and to increase the performance of landfills in cities/regencies. The program to achieve those targests among others were by:

- Reducing the MSW quantity;
- Revitalizing landfill sites and applying the regional system for landfill;
- Monitoring the environmental quality for post closure of landfill process;
- Enforcing small and medium cities to implement the controlled landfill process, while large and metropolitan cities implement the sanitary landfill process;
- Increasing the service coverage as well as the performance of the services.

For that purpose, the MPWH maintains a budget line to provide block grants to the cities to help them to implement the requirements of the law. The central government of Indonesia is committed to close open dumping sites and rehabilitate them to sanitary landfills or controlled landfills. A target has been set to develop/rehabilitate 240 new/old landfills sites by the year 2014.

At the time this draft of manuscript was prepared, the Government of Indonesia was preparing a Government Regulation on the national policy on solid waste management, and a President Decree on the acceleration of the MSW handling and treatment through some pilot projects using waste-to-energy technology as part of the renewable energy program in several cities in Indonesia.

2. Hazardous waste (HW)

Interest regarding HW in Indonesia had emerged since 1990s, especially after the intensified industrial activities. The HW management in Indonesia refers to the principles and guidelines for sustainable development as stipulated in Law no. 4/1982 on Basic Provisions for Managing the Living Environment. The amendment to this Law was issued by Law no. 23/1997, and finally this law was replaced by Law no. 32/2009. The GR no. 19/1994, then revised through the GR no. 12/1995 explained further about the HW management, by introducing a reuse and recycling approach. This regulation was then improved by GR no. 18/1999 amended by GR no. 85/1999. This

regulation did not only prevent and minimize the generation of HW, but it also regulated its control, storage, transport, treatment and final disposal, including recycling and recovery. Finally in 2014, these government regulations were replaced by GR no. 101/2014.

According to GR no. 101/2014, HW management is an activity consisting of reducing, storing, collecting, transportation, utilization, treatment, and/or landfilling. The MEF has released summaries of licenses regarding documents of HW utilization, treatment, transportation, and landfilling. Through policies and regulations, the system of HW management in Indonesia can be described as seen in Figure B-2.

The polluter pays principle is imposed whereby the waste generator is fully responsible for their own waste. However, a combination of the polluter pays principle and the public service principle is applied to solid waste management. This combination principle states that in general, both central and local governments are responsible for solid waste management. In certain cases, the responsibility is delivered to the community and business sector. Fundamental industrial waste management states clearly that the industrial sector should manage its own waste in an environmentally sound manner until the waste quality meets environmental standards. Similar to MSW regulation, importation of HW is prohibited by law.

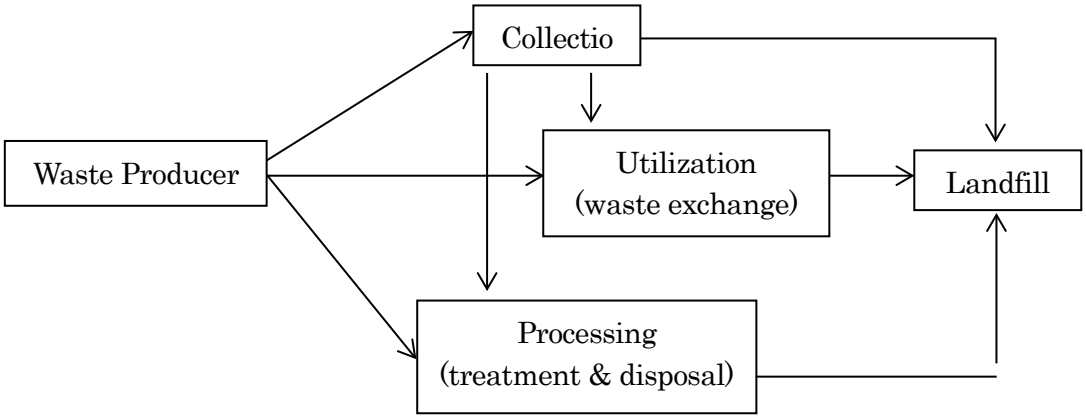


Figure B-2 Cradle-to-grave system in Indonesia *(MEF, 2014b)*

With regard to HW management some programs have been implemented, including:

- Encouraging business sectors that generate HW to do 3Rs by reusing and recycling their waste;
- Improving permission procedure by applying a transparent process, fair and equal services, as well as fast and reliable services;
- Controlling and monitoring the permit by conducting PROPER Program.

Based on the characteristics of HW, the MEF stated that utilization of HW should meet several criteria:

- Completing administration and permit;
- Environmental, health, and safety procedure should be considered;
- Type, amount, and characteristics of HW;
- Laboratory analysis should be conducted;
- HW handling;

- HW composition;
- HW utilization process;
- Product and by products from HW should be meet the Indonesia National Standard (SNI/SAE) and other similar standards;
- Product of HW is not allowed to be used as fill material or road base without any treatment;
- Residual treatment from utilization process should be conducted;
- Air and water quality control instrument(s) should be applied;
- Monitoring of pollution control instruments performance, wastewater quality performance, and trial burn test should be conducted to meet the standard quality;
- Emission test for dioxin and furan should be conducted once in three years if the HW consists of halogen.
- Monitoring of groundwater should be conducted.

HW can be utilized based on specific permits that should be completed through monitoring activities. The indications of these activities are:

- Reduction of environmental negative impacts in HW landfill area;
- Natural resources saving because the product that produce from HW utilization can be used as substitutional fuel and raw material.

HW concern has been reported widely in Indonesia since the beginning of the 1980s. Concerns eventually reached government levels and have been top priority since then. The government not only implemented regulations and decrees to monitor HW from every source, but it also stipulated guidelines and facilities to reduce HW in every way. In 1990, the MEF created *Program Kali Bersih* (PROKASIH) or Clean River Program. In 1995, this program was upgraded into PROPER-PROKASIH which involved water pollution control matters. Some years after that, environmental issues began increasing and the government was urged to create *Program Penilaian Kinerja Peringkat Kinerja Perusahaan* (PROPER) or the Program for Work Performance Assessment of Company which includes water pollution control, air quality control, and HW management. PROPER is an instrument to push for greater management in companies (industry) in terms of environmental management through the information sharing PROPER has assessment criteria that every company will be given an award or brand for their environmental management performance:

- Gold: consistently showing environmental excellence in production process and/or service, perform good etiquette and responsible business to community.
- Green: perform the environmental management more than required in regulations (beyond compliance) through the environmental system management, efficiently use the resources through 4R effort (reduce, reuse, recycle, and recovery), and implement a responsible CSR/Community Development very well.
- Blue: perform environmental management as required in compliance with rules or official regulations.
- Red: the environmental management of its system has not been executed well as it written and ruled in official regulations and is going to be charged by administration punishment.
- Black: deliberately does an action and/or dilatory which results in pollution and/or environmental damage and violates the rules/ official regulations, or not undergoing the administration punishment.

II. Major Treatments and 3Rs Related Technologies

1. Municipal Solid Waste

Information of the source and type of MSW along with data on the rates of generation, composition and characteristics is basic to the planning, design and operation of the MSW handling. Sources of MSW in a community are in general related to land use and zoning. Figure B- below shows the classification of sources of MSW in Indonesia.

So far, most of the existing MSW management systems in Indonesian municipalities rely on the existence of landfills. The excess has been handled by the community through various ways, such as burning, burying, composting, and other ways such as recycling or disposing at improper sites, including ducts or drainage channels. Based on a questionnaire survey conducted by JICA and ITB in 2007 in 154 cities in Indonesia (*MEF, 2008*), the mode of handling of MSW in Indonesia in 2006 is landfilling (68.86%), composting (7.19%), small scale incineration (6.59%), open burning (4.79%), rivers (2.99%), and others (9.58%).

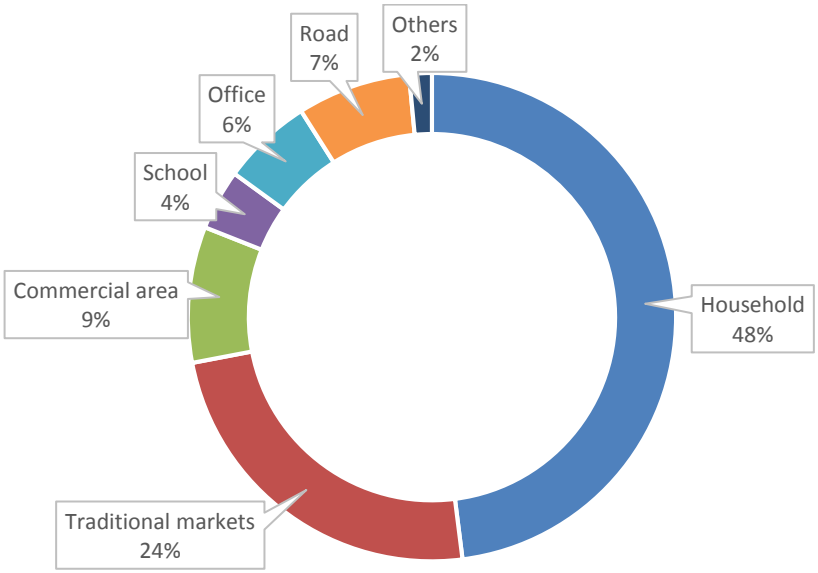


Figure B-3 Percentage of MSW sources in Indonesia in 2013 (based on data in *MEF, 2016*)

Prediction of MSW handling in Indonesia is shown in Figure B-4 and Figure B-5. Table B-1 presents the prediction of percentage of households' waste handling between 2010 and 2013 from rural and urban area.

Over 60% of domestic waste is organic. The government has promoted waste composting through community composting programs and through district level composting programs led by the Central Government. Composting has numerous advantages including reduction in greenhouse gas

production, reduction in the volume of waste going into landfills (reducing operating costs and increasing lifespan), and of course compost for parks and gardens.

Most waste transported to final disposal sites is left in open dumps, and it is estimated that only about 10% of it was handled through better systems such as using controlled landfills. In many sites, these facilities are nothing more than uncontrolled open dumping sites. Lack of serious attention over these final disposals tends to be a general practice on the part of city administrators in Indonesia. In many cases, it was found that waste from industry and also pathogenic waste from hospitals were brought to the same dumpsites as the non-hazardous municipal waste, although since 1995 the government of Indonesia has regulated HW landfill criteria.

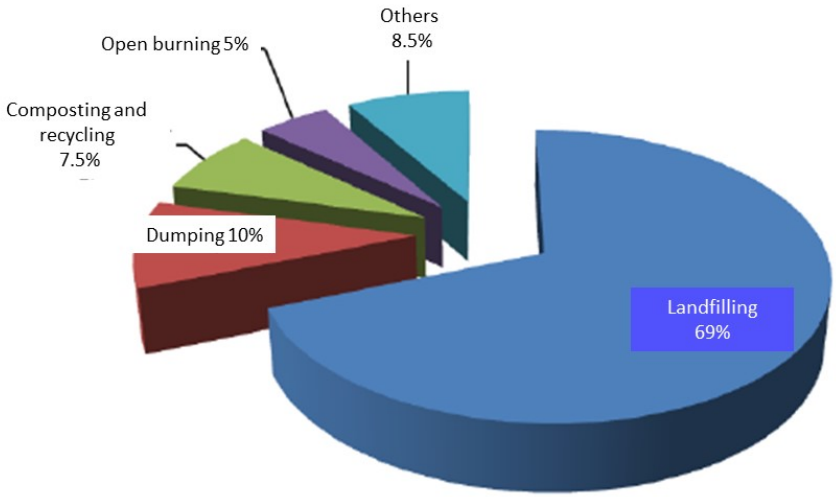


Figure B-4 Percentage of MSW handling in Indonesia in 2013 (*Sidik, 2015*)

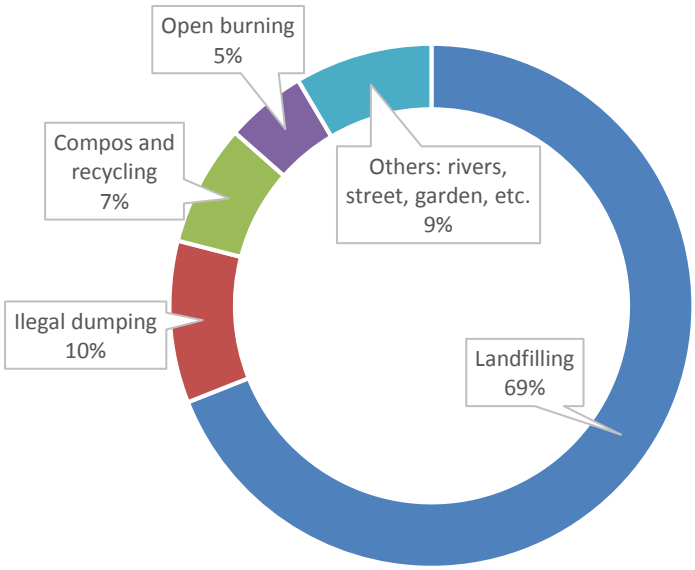


Figure B-5 Percentage of MSW handling in Indonesia in 2014 (based on data in *MEF, 2016*)

Table B-1 Percentage of households handling in Indonesia, 2010-2013

No	Type of handling	2010 % BPS 2010	2012 % BPS 2012	2013 % (BPS 2013)		
				Urban	Rural	Urban + Rural
1	Used as fodder	-	-	6,83	12,69	9,78
2	Littering	75,5	3,86	9,76	29,86	19,88
3	Dumped into the sea/ river/ drainage	10,2	4,63	10,31	17,95	14,16
4	Burned	52,1	23,28	52,24	87,36	69,92
5	Buried in oil	4,2	5,23	14,11	30,36	22,29
6	Sold to junk collectors	23,4	13,34	25,62	26,57	26,1
7	Transported to Transfer Station landfill	24,5	84,74	51,9	4,38	27,98
8	Composted / fertilizer	1,1	2,94	3,8	7,29	5,56
9	Recycled	-	1,67	2,11	1,42	1,76
10	Others	9	0,86	-	-	-

The mandates of Law no. 18/2008 about managing waste as early as possible at the source and they consider that waste with economic potential can be accommodated through the implementation of Material Recovery facility (MRF). Nomenclature of MRF in Indonesia is implicitly known as 3Rs-Transfer Point (known as TPS-3R and TPST) and explicitly in GR no. 81/2012. TPS-3R organized for sub-district scale on a community-base while TPST is organized for the city scale-based institution (*MPWH*, 2014a). In order to accelerate the multiplication of such activities, the MPWH has launched 3R activities in more than 200 locations in 150 cities since 2006, by adopting cost sharing mechanisms with the local community, NGO, and municipalities. Components of the project are a composting hall, a plastic crusher, a rotary screen, three cart motorcycles, and other ancillary items. Some difficulties arise especially in the formation of a local institution to run the project, and the limited capability of the local community to pay the collection fee, among others. The same activities are conducted by the MEF with their 3R activities which are particularly to reduce waste at disposal sites.

The evaluation of 146 profile data TPS-3R in Java, Sumatra and Kalimantan showed a low level of functioning TPS 3R, only 12% of TPS 3R functioning and 32% TPS-3R are less functioning, while 41% dominated by TPS-3R are not functioning. TPS 3R are also not in accordance with the function, as it is only as a TPS without any waste reduction efforts, amounting to 15% (*MPWH, 2014b*).

Another method of treating MSW in some cities in Indonesia is incineration. There are several small-scale incinerators in operation in different cities, each with a capacity of about 100 – 200 kg/hour operating 8 hours per day. Therefore, the system is only able to handle a small percentage of the total MSW generated. Composting of organic waste has also been introduced as part of waste treatment. They are mainly located in final disposal sites. In principle, the composting system comprises a centralized sorting and shredding system, and thereafter composting of the organic matter is by a simple composting method.

To accelerate the process of better waste management in the cities, the central government decided a policy to accelerate the handling of waste through the use of thermal waste processing technology (waste-to-energy) through Presidential Decree No. 18/2016. This Decree appointed 7 (seven) cities

(Jakarta, Surabaya, Bandung, Semarang, Makassar, Tangerang, and Solo) to be selected in development of WtE technology in 2018 in Indonesia.

Landfill improvement (including rehabilitation of open dumping sites) as well as controlled landfill or sanitary landfill is carried out in 190 cities (2006-2012). Some of them have been promoted for CDM project. In line with 3R programme, landfill improvementshave been promoted to fulfil the requirement of regulation and to protect greenhouse gas emissions. Landfill infrastructure has been constructed for 190 cities (from the target 250 cities until 2014). For main infrastructure construction (liner,leachate treatment, gas utilization), heavy equipment is supported by national budget with requirements of readiness criteria (ie. capability of institutional development including operator and human resources, operation and maintenance budget, 3R development). For complete landfill facilities, local budget is needed, either for operation and maintenance budget. Post construction will be carried out by local governments. During the operation period, local governments face financial problems and improper operation of landfill sites *(Republic of Indonesia, 2013).*

2. Hazardous waste

Recycling approach has been the first priority for HW management. Until 2007, the number of permits for HW treatment and recycling facilities published by the MEF reached 491 permits *(Sani, 2007)*. Meanwhile, there were 225 additional permits published by the MEF for HW utilization including waste oils, fly and bottom ash, ashes from metallurgical processes, chemical waste, sludge paper, etc. *(Rachmatunisa, 2014)*. Besides, the MEF has attempted to carry out remediation to revive environmental quality after HW pollution occurred over total areas of 11,97 ha and 9,200.93 tonnes (*Sani, 2007*).

According to GR no. 101/2014, HW utilization is an activity to reuse, recycle, and/or restore HW in order to convert HW into substitute product for raw material, supporting material, and/or fuel which are safe for human health and living environment (Government Regulation No. 101/2014). There are two parts to HW utilization activity, namely utilization by the generator itself (by special permit), and utilization by third parties or authorized institution. Data in 2010 shows that 29 industries utilized their HW, and 53 industries treated HW in their area (Table B-2). Data in 2010 shows that there were 9 authorized centralized treatment facilities by third parties in Indonesia (Table B-3), and one centralized HW landfilling facility.

So far, most of the existing MSW management systems in Indonesian municipalities rely on the existence of landfills. The excess has been handled by the community through various ways, such as burning, burying, composting, and other ways such as recycling or disposing at improper sites, including ducts or drainage channels. Based on a questionnaire survey conducted by JICA and ITB in 2007 in 154 cities in Indonesia (*MEF, 2008*), the mode of handling of MSW in Indonesia in 2006 is landfilling (68.86%), composting (7.19%), small scale incineration (6.59%), open burning (4.79%), rivers (2.99%), and others (9.58%).

Table B-2 Waste utilization and treatment by generator in 2010 *(MEF, 2010)*

No	Province	Utilization	Treatment
1	NAD (Aceh)	-	1
2	Jakarta	-	9
3	Banten	3	8
4	West Java	9	10
5	Central Java	1	1
6	East Java	5	6
7	South Kalimantan	1	4
8	East Kalimantan	2	10
9	North Sumatera	1	1
10	South Sumatera	1	2
11	Lampung	-	1
12	Papua	2	-
13	Riau	1	-
14	Riau Island	1	-
15	NTB	1	-
16	South Sulawesi	1	-
Total		29	53

Table B-3 Centralized handling facilities by third party in 2010 *(MEF, 2010)*

No	Region	Treatment	Landfill
1	DKI Jakarta	3	
2	West Java	2	1
3	Banten	3	
4	Riau	1	
Total		9	

In order to enhance waste pollution control caused by HW, the MEF created the PROPER program, a scenario for industries to take care of their own waste complete with a treatment facility and systems in order to minimize pollution to the environment. This act has increased the number of recycling and treatment facilities in every region as seen in Figure B-6 and Figure B-7. In 2009 the MEF issued permits more than 600 treatment facilities for operation *(Aslia Kamil and Tumindi, 2011).*

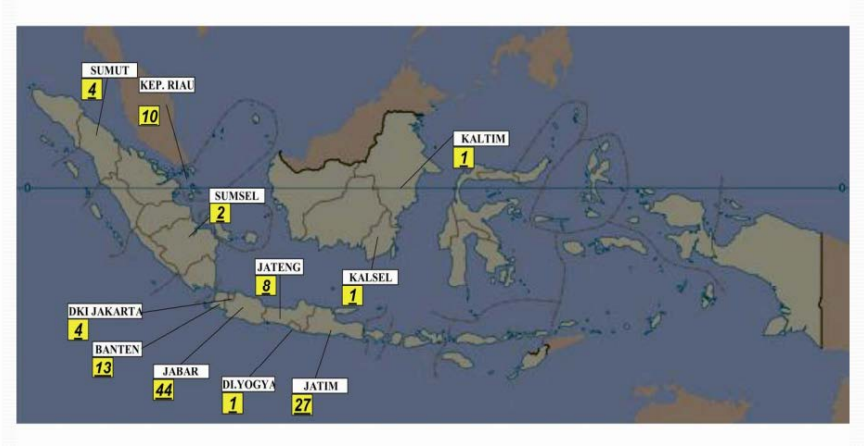


Figure B-6 Mapping of current practices of HW recycling facilities in Indonesia, 2009 – 2011 (Aslia Kamil and Tumindi, 2011)

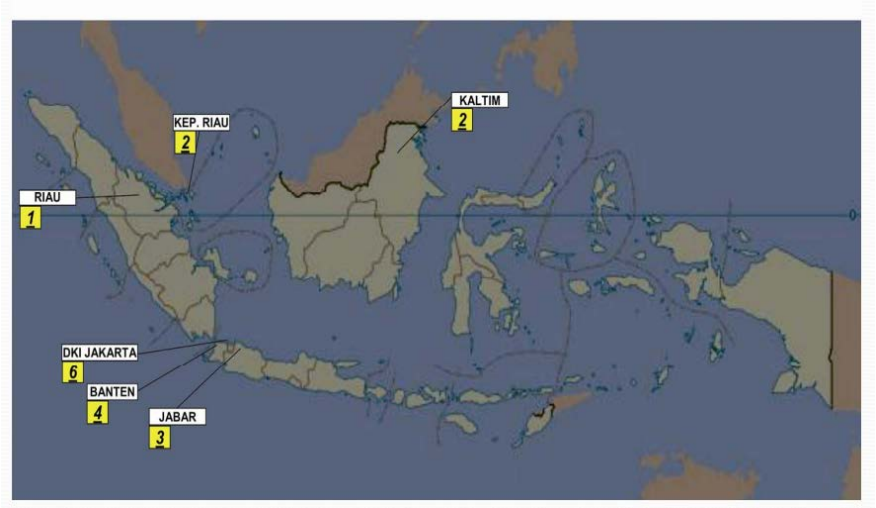


Figure B-7 Mapping of current practices of HW treatment facilities in Indonesia, 2009 – 2011 (Aslia Kamil and Tumindi, 2011)

Table B-4 presents HW utilization as energy substitute, while Table B-5 presents those as material substitute.

Table B-4 HW utilization as energy subsitute (*MEF, 2010*)

No.	Type of waste	Amount (tonne)		
		2005	2006	2007
1	Oil Slop	2,644.10	3,283.65	13,866.80
2	Oil Sludge	1,983.07	2,462.74	10,450.10
3	Dirty Oil	1,322.05	1,641.82	6,933.40
4	Used Oil	661.02	820.91	3,466.70
Total		6,610.24	8,209.12	34,717.00
Persentage of increase		-	19.48	76.35

In 2012, HW generation increased to 65,970,612.24 tonnes due to economic growth in services & manufacturing, agro industry, mining, and the oil and gas sector. Most major companies in Indonesia are required to participate in this program and each will be given a score and an award. Due to the implementation of PROPER, over the three years after 2011 (2012 – 2014), 50,000,000 tonnes HW have been treated.

Meanwhile, there has been a great effort to monitor HW handling in contaminated land that is written in Regulation of Ministry of Environment of Indonesia no. 33/2009 about HW Contaminated Land Recovery Guideline. Efforts to supervise this activity have risen significantly from 2010 until 2013. It is recorded that 278,631.41 tonnes of HW was recovered by June 2013, and 21,046.13 tonnes HW is currently being treated.

Table B-5 HW utilization as raw material substitute (*MEF, 2010*)

No.	Type of waste	Amount (Tonne)		
		Year 2005	**Year 2006**	**Year 2007**
1	Copper slag	511,303.00	525,820.00	530,000.00
2	Fly ash & bottom ash (abu batubara)	550,000.00	750,000.00	1,009,183.00
3	Tin/solder	313.00	1,620.00	1,750.00
4	EAF ash	6,634.00	10,786.00	11,000.00
5	Ash valley	28,524.00	34,569.00	35,000.00
6	FeCl, CuCl2, and used solvent	1,500.00	8,500.00	14,680.00
7	Waste of PTA		56.46	1,802.00
8	Zinc dross, zinc ash, zinc blowing	165.00	287.69	12,814.00
9	Steel slag/Iron Slag		41,439.07	234,663.00
10	Nickle slag			2,700,000.00
11	Sludge from wastewater plant	50,000.00	60,000.00	79,718.00
12	Accu scrap, Pb scrap, Pb Sludge, used dry batteries	1,276.00	2,500.00	9,455.00
13	Used carbon electrode, used refractory material			3,000.00
14	Used catalist (Fe-base dan RRC-15)	125.00	256.00	1,000.00
15	Acid mist (H2SO4, 27%)			50.00
16	Drilling cutting			105.28
17	Dregs/grits		25,000.00	60,000.00
18	Tailling			56,250.00
19	Waste garnet			750.00
20	Iron sludge			
	- Domestic market		34,628.00	63,260.00
	- Export		109,384.00	506,788.00
Total		**1,149,840.00**	**1,604,846.22**	**5,331,268.28**

Waste recycling industry, especially for HW could be classified into *(Damanhuri et al., 2012)*:

- Recycle industry PMA (Foreign Capital Investment), large scale industry;
- Recycle industry non-PMA, middle scale industry;
- Recycle industry non-PMA from home industry group.

Based on observation, in can be concluded that:

- The industry-PMA and large scale industries give serious attention to the environment-related regulations. Their products are mostly intended to be export oriented so that the environmental regulatory compliances become one of their important consideration.
- In the case of middle scale industries, they are relatively aware to the environmental issues. To minimize the gap between large-scale and medium-scale recycling industries, a concept of partnership was developed, called a platform approach. With this approach, most of the middle scale industries are motivated to implement environmental regulations.
- While the small scale and home industries are the industrial sector which can be said to be untouched by the environmental regulations. Capital constraints and low understanding of environmental issues are the main reasons.

The platform approach in industrial HW recycling has been developed by the cement industry such as the company, Inducement, which is based on the *World Business Council for Sustainable Development*. There are four elements that contribute to the sustainable development of the cement industry, among others *(Damanhuri et al., 2012)*:

- Managing resources: to increase production process efficiency, assist to find new alternatives in order to utilize waste and other by-products;
- Protecting ecosystem: to reduce the eco-footprint of each operational and preventive activity;
- Reducing pollution: to minimize pollutant concentration in air, soil, or water produced in each activity;
- Promoting quality of life: to produce high quality products for every construction project considering health and safety protection, and provide job opportunities to workers in order to improve social and economic aspects.

Ministry of Environment mandates that HW which has a heat value of more than 2,500 Kcal with silica compound of more than 75% could be utilized as fuel and as a material alternative in the cement industry. When the heat value is less than 2,500 Kcal, pre-treatment should be conducted.

III. Future Market Needs in Waste Recycling

There has been a long practice of trading used goods in urban areas of Indonesia, with junk markets dating from 1945 until recently. The types of junk that could be traded among junkmen, junk stores and junk markets are as follows: home appliances such as irons, blenders, cake mixers, hair dryers, electric fans, TVs, radios and tape recorders, used clothes, shoes and bags, used books, used cassettes, as well as wood materials from building demolition and furniture (*Damanhuri, 2010*).

These used goods are usually placed at special locations, in the form of stores, street trading sites, and junk markets (street electronic-junk market, junk-clothes market, used books and electronic junk), lumbers trading businesses, or used goods stores. These stores accept various useable objects under a revenue-sharing scheme. Unlike junk markets, these stores are actually formal businesses, due to the fact that they display their wares in the same way as ordinary business stores.

In addition to used goods, such as electronic/electric appliances, lead batteries and other objects that are assumed as non-waste among Indonesia people, waste-category goods, i.e any item that has been disposed by its owner and is commonly found in public waste bins but still has the potential to serve as an object for trade in Indonesia are generally as follows: hard plastic packaging (containers and cups/glasses), transparent plastic sheets, papers (blanks, magazines, books, newspapers, writing books, cartoons), metals (nails, irons, coppers), glass packaging. These objects serve as economically valuable business objects among recycling entities from the residential level, junkmen, scavengers, intermediates (*lapak*), dealers (*bandar*) to the industrial level (recyclers). The pathways of potentially recyclable waste and used goods vary depending on their respective market circumstances and the availability of recyclers as end processors.

Several aspects which influence the HW utilization/recycle are regulations, technology, human resources, investment, and culture as shown in Table B-6.

The path flow mechanism of recyclable waste and used goods between the seller and the buyer is actually pure market mechanism. These goods move from one hand to another due to the very existence of market demands. The sellers supply these goods because their buyers are there. In case of no market demand, then the actual occurrence is that these goods move from one hand to another due to gifts to anyone who needs them (donation). If these needs did not exist, even for free-of-charge goods, then these goods would end up as waste entering the environment, because their owner thought that these goods are of no use anymore and should be disposed.

Table B-6 Constraints in development of waste recycling industry (*Multihana, 2011*)

Regulations	Technology	Human resources	Investment	Culture
Limited understanding about HW regulations.	Technology used for waste utilization is still conventional.	Limited human resources with an understanding of waste material.	Quite high investment required for waste utilization.	Limited understanding of "*polluter pays*" principle.
Second level regulations have not met the actual problem.	Operational cost for waste processing is quite high.			Gap perception regarding HW management in society and industrial actor

Processing the use of waste and used goods are mostly performed by the informal sectors in developing countries like Indonesia, so consideration should be taken of the following standards and guidance of market demands, workers safety and environmental standard compliances.

C: 3R INDICATORS BASED ON 9 CORE INDICATORS

I. Total MSW Generated and Disposed and MSW Generation Per Capita

The availability of data associated with MSW handling in Indonesia is currently limited in nature. Municipalities and districts have no adequate data except general data such as number of trucks, number of personnel and the like. There is no systematic data collection on the volume of waste unable to be transported, due to the current practices of measurement based on truck travel frequencies to final disposals. Any waste being handled by the community through self-effort or unsystematically disposed of at improper sites is not systematically calculated.

Although each City/District Cleanliness Division should be responsible for data recording of solid waste measurements in their respective areas, these data are rarely found. Measurement is usually conducted to support certain study activities. Some data are included in Municipal/City Annual Statistics. Related data are submitted to the MPWH or to the MEF as part of annual MSW management performance questionnaire, or for yearly Environment Statistics Report.

For the purpose of predicting greenhouse gases emissions from the waste sector, the National Development Planning of Indonesia (*Bappenas, 2010*) assumed that in 2005 the MSW generation in urban areas was 0.6 kg/capita/day, and that in rural areas, it was 0.3 kg/capita/day. Along with economic growth, in 2030 it was predicted to rise to 1.2 kg/capita/day for urban areas and 0.55 kg/capita/day in rural areas. Figure C-1 presents the projection of MSW generation between 2005 and 2030.

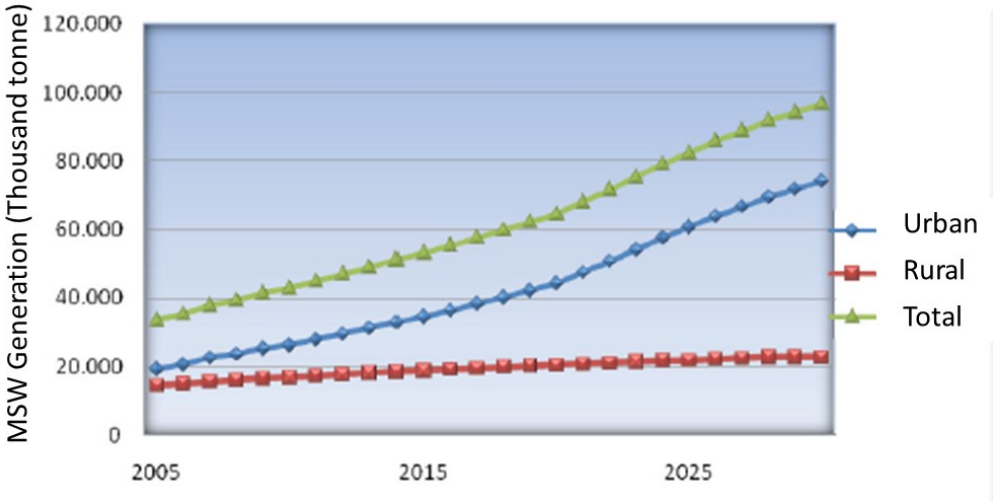


Figure C-1 MSW predictions in 2005-2030 *(Bappenas, 2010)*

For the purpose of setting up a policy and strategy for MSW management in Indonesia, the MEF assumed that the average generation rate of MSW was 0.7 kg/capita/day (constant), and the population increased at a rate of 1.4% annually, as presented in Figure C-2.

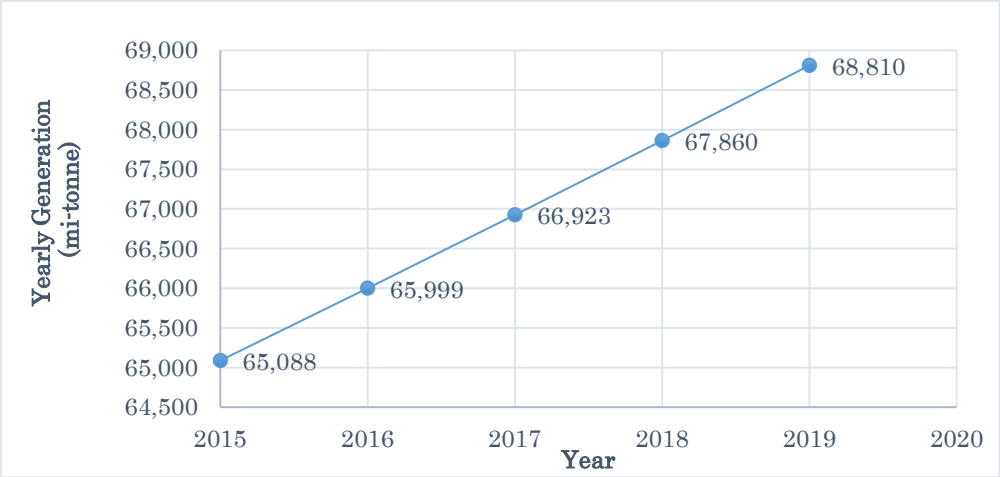


Figure C-2 MSW projection 2015-2019 (*MEF, 2016*)

Some cities provide their generation data by conducting surveys and sampling but many other cities usually estimate their waste volume by using the estimated generation rate as 2.5-3.0 l/capita/day based on standard national of MSW generation (SNI S 04-1993-03) established in 1993. Therefore, the accuracy of solid waste generation figures is questionable. Table C-1 and Table C-2 show the MSW generation from all provinces in Indonesia based on those approaches.

II. Overall Recycling Rate and Target (%) and Recycling Rate of Individual Components of MSW

The Waste Management Law no. 18/2008 emphasizes the 3Rs approach as one that can work effectively with community participation. This law also aims to promote MSW as a resource. In this respect Indonesia already has a relatively well-established private sector recycling industry. Up to 20% of plastics, metals, glass, paper, tyres, and other materials are recovered and recycled by private sector individuals, and small and medium-sized enterprises (SMEs). The income generated from this is potentially very significant. A recent UNDP waste management livelihoods project formed 220 SMEs which generated over USD 6 million in revenue within the first two years of operation (*Landon, 2013*).

3R (municipal solid waste) development in Indonesia has been promoted since 2006 with a focus on composting and recycling activities in the community.
The aim was to recycle 20% of waste, by promoting and encouraging local governments and people through campaign education and pilot projects of 3R facilities for 356 locations or cities (*RI, 2013*).

The government has promoted waste composting through community composting programs and through a district level composting program. The government is also promoting recycling through the construction of Waste Banks (see explanation B.1). The total amount of non-organic waste processed in the Waste Banks reached approximately 2,262 tonnes per month in 2012.

Table C-1 Prediction of MSW generation in capital cities, 2011 – 2012 (*MEF, 2012b*)

No	Province (Capital city)	2011			2012		
		Estimate of daily waste generation (m^3)	Daily waste collected (m^3)	Estimate % of waste collected	Estimate of daily waste generation (m^3)	Daily waste collected (m^3)	Estimate % of waste collected
1	Banda Aceh	670	509	76	680	530	78
2	Medan	6000	5100	85	7136	6122	86
3	Padang	2111	1267	60	2179	1338	61
4	Pekan Baru	1326	531	40	2295	763	33
5	Jambi	1440	833	57	1465	900	58
6	Palembang	3333	2144	64	3438	2226	65
7	Bengkulu	370	137	37	488	179	37
8	Bandar Lampung	2555	2555	100	3000	2875	96
9	Pangkal Pinang	449	364	81	509	446	88
10	Tanjung Pinang	622	310	50	598	374	63
11	DKI Jakarta	23324	20776	89	26487	25018	94
12	Bandung	1500	1100	73	1500	1035	69
13	Semarang	4679	3697	79	4757	3853	81
14	Yogyakarta	1100	834	76	903	722	80
15	Surabaya	9071	4171	46	9377	3898	42
16	Serang	1393	905	65	1463	951	65
17	Denpasar	2700	2264	84	3220	2703	84
18	Mataram	1221	898	74	1315	977	70
19	Kupang	882	161	18	-	-	-
20	Pontianak	1395	1105	79	1462	1217	83
21	Palangkaraya	562	361	64	693	424	61
22	Banjarmasin	1669	650	39	1682	721	42
23	Samarinda	2071	1143	55	-	-	-
24	Manado	2271	2044	90	2725	2452	90
25	Palu	853	360	42	868	543	63
26	Makassar	3924	3520	90	4057	3643	90
27	Kendari	1004	869	87	1090	967	89
28	Gorontalo	613	171	28	713	193	27
29	Mamuju	425	315	74	200	166	83
30	Ambon	790	652	83	1056	905	86
31	Ternate	427	327	77	486	336	69
32	Manokwari	119	88	74	225	92	41
33	Jayapura	2713	1238	46	1268	1014	80

Table C-2 MSW generated in main cities, 2005 (Mursito et al., 2013)

Cities	*Population (Inhabitant)*	*Waste Generation (M^3/day)*	Generation Rate (L/cap/day)
Surabaya	2,599,796	6,700.0	2.58
East Jakarta	2,385,121	5,442.0	2.28
Bandung	2,141,837	6,473.7	3.02
Medan	2,068,400	4,382.0	2.12
South Jakarta	1,708,269	5,223.0	3.06
Tangerang	1,700.000	4,225.0	2.49
West Jakarta	1,565,406	5,500.0	3.51
Palembang	1,500,872	4,698.0	3.13
Semarang	1,424,000	4,274.0	3.00
North Jakarta	1,176,307	4,180.0	3.55
Makassar	1,160,011	3,580.2	3.09
Central Jakarta	897,789	4,651.0	5.18
Bogor	820,707	1,996.0	2.43
Denpasar	585,150	2,320.0	3.96
Yogyakarta	512,464	1,571.0	3.07

The central government through the MPWH is also encouraging waste reduction at the city level. The waste handling policy through the MPWH is that 50% of the MSW will be transported directly to landfill, while the remaining 50% is processed at the MRF. The target was to reduce waste up to 20% (see explanation at section B1). However, the last evaluation in 2015 of the existing function of 146 of TPS-3R located in Java, Sumatra and Kalimantan showed that only 12% of them were functional, while 41% were fall into the category unused.

Table C-3 is the updated target of MSW management as draft Decree of President in MSW management policy. Table C-4 shows the target for waste handling technology for 2015-2019 (note: 2019 is the end of the current presidential period).

Table C-3 Target of MSW management 2015-2015 *(MEF, 2016)*

Indicator	**2015**	**2016**	**2017**	**2018**	**2019**	2020	2021	2022	2023	2024	2025
Generation mi-tonne	64.4	65.2	65.8	66.5	67.1	67.8	68.5	69.2	69.9	70.6	71.3
Reduction mi-tonne (%)	6.44 (10)	7.82 (12)	9.89 (15)	12 (18)	13.4 (20)	14 (22)	16.4 (24)	17.9 (26)	18.9 (27)	19.7 (28)	20.9 (30)
Handling (%)	70	71	72	73	75	75	74	73	72	71	70

Table C-4 Target of MSW handling (2015-2019) *(Sidik, 2015)*

Items	**2015**	**2016**	**2017**	**2018**	**2019**
Landfilling (mi-tonne)	46.3	46.1	46.7	48.5	50.5
Incineration (thou-tonne)	-	365	574	912	1,800

III. Amount of Hazardous Waste Generated and Disposed in Environmentally Sound Manner

Similar to the MSW, data requiring periodical updates such as wastes generation, wastes composition and characteristics, waste recycling and the like for non-MSW are lacking or incomplete. There are several types of information recorded by various institutions about HW generation in Indonesia. Mostly, this type comes from industrial waste. Table C-5 is old data for the purpose of determining the capacity of the first hazardous disposal facility in Indonesia.

Table C-5 HW generation in some areas of Indonesia (*Hilman, 1996*)

Location	Year of survey	Total amount (tonnes/year)
Lhokseumawe	1995	1,000
Batam Island	1992	2,000
Medan & surrounding area	1986	25,000
Palembang	1987	1,150
Jabotabek	1987	68,000
Cilegon	1989	7,741
Semarang	1990	58,900
Gerbangkertosusilo	1990	88,860
East Kalimantan	1995	46,256

Hundreds of industries that generate HW exist in Indonesia. They are mostly in the chemical industry, mining, food processing, textile, and others. These industries are spreading across the region.

The first centralized HW treatment plant in Indonesia began operating 1994. It was located in Cileungsi - Bogor (West of Java Province). More than 90% of waste entering this facility is dispose of into a double-liner landfill. This facility was meant initially to accept all waste categorized as hazardous from industries in the surrounding areas of Jakarta, Bogor, Tangerang and Bekasi. Since this facility is the only certified HW landfill in Indonesia, nearly all HW generated by medium and large-scale industries that is not recycled, is transported to this facility. It was presumed that from the planned operation area in 2001, there would be 67,000 tonnes of sludge deposits from industrial waste treatment processes per year, and 18,000 tonnes of liquid waste containing solvents, oil-spill or used oil per year.

In 2012, HW generation increased to 65,970,612 tonnes due to economic growth in service and manufacture, agro industry, mining, and oil and gas sector. Due to the implementation of PROPER program, for three years after 2011 (2012 – 2014), 50,000,000 tonnes of HW have been treated. Meanwhile, there was a great effort to monitor HW handling in contaminated land as written in Regulation of Ministry of Environment of Indonesia no. 33/2009 about HW Contaminated Land Recovery Guideline. The effort to supervise this activity has risen significantly from 2010 until 2013. It is recorded that 278,631 tonnes of HW have been recovered by June 2013 and 21,046 tonnes HW has been treated up to now.

The rise in material consumption also leads to increased HW generation. Based on the Department of Communication and Informatics of East Java (2013), there has been a rise in HW generation up

to 7,000 tonnes/month. This phenomenon encourages the government to build other waste treatment facilities so they can handle the issues and prevent environmental damage (*Kominfo, 2015*).

IV. Indicators Based on Macro-level Material Flows (Secondary Indicator)

Combining the data on material consumption and GDP allows indicators of resources or material productivity to be derived. Material consumption is used to measure material productivity. These efficiency indicators show how much economic value is being generated per unit of material consumption (*Giljum, 2010*).

Over the past 10 years, average annual GDP growth has been more than 5.8%, helping to reduce poverty levels. Economic growth has reduced poverty, with the World Bank estimating that the national poverty rate fell from 23.4% to 12.5% between 1999 and 2011. With a population of almost 250 million, Indonesia now boasts the world's third-fastest growing consumer market and a rapidly-growing middle class. However, Indonesia faces many domestic economic challenges, such as poor infrastructure, declining foreign investment, a weak manufacturing sector and a heavy dependence on commodity exports, expensive fuel subsidies (*Gleason, 2014*). Consumer spending has increased by double digits annually during most of the same period. With a burgeoning middle class, investors are increasingly drawn to the country's domestic consumer market. Challenges in the consumer industry include rising wages, higher energy prices, electricity rate increases, the shifting value of the rupiah, dependence on imported raw materials and weakness in human resources.

The economic growth forecast for Indonesia remained at 6.1% in 2012. Growth is still being driven to a large degree by domestic consumer demand and spending from a growing middle class of over 100 million people with increasing levels of disposable income and a relaxed savings mindset. Indonesia's GDP rose to 6.4% in 2012 and was projected to be maintained at 6.3% in 2013.

Figure C-3, Figure C-4 and Figure C-5 below are indicators for resource use and productivity published by UNEP:

- The use of materials in the Asia-Pacific region increased from 5.7 to 37.0 billion tonnes in the 40 years from 1970 to 2010. Economic and population growth has driven the rapid expansion of material extraction in China, India, and Indonesia since 1980 (*UNEP , 2015a*).
- Indonesia's GDP (Figure C-3) has grown considerably faster than the other four overview indicators, with possible exception of GHGs (*UNEP, 2015*b).
- The increase in domestic extraction (DE) indicates that local extraction of materials has escalated to meet requirements of the growing economy.
- Growth in DE is slightly slower than the growth in DMC, indicating a growing dependence on imported primary resources (*UNEP, 2015*b).
- The patterns in the changing shares between materials are consistent: nations undergoing socio-metabolic transitions from advanced agrarian to industrialized society. A move away from biomass resources towards minerals is a common feature of a developing nation changing from biomass-based materials and energy systems of an advanced agrarian society to the mineral-based systems of industrial society *(UNEP, 2015b)*.
- Gross Domestic Product (GDP) in Indonesia was worth USD 868.35 billion in 2013. The GDP

value of Indonesia represents 1.40% of the world economy. GDP in Indonesia averaged USD 196.61 billion from 1967 until 2013, reaching an all-time high of USD 878.04 billion in 2012 and a record low of USD 5.98 billion in 1967. GDP in Indonesia is reported by the World Bank Group (Ref.28).

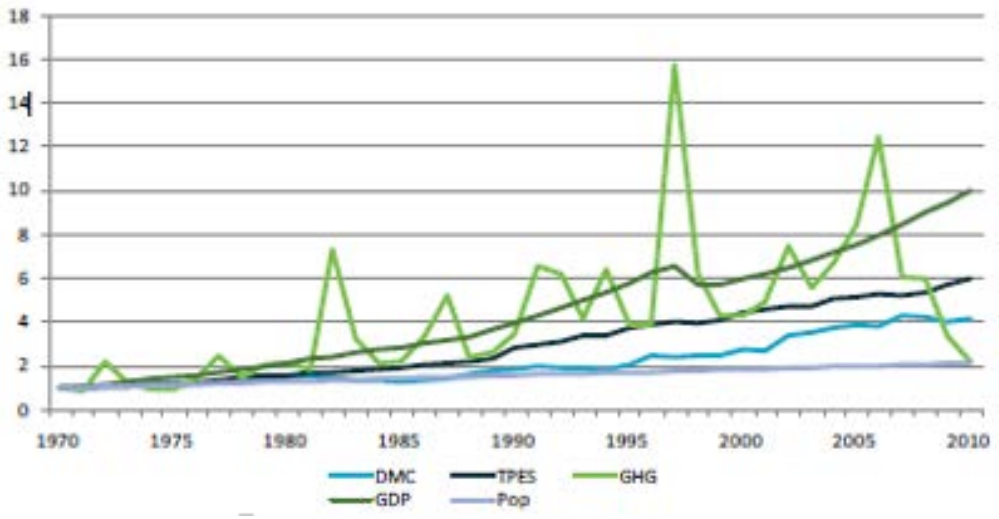


Figure C-3 Five indexed overview indicators (1970=1) (UNEP, 2015b)

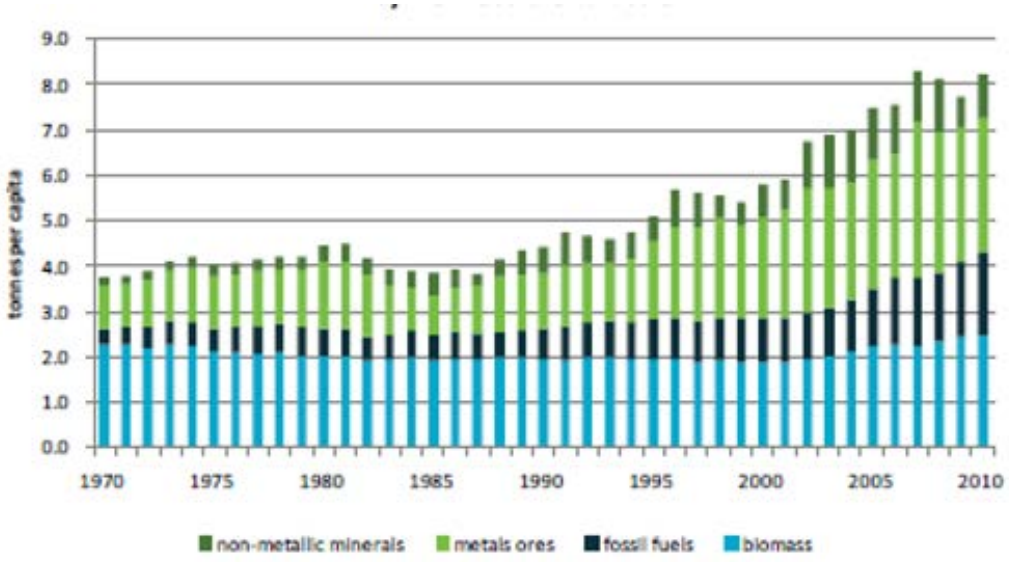


Figure C-4 Domestic extraction (UNEP, 2015b)

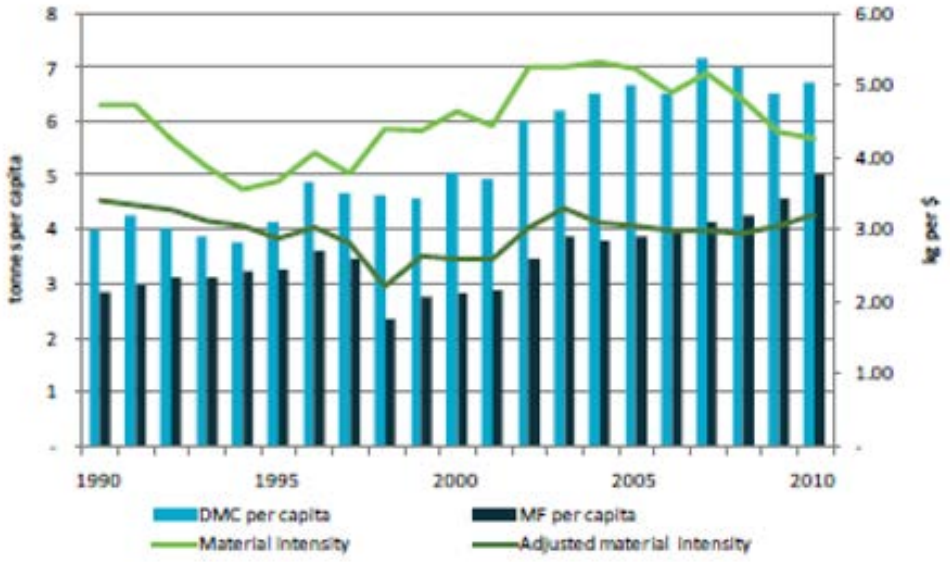


Figure C-5 Material consumption per capita and intensities (UNEP, 2015b)

V. Amount of Agricultural Biomass to be Used

In general, there are two important sources of biomass residues in Indonesia, from agricultural (crops) activity and from forests. The principal agriculture residues from crops are as follows: palm oil (empty fruit bunches and palm shells), coconut (shell and fibre), rubber (small log from replanting), sugar (bagasse), rice (husk) and corn (corn cob). Forest waste that can be used as a source of bioenergy is waste generated from logging and saw timber. Indonesia contains the world's second largest expanse of tropical forest, and much of this forest is used for timber. Deforestation is of great concern to Indonesia's environment. Currently, Indonesia's agriculture sector is a significant producers of rice, palm oil, coffee, rubber, and spices. Half of the population is considered rural, yet agriculture only comprises 14% of GDP. The technical energy potential of solid biomass in Indonesia in 2010 from agriculture residues is around 614.6 mill GJ/year and from forest waste, around 141.483 mill GJ/year. This is a total of around 756.083 mill GJ per-year *(Prastowo, 2011)*.

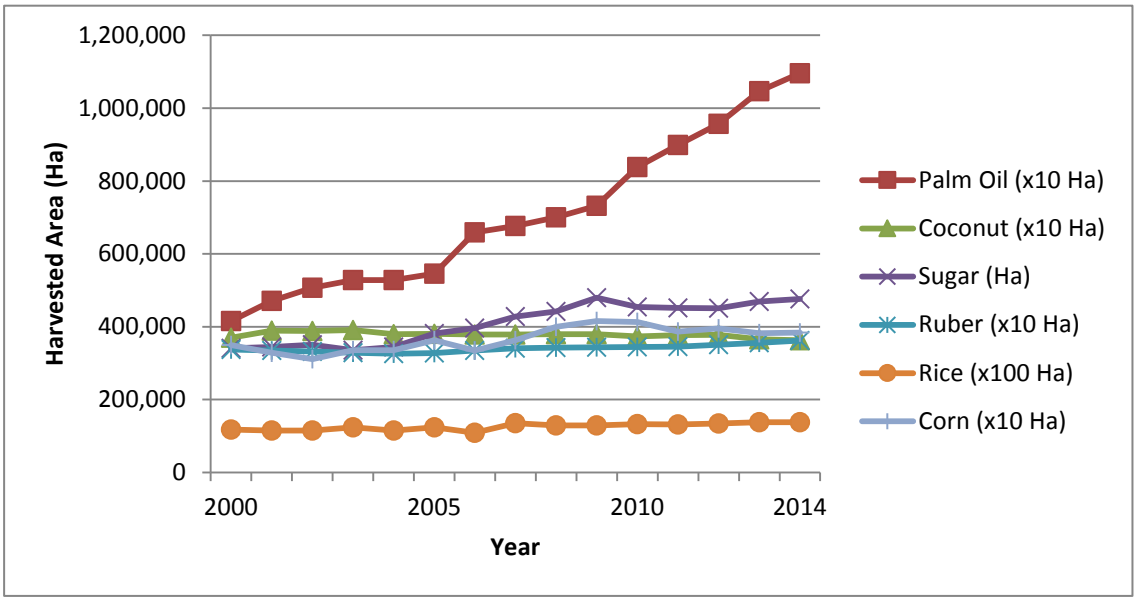
Residues from agriculture are important biomass from an economic perspective because it is used in both traditional and modern applications. More than 40% of the population of approximately 225 million engage in this sector. They depend on fossil fuel and wood to run their daily activities including agriculture. When discussing the potential of solid biomass energy, consideration must be given to food security and sustainability of agriculture (and forestry in general). Biomass resources from the rural sector as a potential solid biomass energy are coming from the residues of certain agriculture crops and the forest (*Prastowo, 2011*).

The solid biomass energy potential is theoretically increasing along with the increasing of production of energy crops in the last ten year, unfortunately its utilization is still very limited, that is around 3.25% (*Prastowo, 2012*).

There are other potensial crops actually, where their main yield can produce liquid biofuel (non solid biomass energy) such as physic nut or jatropha curcas, nyamplung (*Calophyllum Inophyllum*), candle nut, and also sugar palm, corn, cassava, sago and sorgum. These crops are grown over a scattered, not so large planted area. Data in Figure and Figure show that some harvested areas of energy crops are increasing significantly, apart from rubber, sugar and coconut.

Indonesia has abundant biomass potential from various sources of biomass. Biomass potential energy is generated from the biomass waste of the plantation sector, agricultural waste, wood, and organic components of the industrial and household sectors. Within the last few years, the Indonesian government has worked hard to utilize renewable energy resources spread widely across Indonesia. The feed-in tariff (FIT) for electricity as a policy for renewable energy has been applied, followed by other supporting policy. According to the Ministry of EMR (Energy and Mineral Resources) Regulation No. 4 issued in 2012 related to FIT for biomass/biogas electricity, which is under revision, the Indonesian government gives incentives to the private sector to develop and invest in renewable energy projects specifically related to biomass/biogas *(BKPM, 2015)*.

In 2012, the biomass waste potential energy map consists of three potential commodities specifically rice, corn and cassava. The total potential biomass owned by Indonesia is approximately 49.81 GW but only 445 MW has been utilized and connected to National Electricy Entreprise network (on grid), or installed potential ratio= 0.89%. The government has been urged to find alternative energy sources and to improve the value added of the raw material in order to develop downstream industries in Indonesia. These actions are to support the implementation of a National Energy Policy (Law no. 4/ 2009). The government expects renewable energy contributions of approximately 17% in the national primary energy mix by 2025 *(BKPM, 2015)*.

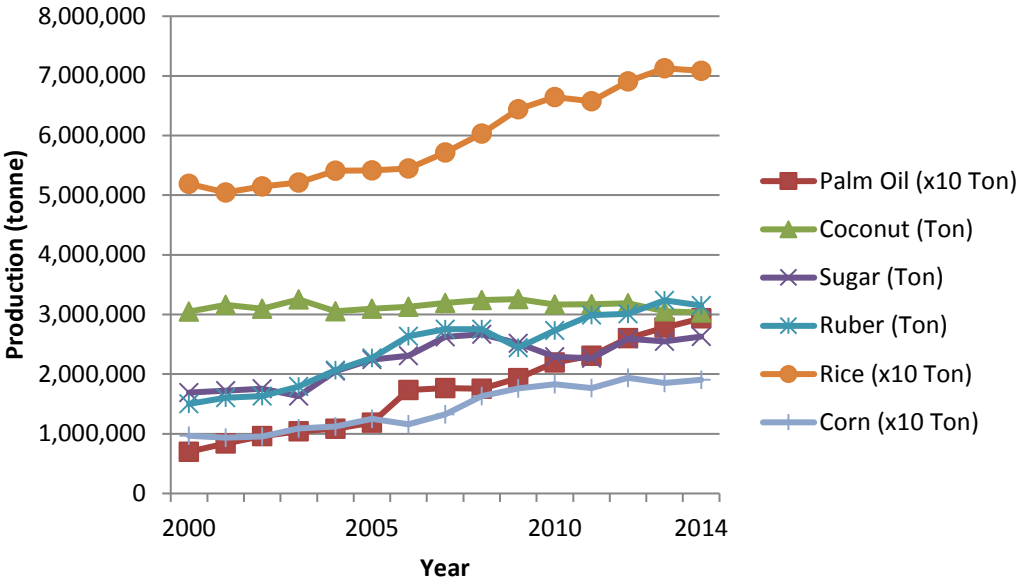


Source of data: Prastowo (2012) and MA (2014)

Figure C-6 Harvested area (Ha) of energy crops in Indonesia 2000 – 2014 *Source of data: Prastowo (2012) and MA (2014)*

VI. Marine and Coastal Plastic Waste (Primary)

The research shows that out of the 285Mt of plastic produced in 2014, 4.76 Mt entered the marine environment as beach litter, depositions on the seafloor and microplastics in the gyres. The main flows towards the gyres were identified as 0.4 Mt/year extra-gyral input of beach litter as well as 0.3 Mt/year inflow from anthropogenic pre-and postconsumer plastic stocks in the case of a tsunami. The flow of litter towards the beach stemmed mainly from uncollected plastics, amounting to 0.56 Mt/year, and dumpsite leaking, equaling 4.19 Mt/year as of 2014 *(Kellen, 2014).*



Source of data: Prastowo (2012) and MA (2014)

Figure C-7 Production (tonne) of energy crops in Indonesia 2000 – 2014

Plastic debris in the marine environment is widely documented, but the quantity of plastic entering the ocean from waste generated on land is unknown. By linking worldwide data on solid waste, population density, and economic status, an estimate was made of the mass of land-based plastic waste entering the ocean. It was calculated that 275 million metric-tonnes (MT) of plastic waste was generated in 192 coastal countries in 2010, with 4.8 to 12.7 million MT entering the ocean. Population size and the quality of waste management systems largely determine which countries contribute the greatest mass of uncaptured waste available to become plastic marine debris. Without waste management infrastructure improvements, the cumulative quantity of plastic waste available to enter the ocean from land is predicted to increase by an order of magnitude by 2025 (*Jambeck et al., 2015*).

Indonesia is predicted to be the second biggest source of plastic waste dumped into the sea worldwide every year (after China). Indonesia was predicted to generate around 0.48-1.29 million MT of plastic marine debris per year (*Jambeck et al., 2015*). The figures were calculated by analyzing waste sources and the amount of garbage churned out by people living within 50 kilometers of the coast in 192 countries bordering the sea, and then factoring in population density

and economic status. For Indonesia's case, the calculation was based on the following data:

- Coastal population = 187.2 million;
- Waste generation = 0.52 kg/capita;
- Contribution of plastic in waste = 11%;
- Mismanaged of plastic waste = 3.22 million MT.

Two studies on several islands off Jakarta Bay and islands further to the northwest in the Java Sea, reported that debris pollution on shorelines had substantially increased between 1985 and 1995. Both studies noted that results implicated Jakarta as a major source of the debris. On 23 of the islands, it was reported that the mean total litter at the strandline ranged from not detectable to 29.1 items/m. Plastic bags, polystyrene blocks and discarded footwear accounted for 80% *(Rahardyan, 2008)* of the items found.

VII. Amount of E-waste Generation, Disposal and Recycling

Under national regulations, until this time there has been no specific definition of e-waste. No applicable laws and regulations in Indonesia have specifically defined e-waste. E-waste regulations follow the HW Management (Law no.32/2009). However, the definition of e-waste in the draft regulation is all electronic and electrical equipment which are not functional and/or are not being used for their original purpose. E-waste is still part of HW in Indonesia. The regulation covers the same scope and there is on-going differentiation in terms of law and management *(MI, 2013)*. Besides generating from post-consumer, e-waste generally comes from existing local manufacturers and from imports from aboard. Recently however, there have been cases of smuggling used electrical appliances. It is very difficult to find the exact figures for imported electronic wastes. According to Wiryono (*in MI, 2013*), the problems of electronic waste on a national level are, but not limited to:

- The ever-increasing consumption of electronic goods as a response to technological and lifestyle developments;
- There is no public awareness in managing electronic waste for use at the household level (Home appliance);
- Minimum information on electronic waste (e-waste) management among the general public;
- Different understanding among institutions in relation to electronic waste and related management procedures, including at the local governmental level;
- Non-availability of accurate data on the amount of electronic appliances used in Indonesia;
- Non-availability of any other technical regulations such as the lifetime for any appliance to be recycled.

While the importation of electronic waste is prohibited, illegal activities are still occurring, for example, in industrial areas in East Java, Batam and Pare-Pare (*Agustina, 2010*). The illegal importation in East Java originated from the USA, while in Batam case, they originated from Singapore and Malaysia. In the importation documents, these imported second-hand electronic appliances were declared as metal scrap or office appliances. Some of these products were further reconditioned or re-exported to China, Taiwan and Hong Kong and for local markets. For the rest of them, any usable materials such as metal or plastic material was recycled and recovered, disposed

or burned. For example, in 2005, there were 50 containers each of 40-feet transporting PCB containing metal scraps that entered Indonesia under documents that declared them as new office appliances and metal scrap (*Agustina, 2010*).

Non-availability of accurate data on the amount of electronic appliances used in Indonesia is one of the difficulties in predicting e-waste generation in Indonesia. Table C-6 shows the prediction of e-waste generation per unit activity in some locations in Indonesia in 2005-2006. Table C-8 shows data in 2010 about recycling facilities in Batam Island, Table C-8 shows several regions which have activities on collection and dismantling of e-waste.

Annual surveys conducted by the MEF at more than 300 domestic landfill facilities owned by local governments throughout Indonesia have not shown e-waste to be found on those sites.

Only in limited final disposal for domestic wastes sites has a very limited amount of e-waste been found. These findings indicate that there is an unofficial system to absorb most e-waste in Indonesia. Further research is needed to learn how the system works, and whether it is conducted in an environmentally friendly way or not. Electronic service centres have a role to identify the route of the e-waste prior to its disposal or destruction. There also need to be clarification of reports from some manufacturing companies to the Ministry of Environment (MOE) on sending obsolete PCs, printers and other electronic equipment to secured landfill facility (MEF, 2010).

Table C-6 E-waste generation in West Java (*Rahmatunisa, 2014*)

No	Location	E-waste	Activity	Average e-waste produced
1	Cirebon	Motherboard/CPU/PCB/IC computer, HP, TV	Informal collection	1.2 tonnes/business/month
2	Bandung Municipality	Motherboard/CPU/PCB/IC computer, HP, TV, Radio	Collection Processes	1.25 tonnes/activity/month
3	Bandung City	Motherboard/CPU/PCB/IC computer, HP, TV, Radio	Informal Collection Processes	0.4 tonnes/activity/month
4	Depok	Motherboard/CPU/PCB/IC computer, HP, TV, Radio	Informal Collection Processes	0.25 tonnes/activity/month
5	Bekasi	Motherboard/CPU/PCB/IC computer, HP, TV, Radio	Informal Collection Processes	Formal: 150 tonnes/activity/month Informal: 0.3 tonnes/activity/month
6	Garut	Motherboard/CPU/PCB/IC computer, HP, TV, Radio	Informal Collection Processes	0.3 ton/business/month
7	Tasikmalaya	Motherboard/CPU/PCB/IC computer, HP, TV	Informal Collection Processes	0.6 tonnes/activity/month

Table C-7 Recycling facilities in Batam Island (*Haruki, 2010*)

No	Company	Activities	E-waste
1	PT[1] Wajar Logam	importer mix scrap metal, TV and monitor, dismantling CPU and printer; recondition monitor, produce scrap metal or aluminum, brass ingots, grinded casings, export	e-waste: CPU, printer, TVs, monitor
2	PT Sun Doly	Importer mix scrap metal, TV and monitor, dismantling CPU and printer; recondition monitor, produce scrap metal or aluminum, brass ingots, grinded casing, export	e-waste: CPU, printer, TVs, monitor
3	PT Kingson Metal Industry	Metal smelter using imported material in form scrap of vehicles	e-waste: not found
4	PT Metalindo Jaya Abadi	Recondition of CPU, fax machine, and printer from domestic originated for local market	e-waste: CPUs, computers , printer
5	PT Fremont Nusa Metal	Nonferrous smelter using local mix scrap metal, metal apparatus reconditioned	e-waste: not found
6	PT Hanjaya Perkasa Metal Indonesia	Nonferrous smelter using imported mix scrap metal, recondition metal apparatus, imported PCBs powder	e-waste: used PCBs, PCBs scrap, PCBs Powder

[1] *PT (Perusahaan Terbatas) equal to limited liability company*

Table C-8 Recycling of e-waste in several regions of Indonesia (*Rahmatunisa, 2013*)

Location	Number of industries	Kind of collection
Batam Island	1	Rejected small parts of electronic component, plastic, ewaste, used PCBs, Computer monitor, electronical and electronic parts (only dismantling, and the waste produced uses as raw material in smelter industries)
Central Java	2	Dry cell batteries collection and smelters
West Java	3	All e-waste material (only collection, the waste goes for export, smelter industries in Batam, and other smelter industries in Jakarta area)
Tangerang	1	All e-waste (only collection)
Central Java	1	Used Monitor (stop processing CRT for re-used since 2011)

VIII. Policies, Guidelines, and Regulations Based on the Principle of Extended Producer Responsibility (EPR)

Extended producer responsibility (EPR) is the principle approach to improve environmental standards and practices in waste management. It can be used to improve environmental conditions in waste management. In Indonesia, the Law no.18/2008 related to EPR concept is being implemented under GR no. 81/2012 on mandatory extended producer responsibility. This regulation aims to regulate post-consumer packaging. Some important points from this regulation are:

- The companies, individuals and communities are required to take responsibility for solid waste recovery through reuse, recycling and recovery. The regulation requires producers to take responsibility for solid waste, including after sale.
- The producers are obliged to put labels related to waste handling on their packaging, to establish

recycling channels for the materials they sell, and to use materials that can be re-used, re-cycled or easily decomposed. The law also insists that manufacturers be responsible for their own packaging. It will be the producers' responsibility to recover waste not the consumers'. The cost of implementation will go directly to companies that are obliged to make changes to reduce the environmental impact of their products. The producers must establish recycling channels, and use materials that can be re-used, re-cycled or easily decomposed.

- The producers are obliged to develop programs to reduce, recycle and reuse waste as part of their activities, producing goods which are easily decomposed or generate less waste, using raw material that are easily recycled and can be reused, and taking back their packaging to be recycled and reused. This obligation shall be done step-by-step on the basis of 10 year roadmap.

However, according to business sectors, EPR will put additional burdens on producers, with consumers facing rising costs. With companies responsible for consumers' waste under the law, collecting and managing waste from products distributed throughout Indonesia will become even more complicated. Products could also become less competitive due to the cost adjustment of EPR. This will be a disadvantage for companies as they will also be responsible for consumers' waste. They requested the government to consider revising the regulation that mandates companies to be responsible for recycling consumer products and packaging to make it more applicable in the Indonesian context. In order to implement EPR, access to large amounts of capital will be needed to upgrade capacity.

The EPR approach concerning e-waste management is currently being drafted. The scope of the draft regulation is the prohibition of the importation of electronic wastes, while non-new but still usable products would be scrutinized through checking procedures in the exporting countries and should have minimum 5-year production codes before the time of export. The electronic products that will be regulated are small-size electronic products such as laptop, cellular phones, printers and the like, and this will be voluntary in nature. The draft stipulates that each party has specific tasks and obligations according to their respective circumstances as follows:

1. The Producers:
    - Are responsible for monitoring the distribution of their products and have an obligation to handle resulting electronic waste.
    - Manage the resulting electronic waste
    - Are responsible for producing environmental-friendly products
2. Consumers and Distributors:
    - Segregate their resulting electronic wastes
    - Bring their electronic wastes to the stipulated collection sites
    - Should not sell their electronic wastes directly to illegal collectors
3. The Collectors:
    - Cooperate with the producers and local governments in providing electronic waste collection sites.
    - Assist in the implementation of incentive mechanisms for consumers who return their electronic waste
4. Reconditioning Industries
    - Do the reconditioning work under the responsible product criteria

- Responsible for managing the resulting waste and scraps

Similar to the EPR for packaging waste, the Union of Electronic Business Persons on the series of their FGDs that discussed the draft of the ministerial regulation on the series of their FGDs rejected this EPR programfor the reason that this program would put a burden on the production costs of electronic goods, and it will be a tight competition in the marketing of electronic products. Table C-9 summarizes the EPR implementation policy.

Table C-9 Status of EPR implementation policy

Status of implementation	Name of the regulation (year)	Product items covered by the policy
Postponement period before full implementation	GR 101/2014 (Under Law 18/2008)	Packaging of product in MSW
Under preparation of specific legislations	Goverment regulation (under Law 39/2009)	Small size electronic products
Based on voluntary approach/agreement	Voluntary and agreement	

IX. GHG Emissions from Waste Sector

In 2007, the Ministry of Environment issued *the National Action Plan on Climate Change* (RANPI) which describes climate change policies and programs in the short, medium and long term. The document was further refined by the *National Development Planning Agency* (BAPPENAS). During the G-20 meeting in September 2009 in Pittsburg, the President of the Republic of Indonesia stated the national target to combat climate change: reducing national greenhouse gas (GHG) emissions by 26% from the business-as-usual level by 2020 based on unilateral actions, and a further reduction of up to 41% with adequate international support.

In 2010 BAPPENAS developed a document called *Indonesia Climate Change Sectoral Roadmap* (ICCSR) which outlines the principles, approach and priorities to mainstream climate change adaptation and mitigation measures into development planning. Furthermore, in order to bring the GHG mitigation policy into a set of planning activities, the Government issued the Presidential Decree no. 61/2011 on *the National Action Plan on GHG Emission Reduction* (RAN-GRK). This document functions as a working plan document for line ministries in implementing direct and indirect activities for reducing GHG emissions. The RAN-GRK also serves as a guideline for provincial government in formulating the regional action plans for reducing GHG emissions (RAD-GRK). The RAN-GRK is regarded as the starting point for the development and implementation of *the Nationally Appropriate Mitigation Actions* (NAMAs).

In November 2011, BAPPENAS released Indonesia Adaptation Strategy which sets out the priorities aiming to reduce the vulnerability of its economy and community to adverse impacts of climate change that are already occurring.

Alongside RAN and RAD-GRK preparation, and to enable GHG emissions reduction calculation, the Government issued the Presidential Decree no. 71/2011 on *the Implementation of Green House*

Gas Emission Inventory. The objective of this decree is to ensure the availability of periodic GHG data regarding the level, status, and trends of emission. It also aims at providing information about the accomplishment of GHG mitigation effort at the national level.

The RAN-GRK implementation is expected to align with national development principles and priorities, mitigation potentials and feasibility, as well as financial support. The RAN-GRK provides the framework for central government, local governments, the private sector, and other key stakeholders in implementing actions related directly and indirectly to the GHG emissions reduction target. The RAN-GRK proposes mitigation actions in five priority sectors, namely (a) agriculture, (b) forestry and peatland, (c) energy and transport, (d) industry, and (e) waste management, as well as other supporting actions that are an integral part of national development planning which supports the principles of economic growth, poverty alleviation and sustainable development.

A report published in 2007 stated that Indonesia was among the top three greenhouse gas emitters in the world due to CO_2 released from deforestation and forest fires. A large amount of CO_2 is released from carbon-rich forest during the annual burning season, while emissions from the energy sector are relatively small, but growing, in comparison. Indonesia is in the initial stages of introducing emissions from degradation and deforestation policy that focus on reducing deforestration and forest degradation.

Based on the Climate Change Policy documents in Indonesia, the waste sector is one of the priority areas for GHG reduction. Although the share of its emissions is still much smaller compared to that of other sectors such as forestry and agriculture, the solid waste sector is a significant source of GHG emissions. These are estimated to have reached approximately 43 Mt in 2010 from solid waste disposal, and, according to related scenarios, a rise in GHG emissions is expected. Most of these emissions arise from waste that is processed by disposal in open dumping sites. In managed and unmanaged landfills, anaerobic degradation of organic material occurs, leading to substantial CH_4 emissions. Figure C- shows the scenario of GHG from waste generation in a business-as-usual scenario (2005-2030).

The estimation of net emissions for Indonesia in 2000 is 1,377,753 Gg-CO_{2e} consisting of *(Bappenas, 2010):*

- Land Use Change and Forestry = 649,254 (47%)
- Energy = 280,938 (20%),
- Peat Fire = 172,000 (13%),
- Waste = 157,328 (11%),
- Agriculture = 75,420 (6%),
- Industry = 42,938 (3%).

Most emissions are generated from Land Use Change, Forestry and Peat Fire (LUCF). If the LUCF is excluded, the contribution of four sectors is (a) energy = 50.5%, (b) waste = 28.3%, (c) agriculture = 13.6%, and (d) industry = 7.7%. The Indonesia GHG emission reduction plan is presented in Table C-10.

Table C-10 Indonesia GHG emission reduction plan (Ref. 30)

Sectors	Emission reduction plan (Gt CO_{2e})		Total	Action plan
	26%	41%		
LUCF	0.672	0.367	1.039	・ Land-forest fires control, ・ Water resources-system management, ・ Forest-land rehabilitation, industrial plantation forest, communal forest, ・ Illegal logging eradication, ・ Deforestation prevention, ・ Community empowerment.
Waste	0.048	0.030	0.078	・ 3R strategy of waste management, Integrated waste management in urban, ・ Integrated waste management in urban areas.
Agriculture	0.008	0.003	0.011	・ Intro of low emission rice variety, ・ Efficiency of water irrigation, ・ Organic fertilizer utilization.
Industry	0.001	0.004	0.005	・ Energy efficiency, ・ Renewable energy utilization, etc.
Energy-Transportation	0.038	0.018	0.056	・ Bio-fuel use, ・ High gasoline fuel standard machinery, ・ Improvement of transport demand management, ・ Quality of public road and transportation, ・ Demand side management, ・ Energy efficiency, ・ Development of renewable energy.
Total	0.767	0.422	1.189	

The waste sector contributes around 9-11% of Indonesia's total GHG emissions. Although the share of its emissions is still much smaller compared to that of other sectors such as forestry and agriculture, the waste sector is a significant and growing source of GHG emissions. Based on the Climate Change Policy documents in Indonesia, the waste sector is one of the priority areas for GHG emissions reduction.

Focusing on the municipal solid waste sector, the Indonesian Waste NAMA Project aims at unlocking the so-far largely unused GHG reduction potential in the solid waste sector. The project aims at strengthening national systems by helping overcome such barriers as:

- Lack of financial incentives; lack of political/co-benefit incentives;
- Lack of integration;
- Institutional weaknesses;
- Weak implementation of appropriate technology in waste management;
- Lack of capacity of human resources; and
- Poor availability of data and information.

An innovative approach of vertically integrating three levels of government (national, provincial and municipal) will be used in the project in order to align their respective roles and responsibilities. The project also breaks new ground by developing business models to increase the role of the private sector in waste management. In the long term, project outcomes should build the base for low-emission reform in the waste sector.

The scope of the project will include several groups of provisions to be implemented in six selected project sites, such as:

- Infrastructure investment at final disposal sites (technology for GHG mitigation, such as landfill gas capture and storage),
- 3Rs (Reduce, Reuse and Recycle) facilities,
- Waste to energy facilities; capacity building,
- Community development,
- Awareness raising and education; and
- Institutional strengthening.

The estimated GHG direct mitigation effect from activities planned in the proposed project is 1,722 $mtCO_{2e}$ in the period of 2016-2020. In addition, the proposed NAMA Support Project would trigger indirect mitigation effects, e.g.:

- Savings on fossil fuels that will be substituted by waste;
- Savings in raw materials substituted by secondary raw materials (recycled waste),
- Reduction of GHG emissions in agriculture through partial substitution of chemical fertilizers by compost
- Reductions on emissions from leachate by optimized treatment technology at new sanitary landfills,
- Creation of a better waste management capacity leading to reductions in GHG that originate from improper treatment practices, such as open burning,
- Promotion of controlled digesting and composting techniques to avoid unintended methane emissions; and awareness raising and more conscious consumer behavior for waste minimization.

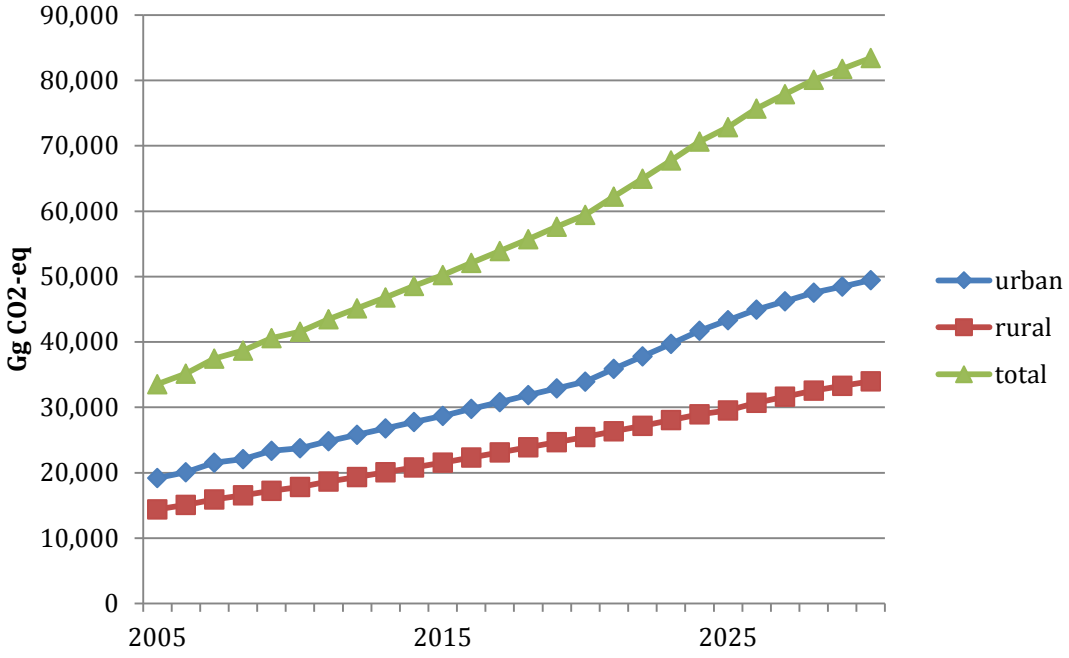


Figure C-8 GHG from waste generation in business-as-usual scenario (2005-2030) ***(Bappenas, 2010)***

Therefore, strategies for proper waste management (into which mitigation actions need to be integrated) should become a top development priority of local governments. Concerned about uncontrolled emission growth and the severe impact it can cause, central government issued guidance to the provincial governments to develop a set of mitigation strategies to reduce GHG emissions produced by the waste sector. Based on the RAN/RAD GRK, the mitigation options are divided in three categories as follows:

- Mitigation action plan 1: development of waste management planning. This could comprise of different activities such as: development of waste management master plan, feasibility study and detailed engineering design of final disposal sites, conducting environmental impact assessment of the final disposal sites, and planning for 3R integrated temporary disposal sites, etc.
- Mitigation action plan 2: waste minimization. The second category of mitigation action usually would evolve around the practices of construction of 3R integrated temporary disposal sites, socialization of 3R activities, waste segregation, waste banks, composting activities, climate village programme, etc.
- Mitigation action plan 3: improvement of waste management facility and gas recovery.

This category focuses more on rehabilitation of final disposal sites, the construction of controlled sanitary landfill, operation of semi aerobic final disposal sites, and recovery of methane gas at the landfill (waste to energy).

Since 2008 the new Waste Management Law no. 18/2008 has been in force, stipulating the principles of avoidance and treatment of waste. Within five years after commencement of the Act, open dumping sites should be substituted with sanitary landfills. The 3R approach (reduce, reuse, recycle) as well as the cooperation between public and private sector, incentive mechanisms for sustainable waste disposal and sanctions are regulated by this law. Furthermore, the law describes the normative and operational responsibilities of different levels of government – national, provincial and local (district, municipality). However, important stages like collection, transportation, storage, treatment and monitoring are not regulated by the law.

The amount of waste reaching the landfills should be reduced by 30% by applying 3R strategies (see C2) through separation of household, commercial and industrial waste, recycling of plastic (mid-term goal 50%, long-term goal 75%), and composting (mid-term goal 20%, long-term 30%). However, reaching these targets is taking longer than planned under the timeline of the strategy, and consequently, the waste reduction potential remains quite high.

With regard to the GHG reduction, the concept of Nationally Appropriate Mitigation Actions (NAMAs) is expected to be the main vehicle for operationalising mitigation actions in developing countries under a future climate agreement. In 2010, Indonesia submitted a list of NAMAs to the UNFCCC Secretariat, stating that the GHG reduction will be achieved through the following actions:

- Sustainable peat land management
- Reduction in rate of deforestation and land degradation

- Development of carbon sequestration projects in forestry and agriculture
- Promotion of energy efficiency
- Development of alternative and renewable energy sources
- Reduction in solid and liquid waste
- Shifting to low emission transportation mode

D: EXPERT ASSESSMENT ON 3R POLICY IMPLEMENTATION

The main target of MSW handling is how to arrange that any waste generated could be well-handled so that the overall city environment would be clean, and simultaneously any waste generated would not bring negative impacts either to human health or their living environment.

The dominant views among Indonesian people, including decision-makers, in understanding the 3Rs concept, have always been associated with efforts in urban waste management. The 3Rs have been associated more with the roles of the community as waste producers, and how this community could participate in these efforts. The Bank of Waste in the community is considered as one of the best approaches. Only in rare cases have these efforts been associated with sectors of industries. Municipal waste recycling activities are performed through community self-help and local government schemes.

Waste generators and their corresponding local governments will be satisfied if these recycling activities actually contribute to decreasing their waste problems, and their wish is that these activities will also decrease the cost that should be provided, due to the existence of revenues from recyclable waste sales.

Waste recycling is an activity that is highly supported by all parties concerned in Indonesia. Through Law no. 18/2008 on Solid Waste Management and GR no. 81/2012 on MSW Management, and GR no.101/2014 on HW management, the Government of Indonesia is emphasising the 3Rs approach. However, these efforts have not been incorporated into actual and integrated activities.

Indonesia has a long-established informal waste management system which goes back generations and is still in operation. Recycling activities are not new in Indonesia. Indonesian citizens have long been familiar with public trading used goods such as used clothes, especially conducted by the informal sector. The main target of waste recycling from an industrial perspective is how to ensure that any material to be recovered from these wastes will have the highest economic value possible. Waste problems are not their problems. They will be satisfied if they can obtain as much waste as possible that has high economic value. They do not care about the remaining non-economic part of these wastes that cannot be sold. Efforts by all parties should focus on how these waste recycling activities in informal (and industrial) sectors could be the integral part of waste handling performed by local government (formal sector) as well as part of a community's self-help.

The trading of dry waste which is non-compostable has been the profession of choice or profitable business among some people generally belonging to informal sectors. Many people look on the informal sector engaging in economic transactions or trading of used goods and waste in Indonesia as scavengers. Actually, scavengers are only one type of multiple stakeholders in the collection of recyclable items. Indeed, it is the group that has attracted most attention due to its association with social issues faced by urban areas in developing countries such Indonesia. In recycling activities, the informal sectors engage primarily in using waste generated by a household, especially dry waste such as plastics, papers, and metals. On the other hand, waste generated by industry that belong to hazardous categories will certainly be dealt with by the formal sectors.

The path flow mechanism of recyclable wastes and used goods between the seller and the buyer is actually pure market mechanism. These goods move from one hand to another due to the very existence of market demands. The sellers supply these goods because buyers exist. If there was no market demand, then these goods would move from one hand to another in the form of a gift to anyone who needs them (donation). If these needs did not exist, even for free of charge goods, then these goods would become waste entering the environment, due to their owner thinking that the goods are no longer of any use and should be disposed of.

The 3Rs efforts in urban waste management are an integral part of the sustainable waste management concept, the main target of which is to drive a community to keep waste to an absolute minimum, and increase the quantities of reusable waste, as well as ensure safe waste filling and processing from the point of view of health and human living environment. On the other hand, recycled goods and waste trading businesses are basically economic activities, with such factors as prices, product/material qualities, supply continuity that are based on their demanded quantities, and the related profit will follow current market mechanism. Both interests, i.e. interests in sound waste handling and recycled product business interests, should be well and proportionally bridged so as to enhance the continuous growth of recycling efforts. If the resulting end-products can be of higher quality, this will ultimately improve their economic value. It is for these reasons that we need a mechanism that will guarantee the quality of goods to be traded, through, for example, certain quality standards.

The problems with waste handling in developing countries are relatively more complex than similar problems faced by developed countries. In many cases, non-technical aspects should be resolved first, such as institutional, financial, environmental aspects. Local government should give priority to resolving these issues. The technology used is generally still relatively simple.

A positive impact derived from the current SWM systems in developing countries and economies in transition is the high level of recycling of the inorganic component of MSW. Although the methods employed for sorting and separation of MSW in these countries are considered inappropriate for solid waste management systems as defined by developed countries, these existing methods not only provide an income stream to the hundreds of thousands of people involved in this informal sector but also ensure a far greater amount of MSW generated is recycled.

The indicators of success of recycling in developed countries are not always suitable when it is applied in developing countries, where the definition of consumer goods, used goods and wastes are different. The used newspaper, used clothes, used furniture, used electronic goods and so on, which are considered as waste in developed countries, are considered as goods that still have economic value in developing countries, and they will not be encountered in the waste management chain. Most likely, if this phenomenon is taken into account in developing indicators for success of waste recycling activities, the results of recycling activity in developing countries would be greater than those achieved in developed countries.

The biggest drawback in assessing of recycling performance efforts in a country like Indonesia is

that the data being used as a measuring tool is not accurate. Many programs to develop waste management in Indonesia are based on an estimated quantity. Reliable statistics are hard to find. Data requiring periodical updates such as wastes generation, waste composition and characteristics, source composition, waste recycling and the like are generally lacking or incomplete. This creates difficulties in evaluating the conditions or the performances of the existing waste management, and contributes to further difficulties in setting future development plans. Availability of these data will be necessary to assess factors such as waste quantity and quality projection for the future.

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