Republic of Indonesia

Indonesia Climate Change Sectoral Roadmap
ICCSR

Waste Sector

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Indonesia Climate Change Sectoral Roadmap – ICCSR
Waste Sector

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The Indonesia Climate Change Sectoral Roadmap (ICCSR) is meant to provide inputs for the next five year Medium-term Development Plan (RPJM) 2010-2014, and also for the subsequent RPJMN until 2030, laying particular emphasis on the challenges emerging in the forestry, energy, industry, agriculture, transportation, coastal area, water, waste and health sectors. It is Bappenas' policy to address these challenges and opportunities through effective development planning and coordination of the work of all line ministries, departments and agencies of the Government of Indonesia (GoI). It is a dynamic document and it will be improved based on the needs and challenges to cope with climate change in the future. Changes and adjustments to this document would be carried out through participative consultation among stakeholders.

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Remarks from Minister of National Development Planning/ Head of Bappenas

We have seen that with its far reaching impact on the world's ecosystems as well as human security and development, climate change has emerged as one of the most intensely critical issues that deserve the attention of the world's policy makers. The main theme is to avoid an increase in global average temperature that exceeds°C2 , i.e. to reduce annual worldwide emissions more than half from the present level in 2050. We believe that this effort of course requires concerted international response – collective actions to address potential conflicting national and international policy initiatives. As the world economy is now facing a recovery and developing countries are struggling to fulfill basic needs for their population, climate change exposes the world population to exacerbated life. It is necessary, therefore, to incorporate measures to address climate change as a core concern and mainstream in sustainable development policy agenda.

We are aware that climate change has been researched and discussed the world over. Solutions have been proffered, programs funded and partnerships embraced. Despite this, carbon emissions continue to increase in both developed and developing countries. Due to its geographical location, Indonesia's vulnerability to climate change cannot be underplayed. We stand to experience significant losses. We will face – indeed we are seeing the impact of some these issues right now- prolonged droughts, flooding and increased frequency of extreme weather events. Our rich biodiversity is at risk as well.

Those who would seek to silence debate on this issue or delay in engagement to solve it are now marginalized to the edges of what science would tell us. Decades of research, analysis and emerging environmental evidence tell us that far from being merely just an environmental issue, climate change will touch every aspect of our life as a nation and as individuals.

Regrettably, we cannot prevent or escape some negative impacts of climate change. We and in particular the developed world, have been warming the world for too long. We have to prepare therefore to adapt to the changes we will face and also ready, with our full energy, to mitigate against further change. We have ratified the Kyoto Protocol early and guided and contributed to world debate, through hosting the 13th Convention of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC), which generated the Bali Action Plan in 2007. Most recently, we have turned our attention to our biggest challenge yet, that of delivering on our President's promise to reduce carbon emissions by 26% by 2020. Real action is urgent. But before action, we need to come up with careful analysis, strategic planning and priority setting.

I am delighted therefore to deliver *Indonesia Climate Change Sectoral Roadmap,* or I call it ICCSR, with the aim at mainstreaming climate change into our national medium-term development plan.

The ICCSR outlines our strategic vision that places particular emphasis on the challenges emerging in the forestry, energy, industry, transport, agriculture, coastal areas, water, waste and health sectors. The content of the roadmap has been formulated through a rigorius analysis. We have undertaken vulnerability assessments, prioritized actions including capacity-building and response strategies, completed by associated financial assessments and sought to develop a coherent plan that could be supported by line Ministries and relevant strategic partners and donors.

I launched ICCSR to you and I invite for your commitment support and partnership in joining us in realising priorities for climate-resilient sustainable development while protecting our population from further vulnerability.

Minister for National Development Planning/
Head of National Development Planning Agency

Prof. Armida S. Alisjahbana

Remarks from Deputy Minister for Natural Resources and Environment, Bappenas

To be a part of the solution to global climate change, the government of Indonesia has endorsed a commitment to reduce the country's GHG emission by 26%, within ten years and with national resources, benchmarked to the emission level from a business as usual and, up to 41% emission reductions can be achieved with international support to our mitigation efforts. The top two sectors that contribute to the country's emissions are forestry and energy sector, mainly emissions from deforestation and by power plants, which is in part due to the fuel used, i.e., oil and coal, and part of our high energy intensity.

With a unique set of geographical location, among countries on the Earth we are at most vulnerable to the negative impacts of climate change. Measures are needed to protect our people from the adverse effect of sea level rise, flood, greater variability of rainfall, and other predicted impacts. Unless adaptive measures are taken, prediction tells us that a large fraction of Indonesia could experience freshwater scarcity, declining crop yields, and vanishing habitats for coastal communities and ecosystem.

National actions are needed both to mitigate the global climate change and to identify climate change adaptation measures. This is the ultimate objective of the *Indonesia Climate Change Sectoral Roadmap*, ICCSR. A set of highest priorities of the actions are to be integrated into our system of national development planning. We have therefore been working to build national concensus and understanding of climate change response options. The *Indonesia Climate Change Sectoral Roadmap* (ICCSR) represents our long-term commitment to emission reduction and adaptation measures and it shows our ongoing, inovative climate mitigation and adaptation programs for the decades to come.

Deputy Minister for Natural Resources and Environment
National Development Planning Agency

U. Hayati Triastuti

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BL	Baseline scenario
cap	capita
CDM	clean development mechanism
CER	certified emission reduction
CH4	methane
CL	controlled landfill
CO	carbon monoxide
CO_2	carbon dioxide
CO_2 eq	carbon dioxide equivalent
DOC	degradable organic carbon
DOCF	degradable organic carbon dissimilated
EF	emission factor
eq	equivalent
g	gram
Gg	gigagram
GHG	greenhouse gas
Gt	gigatonne
H_2	hydrogen
H2O	water
ha	hectare
IPCC	Intergovernmental Panel on Climate Change
k	methane generation rate constant
kg	kilogram
kt	kilotonne
kWh	kilowatt-hour
L	litre
L_0	methane generation potential
LFG	landfill gas
m	metre
m3	cubic metre
MCF	methane conversion factor
Mt	megatonnes
MSW	municipal solid waste
Mt	megatonne
mV	millivolt
MW	megawatt
N	nitrogen
N2	nitrogen gas
NA	not applicable
N/A	not available
N2O	nitrous oxide
O2	oxygen
OD	open dumping
OECD	Organisation for Economic Co-operation and Development
ppb	part per billion
ppbv	part per billion by volume
ppm	part per million

SL	sanitary landfill
SO2	sulphur dioxide
SOx	sulphur oxides
t	tonne
t-km	tonne-kilometre
TWh	terrawatt-hour
UNFCCC	United Nations Framework Convention on Climate Change

CHAPTER 1 INTRODUCTION

1.1 Background and Objective

As efforts to climate change mitigation on national level, Indonesia has implemented the following steps:

- Government of Indonesia has ratified *United Nations Framework of Climate Change Convention* (UNFCCC) through Act No. 6, in1994
- Government of Indonesia has ratified Kyoto Protocol through Act No. 17, in 2004.
- On November 26th 2007, the Ministry of Environment has compiled *Rencana Aksi Nasional Perubahan Iklim* (RAN-PI) as a commitment to greenhouse gas and climate change mitigation.
- Indonesia was the host of UN's 13th Conference of Parties (COP) in Global Warming in Bali on December 3rd-14th 2007.
- According to the speech of President Susilo Bambang Yudhoyono, the Government of Indonesia has committed to reduce greenhouse gases targeting a reduction of 26% in 2020 (including Landuse, Landuse Change and Forestry). With the right mixture of domestic policies and international support, the Government of Indonesia is confident that greenhouse gas emissions can be reduced by as much as 41% [SBY, 2009]. A presidential decree, stipulating this commitment, had been prepared in January 2010.
- In September 2009, the National Development Planning Agency (Bappenas) has launched Indonesia's Climate Change Trust Fund [ICCTF, 2009], as a financing mechanism to bridge international architecture for climate change in an efficient, transparent, and accountable manner.

In general greenhouse gas (GHG) emissions from waste occur during the incineration and open burning of waste, wastewater treatment and discharge, biological treatment of solid waste and from solid waste disposal. In Indonesia the major source of greenhouse gas emissions among the mentioned sources is the disposal and open burning of solid waste. Approximately 42.76 megatonnes of solid waste will be produced in Indonesia in 2010 and hence a signicant amount of GHG equivalents, especially methane (CH4) emitted. CH4 emissions occur in managed and unmanaged landfills from anaerobic degradation of organic material. They cannot be controlled, because final waste disposal technology has not been applied yet and open dumping is still common practice. Currently there are about 400 landfills (open dumping) in Indonesia, which

are managed by the local governments. At national level the local governments are supported by the Ministry of Public Works with technical assistant, regulation and quality control of solid waste management, while environmental aspects are supported and controlled by the Ministry of Environment.

This chapter of the Climate Change Sectoral Roadmap, the Waste Sector Roadmap, attempts to be a facts-based assessment of emissions reduction potential in the Indonesian waste sector, medium (2020) and long term (2030) stating cost estimates for each of the described reduction opportunities. The purpose is to give direction for the mitigation of GHG emissions from domestic solid waste disposal and open burning, as well as integrating these mitigation measures into development planning to build up a sustainable national waste sector management.

In this Waste Sector Roadmap, mitigation options will be discussed for GHG emissions from domestic solid waste only, because (1) they are the major source of GHG emissions from the waste sector, and (2) the management of solid waste seems to be more advanced than the management of wastewater etc. and yet ready to implement GHG emissions mitigation measures in both short and long term. The detailed objectives of this Waste Sector Roadmap are:

- To estimate Indonesia's potential GHG emissions resulting from domestic solid waste to year 2030;
- To estimate the size of GHG emissions mitigation potential from domestic solid waste as a contribution to Indonesia's national commitments to reduce GHG emissions;
- To incorporate the waste sector's emissions reduction efforts into the national economic development plans;
- To position solid waste management as a priority for action in the short and medium-terms; and
- To identify technologies and programs required to support activities that can reduce GHG emissions from solid waste disposal and open burning.

1.2 Reporting Methodology

1.2.1 Analysis

Analysis in the formulation of the Climate Change Sectoral Roadmap for the waste sector was conducted in the following way:

a) Collect and review documents related to the Indonsian waste sector from the Ministry of Public Works, the State Ministry of Environment, the National Development Planning Agency and the Agency for the Assessment and Application of Technology (BPPT) such as *Synthesis Report for Indonesia's Technology Need Assessment on Climate Change Mitigation* (Agency for the Assessment and Application of Technology - GTZ, March 2009).
b) Conduct a literature review and a scientific basis study of the impact of domestic waste on climate change, e.g. by reviewing the document of 2006 IPCC Guideline.
c) Estimate the amount of solid waste generated in Indonesia and derive the GHG emissions originating from domestic solid waste.
d) Build GHG emissions scenarios for different GHG emissions mitigation options.
e) On the base of these GHG emissions scenarios develop a mitigation program for the Indonesian waste sector within the mentioned boundaries.

1.2.2 Stakeholders' Participation Process

Participation of stakeholders during the process of preparing this Waste Sector Roadmap could be achieved in several ways, including:

- Consultation and discussion conducted with the officials, researchers, and experts in the relevant agencies, especially the National Development Planning Agency, Ministry of Public Works, and Ministry of Environment.
- Implementation of Forum Group Discussion (FGD), Pre-FGD, and coordination meeting with the Ministry of Public Works and related agencies, which have been conducted both in Bappenas and in the Ministry of Public Works. This FGD also discussed cross-sectoral issues.

1.2.3 Reporting Systematics

This Waste Sector Roadmap is divided into 5 chapters with the following systematics:

- Chapter 1 discusses background and objective of the Waste Sector Roadmap
- Chapter 2 discusses the condition of waste management in Indonesia
- Chapter 3 discusses the calculation methodology of greenhouse gases from landfills and its potential in Indonesia, as well as various assumptions used in the calculation.
- Chapter 4 discusses various scenarios for the mitigation of GHG emissions from landfills. In order to elucidate the most effective and efficient scenario, the abatement costs of the scenarios are compared.
- Chapter 5 discusses various solid waste management policy alternatives based on cost assumptions of the Government of Indonesia (GoI). These alternatives differ in their

assumptions about the implementaion of laws and regulations for GHG emissions mitigation and the costs, the GOI has to calculate for these programs. The discussion will focus on different issues than the discussion in Chapter 4, which concentrated on various mitigation technologies. In addition, Chapter 5 also discusses mid- and long-term programs as a result of FGDs with related sectors, especially the Ministry of Public Works.

CHAPTER 2 CURRENT CONDITION AND FUTURE CHALLENGES

Post-consumer waste is one of the contributors to global greenhouse gas (GHG) emissions with the largest amount of waste generated methane (CH_4) originationg from landfills. There are about 400 landfills in Indonesia, which are all open dump sites. Solid waste management services in Indonesia are authorized by local governments to encompass collection, transportation, treatment and final disposal of waste. Eventhough currently the dominant final disposal option is still open dumping, which causes many environmental and social problem, most of the local governments have attempted to improve their waste management in an environmentally and socially satisfactory manner using the most economical means available. Solid waste management follows Act No. 18 of 2008 on Waste Management.

Setting a baseline for GHG emissions from domestic solid waste is an essential step for assessing potential GHG emissions mitigation scenarios and actions. A baseline serves as the reference period, which the future change in the amount GHG emissions under different scenarios is estimated from. The choice of the baseline period often depends on the availability of required data. This Waste Sector Roadmap uses the year 2005 as the baseline year, because the available dataset for this year is more comprehensive than for other years.

The baseline condition of waste management in Indonesia in 2005 can be divided into (1) waste source condition, (2) waste transportation condition, (3) waste processing condition, (4) reduce, reuse, recycle (3R) condition, and (5) policies and laws.

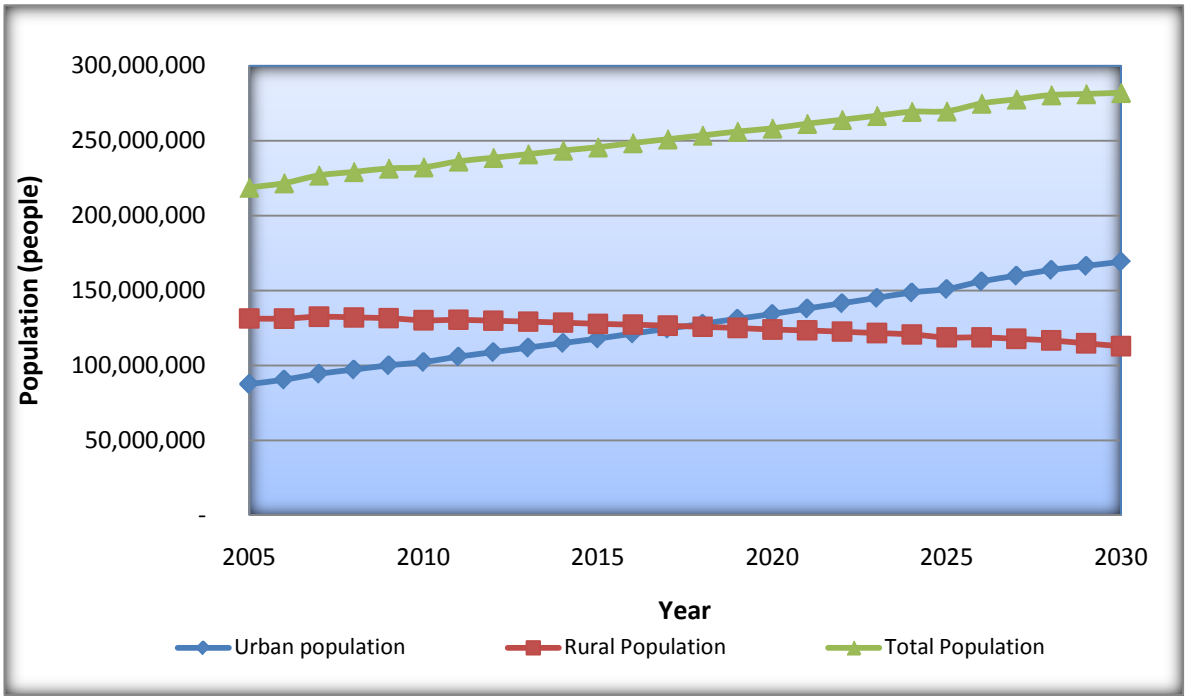


Figure 2.1 Prediction of urban and rural population in Indonesia until 2030

2.1 Municipal Solid Waste Source Condition

In 2005 Indonesia's population counted 218.8 million inhabitants (BPS, 2006). The level of waste generation was estimated to be around 0.6 kg/capita/day for urban areas and 0.3 kg/capita/day for rural areas, resulting in a total amunt of 33.5 Mt of solid waste in 2005. As described in figure 2.2, solid waste generation in Indonesia will continue to increase in such way, that in 2030 it will reach a level of 1,2 kg/capita/day for urban areas and 0.55 kg/capita/day for urban area.

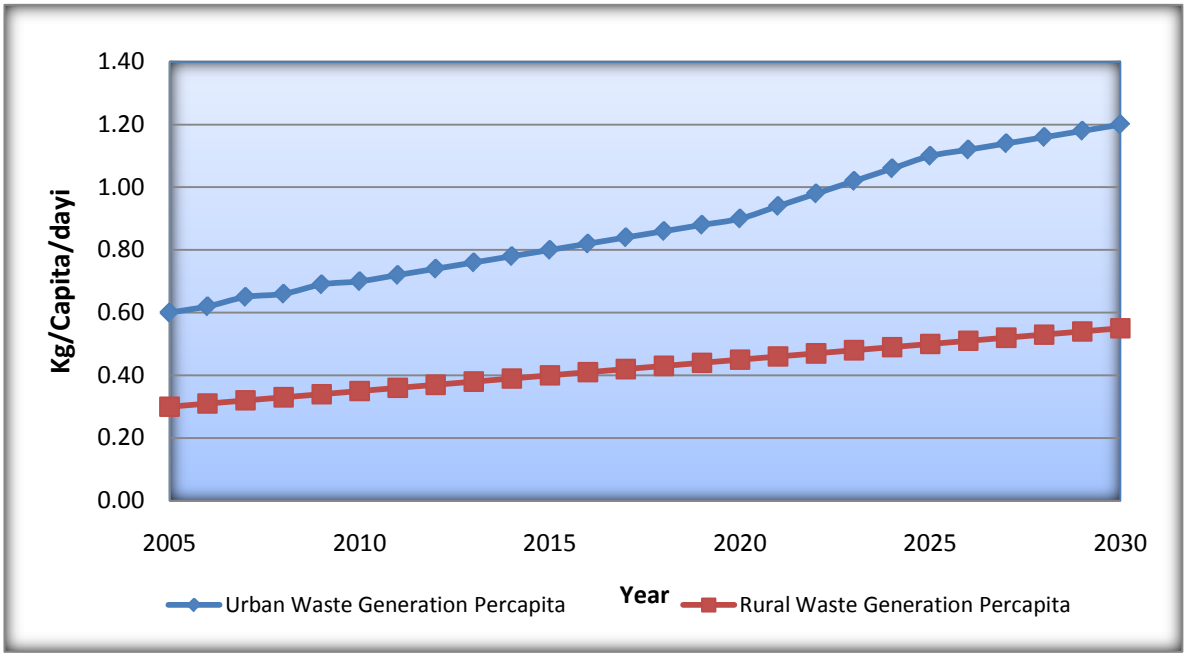


Figure 2.2 Prediction of solid waste generation percapita until 2030

Organic waste is the main component of domestic solid waste. The organic waste proportion in solid waste is in average 20 – 30% higher in Asian countries than in most European countries. However, there is an indication of lifestyle change in Asian countries, which can be proven by the increasing amount of plastic and paper waste and a decreasing quantity of organic waste. Also in Indonesia waste composition is becoming more similar to industrial countries' waste composition in accordance to Indonesia's economical transition.

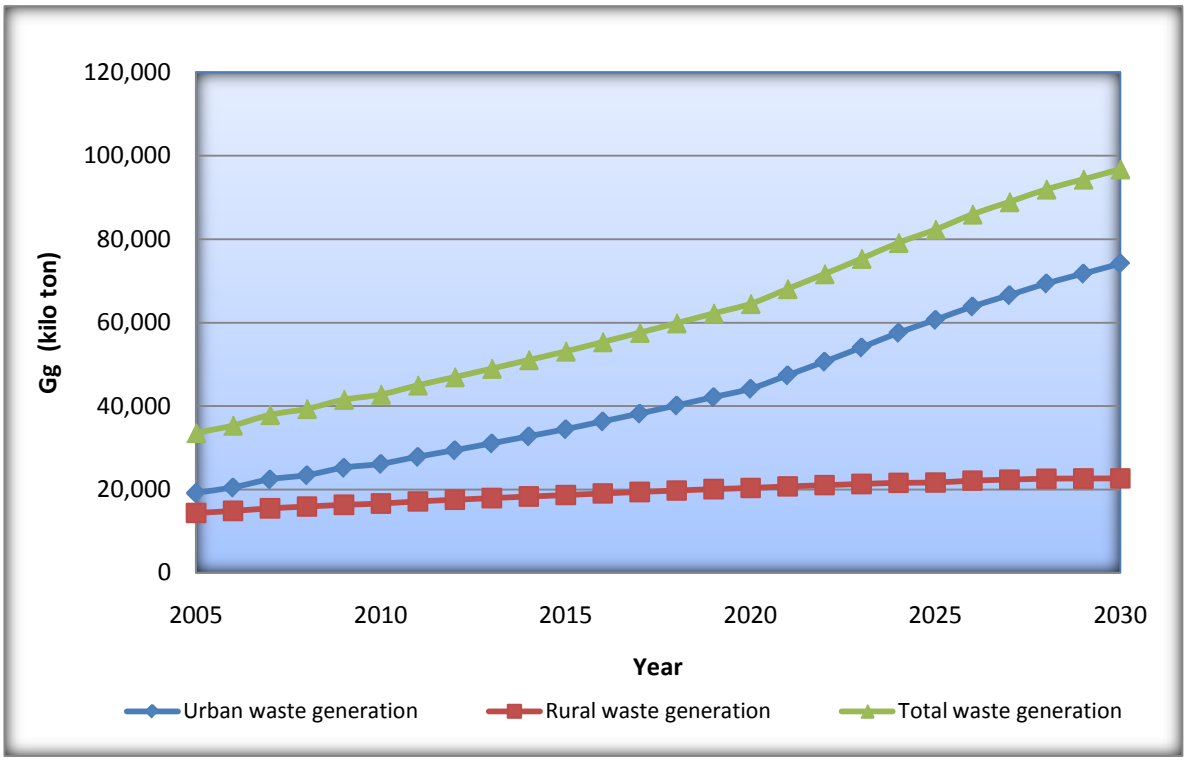


Figure 2.3 Prediction of solid **w**aste generation until 2030

Figure 2.4 and 2.5 show distribution maps of predicted waste generation in Indonesia in 2010 and 2030.

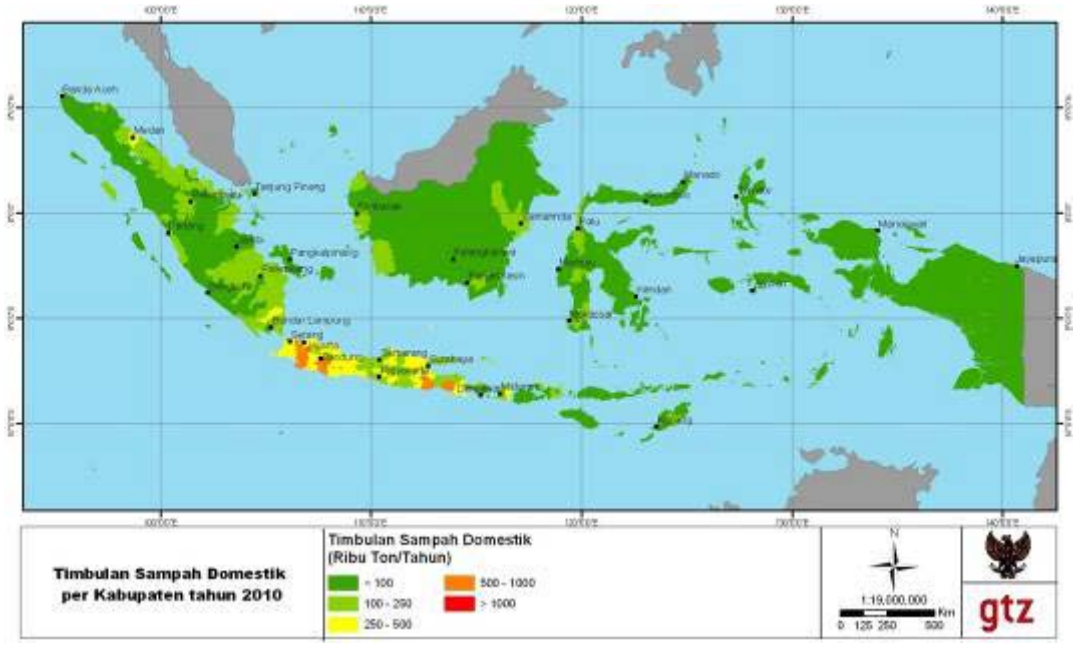


Figure 2.4 Distribution map of waste generation in Indonesia in 2010

As cities grow economically, business activity and consumption patterns drive up solid waste quantities. Figures 2.5 shows that the high volume solid waste area is not only Java island but also Sumatera Island.

Figure 2.5 Distribution map of waste generation in Indonesia in 2030

2.2 Transportation Condition

In Indonesia solid waste originates to approximately 50% in urban areas and 20% in rural areas. It is transported collectively by the Department of Local Solid Waste Management or other appropriate institutions, which are obligated by the local government (figure 2.6). Solid waste, which is not transported by the government, has to be self-managed by the community.

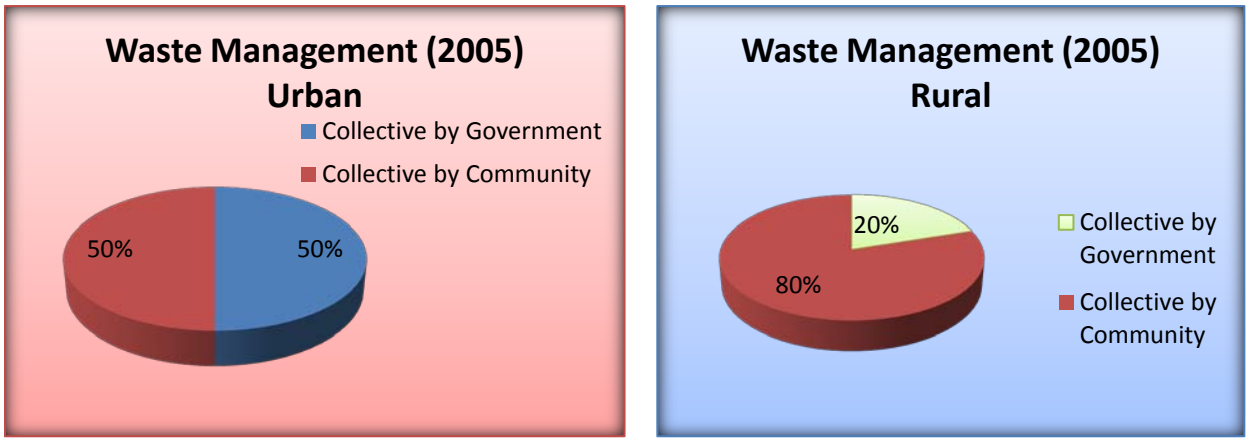


Figure 2.6 Solid waste management condition in Indonesia in 2005

According to the governments' work plans, solid waste transportation is predicted to increase continuously from year to year (figure 2.7). In general, the duty of the Department of Local Solid Waste Management is to collect solid waste from the polling station to the landfill, while urban communities organize the waste collection from the source (house) to the polling station independently. Such solid waste collection system has many weaknesses, since a large amount of solid waste is not collected and instead thrown away into the drainage channels or rivers. In addition, there are still technical problems associated with equipments and supplies in waste management. Generally, cities and regencies in Indonesia are short of vehicles for collecting and transporting solid waste.

Another important aspect is the source of finance of domestic solid waste management. In most Indonesian cities finance originates from the governments' development budget, in some cases from offshore loans or from solid waste retribution charged to the waste generator. Since the economic crisis, the income through retribution in the city has been decreasing along with the slackening economic capacity of society/community. It is indeed hard to raise the retribution, considering the still limited economic capacity of society/community.

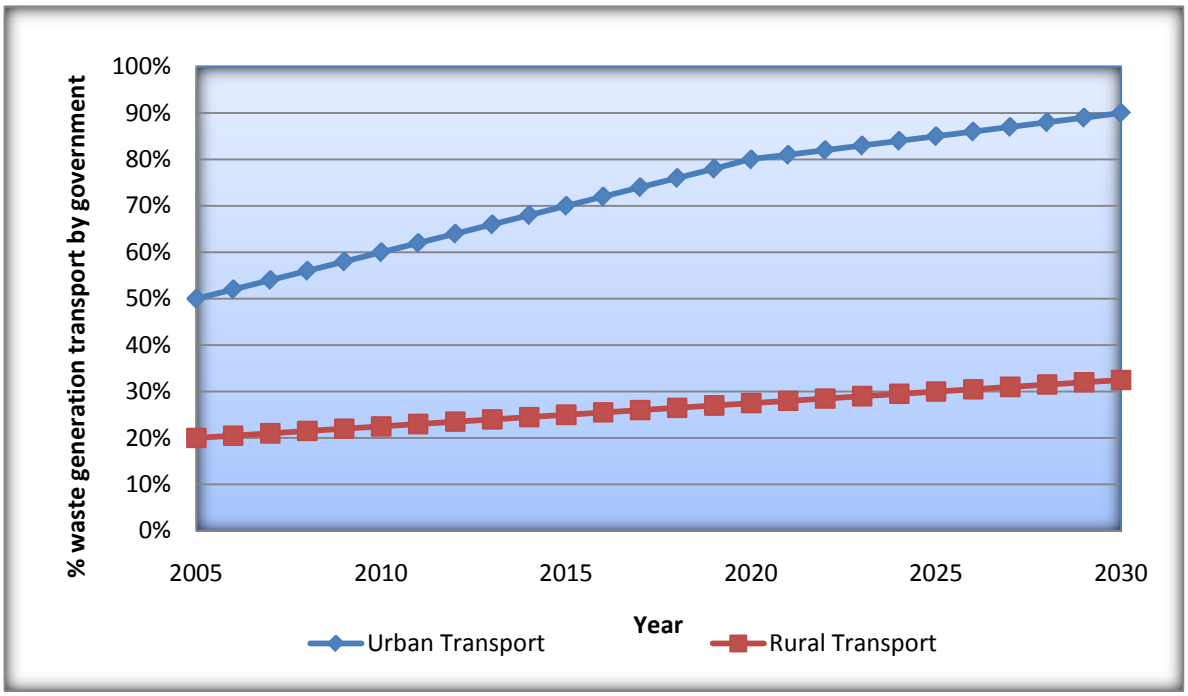


Figure 2.7 Prediction of solid waste that is collected and transported by local government

2.3 Waste Processing Condition

The solid waste transported collectively by the local government is not entirely processed in landfills as described in Figure 2.8. The conditions of waste management in Indonesia are represented in Table 2-1 in detail. Based on the research data of the area of Bandung Raya and other secondary information from several places in Indonesia in 2005 (see Tabel 2-1), we found that [1] (a) 3% of anorganic solid waste was recovered, (b) 1% of organic solid waste was composted, (c) 0.5% of solid waste was burned at the polling stations and landfills; 45% ended up in covering open dumping; and 0.5% in covering landfill equipped with a sanitary biogas capture.

[1] The % unit used in this report is to the weight of wet waste. Usually, the shown data by waste manager in Indonesia is based on % to wet volumewhich will have different density.

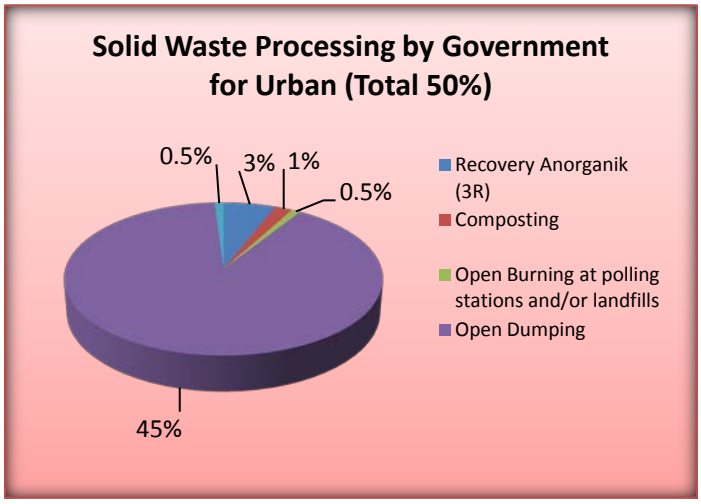
Some waste are managed by the community themselves with a composition of anorganic solid waste-recovery of 3%, organic solid waste composting of 1%, solid waste burning of 5%, and waste disposal into river channels and open dumping anywhere were 1% and 40%, respectively. Only around 20% of solid waste in rural areas were transported collectively by Governmental organizations, while the remaining 80% were managed by the community.

Table 2.1 Waste Management Condition in Indonesia in 2005

Year 2005	Unit	Urban	Rural
Waste generated	kg/capita/day	0.6	0.3
Increase of waste generated per year	%	2.5	1
Waste transported collectively (Office)	%	50	20
Increase of collectively transported waste per year	%	2.5	1
Waste managed collectively in 2005:			
• Inorganic recovered	%	3	0.5
• Organic composted	%	1	5.5
• Burned at polling stations and landfills	%	0.5	10
• Covering open dumping	%	45	4
• Covering sanitary landfill + biogas capture	%	0.5	0
Total	%	50	20
Waste managed by community in 2005:			
Inorganic recovered	%	3	5
Organic composted	%	1	40
Burned	%	5	20
Discharged into river channels	%	1	5
Hide anywhere	%	40	10
Total	%	50	80

Source: Damanhuri, 2008

Figure 2.8 shows that of the 50% of solid waste collected and transported in the urban areas, 45% were processed in open dump sites, and the rest were recovered, composted, burned, and processed at the sanitary landfills. In addition, from the total of 20% of solid waste collected and transported in rural areas, 10% were burned at the polling stations and landfills and some were covered at open dump sites, composted, etc.,



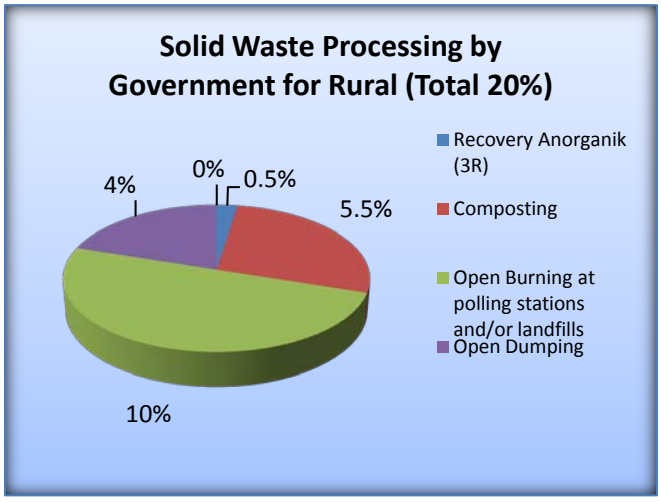
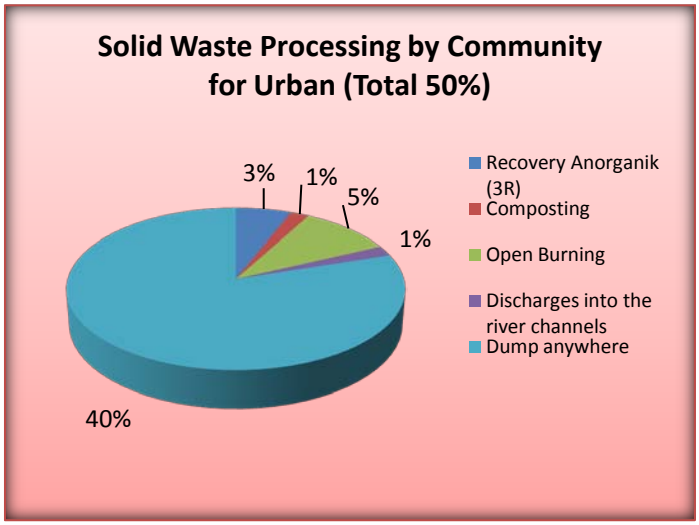


Figure 2.8 Solid waste processing in urban and rural in Indonesia in 2005

Untransported solid waste is self-managed by the community. Figure 2.9 shows the solid waste management activity by urban and rural community.



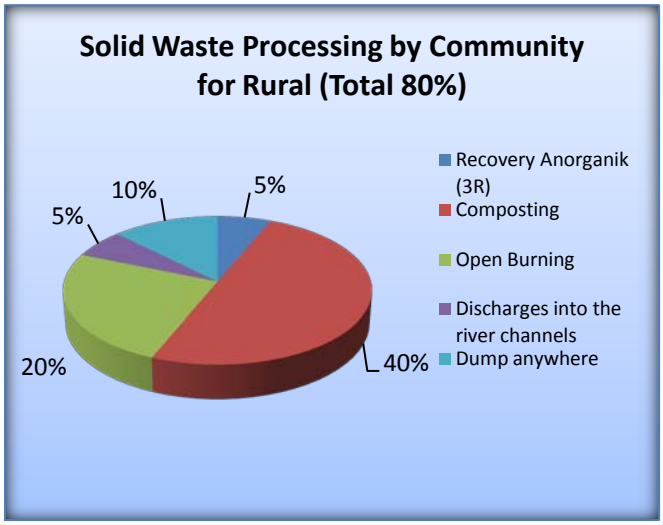


Figure 2.9 Solid waste processing that is managed by community in 2005

The system of domestic solid waste management in Indonesia largely depends on the existence of landfills. Landfills are becoming one of the important issues in handling solid waste due to limited number of landfills in Indonesia, which are correctly maintained. Most of the solid waste transported to the landfill is processed through open dumping, and it was estimated that only 10% is processed through a better system, such as controlled landfill. There is only a little protection or monitoring of ground water, so that alkali from waste can contaminate groundwater or the river. In addition, landfill foundations are usually rocky, gravel, or swamp

areas, which are very sensitive to water pollution (Damanhuri, 2008). Other problems are, the refusal of community/society to change their land into landfills.

The main reason that open dumping continues to be applied in Indonesia is due to the limited operational budget. It is very difficult to cover areas with a layer of soil and compact the waste layer by layer with such limited operational budgets. Open dumping causes many problems such as smoke, odor and flies. In many cases, industrial waste and hospital pathogens waste are also found in the landfill, although in 1995 the GoI set the 3B criteria for waste landfills. Because of the mixing of the waste from various different criterias, the danger posed by landfill is growing.

Another serious problem solid waste management using landfills is, that landfills are still being used when they are already "full". Attention is only risen, when the landfill began to fall or in case of operation interferences.

2.4 Reduce, Reuse, Recycle (3R) Condition

In general, Solid Waste Management (SWM) in Indonesia is very dependent on the presence of landfills/ TPA. Community treatment centers (3R – reduce, reuse, recycle) were formed as a solution to reduce the amount of solid waste. Conditions of reduction, reuse and recycling in 2005 are described in Figure 2.8, Figure 2.9, and Table 2.1 Through the method of 3R, a number of big cities such as Jakarta, Bandung, Surabaya, Medan, Semarang and Yogyakarta began to develop a mid-level processing by composting and recycling anorganic waste to reduce the amount of solid waste disposed at the landfill.. Mid-level processing was built as an attempt to reduce the amount of solid waste disposed to the landfill. Until now, there are only a few mid-level processings, which are professionally managed in Indonesia. One problem was the high price of compost produced compared to the price of inorganic fertilizer, approximately Rp 300 - 400/kg. Indonesia's anorganic waste is usually recycled by a scavenger. From the economic aspect of this sector, it provides significant economical benefit.

Waste compositions are a very determining factor in composting and recycling. There are two main waste compositions, namely wet waste or organic waste (food waste, etc) that could be composted and dry waste or anorganic waste (plastic, paper, glass, etc.) that could be recycled. It should be noted that some of the waste components in Indonesia, such as newspapers, used book/magazines, used clothes, and used electronic components are not treated as solid waste

and disposed to the trashcan. These components are usually collected by the informal sector such as a junkman or a scavenger and could be sold to the waste trader/ junk storage.

Other important aspects of domestic solid waste management are recycling and the role of the informal sector. In Indonesia, there are two main recycle flows. First, the collectors (informal sector), who collect recycleable material from the generators of the solid waste. Second, these collected materials are separated and recycled by the municipality after the MSW collection. The describes cycle involves housewives, cleaning service, and scavangers.

In developing countries, the level of recycling of anorganic waste is high enough to have a positive impact on the economy of the community. Although the methods employed for sorting and separating solid waste in these countries are still considered inappropriate, the existing methods do not only provide an income stream to hundreds of thousand of people involved in the informal sector, but also ensure that a far greater amount of solid waste is recycled.

2.5 Policies and Laws

Waste management is implemented to improve public health, prevent environmental pollution, and protect clean water resources as stated in Act No. 32/2009 on Environmental Management. Waste management is specifically regulated in Act No. 18/2008 of Waste Management. Prior to the issue of Act No.18/2008, the Government Regulation (PP) No.16/2005 has determined the protection of water resources due to pollution from landfill as one of the subjects to focus on. PP No. 16/2005 is a regulation under the Law of Water Resources (Act No.7/2004).

Act No.18/2008 of Waste Management outlined that solid waste management has to support the (a) reduction and (b) waste handling approach. Solid waste reduction is based on the principle of (a) restriction (reduce), reuse, and recycle of waste, which is known as the 3R approach. It can be defined as upstream waste management starting from the effort of how to generate only a minimum amount of waste (reduce) in daily activities. An example for such effort is the change of industrial employment patterns and product packaging, which aims to produce and use environment-friendly packaging with as little volume as possible so that its waste can easily be recycled and handled further. They also outlined to not remain hands-off on the packaging, namely in the form of extended producers responsibility (EPR). To achieve a full implementatin of the 3R approach the involvement of all stakeholders is needed. Solid Waste or the remaining residue has to be further treated professionally through placement, collection, removal, transportation and processing. Residues of these activities must be removed from the

environment safely. Therefore, Act No. 18/2008 outlined that within the first 5 years after its issuing, open dumping has to be replaced by a better method, such as controlled landfill and sanitary landfill. Furthermore, the law emphasized the strengthening of institutional capability and improvement of stakeholders' relation to work together as partners in managing and improving investment source.

Government's eagerness to promote the 3R approach has significantly advanced in Regulation 21/PRT/M/2006 of the Minister of Public Works. The regulation focuses on 3R as the national strategy and outlines that until 2014, solid waste should be reduced up to 20%[2]. Targets of the national strategy on waste management sector are as follows:

1. Support the achievement of service level of solid waste up to 60% in 2010.
2. Support the reduction of solid waste through 3R method up to 20% in 2014.
3. Improve the quality of landfill:
    - Controlled Landfill (CLF) for small and medium-sized cities.
    - Sanitary Landfill (SLF) for large and metropolitan cities.
    - Termination of Open Dumping.
4. Support implementation at institutional level and regional cooperation.

Currently, the implementation of domestic solid waste management at the regional level is conducted by local government regulation, which affects the organization of domestic solid waste management, retribution fee and transportation cost of solid waste from the source to the landfill. The biggest obstacle lies in the lack of legal power that causes weak implementation of these regulations.

2.6 Future Challenges of Waste Management

Population and economic growth will increase the amount of solid waste volume. The projections of generated domestic solid waste for urban and rural areas from 2005 to 2030 are shown in Figure 2-1. This increasing amount of waste volume will become a serious environmental problem if not well handled. Thus, a good municipal waste management is a must.

[2] The unit used is % wet volume. The use of this unit needs careful interpretation such as in claiming the success of recycle efforts. Example: 1 empty plastic bottle truck has an equivalent volume with 1 wet waste truck, but possess different weight.

Domestic Waste Management (Municipal Solid Waste/MSW) in Indonesia still faces many problems, such as:

- The majority of cities does not have a consistent plan (master plan) in handling solid waste because the Domestic Solid Waste Management still has not formalized;
- Domestic Waste Management has not been given sufficient priority in local government regulation, which limits the budget for solid waste management;
- Facilities for collecting, transportating, and storing the solid waste are limited;
- Most of the landfills (TPA) are open dump sites, which cause water pollution, air pollution, and odor.

To solve the mentioned problems, (regency) district/city government as the head of waste management in the (regency) district/city level should increase their waste management revitalitation program. This includes the perfection of waste management institutions, related laws, waste management technical issues, supporting infrastructure, financing and investment alternatives, along with increasing the society's awareness, culture, and knowledge on better waste management.

In addition, two main policies had at least to be implemented for future waste management. The first policy states, that domestic solid waste should be reduced (reduce) as much as possible, used again (reuse), and recycled (recycle) (3R) before transported to the landfill. The second policy outlined, that domestic waste management should involve public participation. These two policies are used as the basic principles of solid waste management as described in the laws of solid waste. Meanwhile, the active participation of community in the 3R solid waste program starts from the household level by changing the habit of society to be cleaner and healthier. Industrial participation will be achieved by implemented EPR (Extended Producer Responsibility) as the principle for waste producers and hazardous waste importers.

Future waste management must start to calculate waste conversion to energy resources. In addition, waste management must be integrated in climate change mitigation activities thus creating a co-benefit. Creating a more evironmentally friendly regional development includes focused programs or increased budget, both a challenge for every (regency) district/city.

CHAPTER 3 MITIGATION POTENTIAL IN WASTE SECTOR

3.1 Calculation Method

Greenhouse gases from the waste sector are generally emitted in the form of methane (CH_4), produced from landfill and Carbondioxide (CO_2) generated from open burning. Emissions from open burning are more difficult to control than emission from landfills. In addition, the burning and recycling of paper and plastic causes nitrous oxide (N_2O) emissions, which equal the 310fold of the impact of the same amount of CO_2.

Based on the descriptions in chapter 2, in Indonesia waste is mostly composted, burned, thrown into rivers, covered, disposed in landfills, etc. The amount of greenhouse gases produced varies depending, which of the mentioned methods is applied. For open burning and natural decomposition, the proportion of waste that can be broken down biologically in Indonesia is higher than in other countries. In the combustion process an aerobic reaction occurs, which produces CO_2 without the release of greenhouse gases into the air. CH_4 emissions from landfills are the result of anaerobic decomposition of organic components in waste. Waste in landfills decomposes slowly and decomposition can last a few decades.

Prior to the development of mitigation strategies for the waste sector, CH_4 emissions generated from the *waste* need to be calculated. Basically, emissions from landfills are calculated using the IPCC First Order Decay (FOD) model (IPCC, 2006) with the basic equation for estimating CH_4 emissions are as follows:

$$CH_4 \text{ year t (Gg/year)} = \sum_x [A \bullet k \bullet MSW_{(t)}(x) \bullet MSW_{(F)}(x) \bullet Lo(x)) \bullet e^{-k(t-x)}]$$

Where

CH_4	= CH_4 generated in year t, Gg/year
t	= year of inventory
x	= years for which input data should be added
A	= $(1-e^{-k})/k$; normalisation factor which corrects the summation
$MSW_T(x)$	= Total municipal solid waste (MSW) generated in year x (Gg/yr)
$MSW_F(x)$	= Fraction of MSW disposed at SWDS in year x
Lo(x)	= Methane generation potential (Gg CH_4/Gg waste)

The rate of CH_4 emissions from landfills is very specific to certain areas, because its formation depends on the type of waste disposed of, elements of humidity, age of the waste and local climatic conditions. So for this report local research data were used as found in Table 3.1.

Table 3.1 Emission Factor for Each Activity of Waste Management

Activity	Emission Factor		Note
1. Waste Transportation Source: Alisan Smith et al, 2001: Waste management options and climate change, AEA Techno-Environment	0.71 kg CO_2/km		The average trip to the landfill = 50 km per 2.5 ton of waste
2. Waste Degradation in Landfill (Calculated based on waste condition in Indonesia: water content, organic carbon level, etc.)	75 kg CH_4/ton of waste 210 kg CO_2/ton of waste		Emission of good sanitary landfill can be captured until 90%.
3. Waste Combustion	Paper & Organic	0.05 kg N_2O/ton	N_2O = 310 CO_2 and CH_4 = 22 CO_2, later reffered to as CO_2 eq.
	Plastic	2237 kg CO_2/ton 0.05 N_2O/ton	
Activity	**Emission Factor**		**Note**
4. Composting	670 kg CO_2/ton of waste		
5. Recycle	Paper and Organic	0.05 kg N_2O/ton	N_2O = 310 CO_2 and CH_4 = 22 CO_2, later reffered to as CO_2 eq.
	Plastic	2237 kg CO_2/ton 0.05 N_2O/ton	
6. Other waste management	Waste dumped anywhere and thrown into the river	750 kg CO2/ton of waste	

Source: Damanhuri, 2008

To calculate the cost of mitigation, a unit price has to be assumed for operating and waste management unit maintenance as shown in Table 3.2. Emission reduction means the difference between the GHG emissions generated under the BAU (Business as usual) scenario and a specific GHG emission reduction scenario. GHG emissions are presented in units of CO_2

equivalent (CO2 eq). The formulas for calculating the emission reduction in CO2 eq are as follows:

The calculation formula of GHG Emissions Reduction (in CO_2 eq):

Emissions Reduction (in CO_2 eq) = BAU emission – ERS emission

BAU = Business as Usual

ERS = Emission Reduction Scenario

Table 3.2 Cost for Each Activity of Waste Management

Activity	**Operating and maintenance cost per Ton Waste**	
	(Indonesia Rupiah)	(Approx. in USD Dollar)
1. Transportation	50,000.00 – 60,000.00	5 – 6
2. Sanitary Landfill	60,000.00 – 100,000.00	6 – 10
3. Open Dumping	10,000.00 – 20,000.00	1 – 2
4. Controlled Landfill	30,000.00 – 50,000.00	3 – 5
5. Composting	15,000.00 – 20,000.00	1.5 – 2

Source: Damanhuri, 2008

The development of mitigation strategies of greenhouse gas emissions can take place after the process of identifying the amount of emissions and its source is completed. In general, mitigation of greenhouse gas emission can be achieved easiest in a place where the solid waste is accumulated (collected) in high volume and under anaerobic condition. For solid waste, landfill is the source of the most significant greenhouse gas release. In addition, GHG emissions are also produced from the transportation of solid waste to the landfill, plastic and paper combustion, as well as composting.

In 2015, referring to the MDG's target, 80% of solid waste in urban areas and 50% in rural areas should be transported to the landfill. This can only be achieved via a realistic management plan, which has to be implemented in the future.

Mitigation costs are calculated based on investment costs and operational/maintenance costs. The interest rate used is 12%/ year. ACERS (Emissions Reduction Scenario Abatement Costs) are calculated based on (Situmeang, 2009):

$$ACERS = \frac{[NPV\ (Total\ Cost\ of\ BAU) - NPV\ (Total\ Costs\ of\ ERS)]}{[NPV\ (Total\ Emission\ of\ BAU) - NPV\ (Total\ Emission\ ERS)]}$$

ACERS = Abatement Costs of the Emissions Reduction Scenario
NPV = Net Present Value
ERS = Emission Reduction Scenario

3.2 Utilization of CH4 from Landfill into Electrical Energy

In developed countries, landfills have become a promising source of electrical energy through the utilization of CH_4 that is emitted. The potential to capture CH_4 and utilize it for electricity generation has never been exploited in Indonesia. However, research has been done within the CDM framework showing that the main obstacle to the implementation of these types of projects is the associated investment cost, which deems them not profitable.

The selling price of electricity from landfills is regulated by the Ministry of Energy and Mineral Resources Regulation No. 31 of 2009, specifically determining the 'Power Purchase Price by PT PLN (Persero) from Power Plants Using Small and Medium Scale Renewable Energy or Excess Power'. According to the regulation, PT PLN (Persero) must purchase electricity from power plants using small and medium scale renewable energy technologies with a capacity of up to 10 MW of electricity or excess power from state owned enterprises, local owned enterprises, private enterprises, cooperatives, and governmental organizations to strengthen the system of local electricity supply.

The power purchase price is determined as follows:
a. USD 656/kWh x F, if interconnected on High Voltage;
b. USD 1.004/kWh x F, if interconnected on Low Voltage.

F is the location-incentive factor in accordance with the purchase of electricity by PT PLN (Persero) with the following scale:
a. Java and Bali region, F = 1;
b. Sumatra and Sulawesi region, F = 1.2;
c. Kalimantan, West Nusa Tenggara and East Nusa Tenggara region, F = 1.3;
d. Maluku and Papua region, F = 1.5.

This Waste Sector Roadmap states that sanitary landfill can be supported by flaring facilities, while electricity generated from CH_4 can be sold to PT PLN. In order to make national scale estimates, the assumptions listed in Table 3.3 are made. These are largely based on a feasibility study conducted on the use of CH_4 for electrical energy generation in Makassar, Indonesia (World Bank, 2007).

Table 3.3 Landfill planing assumptions, flarring installation, and power generation

Parameter	Assumptions
Landfill:	
1 unit of Landfill capacity	300 Gg/year
1 unit of Sanitary Landfill investment cost	4.000.000 USD
1 unit of Controlled Landfill investment cost	3.000.000 USD
1 unit of Open Dumping investment cost	2.000.000 USD
Flaring and Power:	
CH_4 efficiency	50%
Electricity efficiency	99%
Generated Electricity (per Unit Sanitary Landfill)	1 MWh
Flaring and Electricity facilities investment cost	6.000.000 USD

CHAPTER 4 POTENTIAL MITIGATION SCENARIO AND STRATEGIC ISSUES OF CLIMATE CHANGE IN WASTE SECTOR

4.1 Greenhouse Gas Mitigation Scenario of Waste Sector

Potential mitigation scenario projections of the waste sector were made based on Waste Management Act No. 18/2008. As stated in the Act, the efforts to reduce greenhouse gas emissions in the waste sector are to consist of LFG (landflill gas) recovery either from open dumping land which is to be converted to sanitary landfill, or from making new sanitary landfills. Efforts to terminate open dumping and build sanitary landfill sites with LFG recovery technology in its place are in agreement with the Act, which states that all open dumping sites should be closed by 2015. Other actions to reduce greenhouse gas emissions are to consist of efforts to reduce solid waste at its source (household), TPS (Polling station), or TPA (-Landfill) using 3R (reduce, reuse, recycle) techniques. The final proccesing of solid waste in urban and rural areas in Indonesia is to differ. The emphasis in urban areas will be on landfill technology (open dumping, controlled landfill, sanitary landfill), while rural areas will predominantly rely on composting technology. The 3R method can be applied in both urban and rural areas.

The greenhouse gas mitigation scenarios based on Act No. 18/2008, are as follows:

Urban Area:

1) Open Dumping scenario

   This scenario is the closest description to the current situation, which is the use of open dumping as the final proccessing method of solid waste in urban areas.

2) Waste Reduction at the source scenario

   This scenario applies waste reduction efforts at the source, such as conduct campaigns and capacity building aimed at the reduction of plastic, paper, packaging, etc.

3) 3R and Composting scenario

   This scenario applies 3R (reduce, reuse, recycle) in TPS and TPA, and also does composting.

4) Conversion to Sanitary Landfill without LFG installation scenario

   This scenario converts open dumping to sanitary and controlled landfill without the use of CH_4 gas from landfill for electricity generation.

5) Conversion to Sanitary Landfill and the installation of LFG scenario

This scenario converts open dumping to sanitary landfills and makes use of CH_4 gas from landfill for electricity generation.

Rural Area:

1) Burned and dumped anywhere scenario

   This scenario is the closest description to the current situation in rural areas, which consists of waste being burned and dumped anywhere.

2) Waste reduction at the source scenario

   This scenario applies reducing the amount of solid waste at the source.

3) 3R and Composting scenario

   This scenario makes use of a combination of composting technology and 3R.

4.2 Greenhouse Gas Mitigation Scenario in Urban Area

The assumptions made for the projection of GHG mitigation scenarios in urban areas are as follows:

1) Business as Usual (BAU) or Open Dumping scenario

This is the projected BAU condition in accordance with population and economic growth. As explained in chapter 2, the open dumping scenario is the current situation in Indonesia. The assumptions made are the following:

- Transportation of solid waste by the government had a 50% service level in 2005. The level of service is expected to increase 1 - 2% per year from 2005 to 80% in 2020, and to 90% in 2030.
- Solid waste burning (combustion) in urban areas is collectively transported and is expected to increase from 0.5% in 2005 to 0.8% in 2020, and 0.9% in 2030. Self-managed solid waste burning on the other hand, is expected to decrease from 24% in 2005 to 4.8% in 2030.
- The proportion of solid waste generation that is self-managed by the community and dumped anywhere was 25% in 2005 and is expected to decrease to 5% in 2030. Solid waste dumped in rivers was 1% in 2005 and is expected to decrease to 0.2% in 2030.
- The proportion of solid waste that is openly dumped in urban areas was about 49.5% in 2005, and is expected to increase to 89.10% in 2030.

2) Waste Reduction at the Source Scenario

- The assumptions made in relation to the transportation of solid waste are similar to those made for the BAU scenario: service levels were at 50% in 2005 and are expected to increase 1 – 2% per year from 2005 to 2020, reaching 80% in 2020 and 90% in 2030.
- Solid waste generation of urban areas increased from 0.6 kg/ person/ day in 2005 to 1.1 kg/person/day in 2030. Increases in solid waste generation can be minimized by reducing domestic solid waste at its source so that solid waste generation per capita decreases by 20% compared to BAU. Reducing the amount of solid waste signifies a reduction of GHG emissions generated by its disposal.

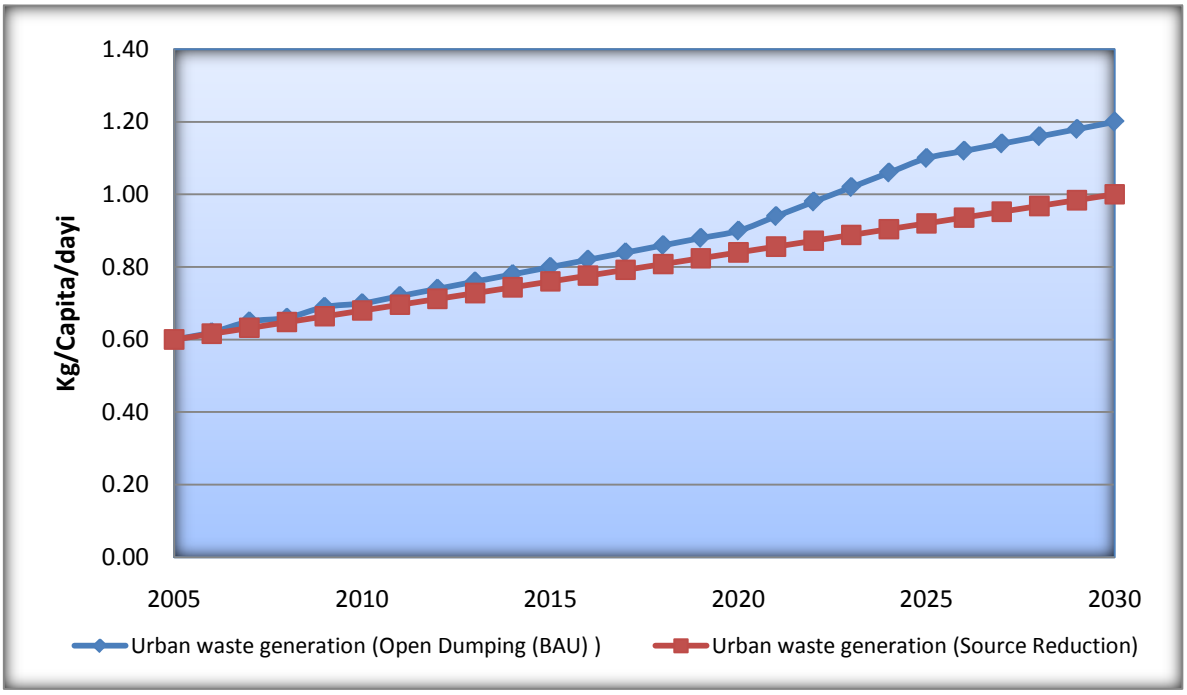


Figure 4.1 Urban waste generation per capita in Source Reduction Scenario

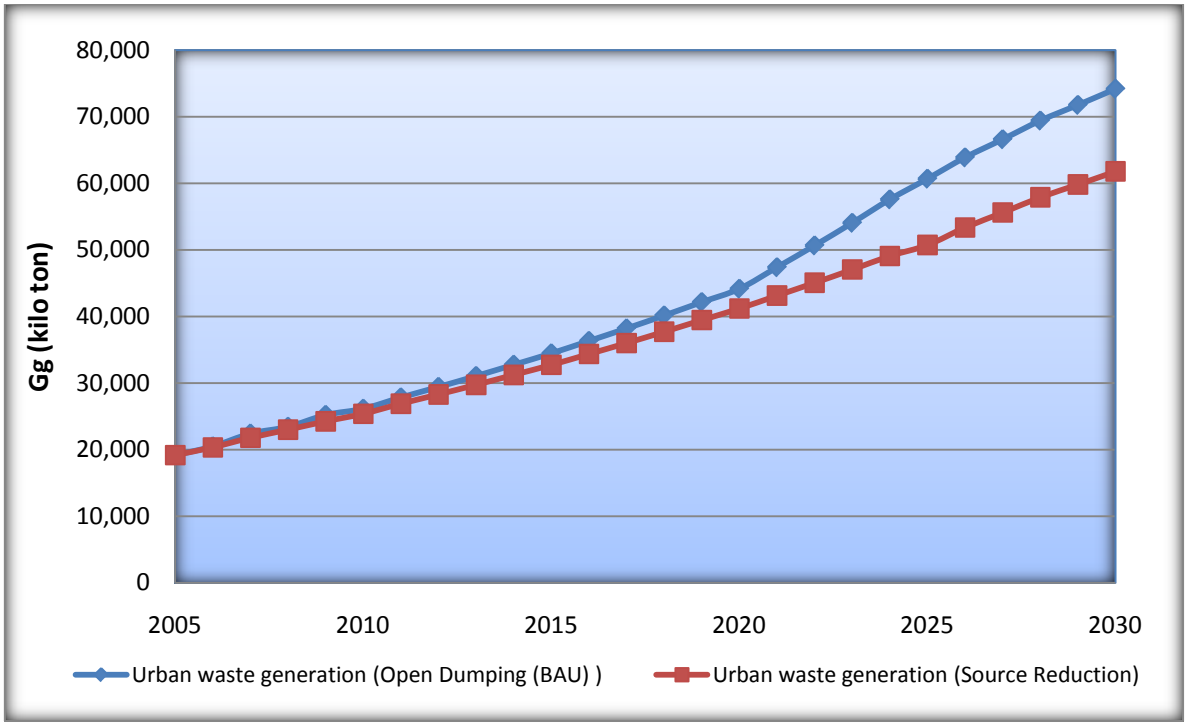


Figure 4.2 Waste generation in Source Reduction Scenario compared with BAU

3) 3R and Composing scenario

- The assumptions made in relation to the transportation of solid waste are similar to those made for the BAU scenario: service levels were at 50% in 2005 and are expected to increase 1 – 2% per year from 2005 to 2020, reaching 80% in 2020 and 90% in 2030.
- The proportion of solid waste which is collectively transported (by government) for composting was 2.5% in the year 2005 and is expected to increase to 4.5% in 2030. The proportion of self-managed (by local community) composted solid waste on the other hand was 5% in 2005, and is expected to decrease to 1% in 2030.
- Collectively transported recycled plastic waste is expected to increase from 2.5% in 2005 to 4% in 2020, reaching 4.5% in 2030. The proportion of self-managed recycled plastic waste was 5% in 2005 and is expected to decrease to 1% in 2030.
- Collectively transported recycled paper waste is expected to increase from 2.5% in 2005 to 4.5% in 2030, while self-managed recycled paper waste is expected to decrease from 5% in 2005 to 1% in 2030.

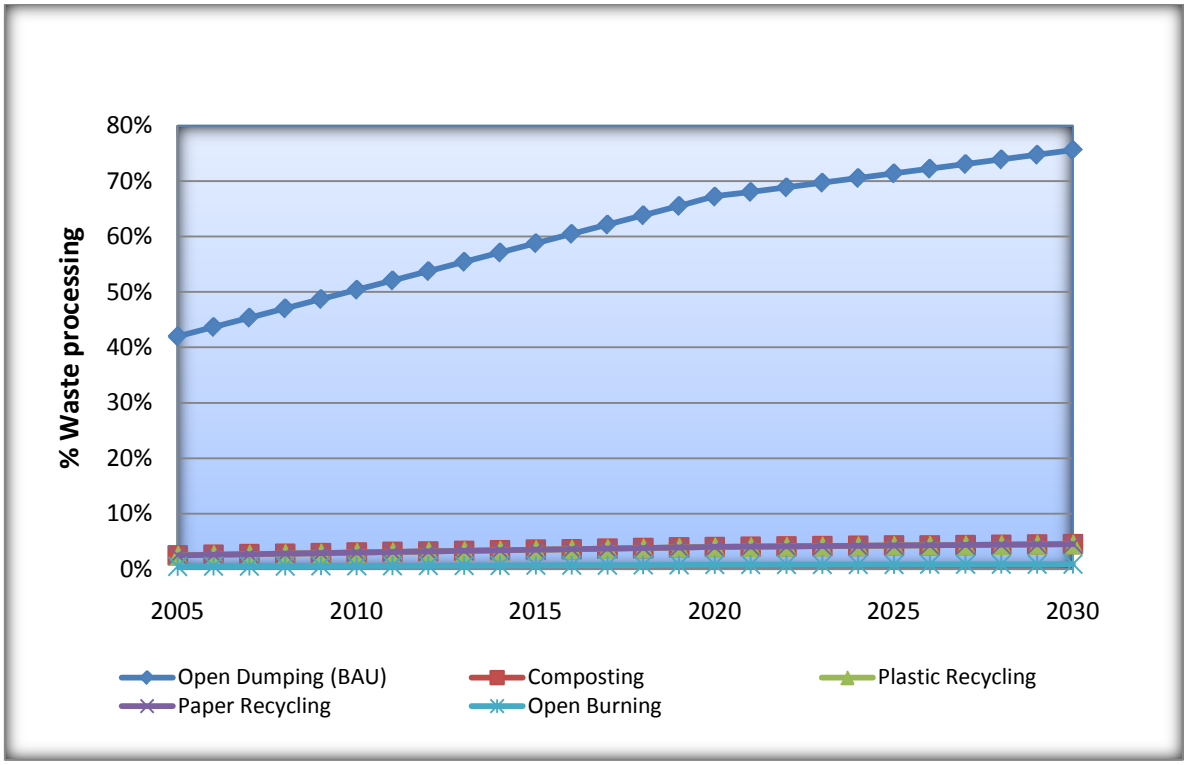


Figure 4.3 Projection of % waste processing by Local Government in 3R and Composting Scenario in Urban areas

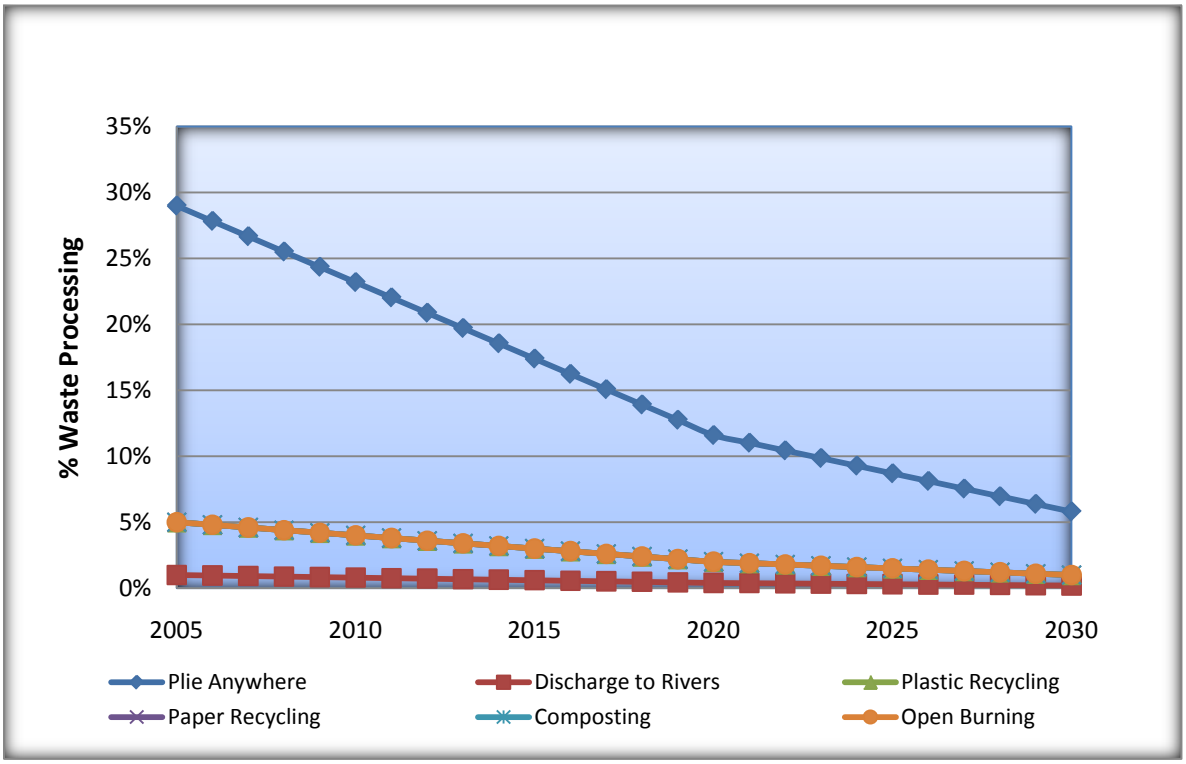


Figure 4.4 Projection of % waste processing by Local Community in 3R and Composting Scenario in Urban areas

4) Sanitary Landfill without LFG installation

- The assumptions made in relation to the transportation of solid waste are similar to those made for the BAU scenario: service levels were at 50% in 2005 and are expected to increase 1 – 2% per year from 2005 to 2020, reaching 80% in 2020 and 90% in 2030.
- The conversion of open dumping to sanitary landfill is expected to increase the proportion of solid waste that is brought to sanitary landfills from 0.5% in 2005 to 2.4% in 2010, reaching 56% in 2020 and 63% in 2030.
- The proportion of waste processed in controlled landfill was 4% in 2005 and is expected to increase to 23.4% in 2020 and 26.1% in 2030.

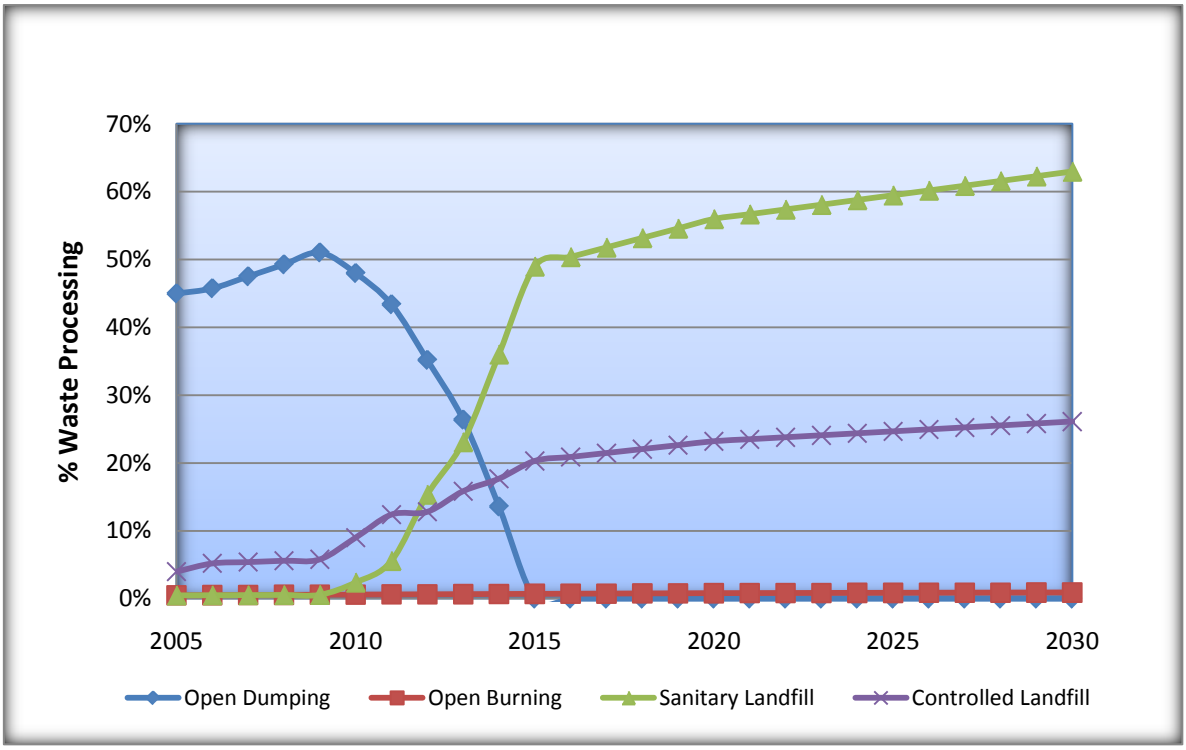


Figure 4.5 Projection of % waste processing by Local Government in SL+CL Scenario in Urban areas

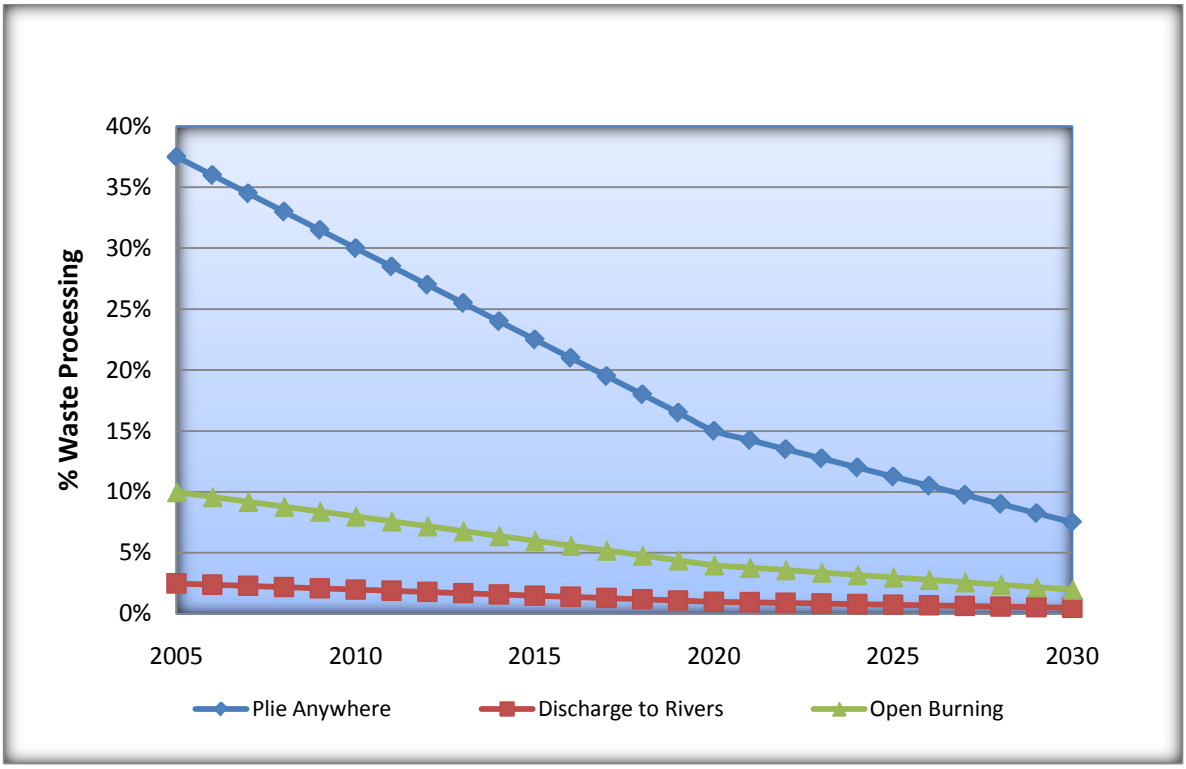


Figure 4.6 Projection of % waste processing by Local Community in SL+CL Scenario in Urban areas

5) Sanitary Landfill with LFG Installation Scenario

- The assumptions made in relation to the transportation of solid waste are similar to those made for BAU scenario,: service level s were at 50% in 2005 and are expected to increase 1 – 2% per year from 2005 to 2020, reaching 80% in 2020 and 90% in 2030.
- The conversion of open dumping to sanitary landfill is expected to increase the proportion of solid waste brought to sanitary landfills from 4.5% in 2005, to 79.2% in 2020 and 89.10% in 2030.
- Sanitary landfills are equipped with LFG (Landfill Gas) capture technologies, so an estimate on the potential revenue for each kWh generated has been made.

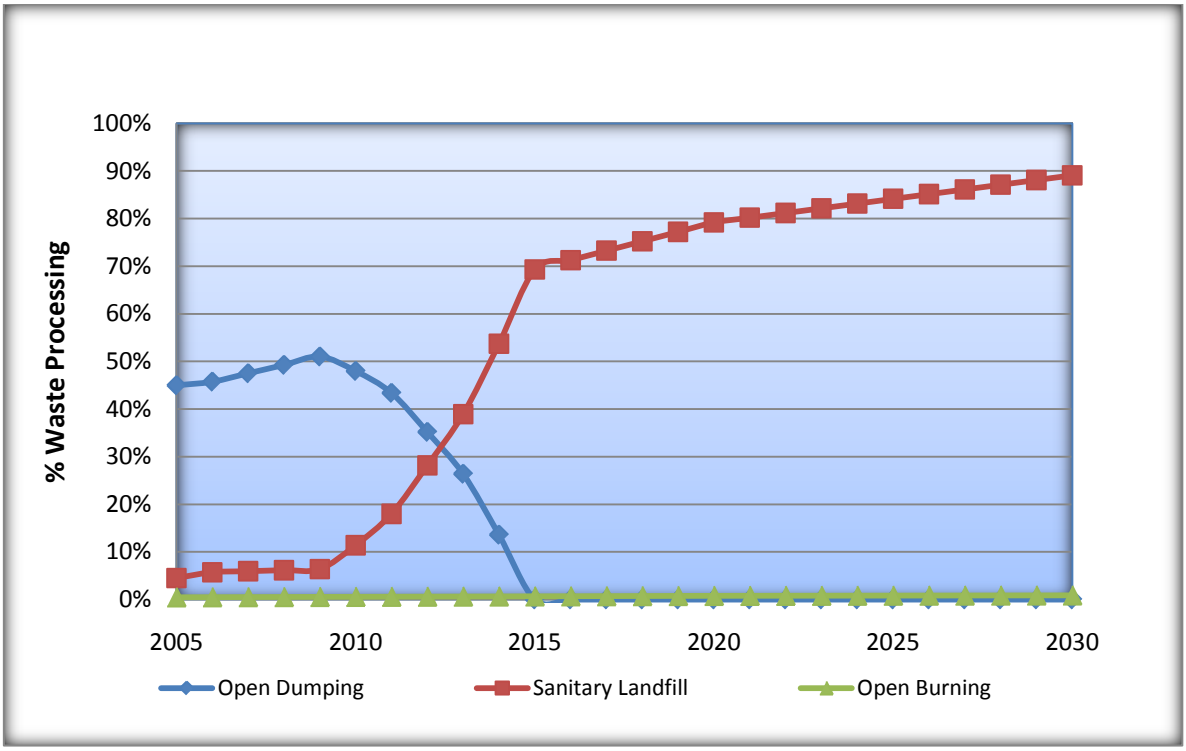


Figure 4.7 Projection of % waste processing by Local Government in SL+LFG Scenario in Urban areas

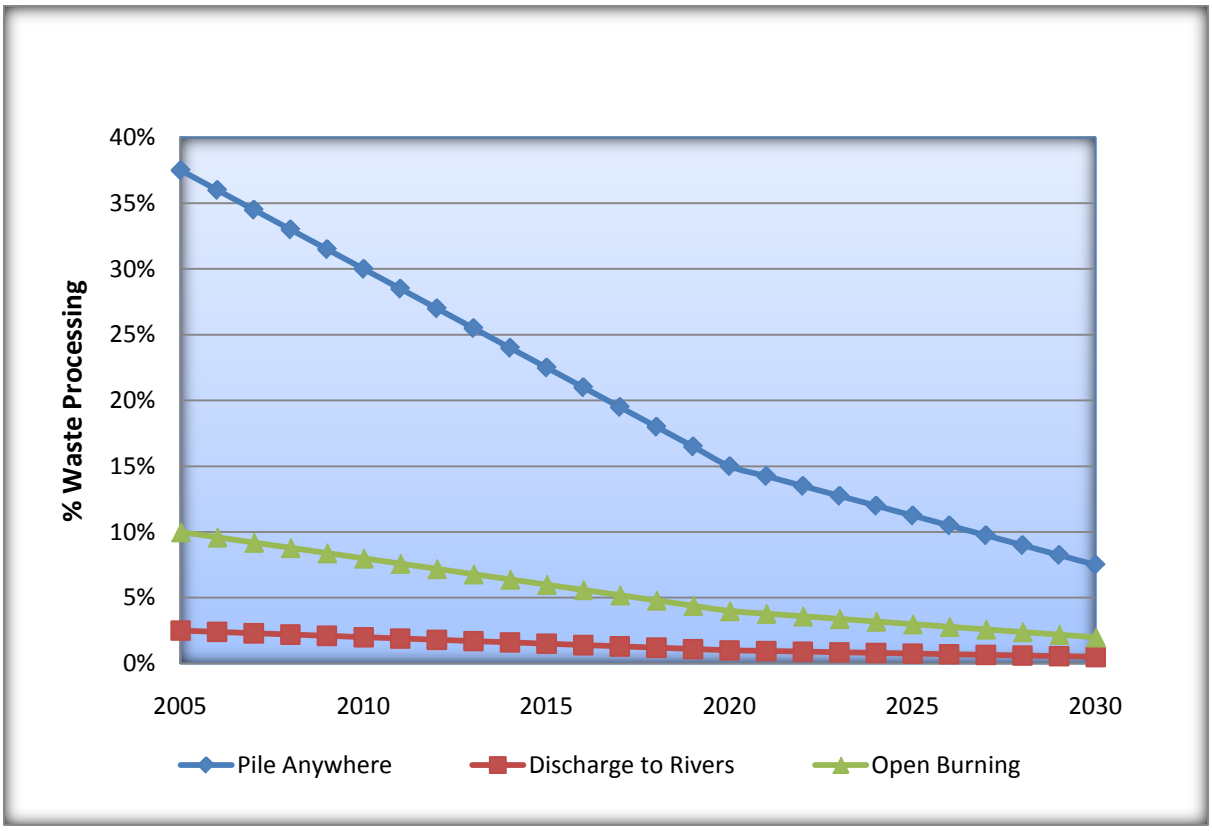


Figure 4.8 Projection of % waste processing by Local Community in SL+LFG Scenario in Urban areas

4.3 Greenhouse Gas Mitigation Scenario in Rural Area

1) Open Dumping and Open Burning Everywhere Scenario

- Solid waste burning (combustion) in urban areas that has been collectively transported is expected to increase from 12% in 2005 to 19.5% in 2030, while the proportion of self-managed solid waste burning (combustion) is expected to decrease from 40% in 2005 to 33.75% in 2030.
- The proportion of self managed solid waste that is dumped anywhere was 28% in 2005 and is expected to decrease to 23.63% in 2030, while the proportion of solid waste that is dumped into rivers was 12% in 2005 and is expected to decrease to 10.13% in 2030.

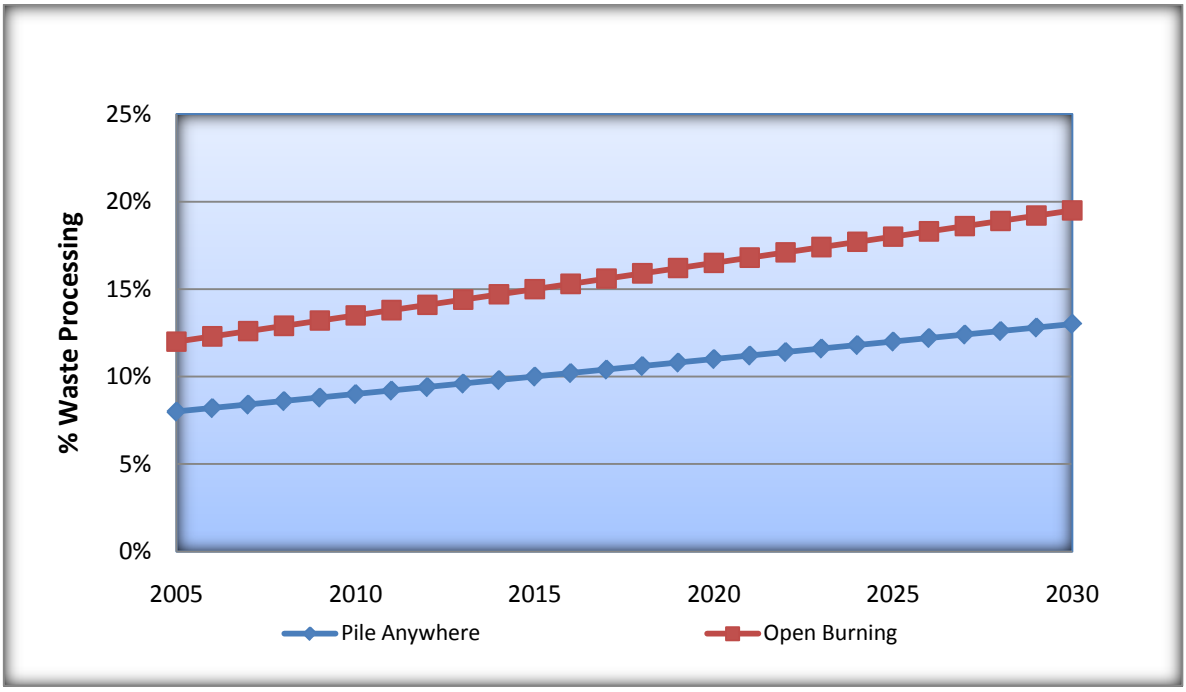


Figure 4.9 Projection of % waste processing by Local Government in BAU Scenario in Rural

2) Source Reduction Scenario

- The assumptions made in relation to transportation are similar to those made for the burning and dumping anywhere scenario: solid waste burning (combustion) in urban areas which is collectively transported is expected to increase from 12% in 2005 to 19.5% in 2030. The proportion of self-managed solid waste burning (combustion) is expected to decrease from 40% in 2005 to 33.75% in 2030
- Rural waste generation per capita is expected to increase from 0.3 kg/capita/day in 2005 to 0.5 kg/capita/day in 2030.

- The increase of rural waste up to 0.5 kg/capita/day comes as a result of reduction efforts (including capacity building) . Otherwise quanitites would reach 0.55 kg/capita/day as is the case in the BAU scenario.

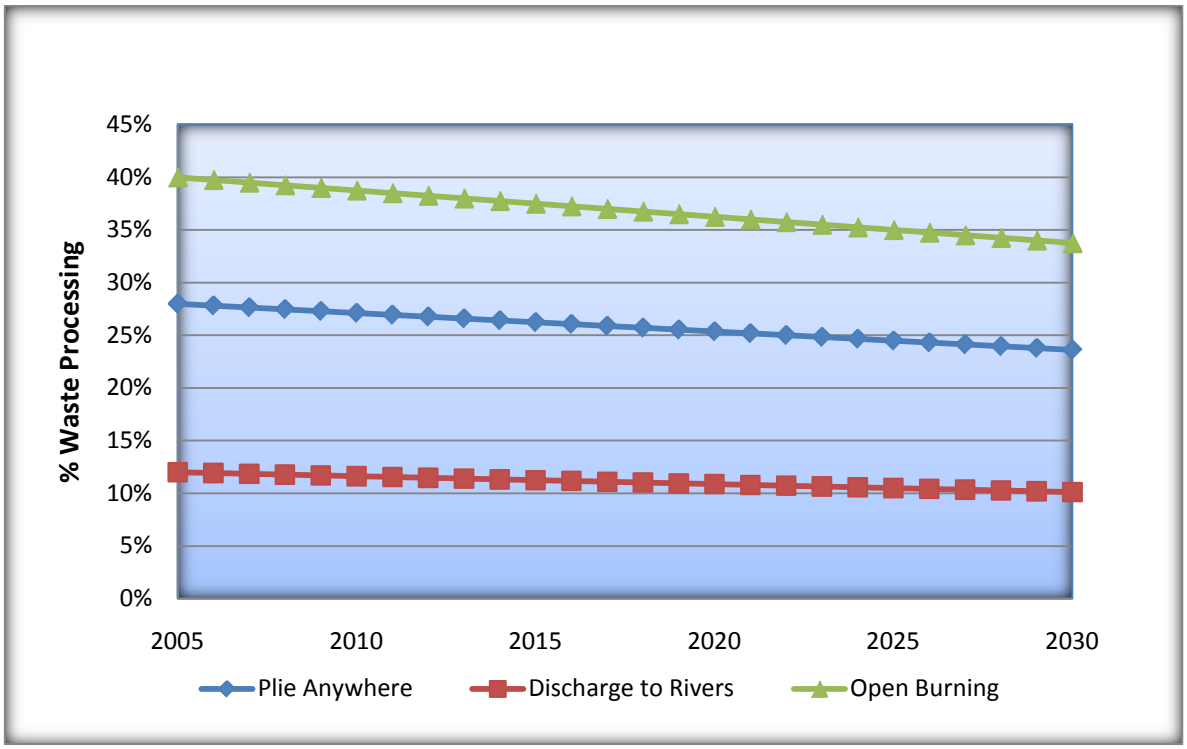


Figure 4.10 Projection of % waste processing by Local Community in BAU Scenario in Rural

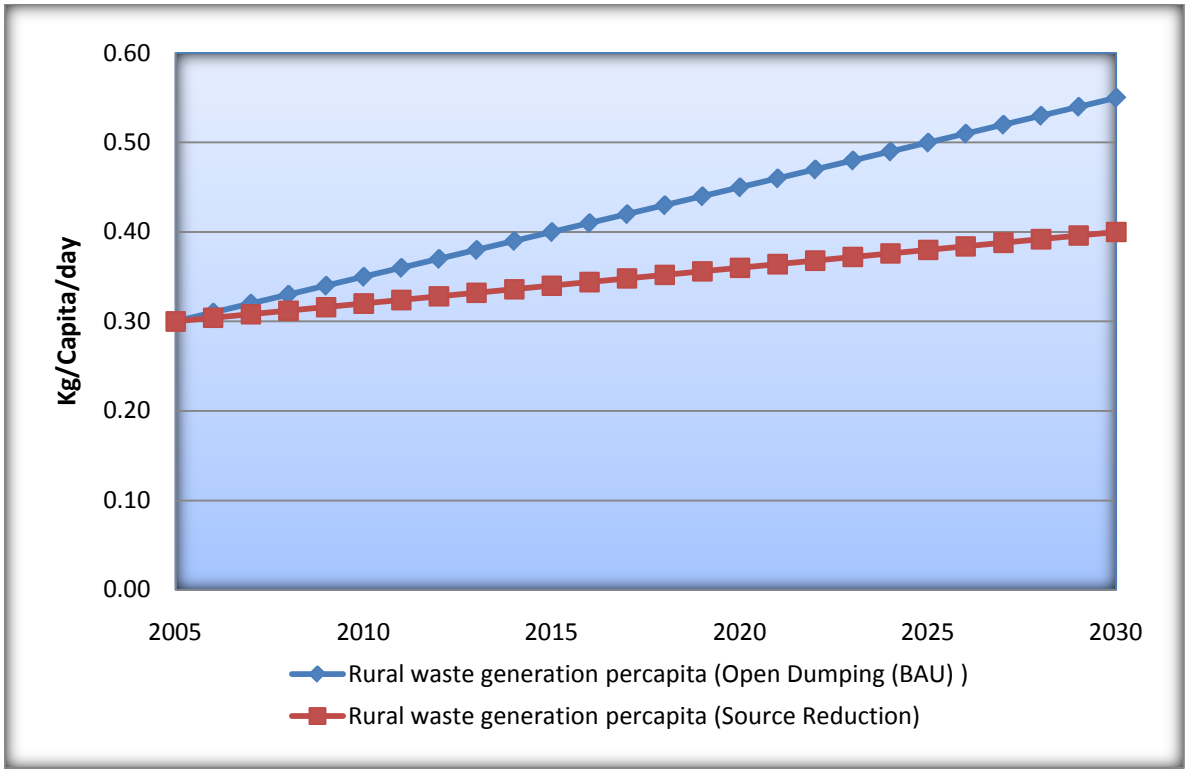


Figure 4.11 Projection of waste generation percapita in Source Reduction Scenario in Rural compared with BAU

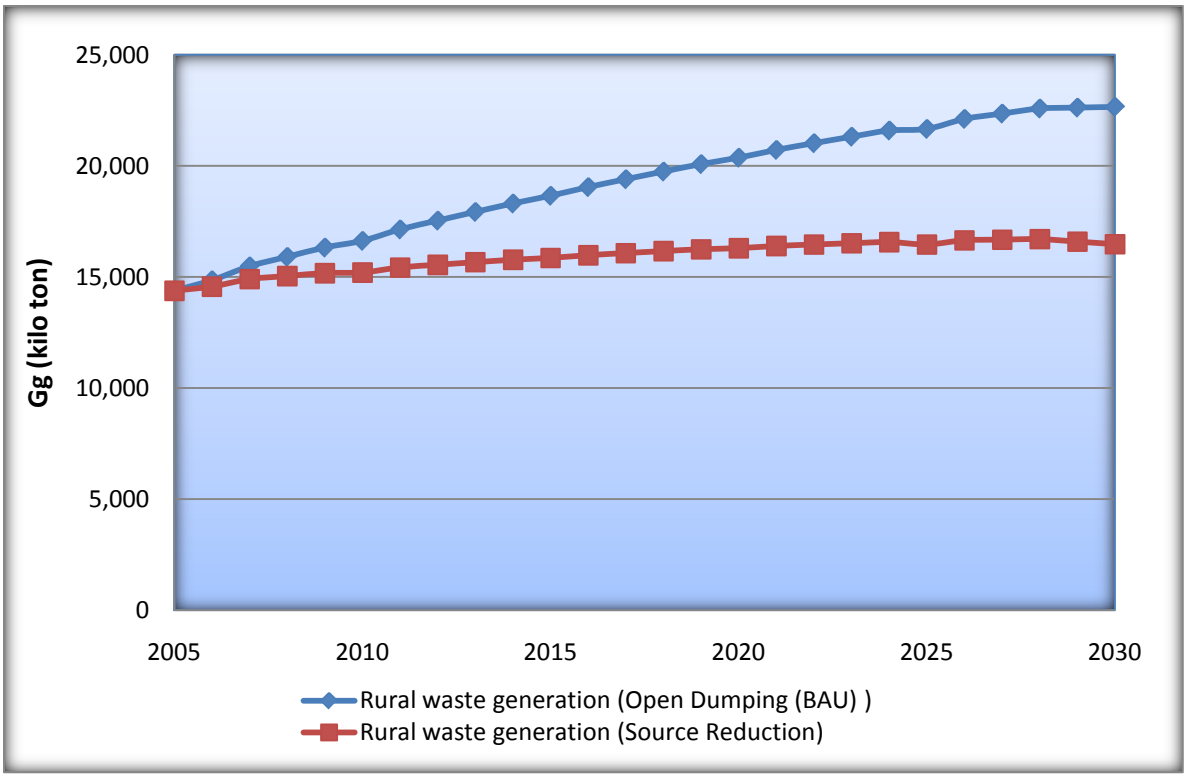


Figure 4.12 Projection of waste generation in Source Reduction Scenario in Rural compared with BAU

3) 3R and Composting

- The assumptions made for transportiation are similar to those made in the burning and dumping anywhere scenario: solid waste burning (combustion) in urban areas which is collectively transported is expected to increase from 12% in 2005 to 19.5% in 2030. The proportion of self-managed solid waste burning (combustion) is expected to decrease from 40% in 2005 to 33.75% in 2030.
- The proportion ofsolid waste generation that is collectively transported for composting was 5.5% in the year 2005 and is expected to increase to 19.3% in 2030, while self-managed composted solid waste was 28% in 2005 and is expected to decrease to 10.5% in 2030.
- The proportion of collectively transported recycled plastic waste is expected to increase from 1% in 2005 to 3.5% in 2030, while self managed recycled plastic waste was 4% in 2005 and is expected to decrease to 1.5% in 2030.
- The proportion of collectively transported recycled paper waste is expected to increase from 1% in 2005 to 3.5% in 2030, while self managed recycled paper waste is expected to decrease from 4% in 2005 to 1.8% in 2030.

4.4 Calculation Result of GHGs Scenario for Mitigation on Waste Sector

Figure 4.13 shows the results of the calculation of GHG emissions from the waste sector. The largest proportion of emissions are generated by the BAU (open dumping) scenario, followed by the other scenarios. The reduction at the source scenario does not decrease GHG emissions significantly due to the limited campaign activities and capacity building that are included. Economic progress might trigger the society to continue to increase the amount of solid waste. Reduction at the source scenario can be successful if it is supported by policies and legislation that follow up with sanctions.

The SL + CL (conversion from open dumping to a Sanitary Landfill and Controlled Landfill) scenario results in higher GHG emissions than the 3R (reduce, reuse, recycle) and composting scenario due to the fact that processing of solid waste in SL and CL increases the anaerobic process that is responsible for CH4 generation; nevertheless, its emissions are not as high as that of the open dumping scenario. The process of aerobically composting solid waste does not

produce CH_4, however 3R activities, such as processing and recycling of plastic, do produce emissions in the form of CO_2 from the combustion process associated with recycling. The SL + LFG scenario has the smallest proportion of emissions due to the flaring (combustion) of CH_4 into CO_2 and H_2O, and its use of CH_4 for electricity generation.

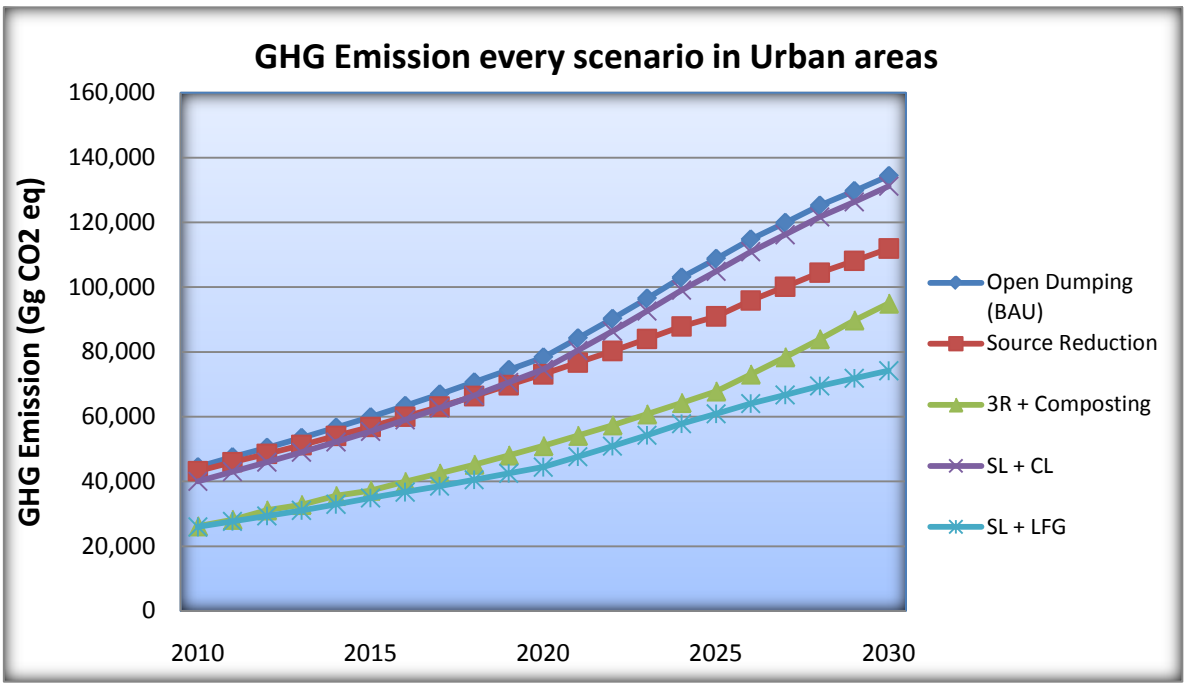


Figure 4.13 GHG emissions (in Gg CO2 eq) in urban areas for every scenario

Figure 4.14 shows GHG emissions produced by solid waste processing in rural areas. BAU scenario emissions are the highest, while emissions from the reduction at the source scenario and the 3R + composting scenario produces less GHG than BAU. In rural areas, composting is recommended for the following reasons: (1) the composition of solid waste in the rural areas is dominated by organic waste suitable for composting, (2) composting activities in rural areas will grow rapidly because land is still widely available, (3) a market is available, as the main users of compost is the agricultural sector and plantation farmers, (4) compost can improve soil quality, (5) composting technology is relatively simple, so it is easy to carry out by villagers. The biggest obstacles to using organic fertiliziser are perceived problems associated with farmers' practice of using chemical fertilizers. Thus, it is necessary to make farmers aware of the detrimental effect that the use of chemical fertilizers have on the quality of the soil in the long run. Another problem is that organic fertilizer requires a relatively long time to be produced. This problem can be tackled by developing a special bacteria to speed up the associated process. Hence, the development of biotechnology related to composting should be developed in line with efforts to increase the uptake of of organic fertilizer use.

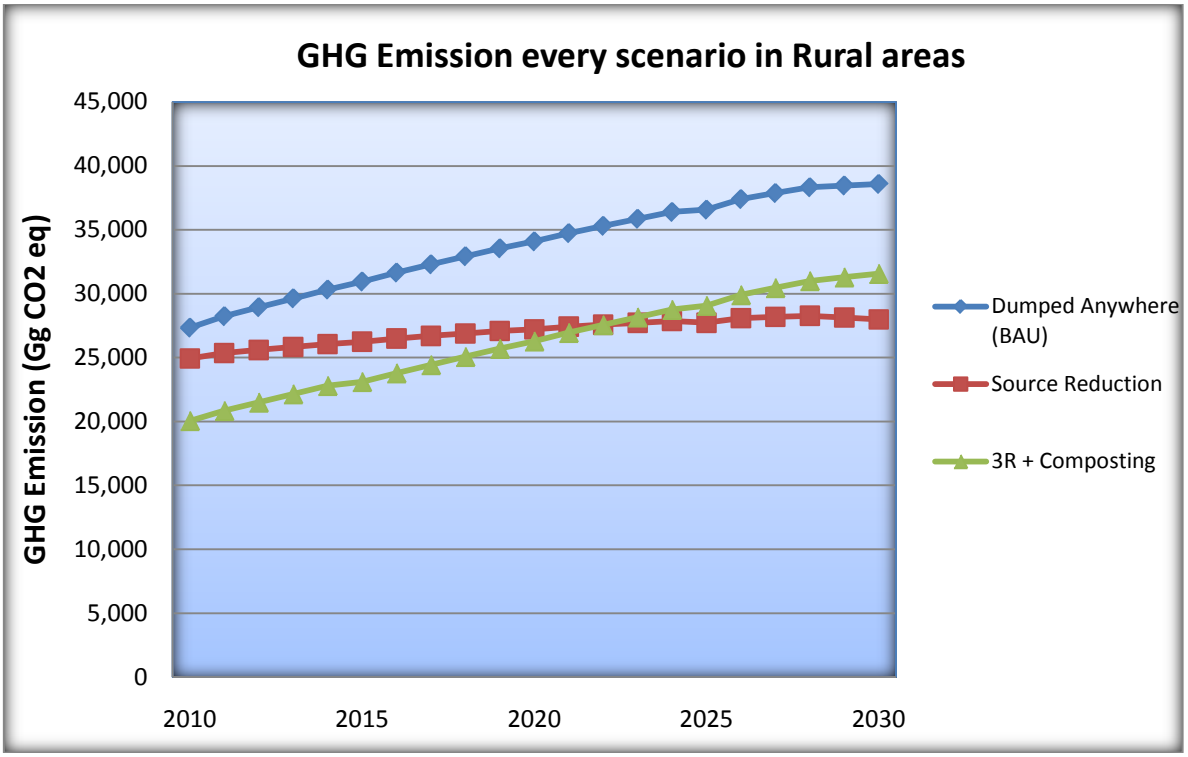


Figure 4.14 GHG emissions (in Gg CO2 eq) in rural areas for every scenario

Figure 4.15 and 4.16 shows GHG emission reductions from each scenario. Emission reduction is calculated by the following formula:

Emissions Reduction = BAU's Emissions- Scenarios' Emissions

As shown in Figure 4.15, the largest reduction of emissions scenario in urban area is SL + LFG. Figure 4.16 shows the reduction of GHG emissions from each scenario in the rural areas.

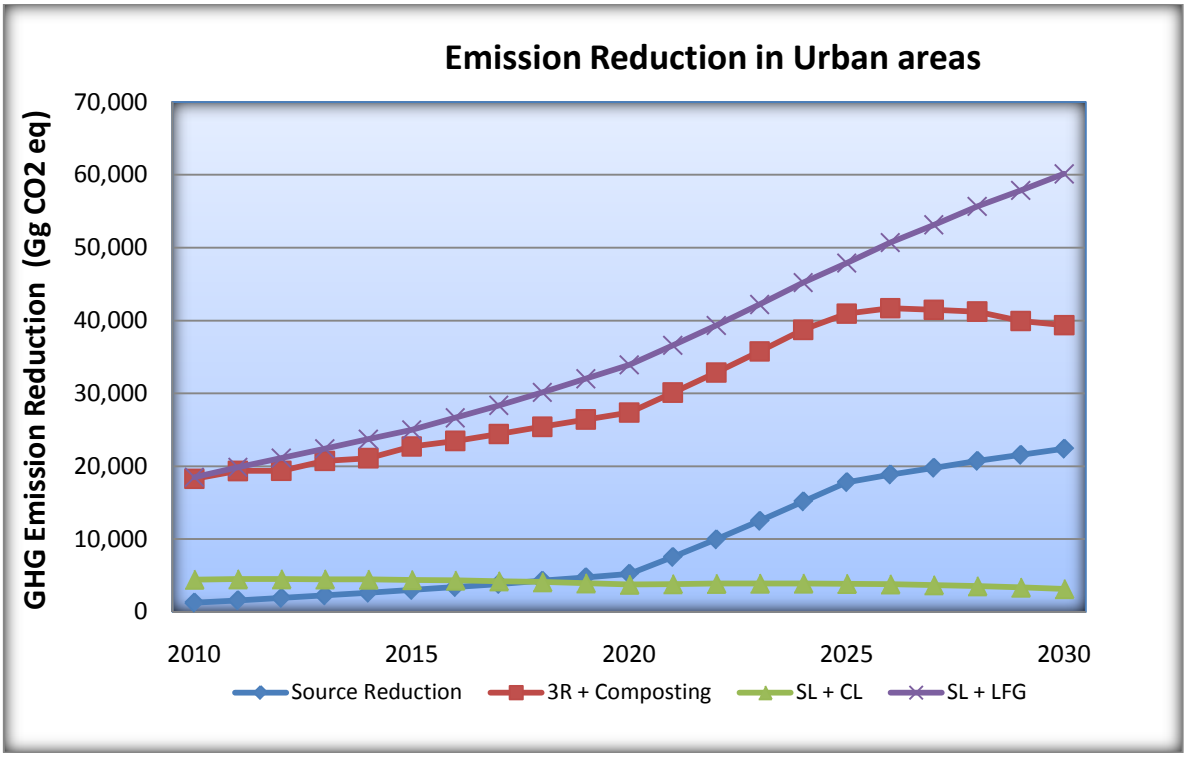


Figure 4.15 GHG emission reduction (in Gg CO_2 eq) in urban areas for every scenario

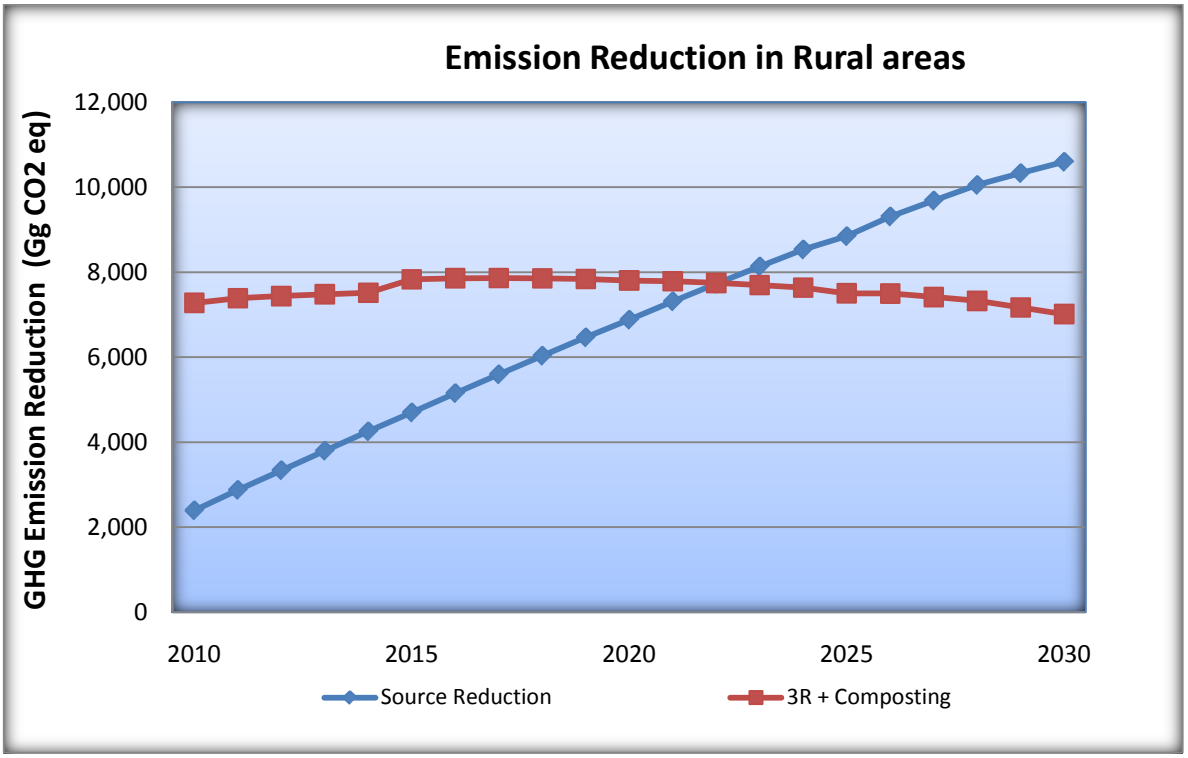


Figure 4.16 GHG emission reduction (in Gg CO_2 eq) in rural areas for every scenario

Figure 4.17 shows the cost of waste management. Figure 4.18 shows the cost of mitigation, namely a certain waste management costs reduced by BAU's scenario costs.

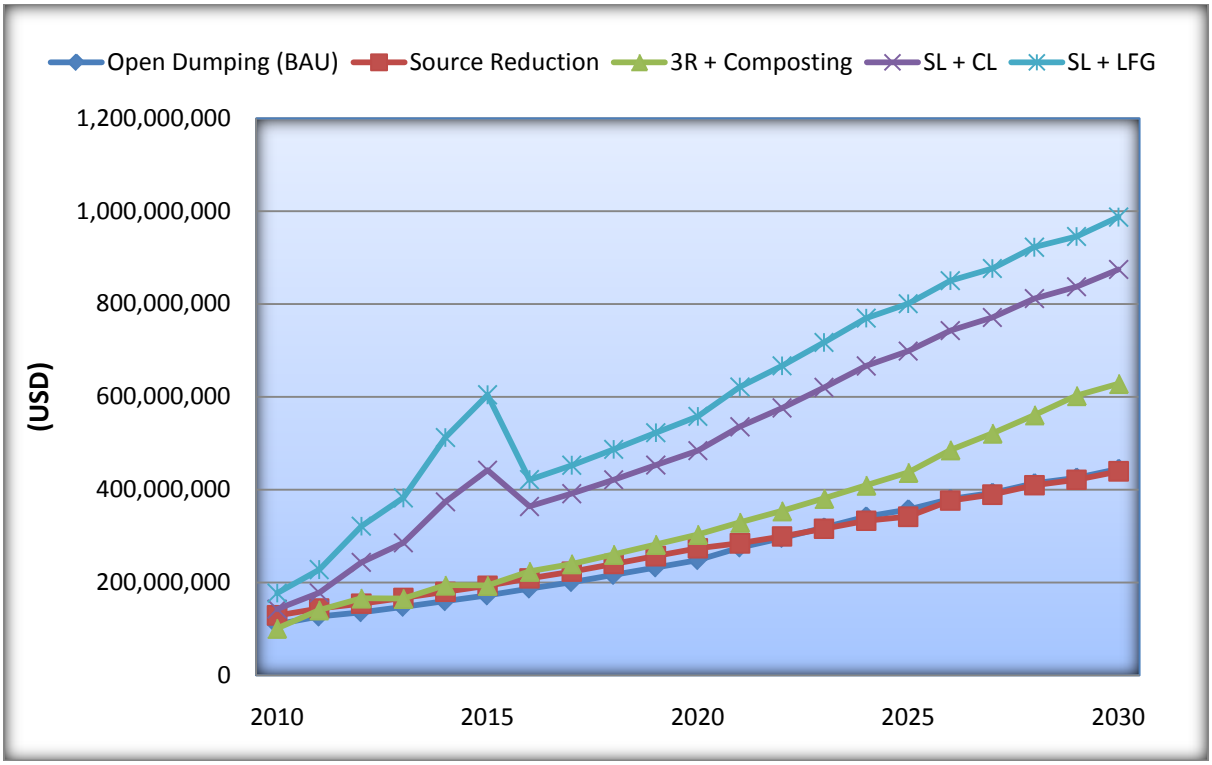


Figure 4.17 Waste Management cost in urban areas for every scenario

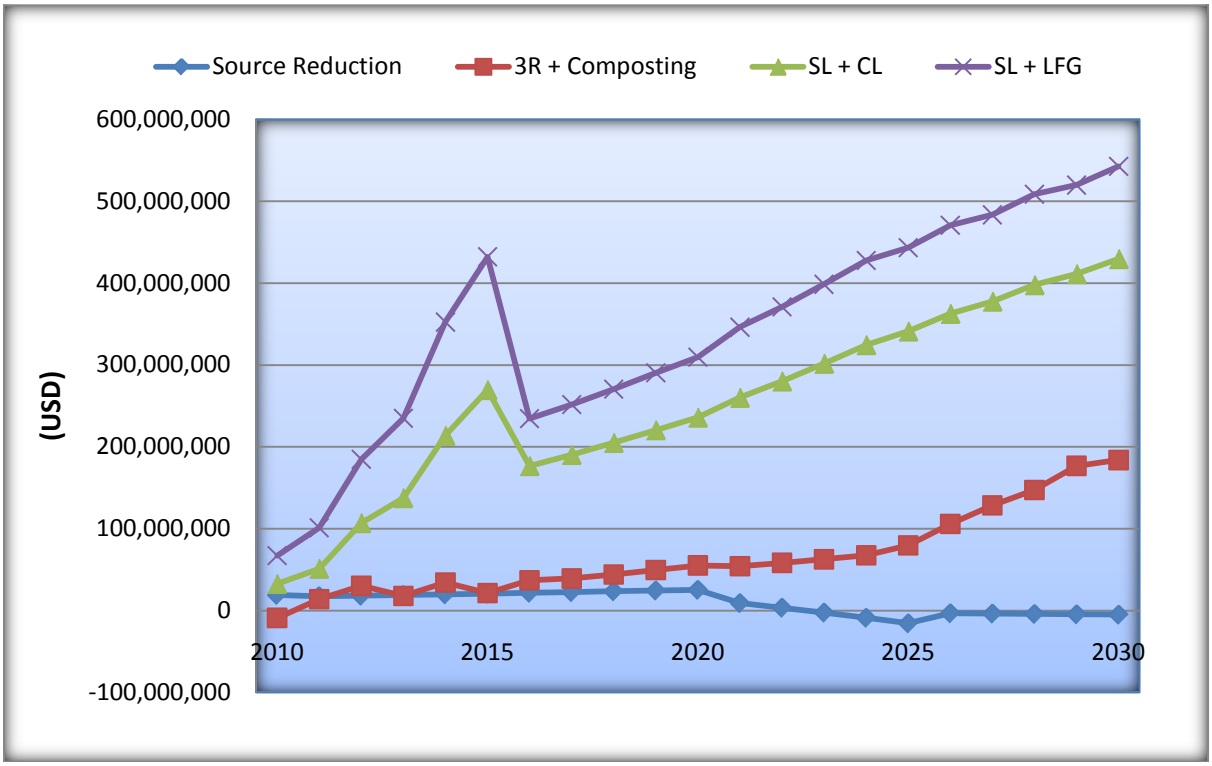


Figure 4.18 Mitigation cost (Scenario Cost - BAU Cost) in urban areas for every scenario

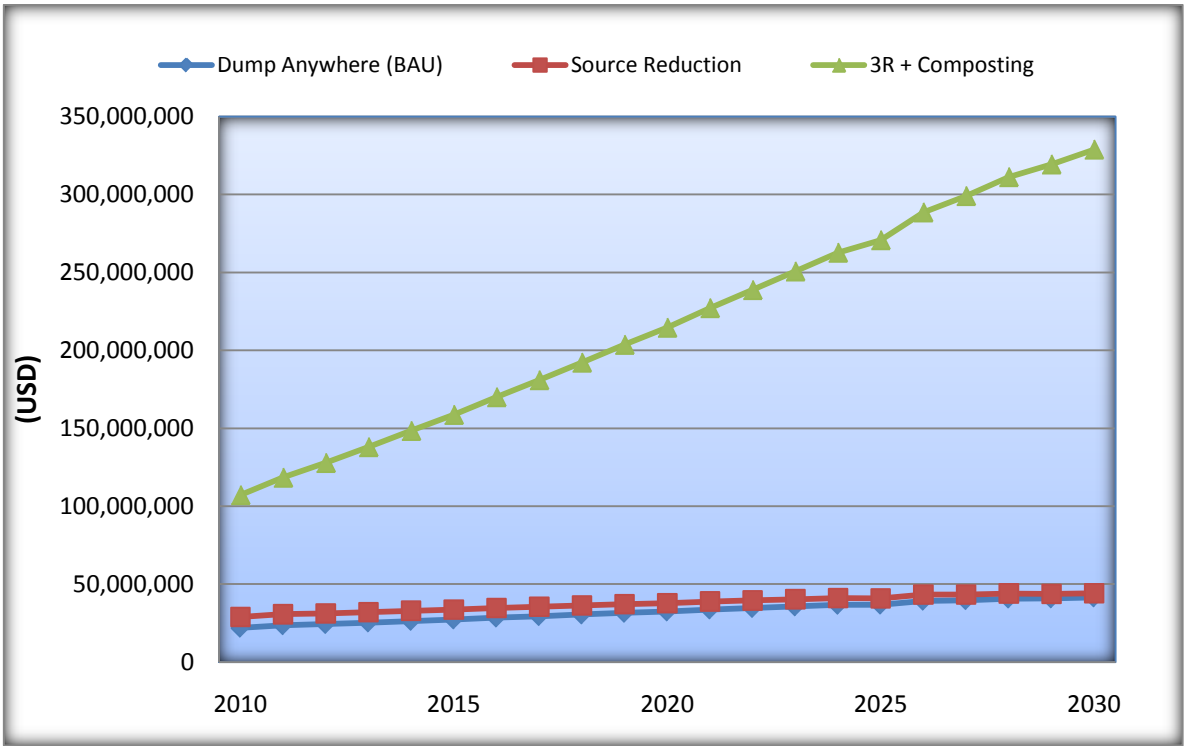


Figure 4.19 Waste Management cost in rural areas for every scenario

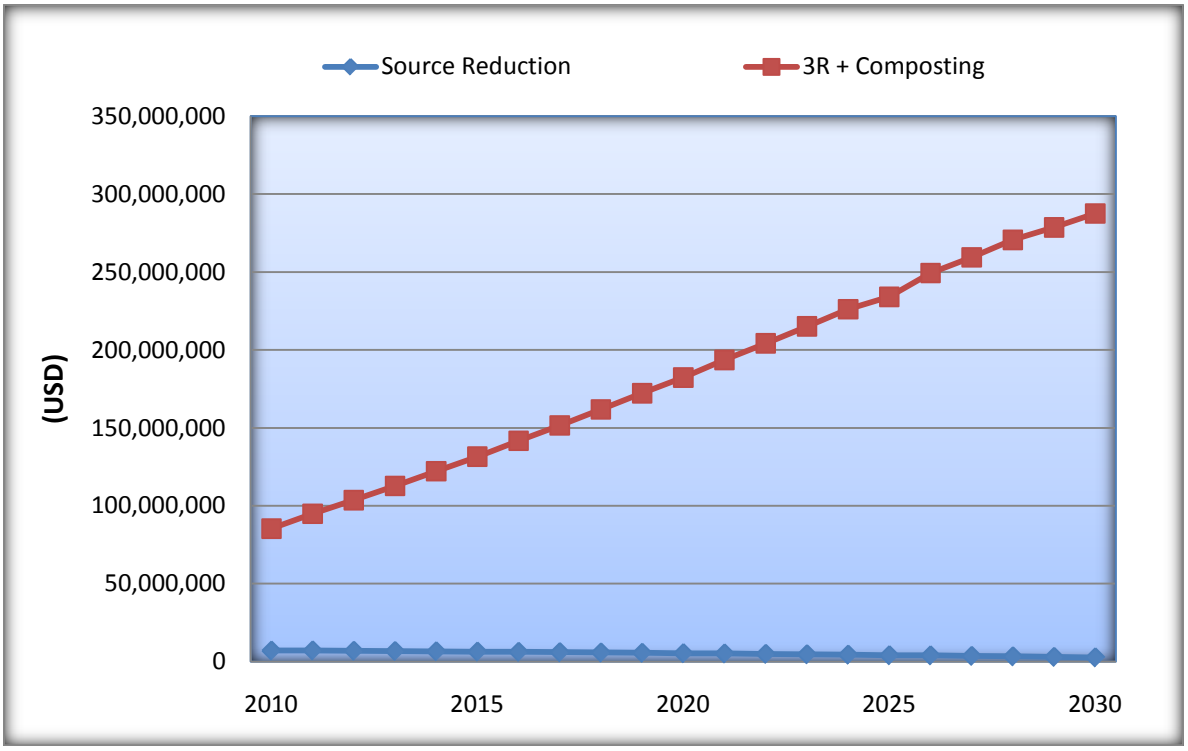


Figure 4.20 Mitigation cost (Scenario Cost - BAU Cost) in rural areas for every scenario

Table 4.1 Comparison Matrix of GHG Emission Mitigation Scenario from Waste Sector in Indonesia for Urban Areas.

Scenarios	Period	Emission Reduction Accumulation (Mt CO2)	Total Cost of Mitigation (billion USD)	Abatement Cost (USD/t CO_2)	Emission Reduction Compared to BAU (%)	Policies Required
Source Reduction	2010 – 2020	17.73	0.13	7.61	5.12%	(1) Carry out an inventory study of GHG from the waste sector which is comprehensive and reliable, accompanied by a systematic GHG reduction plan. (2) Apply infrastructure development policies of source reduction regulation in solid waste, supported by applied technology research and development with an environmental perspective.
	2010 – 2030	45.14	0.13	2.90	11.30%	
3R + Composting	2010 – 2020	143.56	0.16	1.14	37.32%	(1) Carry out an inventory study of GHG from the waste sector which is comprehensive and reliable, accompanied by a systematic GHG reduction plan. (2) Develop and implement environmental policies that support the principle of 3R (reduce, reuse, recycle) and composting in waste management. (3) Develop and establish a 3R and composting center in every city/regency in Indonesia.
	2010 – 2030	211.17	0.33	1.57	35.58%	
SL + CL	2010 – 2020	28.94	0.96	33.34	7.07%	(1) Carry out an inventory study of GHG from the waste sector,

Scenarios	Period	Emission Reduction Accumulation (Mt CO2)	Total Cost of Mitigation (billion USD)	Abatement Cost (USD/t CO_2)	Emission Reduction Compared to BAU (%)	Policies Required
	2010 – 2030	35.77	1.57	43.84	4.74%	which is comprehensive and reliable, accompanied by a systematic GHG reduction plan. (2) Apply infrastructure development policies of conversion of open dumping to sanitary and controlled landfill, supported by applied technology research and development with an environmental perspective. (3) Apply waste management in the TPA (final disposal) from open dumping to controlled landfills in small and medium-sized cities; and sanitary landfills in large and metropolitan cities.
SL + LFG	2010 – 2020	159.18	1.49	9.35	42.28%	(1) Carry out an inventory study of GHG from the waste sector, which is comprehensive and reliable, accompanied by a systematic GHG reduction plan. (2) Apply infrastructure development policies of conversion from open dumping to sanitary landfill, and install LFG electricity generators, supported by applied technology research and development with an environmental perspective. (3) Waste management in the TPA from open dumping to sanitary
	2010 – 2030	243.67	2.27	9.33	43.46%	

Scenarios	Period	Emission Reduction Accumulation (Mt CO2)	Total Cost of Mitigation (billion USD)	Abatement Cost (USD/t CO_2)	Emission Reduction Compared to BAU (%)	Policies Required
						landfills (4) Improved methods of waste gas management (landfill gas - LFG) through collection and combustion, as well as the application of energy to electricity.

Table 4.2 Comparison Matrix of GHGs Emission Mitigation Scenario from Waste Sector in Indonesia for Rural Areas.

Scenarios	Period	Emission Reduction Accumulation (Mt CO2)	Total Cost of Mitigation (billion USD)	Abatement Cost (USD/t CO2)	Emission Reduction Compared to BAU (%)	Policies Required
Source Reduction	2010 – 2020	27.81	0.04	1.56	15.15%	(1) Carry out an inventory study of GHG from the waste sector which is comprehensive and reliable, accompanied by a systematic GHG reduction plan. (2) Apply infrastructure development policies related to source reductions in the waste sector, supported by applied technology research and development with an environmental perspective, (3) Apply source reduction policy
	2010 – 2030	43.66	0.05	1.17	20.02%	
3R + Composting	2010 – 2020	50.40	0.81	16.10	24.76%	(1) Carry out an inventory study of GHG from the waste sector, which is comprehensive and reliable, accompanied by a systematic GHG reduction plan. (2) Apply infrastructure development policies of 3R and composting regulation, supported by applied technology research and development with an environmental perspective. (3) Implement the 3R principle (reduce, reuse, recycle) in waste management. (4) Develop and establish a 3R and composting center in every city/regency in Indonesia.
	2010 – 2030	64.14	1.23	19.23	22.41%	

4.5 Calculation of Abatement Cost

Mitigation costs are calculated based on investment costs and operational/maintenance costs. The interest rate here is 12% / year. ACERS (Emissions Reduction Scenario Abatement Costs) are calculated based on (Situmeang, 2009):

$$\text{ACERS} = \frac{[\text{NPV (Total Cost of BAU)} - \text{NPV (Total Costs of ERS)}]}{[\text{NPV (Total Emission of BAU)} - \text{NPV (Total Emission ERS)}]}$$

ACERS = Emissions Reduction Scenario Abatement Costs

NPV = Net Present Value

ERS = Emission Reduction Scenario

To calculate Abatement Costs, both Mitigation Costs and Emission Reductions arecalculated according to the NPV method; the results of the calculation are as follows:

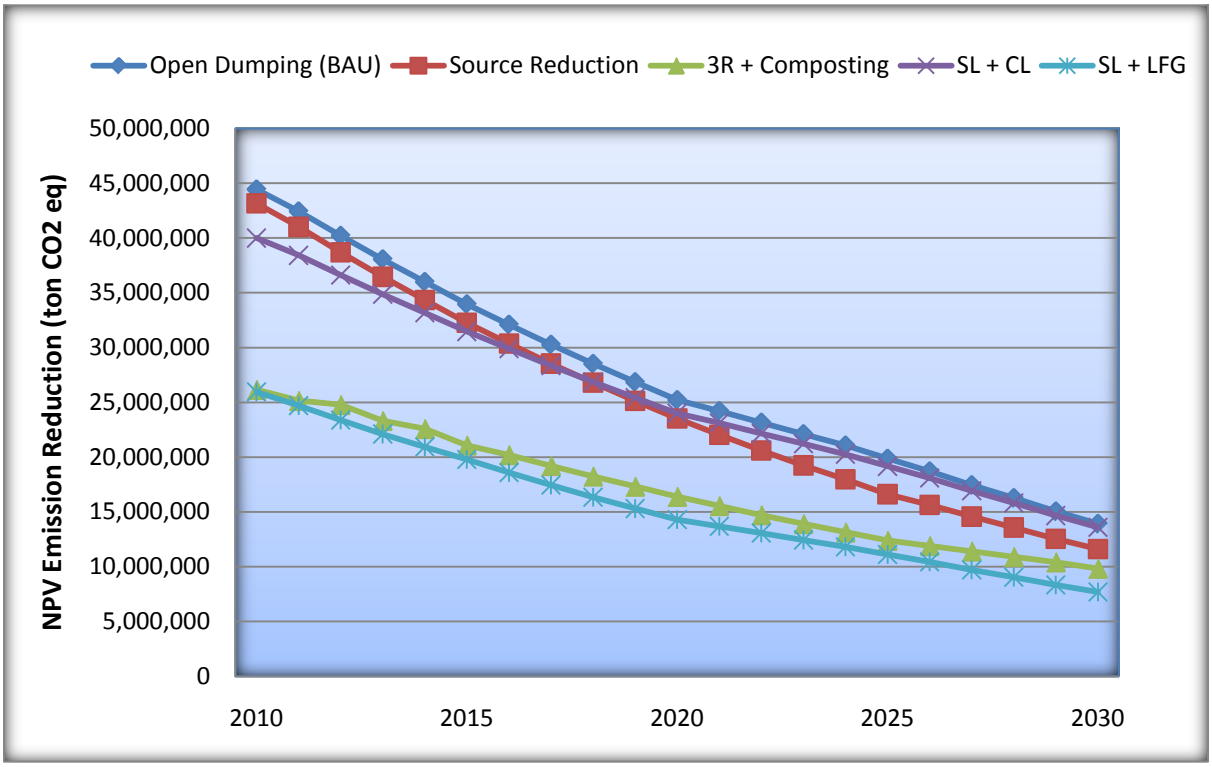


Figure 4.21 Calculation of NPV for Emision Reductions (in tons CO2 eq) for each scenario in urban areas

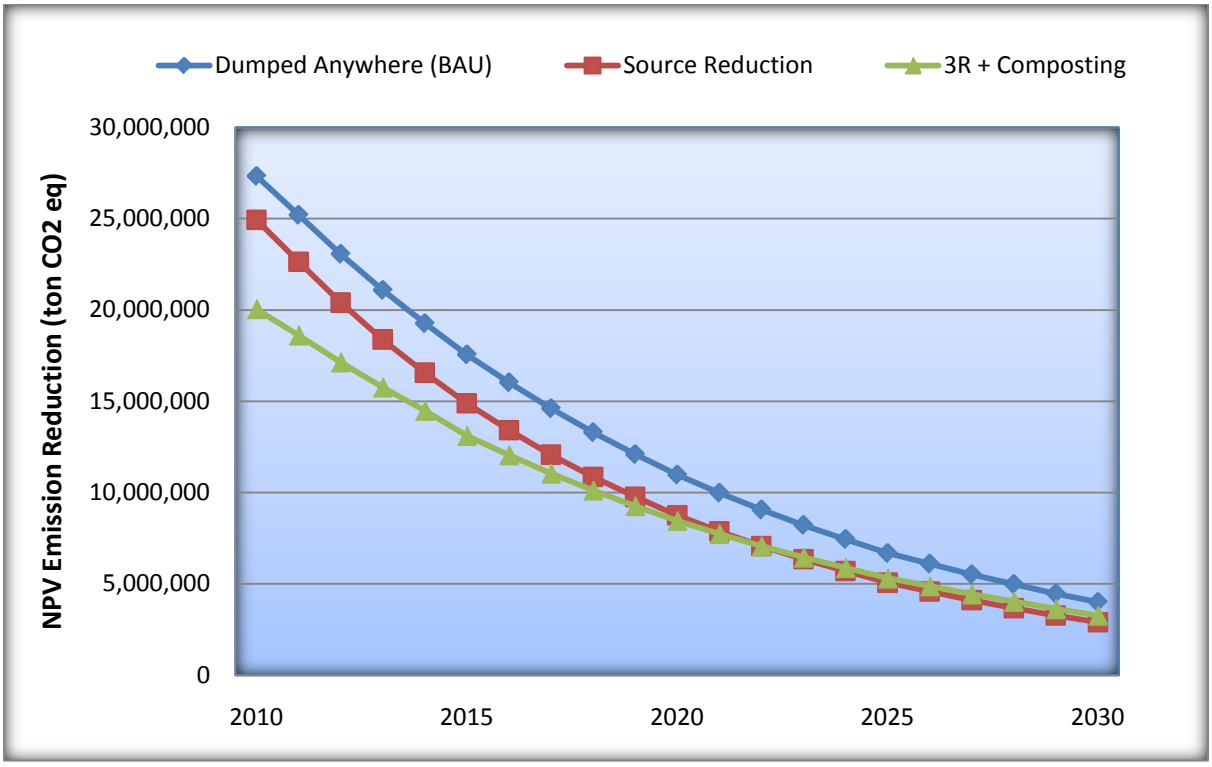


Figure 4.22 Calculation of NPV for Emision Reductions (in tons CO2 eq) for each scenario in rural areas

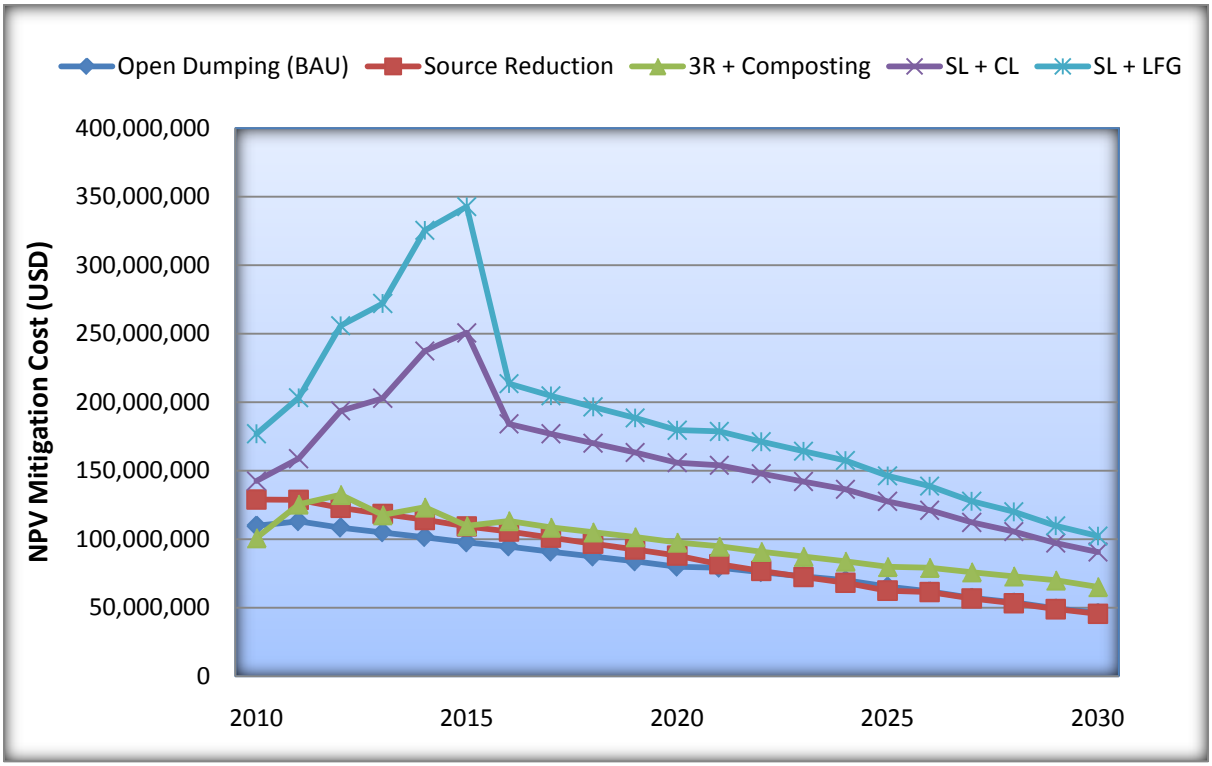


Figure 4.23 Calculation of NPV for Mitigation Costs (in USD) for each scenario in urban areas

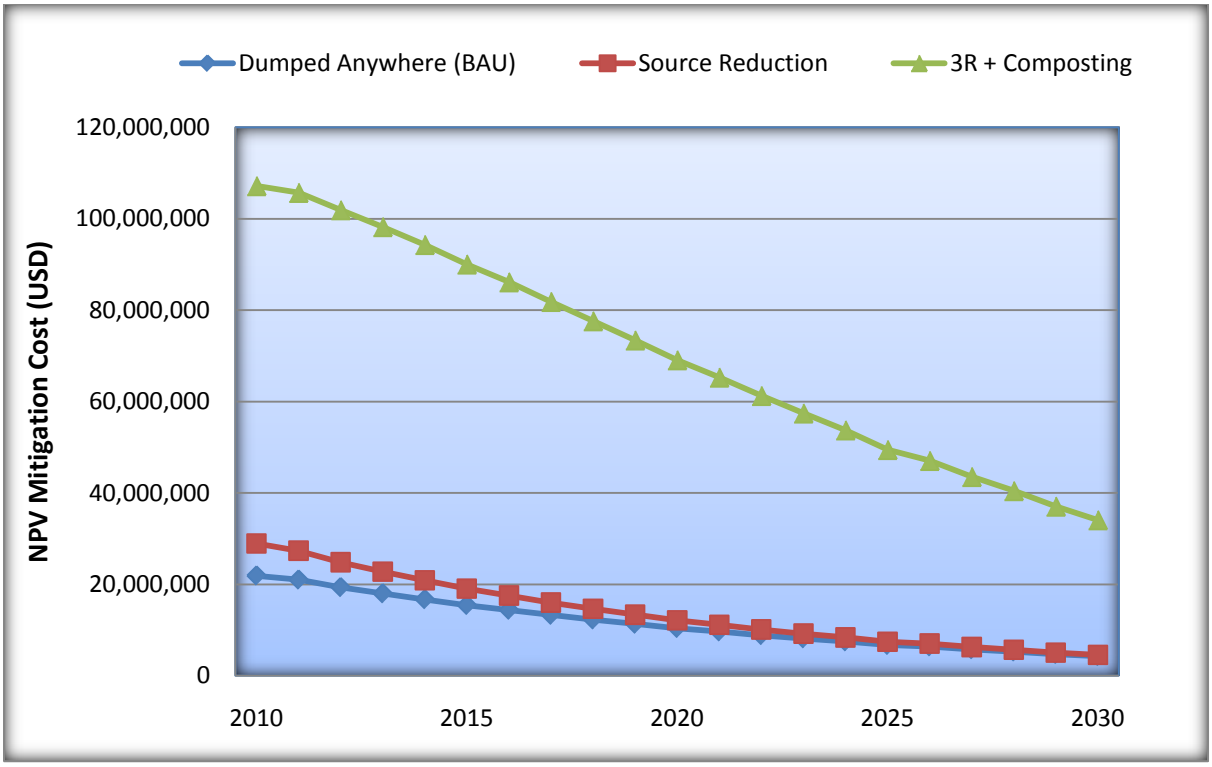


Figure 4.24 Calculation of NPV for Mitigation Costs (in USD) for each scenario in rural areas

Figure 4.25 and 4.26 show the abatement costs for the different scenarios in urban and rural areas respectively.

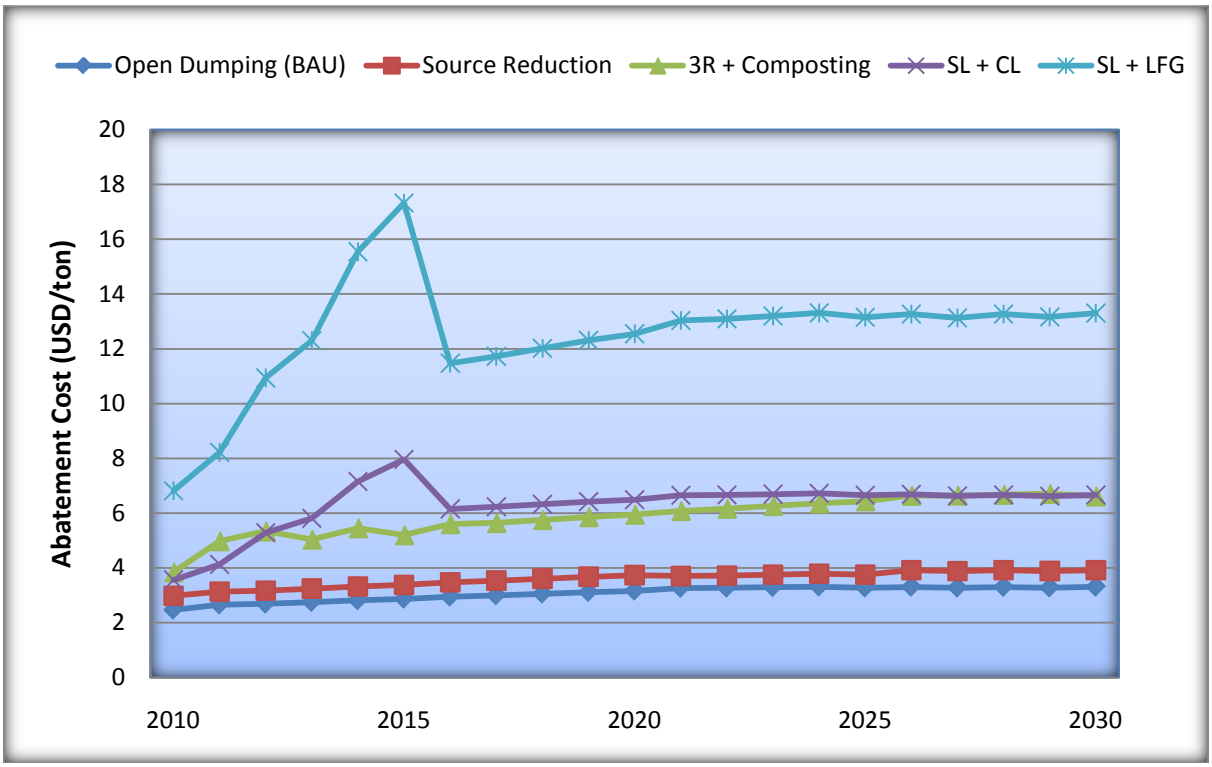


Figure 4.25 Abatement Costs for each scenario in urban areas (in USD/ton)

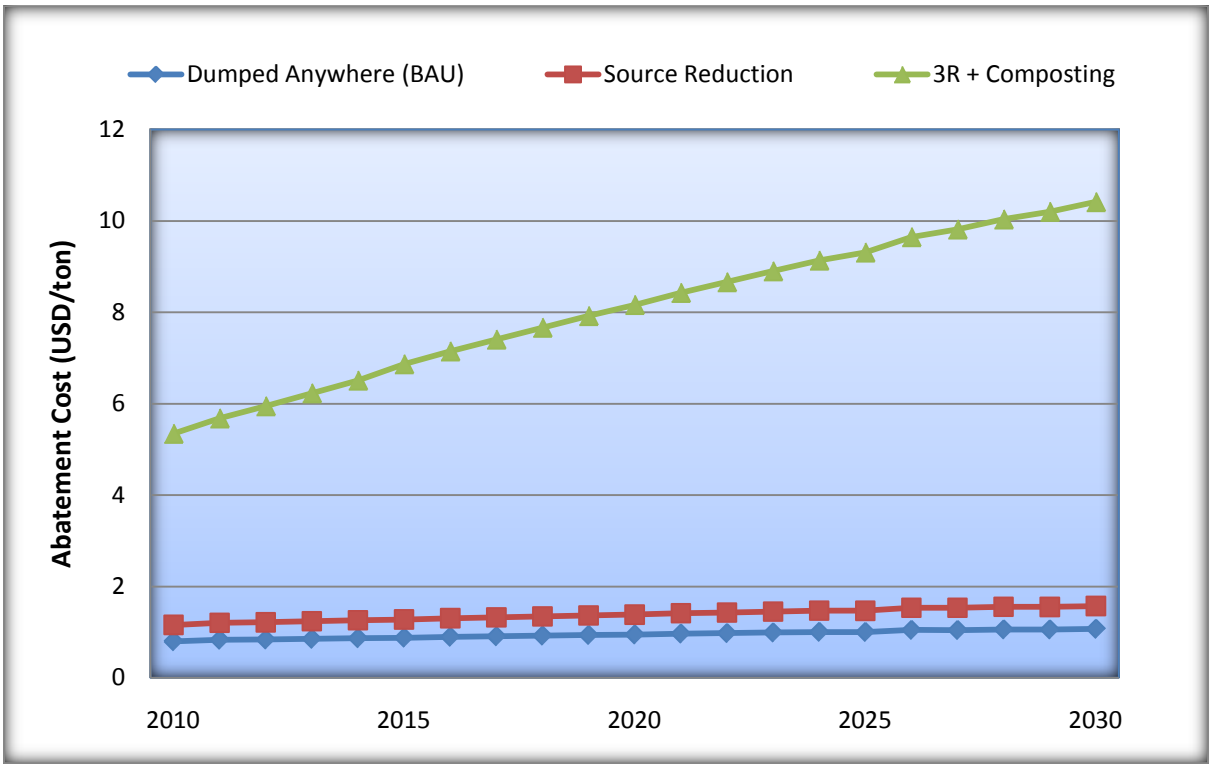


Figure 4.26 Abatement Costs for each scenario in rural areas (in USD/ton)

CHAPTER 5 INTEGRATION OF MITIGATION POLICIES INTO WASTE SECTOR PLANNING

5.1 Alternative Formulation of Mitigation Policies based on the Funding difference

In Chapter 4 the degree of efficiency of each mitigation action for greenhouse gases from the waste sector has been presented. In solid waste management, however, detached actions auch as only 3Ror landfills are not sufficient. Waste management is an integrated activity of various mitigation actions and their implementation according to technical capacitiesand available funding. Therefore chapter 5 will present several alternativewaste management policies in order to determine the most efficient policy mix with the least abatment costs.

Against the background of operational needs of related sectors (according to Ministry of Public Works) and the stage of development in Indonesia, the criteria for the assessment of alternative policies are costs.
(maximum cost, optimistic, moderate, pessimistic, and minimum cost).:

1) Alternative 1 describes current practices in Indonesia (minimum funding), called **BAU (Bussiness As Usual)** means that open dumping remains the widespread practice until 2030
2) Alternative 2 is the most ideal alternative policy of achieviing the target of Act No. 18/2008, which in the year 2015 the entire open dumping have been converted to sanitary/controlled landfill. This alternative is the maximum funding alternative, also called as the **law-based** alternative.
3) Alternative 3 is less ambitious than alternative 2, so that the funding needed is also lower as (so called **optimistic** alternative).
4) Alternative 4 is again less ambitious than policy 3 and also requires less funding (so called **moderate** alternative).
5) Alternative 5 is the least ambitious policy requiring the least funding (so called as **pessimistic** alternative).

Policy alternative 1 (BAU) does not imply waste reduction measures, whereas Alternatives 2 to 5 do suggest this in varying degrees and depending on the available funding. Alternative 2 with maximum financing achieves the largest waste reduction, followed by Alternative 3 (optimistic)

and Alternative 4 (moderate). Alternative 5 (pessimistic) has the smallest impact on waste generation..

The next paragraph elaborates the different policy alternatives in more detail:

1) Alternative 1 reflects current practices (BAU) and does not forsee a reduction of the volume of generated waste for the future. Nevertheless, this assumptions also implies increasing (financial) capacities of local governments and s a consequence increasing waste management capabilities. However, the practices of the waste management themselves are not projected to change, the "gather-transport-disposed" cycle remains the prevailing practice in this scenario, increasing coverage of transportation of waste deposits to landfills will have positive effects on the urban living space. The main technique of waste treatment in landfills will be covering of former open dumpings..
2) Policy Alternative 2 (supports the enforcement of Act No. 18/2008, therefore called law-based, or maximum funding) is a scenario that reflects the current volume of waste generation and future projections and focuces on waste management through (a) reduction of solid waste to the principle of 3R, and (b) the sound handling of solid waste from containing and transport till final disposal. . One of the mandate of Act No.18/2008 is the conversion of Open Dumpings into Sanitary Landfills by 100% until 2014 and Policy Alternative 2 aims at enforcing this law through the systematic use of sanitary landfills.
3) Alternative 3 (optimistic funding assumption), is apolicy based on the results of the FGDs with the Ministry of Public Works on 18 November 2009, targeting at an at a gradual conversion of an average 30 Open Dumping per year to Sanitary Landfill and Controlled Landfills.
4) Policy alternative 4 (moderate funding assumption) is based on the results of the FGDs with the Ministry of Public Works on November 18, 2009 and targets at the conversion of sOpen Dumpings into Sanitary Landfills and the processing of solid waste in Controlled Landfills. .
5) Alternative 5 (minimum or pessimistic funding assumption) is also based on the results of the FGDs with the Ministry of Public Works on 18 November 2009 and aims at the with conversion target from Open Dumping to Sanitary Landfill and solid waste-processing in Controlled Landfill, but with a lower coverage.

Table 5.1 through Table 5.10 show the assumptions used, the phases of the program and the targets of each Policy Alternative in an overview:

Table 5.1 Assumptions used in Alternative 1 (BAU)

Waste Management Component	Assumptions used
1) Waste deposits transported to landfillsc	• Transportation ofwaste was at 50% in 2005. • The level of service increases by 2% every year, thus reaching in 2020. • It is assumed that from 2020 onwards, the level of service increases by 1%, reaching 90% in 2030.
2)Waste reduction	• 3R is a recommendation, not followed by adequate public policies of the Central and Local Government(i.e. 3R target). • Urban waste generation increases from 0.6 kg/ person/ day in 2005 to 1.2 kg/ person/ day in 2030. • Rural waste generation increases from 0.3 kg / person / day in 2005 to 0.55 kg / person / day in 2030.
3)Final Processing	• The amount of waste generations covered in Open Dumpings is at approximately 45% in 2005, and increases up to 76.50% in 2030. • Conversion is achieved for Open Dumpings into Sanitary Landfills for 0.5% in 2005. It is assumed that this will increase only up to 3.2% in 2020 and 3.6% in 2030.
4)Other waste management activities	• Informal waste management practices such as combustion etc. continue with insignificant changes.

Table 5.2 Assumptions recapitulation in Alternative 1 (BAU)

	2005		2010		2020		2030	
	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Aereas	Rural Areas	Urban Areas	Rural Areas
Unit: % (percentage)								
Waste deposits transported to landfills	50	20	60	22.5	80	27.5	90	32.5
Waste managed collectively:								
Plastic recycling	1.5	0.25	1.8	0.45	2.4	0.83	3.6	0.98
Paper recycling	1.5	0.25	1.8	0.45	2.4	0.83	3.6	0.98
Composting of	1	5.5	1.2	6.3	2.4	8	2.7	9.8

	2005		2010		2020		2030	
	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Aereas	Rural Areas	Urban Areas	Rural Areas
organic substances								
Burned at the TPS dan TPA	0.5	10	0.6	9.68	0	8.25	0	7.8
Covered at the Open Dumping	45	4	53.4	5.63	69.6	9.63	76.5	13
Covered with sanitary landfill + biogas captured	0.5	-	1.2	-	3.2	-	3.6	-
Self managed Waste:								
Plastic recycling	1.5	2.4	1.2	2.33	0.6	2.18	0.3	2.03
Paper recycling	1.5	4	1.2	3.88	0.6	3.63	0.3	3.38
Composting	1	40	0.8	38.8	0.4	36.3	0.2	33.8
Burned	5	20	4	19.38	2	18.13	1	16.88
Dumping in river	1	4	0.8	3.88	0.4	3.63	0.2	3.38
Dumping anywhere	40	9.6	32	9.3	16	8.7	8	8.1

Table 5.3 Assumptions used in alternative 2 (Law-Based, Maximum funding)

Waste Management Component	Assumptions used
1) Waste deposits transported to landfills	• Transportation of 50% of total waste in 2005 .The level of service has increased by 2% per year in 2020 reaches 80% and 90% in 2030.
2)Waste reduction	• Waste reduction is taking place. • Urban waste generation increases from 0.6 kg/ person/ day in 2005 to 1 kg/ person/ day in 2030. • Rural waste generation increases from 0.3 kg / person / day in 2005 to 0.45 kg / person / day in 2030.
3)Final Processing	• The amount of solid waste generation covered in the Open Dumping is about 45% in 2005, and decreases to 0% in 2030. • Open Dumping sites will be converted into Sanitary Landfills with a waste generation percentage of 0.5% in 2005 and increase to 56% in 2020 and 63% in 2030 respectively. Sanitary landfills are assumed to capture emissions by 90%.
4) Other waste management activities	• Percentage of the waste generations composted in urban area increases from 1% in 2005 to 6.4% in 2020 and 7.2% in 2030.

Waste Management Component	Assumptions used
	• Plastic recycling increases from 1.5% in 2005 to 4.80% in 2020 and 5.40% in 2030. • Paper recycling increases from 2.4% in 2005 to 3.7% in 2020 and 4.6% in 2030. • Burning of waste decreases from 0.5% in 2005 to 0% in 2020 and 0% in 2030.

Table 5.4 Assumptions recapitulation in Alternative 2 (Law-Based, Maximum Funding)

	2005		2010		2020		2030	
	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas
Unit: % (percentage)								
Waste deposits transported to landfills	50	20	60	30	80	50	90	70
Waste managed collectively:								
Plastic recycling	1.5	0.25	1.8	1.2	4.8	2.5	5.4	4.2
Paper recycling	1.5	0.25	1.8	1.2	4.8	2.5	5.4	4.2
Composting of organic substances	1	5.5	2.4	9	6.4	20	7.2	35
Burning at the TPS and TPA	0.5	10	0.6	12	0	12	0	9.1
Covered Open Dumping	45	4	48	6.6	0	13	0	17.5
g Conversion into sanitary landfill + biogas capture	0.5	-	2.4	-	56	-	63	-
Conversion intocontrolled landfill + biogas capture	0	-	3	-	8	-	9	-

	2005		2010		2020		2030	
	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas
Selfmanaged Waste:								
Plastic recycling	1.5	2.4	1.6	2.8	1.2	3	0.7	2.4
Paper recycling	1.5	4	1.6	4.9	1.2	4	0.8	2.4
Composting of organic substances	1	40	1.6	42	2	36.5	1.2	23.7
Burning	5	20	3.2	10.5	0.6	2.5	0.3	0
Dumping in the river	1	4	0.8	2.8	0.2	1	0	0.3
Dumping anywhere	40	9.6	31.2	7	14.8	3	7	1.2

*) Reductions of CO_2 eq emissions express the difference between the emissions released by the BAU scenario (see Table 5) and Policy Alternative 2 (Maximum Funding)

Table 5.5 Assumptions used in alternative 3 (Optimistic)

Waste Management Component	Assumptions used
1)Waste deposits transported to landfills	• Waste deposit transported to landfills / by 50% in 2005 • The level of service increased 2% per year so in 2020 it reaches 80% and 90.1% in 2030.
2)Waste reduction	• Waste reduction is taking place. • Urban waste generation increases from 0.6 kg/ person/ day in 2005 to 1.05 kg/ person/ day in 2030. • Rural waste generations increase from 0.3 kg / person / day in 2005 to 0.48 kg / person / day in 2030.
3)Final Processing	• The amount of waste generations covered in the Open Dumping is about 45% in 2005, and decreases to 0% in 2030. • Conversion is done for Open Dumping to Sanitary Landfill with a percentage of waste transported to Sanitary Landfills of 0.5% in 2005 to 44% in 2020 and 49.5% in 2030. In addition, conversion is also achieved from Open Dumping into Controlled Landfill from 0% in 2005 to 20% in 2020 and 22.5% in 2030. It is assumed here that Sanitary Landfills and Controlled Landfills are usedto capture emissions by 75%. This optimistic scenario involves the FGD results on November 18, 2009 with the Ministry of Public Works(target of conversion of 30 Open Dumping per year into Sanitary

Waste Management Component	Assumptions used
	Landfills).
4)Other waste management activities	• Percentage of waste generation composted increases from 1% in 2005 to 6.4% in 2020 and 7.2% in 2030. • Plastic recycling increases from 1.5% in 2005 to 4.8% in 2020 and 5.4% in 2030. • Paper recycling increases from 1.5% in 2005 to 4.8% in 2020 and 5.4%. in 2030 • Burning of waste decreases from 0.5% in 2005 to 0% in 2030.

Table 5.6 Assumptions recapitulation in Alternative 3 (Optimistic Funding)

	2005		2010		2020		2030	
	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas
Unit: % (percentage)								
Waste deposits transported to landfills	50	20	60	30	80	50	70	45
Waste managed collectively:								
Plastic recycling	1.5	0.25	1.8	1.2	4.8	2.5	5.4	4.2
Paper recycling	1.5	0.25	1.8	1.2	4.8	2.5	5.4	4.2
Composted organic	1	5.5	2.4	9	6.4	20	7.2	31.5
Burned at the TPS dan TPA	0.5	10	0.6	12	0	12	0	9.1
Covered at the Open Dumping	45	4	48	6.6	0	13	0	21
Covered with sanitary landfill + biogas captured	0.5	-	1.8	-	44	-	49.5	-
Covered with controlled landfill +	0	-	3	-	20	-	22.5	-

	2005		2010		2020		2030	
	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas
biogas captured								
Waste is self managed:								
Plastic recycling	1.5	2.4	1.6	2.8	1.2	3	0.7	2.4
Paper recycling	1.5	4	1.6	4.9	1.2	4	0.7	2.4
Composted organic	1	40	1.6	42	1.2	36.5	0.9	23.7
Burned	5	20	3.2	10.5	1.4	2.5	0.7	0
Dumped in the river	1	4	0.8	2.8	0.2	1	0	0.3
Dumped anywhere	40	9.6	31.2	7	14.8	3	7	1.2

*) Reductions of CO_2 eq emissions express the difference between the emissions released by the BAU scenario (see Table 5) and Policy Alternative 3 (Optimistic Funding)

Table 5.7 Assumptions used in Policy Alternative 4 (Moderate funding)

Waste Management Component	Assumptions used
1) Waste deposits transported to landfills	• Transportation of waste to landfills has reached 50% in 2005 has a 50% service level. • The level of service increased by 2% each year and thus reaches 80% in 2020 and 90% in 2030.
2)Waste reduction	• Waste reduction is taking place. • Urban waste generation increases from 0.6 kg/ person/ day in 2005 to 1.1 kg/ person/ day in 2030. • Rural waste generations increase from 0.3 kg / person / day in 2005 to 0.5 kg / person / day in 2030.
3)Final Processing	• The amount of waste deposits covered in Open Dumpings is at 45% in 2005, and is projected to decreas to 18% in 2020 and to 0% in 2030. • Conversion is achieved for Open Dumpings into Sanitary Landfill for 0.5% of waste deposits taken to Sanitary Landfills in 2005, 19.39% in 2020 and 28.8% in 2030. In addition, waste deposits processed in Controlled Landfills reach 30.4% in 2020 and 45.9% in 2030. it is assumed here that Sanitary Landfills and Controlled Landfills are usedto capture emissions by 50%. This alternative 4 (Moderate Funding) accomodates the FGD

Waste Management Component	Assumptions used
	results on November 18, 2009 with the Ministry of of Public Works.
4)Other waste management activities	• Percentage of waste deposits composted increase from 1% in 2005 to 5.6% in 2020 and 7% in 2030. • Plastic recycling increase from 1.5% in 2005 to 3.2% in 2020 and 4.5% in 2030. • Paper recycling increases from 1.5% in 2005, in 2020 reaches 3.2% and in 2030 reaches 4.5%. • Burning of waste decreases from 0.5% in 2005 to 0% in 2030.

Table 5.8 Assumptions recapitulation in Alternative 4 (Moderate Funding)

	2005		2010		2020		2030	
	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas
Unit: % (percentage)								
Waste deposits transported to landfills	50	20	60	25	80	35	90	45
Waste managed collectively:								
Plastic recycling	1.5	0.25	1.8	0.5	3.2	1.75	4.5	2.7
Paper recycling	1.5	0.25	1.8	0.5	3.2	1.75	4.5	2.7
Composting of organic material	1	5.5	2.4	7.5	5.6	12.3	6.3	18
Burning at the TPS and TPA	0.5	10	0.6	10	0	8.4	0	5.85
Covered at Open Dumpings	45	4	40.5	6.5	18	10.85	0	15.75
Coversion into Sanitary Landfills + biogas capture	0.5	-	5.28	-	19.39	-	28.8	-
Conversion into Controlled Landfill + biogas capture	0	-	7.8	-	30.4	-	45.9	-
Self-managed waste:								
Plastic recycling	1.5	2.4	1.6	3	1.2	3.9	0.7	3.85
Paper recycling	1.5	4	1.6	3.75	1.2	3.9	0.7	4.4
Composting of organic substances	1	40	1.6	41.3	1.2	42.3	0.8	38.5

	2005		2010		2020		2030	
	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas
Burning	5	20	3.2	16.5	1.4	9.75	0.7	5.5
Dumping in the river	1	4	0.8	3	0.2	1.3	0	0.55
Dumpinganywhere	40	9.6	31.2	7.5	14.8	3.9	7.1	2.2

*) Reductions of CO_2 eq emissions express the difference between the emissions released by the BAU scenario (see Table 5) and Alternative 4 (Moderate Funding)

Table 5.9 Assumptions used in alternative 5 (Pessimistic funding)

Waste Management Component	Assumptions used
1) Waste deposits transported to landfills	• Transportation of waste deposits to landfills covers 50% in 2005.The level of service increases by 2% each year and reaches 80% in 2020 and 90% in 2030.
2)Waste reduction	• Waste reduction is taking place. • Urban waste generation increases from 0.6 kg/ person/ day in 2005 to 1.15 kg/ person/ day in 2030. • Rural waste generation increases from 0.3 kg / person / day in 2005 to 0.53 kg / person / day in 2030.
3)Final Processing	• The amount of waste generation covered in Open Dumpings equals 45% of total waste volume in 2005, and decreases to 36.8% in 2020 and 32.4% in 2030. • Conversion of Open Dumpings into Sanitary Landfill increases from 0% of waste generation in 2005 to 16.8% in 2020 and 23.4% in 2030. In addition, waste processing in Controlled Landfills will reach 12.8% in 2020 and 18.9% in 2030. Its is assumed here that anitary Landfills and Controlled Landfill are used to capture emissions by 40%. This alternative 5 (Pessimistic Funding) accommodates the FGD results on November 18, 2009 with the Ministry of Public Works.
4)Other waste management activities	• The percentage of waste composted increases from 1% in 2005 to 5.6% in 2020 and 6.3% in 2030. • Plastic recycling increases from 1.5% in 2005 to 4% in 2020 and 4.5% in 2030. • Paper recycling increases from 1.5% in 2005, in 2020 reaches 4% and in 2030 reaches 4.5%. • Burning of waste decreases from 0.5% in 2005 to 0% in 2030.

Table 5.10 Assumptions recapitulation in Alternative 5 (Pessimistic Funding)

	2005		2010		2020		2030	
	Urban Aresa	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Ares	Rural Areas
Unit: % (percentage)								
Waste deposits transported to landfills	50	20	60	22.5	80	27.5	90	32.5
Waste managed collectively:								
Plastic recycling	1.5	0.25	1.8	0.45	4	1.1	4.5	1.63
Paper recycling	1.5	0.25	1.8	0.45	4	1.1	4.5	1.63
Composting of organic substances	1	5.5	2.4	6.3	5.6	9.35	6.3	11.05
Burningat the TPS and TPA	0.5	10	0.6	9.45	0	7.43	0	6.83
Covered at Open Dumpings	45	4	43.2	5.85	36.8	8.53	32.4	11.38
Conversion into Sanitary Landfills + biogas capture	0	-	6.6	-	16.8	-	23.4	-
Conversion into Controlled Landfills + biogas capture	0.5	-	3.6	-	12.8	-	18.9	-
Self-managed waste:								
Plastic recycling	1.5	2.4	1.6	3.1	1	4.35	0.5	4.05
Paper recycling	1.5	4	1.6	3.88	0.8	4.35	0.7	4.05
Composting of organic substances	1	40	1.6	41.1	1.6	43.5	0.8	43.9
Burning	5	20	3.2	18.6	1.6	14.5	0.8	12.15

	2005		2010		2020		2030	
	Urban Aresa	Rural Areas	Urban Areas	Rural Areas	Urban Areas	Rural Areas	Urban Ares	Rural Areas
Dumping in the river	1	4	0.8	3.1	0.2	1.45	0	0.68
Dumping anywhere	40	9.6	31.2	7.75	14.8	4.35	7.2	2.7

*)Reduction of CO_2 eq emissions expressed the difference between the emissions released by the BAU scenario (see Table 5) with Alternative 5 (Pessimistic Funding)

The calculation of the results of each scenario above is presented in Figure 5.1, 5.2.Figure 5.3 visualizeds the trend of CO_2 emissions, emission reductions, and mitigation costs compared to the Business As Usual Scenario (BAU).

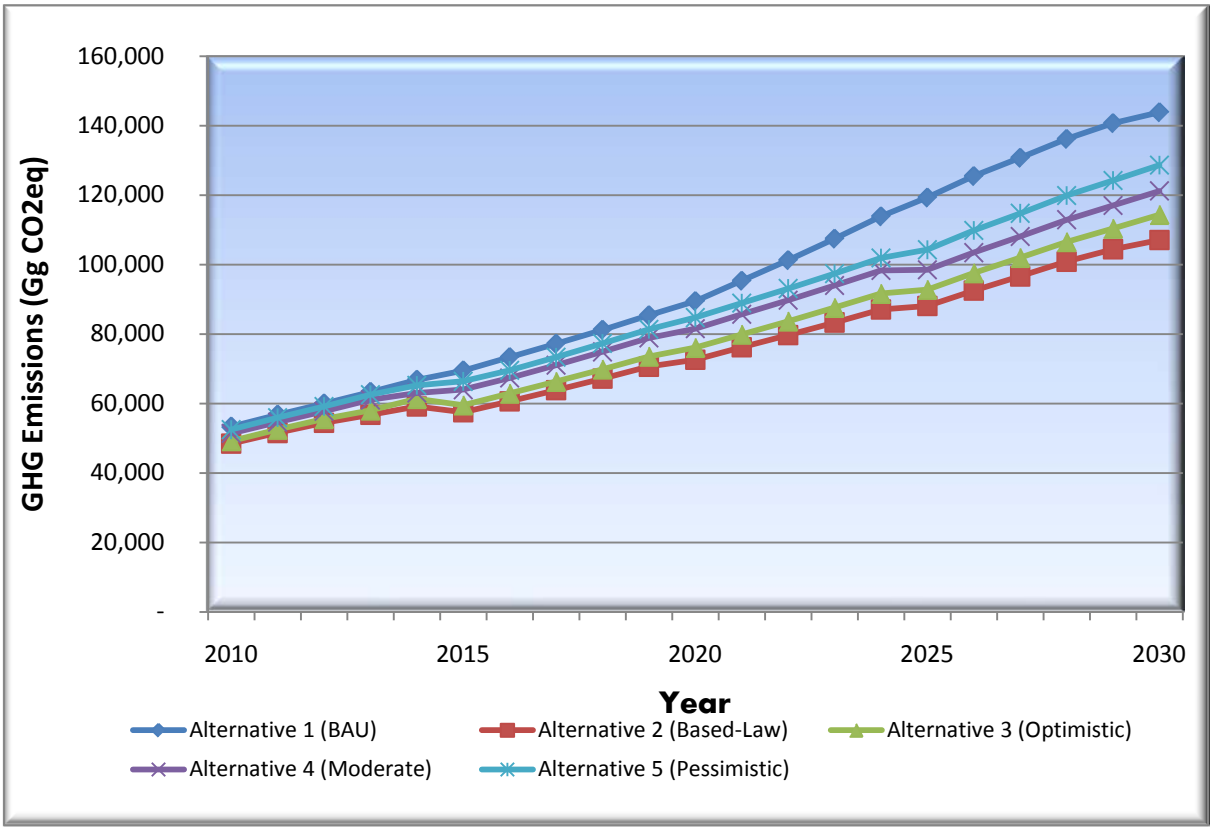


Figure 5.1 GHG emissions (in tons CO_2 eq) for each alternative compared to Alternative 1 (BAU)

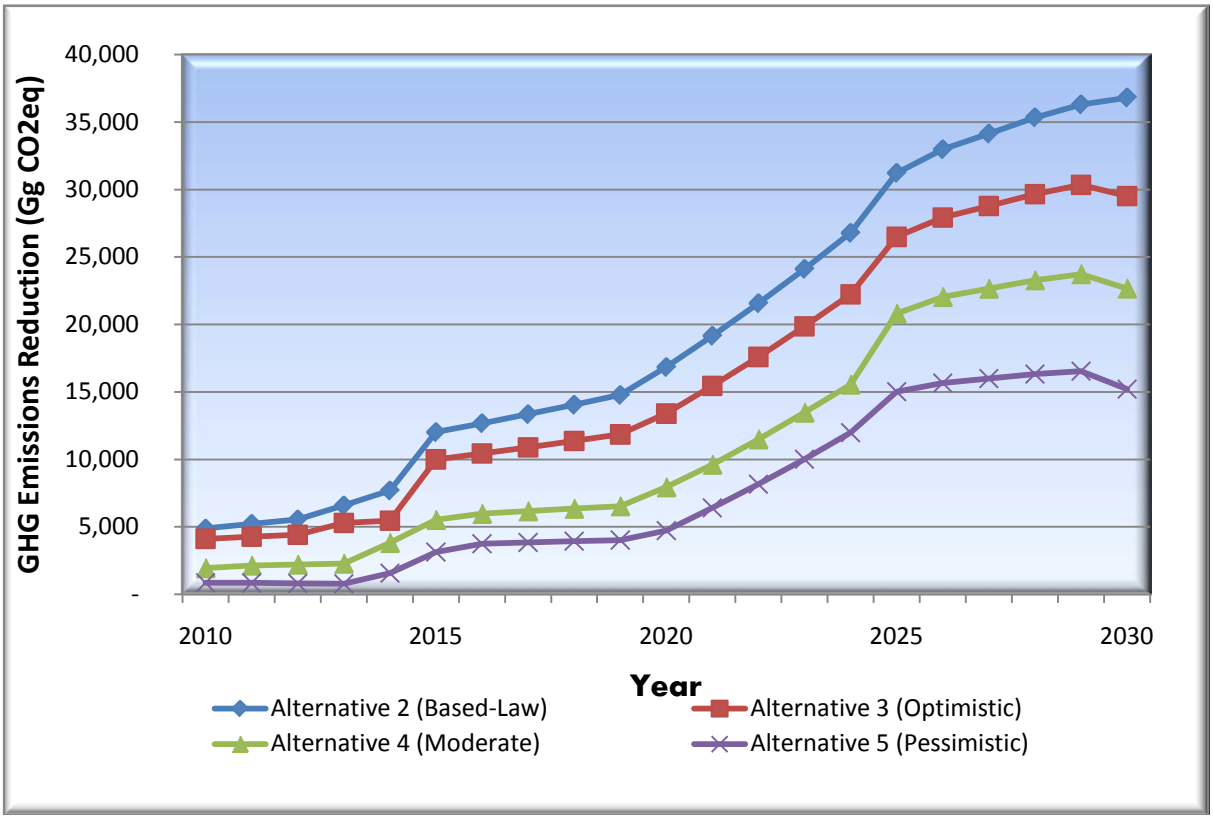


Figure 5.2 GHG emission reductions (in tons CO_2 eq) compared to Alternative 1 (BAU)

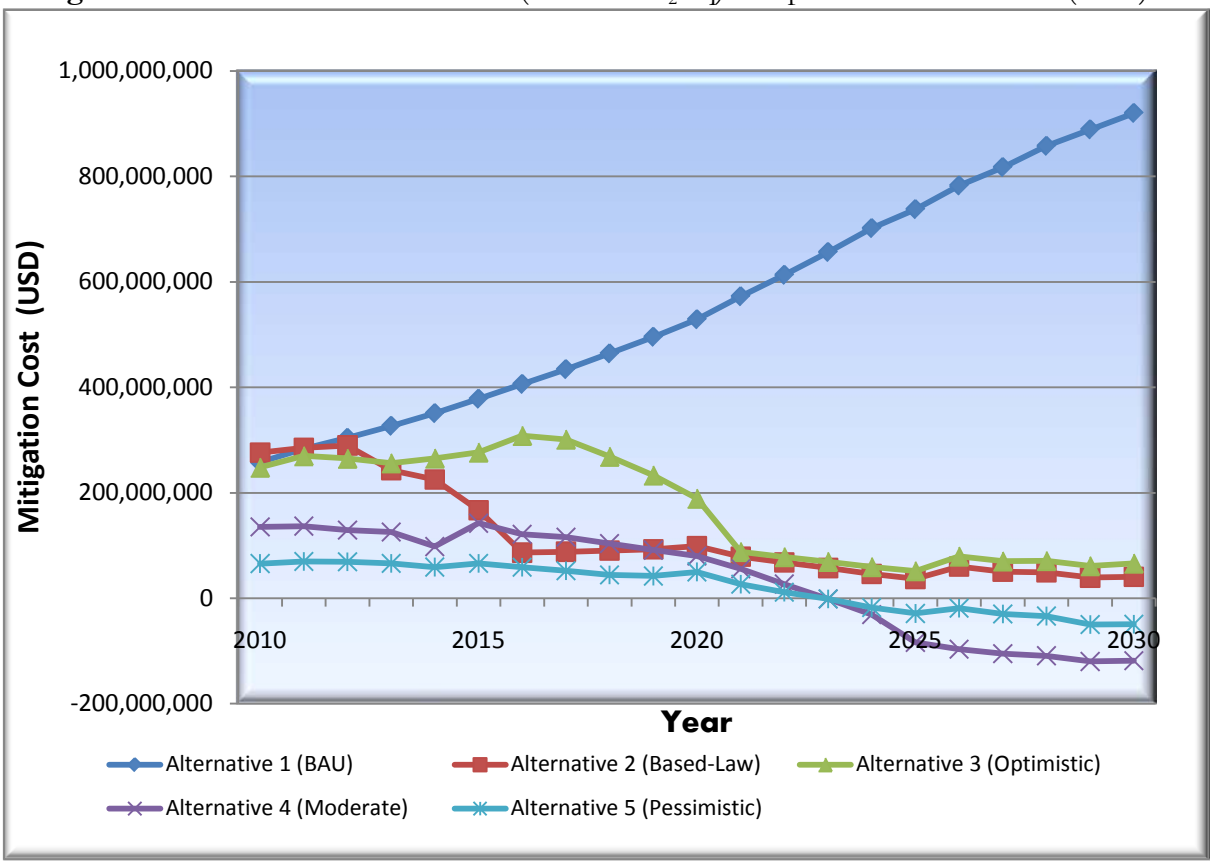


Figure 5.3 Mitigations cost for each scenario compared to Alternative 1 (BAU)

Table 5.11 Mitigation Action Matrix of Alternative Policies (based on the difference in the amounts of funding)

Scenarios	Period	Emission Reduction Accumulation (Mt CO2)	Total Cost of Mitigation (million USD)	Abatement Cost (USD/t CO_2)	Emission Reduction Compared to BAU (%)	Policies Required
Law- Based	2010 – 2020	113.67	3,721	107.20	19,04%	(1) Development of policies and technical concepts to implement Act No. 18 of 2008 for solid waste management, (2) Inventory study of GHG emissions from the waste sector, with the highest degree of detail and accuracy possible, accompanied by a systematic GHG emissions reduction plan, (3) Application of environmentally sound infrastructure development policies for the waste sector, supported by research and applied technology. (4) Implementation of environmentally sound policies for the principle of 3R (reduce, reuse, recycle) in waste management, (5) Reduction waste (reduce) from the source to the greatest extent possible, reuse of substances (reuse) and recycling (recycle) (3R) before transporting to the landfill, (6) Improved methods of waste gas management (landfill gas - LFG) through
	2010 – 2030	412.06	5,130	49.27	26,74%	
Optimistic	2010 – 2020	91.54	4,117.56	166.98	15.34%	
	2010 – 2030	339,39	5,554.50	72.12	22.03%	
Moderate	2010 – 2020	50,90	3,169.98	190.12	8,53%	
	2010 – 2030	236.20	4,407.16	74.08	15.33%	

Scenarios	Period	Emission Reduction Accumulation (Mt CO2)	Total Cost of Mitigation (million USD)	Abatement Cost (USD/t CO_2)	Emission Reduction Compared to BAU (%)	Policies Required
Pessimistic	2010 – 2020	28.30	2,770.80	333.63	4.74	collection and combustion or through application of energy recovery systems. (6) Development of 3R TPST in every city / regency in Indonesia.
	2010 – 2030	159.62	4,057.06	101.16	10.36	

5.2 Strategic Issues of Climate Change in Waste Sector

Waste management and waste management related activities in Indonesia fall under governmental regulation of Act No.18 from the year2008. Referring to this regulation, waste management activities are based on public service by the local government, which has set the 3R principle (Reduce, Reuse, and Recycle) as its target and clearly supports the EPR principle (Extended Producer Responsibility).

Another strategic decision taken by this new regulation is the prohibition of Open Dumpings and the responsibility for local governments to convert these into Controlled Landfills (CLF) in small and medium-sized cities and into Sanitary Landfills (SLF) in cities and metropolitans until the year 2015.

A financial strategy for waste management has to take into account the fact that the allocation of government funds for domestic waste management is still low (<3%). In the future, it is expected that waste management in Indonesia will be based on self-funding or private initiatives, such as local sanitation companies or Public Service Agencies. Government fees for domestic waste management and annual budget allocatins from central and local governments influence such an financial strategy.

From the various strategies that have been mentioned above, the most important strategy is the one dealing with social aspects and community participation. Without community involvement, waste management policies cannot be implemented. Significant impacts on the communitiesshould be taken into account by any government program related to waste management.

In order to achieve GHG emissions reductions from the waste sector, different mitigation options are available, using different alternative policy approaches as described below:

- Inventory studes of GHGs from the waste sector, with the highest degree of detail and accuracy possible., accompanied by systematic recommendations for the reduction of GHG emissions.
- Environment-friendly infrastructure development policies in the waste sector,supported by research and of application of environmentally sound technologies
- Application of environmentally sound policies for the principle of 3R (reduce, reuse, recycle) in waste management.

- Sustainable infrastructure development policies (under consideration of the three development pillarseconomic, social, and environmental aspects) for reduction of GHG emissions and increased carbon absorption.
- Conducting infrastructure development including aspects of capacity building, including human resources and institutional competence, while acknowledging the independence of local governments in the development of environmental infrastructure and encouraging the role of the private sector and communities.
- Development ofwaste management technologies that are environment-friendly and climate-friendly.
- Enforcement of the application of the EPR principle (Extended Producer Responsibility) for producers and importers of B3 waste.
- Development of technologies to improve the quality of landfills:
    - Controlled Landfills (CLF) for small and medium-sized cities,
    - Sanitary Landfills (SLF) for large and metropolitan cities
    - Termination of Open Dumping

Policy strategies outlined above in the priority program related to climate change mitigation are divided into four main clusters:

- Data inventory and planning
- Regulation and policy
- Implementation
- Capacity building (strengthening local governments, private and public institutions)

5.2.1 Data Inventory and Planning Group

The program group of data inventory and planning shall be formed in the beginning of the five-year plan (2010-2014) to conduct GHG assessments and formulation mitigation options for the waste sector.

5.2.2 Regulationand Policy Group

Regulation and mitigation policies for solid waste are divided into four periods of program. For the period of 2010-2014, the strategies that will be applied to each island are as follow:

- Strengthening environmentally sound policy approaches for waste management and support standardization (step-by-step approach).

- Issuance of waste product regulations by the local government according to the NSPK of city/district.
- Enforcementof waste-management-related regulations.
- Preparation of NSPM for the waste sector.
- Regulation, coaching, supervising, development of financial source, and investment patterns for waste management.
- Formulation of guidelines for waste control.
- Formulation of NSPKs for the waste sector.
- Creating provision of Bantek, Bimtek and assistance (SSK) of waste management.

The secondfive-year period (2015-2019) will launch two leading programs:

- Supervision and development of financial sources and investment patterns for waste management.
- Development of a monitoring system for waste products by the local governments according to the NSPK.

The main program in the regulation and policy group for the periods of 2020-2024 and 2025-2030 is the waste monitoring and evaluation system developed by the local governments according to the NSPK. Anther program in the period of 2020-2024 shall be drafting legislationsilfor public-private partnerships in waste management. For the final period covered by this Roadmap (2025-2030) the legislation for public-private partnerships shall be implemented.

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5.2.3 Implementation Group

The implementation group also has several major programs for the 7 main islands in Indonesia (see Appendix A for division of districts/regency and different cities: matrix of mitigation policy recommendations for the waste sector). The points below are general policy recommendations for mitigation in the waste sector:

- Instlallment of waste development commissioner in regencies/cities.
- Waste management in landfills, conversion from Open Dumping into Controlled Landfills (CLF) in small and medium-sized cities; and Sanitary Landfills (SLF) in large and metropolitan cities.

- Reduction of domestic solid waste (reduce) from the sourcereuse and recycle (3R) to the greatest extent possible.
- Improvement of Landfill Gas (LFG) managementthrough collection and combustion or through the application of energy recovery systems.
- Procurement of waste development (*bantek*) replication on the district/city level.
- Provision of waste infrastructure on the district/city level in every island in Indonesia.
- Provision of CDM landfill projects in metropolitan cities.
- Provision of waste management facilities.
- Transportation of waste in cities/districts on every island in Indonesia.
- Transportation of waste in every island in Indonesia.
- Development of 3R in TPST in all cities/districts in Indonesia

5.2.4 Capacity Building Group

Community involvement and society mpowerment becomes an important aspect for realizing emission reductions from the waste sector in Indonesia. This has to be taken into account in planning and policy development. Suggestions how to achieve this are outlined below:

- Strengthening government and community partnerships.
- Strengthening local government institution in waste management.
- Monitoring and evaluation of waste management
- Development of financial sources and investment fornthe waste sector through cooperations between the government and international public entities and companies.

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APPENDIX A

CLIMATE CHANGE MITIGATION STRATEGIES RECOMMENDATION FOR WASTE SECTOR

1. Sumatera

Scientific Base	Mitigation Alternative Strategies Recommendation	Priority Programs for Sumatera			
Inventorization of GHG		**2010 – 2014**	**2015 – 2019**	**2020 – 2024**	**2024 – 2029**
• GHG emission from urban solid waste sector in the form of methane (CH4) emitted by landfill and CO2 emitted by open combustion activity. • Domestic waste level of 0.6 kg/person/day for urban and 0.3 kg/person/day • Overall, only 21% from the total solid waste that was transported to the landfill (Dept. of Public Works, 2009).	• Carry out an inventory study of GHG from the solid waste sector, a more complete and perfect plan, accompanied by a systematic reduction in GHG. • Applying the environment-friendly infrastructure development policy in the waste sector which is supported by the development of applied technology research and environmental perspective. • Develop the application of environmental policy for the principle of 3R (reduce, reuse, recycle) in waste management. • Develope a sustainable infrastructure development (with three balancing development pillars, which are economic, social, and environment) to reduce emission of GHG (Green House Gases) and increase carbon absorption • Conducting infrastructure development of waste that is more concern to the aspect of capacity building, including human resources and institutional competence and the independence of local government in the development of environmental infrastructure and drive private and society sector's participation.	**Data Inventory and Planning** • Inventorization study and GHG reduction from the solid waste sector. **Regulatory and Policy** • Strengthening environmental policy approach to waste management and standardization (stepwise approach). • Issuance of waste product development setting by the local government according to the NSPK of city/district. • Settlement of waste regulation • Preparation of NSPM in the waste field. • Setting, coaching, supervising, developing finance source, and investing pattern in waste management • Creating provision of guideline for waste control. • Creating NSPK in the waste field • Creating provision of Bantek, Bimtek and assistance (SSK) of waste	**Regulatory and Policy** • Supervision and development of source of finance and investment pattern in waste management • Monitoring waste product development setting by the local government according to the NSPK. **Implementation of Program** • Improvement of waste management in landfill, from open dumping to become controlled landfill in small and medium-sized cities; and sanitary landfill in large and metropolitan cities by 20% • Reduction of domestic solid waste (reduce) from the source as much as possible, use again (reuse) and recycle (3R) before transported to the landfill by 30%. • Improve method of	**Regulatory and Policy** • Drafting legislation related to public-private partnerships in waste management • Waste monitoring and evaluation of product development setting by the local government according to the NSPK. **Implementation of Program** • Improvement of waste management in landfill, from open dumping to become controlled landfill in small and medium-sized cities; and sanitary landfill in large and metropolitan cities by 30% • Reduction of domestic solid waste (reduce) from the source as much as possible, use again (reuse) and recycle (3R) before transported to the landfill by 40%. • Improve method of managing waste gas (landfill gas - LFG) through collection and	**Regulatory and Policy** • Waste monitoring and evaluation of product development setting by the local government according to the NSPK. • Evaluation of law implementation related to public private partnership in waste management. **Implementation of Program** • Increase of waste management in landfill, from open dumping to become controlled landfill in small and medium-sized cities; and sanitary landfill in large and metropolitan cities by 50% • Reduction of domestic solid waste (reduce) from the source as much as possible, use again (reuse) and recycle (3R) before

	• Develop a waste management technology that is environment-friendly and anticipative to climate change. • Develop the technology to improve the quality of landfill: (1) Controlled Landfill (CLF) for small and medium-sized cities, (2) Sanitary Landfill (SLF) for large and metropolitan cities (3) Termination of Open Dumping. • Develop the application of EPR (Extended Producer Responsibility) for producer and importer of hazardous waste	management **Implementation of Program** • Implementation of waste development commissioner in the district/city. • Waste management in landfill, from open dumping to become controlled landfill in small and medium-sized cities; and sanitary landfill in large and metropolitan cities by 10%. • Reduction of domestic solid waste (reduce) from the source as much as possible, use again (reuse) and recycle (3R) before transported to the landfill by 20%. • Improve method of managing waste gas (landfill gas - LFG) through collection and combustion or through application of energy recovery system by 5%. • Procurement of waste development (bantek) replication in the district/city. • Provision of waste infrastructure in 41 districts/cities in Sumatera. • Provision of CDM landfill facility in 6 metropolitan cities • Provision of waste management facility of 411 unit • Transportation of waste in	managing waste gas (landfill gas - LFG) through collection and combustion or through application of energy recovery system by 20%. • Building of example project (3R, CDM, biogas) • Provision of waste infrastructure in 86 districts/cities. • Building of waste management facility by 453 unit • Building of CDM landfill facility in 2 Metropolitan cities • Transportation of waste in 86 districts/cities • Transportation of waste in Sumatera by 45%. • 3R integrated landfill in all districts/cities in Sumatera.	combustion or through application of energy recovery system by 30%. • Infrastructure maintenance and improvement of waste service in 41 districts/cities in Sumatera. • Building of CDM landfill facility in 3 major cities • Provision of waste management facility by 498 unit • Improvement of waste transportation in 41 districts/cities in Sumatera. • Transportation of waste in Sumatera by 60%. • Evaluation, maintenance, and development of example project (3R, CDM, biogas) **Capacity building (strengthening of the local government, private, and society institutions)** • Forming of condusive climate for the bussiness (private) world to actively participate in giving waste service, either in transportation handling or landfill management.	transported to the landfill by 50%. • Improve method of managing waste gas (landfill gas - LFG) through collection and combustion or through application of energy recovery system by 50%. • Infrastructure maintenance and improvement of waste service in 86 districts/cities • Building of CDM landfill facility in 3 large cities • Procurement of waste management facility by 548 unit • Development of waste transportation in 86 districts/cities. • Improve method of managing waste gas (landfill gas - LFG) through collection and combustion or through application of energy recovery system by 70%. • Evaluation, maintenance, and development of example project (3R, CDM, biogas) • Transportation of waste in Sumatera by 75%. **Capacity building**

		41 districts/cities in Sumatera. • Transportation of waste in Sumatera by 30%. • Development of 3R in TPST in all city/district in Sumatera. **Capacity building (strengthening of the local government, private, and society institutions)** • Strengthening government and community partnerships. • Strengthening local government institution in waste management. • Procurement of monitoring and evaluation of performance of waste management development • Procurement of facility for financing source development activity and pattern of investment in the waste sector through cooperation of government and international public business			**(strengthening of the local government, private, and society institutions)** • Awareness increase for all stakeholders to the importance of increasing waste service. • Development of condusive climate for business (private) world to participate in giving waste service, either in handling transporatation or in landfill management. • Increase in stakeholders' participation in the effort to reach waste development target.

2. Java, Madura, Bali

Scientific Base	Mitigation Alternative Strategies	Priority Programs for Java, Madura, and Bali			
Inventorization of GHG	**Recommendation**	**2010 – 2014**	**2015 – 2019**	**2020 – 2024**	**2024 – 2029**
• GHG emission from urban solid waste sector in the form of methane (CH4) emitted by landfill and CO2 emitted by open combustion activity. • Domestic waste level of 0.61 kg/person/day (TNA, 2009). • Overall, only 21% from the total solid waste that was transported to the landfill (Dept. of Public Works, 2009).	• Carry out an inventory study of GHG from the solid waste sector, a more complete and perfect plan, accompanied by a systematic reduction in GHG. • Applying the environment-friendly infrastructure development policy in the waste sector which is supported by the development of applied technology research and environmental perspective. • Develop the application of environmental policy for the principle of 3R (reduce, reuse, recycle) in waste management. • Develope a sustainable infrastructure development (with three balancing development pillars, which are economic, social, and environment) to reduce emission of GHG (Green House Gases) and increase	**Data Inventory and Planning** • Inventorization study and GHG reduction from the solid waste sector. **Regulatory and Policy** • Strengthening environmental policy approach to waste management and standardization (stepwise approach). • Issuance of waste product development setting by the local government according to the NSPK of city/district. • Settlement of waste regulation • Preparation of NSPM in the waste field. • Setting, coaching, supervising, developing finance source, and investing pattern in waste management • Creating provision of guideline for waste control. • Creating NSPK in the waste field • Creating provision of Bantek, Bimtek and assistance (SSK) of waste management **Implementation of Program** • Implementation of waste	**Regulatory and Policy** • Supervision and development of source of finance and investment pattern in waste management • Monitoring waste product development setting by the local government according to the NSPK. **Implementation of Program** • Improvement of waste management in landfill, from open dumping to become controlled landfill in small and medium-sized cities; and sanitary landfill in large and metropolitan cities by 20% • Reduction of domestic solid waste (reduce) from the source as much as possible, use again (reuse) and recycle (3R) before transported to the landfill by 30%. • Improve method of	**Regulatory and Policy** • Drafting legislation related to public-private partnerships in waste management • Waste monitoring and evaluation of product development setting by the local government according to the NSPK. **Implementation of Program** • Improvement of waste management in landfill, from open dumping to become controlled landfill in small and medium-sized cities; and sanitary landfill in large and metropolitan cities by 30% • Reduction of domestic solid waste (reduce) from the source as much as possible, use again (reuse) and recycle (3R) before transported to the landfill by 40%.	**Regulatory and Policy** • Waste monitoring and evaluation of product development setting by the local government according to the NSPK. • Evaluation of law implementation related to public private partnership in waste management. **Implementation of Program** • Increase of waste management in landfill, from open dumping to become controlled landfill in small and medium-sized cities; and sanitary landfill in large and metropolitan cities by 50% • Reduction of domestic solid waste (reduce) from the source as much as possible, use again (reuse) and recycle (3R) before transported to the

Scientific Base Inventorization of GHG	Mitigation Alternative Strategies Recommendation	Priority Programs for Java, Madura, and Bali 2010 – 2014	2015 – 2019	2020 – 2024	2024 – 2029
	carbon absorption • Conducting infrastructure development of waste that is more concern to the aspect of capacity building, including human resources and institutional competence and the independence of local government in the development of environmental infrastructure also encourage private and society participation. • Develop a waste management technology that is environment-friendly and anticipative to climate change. • Develop the technology to improve the quality of landfill: (4) Controlled Landfill (CLF) for small and medium-sized cities, (5) Sanitary Landfill (SLF) for large and metropolitan cities (6) Termination of Open Dumping. • Develop the	development commissioner in the district/city. • Waste management in landfill, from open dumping to become controlled landfill in small and medium-sized cities; and sanitary landfill in large and metropolitan cities by 10%. • Reduction of domestic solid waste (reduce) from the source as much as possible, use again (reuse) and recycle (3R) before transported to the landfill by 20%. • Improve method of managing waste gas (landfill gas - LFG) through collection and combustion or through application of energy recovery system by 5%. • Procurement of waste development (bantek) replication in the district/city. • Provision of waste infrastructure in 42 districts/cities in Java, Bali, and Madura • Provision of CDM landfill facility in 12 metropolitan cities • Provision of waste management facility of 411 unit • Transportation of waste in 42 districts/cities in Java, Bali, andMadura	managing waste gas (landfill gas - LFG) through collection and combustion or through application of energy recovery system by 20%. • Building of example project (3R, CDM, biogas) • Provision of waste infrastructure in 65 districts/cities. • Building of waste management facility by 453 unit • Building of CDM landfill facility in 5 Metropolitan cities • Transportation of waste in 65 districts/cities • Transportation of waste in Java, Madura, Bali by 45%. • 3R integrated landfill in all districts/cities in Jawa, Bali, and Madura	• Improve method of managing waste gas (landfill gas - LFG) through collection and combustion or through application of energy recovery system by 30%. • Infrastructure maintenance and improvement of waste service in 42 districts/cities in Java, Madura, Bali. • Building of CDM landfill facility in 15 large cities • Provision of waste management facility by 498 unit • Improvement of waste transportation in 42 districts/cities Jawa, Bali, and Madura • Transportation of waste in Pulau Jawa, Madura, Bali by 60%. • Evaluation, maintenance, and development of example project (3R, CDM, biogas) **Capacity building (strengthening of the local government,**	landfill by 50%. • Improve method of managing waste gas (landfill gas - LFG) through collection and combustion or through application of energy recovery system by 50%. • Infrastructure maintenance and improvement of waste service in 65 districts/cities • Building of CDM landfill facility in 4 large cities • Procurement of waste management facility by 548 unit • Development of waste transportation in 65 districts/cities. • Improve method of managing waste gas (landfill gas - LFG) through collection and combustion or through application of energy recovery system by 70%. • Evaluation, maintenance, and development of example project (3R, CDM, biogas) • Transportation of and Madura by 75%.

Scientific Base Inventorization of GHG	Mitigation Alternative Strategies Recommendation	Priority Programs for Java, Madura, and Bali 2010 – 2014	2015 – 2019	2020 – 2024	2024 – 2029
	application of EPR (Extended Producer Responsibility) for producer and importer of hazardous waste	• Transportation of waste in Java, Bali, and Madura by 30%. • Development of 3R in TPST in all city/district in Java, Madura, Bali. **Capacity building (strengthening of the local government, private, and society institutions)** • Strengthening government and community partnerships. • Strengthening local government institution in waste management. • Procurement of monitoring and evaluation of performance of waste management development • Procurement of facility for financing source development activity and pattern of investment in the waste sector through cooperation of government and international public business		**private, and society institutions)** • Forming of condusive climate for the bussiness (private) world to actively participate in giving waste service, either in transportation handling or landfill management.	**Capacity building (strengthening of the local government, private, and society institutions)** • Awareness increase for all stakeholders to the importance of increasing waste service. • Development of condusive climate for business (private) world to participate in giving waste service, either in handling transporatation or in landfill management. • Increase in stakeholders' participation in the effort to reach waste development target.

3. Kalimantan

Scientific Base	Mitigation Alternative Strategies Recommendation	Priority Programs for Kalimantan			
Inventorization of GHG		**2010 – 2014**	**2015 – 2019**	**2020 – 2024**	**2024 – 2029**
• GHG emission from urban solid waste sector in the form of methane (CH4) emitted by landfill and CO2 emitted by open combustion activity. • Domestic waste level of 0.61 kg/person/day (TNA, 2009). • Overall, only 21% from the total solid waste that was transported to the landfill (Dept. of Public Works, 2009).	• Carry out an inventory study of GHG from the solid waste sector, a more complete and perfect plan, accompanied by a systematic reduction in GHG. • Applying the environment-friendly infrastructure development policy in the waste sector which is supported by the development of applied technology research and environmental perspective. • Develop the application of environmental policy for the principle of 3R (reduce, reuse, recycle) in waste management. • Develope a sustainable infrastructure development (with three balancing development pillars, which are economic, social, and environment) to reduce emission of GHG (Green House Gases) and increase carbon absorption • Conducting infrastructure	**Data Inventory and Planning** • Inventorization study and GHG reduction from the solid waste sector. **Regulatory and Policy** • Strengthening environmental policy approach to waste management and standardization (stepwise approach). • Issuance of waste product development setting by the local government according to the NSPK of city/district. • Settlement of waste regulation • Preparation of NSPM in the waste field. • Setting, coaching, supervising, developing finance source, and investing pattern in waste management • Creating provision of guideline for waste control. • Creating NSPK in the waste field • Creating provision of Bantek, Bimtek and assistance (SSK) of waste management **Implementation of Program**	**Regulatory and Policy** • Supervision and development of source of finance and investment pattern in waste management • Monitoring waste product development setting by the local government according to the NSPK. **Implementation of Program** • Improvement of waste management in landfill, from open dumping to become controlled landfill in small and medium-sized cities; and sanitary landfill in large and metropolitan cities by 20% • Reduction of domestic solid waste (reduce) from the source as much as possible, use again (reuse) and recycle (3R) before transported to the	**Regulatory and Policy** • Drafting legislation related to public-private partnerships in waste management • Waste monitoring and evaluation of product development setting by the local government according to the NSPK. **Implementation of Program** • Improvement of waste management in landfill, from open dumping to become controlled landfill in small and medium-sized cities; and sanitary landfill in large and metropolitan cities by 30% • Reduction of domestic solid waste (reduce) from the source as much as possible, use again (reuse) and recycle (3R) before	**Regulatory and Policy** • Waste monitoring and evaluation of product development setting by the local government according to the NSPK. • Evaluation of law implementation related to public private partnership in waste management. **Implementation of Program** • Increase of waste management in landfill, from open dumping to become controlled landfill in small and medium-sized cities; and sanitary landfill in large and metropolitan cities by 50% • Reduction of domestic solid waste (reduce) from the source as much as possible, use again (reuse) and recycle

Scientific Base Inventorization of GHG	Mitigation Alternative Strategies Recommendation	Priority Programs for Kalimantan 2010 – 2014	2015 – 2019	2020 – 2024	2024 – 2029
	development of waste that is more concern to the aspect of capacity building, including human resources and institutional competence and the independence of local government in the development of environmental infrastructure also encourage private and society participation. • Develop a waste management technology that is environment-friendly and anticipative to climate change. • Develop the technology to improve the quality of landfill: (7) Controlled Landfill (CLF) for small and medium-sized cities, (8) Sanitary Landfill (SLF) for large and metropolitan cities (9) Termination of Open Dumping. • Develop the application of EPR (Extended Producer Responsibility) for producer and importer of hazardous waste	• Implementation of waste development commissioner in the district/city. • Waste management in landfill, from open dumping to become controlled landfill in small and medium-sized cities; and sanitary landfill in large and metropolitan cities by 10%. • Reduction of domestic solid waste (reduce) from the source as much as possible, use again (reuse) and recycle (3R) before transported to the landfill by 20%. • Improve method of managing waste gas (landfill gas - LFG) through collection and combustion or through application of energy recovery system by 5%. • Procurement of waste development (bantek) replication in the district/city. • Provision of waste infrastructure in 41 districts/cities in Kalimantan. • Provision of waste management facility of 411 unit • Transportation of waste in 41 districts/cities in Kalimantan.	landfill by 30%. • Improve method of managing waste gas (landfill gas - LFG) through collection and combustion or through application of energy recovery system by 20%. • Building of example project (3R, CDM, biogas) • Provision of waste infrastructure in 15 districts/cities. • Building of waste management facility by 453 unit • Transportation of waste in 15 districts/cities • Transportation of waste in Kalimantan by45%. • 3R integrated landfill in all districts/cities in Kalimantan.	transported to the landfill by 40%. • Improve method of managing waste gas (landfill gas - LFG) through collection and combustion or through application of energy recovery system by 30%. • Infrastructure maintenance and improvement of waste service in 41 districts/cities in Kalimantan. • Provision of waste management facility by 498 unit • Improvement of waste transportation in 41 districts/cities in Kalimantan. • Transportation of waste in Kalimantan by 60%. • Evaluation, maintenance, and development of example project (3R, CDM, biogas) **Capacity building (strengthening of the local government, private, and society institutions)**	(3R) before transported to the landfill by 50%. • Improve method of managing waste gas (landfill gas - LFG) through collection and combustion or through application of energy recovery system by 50%. • Infrastructure maintenance and improvement of waste service in15 kab/kota • Procurement of waste management facility by 548 unit • Development of waste transportation in 15 districts/cities. • Improve method of managing waste gas (landfill gas - LFG) through collection and combustion or through application of energy recovery system by 70%. • Evaluation, maintenance, and development of example project (3R, CDM, biogas) • Transportation of waste in Kalimantan by 75%.

Scientific Base Inventorization of GHG	Mitigation Alternative Strategies Recommendation	Priority Programs for Kalimantan 2010 – 2014	2015 – 2019	2020 – 2024	2024 – 2029
		• Transportation of waste in Kalimantan by 30%. • Development of 3R in TPST in all city/district inPulau Kalimantan. **Capacity building (strengthening of the local government, private, and society institutions)** • Strengthening government and community partnerships. • Strengthening local government institution in waste management. • Procurement of monitoring and evaluation of performance of waste management development • Procurement of facility for financing source development activity and pattern of investment in the waste sector through cooperation of government and international public business		• Forming of condusive climate for the bussiness (private) world to actively participate in giving waste service, either in transportation handling or landfill management.	**Capacity building (strengthening of the local government, private, and society institutions)** • Awareness increase for all stakeholders to the importance of increasing waste service. • Development of condusive climate for business (private) world to participate in giving waste service, either in handling transporatation or in landfill management. • Increase in stakeholders' participation in the effort to reach waste development target.

4. Sulawesi

Scientific Base	Mitigation Alternative	Priority Programs for Sulawesi			
Inventorization of GHG	**Strategies Recommendation**	**2010 – 2014**	**2015 – 2019**	**2020 – 2024**	**2024 – 2029**
• GHG emission from urban solid waste sector in the form of methane (CH4) emitted by landfill and CO2 emitted by open combustion activity. • Domestic waste level of 0.61 kg/person/day (TNA, 2009). • Overall, only 21% from the total solid waste that was transported to the landfill (Dept. of Public Works, 2009).	• Carry out an inventory study of GHG from the solid waste sector, a more complete and perfect plan, accompanied by a systematic reduction in GHG. • Applying the environment-friendly infrastructure development policy in the waste sector which is supported by the development of applied technology research and environmental perspective. • Develop the application of environmental policy for the principle of 3R (reduce, reuse, recycle) in waste management. • Develope a sustainable infrastructure development (with three balancing development pillars, which are economic, social, and environment) to reduce emission of GHG (Green House Gases) and increase carbon absorption • Conducting infrastructure development of waste that is more concern to	**Data Inventory and Planning** • Inventorization study and GHG reduction from the solid waste sector. **Regulatory and Policy** • Strengthening environmental policy approach to waste management and standardization (stepwise approach). • Issuance of waste product development setting by the local government according to the NSPK of city/district. • Settlement of waste regulation • Preparation of NSPM in the waste field. • Setting, coaching, supervising, developing finance source, and investing pattern in waste management • Creating provision of guideline for waste control. • Creating NSPK in the waste field • Creating provision of Bantek, Bimtek and assistance (SSK) of waste management **Implementation of Program**	**Regulatory and Policy** • Supervision and development of source of finance and investment pattern in waste management • Monitoring waste product development setting by the local government according to the NSPK. **Implementation of Program** • Improvement of waste management in landfill, from open dumping to become controlled landfill in small and medium-sized cities; and sanitary landfill in large and metropolitan cities by 20% • Reduction of domestic solid waste (reduce) from the source as much as possible, use again (reuse) and recycle (3R) before transported to the landfill by 30%. • Improve method of	**Regulatory and Policy** • Drafting legislation related to public-private partnerships in waste management • Waste monitoring and evaluation of product development setting by the local government according to the NSPK. **Implementation of Program** • Improvement of waste management in landfill, from open dumping to become controlled landfill in small and medium-sized cities; and sanitary landfill in large and metropolitan cities by 30% • Reduction of domestic solid waste (reduce) from the source as much as possible, use again (reuse) and recycle (3R) before transported to the landfill by 40%.	**Regulatory and Policy** • Waste monitoring and evaluation of product development setting by the local government according to the NSPK. • Evaluation of law implementation related to public private partnership in waste management. **Implementation of Program** • Increase of waste management in landfill, from open dumping to become controlled landfill in small and medium-sized cities; and sanitary landfill in large and metropolitan cities by 50% • Reduction of domestic solid waste (reduce) from the source as much as possible, use again (reuse) and recycle (3R) before transported to the

Scientific Base Inventorization of GHG	Mitigation Alternative Strategies Recommendation	Priority Programs for Sulawesi 2010 – 2014	2015 – 2019	2020 – 2024	2024 – 2029
	the aspect of capacity building, including human resources and institutional competence and the independence of local government in the development of environmental infrastructure also encourage private and society participation. • Develop a waste management technology that is environment-friendly and anticipative to climate change. • Develop the technology to improve the quality of landfill: (10) Controlled Landfill (CLF) for small and medium-sized cities, (11) Sanitary Landfill (SLF) for large and metropolitan cities (12) Termination of Open Dumping. • Develop the application of EPR (Extended Producer Responsibility) for producer and importer of B3 waste	• Implementation of waste development commissioner in the district/city. • Waste management in landfill, from open dumping to become controlled landfill in small and medium-sized cities; and sanitary landfill in large and metropolitan cities by 10%. • Reduction of domestic solid waste (reduce) from the source as much as possible, use again (reuse) and recycle (3R) before transported to the landfill by 20%. • Improve method of managing waste gas (landfill gas - LFG) through collection and combustion or through application of energy recovery system by 5%. • Procurement of waste development (bantek) replication in the district/city. • Provision of waste infrastructure in 39 districts/cities in Sulawesi. • Provision of waste management facility of 411 unit • Transportation of waste	managing waste gas (landfill gas - LFG) through collection and combustion or through application of energy recovery system by 20%. • Building of example project (3R, CDM, biogas) • Provision of waste infrastructure in 31 districts/cities. • Building of waste management facility by 453 unit • Transportation of waste in 31 districts/cities • Transportation of waste in Sulawesi by 45%. • 3R integrated landfill in all districts/cities in Sulawesi.	• Improve method of managing waste gas (landfill gas - LFG) through collection and combustion or through application of energy recovery system by 30%. • Infrastructure maintenance and improvement of waste service in 39 districts/cities in Sulawesi. • Provision of waste management facility by 498 unit • Improvement of waste transportation in 39 districs/cities in Sulawesi. • Transportation of waste in Sulawesi by 60%. • Evaluation, maintenance, and development of example project (3R, CDM, biogas) **Capacity building (strengthening of the local government, private, and society institutions)** • Forming of condusive climate for the bussiness	landfill by 50%. • Improve method of managing waste gas (landfill gas - LFG) through collection and combustion or through application of energy recovery system by 50%. • Infrastructure maintenance and improvement of waste service in 31 districts/cities • Procurement of waste management facility by 548 unit • Development of waste transportation in 31 districts/cities. • Improve method of managing waste gas (landfill gas - LFG) through collection and combustion or through application of energy recovery system by 70%. • Evaluation, maintenance, and development of example project (3R, CDM, biogas) • Transportation of waste in Sulawesi by 75%. **Capacity building**

Scientific Base Inventorization of GHG	Mitigation Alternative Strategies Recommendation	Priority Programs for Sulawesi 2010 – 2014	2015 – 2019	2020 – 2024	2024 – 2029
		in 39 districts/cities in Sumatera. • Transportation of waste in Sulawesi by 30%. • Development of 3R in TPST in all city/district in Sulawesi. **Capacity building (strengthening of the local government, private, and society institutions)** • Strengthening government and community partnerships. • Strengthening local government institution in waste management. • Procurement of monitoring and evaluation of performance of waste management development • Procurement of facility for financing source development activity and pattern of investment in the waste sector through cooperation of government and international public business		(private) world to actively participate in giving waste service, either in transportation handling or landfill management.	**(strengthening of the local government, private, and society institutions)** • Awareness increase for all stakeholders to the importance of increasing waste service. • Development of condusive climate for business (private) world to participate in giving waste service, either in handling transporatation or in landfill management. • Increase in stakeholders' participation in the effort to reach waste development target.

5. Nusa Tenggara Islands

Scientific Base	Mitigation Alternative Strategies Recommendation	Priority Programs for Nusatenggara Islands			
Inventorization of GHG		**2010 – 2014**	**2015 – 2019**	**2020 – 2024**	**2024 – 2029**
• GHG emission from urban solid waste sector in the form of methane (CH4) emitted by landfill and CO2 emitted by open combustion activity. • Domestic waste level of 0.61 kg/person/day (TNA, 2009). • Overall, only 21% from the total solid waste that was transported to the landfill (Dept. of Public Works, 2009).	• Carry out an inventory study of GHG from the solid waste sector, a more complete and perfect plan, accompanied by a systematic reduction in GHG. • Applying the environment-friendly infrastructure development policy in the waste sector which is supported by the development of applied technology research and environmental perspective. • Develop the application of environmental policy for the principle of 3R (reduce, reuse, recycle) in waste management. • Develope a sustainable infrastructure development (with three balancing development pillars, which are economic, social, and environment) to reduce emission of GHG (Green House Gases) and increase carbon absorption • Conducting infrastructure development of waste that is more concern to	**Data Inventory and Planning** • Inventorization study and GHG reduction from the solid waste sector. **Regulatory and Policy** • Strengthening environmental policy approach to waste management and standardization (stepwise approach). • Issuance of waste product development setting by the local government according to the NSPK of city/district. • Settlement of waste regulation • Preparation of NSPM in the waste field. • Setting, coaching, supervising, developing finance source, and investing pattern in waste management • Creating provision of guideline for waste control. • Creating NSPK in the waste field • Creating provision of Bantek, Bimtek and assistance (SSK) of waste management **Implementation of Program**	**Regulatory and Policy** • Supervision and development of source of finance and investment pattern in waste management • Monitoring waste product development setting by the local government according to the NSPK. **Implementation of Program** • Improvement of waste management in landfill, from open dumping to become controlled landfill in small and medium-sized cities; and sanitary landfill in large and metropolitan cities by 20% • Reduction of domestic solid waste (reduce) from the source as much as possible, use again (reuse) and recycle (3R) before transported to the landfill by 30%. • Improve method of	**Regulatory and Policy** • Drafting legislation related to public-private partnerships in waste management • Waste monitoring and evaluation of product development setting by the local government according to the NSPK. **Implementation of Program** • Improvement of waste management in landfill, from open dumping to become controlled landfill in small and medium-sized cities; and sanitary landfill in large and metropolitan cities by 30% • Reduction of domestic solid waste (reduce) from the source as much as possible, use again (reuse) and recycle (3R) before transported to the landfill by 40%.	**Regulatory and Policy** • Waste monitoring and evaluation of product development setting by the local government according to the NSPK. • Evaluation of law implementation related to public private partnership in waste management. **Implementation of Program** • Increase of waste management in landfill, from open dumping to become controlled landfill in small and medium-sized cities; and sanitary landfill in large and metropolitan cities by 50% • Reduction of domestic solid waste (reduce) from the source as much as possible, use again (reuse) and recycle (3R) before transported to the

Scientific Base Inventorization of GHG	Mitigation Alternative Strategies Recommendation	Priority Programs for Nusatenggara Islands 2010 – 2014	2015 – 2019	2020 – 2024	2024 – 2029
	the aspect of capacity building, including human resources and institutional competence and the independence of local government in the development of environmental infrastructure also encourage private and society participation. • Develop a waste management technology that is environment-friendly and anticipative to climate change. • Develop the technology to improve the quality of landfill: (13) Controlled Landfill (CLF) for small and medium-sized cities, (14) Sanitary Landfill (SLF) for large and metropolitan cities (15) Termination of Open Dumping. • Develop the application of EPR (Extended Producer Responsibility) for producer and importer of B3 waste	• Implementation of waste development commissioner in the district/city. • Waste management in landfill, from open dumping to become controlled landfill in small and medium-sized cities; and sanitary landfill in large and metropolitan cities by 10%. • Reduction of domestic solid waste (reduce) from the source as much as possible, use again (reuse) and recycle (3R) before transported to the landfill by 20%. • Improve method of managing waste gas (landfill gas - LFG) through collection and combustion or through application of energy recovery system by 5%. • Procurement of waste development (bantek) replication in the district/city. • Provision of waste infrastructure insemua kab/kota di Nusa Tenggara Islands. • Provision of waste management facility of 411 unit • Transportation of waste	managing waste gas (landfill gas - LFG) through collection and combustion or through application of energy recovery system by 20%. • Building of example project (3R, CDM, biogas) • Provision of waste infrastructure in all districts/cities. • Building of waste management facility by 453 unit • Transportation of waste in all districts/cities • Transportation of waste in Nusa Tenggara Islands by 45%. • 3R integrated landfill in all districts/cities in Nusa Tenggara.	• Improve method of managing waste gas (landfill gas - LFG) through collection and combustion or through application of energy recovery system by 30%. • Infrastructure maintenance and improvement of waste service in all districts/cities di Nusa Tenggara Islands. • Provision of waste management facility by 498 unit • Improvement of waste transportation in alldistricts/cities in Nusa Tenggara Islands. • Transportation of waste in Nusa Tenggara Islands by 60%. • Evaluation, maintenance, and development of example project (3R, CDM, biogas) **Capacity building (strengthening of the local government, private, and society institutions)**	landfill by 50%. • Improve method of managing waste gas (landfill gas - LFG) through collection and combustion or through application of energy recovery system by 50%. • Infrastructure maintenance and improvement of waste service in all districts/cities • Procurement of waste management facility by 548 unit • Development of waste transportation in all districts/cities. • Improve method of managing waste gas (landfill gas - LFG) through collection and combustion or through application of energy recovery system by 70%. • Evaluation, maintenance, and development of example project (3R, CDM, biogas) • Transportation of waste in Nusa Tenggara Islands by 75%.

Scientific Base Inventorization of GHG	Mitigation Alternative Strategies Recommendation	Priority Programs for Nusatenggara Islands			
		2010 – 2014	2015 – 2019	2020 – 2024	2024 – 2029
		in all districts/cities in Nusa Tenggara Islands. • Transportation of waste in Nusa Tenggara Islands by 30%. • Development of 3R in TPST in all city/district in Nusa Tenggara Islands. **Capacity building (strengthening of the local government, private, and society institutions)** • Strengthening government and community partnerships. • Strengthening local government institution in waste management. • Procurement of monitoring and evaluation of performance of waste management development • Procurement of facility for financing source development activity and pattern of investment in the waste sector through cooperation of government and international public business		• Forming of condusive climate for the bussiness (private) world to actively participate in giving waste service, either in transportation handling or landfill management.	**Capacity building (strengthening of the local government, private, and society institutions)** • Awareness increase for all stakeholders to the importance of increasing waste service. • Development of condusive climate for business (private) world to participate in giving waste service, either in handling transporatation or in landfill management. • Increase in stakeholders' participation in the effort to reach waste development target.

6. Maluku Islands

Scientific Base	Mitigation Alternative	Priority Programs for Maluku Islands			
Inventorization of GHG	**Strategies Recommendation**	**2010 – 2014**	**2015 – 2019**	**2020 – 2024**	**2024 – 2029**
• GHG emission from urban solid waste sector in the form of methane (CH4) emitted by landfill and CO2 emitted by open combustion activity. • Domestic waste level of 0.61 kg/person/day (TNA, 2009). • Overall, only 21% from the total solid waste that was transported to the landfill (Dept. of Public Works, 2009).	• Carry out an inventory study of GHG from the solid waste sector, a more complete and perfect plan, accompanied by a systematic reduction in GHG. • Applying the environment-friendly infrastructure development policy in the waste sector which is supported by the development of applied technology research and environmental perspective. • Develop the application of environmental policy for the principle of 3R (reduce, reuse, recycle) in waste management. • Develope a sustainable infrastructure development (with three balancing development pillars, which are economic, social, and environment) to reduce emission of GHG (Green House Gases) and increase carbon absorption • Conducting infrastructure development of waste	**Data Inventory and Planning** • Inventorization study and GHG reduction from the solid waste sector. **Regulatory and Policy** • Strengthening environmental policy approach to waste management and standardization (stepwise approach). • Issuance of waste product development setting by the local government according to the NSPK of city/district. • Settlement of waste regulation • Preparation of NSPM in the waste field. • Setting, coaching, supervising, developing finance source, and investing pattern in waste management • Creating provision of guideline for waste control. • Creating NSPK in the waste field • Creating provision of Bantek, Bimtek and assistance (SSK) of waste management	**Regulatory and Policy** • Supervision and development of source of finance and investment pattern in waste management • Monitoring waste product development setting by the local government according to the NSPK. **Implementation of Program** • Improvement of waste management in landfill, from open dumping to become controlled landfill in small and medium-sized cities; and sanitary landfill in large and metropolitan cities by 20% • Reduction of domestic solid waste (reduce) from the source as much as possible, use again (reuse) and recycle (3R) before transported to the landfill by 30%.	**Regulatory and Policy** • Drafting legislation related to public-private partnerships in waste management • Waste monitoring and evaluation of product development setting by the local government according to the NSPK. **Implementation of Program** • Improvement of waste management in landfill, from open dumping to become controlled landfill in small and medium-sized cities; and sanitary landfill in large and metropolitan cities by 30% • Reduction of domestic solid waste (reduce) from the source as much as possible, use again (reuse) and recycle (3R) before transported to the	**Regulatory and Policy** • Waste monitoring and evaluation of product development setting by the local government according to the NSPK. • Evaluation of law implementation related to public private partnership in waste management. **Implementation of Program** • Increase of waste management in landfill, from open dumping to become controlled landfill in small and medium-sized cities; and sanitary landfill in large and metropolitan cities by 50% • Reduction of domestic solid waste (reduce) from the source as much as possible, use again (reuse) and recycle (3R) before

Scientific Base Inventorization of GHG	Mitigation Alternative Strategies Recommendation	Priority Programs for Maluku Islands 2010 – 2014	2015 – 2019	2020 – 2024	2024 – 2029
	that is more concern to the aspect of capacity building, including human resources and institutional competence and the independence of local government in the development of environmental infrastructure also encourage private and society participation. • Develop a waste management technology that is environment-friendly and anticipative to climate change. • Develop the technology to improve the quality of landfill: (16) Controlled Landfill (CLF) for small and medium-sized cities, (17) Sanitary Landfill (SLF) for large and metropolitan cities (18) Termination of Open Dumping. • Develop the application of EPR (Extended Producer Responsibility) for producer and importer of B3 waste	**Implementation of Program** • Implementation of waste development commissioner in the district/city. • Waste management in landfill, from open dumping to become controlled landfill in small and medium-sized cities; and sanitary landfill in large and metropolitan cities by 10%. • Reduction of domestic solid waste (reduce) from the source as much as possible, use again (reuse) and recycle (3R) before transported to the landfill by 20%. • Improve method of managing waste gas (landfill gas - LFG) through collection and combustion or through application of energy recovery system by 5%. • Procurement of waste development (bantek) replication in the district/city. • Provision of waste infrastructure in 11 districts/cities in Maluku Islands. • Provision of waste management facility of 411 unit	• Improve method of managing waste gas (landfill gas - LFG) through collection and combustion or through application of energy recovery system by 20%. • Building of example project (3R, CDM, biogas) • Provision of waste infrastructure in 7 districts/cities. • Building of waste management facility by 453 unit • Transportation of waste in 7 districts/cities • Transportation of waste in Maluku Islands by 45%. • 3R integrated landfill in all districts/cities in Maluku.	landfill by 40%. • Improve method of managing waste gas (landfill gas - LFG) through collection and combustion or through application of energy recovery system by 30%. • Infrastructure maintenance and improvement of waste service in 11 districts/cities in Maluku Islands. • Provision of waste management facility by 498 unit • Improvement of waste transportation in 11 districts/cities in Maluku Islands. • Transportation of waste in Maluku Islands by 60%. • Evaluation, maintenance, and development of example project (3R, CDM, biogas) **Capacity building (strengthening of the local government, private, and society institutions)** • Forming of condusive climate	transported to the landfill by 50%. • Improve method of managing waste gas (landfill gas - LFG) through collection and combustion or through application of energy recovery system by 50%. • Infrastructure maintenance and improvement of waste service in 7 districts/cities • Procurement of waste management facility by 548 unit • Development of waste transportation in 7 districts/cities. • Improve method of managing waste gas (landfill gas - LFG) through collection and combustion or through application of energy recovery system by 70%. • Evaluation, maintenance, and development of example project (3R, CDM, biogas) • Transportation of waste in Maluku Islands by 75%.

Scientific Base Inventorization of GHG	Mitigation Alternative Strategies Recommendation	Priority Programs for Maluku Islands 2010 – 2014	2015 – 2019	2020 – 2024	2024 – 2029
		• Transportation of waste in 11 districts/cities in Maluku Islands. • Transportation of waste in Maluku Islands by 30%. • Development of 3R in TPST in all city/district in Maluku Islands. **Capacity building (strengthening of the local government, private, and society institutions)** • Strengthening government and community partnerships. • Strengthening local government institution in waste management. • Procurement of monitoring and evaluation of performance of waste management development • Procurement of facility for financing source development activity and pattern of investment in the waste sector through cooperation of government and international public business		for the bussiness (private) world to actively participate in giving waste service, either in transportation handling or landfill management.	**Capacity building (strengthening of the local government, private, and society institutions)** • Awareness increase for all stakeholders to the importance of increasing waste service. • Development of condusive climate for business (private) world to participate in giving waste service, either in handling transporatation or in landfill management. • Increase in stakeholders' participation in the effort to reach waste development target.

7. Papua

Scientific Base	Mitigation Alternative	Priority Programs for Papua			
Inventorization of GHG	**Strategies Recommendation**	**2010 – 2014**	**2015 – 2019**	**2020 – 2024**	**2024 – 2029**
• GHG emission from urban solid waste sector in the form of methane (CH4) emitted by landfill and CO2 emitted by open combustion activity. • Domestic waste level of 0.61 kg/person/day (TNA, 2009). • Overall, only 21% from the total solid waste that was transported to the landfill (Dept. of Public Works, 2009).	• Carry out an inventory study of GHG from the solid waste sector, a more complete and perfect plan, accompanied by a systematic reduction in GHG. • Applying the environment-friendly infrastructure development policy in the waste sector which is supported by the development of applied technology research and environmental perspective. • Develop the application of environmental policy for the principle of 3R (reduce, reuse, recycle) in waste management. • Develope a sustainable infrastructure development (with three balancing development pillars, which are economic, social, and environment) to reduce emission of GHG (Green House Gases) and increase carbon absorption • Conducting infrastructure development of waste	**Data Inventory and Planning** • Inventorization study and GHG reduction from the solid waste sector. **Regulatory and Policy** • Strengthening environmental policy approach to waste management and standardization (stepwise approach). • Issuance of waste product development setting by the local government according to the NSPK of city/district. • Settlement of waste regulation • Preparation of NSPM in the waste field. • Setting, coaching, supervising, developing finance source, and investing pattern in waste management • Creating provision of guideline for waste control. • Creating NSPK in the waste field • Creating provision of Bantek, Bimtek and assistance (SSK) of waste management	**Regulatory and Policy** • Supervision and development of source of finance and investment pattern in waste management • Monitoring waste product development setting by the local government according to the NSPK. **Implementation of Program** • Improvement of waste management in landfill, from open dumping to become controlled landfill in small and medium-sized cities; and sanitary landfill in large and metropolitan cities by 20% • Reduction of domestic solid waste (reduce) from the source as much as possible, use again (reuse) and recycle (3R) before transported to the landfill by 30%.	**Regulatory and Policy** • Drafting legislation related to public-private partnerships in waste management • Waste monitoring and evaluation of product development setting by the local government according to the NSPK. **Implementation of Program** • Improvement of waste management in landfill, from open dumping to become controlled landfill in small and medium-sized cities; and sanitary landfill in large and metropolitan cities by 30% • Reduction of domestic solid waste (reduce) from the source as much as possible, use again (reuse) and recycle (3R) before transported to the	**Regulatory and Policy** • Waste monitoring and evaluation of product development setting by the local government according to the NSPK. • Evaluation of law implementation related to public private partnership in waste management. **Implementation of Program** • Increase of waste management in landfill, from open dumping to become controlled landfill in small and medium-sized cities; and sanitary landfill in large and metropolitan cities by 50% • Reduction of domestic solid waste (reduce) from the source as much as possible, use again (reuse) and recycle (3R) before

Scientific Base Inventorization of GHG	Mitigation Alternative Strategies Recommendation	Priority Programs for Papua 2010 – 2014	2015 – 2019	2020 – 2024	2024 – 2029
	that is more concern to the aspect of capacity building, including human resources and institutional competence and the independence of local government in the development of environmental infrastructure also encourage private and society participation. • Develop a waste management technology that is environment-friendly and anticipative to climate change. • Develop the technology to improve the quality of landfill: (19) Controlled Landfill (CLF) for small and medium-sized cities, (20) Sanitary Landfill (SLF) for large and metropolitan cities (21) Termination of Open Dumping. • Develop the application of EPR (Extended Producer Responsibility) for producer and importer of B3 waste	**Implementation of Program** • Implementation of waste development commissioner in the district/city. • Waste management in landfill, from open dumping to become controlled landfill in small and medium-sized cities; and sanitary landfill in large and metropolitan cities by 10%. • Reduction of domestic solid waste (reduce) from the source as much as possible, use again (reuse) and recycle (3R) before transported to the landfill by 20%. • Improve method of managing waste gas (landfill gas - LFG) through collection and combustion or through application of energy recovery system by 5%. • Procurement of waste development (bantek) replication in the district/city. • Provision of waste infrastructure in 13 districts/cities in Papua. • Provision of waste management facility of 411 unit • Transportation of waste	• Improve method of managing waste gas (landfill gas - LFG) through collection and combustion or through application of energy recovery system by 20%. • Building of example project (3R, CDM, biogas) • Provision of waste infrastructure in 17 districts/cities. • Building of waste management facility by 453 unit • Transportation of waste in 17 districts/cities • Transportation of waste in Pulau Papua by 45%. • 3R integrated landfill in all districts/cities in Papua.	landfill by 40%. • Improve method of managing waste gas (landfill gas - LFG) through collection and combustion or through application of energy recovery system by 30%. • Infrastructure maintenance and improvement of waste service in 13 districts/cities in Papua. • Provision of waste management facility by 498 unit • Improvement of waste transportation in 13 districts/cities in Pulau Papua. • Transportation of waste in Papua by 60%. • Evaluation, maintenance, and development of example project (3R, CDM, biogas) **Capacity building (strengthening of the local government, private, and society institutions)** • Forming of condusive climate	transported to the landfill by 50%. • Improve method of managing waste gas (landfill gas - LFG) through collection and combustion or through application of energy recovery system by 50%. • Infrastructure maintenance and improvement of waste service in 17 districts/cities • Building of CDM landfill facility in 3 large cities • Procurement of waste management facility by 548 unit • Development of waste transportation in 17 districts/cities. • Improve method of managing waste gas (landfill gas - LFG) through collection and combustion or through application of energy recovery system by 70%. • Evaluation, maintenance, and development of example project (3R, CDM, biogas) • Transportation of

Scientific Base Inventorization of GHG	Mitigation Alternative Strategies Recommendation	Priority Programs for Papua 2010 – 2014	2015 – 2019	2020 – 2024	2024 – 2029
		in 13 districts/cities in Papua. • Transportation of waste in Papua by 30%. • Development of 3R in TPST in all city/district in Papua. **Capacity building (strengthening of the local government, private, and society institutions)** • Strengthening government and community partnerships. • Strengthening local government institution in waste management. • Procurement of monitoring and evaluation of performance of waste management development • Procurement of facility for financing source development activity and pattern of investment in the waste sector through cooperation of government and international public business		for the bussiness (private) world to actively participate in giving waste service, either in transportation handling or landfill management.	waste in Papua by 75%. **Capacity building (strengthening of the local government, private, and society institutions)** • Awareness increase for all stakeholders to the importance of increasing waste service. • Development of condusive climate for business (private) world to participate in giving waste service, either in handling transporatation or in landfill management. • Increase in stakeholders' participation in the effort to reach waste development target.