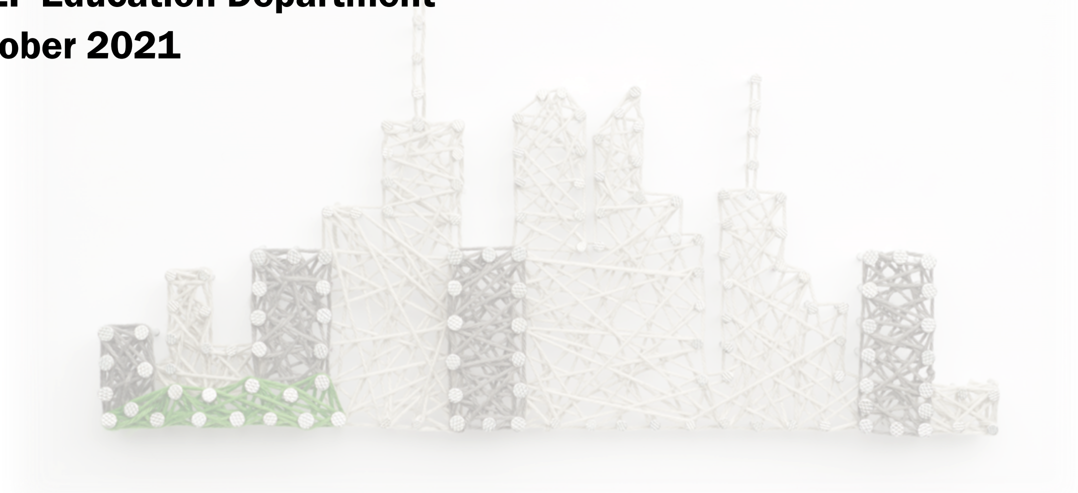
Waste Management in Indonesia and Jakarta: Challenges and Way Forward

Aretha APRILIA

Background Paper
23rd ASEF Summer University
ASEF Education Department
October 2021



ASIA-EUROPE FOUNDATION

Summary

Worldwide waste quantity continues to increase, leading to the escalation of environmental problems. Waste is an important source of greenhouse gas (GHG) emissions, contributing 3.2% of the total GHG emissions worldwide. Indonesia has also been encountering pressing problems with regards to the management of solid waste. Along with the increasing urbanisation, major urban centres in Indonesia produce up to 8 million tonnes of waste per day. Greenhouse gas emission from these waste place Indonesia as the world's third-largest emitter in the waste sector. Waste management shall consider both the end-users (i.e. waste generators such as households) who need to reduce waste generation as well as end-of-pipe solutions through the application of advanced solid waste management (SWM) systems/technologies. The government is responsible to optimise end-of-pipe solutions by: a) enforcing at-sources segregation, b) enacting waste policy, c) adjusting local budgets to cover waste management costs, c) upgrading waste collection, and d) applying advanced SWM system as appropriate. The public can also reduce the production of waste in the first place by conducting at source sorting (i.e. segregating recyclables and organic waste), composting, and being actively involved in waste banks.

About this Background Paper

This Background Paper was commissioned by the Asia-Europe Foundation's Education Department and the Hanns Seidel Foundation as part of the 23rd ASEF Summer University (ASEFSU23) on '*Liveable Cities for a Sustainable Future*', an international Hackathon to tackle urban challenges in Bangladesh, India and Pakistan which took place between September and November 2021.

This Background Paper is linked to one of the Hackathon challenges – Waste Management in Bangladesh – which was tackled by the young ASEFSU23 participants coming from 39 ASEM countries in Asia and Europe. It provides insights on the topic of Waste Management by focusing on a different ASEM country & context: Indonesia.

This Background Paper was proofread and copyedited by the Asia-Europe Foundation's Education Department.

Disclaimer

The author, Dr. Aretha APRILIA, is Director of Foreign Construction Representative Office, at CDM Smith GmbH, Jakarta, Indonesia. The views and opinions expressed in this background paper are the author's own and do not reflect the views of the Asia-Europe Foundation (ASEF).

List of Acronyms

3R	Reduce, Reuse, Recycle
APBD	*Anggaran Pendapatan Belanja Daerah* /Regional Government Budget
BLUD	*Badan Layanan Umum Daerah*/Regional Public Service Agency
BUMD	*Badan Usaha Milik Daerah/ Regional-Owned Enterprise*
DLH	Dinas Lingkungan Hidup/*Environmental Agency*
EPR	Extended Producer Responsibility
GHG	Greenhouse Gas
GDP	Gross Domestic Product
GoI	Government of Indonesia
ITF	Intermediate Treatment Facility
KPBU	Kerjasama Pemerintah dengan Badan Usaha/*Public Private Partnership*
MBT-RDF	Mechanical Biological Treatment-Refused Derived Fuel
MoEF	Ministry of Environment and Forestry
MSW	Municipal Solid Waste
NDC	Nationally Determined Contribution
NIMBY	"Not in My Backyard"
NIMBI	"Now I Must Be Involved"
PLN	*Perusahaan Listrik Negara/*State Electricity Company
PPP	Public Private Partnership
PT	*Perseroan Terbatas/*Limited Liability Enterprises
RPJMD	*Rencana Pembangunan Jangka Menengah Daerah/* Regional Medium-Term Development Plan
SMS	Sound Material-Cycle Society
SWM	Solid Waste Management
TPS	Tempat Penampungan Sampah Sementara/Temporary Waste Storage
TPST	Tempat Pengolahan Sampah Terpadu/Integrated Waste Treatment Site
UPTD	*Unit Pelaksana Teknis Daerah* / Regional Technical Implementation Unit
WtE	Waste-to-Energy

1. Overview of Waste Management in Indonesia

The current worldwide demand for resources is increasing amid the progressing globalisation of economic activity. At the same time, the increasing quantity of wastes escalates problems that pose burdens to the environment. Waste is a source of greenhouse gas emissions that contributes 1,580 billion tonnes of CO_2e (CO_2 equivalent), equivalent to 3.2% of the total CO_2 emission worldwide (Ritchie & Rosser, 2020). Thus, waste management and recycling measures have begun to take on international aspects. The current trend towards the establishment of an international sound material-cycle society (SMS) is centred on the 3Rs (Reduce, Reuse, and Recycle) and circular economies.

Despite scattered community initiatives in solid waste management, the worldwide quantities of household solid waste have continued to rise. The prevailing conception of waste management was about getting rid of waste. However, there is a current new economy of waste, in which there are three basic drivers of change that are turning waste and waste management into a dynamic, fast-changing, economic sector, which are:

a) growing concern about the hazards of improper waste disposal;
b) broader environmental concerns – especially climate change and resource depletion; and
c) economic opportunities created by new waste regulations and technological innovation.

Rising problems related to solid waste management (SWM) have called upon each community members to contribute to participative waste management. In the past, the paradigm and attitude of householders towards wastes was aptly summarised with the term “not in my backyard” (NIMBY). It should now be replaced with “now I must be involved” (NIMBI), with more importance given to 3R practices from the households.

Currently, more than 55% of Indonesians live in cities. With the current rate of urbanisation, more than 73% of Indonesians will live in cities by 2030 (UNDP, 2017). In light of this, Indonesia has been encountering pressing problems with regard to the management of

Figure 1 Landfill in Bekasi city, 2019

municipal solid wastes (MSW). MSW is generally defined as waste collected by municipalities or other local authorities. Typically, MSW includes household waste, garden/yard, park waste, and commercial /institutional waste (IPCC, 2006). With a total population of 270,200,000 people (BPS, 2020), Indonesia generates 194,002 tonnes/day of MSW in a total area of 1,910,931 km^2. This amount of waste generation is dominated by urban centres (Christy, 2020).

Indonesia is one of Southeast Asia's largest economies and is bound to have residents with far higher living standards than previously (OECD, 2020). Although the COVID-19 pandemic slumped Indonesia’s real GDP growth from 5% in Q4 2019 to 0% in 2020, it is projected to increase to 4.8% in 2021, and to 6% in 2022 (World Bank, 2020). The expected growth would essentially lead to the rising production and consumption of goods which will result in waste.

The largest stream of municipal solid waste in Indonesia flows from house households (39.8%), followed by traditional markets (17.2%) (SIPSN, 2020).

SWM usually relates to both formal and informal sectors. In Indonesia, the formal sector includes municipal agencies and formal businesses, whereas the informal sector consists of individuals, groups and small businesses engaging in activities that are not registered and are not formally regulated. In solid waste activities, the informal sector refers to recycling activities conducted by scavengers (itinerant waste pickers) and waste buyers (Sembiring and Nitivatta, 2010).

1.1 Greenhouse Gases Emissions from Waste

Solid waste is the discarded material that derived from various sources, which is often perceived as problems due to improper management such as open dumping or burning. These circumstances would essentially result in various environmental and health issues, including the increased emission of greenhouse gases (GHGs).

In 2019, major urban centres in Indonesia produced up to 8 million tonnes of waste per day (BPS, 2020). Indonesia is one of the top GHG emitting countries and the largest archipelagic state in the world, which makes it vulnerable to the negative impacts of climate change. However, the Government of Indonesia (GoI) has also expressed commitments in lowering the GHG emissions through the updated 2021 Nationally Determined Contribution (NDC) document. Indonesia has set an unconditional reduction target of 29% and a conditional reduction target of up to 41% of the business-as-usual scenario by 2030.

Figure 2. A woman scavenger sorting recyclables at Piyungan landfill, Yogyakarta (2019)

The target of GHG emission reduction is presented in Table 1 (Indonesia's NDC, 2021). According to Table 1, the waste sector is the fourth largest national GHG emission reduction target after forestry, agriculture, and the energy sector. The emission sources in Indonesia consist of forest and land conversion (50%), energy (34%), waste (7%), agriculture (6%), and industrial process (3%) (Ministry of Environment and Forestry, 2020). Hence the waste sector is the third largest source of GHG emission in Indonesia and to reach the mitigation targets, the waste sector shall be of focal concern.

Emissions from the waste sector are relatively small compared to the other sectors, but are the main contributor of methane (CH_4) and nitrous oxide (N_2O) emissions. GHG emissions from the Indonesian waste sector are equivalent to 127 billion tonnes CO_2e (BPS, 2020), which ranks Indonesia as the third largest emitter in the waste sector (Ritchie & Rosser, 2020).

Sector	GHG Emission Level 2010* (MTon CO_2e)	GHG Emission Level 2030			GHG Emission Reduction				Annual Average Growth BAU (2010-2030)	Average Growth 2000-2012
		MTon CO_2e			MTon CO_2e		% of Total BaU			
		BaU	CM1	CM2	CM1	CM2	CM1	CM2		
1. Energy*	453.2	1,669	1,355	1,223	314	446	11%	15.5%	6.7%	4.50%
2. Waste	88	296	285	256	11	40	0.38%	1.4%	6.3%	4.00%
3. IPPU	36	70	67	66	3	3.25	0.10%	0.11%	3.4%	0.10%
4. Agriculture**	111	120	110	116	9	4	0.32%	0.13%	0.4%	1.30%
5. Forestry and Other Land Uses (FOLU)***	647	714	217	22	497	692	17.2%	24.1%	0.5%	2.70%
TOTAL	**1,334**	**2,869**	**2,034**	**1,683**	**834**	**1,185**	**29%**	**41%**	**3.9%**	**3.20%**

Notes: **CM1**= Counter Measure 1 (*unconditional mitigation scenario*)
CM2= Counter Measure 2 (*conditional mitigation scenario*)

Table 1: National GHG Emission Reduction Targets

1.2 Waste Reduction and Recycling

When considering the most appropriate solid waste management (SWM) systems in any given city or regency, an integrated approach shall be taken to consider both the end-users (waste generators) as well as end-of-pipe solutions. There have been active public participatory movements in Indonesia in the form of 'waste banks', which is essentially a community-based SWM system to collect recyclables. There are also movements to achieve 'zero waste' or 'zero landfilling', which revolves around waste reduction at the source.

As the term Reduce, Reuse, Recycle (3R) became popular in the 1990s, Indonesians have adopted the principles of waste banks. However, there is only a small percentage of waste managed by these initiatives, with only 1.7% of the total waste generated treated by waste banks in 2018. This estimate was derived from the 7,488 units of waste banks established in Indonesia (BPS, 2019).

It should be noted that waste banks only treat inorganic waste with economic value, whereas organic wastes are treated by the so-called 'composting houses', outside the typical operational system of waste banks. Hickman (2016) estimated the net energy savings associated with the use of secondary (recyclable) resources to manufacture the specified materials as compared to the use of virgin resources. He compared the GHG implications of recycling and waste-to-energy technologies in Nova Scotia and argued that recycling is a more effective GHG mitigation strategy than the application of waste-to-energy (WtE).

However, recycling plants in Indonesia are currently unregulated and many operate without sufficient operational health and safety practices. The varying degree of uncertainties in the methods/technologies used for recycling makes it difficult to precisely estimate the actual GHG emission savings.

Table 2 presents the percentage of waste managed by waste banks in different cities. The average percentage of the total waste treated by waste banks is between 0.004% to 2.9%. While the promotion of at-source waste sorting is of course important, appropriate end-of-pipe technologies for the treatment of waste are a prerequisite to deal with the majority of waste that would otherwise end up in the landfills.

Bogner (2007) argues that flexible strategies and financial incentives can expand SWM systems to achieve GHG mitigation goals in the context of integrated SWM, whereby local technological decision is a function of many competing variables, including waste quantity and characteristics, cost and financing issues, infrastructure requirements including available land area for siting the waste treatment, collection and transport considerations, as well as regulatory constraints.

City/regency	Total waste treated by waste banks (tons/day)	Waste generation (tons/day)	Percentage	References
Yogyakarta city	5.32 – 6.12	1280	0.004 - 0.005%	Yogyakarta City Waste Reduction Master Plan 2017
Banda Aceh city	56.89	165	2.9%	Regional Medium-Term Development Plan (RPJMD) 2018
DKI Jakarta	72.69	8500	0.85%	DLH of DKI Jakarta Province (2018)
Pekanbaru City	1.9	867	0.2%	DLH of Pekanbaru City (2018)

Table 2: Percentage of Waste Managed by Waste Banks

1.3 SWM Technologies

A technological approach can be applied to waste management to make waste processing steps more efficient. SWM technology allows waste to be converted into other forms that do not harm the environment. SWM technology can be chosen by adjusting the existing conditions and the final needs of the waste processing itself. Several examples of SWM technologies are:

- Incineration, which is a waste treatment process that involves the combustion of substances contained in waste materials
- Mechanical-Biological Treatment to produce Refused-Derived Fuel (MBT-RDF)[1]. MBT may alternatively process the waste to produce a high RDF, which can be used in cement kilns or thermal combustion power plants.
- Anaerobic digestion, which is a process through which bacteria break down organic matter, such as organic wastes, in the absence of oxygen.
- Composting, which is a process in which organic material is broken down by bacteria and other microorganisms via decomposition. The resulting material is called compost, which can be used for gardening or agricultural purposes.

Selection of technologies needs to take into account the circumstances of the city/regency. When considering incineration option, the local government shall refer to the Presidential Decree[2] that lists the cities selected to receive preferential consideration for development of waste incineration. For cities that are not listed, it is difficult to successfully apply for/receive approval to construct and operate an incineration facility.

With regards to the MBT-RDF, careful consideration shall be taken to ensure that potential off-takers such as cement kilns or power plants will purchase RDF products sustainably. 'Economies of scale'[3] shall be considered when designing the capacity of the SWM facilities.

While anaerobic digestion[4] and landfill gas recovery also perform well in terms of potential GHG emissions savings, it has the highest capital investment compared to the other technologies (Aprilia, 2012). Recycling and controlled landfilling has the lowest potential for GHG emission reduction, although they remain better than sanitary landfilling.

1.4 Financing for Solid Waste Management

Financing of waste management relies on the Local Budgets (APBD)[5] as waste levies are typically not imposed in the cities and regencies in Indonesia. Waste fees collected from users are mostly for the transportation of waste from the source to temporary storages (TPS), but not for the actual treatment of waste. The allocation of funds from the APBD for waste management is presented in Annex 2.

The allocated funds for waste management are between 1 – 4%, and waste fees are usually being collected from residents for the purpose of waste transfer from sources to temporary storages. These fees are usually collected by the neighbourhood units/associations. There are no waste levies imposed by local governments for waste management service.

The local budget allocation for waste management as presented in Annex 2 highlights that the business-as-usual practice of open dumping remains the main method of waste disposal. Therefore, there is a need to

[1] A mechanical biological treatment (MBT) system is a type of waste processing facility that combines a sorting facility with a form of biological treatment to produce refused-derived fuel (RDF) that can be used as alternative fuel for cement kilns and power plants.
[2] Presidential Decree (*Peraturan Presiden/PerPres*) No. 35/2018
[3] Economies of scale refer to the cost advantage experienced when the level of outputs is increased.
[4] Anaerobic digestion is a biological process to break down biodegradable material in the absence of oxygen. Biogas is produced throughout the anaerobic digestion process.
[5] Local Budget (APBD) is the annual financial plan of regional governments in Indonesia which is approved by the Regional House of Representatives. APBD is determined by Regional Regulation and covers a period of one year.

adapt the allocation of the local budget to waste management if the cities/regencies are to apply advanced SWM technologies such as incineration or MBT/RDF. Other alternatives are: a) implementation of 'circular economy'; b) improvement of collection of waste retribution[6]; and c) enforcement of Extended Producer Responsibility (EPR) for companies to be responsible for the financial costs incurred by the local government for the management of packaging materials.

3.2. Circular Economy

In general, circular economy is defined as an economy that is restorative and regenerative by design and which aims at keeping products, components, and materials at their highest utility and value at all times. The concept distinguishes the technical (industrial) cycle from the biological (ecological) one. This is because the resources which are part of the biological cycle (e.g. organic matter) can be regenerated entirely, for instance by composting. However, the resources currently produced in the technical cycle such as plastic can only be recovered and restored (e.g. by recycling).

To implement the notion of Circular Economy, we need to sort waste at source, washing and drying to facilitate recycling. There is already a Government Regulation in 2012 concerning the management of household waste and household-like waste. However, most of Indonesian residents do not conduct at-source waste separation and most of the waste separation is done at the temporary storages (TPS) and landfills by the scavengers. As most of the wastes are mixed, scavengers cannot optimally retrieve recyclables that are mixed with wet organic waste. Hence, enforcement of regulations and implementation of scheduled waste collection based on the type of waste are needed for Indonesia to achieve a circular economy.

2. Overview of Waste Management in Jakarta

Waste management in Jakarta is carried out by local governments under the Environmental Agency (DLH). The current condition of waste management is still focusing on transporting waste from the source to the temporary waste storage and to the landfill. However, the condition of waste management in Jakarta is critical as the amount of waste generated increases without being followed with appropriate waste management. Waste at the source is still not segregated and a substantial amount of waste is directly dumped into open dumps or landfills.

The main constituent of the waste generated in Jakarta is organic wastes with 49,7% (SIPSN, 2020). With the total population of 10.56 million (BPS, 2020), Jakarta generates 8,369 tonnes/day of MSW (SIPSN, 2020) within a total area of 664,01 km². With a waste generation rate of 0.7 kg/capita/day (Baqiroh, 2019), it is predicted that by 2035, the volume of waste in Jakarta will reach more than 9,000 tonnes/day (BPS, 2021).

Municipal waste from households in Indonesia is the largest stream of MSW, followed by traditional markets. Currently, the most common waste management methods are open dumping and burning in open spaces. Even though landfills were built in Jakarta, open dumping is still taking place (Aye, Widjaya, 2006). This is reinforced by a statement from the DKI Jakarta (Special Capital Region of Jakarta) government that the mountain of waste in Bantargebang landfill reached a maximum height of 50 meters in an existing land area of 104 hectares (Tempo, 2019).

The method of open dumping is a major source of environmental pollution as it has become increasingly difficult to identify new sites for disposal due to public opposition, cost of land

[6] Waste retribution refers to the fees that must be paid by the community or commercial area to the Local Governments for services provided related to waste handling and management.

and lack of appropriate land area. Attempts to adopt sanitary landfilling techniques have been unsuccessful, partly due to inappropriate designs and poor operational management (Shekdar, 2009).

Jakarta uses a major landfill located at Bantargebang in the suburban town of Bekasi, which is only able to absorb approximately 6,000 tonnes of waste per day. As the capacity of the landfill decreases over time, the waste service providers – in particular, the government – are confronted with the need to reorganise the present system for the treatment and management of solid waste. However, the issue of waste management is not just a government task but a shared responsibility that includes citizens and households of Jakarta, who are the main end-users of waste management facilities and services. When reorganising solid waste management systems, understanding the role of households, their attitudes, their waste handling practices and their interactions with other actors in the waste system is therefore essential (Oosterveer et al, 2010; Oberlin, 2011).

Error! Reference source not found.3 presents the simplified flow chart of the current solid waste management system in Jakarta:

Temporary storage sites are established to reduce hauling distances for the collection trucks, thereby lowering transportation costs. These sites are depots where handcarts to transfer waste to the garbage trucks are stored. Depots also include a base for the handcarts, which is usually located on the side of the road, a trans-ship (shipping/transfer) site, and a waste collection point made of concrete. There are 1,006 temporary storage sites available in Jakarta (Putra, 2020). At the temporary storage sites, waste is transferred to waste trucks by either manual labour or shovel loader. The waste is subsequently transported to intermediate treatment facilities (ITFs), waste banks, composting centres, and/or the landfill. There is no intermediate treatment at these temporary storage sites.

For the continuity of waste management, Jakarta needs extra attention in handling the waste problem. The main reason is that Bantargebang's landfill current capacity is almost full, after 31 years of operation receiving waste from Jakarta. The lack of overall public awareness in waste reduction efforts aggravates the situation.

→	The flow of waste that is transported from households, TPS, and subsequently the landfill
→	The flow of waste that is transported to TPS and then taken by waste pickers for recycling.
→	The flow of waste that is transported from households, TPS, and then intermediate treatment facilities (ITFs).
→	The waste that is transported to the communal composter and waste banks.

Figure 3: Flow chart of the household solid waste management system in Jakarta

2.2 Promising initiatives and best practices

To promote waste reduction efforts, several innovative initiatives have been tried to reduce waste which end up at landfills. An example is the initiative that utilises plastic as an ingredient for asphalt mixtures, which could increase asphalt stability by 40% (Iqbal, 2017).[7] Other efforts were also made through an online application (mobile app) named Gringgo. Gringgo allows users to take photos of waste items which are then identified through image recognition and associated with a market value.[8] This can educate waste workers about the market value of materials, help them optimise their operations and maximise their income. Ultimately, the app is also expected to boost the recycling rates (Javerbaum, 2019).
Another promising application, named Octopus, is a new waste management app to collect and connect valuable waste from the source to the recycling industries.
At the household level, waste reduction efforts are supported by an application-based innovation named *Siklus Refill.*[9] *Siklus* is able to deliver refills of household products directly to customers' homes without plastic packaging (Purnama, 2021). It is expected to encourage people to reduce the use of plastic in their homes.

3. The Way Forward

Indonesia is bound to have increasing amounts of waste that need proper treatment, which is why the government shall phase out current practices of open dumping which emit the largest amount of GHG emissions. On the upstream, citizens shall conduct concerted efforts to reduce waste at the source, while the government should facilitate the system through the establishment of scheduled waste collection.

The public should also be encouraged to separate and compost organic waste and be involved in waste banks to further reduce waste that would otherwise need to be treated or disposed. The total waste treated in waste banks is currently less than 3% of the total waste generated, which requires to upscale these initiatives. Circular economy should also be applied to the entire value chain. Manufacturing companies shall expedite EPR efforts (e.g. through take back schemes) and take into account the costs of SWM – for instance by embedding SWM costs into the products' costs that will be transferred to the institution that manages and provides SWM system services.

On the downstream, MBT-RDF and incineration appear to have the highest potential to reduce GHG emissions from waste compared to other options – based on the curation and comparison of previous studies on GHG emissions in Indonesia. However, the application of these technologies needs further consideration on the availability and commitment of potential off-takers, such as cement kilns or power plants that may utilise the refuse-derived fuel (RDF). Decisions on the construction of waste incineration plants also requires reference to the Presidential Regulation listing the cities entitled to

[7] A mixture of asphalt with plastic produces asphalt with a stickier texture compared to asphalt that does not use plastic. Therefore, the stability and resistance of asphalt are increased by 40%, leading to better asphalt performance.
[8] See: https://www.gringgo.co/
[9] See: https://www.siklus.com/

preferential consideration for waste incineration. Both options are likely to require additional land for landfilling the residues.

In order to apply advanced SWM technologies, the government needs to increase allocation of APBD funds for SWM, along with alternative funding from the private sectors through Public Private Partnership (PPP) schemes. The government shall also consider alternative financing by enactment and enforcement of tourist waste tax and EPR. Collection of retribution shall be improved, and local governments shall decouple the local Environmental Agency's dual roles as regulator and operator by establishing UPTDs, Regional Public Service Agency (BLUD), or local-owned enterprises (BUMD/BUMDES).

There are several follow-up actions that can be proposed for relevant stakeholders in SWM as presented in Table .

The solid waste problem in Indonesia is a complex problem that cannot be tackled with a 'silver bullet' or a 'one-size-fits all' solution, as the issues are specific to each city/regency and largely depend on local governments' commitment, as well as their financial, technical, and institutional capacities. The current waste problem needs to be managed comprehensively from upstream to downstream with a 'cradle-to-the-grave' way of thinking – so that improvements of Indonesia's solid waste management can be tangibly achieved.

Producers / Private Sectors	Citizens / Consumers (End-users)	Government / Waste Management Operators
1. Account the cost of waste management in the products	1. Conduct at-source sorting to separate recyclables from wet/organic waste	1. Enforcement on at-source sorting and scheduled waste collection
		2. Optimise waste fleets to collect waste from source to the waste treatment sites to increase waste collection rates.
2. Implement EPR for producers to be responsible for the financial cost incurred by the local government for management of waste materials	2. Separate and compost organic waste	3. Enact the policy on waste tax for tourists
	3. Be actively involved in community waste banks	4. Increase APBD for waste management, increase collection, and application of advanced SWM systems to phase out open dumping
		5. Improve retribution collection

Table 3: Proposed follow-up actions for SWM stakeholders

Key Further Readings and E-learning materials

IPCC 5th Assessment Report https://www.ipcc.ch/report/ar5/syr/

Updated Nationally Determined Contribution Republic of Indonesia:
https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Indonesia%20First/Updated%20NDC%20Indonesia%202021%20-%20corrected%20version.pdf

Long Term Strategy to Achieve DKI Jakarta's Low Carbon Society 2050:
https://www.iges.or.jp/en/publication_documents/pub/discussionpaper/en/10653/2020_LCS_DKI_RDG_r1.pdf

Summary Report of Waste Management in ASEAN Countries:
https://environment.asean.org/wp-content/uploads/2020/03/Summary-Report-Waste-Management-in-ASEAN-Countries-UNEP.pdf

National Waste Management Information System (Sistem Informasi Pengelolaan Sampah Nasional): https://sipsn.menlhk.go.id/sipsn/

WHAT A WASTE 2.0: A Global Snapshot of Solid Waste Management to 2050:
https://datatopics.worldbank.org/what-a-waste/trends_in_solid_waste_management.html

References

Andryanto, S.D. (2021, May, 9). Satu Orang Indonesia Hasilkan 0,68 Kilogram Sampah Per Hari, JugaSampah Plastik. Retrieved from: https://tekno.tempo.co/read/1460843/satu-orang-indonesia-hasilkan068-kilogram-sampah-per-hari-juga-sampah-plastik/full&view=ok

Aprilia, A. (2012). Household Solid Waste Management in Jakarta, Indonesia: Evaluation on Human Behaviour, GHG Emissions, and Economy.

Aprilia, A (2013). Inorganic and Hazardous Solid Waste Management: Current Status and Challenges for Indonesia.
Retrieved from:https://www.sciencedirect.com/science/article/pii/S1878029613000820

Aye, L., Widjaya, E.R. (2006). Environmental and economic analyses of waste disposal systems for traditional markets in Indonesia, Waste Management 26: pp. 1180 – 1191.

Badan Pusat Statistik Provinsi DKI Jakarta. (2021). Proyeksi Penduduk 2010-2035 (Perempuan+Laki-Laki) (Ribu Jiwa), 2033-2035. Retrieved from: https://jakarta.bps.go.id/indicator/12/28/1/proyeksi-penduduk-2010-2035-perempuan-laki-laki-.html

Badan Pusat Statistik (BPS) Indonesia. (2020). Statistik Lingkungan Hidup Indonesia. Jakarta, Indonesia: Badan Pusat Statistik

BPS Indonesia. (2019). Statistik Indonesia 2019

Baqiroh, N, F, A, B. (2019, Feb 21). Timbulan Sampah Nasional Capai 64 juta ton per Tahun. Retrieved from: https://ekonomi.bisnis.com/read/20190221/99/891611/timbulan-sampah-nasional-capai-64-juta-ton-per-tahun#:~:text=Bisnis.com%2C%20JAKARTA%20-%20Kementerian%20Lingkungan%20Hidup%20dan%20Kehutanan,dihasilkan%20setiap%20orang%20per%20hari%20sebesar%200%2C7%20kg.

Christy, F,E. (2020, Jul 16). Urbanisasi Indonesia 10 Tahun Terakhir. Retrieved from: https://data.tempo.co/data/805/urbanisasi-indonesia-10-tahun-terakhir

First Nationally Determined Contribution Republic of Indonesia (2016, November). Retrieved from: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Indonesia%20First/First%20NDC%20Inonesia_submitted%20to%20UNFCCC%20Set_November%20%202016.pdf

Ritchie, H., Roser, M. (2020). CO_2 and Greenhouse Gas Emission. Retrieved from: https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions

IPCC (2006). 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Retrieved from: https://www.ipcc.ch/report/2006-ipcc-guidelines-for-national-greenhouse-gas-inventories/

Iqbal, M. (2019, Feb 14). Aspal Campur Plastik Bakal Diuji Coba di Cilegon. Retrieved from: https://finance.detik.com/infrastruktur/d-4427829/aspal-campur-plastik-bakal-diuji-coba-di-cilegon

Javerbaum, M. (2019, July 10). To reduce plastic waste in Indonesia, one startup turns to AI. Retrieved from: https://blog.google/outreach-initiatives/google-org/reduce-plastic-waste-indonesia/

Mangkoedihardjo, M., Pamungkas, A.P., Ramadhan, A.F., Saputro, A.Y., Putri, D.W., Khirom, I., Soleh, M. (2007). Priority Improvement of Solid Waste Management Practice in Java. Journal of Applied Sciences in Environmental Sanitation vol. 2, (1): pp. 29-34.Murray, 1999

Ministry of Environment and Forestry. (2020). Laporan Inventarisasi Gas Rumah Kaca (GRK) dan Monitoring, Pelaporan, Verifikasi. Jakarta, Indonesia: Direktorat Jenderal Pengendalian Perubahan Iklim dan Direktorat Inventarisasi GRK dan Monitoring, Pelaporan, Verifikasi

Ministry of Environment and Forestry. (2020). Komposisi Sampah. Retrieved from: https://sipsn.menlhk.go.id/sipsn/public/data/komposisi

Ministry of Environment and Forestry. (2021). Updated Nationally Determined Contribution Republic of Indonesia

Oberlin, A. (2011). The role of households in solid waste management in East Africa capital cities. Dissertation. Wageningen: Wageningen Academic Publishers.

Oosterveer, P., Spaargaren, G. (2010).Meeting Social Challenges in Developing Sustainable Environmental Infrastructures in East African Cities. In: Social Perspectives on the Sanitation Challenge. Dordrecht: Springer

Purnama, B, E. (2021, Apr 21). Siklus Tawarkan Solusi Isi Ulang Produk Konsumen. Retrieved from: https://mediaindonesia.com/ekonomi/399493/siklus-tawarkan-solusi-isi-ulang-produk-konsumen

Putra, I.I. (2020, April 29). Tempat Penampungan Sementara (TPS) Sampah di DKI Jakarta Januari 2020. Retrieved from: https://statistik.jakarta.go.id/tempat-penampungan-sementara-tps-sampah-di-dkijakarta-januari-2020/

Ritchie, H., Roser, M. (2020). CO_2 and Greenhouse Gas Emission. Retrieved from: https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions

Sembiring, E, Nitivattananon, V. (2008). Role of Informal Sector in Solid Waste Management: Dilemma on Decision Making for Urban Environment, In: Proceeding of International Conference on Sustainable Urban Environmental Practices.

Sembiring, E, Nitivattananon, V. (2010). Sustainable solid waste management toward an inclusive society: Integration of the informal sector. Resources, Conservation and Recycling 54: pp. 802-809

Shekdar, A.V. (2009). Sustainable solid waste management: An integrated approach for Asian countries. Waste Management 29: pp. 1438–1448

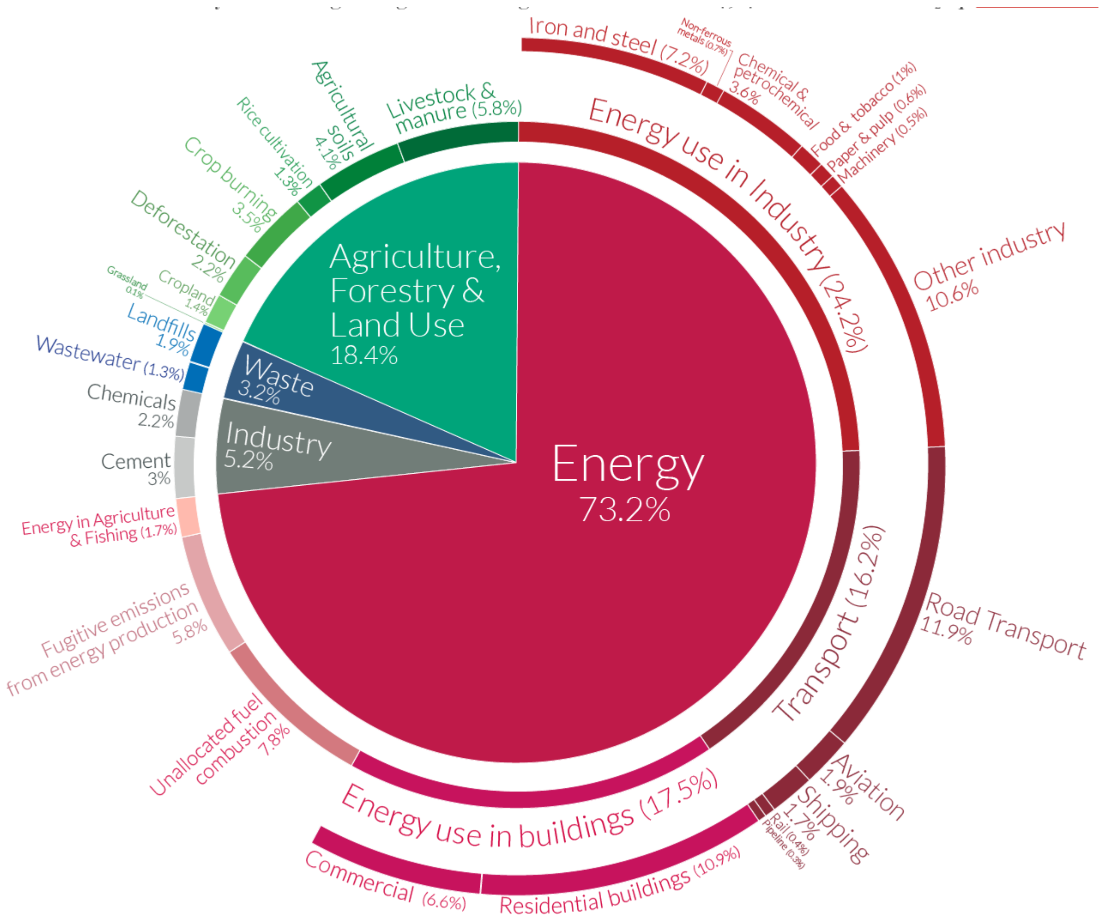
UNDP, 2017. UNDP Indonesia Sustainable Urban Development Strategy. Retrieved from: https://www.undp.org/content/dam/indonesia/2017/doc/Urban%20Strategy%20English.pdf#:~:text=Currently%2C%20more%20than%2055%20percent%20of%20Indonesians%20live,percent%20of%20the%20generated%20waste%20goes%20to%20landfills

Wijaya, L.D., Hantoro, J. (2021, October 25). DKI - Bekasi Teken Perjanjian Pembuangan Sampah di Bantargebang, Berlaku 5. Retrieved from: https://metro.tempo.co/read/1520951/dki-bekasi-teken-perjanjian-pembuangan-sampah-di-bantargebang-berlaku-5-tahun

World Bank. (2018, Sept 20). Global Waste to Grow by 70 Percent by 2050 Unless Urgent Action is Taken: World Bank Report. Retrieved from: https://www.worldbank.org/en/news/press-release/2018/09/20/global-waste-to-grow-by-70-percent-by-2050-unless-urgent-action-is-taken-world-bank-report

Annexures

Annexure 1



Global Greenhouse Gas Emission per Sector

Annexure 2

No.	City/Regency	Local budget (APBD) for SWM		
		Rp/year	Percentage	Fiscal Year
1	Banda Aceh City	55,942,157,682	4%	2017
2	Surabaya City	160,643,003,489	2%	2019
3	Bandung City	65,597,720,273	1%	2018
4	Jakarta City	3,700,000,000,000	4%	2019
5	Bekasi City	756,252,200,000	1%	2019
6	Yogyakarta City	20,014,317,361	1%	2019
7	Bogor City	19,000,000,000	1%	2019
8	Banyuwangi Regency	16,426,900,000	1%	2019
9	Cirebon City	9,302,720,013	1%	2016
10	Semarang Regency	38,891,120,000	1%	2019

Allocation of funds from the Local Budgets (APBD) for SWM

(Source: APBD reports of each local government)

About the Author

Dr. Aretha APRILIA
Director, Foreign Construction Representative Office
CDM Smith Indonesia

Dr. Aretha Aprilia is currently working as the Director of Foreign Construction Representative Office (FCRO) at CDM Smith. She also serves as the Deputy Team Leader for the Australia-Indonesia Infrastructure Partnership project on the 'Upgrade of Waste Collection and Transportation System in DKI Jakarta'. She previously worked as the Waste & Environmental Expert on the German KfW funded project on advanced solid waste management and as the Lead for the US-funded off-grid renewable energy project. Prior to that, she was the Coordinator of the Asia Pacific Forum for Environment and Development Showcase Facility at the UN Environment Programme in Bangkok. She received the 'Green Talents 2017' award from the German Ministry of Education and Research in Berlin, Germany. She was also awarded with the "50 Most Impactful Green Leaders (Global listing)" award by World CSR Day and World Sustainability, presented in Mumbai, India. She holds a PhD in Energy Science from Kyoto University, Japan.

The views and opinions expressed in this background paper are solely by the author(s) and do not represent that of the Asia-Europe Foundation (ASEF).

Copyright © 2021.

Co-organised by:

Supported by: