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Scoping study – West Java waste management and potential actions

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Abstract

Generation of waste in Indonesia exceeds the waste management systems' capacity to handle all the material. Large parts of the waste end up as un-managed and will be subject for open air burning, dumping in the nature or water streams. The negative environmental-, health- and economic impacts from the lack of proper waste management is substantial. The Indonesian government have initiated plans to improve the situation, including actions to reduce single-use plastics, increase waste collection and recycling, as well as supporting realization of waste incineration.

The aim of this report is to provide background and recommendations on actions for improved waste management in West Java with a special focus on waste incineration with energy recovery and landfill gas actions. Improving waste management should be based on a system approach, where the components are all integrated parts of the same network acting to ensure high level of circularity of materials, minimizing environmental impacts and providing added values to society in form of for example material recycling, economic value and jobs.

West Java is the most populated state in Indonesia, with a population of about 48 million. The state has densely populated areas, large urban areas as well as more remote places with lesser number of people. The challenges in waste collection and final disposal of waste is similar to the rest of Indonesia, including high shares (in some cases more than 40%) of the waste being unmanaged, final disposal of collected waste in open dumpsites which are often almost full resulting in risks of accidents apart from the environmental impacts and methane emissions.

One priority to improve waste management is to increase the share of waste that is collected as part of the formal system and thereby reduce the unmanaged waste and improve the possibilities for waste to be handled properly. Another is to strategically build systems that will have the capacity to handle the generated waste. This would include pushing for increased recycling and energy recovery actions as well as to opt for landfills that have the capacity to receive the waste generated. Regional solutions seem most attractive as it brings scale of economy and can be operated as sanitary landfills. Actions on incineration with energy recovery is feasible and will provide reduced volume and energy before final disposal.

Collection of landfill gas would be motivated on more every landfill and dumpsite as it reduces emission of methane to the atmosphere which adds to the greenhouse effect. The landfill gas can be used for electricity generation, industrial processes or other.

Refuse derived fuel production is an option. If finding end-users of this product it provides a fuel that can substitute oil or coal. RDF will reduce volume of waste and also represents a step up in the waste hierarchy (from disposal to recovery). Combination of RDF production, actions on recycling and waste incineration could provide an attractive combination.

One of the challenges for realizing solutions in the waste sector is low revenue streams. Even though provision for gate fess exists, these are not enforced. A risk of increasing fees on waste management is that it would increase share of un-managed waste. Another challenge

is that receiving the permits and contract to sell electricity to the gird is a relatively complex process. It easier to produce electricity for own use at this does not require these permits.

Actions on improving waste management, increasing recycling and take actions to improve existing dumpsites and landfills are strongly motivated. The actions are short-term as well as long-term investments and initiatives. To increase collection of un-managed waste and to ensure that further steps upward the waste ladder are taken should be priority and guiding principle in actions. Actions should be assessed considering the full waste management system and not as isolated quick fixes. It is also advisable that attention is given to ensuring that actions supported consider potential for un-wanted lock-in and to ensure that proper attention is given that any residues or by-products from a process are handled in a correct manner.

The contribution to the sustainable development goals are seen at many levels via the actions to improve the overall waste management system. Including SDG6 on clean water, SDG7 on renewable energy, SDG 11 on sustainable cities and communities as well as SDG 13 on climate actions and contributing to SDG14 on life below water. The actions could also support human well-being and development via including marginalized and exposed groups presently finding their livelihoods as waste pickers in the proposed actions.

1 Introduction

Indonesia has a population of more than 270 million people spread over more than 16,000 islands and total land area is 1,916,907 km^2 (BPS 2021). The country has a tropic climate where the variations in temperature is relatively small, while the rainfall will differ greatly between seasons. There is a big variation between the megacity areas of for example Jakarta and more remote areas on Maluku.

One of the sustainability challenges now experienced in Indonesia is proper management of waste. Collection is far from the reality for substantial parts of waste generated and is perhaps the most dominating reason for the problems of marine plastic debris, dumping in water ways and open air burning that are experienced. The parole of "3R – reduce, reuse and recycle" is commonly referred to in the presentation of work on waste management. There is even a 3R sign with three straight fingers representing the 3Rs and the thumb and index finger joined to represent "zero waste". The 3R parole is intrinsically based on the idea that waste is collected and handled in a formal waste management system. For Indonesia the need to reduce volumes of waste that is not collected is an important action but that will further add to volumes of waste that needs to be handled.

Ensuring increased level of recycling, waste prevention and proper handling of the final stage is high priority. The challenge connects to increasing volumes of wastes generated in the society, challenges in ensuring safe collection and scaling up recycling of recyclable materials and to provide safe and climate efficient end-of-life deposit in landfills. The actions from the Indonesian government includes targeting improved waste collection, handling of waste not collected properly, actions to reduce volumes of waste for landfilling and energy recovery from waste, as well as actions to improve landfills (KLHK 2020). Today large parts of the waste, up to 24% as a national average, is *not managed at all* but is buried, open-air burning or just dumped in nature or in waterways (KLHK 2020). To increase collection requires actions on collection system, behavioral changes and a formalization of the waste sector.

Indonesia has been identified as one of the major hot spots for release of plastics to the oceans (Jambeck *et al.* 2015; Pandjaitan 2020). In 2017 it was estimated that about 620,000 ton of plastics was released to the country's water bodies (WEF 2020) with substantial parts ending up in the ocean. Indonesian government recognize that mismanaged waste will cause substantial economic, environmental and health negative impacts and must be solved to avoid long-term irrevocable changes to ecosystems and biosphere.

The waste challenge is not new. Already in the 80's the challenges of the growing volumes of waste generated in the large cities was discussed (Maniatis *et al.* 1987). At this time, it was already evident that increasing population on a small area, together with poor waste management would cause substantial amounts of the waste not being handled. In Maniatis *et al.* (1987) the strategy to apply waste incineration for reducing the volumes to be put on landfill is mentioned, along with actions on collection of landfill gas or separation to allow for composting. Unfortunately, these suggestions were never realized.

The realization of actions to tackle waste mismanagement and growing waste generation streams has been slow. Only recently the construction of the first waste to energy incineration plant was started situated in North Jakarta. Energy recovery from waste is one step up the waste ladder from only landfilling. In the Indonesian context it also provides a strategy to handle the restricted space available for landfilling. Incineration will typically reduce waste volume with up to 90% and the weight of 70%-80% depending on the waste composition (Kalogirou 2018). Many of the existing landfills have almost reached their capacity and expansion is difficult due to approval from the community and available land.

Only a handful landfills in Indonesia are equipped with landfill gas capture resulting in emissions of greenhouse gases (methane) to the atmosphere. Improved waste management is presented in the first Nationally Determined Contributions as one central component to reduce the emissions from the waste management sector (eg methane from landfills and dumpsites) as well as use waste in the energy sector (GOI 2016).

The responsibility to ensure a functional waste management, including final disposal of the waste, to the citizens, businesses and institutions is with the city or regency organizations. There are some cases of regional landfills where regencies and cities cooperate to find a solution for the final disposal. This means that in most cases the organization of waste management is highly decentralized. To get an understanding of the number of waste management systems that are operated in Indonesia the number of regencies and cities can provide some illustration. In total there are a bit more than 500 regencies and cities. The number of regencies or cities with population *below* 500,000 is 366 with about 30% of the population living here. Regencies and cities with population *of more than* 500,000 are 145 and this is also where 70% of the population is found (Figure 1).

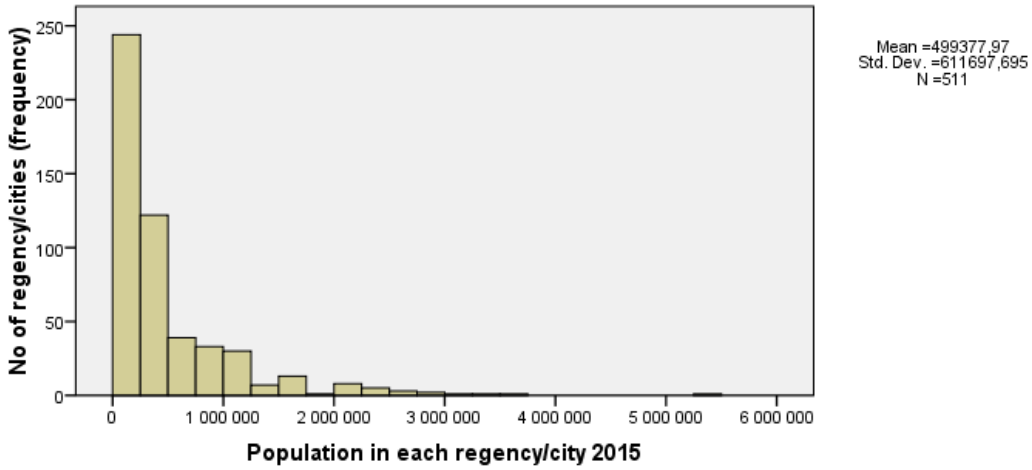

Figure 1: Histogram of population in regencies, cities, and city districts

The amount of waste that is lost via open air burning, dumped in the environment or water ways is higher in the medium cities where about 39% is lost than in the bigger cities with a 17% loss rate (KLHK 2020). Smaller cities would typically have even higher levels of loss than the medium city. The big variations illustrate the need for both dynamic solutions of waste management suitable for smaller application, and the need for large scale solutions.

There is a growing realization that cost-, environmental- and space- efficient solutions will be based on joint waste management solutions where neighboring regencies and cities go together to build and operate regional sanitary landfills. The structure of heavy dependency of local subsidy and decentralized responsibility is a barrier to regional solutions as there is a concern that you will be sitting with even higher costs for final handling of the waste. Regional solutions are advocated from provincial and national levels, but there need to be involvement of the regency and city organizations.

The government institutions from national, provincial, and local levels have all implemented regulations, policies and plans for turning the situation with escalating volumes of waste. Relevant framework includes action on stimulation of waste to energy, regulation on household, hazardous and plastic waste and regulation on import of waste to Indonesia (Table 1).

Table 1: Waste management regulations in Indonesia (table from KLHK 2020)

National Law	Act No. 18/2008 on Solid waste management		Act No. 32/2009on Environmental Protection and Management		
Government regulation	PP No. 81/2012 Government Regulation on Management of Household and Household-like Waste	PP No. 101/2014Government Regulation on Hazardous WasteManagement	DRAFT Government Regulation on Excise on Plastic	DRAFT Government Regulation on Specific Waste Management	
Presidential Regulations	Perpres No. 97/2017Presidential Regulation on National Policy and Management Strategy of Household Waste and Household-like Waste	Perpres No. 83/2018 Presidential Regulation on Marine Debris Management	Perpres No. 18/2015 Presidential Regulation on Income Tax Facilities for Investment in Certain Business Fields and/or in Certain Regions	Perpres No. 15/2018 Presidential Regulation on Acceleration of Damage and Pollution Control on Citarum River Basin	Perpres No. 35/2018 Presidential Regulation on Acceleration of Development of Waste-to-Energy Installation using Environmentally-sound Technology
Presidential Decree	Keppres No. 61/1993 and No. 47/2005 Presidential Decree on Ratification of the Basel Convention on the Control of the Transboundary Movement of Hazardous Waste and Their Disposal				
Ministerial Regulation	Ministry of Trade Regulation No. 31/2016 on Non-Hazardous Waste Import	Ministry of Public Works Regulation No. 3/2013 on Implementation of Solid Waste Infrastructure and Facilities	Ministry of Trade Regulation No. 48/2015 on General Provisions in the Import Sector	Ministry of Trade Regulation No. 70/2015 on Importer Identification Number	Ministry of Industry Regulation No. 48/2015 on Requirements for Income Tax Facilities Implementation
	Ministry of Environment and Forestry Regulation No. P.75/2019 on Roadmap to Waste Reduction by Producers		DRAFT Ministerial Regulation (MoEF) on Shopping Plastic Bag Reduction		
Local regulation	Regional/Local Regulations on Single-use Plastic Bans; 3 provinces and 34 municipalities as of December 2019 (Provincial level) Pergub Bali No.97/2018, Pergub DKI Jakarta No.142/2019, Surat Edaran Yogyakarta No.490/1758(Municipal level) Perbup Kabupaten Purwakarta No.37/2016, Peraturan Bupati				

	Badung No.47/2018, Peraturan Bupati Hulu Sungai Utara No.8/2019, Peraturan Bupati Biak Numfor No.28/2019, Peraturan Bupati Bogor No.13/2019, Peraturan Bupati Nunukan No.32/2019, Peraturan Bupati Nunukan No.45/2019, Instruksi Bupati Tulungagung No.2/2019, Peraturan Bupati Pati No.33/2019, Peraturan Bupati Merauke No.23/2019, Peraturan Daerah Bandung No.17/2012, Perwali Bandung No.37/2019, Perwali Banjarmasin No. 18/2016, Peraturan Daerah Balikpapan No.1/2019, Perwali Balikpapan No.28/2019, Perwali Bogor No.61/2018, Perwali Jambi No.61/2018, Perwali Denpasar No.36/2018, Perwali Banjarbaru No.66/2016, Perwali Bukittinggi No.28/2018, Perwali Sam

As the reliance on public funds is the dominant source for funding the waste sector, many larger investments in improved waste management and final handling will require substantial time for realization. In a study of waste management solutions in the city of Probolinggo in East Java it was assessed that realization of new landfill and potential waste incineration would require 6-10 years for realization (Gustavsson *et al.* 2018). One important reason was linked to the process of acquire funding from government budget as it could not be based on viable business case (no gate fees and unsure opportunities for revenues from sale of electricity).

The interest to showcase solutions for improved waste management along the whole waste stream, as well as introduce re-use, recycle and reduce actions, is high among all stakeholders in Indonesia. People, decision makers and private sector are all aware about *why this is needed*, but the big challenge is *how to do it* and especially how to realize the necessary actions to reach at least acceptable management situation is a huge step.

The aim of this report is to provide background and recommendations on actions for improved waste management in West Java with a special focus on waste incineration with energy recovery and landfill gas actions. Business Sweden have been cooperating with the West Java province to look for opportunities to showcase Swedish solutions. There are Swedish providers of technical systems for landfill gas as well as systems for waste incineration. Swedish solutions will provide knowledge and expertise not only on these technical solutions but are typically seen and provided as solutions in a context of circular and resource efficient economies. This means that suggested incinerators for example would as part of the pretreatment stage include sorting to further increase recyclable materials to be collected.

Effective solutions on waste management are typically based on system approach where the management is done in different steps and all with the same purpose to have as much of the waste materials recycled or re-used, minimizing the waste for final disposal. Introducing source separation will provide a relatively clean fraction of waste that can be handled separately but will also affect the composition of the residual waste that is part of the waste stream. Working to find a systems-based solution will create added values in terms of job opportunities, added economic values and higher level of resource efficiency. This report considers waste incineration with energy recovery as one solution. In the context of this report an incinerator should be understood as part of the system solution and not a silver bullet for the waste problem. The incineration with energy recovery is a way to handle the residual waste stream before final disposal. The residual waste stream should be minimized in favor of reuse, reduce and recycle materials. In this report we present the waste incineration and landfill gas as *integrated parts* of a waste management system including parallel actions to increase collection of waste, source separation actions, recycling actions via for example extended producer responsibility and deposit system and waste banks and mechanical and

manual handling. One of the challenges is to ensure that actions are long-term sustainable and scaling up is possible. Initiating quick fixes may solve an immediate problem of lacking landfill capacity for example but create a lock-in or barrier for actions that are more long-term sustainable. The report provides some discussion on this topic.

The report provides background and strategic considerations on opportunities for actions on proposing waste to energy solutions via landfill gas and waste incineration with energy recovery. These solutions as integrated parts of the waste management system are motivated from climate, environment and socio-economic perspectives and would in the Indonesian context support realization of plans and targets for improved waste management and also support the UN 2030 Sustainable Development Agenda (UN 2021). The scope is on solutions relevant to energy sector. Actions to support source separation, increased recycling and reduce upstream impacts on generation are outside the scope of this report but are natural components of the overall waste management solutions and necessary to pursue in parallel.

2 West Java – background

West Java province is the province with the highest population in Indonesia. The total population in 2020 was assessed to 48 million people and with a population growth of about 1.1% (BPS 2021).

Table 2: Data on West Java, regencies and cities.

Name	City or regency	Area (km^2)	% of West Java	Population 2015	Pop density (person/km^2)
Kota Bandung	City	167.67	0.5%	2,480,615	14,795
Kota Banjar	City	113.49	0.3%	181,331	1,598
Kota Bekasi	City	206.61	0.6%	2,708,721	13,110
Kota Bogor	City	118.5	0.3%	1,046,579	8,832
Kota Cimahi	City	39.27	0.1%	585,931	14,921
Kota Cirebon	City	37.36	0.1%	307,319	8,226
Kota Depok	City	200.29	0.6%	2,099,989	10,485
Kota Sukabumi	City	48.25	0.1%	317,883	6,588
Kota Tasikmalaya	City	171.61	0.5%	657,169	3,829
Bandung	Regency	1,767.96	5.0%	3,528,873	1,996
Bandung Barat	Regency	1,305.77	3.7%	1,627,816	1,247
Bekasi	Regency	1,224.88	3.5%	3,235,556	2,642
Bogor	Regency	2,710.62	7.7%	5,463,849	2,016
Ciamis	Regency	1,414.71	4.0%	1,168,254	826
Cianjur	Regency	3,840.16	10.9%	2,243,328	584
Cirebon	Regency	984.52	2.8%	2,124,866	2,158
Garut	Regency	3,074.07	8.7%	2,546,859	828
Indramayu	Regency	2,040.11	5.8%	1,690,643	829
Karawang	Regency	1,652.2	4.7%	2,271,681	1,375
Kuningan	Regency	1,110.56	3.1%	1,054,862	950
Majalengka	Regency	1,204.24	3.4%	1,181,701	981
Pangandaran	Regency	1,010	2.9%	390,316	386
Purwakarta	Regency	825.74	2.3%	920,639	1,115
Subang	Regency	1,893.95	5.4%	1,527,952	807
Sukabumi	Regency	4,145.7	11.7%	2,433,265	587
Sumedang	Regency	1,518.33	4.3%	1,136,816	749
Tasikmalaya	Regency	2,551.19	7.2%	1,735,401	680
Province West Java	***Province***	***35,377.76***	***100***	***46,668,214***	***1,319***

The population density in 2015 was about 1,300 people per square km which can be contrasted to the average population density of Indonesia of about 140 persons per square km.

West Java is neighboring Jakarta area and is thereby an integrated part of the economic activities and the expansion of this metropolitan area. The province has a strong manufacturing industry with exports of machinery, electronics, textiles and rubber (WJP 2021). There is some oil and gas reserve off-shore as well as reserves of minerals such as iron, gold and limestone.

Even though parts of West Java have dense population, there are other areas that display a lower population density. Figure 2 illustrates population density per regency and city. Dots represents villages.

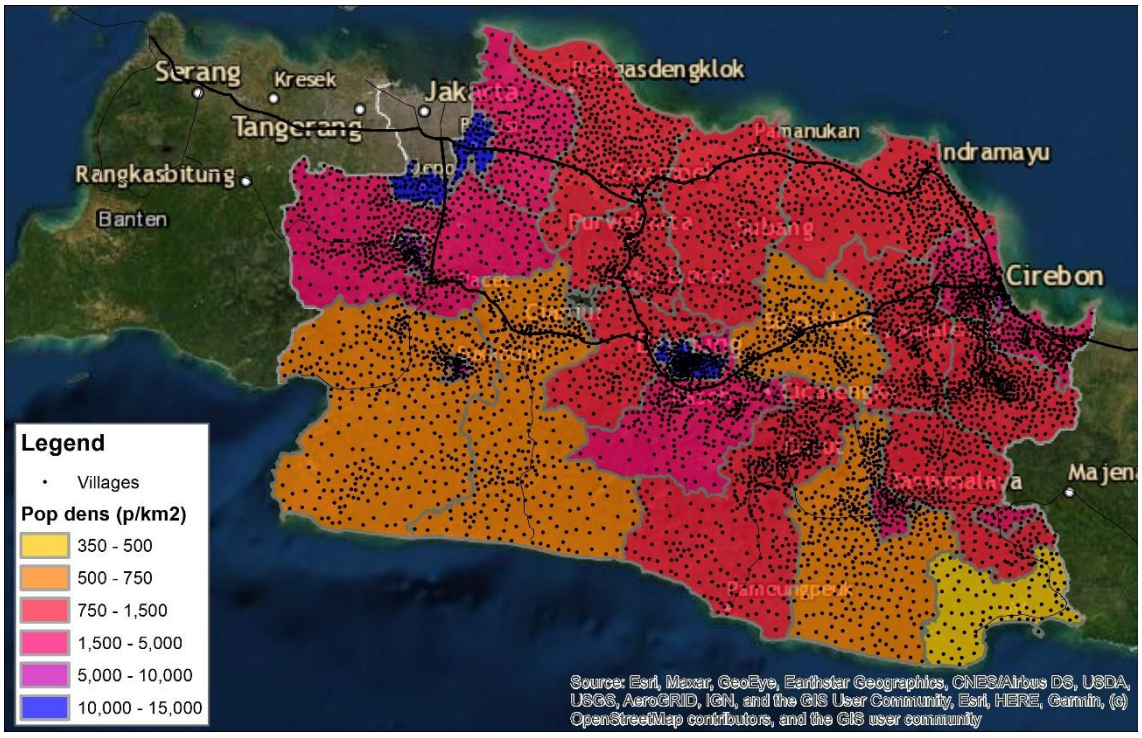

Figure 2: West Java with regencies and cities indicating population density. Villages illustrates the concentration of population to certain areas.

Figure 2 illustrates how the population in West Java are not equally spread over the province. This will have significant implications on the resulting waste generated and also long-term efficient solutions for waste management, recycling and final disposal. The solutions suggested for the areas with dense population require large scale approaches regional cooperation will provide stronger business cases and improved solutions from environmental point of view. In the case of for example more remote areas with lower population actions on more local solutions could be more viable.

3 Waste management in West Java

The waste management of West Java is regulated via national, regional and local framework. The way waste is handled in the different regencies and cities will differ as there are variations between the big cities like Bandung or Bekasi or more remote areas. It should also be pointed out that Bandung and Bekasi are both mentioned as part of the prioritized cities for supporting waste to energy solutions.

3.1 Waste generation

The quality of data on waste topics can to certain extent be contested. Data on waste management in the formal system, that is temporary waste collection point (TPS), waste banks and landfill (TPA), is monitored and compiled, while the informal systems, including unmanaged waste, are less known. The volume of unmanaged is based on gap analysis between assessed total mass and mass of materials with known management.

Waste generation per capita will not be static over time and will neither be the same all over the country. It is expected that waste generation will increase with income levels for example. In Shuker och Cadman (2018) the level of 0.87 kg/person/day is used for assessing and modelling the waste generation[1].

Table 3: Standardized waste generation in medium and small cities (SNI 1995 as found in Shuker och Cadman 2018)

City classification	Volume (l/person/day)	Weight (kg/person/day)
Medium city (100,000-500,00 pop)	2.75-3.25	0.70-0.80
Small city (<100,000)	2.5-2.75	0.625-0.70

Hoornweg och Bhada-Tata (2012) suggest a level for Indonesia in 2025 that is 0.85 kg/person/day but also show the importance to acknowledge that income levels will affect the suggested waste generation factor. With West Java being one of the most economically active provinces of Indonesia there is a certain risk that waste generation may increase.

West Java developed a strategic plan for the waste management including assessment of the waste volumes to be anticipated in the future (Jawa Barat 2019). The results show an increase of about 11% as compared to present waste generation of 23,442 ton/day in the whole province. Table 4 provides the assessed levels for each regency and city in West Java. This represents all waste generated.

Table 4: Projected waste volumes in the different regencies and cities in West Java (Jawa Barat 2019)

Name	**City/regency**	**Waste generation (kg/day/person)**	**Waste generation (projections) (t/day)**		
			2020	2025	Increase
Bandung	Regency	0.40	1,562	1,747	12%

[1] For historical comparison the factor used by Maniatis *et al.* (1987) was given to 0.5 kg/person/day for large cities.

Name	City/re-gency	Waste generation (kg/day/person)	Waste generation (projections) (t/day)		
			2020	2025	Increase
Bandung Barat	Regency	0.65	1,204	1,327	10%
Bekasi	Regency	0.42	1,598	1,932	21%
Bogor	Regency	0.49	3,120	3,725	19%
Ciamis	Regency	0.67	953	980	3%
Cianjur	Regency	0.20	487	512	5%
Cirebon	Regency	0.43	1,223	1,435	17%
Garut	Regency	0.17	483	522	8%
Indramayu	Regency	0.37	643	655	2%
Karawang	Regency	0.40	937	998	6%
Kuningan	Regency	0.50	541	557	3%
Majalengka	Regency	0.43	519	532	3%
Pangandaran	Regency	0.63	277	287	4%
Purwakarta	Regency	0.43	416	441	6%
Subang	Regency	0.40	639	672	5%
Sukabumi	Regency	0.44	1,115	1,155	4%
Sumedang	Regency	0.38	439	449	2%
Tasikmalaya	Regency	0.43	757	771	2%
Kota Bandung	City	0.60	1,551	1,687	9%
Kota Banjar	City	0.43	62	68	8%
Kota Bekasi	City	0.64	1,970	2,190	11%
Kota Bogor	City	0.51	571	605	6%
Kota Cimahi	City	0.49	279	308	10%
Kota Cirebon	City	0.51	164	173	6%
Kota Depok	City	0.59	1,444	1,746	21%
Kota Sukabumi	City	0.55	158	160	1%
Kota Tasikmalaya	City	0.51	331	349	6%
Province West Java	**Province**		**23,442**	**25,983**	**19%**
Assumed waste generation (kg/pers/day)			0.50	0.56	

Waste composition data indicates that the organic part of the MSW is substantial. About 60-70% would be organic, 10-20% plastics and 5-10% of other (Table 1). This is in line with other lower and upper middle-income countries (Hoornweg och Bhada-Tata 2012).

An assessment of the waste composition at Sarimukti Landfill shows 50% kitchen and garden waste, 27% palstics of which about 1.7% was considered recyclable, 7% nappies and equal

share (7%) of paper, textile about 5% and 4% of rubber, metal, glass, mineral and other. The level of hazardous was 0.12% (MoF och West Java 2019).

The variations in municipal waste composition in Indonesia vary (Figure 3). For West Java the share of organic may be slightly lower than average Indonesian levels due to the higher economic activity but factor for waste generation is also slightly higher.

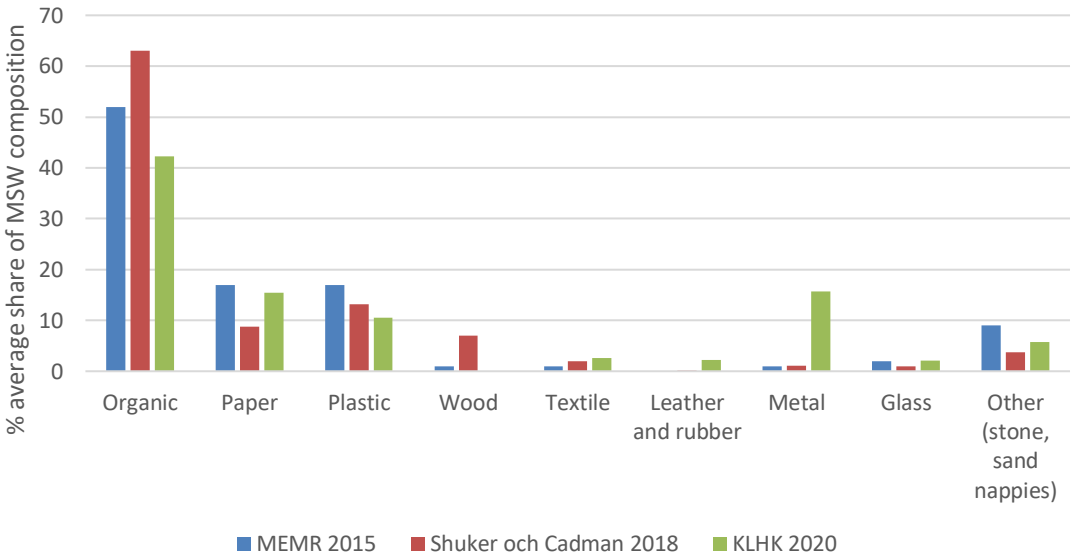

Figure 3: Assessment of the share of MSW in Indonesia (MEMR 2015; Shuker och Cadman 2018; KLHK 2020)

The composition of waste will also depend on where the assessment is made. As large volumes of waste never reach the landfill, and there is an extraction of certain recyclable materials between the household to the landfill the MSW composition may vary. Data on composition at landfills will provide input for analysis of potential energy content in the waste for energy recovery, or amount of organic in the active volume of the landfill for landfill gas recovery.

For any waste handling the moisture content will be an issue. Indonesian climate has high humidity and during the rainy season the amount of rain can be substantial.

3.2 Waste collection

As is the case in rest of Indonesia the responsibility of the waste handling is with the local government of the regency or city. Each city or regency will have a plan to take care of the generated waste and there is often also a local landfill or open dumpsite that will be used in the final stage. There is also waste that is not collected at all which will end up in nature or water ways or is burned in open air. A simplified flowchart of the collection system is found in Figure 4.

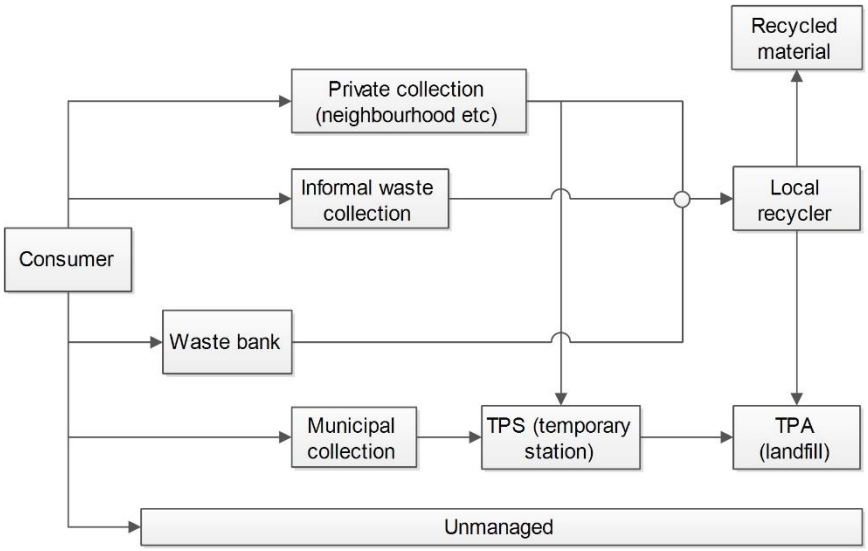

Figure 4: Simplified system for collection and recycling

Waste is generated at the consumer level which includes households, commercial, markets and institutions. On average the main share, 60-75%, of the MSW has the origin in households (Table 5).

Table 5: Typical share of municipal solid waste with specific source (Shuker och Cadman 2018)

Source	**%**
Domestic Waste	60-75
Markets	5-10
Commercial waste	4-12
Institutional	1-6
Street sweeping	0.5-2

The collection from the consumers may vary but it is common that private collection is arranged for a neighborhood which will also organize that the waste is brought to the temporary station for collection and further transport to landfill. The private collector will receive the waste collection fee from the household and would in most cases not pay anything to leave the collected waste as the TPS. The households thus may pay a fee for someone to take care of their waste, but this fee is not part of a revenue stream for supporting the public organization of the waste handling. From the TPS waste is transported to the landfill.

Collection of recyclable materials is done in several places. The Waste banks is part of public initiative to increase recycling. Households and other may bring plastics and other recyclable material to the waste bank and get refund for the material. This is not a deposit system, but collection of the materials and providing the person who hand it in with certain payment. There are about 1,700 waste banks in West Java (WJP 2021). Collection of plastics and other materials which can be sold is done by the private collectors, by informal waste pickers at the point where waste is left for collection, at TPS and at the landfill. The materials are often

brought first to a collection point, and then sold to the recycler. At some TPS and landfills there may be organized recycling taking place.

The waste collection system in Indonesia is faced with a number of challenges:

- There is a substantial amount of waste that is never captured by the formal recycling and waste management system, resulting in informal management (open air burning, dumping) and waste ending up in nature, water ways and marine environments.
- The capacity in the waste management system to handle all waste generated in the society is not enough. Includes capacity for collection, recycling and landfill.
- Recycling of certain materials is done, the system is based on both formal approach with waste banks and collection of recyclable materials at temporary station and markets, but also informal via waste pickers. Scaling up will require updated and/or alternative approaches.
- The recycling market is fragmented and includes many middleman, examples of poor handling of residual materials from sorting and difficult market conditions.
- Investments and revenue streams in the waste sector are low. The responsibilities lie with the local governments. Investments and operational costs are covered in the local government budget. Private involvement is difficult due to absence of revenues.

This is in a sense a vicious circle where the capacity to take care of collected waste is limited, while there is a realization that far from all waste generated is collected. Increasing collection, requires increased capacity to handle the waste and is of course also represents increased costs in terms of budget allocation. Stakeholders are at the same time well aware of the societal costs and negative economic and other impacts that unhandled waste is causing.

3.3 Landfills

Landfills in West Java are either controlled landfills or open dumping. In Jawa Barat (2019) some of the controlled landfills are referred to as Sanitary landfills. According to the classification in ISWA (2015) a sanitary landfill will include landfill gas capture as well as leachate treatment. Further on there should be no waste picking onsite. Based on these classifications it seems more reasonable to expect the landfills to be categorized as controlled, rather than sanitary landfills[2].

There is currently one regional landfill, TPA Sarimukti, serving Bandung and Cimahi cities and regencies Bandung and Bandung Barat. It receives about 1,700 tons waste per day and is a so-called controlled landfill. Controlled landfill would involve covering with soil every seven day and can also involve levelling and compacting. This landfill is expected to have reached its maximum capacity around 2023/2024.

A second regional landfill called TPA Legok Nangka is currently planned. TPA Legok Nangka will include a waste to energy installation which is designed for a minimum of 1,850 t/day and up to 2,100 solid waste (MoF och West Java 2019).

[2] A list of the landfills existing in West Java was received from . Coordinates to the landfills were identified to make it possible to review the aerial photos.

Most landfills are operated for a single regency or city, which is the most common solution. Here there are six controlled landfills identified. The daily average waste to the landfill is reported as 207 t/day, and median 144 t/day.

The majority of landfills in West Java are of "open dumping" type where the waste is simply dumped in a pile. Not all of the open dumping landfills have leachate treatment and many are very basic[3]. The daily average waste to the "open dumping" landfill are reported as 189 t/day, and median 146 t/day (Table 6).

Table 6: Landfills West Java

Type of landfill	Number	Average waste/day	Median waste/day
Regional landfills	*1 (+1*)*	*1,754*	*1,754*
Controlled	1	1,754	1,754
(Sanitary landfill)	(1)	(1,853-2,153)	(1,853-2,153)
Local landfills	*25*	*223*	*146*
Controlled landfills	6	207	144
Open dumping landfills	15	189	146
Unknown	4	592	592

* TPA Legok Nangka will be a sanitary landfill.

Many of the existing landfills in operation have reached, or are close to reach their maximum capacity. The need to establish new landfill cells or new sites is evident. There are also indications that there are additional informal dumpsites, an indication which is also supported in the literature. These informal dumpsites can be smaller or larger sites where the waste is occasionally burnt (open air burning) to reduce volume.

Figure 5 provides a map of West Java with the locations of the known landfill sites plotted. The figure provides the location but not the amount of waste received per day. The locations provide guidance to the waste management challenges considering that regencies and cities have the main responsibility, while in certain cases efficient positions could serve an area with more than one regency. While the waste to energy plant planned in TPA Legok Nangka is designed for a minimum of 1,850 t/day these volumes of waste is not found in other places. Based on Jawa Barat (2021) the amount of unmanaged waste can be above 40% of total waste generated. This assessment is based on the gap between waste generated (population multiplied with waste generation factor) and the amount of managed and recycled waste. Unmanaged waste ends up in nature, is burned in open air, or just dumped. *It is of the highest priority to reduce the un-managed part of the waste generated.*

[3] Based on review of aerial photos via Google earth of the identified landfills.

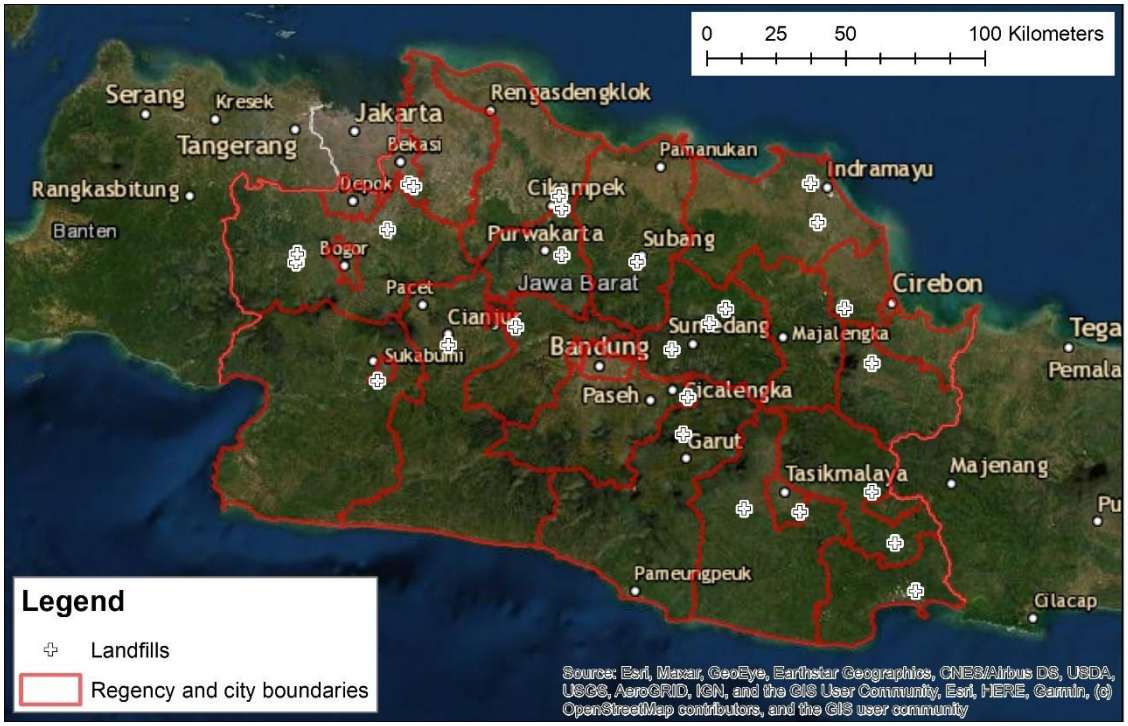

Figure 5: West Java with the identified landfills plotted (Jawa Barat 2021).

Figure 5 provides a relatively good illustration of the situation where each regency and city are required to ensure a solution to final disposal of waste. One result is that in some areas the distance to the regency landfill is quite far. Transports are costly, and in some cases difficult due to road conditions. In areas far from a formal landfill it is reasonable to think there are alternative solution to collect and dispose of waste, including uncontrolled dumping and open air burning.

The environmental impacts from an uncontrolled dumpsite, open dumpsite or controlled landfill are substantial. The lack of, or only partial leachate treatment will result in discharge of contaminated water to water table and streams. Based on available information none of the landfills are equipped with proper landfill gas capture, thus substantial amount of methane is released to the atmosphere where it acts as a greenhouse gas. Further aspects of odor, dust, health issues and risk of accidents via landslides are all relevant considerations.

3.4 Recycling

Recycling is done as part of waste picking along the way from the deposit at households or other places, to transfer stations and lastly at the landfill. The picking out recyclable material from the collected waste is an activity done by people involved in the waste handling (eg collection at the household, or at the transfer station), but also by people that have this as their main income. This recycling is organized by private companies and by individuals involved in the picking. Any revenues are to the pickers and the private companies that purchase the materials handed in by the pickers.

A national program on waste banks is also found. Waste banks are locations where people can bring their recyclable materials and hand them in and get a compensation. The compensation is in line with the value that will later be received for selling material to the recycling companies.

Composting of organic waste streams can be found. Typically, the waste would originate from green markets and similar places. The resulting compost can be sold or used by the city/regency. Composting is no large activity.

The majority (80-90%) of the recycling companies are concentrated on the Java island (WEF 2020) making the access to recycling better in West Java than in other places. According to WEF (2020) 7% of the total plastics in the waste stream is collected at the residential areas, and then additional 8% of the total along the chain between residential area to and on the landfill. It is estimated that 1 million tons of plastics is collected in this way annually in Indonesia. Of this volume 70% is recycled, while 30% is disposed due to organic contamination or other reasons.

The many jobs created in the waste picking for low-income groups is a challenge if changing how waste is handled. Operation of sanitary landfills for example will require that no waste pickers are allowed at the actual tipping ground as compacting and covering is done with machinery. Alternative approaches exist and are tested world-wide where waste pickers are employed by the waste companies to sort the waste in controlled environment.

The problem is to scale-up the system, as it is very labor intensive and relatively inefficient. There are some cases where mechanical sorting and using central sorting bay to produce Refuse derived fuel (RDF), compost and other organic material has been realized. One such example has been identified in Cirebon regency (Ahadijat 2019; Anasstasia *et al.* 2020). The production of RDF is based on a cooperation with the surrounding area. Based on Anasstasia *et al.* (2020) open air burning at informal dumpsites is commonly found and can be (partly) avoided with the RDF approach. The RDF is used in local cement industry replacing coal. From a life cycle perspective, the RDF pathway is associated with reduced climate emissions as compared to open dumping or open air burning (Anasstasia *et al.* 2020). RDF production sites are also found in other parts of Indonesia[4] and internationally (see for example ADB 2017; Dianda *et al.* 2018; Maletz *et al.* 2018).

3.5 Revenues waste management

To the regencies and for the cities the waste management is only representing a cost. There are few, if any, revenue streams. There are no gate fees at the landfills, and the revenues from waste collection are few. Local regulatory framework include provision to take out compensation for the handling of waste (transport, disposal etc). Based on earlier studies (Gustavsson *et al.* 2018; Business Sweden och IVL 2019) it seems that the collected revenues may not reach the public utility responsible for the waste handling, but rather fees may be collected by other actors involved to ensure parts of the chain. This needs to be followed up

[4] For example, DANIDA supported project in Cilacap, Central Java.

from case to case. Example of the regulation is found in *Annex 2: Regulation on waste collection fees, Bandung City (LDKB* 2012).

The waste sector is underfunded as compared to international benchmark. Shuker och Cadman (2018) estimates that about USD 5-6 USD per capita and year of the regional budget is spent on waste management, which can be compared to international benchmark levels of about USD 15-20 per capita and year. Gate fees at landfills are not typically implemented meaning that the waste management is normally heavily subsidized via the local budgets. In 2018 it was announced that waste to energy plants in 12 priority Indonesian cities would have a gate fee of maximum IDR 500,000 (€28.5) per ton, and defined feed in tariff for the electricity generated (PRI 2018). The regulation provides baselines on guaranteeing revenue streams for investments in the prioritized cities but is not applicable as general rules. Based on interviews there are no gate fees in place at the landfills in West Java. Trucks, lorries, carts etc can enter landfills and dispose of the garbage.

Recycled material can provide a revenue. Waste pickers, people leaving items for the waste banks and other sorting operations will generate income when selling to the recycling companies. The waste banks provide some opportunities to earn some money on the handling and cases where these are operated as social enterprises can be found.

To the public bodies handling waste and disposal of waste represents a cost. The money to support the operation is part of the annual budget. Investment will require that proper request for money, including motivation, is provided. Actions to improve waste sector have a priority and with good motivation (including feasibility studies etc) the province can provide investment support. The process is possibly time consuming and may take at least 3-5 years.

Changing the tariffs and enforcing higher costs is sensitive. The provision to introduce a gate fee at the landfill exist and there are also a number of fees detailed relating to waste collection and disposal. The challenge is to ensure these fees are collected and monitored. In the present situation with much of the waste disposed outside the formal system there is a risk that introducing and ensuring fee collection will result in increased volumes of waste that are handled outside the formal system. This is in a sense a vicious circle where lack of revenue streams in the waste management is a barrier for investments. Increasing or ensuring collections of set tariffs will increase risk of further volumes ending up as unmanaged waste. There is thus a balance here between *increasing the revenue* streams to ensure a more modern and environmentally sound management and *decreasing* the volume of waste that is leaving the formal waste management system.

Introduction of a carbon tax is presently under discussion in Indonesia. The ministry of finance has presented draft regulation on carbon tax on fossil fuels as well as factory or vehicle emissions. Other carbon intensive industries such as cement, power generation and petrochemical industries could also be targeted in such scheme. Indonesia is a coal mining country as well as having domestic oil and gas resources. At this point this is a proposal and levels are not set. An introduction of a carbon tax will provide direct and indirect stimulation on shifting away from fossil resources. Landfill gas does have a strong climate impact and is strongly motivated in terms of reducing climate emissions. There are no indications that this

would be targeted in the available documentation. Some energy intensive industries, such as cement, could use RDF to replace fossil fuel and thereby reduce emissions.

4 Power generation and electricity tariffs

Selling electricity by private power producers to the grid is possible in Indonesia. The grid is operated by Perusahaan Listrik Negara (PLN) which is the government owned utility that have the main power production capacity in the country and has the monopoly of the power distribution. It is to PLN that a negotiation and agreement of power production will have to be made if distributing power to the main grid should be allowed. The regulating framework that allows and regulates the opportunities to connect to grid, sell electricity and tariffs is rather well defined (BKPM 2015). Increasing capacity in renewable power production as a means to reduce fossil energy use is a priority for the government (MESM 2017; MESM 2020). Based on MESM (2017) all waste to energy installations below 10 MW should be allowed connection to the grid, which is to support local authorities in improving waste management. Any installation should at the same time be part of/relate to the national electricity supply plan (see for example the most recent one PLN 2019)

The challenge is linked to the actual interpretation of legal framework and operational and technical parameters of the Indonesian power system. One of the challenges is to have the opportunity to sell to the grid. In some parts of Indonesia (Java island and Bali) there is a power surplus which results in a situation where PLN have low interests to add more capacity to the grid and thereby affecting their own operations. PLN will thus have double roles in relation to independent power producers (IPP). The power purchase agreement will be signed with PLN. In the case of installations below 10MW the levels are defined, while larger installations will be subject for negotiations.

The tariff that can be received will also depend on the Basic Provision Cost (BPP). To PLN some solutions may represent a cost for their operation, and they are not willing to enter such agreements unless there are other public bodies that can support the agreement. As seen in Figure 6 BPP prices areas in Indonesia shows substantial differences, where West Java is amongst the provinces with lowest BPP.

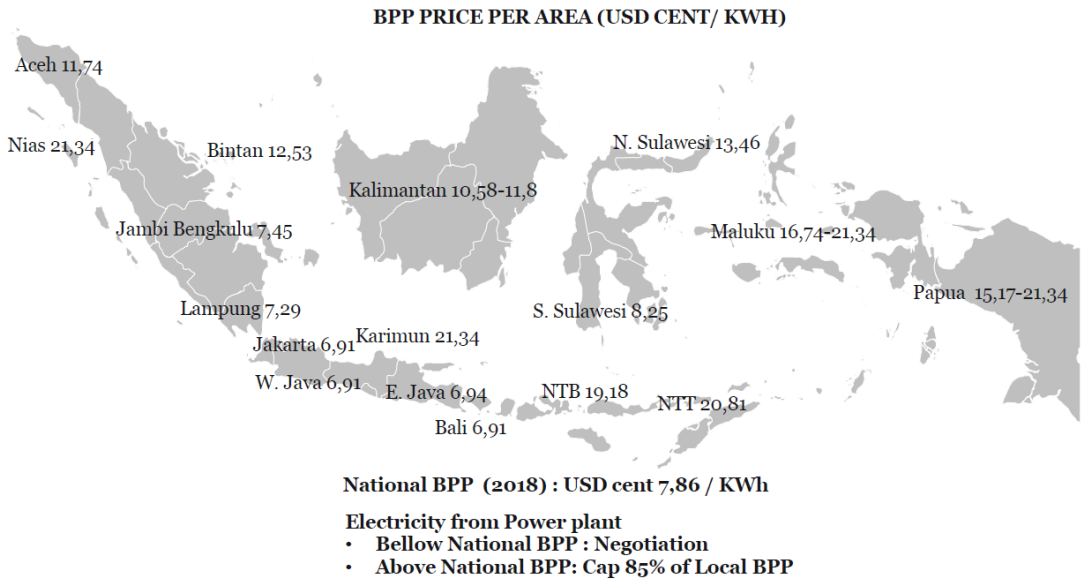

Figure 6: Electricity Basic Provision Cost (BPP), which defines the cap for tariff for renewables

Waste incineration and landfill gas will have a tariff level of BPP and additional 100% which for Waste Java will reach 13.82 USD cents/kWh. PLN will be the body that *always* distribute the energy if sold and PLN is the only body that can sell electricity to any end-user. This means that a power producer cannot sell electricity even on an isolated grid. There is a total of 50 companies that have signed power purchase agreements with PLN in 2017, most are micro hydro plants. Net-metering exists but only for solar installations.

It is ok to produce electricity for own use by a commercial entity but not sell excess production unless there is a contract with PLN. As soon as any electricity is sold this will require involvement of PLN. Example of industries with own power productions are palm oil industries utilizing the biobased residues from the palm kernels and fruits, textile industries where coal fired power plants may be found and sugar mills. In order to be called "own use" there is a requirement on ownership. Smaller plants, 1-10 MW, a maximum of 45% external ownership and larger plants max 95% external ownership. In cases with public private partnership (PPP) schemes it may go up to 100% (BKPM 2015).

Any new installation above 10MW installed electric capacity will have to be included or ensure that there is unmet planned capacity requirements in the Electricity Supply Business Plan also referred to as RUPTL (PLN 2019). Installations below 10 MW does not require to be listed. Based on the available background information there is an excess capacity in power production in West Java at present. An anticipated growth of electricity demand is foreseen thus requiring certain expansion. At the same time most power production is fossil based and renewable options may be more attractive considering carbon tax introduction and also further action to reduce climate emissions.

5 Potential for solutions to support improved waste management, energy production and environmental actions

There are large potentials for actions to support environment and climate via improving waste management from the source to final disposal at the landfill/dumpsite. As presented in the introduction the waste management should be considered as a system where all components provide parts of the final solution. Based on this system based perspective there are some important aspects to consider:

- Regional sanitary landfill options should be sought for in terms of final disposal. Cooperation between regencies and cities is needs to ensure that proper final handling of the waste is achieved. Scale of economy in regional approaches provides opportunities for proper management and ensuring mitigation of climate, and environmental impacts. Sanitary landfill standard is not found today, one is under construction.
- Volumes of generated waste are large in the more populated places. Actions should have enough scale to be able to handle the total volumes generated, also accounting for presently unmanaged waste.
- Any actions and solutions that can reduce volume of waste before it ends up at landfill is beneficial. Mechanical sorting, RDF production, source separation of organic waste or other recyclable products are good opportunities.
- Potential for scaling up actions for recycling and separation should be considered. Recycling via deposit system (extended producer responsibility) has proven track record of scale and impact. Will also affect the residual waste stream and potential materials for recycling.
- The waste situation is well understood as a big problem both physically as landfill space is limited, but also environmental problems, economic losses (tourism) and climate.
- To the public organization waste handling and disposal is only representing a cost. There are no gate fees and marginal revenues from collection. Actions on increasing revenues must consider rebound effects that waste is dumped in environment without costs.
- Consideration of the revenue streams. Selling electricity may be a challenge, it is possible but require agreements with PLN. Ownership issues are part of the consideration.
- Local presence to support safe operation, maintenance, and support if unexpected things happens is motivated. The waste sector in Indonesia show examples of technologies that have fallen into disrepair. Local presence of the suppliers is possibly also advisable to support good connections with authorities and to ensure that agreements and contracts are followed.

Based on these aspects there are some potential solutions that can be identified.

5.1 Landfill gas capture

Actions on landfill gas capture is strongly motivated in all the existing landfills and dumpsites in West Java (and Indonesia). Methane is a strong greenhouse gas and by capturing the gas and burning it there is a decrease of contribution by a factor of 25. Additional environmental benefits can be attained such as reduced odor.

Based on the scenarios for waste generation it is likely that sanitary landfills with substantial parts of organic materials will still be found in Indonesia for years to come. Providing landfill gas system to new regional sanitary landfills would be one opportunity, but also acting on the existing and closed landfills.

Landfill gas is potential showcase but will require proper negotiations and support from province, local governments and so on. Sweden have realized one landfill gas project in Palu on the island of Sulawesi which acts as a reference case. The Palu project did not operate the landfill gas system on commercial case but was part of development of people's livelihoods and waste management in the city.

The main problem is to find a suitable business case. To use gas for production of electricity and selling to the grid has proven complicated[5]. Alternatively, if there is an industry with gas or electricity demand that would be interested in the investment it could be a solution. There are also closed dumpsites that could be considered.

5.2 RDF and mechanical sorting

Actions on RDF production will provide reduced waste to the landfill. It will showcase sorting technology and opportunity for provision of products that can substitute fossil fuels. Further analysis on the market for RDF should be made to understand the resulting RDF and potentials for replacing existing fuel use. Also understanding the energy costs as well as potential impacts for the industry on environmental permits in doing this shift.

The RDF production includes removing biological part from the mixed municipal household waste. The RDF product will be a well-defined fuel to be used for different purposes. The resulting biobased material that is removed from the RDF may not be suitable for composting and recycling for farming as it may contain high levels of contaminants. This should be considered and monitored in order to ensure safe operation. Examples of use of the organic part is landfill coverage (soil).

Identification of potential customers of the RDF is needed. The cases identified with RDF production indicate that the industry with demand were themselves involved in the establishment and production of the RDF. Further investigation on whether other cement industries could be interested to by the RDF directly, and at what cost.

[5] One example of such installation is found at the landfill Bantar Gebang. Bantar Gebang is found in West Java but is the landfill of Jakarta. There is about 8,000 ton of waste per day. There is a landfill gas system installed with a number of engine generator sets.

5.3 Incineration with energy recovery

Incineration with energy recovery provides an opportunity to reduce volumes of waste and avoid organic material to end up on the landfills. Both these actions are important and fits in the Indonesian strategies. Actions on incinerators should have a future perspective, thus looking at the landfill solutions of the future, rather than to lock-in the present very unsustainable system. This means that regional centralized sanitary landfill solutions should be the preferred option where incinerators are put.

Distributed smaller systems forming a network of incinerators from which the ashes are transported to more central final landfilling is difficult to motivate from environmental and climate perspectives. The efficiency will be better in a larger system, cleaning of flue gases and other environmental aspects can be improved. Economy of scale would probably also be an argument. It is better than to have a larger centralized incinerator and decentralized compacting stations if needed to reduce transports.

Incineration can be an interesting solution in industries to provide electricity and heat for own use. This can be combined with the RDF station which then would be a pre-treatment of the waste. By having an industry to operate the system directly the PLN will not have to be involved issuing permits to sell electricity. The price of the electricity will be known as it is the tariff that is replaced.

Two items should be noted in such a scenario:

1. The emission standard for Indonesia is different from international best practice. Any Swedish action on supporting incineration technology in Indonesia should adhere to the EU legislation thresholds (Table 7).
2. Attention should be given to the source of waste to the incinerator in order to reduce risk of burning hazardous waste and other unwanted items. Ashes should also be considered. Low standard of dumpsites around West Java as well as uncontrolled dumpsites may provide risk that ashes are handled in an unsafe way. These are difficult items to control as operational parameters may be outside the control of the technology provider but nevertheless important.

A combination of mechanical sorting facility and incinerator at industry is an interesting concept to showcase the solution.

Table 7: Thresholds for daily average emissions limit values of polluting substances in flue gases, EU levels (European Parliament 2010) and Indonesian levels (MLHK 2016)

Component	EU legislation	Indonesia legislation*
Total particular [mg/Nm3]	10	120
Sulphur dioxide (SO_2) [mg/Nm3]	50	210
Nitrogen (NO and NO_2) [mg/Nm3]	200	470
Hydrogen chloride (HCl) [mg/Nm3]	10	10
Mercury (Hg) [mg/Nm3]	0.05	3
Carbon monoxide (CO) [mg/Nm3]	50	625

Hydrogen fluoride (HF) [mg/Nm3]	1	2
Dioxins and Furans [ng/Nm3]	0.1	0.1

Note: Thresholds for other intervals than daily average also applies, these are some examples.

6 Recommendations

Actions on improving waste management in West Java is strongly motivated from climate, environment, economic and social aspects. Actions should consider the long-term sustainability and priorities in order to prevent lock-ins and facilitate cost effective solutions on a system level. Recommendations will depend on location and the context where the actions are suggested (Table 8). The recommendations are based on a system approach where the suggested action is done in parallel and in coordination with actions on increased collection of unmanaged waste, and actions to reduce, recycle and reusing materials in the waste streams.

In the more densely populated areas priority should be given to *regional cooperation action* where increased capacity, proper environmental safeguards can be put in place as economy of scale can be reached. This will be a more long-term solution than solutions based on each regency or city seeking its own solution. It is better to advocate regional actions for future realization of modern sanitary landfills. The example of the on-going initiatives at TPA Legok Nangka can serve to illustrate an approach for handling large (2,000 t/day) waste, reducing volume and ensuring a proper final disposal at sanitary landfill. In order to build effective system recycling stations, RDF production sites and sites with compactors can provide options for ensuring unnecessary transports can be avoided. Realization of these solutions will require time as several steps are needed to ensure that waste to energy plant is introduced in national plans, setting up regional cooperation on joint landfill and business require time. At the same time, it is strongly motivated from environmental, social, climate and economic point of view.

In more remote areas priority is to ensure collection of waste and proper final disposal, including improving landfill sites. Opportunities to have local energy production and utilize RDF is inspiring. A combination of smaller size incinerators and mechanical sorting and pretreatment could provide a system which can provide a business case, as well as be motivated by climate and environmental arguments.

Table 8: Recommended actions short- and long-term in densely and more remote areas.

	Densely populated areas	**More remote areas**
Actions short-term	- Improving existing landfill/dumping env. status including landfill gas capture and use. Closing full cells. - Scaling up recycling - Small-scale waste incineration at industrial sites – incl RDF and sorting - RDF production as transitional action to reduce volume of waste to landfill. - Regional sanitary landfills, compacting stations - Actions to increase collection of uncollected waste. - Facilitate and increase formal revenue streams in waste management	- Improving existing landfill/dumping env. status including landfill gas capture and use. Closing full cells. - Scaling up recycling - Small-scale waste incineration to reduce volume of waste. - RDF production - Actions to increase collection of uncollected waste - Facilitate and increase formal revenue streams in waste management

Actions long-term	- Scaling up recycling, actions on single use plastics, introducing source separation etc. - Actions to increase collection of uncollected waste. - Regional sanitary landfills, compacting stations, large scale waste incineration. - Facilitate and increase formal revenue streams in waste management	- Scaling up recycling, actions on single use plastics, introducing source separation etc. - Actions to increase collection of uncollected waste. - Regional sanitary landfills, compacting stations, large scale waste incineration. - Facilitate and increase formal revenue streams in waste management

Mitigation of the negative impacts from emissions of methane (greenhouse gas emission), lack of proper leachate treatment and open dumping causing odor, dust and other risks at already existing dumpsites/landfills is strongly motivated. Also closed dumpsites can be considered for landfill gas installations. By *installing landfill gas capture*, the methane emissions from the dumpsite can be reduced. Potentially all existing dumpsites in West Java can be equipped with such installations.

The challenge is to find a working business model as revenue streams in the waste sector are small and investments is on a relatively low level. Another barrier seems to be the complexity in the process to ensure contract with PLN to sell electricity to the grid. One option is to target industries where supply of electricity generated on-site could reduce costs. In cases where there is already own energy generation, a waste-based solution could be evaluated as compared to present system. RDF and landfill gas sold to end-users will not require a negotiation with PLN as this is only required for selling electricity.

Depending on the action the negotiating partner will vary. This is relevant in terms of understanding that any actions on local governments will involve finding a business solution where investments are low, waste handling mainly represent a cost and many urgent priorities for actions. The interest to find solution is big, but challenge is on *how to realize* the investment. Industries may represent an option especially in case there is an own energy demand that can be met. The business case may be stronger and become attractive to the investor. Examples of actions are presented in Table 9.

Table 9: Possible actions/initiatives from Swedish partners

Site	**TPS**	**Landfill**	**Industry**
Level/stakeholder	Local government (city or regency)	Local government (city or regency)	Industry
Possible actions/initiatives from Swedish partners	- Sorting, recycling - RDF - Compacting - Composting	- Sorting - RDF - Landfill gas - Landfill operation and improved env status - Waste to energy with electricity generation (negotiations with PLN) - Composting	- Use of landfill gas in process or for own electricity generation and use. - Incineration with energy recovery and use of electricity - RDF

Actions on improving waste management, increasing recycling and take actions to improve existing dumpsites and landfills are strongly motivated. The actions are short-term as well as long-term investments and initiatives. To increase collection of un-managed waste and to ensure that further steps upward the waste ladder are taken should be priority and guiding principle in actions. Actions should be assessed considering the full waste management system and not as isolated quick fixes. It is also advisable that attention is given to ensuring that actions supported consider potential for un-wanted lock-in and to ensure that proper attention is given that any residues or by-products from a process are handled in a correct manner (ashes, organic part from RDF).

The contribution to the sustainable development goals are seen at many levels via the actions to improve the overall waste management system. Including SDG6 on clean water, SDG7 on renewable energy, SDG 11 on sustainable cities and communities as well as SDG 13 on climate actions and contributing to SDG14 on life below water. The actions could also support human well-being and development via including marginalized and exposed groups presently finding their livelihoods as waste pickers in the proposed actions.

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Annex: Landfills in West Java

The following list of landfills in West Java provides some

NAMA TPAS	KOTA/ KABUPATEN	Pop 2015	Waste generated in regency/city (t/day)[1]	Waste to TPA (t/day)[2]	Type
TPAS Legoknangka (to be build)	*Kabupaten Bandung*	*3,528,873*		*1800*	*Regional Sanitary (incl incineration and energy recovery)**
TPAS Sarimukti	Kabupaten Bandung Barat	1,627,816		1708	Regional Controlled*
TPA Burangkeng	Kabupaten Bekasi	3,235,556	1,598	376	Open dumping
TPAS Nambo	Kabupaten Bogor	5,463,849	3,120	1,700	Controlled
TPAS Sindangrasa	Kabupaten Ciamis	1,168,254	953		Controlled
TPA Ciminyak	Kabupaten Ciamis	1,168,254	953	44.1	Open dumping
TPA Pasir Sembung Cianjur	Kabupaten Cianjur	2,243,328	487	98	Open dumping
TPA Gunung Santri	Kabupaten Cirebon	2,124,866	1,223	474	Open dumping
TPA Pasir Bajing	Kabupaten Garut	2,546,859	483	130.1	Open dumping
TPAS Pecuk	Kabupaten Indramayu	1,690,643	643	144.19	
TPA Pecuk	Kabupaten Indramayu	1,690,643	643	144.19	Controlled
TPA Jalupang	Kabupaten Karawang	2,271,681	937	152.86	Open dumping
TPAS Ciniru	Kabupaten Kuningan	1,054,862	541	252	Open dumping
TPA Kab Majalengka	Kabupaten Majalengka	1,181,701	519	128	Open dumping
TPAS Purbahayu	Kabupaten Pangandaran	390,316	277	22.75	Open dumping
TPAS Cikolotok	Kabupaten Purwakarta	920,639	416	169.5	Controlled
TPAS Panembong	Kabupaten Subang	1,527,952	639		

NAMA TPAS	KOTA/ KABUPATEN	Pop 2015	Waste generated in regency/city (t/day)[1]	Waste to TPA (t/day)[2]	Type
TPAS Cibeureum Wetan	Kabupaten Sumedang	1,136,816	439	50	Open dumping
TPAS Cijeruk	Kabupaten Sumedang	1,136,816	439		
TPAS Nangkaleah	Kabupaten Tasikmalaya	1,735,401	757		Open dumping
TPA Nangkaleah	Kabupaten Tasikmalaya	1,735,401	757	200	
TPA Sumur Batu	Kota Bekasi	2,708,721	1,970	438	Open dumping
TPA Galuga	Kota Bogor	1,046,579	571	475	Controlled
TPAS Kopi Luhur	Kota Cirebon	307,319	164	146.48	Open dumping
TPAS Cipayung	Kota Depok	2,099,989	1,444	750	
TPAS Cikundul	Kota Sukabumi	317,883	158	102.68	Controlled
TPAS Ciangir	Kota Tasikmalaya	657,169	331	147.25	Open dumping
TPAS Galuga	Kota/ Kabupaten Bogor	1,046,579	571	433.35	

* Regional landfill that serves City Bandung, Regency Bandung, Regency Bandung Barat, city Cimahi

[1] [REF]

[2] [REF]

Annex 2: Regulation on waste collection fees, Bandung City (LDKB 2012)

Text translated from Bahasa Indonesia via google translate. Included here for illustration purpose.

Paragraph 3

Principles and Objectives in Structuring And the amount of service retribution rates Garbage / Cleanliness

Article 14

(1) Principles and targets in tariff setting Service Retribution Garbage / Cleanliness determined with due observance of the cost of provision services concerned, capabilities society, aspects of justice, and effectiveness control over service Garbage / Cleanliness.

(2) Fees as referred to in paragraph (1) includes operating and maintenance costs, interest costs, and capital costs.

(3) In the case of full tariff determination pay attention to the cost of providing services, tariff setting is just to close part of the cost.

Paragraph 4

Structure and Amount of Rates Retribution for Garbage / Cleaning Services

Article 15

The structure and amount of the Service Retribution tariff Garbage / Cleanliness is defined as following:

1. Residential Retribution Rates

   a. For Transportation and Management waste from TPS to TPA in the environment residential house the amount of the rate per month at categorize based on classification as follows:
      1) First Class Rp. 8,000; / mth / kk
      2) Class I Rp. 6,000; / mth / kk
      3) Class II Rp. 5,000; / mth / kk
      4) Class III Rp. 4,000; / mth / kk
   b. For collection, transportation and garbage disposal from residential homes with Individual pattern right from source to the TPA implemented by Local Government, the amount of each tariff months are categorized by classification as follows:
      1) First Class Rp. 9,500; / mth / kk
      2) Class I Rp. 7,500; / mth / kk
      3) Class II Rp. 6,500; / mth / kk
      4) Class III Rp. 5,500; / mth / kk

2. Non-Residential Retribution Rates

a. For Freight Services and Garbage Management from the shop down the line Protocol, the amount of the Retribution Tariff is Rp. 30,000, - per m3 (per cubic meter);
b. For Freight Services and Waste Management from Companies Industry, the tariff is Rp. 30,000; per m3 (per cubic meter);
c. For Freight Services and Waste Management from Hotels / Lodging, the rate is determined based on the following classifications:
    1) Star Class Hotel Rp. 35,000 per m3
    2) Budget Class Hotel Rp. 30,000 per m3
    3) Inn / Lodging Class Rp. 27,500 per m3
    4) For Freight Services and Waste management from restaurants, houses food, the amount of retribution is Rp. 35,000.00 per m3 (per cubic meter);
a. For Freight Services and Waste Management from Hospitals and PUSKESMAS, the amount of retribution rates in the amount of Rp. 27,500.00 per m3 (per meter cubic);
b. For Freight Services and Waste Management from Cinemas / General Entertainment and Crowd as well as the place of tourism, the amount of the tariff retribution of Rp. 35,000.00 per m3 (per cubic meter);
c. For Freight Services and Waste Management from Companies Office Services, the amount of retribution rates in the amount of Rp. 35,000.00 per m3 (per meter cubic);
d. For Freight Services and Waste Management from Companies Transportation / warehouse, the amount of the tariff retribution of Rp. 35,000.00 per m3 (per cubic meter);

3. Waste Disposal to TPA Disposal of waste to government-owned landfills Areas that are implemented by the private sector and or Agency outside the Government environment Bandung Regency is subject to Retribution in the amount of Rp. 35,000.00 per m3 (per meter cubic);

4. Market Waste Retribution Rates The amount of the Freight Retribution Tariff Special Trash at market locations and street vendors as well as seasonal traders of magnitude as following:

a. Wholesaler Rp. 3,000.00 / day
b. Shop Trader Rp. 2,500.00 / day
c. Kiosk Trader Rp. 2,000.00 / day
d. Field Trader Rp. 1,500.00 / day