Eco-Innovation in the Waste Management sector towards SCP and Circular Economy

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Case Studies on Plastics in selected ASEM countries

ASEM SMEs Eco-Innovation Center

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Foreword

ASEM SMEs Eco-Innovation Center (ASEIC) developed the ASEM Eco-Innovation Index (ASEI) in 2012 and measured eco-innovation status across ASEM member states each year. Understanding the status forms the basis for eco-innovation dialogue between Asia and Europe and contributes to effective strategies and international cooperation in the ASEM regions. Since there is a wide discrepancy between Asia and Europe in terms of data availability, ASEI has been continually improved and updated, and supplementary reports have been issued in parallel. Country reports for 10 Asia countries, including India, Mongolia, the Philippines, Australia (2017), Singapore, Thailand (2016), Vietnam, Japan, Myanmar, Republic of Korea (2015) were published sequentially.

This year eco-innovation sectoral study for selected countries was designed to provide a chance to explore more closely by sector and to better understand ASEM countries in this sector. Waste management has been chosen as the first theme, focusing on the plastic waste that have received great attention recently. Waste management is one of the areas that need more consideration and international supports in Asian countries and is essential to move towards Circular Economy and Sustainable Development Goals, especially SDG 12, Sustainable Consumption and Production (SCP). This report provides information on each country's political instruments in the waste management sector, overall status, best practices, lessons learnt, and recent efforts and concerns. We sincerely thank all authors for making this report possible by studying and writing their own country part, designing the report structure and providing feedback. We hope that this report will promote more active dialogue and international cooperation in the ASEM regions.

Sejong Kim
ASEIC Secretary General
Sejong Kim

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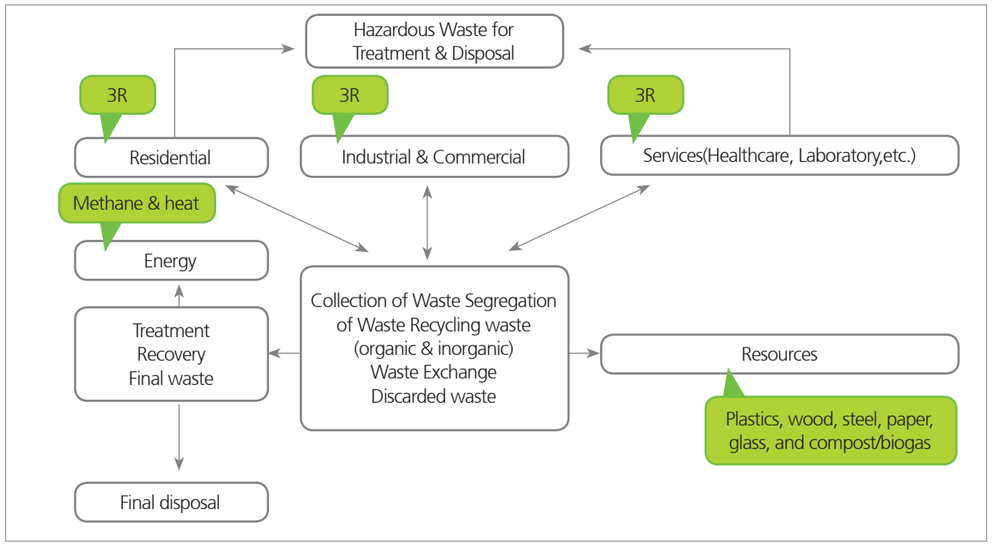
1.1 Introduction of Non-biodegradable Waste

1.1.1 Importance of waste management

Waste management is one of the most important public advocacies. According to the UNEP, annual figure for urban waste generation reached approximately 7 to 10 billion tons in OECD countries . While waste conceptually undergoing the process of collection[1], segregation, recovery and disposal by landfill or incineration process[2] , most wastes typically accumulates at the landfill stage.

Figure 1 Solid Waste Management Diagram



(Source: UNEP, 2009)

Developing countries are especially in severe condition as there are lack of collection coverage as well as controlled disposal. The World Bank pointed out that, while 20 to 50 percent of municipal budgets are directed on solid waste management, 30 to 60 percent of urban solid waste are uncollected in developing countries[3] . Uncontrolled landfill is especially prevalent in municipal level, and this untreated wastes on open sites often cause public health concerns and environmental pollution issues. Therefore, preventing this accumulation by adequate waste management will enhance global competence to alleviate environmental challenges the world is currently facing.

International entities repeatedly raise issues associated with waste management to address and improve global eco-friendly performance level. In line with this fashion, UN's 12th goal of Sustainable Development Goals (SDGs), 'Responsible Consumption and Production' deeply aligns with this notion of waste management. According to the UN SDGs, it is a fundamental obligation for countries under the UN convention to manage one's responsible consumption and production level, and the countries "are requested to regularly report data and information" associated with wastes[4].

1. UNEP, 2015, The Mounting Problem: World's Cities Produce up to 10 Billion Tonnes of Waste Each Year, UN Study Estimates
2. UNEP, 2009, Developing Integrated Solid Waste Management Plan Training Manual Vol.2 Assessment of Current Waste Management System and Gaps Therein
3. The World Bank, 2016, Urban Solid Waste Management
4. https://sustainabledevelopment.un.org/sdg12

Figure 2 UN Sustainable Development Goals

(Source: United Nations, 2018)

The concept of adequate waste management is also connected to the ASEM Eco-Innovation Index (ASEI), the index developed by the ASEM SMEs Eco-innovation Center (ASEIC). The ASEI fundamentally assesses the sustainability of Asia and Europe, and it is a comprehensive index that consists of four main categories: Capacity, Supporting Environment, Activity and Performance. Among those categories, Supporting Environment and Performance well corresponds with this issue of waste management[5].

Despite global endeavors to handle waste management, it is especially a challenge for disposal of non-biodegradable wastes since non-biodegradable wastes' innate character is not decomposable over time.

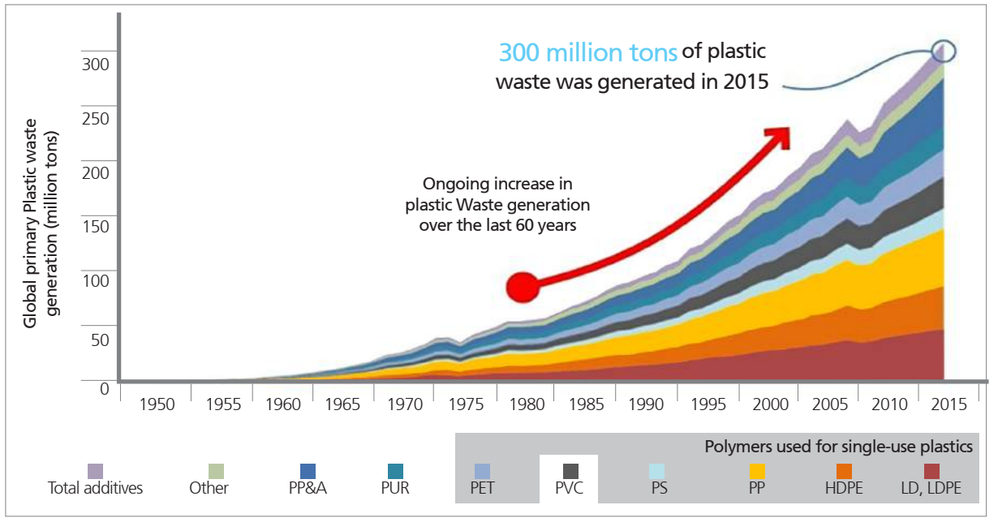
1.1.2 Non-biodegradable wastes and the matter of plastic

Non-biodegradable waste (NBDW) is a composite term of the words 'non-biodegradable' and 'waste.' To understand what NBDW means, one should understand what 'non-biodegradable' means to further identify the meaning of NBDW.

Biodegradable means being able to decompose under natural environment[6] . In natural condition, organic substances break down into smaller substances all the way down to organic molecules. In other words, non-biodegradable substances will not decompose in biological process. While the United Nations Statistics Division (UNSD) defining wastes as "materials that are not prime products (that is, products produced for the market) for which the generator has no further use[7] ," non-biodegradable waste thus means indecomposable materials with no further economic value.

5. ASEM, 2015, ASEM Eco-Innovation Index
6. UNSD, 1997, Glossary of Environment Statistics
7. UNSD, 1997, Glossary of Environment Statistics

Figure 3 Global Plastic Waste Generation, 1950-2015



(Source: UNEP, 2018)

One of the most common NBDWs is plastic. In annual basis, the amount of annual global plastic production reached approximately 400 million tons, while 39% of these products are for single-use packaging such as plastic bags. Among those plastic products, 300 million tons of them are discharged as wastes in 2015. In other words, 75% of plastic products are going to the wastes, and 47% of these wastes are from packaging[8].

Table 1 Approximate Time for Plastic Wastes to Decompose

Plastic Wastes	Time to Decompose
Plastic Beverage Bottles	450 years
Disposable Diapers	450 years
Foamed Plastic Buoy	80 years
Foamed Plastic Cups	50 years
Nylon Fabric	30-40 years
Plastic Bag	10-20 years

(Source: NH Department of Environmental Services, 2017)

This plastic does not completely decompose, but rather becomes "microplastic," which is the smallest possible form for plastic less than 5nm long[9]. The above table (Table 1 Approximate Time for Plastic Wastes to Decompose) illustrates how long it takes for common plastic wastes to decompose in the natural environment, and there is no surprise that it takes for plastic beverage bottles as long as 450 years to decompose.

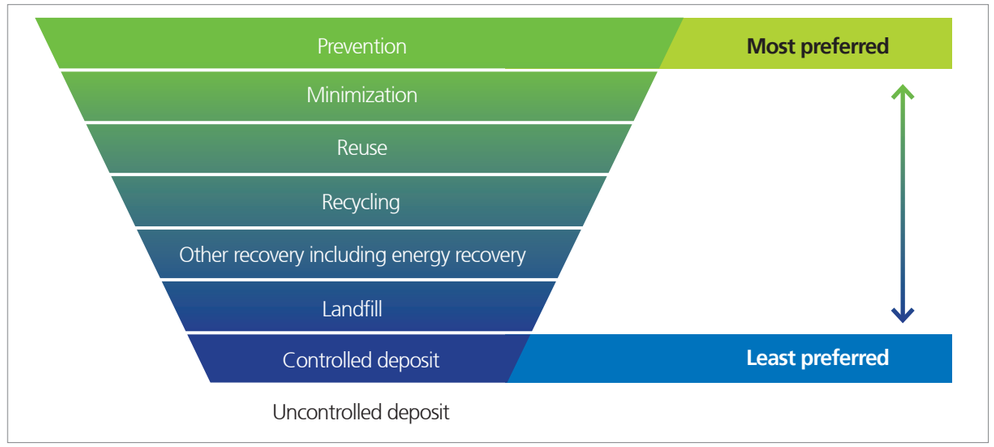
8. UNEP, 2018, Sing-Use Plastics - A Roadmap for Sustainability
9. NH Department of Environmental Services, 2017, New Hampshire Department of Environmental Services

While untreated plastic wastes accumulated in open and uncontrolled sites will cause public health problem as well as environmental pollution issues, 79% of plastic wastes accumulates from landfill and uncontrolled deposit[10]. Preventing this accumulation will enhance global competence to alleviate environmental challenges the world is currently facing.

1.1.3 Plastic on the 3Rs (Reduce, Reuse, and Recycle)

According to the UNEP's waste management hierarchy, disposal is "a last resort for waste[11]" when there was no other actions taken. Prior to this disposal, Reduce (Minimization in the Hierarchy), Reuse and Recycle, so-called "3Rs" integrate in the middle process of waste management and decrease the amount of plastic wastes winding up on open dump sites. 3Rs thus enhances the efficiency of plastic waste management structure.

Figure 4 Waste Management Hierarchy



(Source: UNEP, 2018)

The most preferred 3Rs to handle plastic wastes is reduction. Reducing plastic waste generation is attainable either by utilizing alternative design or material[12] or by reducing frequency of plastic use. For instance, one can carry fabric bags (e.g. cotton or linen) instead of buying plastic bags every time the person goes on shopping. This consumer-level effort will decrease the use of plastic bags thus to generate less plastic wastes. However, reducing use of plastic product is rather administrative approach since countries often implement regulatory scheme in municipal level. According to the International Environmental Technology Centre (IETC), 75 countries enacted regulations on plastic bag use by complete banning or imposing levy on its use (Refer to Table 2 Four Types of Policy Tool to Reduce Plastic Bag Use).

10. UN, 2018, Sustainable Development Knowledge Platform
11. UNEP, 2013, Guidelines for National Waste Management Strategies
12. P SinghV.P, 2016, International Conference on Solid Waste Management

Table 2 Four Types of Policy Tool to Reduce Plastic Bag Use

Policy Tool	Features
Total Ban	Use and sell of plastic bags prohibited
Levy on Retailers	Levy for dispensing plastic bags, encouraging stores to charge a fee, use alternative bags, and pushing the use of reusable bags
Levy on Consumers	Charge on each bag sold at the point of sale
Policy Mix	Ban on thin plastic bags and levy on thicker ones

(Source: EITC, 2017)

The next preferred method for plastic waste management is reuse. German Circular Economy Act of 2012 defines reuse as "any operation by which products or components that are not waste are used again for the same purpose for which they were originally conceived[13]." In other words, using a plastic item again for the same function well serves the purpose of reuse. In order to enhance global sustainability, the United Nations Environment Programme (UNEP) advocates on reducing single-use plastics, and it introduces way of using plastic packaging boxes for multiple times as an example of reusing plastic waste.

The last component of 3Rs is recycle. In the contrast of reuse, recycle is transforming polymer characteristic of materials or redesign of plastic wastes to let them perform different functions. Recycle of plastics consume less energy to become another product[14]. For instance, the embodied energy for primary PET plastic material was ranging between 79-88 MJ/kg while the embodied energy for reused PET plastic material was around 60-64, approximately 26% lower than primary PET plastic material[15]. It is unfortunate that less than 10% of total global plastic wastes undergoes recycling process,[16] thus collective efforts to recycle plastic wastes should be encouraged further.

1.1.4 Plastic on Eco-innovation approach

European Commission defines eco-innovation as "any form of innovation aiming at significant and demonstrable progress towards the goal of sustainable development, through reducing impacts on the environment or achieving a more efficient and responsible use of natural resources, including energy.[17]" In the perspective of plastic, it is a comprehensive development of new products to enhance social, economic and environmental aspects of existing ones.

For instance, the design center of material technology in Italy (CETMA; Centro di Progettazione, Design e Tecnologie Dei Materiali) partnered with Italian and Spanish companies, developed pultruded rods from recycled plastic beam that can be applied to furniture. As part of PROWASTE – Efficient Utilization of Plastic Waste through Product Design and Process Innovation – initiative, the main source of raw material procurement is plastics that are originally discarded for landfill and incineration. While the product significantly enhancing flexibility, resistance and weight of the products, it also successfully reduced the amount of plastic wastes generated. It is one of the eco-innovative products that enhances social, economic and environmental aspects from existing plastic product[18].

Another example utilizes ocean plastic wastes such as fishing nets, ropes and components (FNRCs)[19]. Since 8 million tons of plastic wastes are annually going into ocean[20], the European Regional Development Fund (ERDF) and Northern Periphery and Artic (NPA) took a powerful eco-innovation initiative and created a guideline for start-ups, entrepreneurs and small and medium-sized enterprises (SMEs) for developing eco-innovative products. This initiative gave an opportunity for Klättermusen, Swedish outdoor gear company, to develop clothing and outdoor gear produced from recycled fish nets and other plastic wastes.

Figure 5 FNRCs Clothing Sample and Showcasing

(Sources: CharterMartin, 2018)

For many countries, institutional efforts have been made for eco-innovations. However, they are currently leaning more on entrepreneurs for development of eco-innovative products as it illustrates in the above cases. Therefore, it is important for this report to deeply reflect on current legal and regulatory framework towards eco-innovation to further improve the efficiency of reducing the amount of plastic waste generation.

1.2 Research Design

This research focuses on the reduction of plastic production and consumption which takes critical part of environmental degradation, and therefore aims to analyze the eco-innovation approach under the concept of circular economy on the subject of plastic. It will also be analyzed what national policy of major industrialized countries has been established in an effort to minimize environmental impacts from plastic wastes. Plus, the same research agenda will be used for exploring those in developing countries to find out the applicability of the advanced methods from the developed world.

In the first part of research for each country in the next chapter, an analysis will be made on the current state of plastic waste generation, the measures to reduce those through government activities, and the different methods of consumption reduction, re-usage and recycling. In the second part, the concept of eco-innovation will be applied to discover methods to reduce plastic production. Hence, the next chapter consists of plastic waste disposal as it has been managed, the circular economy including eco-innovation activities as a research platform of each country.

13. UNEP, 2016, Guidelines for Framework Legislation for Integrated Waste Management
14. UNEP, 2013, Guidelines for National Waste Management Strategies
15. The Cambridge-MIT Institute, 2005, The ImpEE Project - Recycling of Plastics
16. UNEP, 2018, Sing-Use Plastics - A Roadmap for Sustainability
17. ASEIC, 2018, ASEM SMEs Eco-Innovation Center
18. European Comission, 2018, PROWASTE - EFFICIENT UTILIZATION OF PLASTIC WASTE THROUGH PRODUCT DESIGN AND PROCESS INNOVATION (PROWASTE)
19. CharterMartin, 2018, Circular Ocean: Eco-innovation Guide for Start-ups, Entrepreneurs & Small and Medium-Sized Enterprises (SMEs)
20. IETC, 2017, Plastic Waste Management

2.1 European Union

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Waste management has been an important theme in European environmental policy for decades. More recently, the economic dimension of waste management has come to the fore, with an emphasis on the potential for jobs and growth in a circular economy that exploits the resource value of waste. In relation to plastics, the European Commission has identified the following key challenges[21].

- Growth in plastic waste generation of, in particular, single-use plastics. These plastics are used only shortly, rarely recycled, and contribute to littering.
- Low collection rates and issues with inadequately labelled biodegradable plastics, which complicates recycling.
- ow recycled input rate (compared to the collection of recyclables), a falling share of Europe in global plastics production, and changes in trade flows.
- Global and local environmental impacts of plastics: carbon emissions from waste incineration and leakage of (micro) plastics to oceans.

The above concerns are related to broader concerns regarding economic growth, competitiveness, and environmental pollution in the European Union. In Europe, more efficient use of resources is seen not only as a means to protect the environment but also as a means to stimulate economic growth and increase competitiveness[22] .

2.1.1 Waste collection and management system

Environmental and waste policy in the European Union member states is strongly shaped by European directives. The directives are negotiated by representatives of the member states and transposed into national law with considerable freedom for interpretation. Directives mainly set out definitions and standards and set headline targets to be achieved at the national level. They do not prescribe individual policy instruments though they may indicate the types of policy instruments that are required.

The Waste Framework Directive (WFD)[23] is the main piece of European legislation regarding waste management. It promotes adherence to the waste hierarchy and sets legally binding recycling targets. It calls for National Waste Prevention Plans and Extended Producer Responsibility. The directive forms the umbrella for various other directives that focus on particular waste streams (e.g. packaging waste), waste treatments (e.g. incineration), or waste prevention activities (e.g. eco-design).

21. European Commission, 2018, "A European Strategy for Plastics in a Circular Economy {SWD(2018) 16 final}
22. W. McDowall, Y. Geng, B. Huang, E. Barteková, R. Bleischwitz, S. Türkeli, R. Kemp, and T. Doménech, 2017, "Circular Economy Policies in China and Europe," J. Ind. Ecol., vol. 0, no. 0, pp. 1–11
23. EC, "DIRECTIVE 2008/98/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 19 November 2008 on waste and repealing certain Directives," Off. J. Eur. Union, 2008.

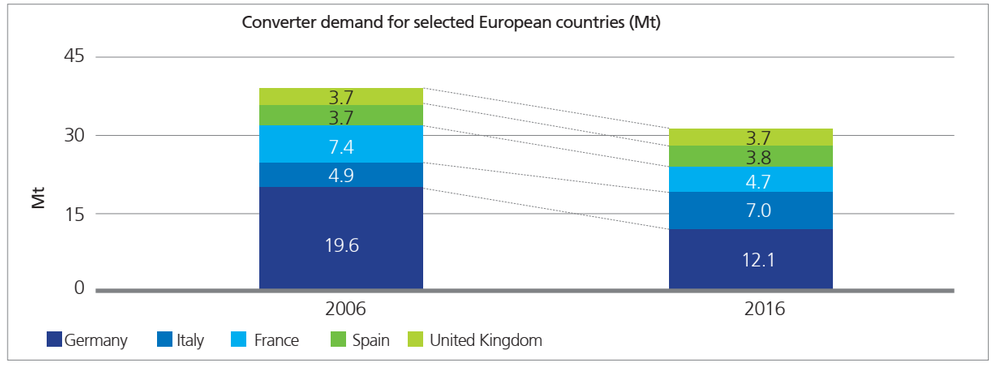
BOX 1. The European Waste Framework Directive

Waste Framework Directive (2008)	
The WFD sets out relevant definitions and priorities. The main objective of the WFD is to protect human health and the environment from the impacts of waste, reduce the use of resources, promote the practical application of the waste hierarchy, and promote policies consistent with the polluter-pays-principle.	
Waste hierarchy (WH)	Upholds the following priority order for waste management: prevention, (preparing for) re-use, recycling, other recovery (e.g. energy recovery), and disposal.
Extended Producer Responsibility (EPR)	Promotes legislative or non-legislative action to ensure manufacturers consider the end-of-life phase of their products by, for example, taking them back or designing them differently.
Recycling targets	Mandate reuse and recycling of at least 50% of paper, metal, plastic, and glass and reuse, recycling, and backfilling of at least 70% construction and demolition waste, by 2020.
Waste prevention programs	Mandate the establishment of objectives and measures to prevent waste including qualitative or quantitative benchmarks, with the aim of de-linking economic growth from the impacts of waste.

2.1.2 Key trends in plastic waste disposal

Europe produced 19% of global plastics in 2016[24]. Figure 6 Plastic converter demand in Europe. Estimates based on shows plastic converter demand in the five largest plastics producing countries in Europe in 2006 and 2016. In spite of rising global plastics production, European production is in decline. In Europe, packaging is by far the largest application, with 40% of plastics demand, followed by building and construction (20%), and the automotive sector (10%) [4].

Figure 6 Plastic converter demand in Europe. Estimates based on [24, 25]

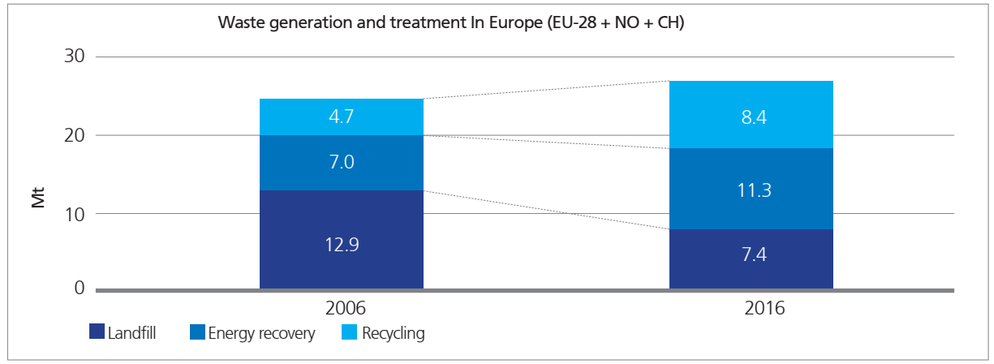


(Source: PlasticsEurope, 2008 & 2017)

24. PlasticsEurope, 2017, "Plastics – the Facts 2017 An analysis of European plastics production, demand and waste data"
25. EC, 2015, "Closing the loop - An EU action plan for the Circular Economy"

Figure 7 Plastic waste generation and treatment in Europe. Data from [24] shows plastic waste generation in the European Union, Norway, and Switzerland 24. In spite of a decline in plastics production in Europe, plastic waste generation (and most likely consumption too) has increased over the past decade. Plastic waste treatment has shifted from landfill to energy recovery and recycling. Still, in 2016, 27% of plastic waste was landfilled and only 31% was recycled.

Figure 7 Plastic waste generation and treatment in Europe. [24]



(Source: PlasticsEurope, 2017)

The data confirms the key challenges outlined in the previous section: declining production, increasing consumption, and increasing waste generation. A circular economy is thought to potentially address all three issues through more domestic sourcing of waste plastics, less single-use plastics, higher recyclability of plastic products, and better infrastructure and facilities for recycling.

2.1.3 Beyond waste management: eco-innovation and circular economy

The European Union launched A European Strategy for Plastics in a Circular Economy in early 2018 [1]. The strategy builds on the EU Action Plan for a Circular Economy[25] and aims to achieve an economy in which plastics reuse, repair, and recycling is the norm. The strategy is meant to protect the environment and contribute to innovation and prosperity. There are four main goals of the Strategy.

- Improving recycling: improving product design, improving separate collection of waste, expanding sorting and recycling capacity, and stimulating markets for recycled and renewable plastics.
- Reducing waste generation and littering: less single-use plastics, monitoring and reducing marine litter, effectively regulating compostable and biodegradable plastics, restricting micro-plastics.
- Promoting investment and innovation: funding technological innovation projects with a focus on alternative feedstocks, recyclability of plastics, improving recycling processes, and managing contamination.
- Promoting global change: supporting international action through international projects, dialogue on best practices, and standardization and certification, with a focus on marine plastics and East and South-East Asia.

The success of these measures is strongly dependent on the systemic interactions between production, consumption, and waste generation and treatment. For example, measures to improve product design need to be consistent with developments in waste management and material processing industries. Globalization of production and consumption further complicates these linkages and implies a need for far-reaching coordination and standardization.

Case study 1: The UK Plastics Pact

Packaging accounts for a large proportion of plastic consumption and much of it is used for supermarket products. Initiatives from supermarkets in various European countries reveal there are as many ideas as challenges. For example, major UK retailers have signed a "Plastics Pact" which aims to make all packaging reusable, recyclable, or compostable by 2025 . At the same time, the pact aims for only 30% average recyclable content in packaging, reflecting the difficulty of closing the loop, which is hampered by, among others, the risk of food contamination by trace chemicals. At the same time, a small number of smaller stores aim for source reduction by allowing customers to buy food in bulk using reusable containers.

Case study 2: Challenges for biodegradation

Bio-degradable plastics are a common cause for confusion. For example, Dutch retailer Ekoplaza opened the world's first "plastic-free aisle" but heavily relies on bio-degradable plastics. Unfortunately, biodegradable plastics do not always live up to their promise of a clean, harmless, closed cycles; biodegradation only happens when materials are separately collected and treated in compositing facilities. Many plastics require industrial composting but the waste separation and treatment infrastructure is often not in place. Another challenge of bioplastics is potential competition between feedstock and food production. The European Commission aims to address some of these challenges through life cycle assessment and harmonization of product labelling[27, 28].

Case study 3: The Ocean Cleanup

The Rotterdam-based non-profit organization The Ocean Cleanup started with a school assignment inspired by a diving trip; eighteen-year-old Boyan Slat from the Netherlands says he saw more plastic bags than fish when diving on the Azores Islands and set out finding a solution. The technology is still under development and consists of a long float with a three-meter deep skirt that traps buoyant particles. The floater is carried by the current and the wind and concentrates the plastics, upon which a vessel can collect them. The Ocean Cleanup has received much praise but also some criticism: the operation could potentially disturb marine life and some argue that source reduction – including limiting the use of plastics and better waste management – is more effective[29,30]

24. PlasticsEurope, 2017, "Plastics – the Facts 2017 An analysis of European plastics production, demand and waste data"
25. EC, 2015, "Closing the loop - An EU action plan for the Circular Economy"
27. M. Rujni¿-Sokele and A. Pilipovi¿, 2017, "Challenges and opportunities of biodegradable plastics: A mini review," Waste Manag. Res., vol. 35, no. 2, pp. 132–140.
28. EC, 2018, "A European Strategy for Plastics in a Circular Economy," Eur. Comm. website, vol. SWD(2018), no. 1, pp. 1–18
29. D. Cressey, 2016, "Bottles, bags, ropes and toothbrushes: the struggle to track ocean plastics," Nat. News, vol. 536, no. 7616, p. 263
30. "The Ocean Cleanup." [Online]. Available: https://www.theoceancleanup.com

2.1.4 Lessons learned

The European experience shows the importance of the role of the European Union in creating consistent frameworks for waste data collection, regulation of waste treatment, and the promotion of reuse and recycling. Consistent with the single market, the EU levels the playing field by raising the performance of late accession states (e.g. Central and Eastern European countries) to the level of environmental leader countries in North-West Europe. This has made Europe a global leader in recycling though much can be improved still.

For plastics, a confluence of environmental and economic concerns has led to a heightened interest in circular economy strategies. Waste management and the circular economy are considered valid strategies for achieving both environmental and economic outcomes through leadership in technological innovation and the creation of domestic jobs. The success of early policies, such as the plastic bag charge, have paved the way for more stringent measures on (single-use) plastics.

The involvement of non-governmental actors, such as the UK-based Ellen MacArthur Foundation (EMF), has undoubtedly contributed to the significant rise in attention for the circular economy on behalf of European policy makers. It remains to be seen to what extent different interpretations of the circular economy by various societal actors are consistent, but for the time being, they constitute a powerful force for change.

2.2 Republic of Korea

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After the 1960s, where Korea saw rapid industrialization and urbanization under the '5-year economic development plan', the amount of waste materials and their characteristics have sharply increased. To address the mounting disposal problem, a more fundamental solution was needed away from landfill and incineration. Policies for the waste reduction and recycling stimulation were developed and the infrastructure was expanded accordingly.[31]

As of 2016, Korea's waste generation (excluding specified wastes) is 415,345 tons per day, increased by about 2.6%p from the previous year (404,812 tons per day). The waste generation consists of municipal solid waste (13.0%), industrial waste (39.0%), and construction and demolition waste (48.0%).[32]

Waste management mainly includes landfill, incineration, and recycling. As of 2016, the landfill rate is 8.4%, which has decreased by about 0.3%p compared to last year (8.7%). The incineration rate is about 5.8%, which is about 0.1%p less than last year (5.9%), and the recycling rate is about 85.7%, which is about 0.5%p more than last year (85.2%).[33]

While plastic waste among recycled waste are managed separately by the private sector (private waste service company) and the government sector (Extended Producer Responsibility action and voluntary agreement), the private sector is difficult to manage compared to the government sector, in terms of performance and so forth.

Korea is the world's eighth-largest consumer of oil, the world's fourth-largest producer of plastic, producing 21,978,000 tons of plastic annually, of which 11,629 tons are used in the domestic market. Although the volume of plastic waste is growing significantly along with increased demand for plastic products, they are mostly incinerated or buried aside from being used in low-grade products.[34]

According to the Korea Environment Corporation, synthetic high molecular compounds (including plastic products) of recycled waste reported in 2016 is about 5,095,000 tons per year and among them about 2,570,000 tons per year(about 50.4%) are being recycled while about 2,525,000 tons per year (about 49.6%) are not being recycled but buried or incinerated. In particular, plastic waste are not easily decomposed in the natural environment, which causes environmental pollution after or while being buried or incinerated.[35, 36]

Therefore, the Korean government announced the Comprehensive Measures for Recycled Waste Management in May 2018 and developed comprehensive measures to reduce the amount of plastic waste by 50 percent by 2030 and to raise recycling rates from 34 percent to 70 percent by 2030.[37]

31. Ministry of Environment, 2017, A Story of Precious Resources in Life
32. Ministry of Environment, 2017, World Waste Production and Processing Status (2016)
33. Woojin Choi, 2018, Development of Plastic Waste Screening Technology, Monthly Environmental Technology (October)
34. Seoul News, 2018, [editorial] Regulation on the Use of Disposable Products is Not Subject to Deregulation (2018.04.06)
35. Korea Environment Corporation, 2017, Performance and Business Status of Waste Recycling
36. Ministry of Environment, 2018, Reduce 50% of Plastic Waste by 2030 (Report)
37. Ministry of Environment, 2018, Comprehensive Countermeasures for Recycling Waste Management

BOX 2. Country policy instruments for waste management sector – Republic of Korea

Types of Policy Instruments		Category	Title of Policy (Year)
National Plan And Strategy	Sustainability		• The 3rd Master Plan for Sustainable Development (2016-2035) • The 4th National Environmental Comprehensive Plan (2016-2035) • The 1st Master Plan for Resource Circulation (2018-2027)
	Eco-Innovation	Waste	• 2018 Comprehensive Measures for Recycled Waste Management (2018)
Programs And Actions	National	Waste	• Waste Deposit Refund system (1992) • Volume-based waste fee system (1995) • Guidelines for separate collection of recyclable resources (2002) • Extended Producer Responsibility(EPR) (2003) • Mandatory procurement of eco-friendly products (2005) • Operating Procedures for voluntary agreement of plastic waste collection and recycling (2013) • Ban on disposable plastic cups inside coffee shops (2018) • Gradual ban on disposable plastic straw usage (2018)
	International	Waste	• The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, Basel Convention(1994, in effect in Korea) • The Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, London Convention(1994, in effect in Korea)
Legislation	Waste		• Framework Act on Environmental Policy (1990) • Waste Management Act (1991) • Transboundary Movements of Wastes and their Disposal (1992) • Act on Promotion of Saving and Recycling of Resources (1992) • the Act on Promotion of Installation of Waste Treatment Facilities and Support of Surrounding Areas (1995) • Act on Promotion of Purchasing Environment-friendly Products (2008) • Radioactive Waste Management Act (2008) • Construction Waste Recycling Promotion Act (2009) • Act on Resource Circulation of Electrical and Electronic Equipment and Vehicles (2016) • Fundamental Law of Resource Circulation (2017)
Finance	Waste		• Budget support by government subsidies for waste disposal facilities and integrated processing guidelines (2018) • Environmental Policy Funds (Korea Environment Corporation) • Recycling Industry Promotion Fund (Korea Environment Corporation) • Green Climate Fund (GCF)
Information	Waste		• Resource Circulation Information System (KCO) • Circular Resource Information Center (KCO) • Korea Resource Circulation Service Agency • Korea National Environmental Technology Information System (KEITI)

2.2.1 Waste collection and management system

The sources of waste plastic in Korea are divided into domestic waste plastic generated at home, industrial waste plastic, and rural vinyl waste generated from agricultural activity. Among them, domestic waste plastics are classified as containers, packaging materials and expanded polystyrene (ESP) for recycling and collected separately.[38]

Since the introduction of the Volume-based Waste Fee System and Separate Collection of Recyclable Waste System in January 1995, Korea has assigned collection and disposal of waste and recycled products to the responsibility

38. Korea National Environmental Technology Information Center (KONETIC), 2016, Technology Trends About Processing and Recycling of Waste Plastics

of the local government. Accordingly, local governments have applied the 'polluter pays principle' and have been collecting recyclable waste without fee in an effort to promote recycling and to reduce the amount of recyclable waste including waste plastic.

Currently, recycling waste is separately collected in accordance with [Guidelines for Separate Collection of Recyclable Resources, etc.], which was promulgated in August 2018, pursuant to Article 13 of the [Resource Saving and Recycling Promotion Act]. According to this guideline, the head of the local government shall segregate the recyclable resources into at least four types and collect them separately, but the suitable form of waste sorting can be established and operated considering local circumstances such as housing type (apartment house, detached house, etc.) and whether or not a local waste disposal facility (Recycling Neighborhood) is installed. However, it is allowed to operate the system as an integrated discharge method in a detached housing area where it is difficult to efficiently sort waste, and the integrated discharge method is required to follow the discharge guidelines of the integrated discharge method of recyclable resources.

In addition, the local government designates and operates regular collection dates or days for efficient collection of recyclable resources, in which case, it collects recyclable resources in a timely manner so that it minimizes the inconvenience for the generator of recyclable source.[39]

Even though the local government is the subject of collection and treatment of recyclable wastes, the local government has been processing only the trash and recyclable products of small apartment complexes with less than 100 households and general waste of apartment complexes. Recyclable waste from large apartment complexes has been directly disposed of in accordance with the resident representatives' committee and private waste service company's contracts at the request of the resident representatives' committee.[40]

Such recyclable waste collection and management practices have been implicit among the public and private sectors over the past 20 years in that apartment units with better waste sorting systems than detached houses can benefit from the sale of recycled wastes and that local governments can reduce the burden of collection.[41]

However, in July 2018, when China announced restrictions on the import of 24 recycled items such as waste plastics and waste paper, the export route of domestic private waste service companies was blocked. In addition, recycled wastes from abroad including the U.S. and Europe were imported into Korea in large quantities, lowering the price of recycled product, therefore leading private recyclable waste service companies refuse to collect waste plastics from Seoul and some apartment complexes in the metropolitan area, causing serious problem with recycling collection and processing.

The residents of apartment complexes called for local governments to collect and dispose of recycled waste, including waste plastic, in order to solve this problem, but the local governments, which has been relying on private waste service companies about the collection and disposal of the recycled waste, failed to provide proper measures.

The Korean government belatedly proposed collection in consultation with private waste service companies, but it is urgently needed to expand the infrastructure to allow local governments to directly collect and dispose of recycled products since the problem may arise again at any time.[32]

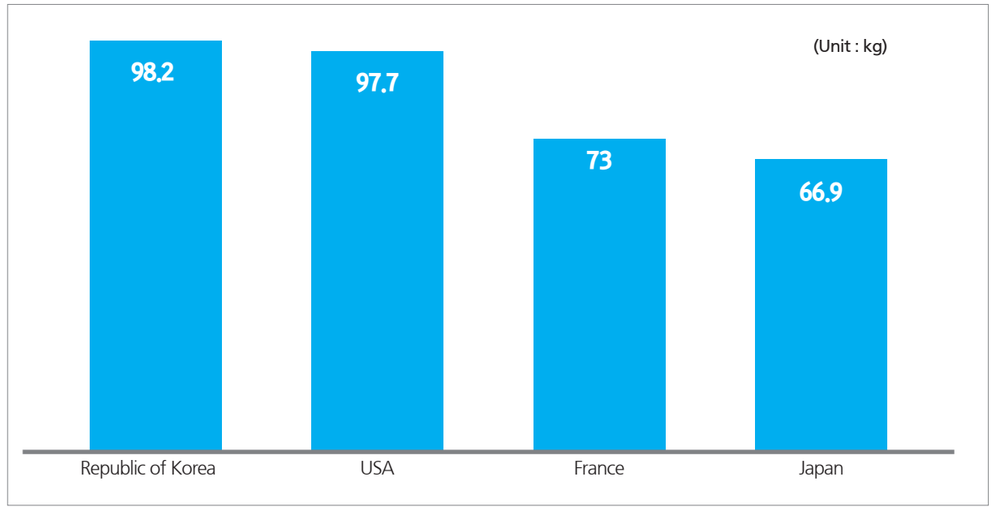
39. Ministry of Environment, 2018, Guidelines for Separate Collection of Recyclable Resources
40. MoneyToday, 2018, [MT Report], The Urgent fire of "Recycling Chaos" is still Remaining
41. http://news.mt.co.kr/mtview.php?no=2018040219491194621

2.2.2 Key trends of plastic waste disposal

Since the execution of the Volume-based Waste Fee System and the Separate Collection of Recyclable Waste System in January 1995, Korea witnessed significant decrease of amount of waste, including spent plastics, and significant increase of the recycling rate. Yet a large amount of useful resources including waste plastics are still simply buried and incinerated.

According to the Korea National Statistical Office, in 2016, Korea's annul plastic use per capita was 98.2 kg, ranking the first in the world compared to the U.S. (97.7 kg), France (73.0 kg), and Japan (66.9 kg).

Figure 8 Annul plastic use per capita

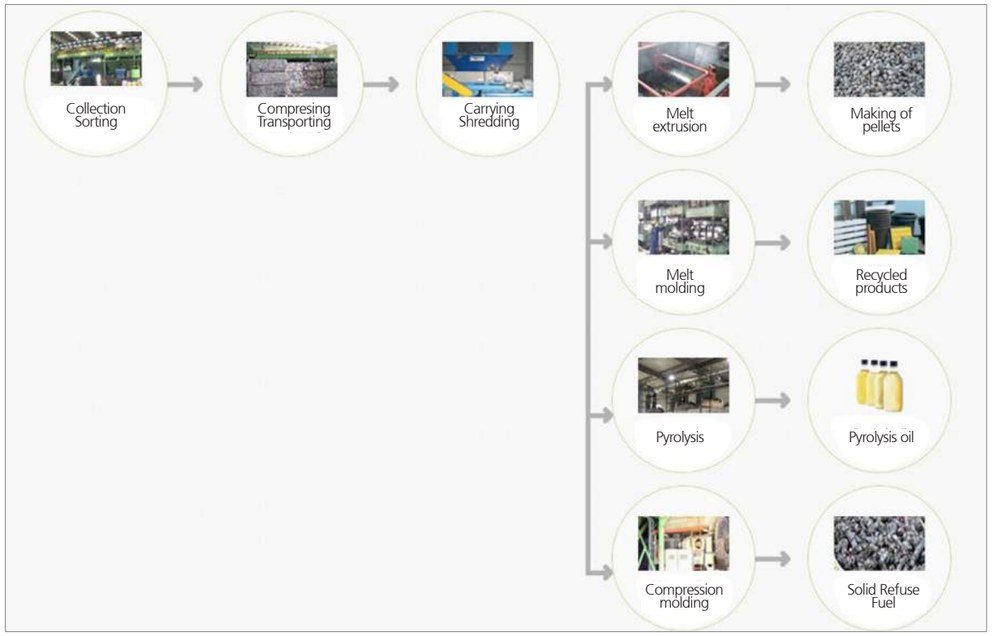


(Source: Korea National Statistical Office, 2016)

For Korea, the amount of such waste plastic has increased by 510,000 tons/year to about 6.9 million tons/year as of 2015, increasing rapidly by about 6.4 percent annually from 2010 to 2015. The ratio of waste plastic components was found to be the largest with 57.3 percent of industrial waste, followed by 33.8 percent of municipal solid waste and 8.7 percent of construction and demolition waste. The rate of recycling and throughput of waste plastic increased about 2.7% and 9.3% respectively, annually from 2011 to 2015, while incineration and landfill were on the decline. As of 2015, approximately 60% of total waste plastic is recycled, 35% is incinerated, and 5% is buried, meaning large amounts of waste plastics are still wasted and not recycled. [41]

Figure 9 Recycling Process of Single Material Plastic Containers

Figure 10 Recycling Process of Composite Material Packaging



Organized recycling of waste plastics in Korea began in January 1983, and is in full force after Korean government implemented the Extended Producer Responsibility (EPR) action in January 2003 to supplement the Waste Deposit Refund system that has been operating since 1992 according to the Principal of Producer Responsibility. The recycling was originally limited to food, detergents, and medicines. In 2004, however, plastic film products were added to the list, making it possible to utilize thin films such as instant noodle bags or bread bags as alternative energy or to convert them into products such as flowerpot or building materials.[39]

As of 2016, the number of registered plastic products (synthetic high molecular compounds) recycling companies in Korea increased to 3,763, implying the condition for recycling has improved. Nevertheless, the number of packaging and parcel shipments, usage of disposable products and overpacking have increased rapidly due to the increase of single households. This led to a sharp increase of plastic waste such as vinyl waste and plastic bottle. These plastic waste include foreign substances and additives, causing problems in using them as circular resources, which in turn makes it crucial to develop intensive management.

In particular, the price of oil, which is used as raw materials for plastics, primary plastic price variability, increased waste plastic transportation/collection costs, illegal trading of waste plastics, use of various plastic materials, and hazardous additives are all obstacles in recycling plastics.[42]

The problems with recycling in Korea's plastic production/consumption/collection/reuse stage are as following:[34, 43]

- (Manufacturing and Production) It is difficult to recycle due to the increased production of colorful labels, labels made hard to remove from plastic, and plastic bottles made of different materials
- (Distribution and Consumption) Increased number of single person household and online shopping led a sharp rise of consumption of disposable goods and packaging waste, etc.
- (Separate Collection) Separated collection of waste is commonly performed, but there is not enough education or guidance on the exact discharge method, resulting in large amounts of foreign substances being mixed in recycled waste.
- (Collection and Screening) Even though local governments are responsible for the disposal of recycled products in apartments, they are relying on private waste service company (approximately 70%). Moreover, they are not aware of basic conditions such as processing company, and processing quantity.
- (Recycling) The profitability of the recycling industry has been continuing to deteriorate due to rising recycling costs and oil price fluctuations, waste importation has not been properly managed and domestic recycled product demand is limited.[44]

2.2.3 Beyond waste management: Eco-innovation and circular economy

To solve the management issue of recycling waste and waste plastics, the Korean government has announced a long-term plan reducing plastic waste by 50% and increasing the current recycling rate of 34% to 70%, by 2030.

- (Manufacturing and Production) By 2020, all non-recyclable products will be withdrawn from the stage of production, for instance all colored plastic bottles will be replaced by the colorless. To be specific, a ratio of colored plastic bottles will be reduced from 36.5% to 15.5% by next year and to 0% by 2020. Besides of improving the design of product, the liability of manufacture is going to be further expanded and strengthened for recycling of the products and packaging materials being sold.
- (Distribution and Consumption) In order to reduce the use of vinyl and polystyrene during the distribution, excessive packaging management will be tightened, and packaging standards for the parcel and electronic

39. Ministry of Environment, 2018, Guidelines for Separate Collection of Recyclable Resources

42. Wontaek Cho, 2017, Plastic Recycling Trends, 42nd Far East Plastic Industry Conference (EPIC)
43. Financial News, 2018, OECD 'Plastic Production Increased 200 Times during the past 65 Years'.
44. Should Create Recycling Markets (2018.06.09)

products will be newly established. The Korean government also plans to drastically reduce the use of disposable items in the consumption stage, including disposal cups and plastic bag usage reduction to 35% by 2022.

- (Separate Collection) The government will prepare an easy-to-follow disposal manual (guideline) by June this year along with intensive promotion of the proper method of waste separation and discharge. In addition, it provides series of plans as following: to develop a smartphone help-desk application enhancing public awareness, to support expanding waste disposal facilities in underserved areas, and to designate specialists to supervise the facilities and the area.
- (Collection and Screening) In regard of waste collection in public housing area, the contract with private waste service companies and waste processing results shall be reported to the local government. In addition, the private collectors are responsible to notify in advance when the waste collection is stopped. Through such measures, the government expects the public waste management system to be consolidated, increasing the public management ratio of recycling products from 29% to 40%.
- (Recycling) The government plans to gradually put vinyl and plastic items, which were not obliged to be recycled, into a group of items targeted for recycling, increasing the number of items in the group from 43 to 63 by 2020. On the other hand, the government plans to raise 50 billion won worth of funds to stabilize the recycling market so that purchasing and storing of recycling materials can be promptly followed when the price of the materials fall. Furthermore, the Ministry of Environment and the Customs Service are required to expand cooperative inspections to prevent reckless import of waste in such international market fluctuation. Not only that, the pre-audit system should be consolidated upon the import declaration and approval, considering recycling conditions in Korea. Aiming demand increment of recyclable product in Korea, the government readjusts relevant regulations first such as public procurement guidelines, standards, and additional points which will increase the purchase ratio of green products in public sector to 60%. Based on environmental safety investigation for Solid Recovered Fuel (SRF), the main recycling method of waste vinyl, it also plans to increase recycling rate of plastic wastes by expanding new usages such as sewage sludge and incineration facilities. [38, 45]

The examples of Korea's major public and private initiatives to reduce the use of plastic wastes are as following.

Case study 1. Product design in consideration of recycling

On April 28, 2018, a voluntary agreement of material improvement and recycle promotion was signed by 19 companies including Lotte Chilsung. Through that, it can be expected to replace the colored plastic bottles into the colorless, to ban on direct printing of metal caps and the surface of the plastic bottles, and to use same materials on caps, labels, and bodies of the bottle.

Case study 2. Restriction on the usage of disposable items

Large retailers voluntarily signed to an agreement on April 26, 2018 to eliminate doubled-packaging of the event bundles and to tackle the entry of excessively packaged products in the store by 'Packing Inspection Report'. Also, the plastic bags should be replaced to paper bags according to the agreement.

Meanwhile, on May 24, 2018, 21 brands and local businesses (cafes, fast food restaurants, etc.) agreed to promote the use of non-disposable cups instead of disposal ones, simplify the materials of cups, and provide a discount for those who bring personal tumblers.

Case study 3. Expansion of public sector in recycling waste and profitability improvement of private waste service company

On June 24, 2018, the government developed a smartphone app to advertise appropriate methods of separating recyclable wastes and distributed easy-to-understand guidelines for waste separation. In addition, the government currently pushes forward a pilot project of dispatching assistants to 20 apartment complexes across Seoul Metropolitan city.

The guidelines for the recyclable product management in apartments were implemented to secure stable profits for private waste service companies. To be specific, it was required to prepare 'Flexible market price contract' and to report directly to local government about the contract details between apartment buildings and waste service companies as well as throughput of waste. Besides, local government ensures that plastic wastes could be collected and recycled smoothly via establishing a correspondence manual to emergency situations, such as rejection of waste collection by waste service companies.

Case study 4. Governmental encouragement for citizen participation

The Korean government declared the World Environment Day (5th of June) as "no plastic day" and held the opening ceremony of the council for single-use plastics reduction to promote pan-national participation in reducing the use of plastic and other disposables.

45. http://www.fnnews.com/news/201806090838098397

2.2.4 Lessons learned

As of 2017, Korea has consumed 64.1kg of plastic packaging per year, ranking the second in the world after Belgium, and 420 plastic bags (as of 2015) which is 100 times more than the number of Finland. In particular, disposable cups have an annual usage of 26 billion and an average of 70 million per day, and the amount of recycled waste tends to increase each year.[44]

However, the proper treatment of recycled wastes every year is hindered by statistical, regulatory, technological and environmental barriers as followings: inadequate statistics on the generation and treatment of plastic wastes; restrictions due to an illegal trading and disposal of plastic wastes; difficulties in screening due to use of various plastic materials, and limitations on recycling by harmful additives in products.[43]

In the meantime, the Korean government has introduced various recycling systems, including the development of alternative materials, to solve the problem of recycling waste issues. A typical example is the deposit system for disposable cups in 2002, which was the policy ahead of the times. However, such ambitious movements of recycling were pushed out of priority due to the government's policy of strengthening corporate competitiveness – the deposit system for disposable cups was abolished in 2006, waste charge reduced in 2010, and restriction on using single-use items discontinued in 2013. At the same time, the public infrastructure to support recycling policies has been weakened by entrusting most of the governmental and municipal duties, waste collection, and recycling with private sector. Moreover, industries have been reluctant to develop eco-friendly materials in comparison to the increased investments in plastics production.[44, 46, 47]

Along with such a social situation, due to China's stringent environmental regulations to ban import of plastic wastes since January 2018, the volume of plastic wastes which were planned to be exported to China has been saturated in Korea. In addition, as the profitability of recycling companies deteriorated due to the strengthening of regulations on SRF (Solid Recovered Fuel) fueling of residues generated in disposal process of recycling waste, the companies refused collection of plastic and vinyl wastes. Consequently, it caused a so-called social crisis in Korea regarding the treatment of plastic wastes.

The Korean government acknowledged that joint efforts of both the private and public sectors are strongly required as of now. It also introduced "The Comprehensive Measures for Recycled Waste Management" in May 2018, implementing blanket measures for recycling waste including reducing the amount of generated plastic wastes.

Proper disposal of recycled wastes including plastic wastes is a problem not only in Korea but also in many countries around the world. It is, therefore, necessary to strengthen the roles of each government, local government, producer, and consumer. Establishing production and consumption structures that inhibit the generation of plastic wastes, and improving all recycling steps are also expected. Especially, there is a need for the government-led active interventions and supports, such as the establishment of realizable goal for recycling, systematic educational programs, advertisement, and improvement of the recycling management and system. Furthermore, the private sectors (producers and consumers) are expected to voluntarily participate in recycling and use of eco-friendly materials as they increase their own awareness of environmental issues.

The following efforts are needed to address the problem of recycling waste, including plastic wastes: reduction of waste generation; standard designs for recycling; manufacture and production of alternative materials for plastics; distribution and consumption that minimize waste generation by avoiding use of disposable items and excessive packaging; separation and discharge of garbage in a proper way for not containing impurities; planned waste collection and screening under the leadership of public authorities; and the sustainable and economical recycling. Furthermore, it is necessary to utilize public procurement policies to create demands for recycling, to share best practices related to all the stages of waste collection, screening, and reprocessing, and to develop and share market information to create and expand new markets.[43]

However, it seems that more cautious approach is required in development of alternative products for plastics. There are growing concerns that the replacement of paper straws with plastic straws will inevitably lead to consumption and wastage of other natural resources including natural woods. Recognizing that development of plastic substitute material is important, policy support to reduce the consumption of plastics and to increase the recycling rate of plastic wastes should be preceded at first. To do so, on the other hand, there may be social burdens and inconveniences as even good institutional policies require public participation, and citizens' consciousness and consumption behavior must be changed accordingly. Also, it is essential to create a social atmosphere that takes the recycling cost for granted. Indeed, in order to solve the recycling issues, all members of Korean society should overcome such social burdens and inconveniences decreasing use of plastic wastes.

46. Shinhan Investment Corp., 2018, China's Headwind; Plastics and Fine Dust, Shinhan Idea, 3393
47. Korea Society of Waste Management, 2018, Parliamentary Debate on Recycling Waste Management Comprehensive Countermeasures

2.3 India

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With a population of more than 1.2 billion, India is the second most populated country in the world. Over the last two decades, India has witnessed unprecedented economic growth and development. This has alleviated poverty, increased migration of people to cities and towns for exploring economic opportunities, and demand for various goods and services. The implications are increased pressure on resources and the environment. Growing population, rising aspirations of growing middle class, increased per-capita income will further drive demand for resources for the economy in the future. India is likely to be the largest populated country in the world in a decade, with share of youth expected to reach as high as 35 percent by 2020 from 20percent estimated in 2011. Between 2005 and 2012, the middle income class population increased from 300 million to 600 million and by 2025, it may increase by more than 1.5 times. By 2030, urbanization is expected to rise to 50 percent from its current level of 34 percent (Census of India, 2011).

2.3.1 Waste generation, collection and management system

2.3.1.1 Overview of current waste management

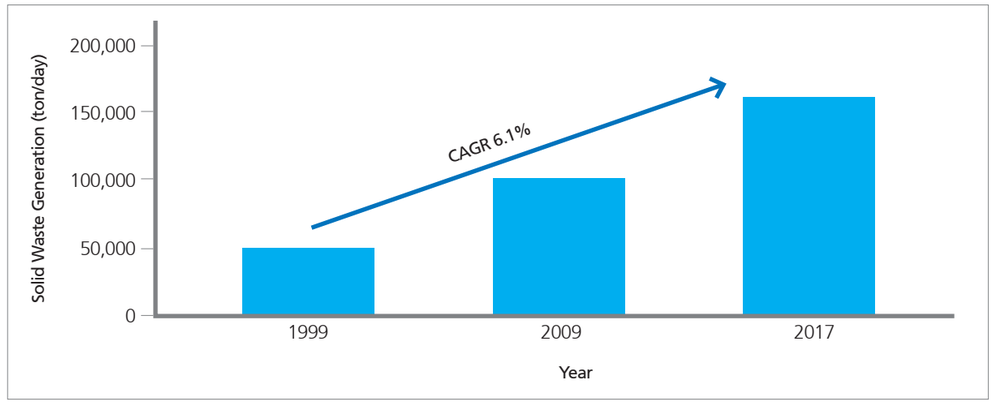
The change in socio-economic profile in recent times had significant impact on resource consumption and waste generation. Increased demand for resources driven by economic growth and urbanization has resulted in growing volume of waste generated in India and municipal wastes are a major category. Urban local bodies like municipal corporations, city development authorities, and relevant parastatal agencies, which are key agencies level responsible for waste management at city levels, are facing challenges with regard to collection, transportation and scientific disposal of municipal wastes.

India generates more than 50 million tons of waste per annum. Projected estimates by the erstwhile planning commission of the government of India reveal that the annual volume of waste generation is projected to reach 165 million tons that by 2031. This represents an annual increase of more than 6 percent. Further, by 2050, the volume of waste generation per annum can reach as high as 436 million tons.

Availability of reliable data on the volume and composition of waste generation is a major concern. Estimates that are available in literature and public reports are largely based on the pilot level assessment undertaken by selected agencies at major cities and towns.[48]

Estimates on generation of solid waste in India are available only after the 1990s. Further, whatever data which is officially available are for very limited years and hence a detailed time series analysis is difficult. Nevertheless, a quick analysis of the quantum of waste generated over the last two decades reveal that waste generation has increased significantly. In 1999, total waste generation was estimated at 52125 tons/day which increased to 96726 tons/day in 2009. In 2016 the volume of waste generation has increased further to 142870 tons/day. This represents a 6.11 percent compound annual growth in waste generation in India as presented in Figure 1.

Figure 11 Change in volume of waste generation in India



(Source: CPCB, 2017)

Nearly 70 percent of the waste is generated in nearly 8000 towns and cities where more than 300 million resides. As per the estimates of the Central Pollution Control Board (2017), around 47 million tonnes (MT) of the waste is collected, 11 MT is treated and 13 MT is dumped in landfill sites. In 2017, India is reported to have 108 landfills and 639 compost plants distributed across different states in India. Statewise waste generation, collection and treatment is presented in Table 3 Statewise generation, collection and treatment of solid waste.

48. http://journals.sagepub.com/doi/pdf/10.1177/0956247815581747

Table 3 Statewise generation, collection and treatment of solid waste

States/UTs	Volume of waste generated (tonnes/day)	Volume of waste collected (tonnes/day)	Volume of waste treated (tonnes/day)	Volume of waste landfilled (tonnes/day)	Nos. of Com-post Plant	Nos. of Land-fill
Andhra Pradesh	6440	6331	500	143	18	2
Arunachal Pradesh	13	11	0	0	0	1
Assam	650	350	0	0	0	0
Bihar	1670	0	0	0	0	0
Chandigarh	370	360	250	230	0	1
Chhattisgarh	1896	1704	168	-	3	0
Daman and Diu, Dadra	85	85	0	0	0	0
Delhi	8370	8300	3240	5060	2	4
Goa	450	400	182	-	8	7
Gujarat	10480	10480	2565	7730	93	11
Haryana	3103	3103	188	-	10	3
Himachal Pradesh	276	207	125	150	9	0
Jammu and Kashmir	1792	1322	320	375	3	1
Jharkhand	3570	3570	65	0	1	3
Karnataka	8697	7288	3000	-	155	13
Kerala	1339	655	390	0	33	0
Lakshadweep	21	-	-	-	0	0
Madhya Pradesh	6678	4351	-	-	10	5
Maharashtra	21867	21867	6993	14894	74	8
Manipur	176	125	-	-	1	1
Meghalaya	208	175	55	122	2	1
Mizoram	552	276	0	0	0	0
Nagaland	344	193	-	-	1	1
Odisha	2575	2284	30	-	1	0
Punjab	4456	4435	3.72	3214	3	8
Rajasthan	5037	2491	490	-	-	1
Sikkim	49	49	0.3	0	1	1
Tamil Nadu	14500	14234	1607	-	182	3
Tripura	415	368	250.4	164	2	1
Telengana	6628	6225	3175	3050	3	1
Uttar Pradesh	19180	19180	5197	-	-	16
Uttrakhand	918	918	0	0	0	0
West Bengal	9500	8075	851	515	23	15
India	142870	129967	29650.42	35647	639	108

Source: Central Pollution Control Board (2017)

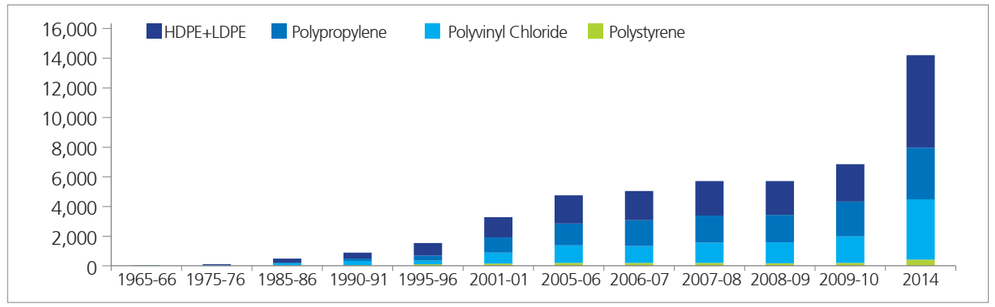
Out of 142 thousand tonnes of solid waste that is generated per day, 129 thousand tonnes is collected and the 29 thousand tonnes is treated reflecting that the share of waste treatment is very low. Further, from the table it clearly reflects that India has not been able to augment landfills sites and waste processing capacities in different states in India in line with the volume of the solid waste generated. This largely attributes to scarcity of financial resources of the municipal corporations to develop landfill sites that can scientifically dispose solid wastes and as well as getting public approval on land procurement for landfill development and the growing problem of 'not at my backyard' further complicating the issue of the acquisition of land.

2.3.1.2 Plastic production and plastic waste management issues

Plastics sector in India has experienced phenomenal growth in recent decades that is largely driven by the packaging and consumer goods industry. The growing importance of the plastic in our daily life styles is evident from the growing share of the plastic wastes being generated in various cities and towns in India. Between 2000 and 2010, the demand for plastic raw material has more than doubled reaching 6.8 million tons in 2010 as compared 3.3 million tons in 2000. This is largely attributed to growing urbanization; proliferation of retail chains, growth of plastics based packaging from grocery to food & vegetable products to cosmetics & consumer items. It is estimated that there are around 55,000 plastic processing units in India employing more than 3.5 million people – directly and indirectly.

India is poised to emerge as one of world's leading manufacturer of different types of plastics. According to data provided by Platini (2014) the polymer manufacturing capacities (including PS, LDPE, PVC, LLDPE, PET, HDPE and PP) grew from 10.4 million tonnes in Financial Year (FY) 2013-14 to 15.2 million tonnes in FY 2017-18. Within the same timeframe, strongest growth has occurred for LDPE (295%), LLDPE (202%), PET (185%) and HDPE (170%). Around 43 percent of plastics that is manufactured are used in the packaging industry which is largely of single use plastics.[49] A detailed breakdown growth in demand of various plastics is presented in Figure 12 Increase in demand for various types of polymers (units in thousand tonne) below.

Figure 12 Increase in demand for various types of polymers (units in thousand tonne)

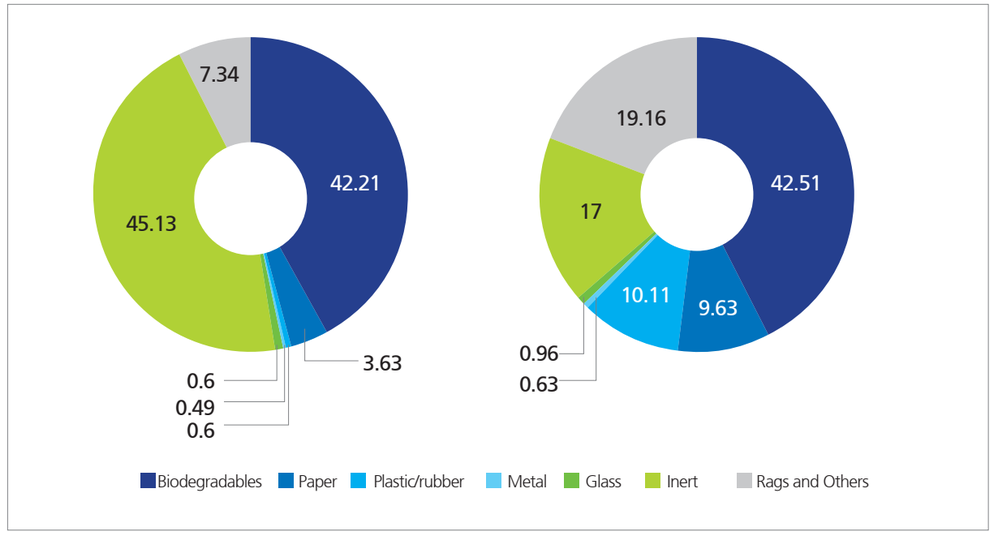


(Source: FICCI, 2014)

49. http://www.teriin.org/sites/default/files/files/factsheet.pdf

Change in consumer behaviour and consumption pattern have also resulted in changing composition of municipal solid waste with time as presented in Figure 2. In recent years plastic consumption, largely driven by consumer goods packaging industry, has experienced unprecedented growth. India generates around 25,940 tonnes of plastic waste a day. Out of this around 94 percent contains thermoplastic, such as PET (polyethylene terephthalate) and PVC (polyvinyl chloride), which is recyclable. The remaining belongs to thermoset and other categories, which are non-recyclable.

Figure 13 Change in composition of municipal solid waste in India 1995 (left) and 2011 (right)



(Source: Joshi, 2016[50])

Share of plastics and rubber in total waste generation has increased from 0.49 percent to more than 10 percent during the same period.

In India, the responsibility of transferring waste (including plastic) to the common collection point resides with the households. The municipality/parastatal agencies are responsible for collection of wastes from collection points to the disposal sites. The household waste generated are generally placed in small containers and then transferred to community bins commonly known as Dhalaos. However, larger cities have collection of wastes organized by municipalities in association with the local NGOs or Resident Welfare Associations from houses, shops and institutions. Some of these cities include Kanpur, Ahmedabad, Hyderabad, Chennai, Surat, Nashik, Panjim, Vijayawada, Vishakapattnam, Nagpur and Pondicherry where this system is in place. This method will be promoted as an improvement to the existing system in various cities and towns. Sometimes informal recyclers often visit these places where residents give back the waste items that fetch money. This mostly includes, glass items, papers and metals.

The informal level segregation takes place at these collection points. The items that are mostly collected by the informal recyclers include recyclable plastics, glass, and metals. The municipality trucks transport the remaining items to landfills. Major cities have the mechanism of weighing loaded trucks at weigh bridges to estimate the wastes that are disposed at landfill sites. Transportation of waste from collection point to disposal sites is undertaken using different types of vehicles. Normally smaller vehicles are used to transfer wastes from community level collection points to secondary collection points. This depends on the volume and the distances to be covered. However, bigger vehicles/tipper trucks are used to transport the wastes from secondary collection points to the landfill Transfer stations are centralized facilities where waste is unloaded from smaller collection vehicles and re-loaded into larger vehicles.

Most of the waste that is collected from cities and towns are dumped at waste disposal sites which are not scientifically designed. There is no processing of waste being done in most of the cities. The disposal is carried out following the method of crude dumping where the waste is neither spread nor covered. There are also growing issues of the waste being recklessly burnt in open dump yards situated along highways. CPCB has estimated the collection efficiency as 80.28 percent in 2014, out of which only 28.4 percent was treated. Remaining quantities were disposed in landfills or open dumps. Land filling of mixed waste like non-biodegradable, inert waste and other waste that are not suitable either for recycling or for biological processing is dumped together with recyclable material. Waste processing facilities are not available with proper capacity except few cities[51].

Poor plastic waste management in India has led to many problems in India. Plastics, being non-biodegradable, may cause permanent damage to ecology. Plastics severely contaminate water bodies and land since they attract and sustain other pollutants. Plastics littering not only leads to clogging of drain but as affect natural water systems like streams, rivers, lakes, and artificial channels. Further choking of drains lead to breeding of harmful disease causing pathogens caused from water stagnancy.

There is a growing problem of plastic pollution in seas. It has been found that, 0.60 million tonnes of plastic waste (although an old estimate), end up reaching seas per annum. Seas along major coastal cities like Mumbai, Kerala, and the Andaman and Nicobar Islands are amongst the worst polluted. Plastic wastes (including micro-plastics) can enter into the marine environment. This is one of the leading environmental impacts on marine species including whals, turtles, fish, coral reefs, and other marine habitats. Key risks arise from plastic debris ingestion and entanglement in marine life, leading to injuries and death of these animals. There are almost no proper assessments of the plastic waste on marine environment.

Used plastic items that fetch maximum price are the discarded PET bottles that are bought back by scrap dealers for at USD 0.2/kg. This makes their recycling rate of PET bottles at 90 percent. They are mostly washed, shredded

50. http://home.iitk.ac.in/~anubha/H13.pdf

51. http://www.teriin.org/sites/default/files/files/factsheet.pdf

and sold to artificial yarn makers as 'flakes', which are further used for making apparel and upholstery items. India currently has more than 40 large manufacturers who use recycled PET as raw material. The yarn manufacturers get these flakes at USD 1 – 1.25 Rs./kg. The recycling business for PET is estimated to be worth USD 0.5 – 0.6 bn per annum[52].

2.3.1.3 Policy and legislations on waste management along product life cycle stages

In India, waste management regulations and policies are based on the key environmental sustainability principles like "achieving sustainable development", "precaution principle" and "polluter pays". The Ministry of Environment, Forest and Climate Change (MoEFCC) serves as the nodal agency of the central government for the policy formulation, planning, awareness building, coordination with relevant ministries and state departments (including autonomous bodies) for overseeing and implementation of environmental policies and programs in India. The increase in waste generation as a by-product of economic development has led to various subordinate legislations for regulating the manner of disposal and dealing with generated waste are made under the umbrella law of Environment Protection Act, 1986 (EPA). There are a number of policies on environmental protection in general and waste management in particular in India, including strategies, master-plans, programs, action plans, laws and by-laws and some of the notable ones are presented in box 1. These policies can be assessed typically from the product life cycle stages point of view. The use of various instruments for addressing waste management are already built into most of these policies.

BOX 3. Country policy instruments for waste management sector - India

Types of Policy Instruments		Category	Title of Policy (Year)
National Strategy Paper on Resource Efficiency	Resource Efficiency and Sustainable Consumption and production (EU-NITI Aayog)	Critical materials/ resources	• Strategy for Promoting Processing of Construction and Demolition (C&D) Wastes and Utilization of Recycled Products (2018) • National Steel Recycling Policy (draft stage, 2018)
Policy/Programs (that includes use of various economic and financial instruments to create incentives for management of wastes	Eco-innovation	Promoting SCP in Mining Sector	• National Mineral Policy (2008) • Sustainable Development Framework for Mining Sector in India (2011) • Minerals and Mining Development Regulatory Act (MMDR) (2016)
		SCP through Product design	• Science, Technology and Innovation Policy (2013) • Bureau of Indian Standards Act (2016)
Legislations and/ or policies or rules arising from relevant legislations/Acts (Policies use combination of command and control approach as well as use of various economic and financial instruments to create incentives for management of wastes at various life cycle stages)	Eco-innovation	SCP at manufacturing stage	• National Manufacturing Policy (2011) • National Policy on Electronics (2012) • National Manufacturing Competitiveness Program (2014) • Financial Support to MSMEs in Zero Effect and Zero Defect Certification Scheme (2017)
		SCP during Consumption phase	• Eco-Labelling scheme (Eco mark) 1991 • Biofuel Programme including production of biobased products (2009) • Fly Ash Utilization Policy (1999)
		SCP during disposal phase	• Batteries (Management and Handling) Amendment Rules (2010) • Solid Waste Management Rules (2016) • Construction and Demolition Waste Management Rules (2016) • E-Waste (Management) Rules (2016) • Plastic Waste Management Rules (2018)
	International	Multilateral	• Hazardous and Other Wastes (Management and Transboundary Movement) Rules (2016)

In the context of promoting solid waste management and in particular plastic waste management in India, it is important to describe in detail some of the most policies that has been mentioned in the above box at the post consumption stage and has maximum implication so far waste management in India is concerned. These include (i) Solid Waste Management Rules (2016), (ii) E-Waste (Management) Rules (2016) and Plastic Waste Management Rules (2018).

52. Swachh Bharat Mission, 2017.

2.3.1.3.a Solid waste Management Rules (2016)

The MoEFCC, in 2016, issued the new Solid Waste Management Rules (SWM), 2016. This replaced the earlier Municipal Solid Wastes (Management and Handling) Rules, 2000, which came into existence 16 years ago.

The Solid Waste Management Rules, 2016, identifies the role of the material recovery as a key strategy towards effective waste management in India. It calls for establishment of material recovery facilities where non-compostable solid waste can be stored by authorized agencies thus facilitate segregation, sorting, and recovery of resources by the formal and informal sector.

The new rules, among other things, has mandated source segregation of waste so that it can help in channelizing conversion of waste to wealth by through cost effective recovery, reuse and recycle. Generators of waste are supposed to segregate waste into three major categories i.e. biodegradables, dry materials like (i.e. paper, plastic, metal, wood, etc.) and other materials that include sanitary items, mosquito repellants, cleaning agents, cosmetic items, etc before they are disposed. Institutional generators are responsible for segregation of their waste and manage in partnership with local bodies. Further waste generated during large gathering need to be segregated at source and handed over to waste collector or agency, as specified by the local authority.

Institutions that generate a lot of biodegradable waste, particularly hotels and restaurants, are also required to segregate biodegradable waste and set up a system of collection to ensure that such food waste is utilised for composting / biomethanation. As per the rules, retailers and/or brand owners who are selling their products packaged form and are not non□biodegradable, need to introduce mechanism that would help them collect back the packaging waste. The new rules have also given power to local bodies across India to fix user charges. Authorities need to levy user fees for collection, disposal and processing from bulk generators.

The rules govern that the waste generators need to pay user charges to the agencies managing wastes else spot fine would be imposed for littering and non-segregation. Since there is a huge informal sector associated with the waste management in India, there is need to integrate rag pickers, waste pickers and kabadiwalas with the formal sector by the state government. In this context the role of the zero tolerance for violation has been introduced.

In order to promote natural composting the rule suggests the processing of bio-degradable waste within institutional premises as mentioned above. The developers of Special Economic Zone, industrial parks/estates need to earmark at least 5 percent of the total area or minimum 5 plots/ sheds for such treatment facilities.

From the industrial ecology point of view using resources that is already in the economy uses much less energy than processing virgin materials, by as much as 95 percent in case of aluminium or nearly 80 percent in case of plastics. Hence recycling is an essential part of responsible materials management and helps to shift from a 'linear' to 'circular' economy. It helps in generating more jobs, retrieving valuable products as sources of revenue, reduces waste transportation costs and emissions along with landfill expenses. Waste processing facilities will have to be set up by all local bodies having a population of 1 million or more within two years. For census towns with a population below 1 million or for all local bodies having a population of 0.5 million or more, common, or stand-alone sanitary landfills will have to be set up in three years time. Also, common, or regional sanitary landfills to be set up by all local bodies and census towns with a population under 0.5 million will have to be completed in three years.

2.3.1.3.b Plastic Waste Management Rules, 2016 and amendment notification

With the revision of the Plastic Waste Management Rules in 2016, the Government of India brought around ambitious initiatives deal with the growing problem of tackle the issue of plastic waste. It aims at increasing minimum thickness of plastic carry bags from to 50 microns and stipulate of 50 micron for plastic sheets too facilitate collection and recycle of plastic waste. Given that plastic waste is emerging as a growing environmental problem in rural areas, it aims to expand the jurisdiction of applicability of the rules from urban locations managed by municipalities to rural areas managed by 'Gram Panchayat' or village administration. It also promotes in bringing responsibilities of producers and generators, both in plastic waste management system and to introduce collect back system of plastic waste by the producers/brand owners, as per extended producers responsibility. The rules also talk of use of economic instruments in the form of collection of plastic waste management fee through pre-registration of the producers, importers of plastic carry bags/multilayered packaging and vendors selling the same for establishing the waste management system.

The rules mandates that institutional generators of plastic waste, must segregate and store the waste generated as per the Solid Waste Management Rules, and handover segregated wastes to authorized waste processing or disposal facilities, either on its own or through the authorized waste collection agency.

The aspect of the Extended Producers Responsibility (EPR) was introduced that would help in assisting municipalities dealing with the plastic waste issue. As a part of the EPR, bulk producers of consumers need to provide management of plastic carry bags/multilayered packaging as well fees in order to strengthen the financial status of local authorities and, therefore, the plastic waste management systems. This was further revised in 2018, that included three major changes The rules notify that under Section 9(3), the term 'non-recyclable multilayered has been substituted by 'multilayered plastic which is non-recyclable or non-energy recoverable or with no alternate use'. The rule required vendors, who made plastic bags available, to register with the respective urban local body and pay a fee of nearly INR 700 annually. The new rules also attempt to establish a centralized registration system by mandating brand owners and producers operating in more than two states to register with the CPCB.

2.3.1.3.c Guidelines for Disposal of Thermoset Plastics

As per Rule 5(c) of Plastic Waste Management Rules, 2016, the MoEFCC introduced Guidelines for Disposal of Thermoset Plastic Waste including Sheet moulding compound (SMC)/Fiber Reinforced Plastic (FRP). Key recommendations include :

- The most preferred option is minimization of use of SMC/FRP/Polycarbonate polymer products & promoting use of alternate material, which could be easily recyclable / reusable / degradable.
- The preferred option for disposal of thermoset plastic -SMC/FRP wastes is therefore co-processing in cement plants due to its high temperature (upto2000°C and long residence time). The producers of thermoset plastic, major user like industries, Electricity authority etc, in consultation with local authority, cement plants shall working out modalities for co-processing of such waste in cement kiln.
- The producers of SMC/FRP, major user like industries, Electricity authority etc shall assist the cement plants for establishment of required facilities for utilization of SMC/FRP like shredding, feeding system, safety measures as applicable for coincineration, online emission monitoring for PM, SO2 and NOx, and stack monitoring of heavy metals, dioxin and furans based on Extended Producers Responsibility.
- The State Pollution Control Board / Pollution Control Committee may consider stipulating suitable condition in consent order of the such Cement Plants on the co-processing of SMC/FRP/Polycarbonate polymer products.
- SPCB/PCC may consider incentives such as reduction of water cess / consent fee etc. for such cement plants.

2.3.1.3.d Links to Indian Standards

India has also introduced number of standards that would support plastic waste management policies. Over the last two decades, ISO standards have been adapted to the Indian context and issued as Indian Standards (IS) through the Indian Bureau of Standards (BIS). BIS is the national standardisation body of India established under the BIS Act 1986 and thus responsible for the harmonious development of standardisation, marking and quality certification of goods. With regards to resource efficiency and circular economy, the PWMR 2016 make reference to IS 14534:1998 titled as the Guidelines for Recycling of Plastics. It classifies recycling efforts, differentiates types of plastic and gives general instruction concerning recycling practises (Bureau of Indian Standards 1998). Relevant Standards that are related to resource efficiency and circular economy are presented in the figure.

2.3.2 Beyond waste management: Eco-innovation and circular economy

While there has been growing number of regulations to deal with the problem of solid waste and in particular plastic waste in India, a long term sustainable and economically viable models can develop only where there are innovative processes and products that have large consumer acceptance and greater financing appeal. Interestingly, a strong public private partnership is emerging where technologies and processes that are being developed by the public sector laboratories and research and development institutes are being used by private sectors to create products that have significant consumer appeal. Public campaigns have also increased awareness among consumers who have become responsible in using plastic products (e.g. poly bags) that comply new rules and regulations.

- Manufacturing recycled materials from plastic waste

Globally there is a growing demand for recycled products and India has huge potential to tap the market of recycled plastic products thereby reducing the impact on the environment. India is a huge importer of crude oil and moving to recycled plastics can reduce her high oil import bill. Every tonne of plastic waste recycled results in savings of near 4 barrels of petroleum. Sectors that can use recycled plastics can span from construction, to consumer durables, and others. Council for Scientific and Industrial Research (CSIR) institute, the National Chemical Laboratory, have developed fabric from the recycling of PET bottles. This has already been commercialized and fabric is being manufactured for making of different garments by many companies.

Further blending recycled plastics with fillers and additives will enhance the strength and usability leading to value-added products. Fire retardant composite building materials can be manufactured using recycled plastics with fly ash that has with a wide scope of applications. Segregation of individual plastics at source is difficult, hence recycling of mingled plastics and inclusion of non-halogenated fire-retardant additives will to an extent mitigate the problem of segregation while leading to value-added products with adequate strength and fire safety[53].

- Bio-based products

Markets for bio-based products have a huge potential in India largely due to the abundant availability of resources. A recent market survey by DuPont, reveals that nearly two thirds of the consumers are familiar with bio-based plastics. Further, a study published by Frost & Sullivan reveals that the annual growth rate of the bioplastics market can be very high in the medium term.

Companies are increasing investing in developing bioplastics products in India. For example, J&K Agro Industries Development Corporation Ltd in collaboration with Earthsoul, has launched India's first bioplastics product manufacturing facility with a production capacity of about 960 metric tonnes per year. Other companies, like Truegreen, Biotec Bags Tamil Nadu, Ravi Industries Maharashtra, Ecolife Chennai, have emerged as leaders in bioplastics industry in India. Truegreen manufacturing plant has a capacity to produce around 5,000 tonnes of bioplastics products each year. Start-up companies also making use of seed funding to develop bioplastics in India. Envigreen has started its production in Bengaluru and is capable of producing 1,000 tonnes of bioplastics per

53. http://www.teriin.org/sites/default/files/2018-06/plastic-waste-management_0.pdf

annum. Bio-based products can be developed using different techniques and raw materials. Recycled polymeric materials and blending them with biopolymers has emerged a viable option. Another approach is to develop composites from only biopolymers without the incorporation of any kind of synthetic polymer[54].

- Converting plastic to fuels that can be used for transportation

Pyrolysis is the process of breaking down polymers into smaller molecules by thermal decomposition at high temperatures of 350 degree Centrigrade in the presence of catalysts like aluminium oxides, fly ash, red mud, and calcium hydroxide in an inert atmosphere. Depending upon the process followed, pyrolysis of plastics has an average yield of 45%–50% oil, 35%–40% gases, and 10%–20% tar. A review of UNEP research report[55] suggests that the yield can be improved to upto 80 percent under specific conditions. The product thus produced is similar to conventional diesel. This showcases an effective approach to recycle plastic waste into alternate fuels.

A CSIR institute the Indian Institute of Petroleum based in Dehradun Uttaranchal, has developed a unique process of converting plastic waste, like polyethylene and polypropylene to either gasoline or diesel. The efficiency of the technology developed is very promising and is capable of converting 1 kg of plastic to 750 ml of automotive grade gasoline.

Pune based Rudra Environmental Solutions, Pune, has designed pyrolysis plant where 1 tonne of plastic waste can be converted to 600–650 litres of fuel with almost 60% conversion rate. M K Aromatics Ltd, has set-up two plants in Goa to convert plastic waste to fuel. Hydroxy systems Pvt. Ltd. Hyderabad, has adopted a different technique in the production of fuel oil from plastic waste. It has been claimed that the process is safe, controllable, and pollution-free and also holds the approval of the State Pollution Control Board. The facility has the capacity to convert around 13–15 tonnes of plastic waste per month into approximately 500 litres of fuel. Hence, in order to successfully establish the business model to convert plastic waste to fuel for both industrial and domestic use, it is crucial to develop proper infrastructure and also to create better customer awareness[56].

2.3.3. Lessons learned

India's sustained economic growth coupled with rising aspiration and growing population has added to growth of solid waste generation in India recent decades. Plastics, which has emerged as a cheap and preferred packaging materials among producers, has also found significant interest among consumers particularly when it comes to their ease in carrying. With growing volume of solid waste, plastic is contributing to nearly 8 percent of the waste being generated in India. The situation, till recent years, was that the waste management had to heavily rely on the inadequate infrastructure of local agencies/ULBs, the huge informal sector, and crude and unrestricted dumping. There were issues related to appropriate public participation and support waste management, and lack of responsibility towards waste in the community. However, public campaigns through numerous channels have been able to create some awareness among stakeholders. It has also motivated thinking at the policy level and one of the immediate outcomes has been the amendment of the waste management rules as well as the plastic management rules. Issues with regard to availability of data on volume of waste and composition, appropriate segregation, treatment of recycled wastes still exist. Uncontrolled waste littering in major urban centres are a common example, although, with the introduction of the new rules, major urban local bodies of major cities have been deploying increase human and financial resources to prevent environment degradation and clogging of the drains and water bodies.

One of the critical aspects of the waste management is segregation at source. This will ensure in much more efficient value extraction and recycling. Further informal sectors can be engaged by aggregators, and processors to collect segregated at source thereby creating volume. However, a long term waste management require planning and financing for the urban local bodies. Waste generation need to tax need to regressive. While it may be difficult to implement, they can be designed appropriately depending the localities. Such fees/taxes need to be revised at periodic intervals to ensure that it meets the cost of the waste management.

The roles and responsibilities for delivering sustainable systems need to be defined based on an effective and implementable monitoring and evaluation framework to monitor progress. Such information should be publicly available. Sharing of experiences and good practices is critical and help to learn a lot and make necessary course correction.

Finally technical solutions that are being developed for waste management need to find right takers. In case of public funded R&D programs where such technologies are designed and developed, should also have targets not only in terms of their demonstration of technologies with different stakeholders/users, but also ensuring a model that will help replication/commercialization of technologies in the short to medium term. A the same time efforts are needed to address the problem of increasing recycling capacities of waste, including plastic wastes: implementing design standards for recycling; promoting use of alternative materials for plastics and providing necessary support as and wherever required for possible scale up; distribution and consumption that minimize waste generation by avoiding use of disposable items and excessive packaging; separation and discharge of garbage in a proper way for not containing impurities; planned waste collection and screening under the leadership of public authorities; and the sustainable and economical recycling. Furthermore, making use of public procurement policies can go a long way in addressing the issue of scale of sustainable products and as well create scale for financially viable material recycling.

54. IBID
55. United Nations Environmental Program. Converting Waste Plastic into a Resource. 2009
56. http://www.teriin.org/sites/default/files/2018-06/plastic-waste-management_0.pdf

2.4 Viet Nam

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Viet Nam is a low-middle income country with a population of around 93.7 million people in 2017[57] and average economic growth of 6.08% of GDP in the period 2011-2017. In the field of waste management and plastic production and consumption, the country is facing several challenges including:

Waste generation, including plastic waste, is increasing rapidly: The municipal solid waste (MSW) generation increased by 12% per year and reached 38,000 ton/day in 2015 (MONRE, 2016). Plastics production increased from around 1.2 million tons in 2005 to 5-6 million tons in 2015 (Truong T.X., 2016). There is nearly a 10-fold increase of imported plastic waste in 2018 after China's ban on scrap import at the end of 2017.

The awareness on sustainable consumption in general plastics in particular, is still low. Growth of middle-income class leads to higher consumption, however, sustainability in lifestyle has not been practiced widely in communities; the usage of plastic products such as nylon bags is still very popular.

Shortage of financial investment for waste management infrastructure: Being a low-middle income country, financial investment for waste management in Viet Nam is still very low and does not meet the demand. The solid waste management charge, about 21,000 VND (~0.9 USD) per household per month in urban area in 2015, could cover less than 60% of the total waste management cost and in some municipalities, only 20-30% the cost.[58]

Plastic waste is mixed, waste treatment technologies are still obsolete and cause environmental pollution: Nylon waste is still mixed and treated with general waste. Waste recycling is carried out mainly by the informal sector with backward technologies. 70% of MSW is landfilled while composting, incineration, and waste-to-energy are not popular and still face many problems in application.

Lack of coordination/cooperation among management agencies and a systematic database on waste management in general and plastic waste in particular: There is a lack of efficient coordination/cooperation in waste management among MONRE and related line ministries such as MOC, MARD, MOIT and MOH. It is lacking a time-series and consistent database on waste management in general and plastic waste in particular.

57. General Statistic Office (GSO), Socio-economic development in 2017, 2018; http://gso.gov.vn/default.aspx?tabid=621&ItemID=18668
58. Tien N.H., T. A. Tuan, D.A.Thu, N. K. Long, T. K. Anh, 2016, Overview of household solid waste management in Vietnam.

2.4.1 Waste collection and management system

2.4.1.1 Policy and legislations on waste management

There are a number of documents on environmental protection in general and waste management in particular in Viet Nam, including strategies, master-plans, programs, action plans, laws and by-laws (see Box 4).

With regards to plastic waste, since 2013, the Program on strengthening control on environmental pollution by nilon bags to 2020 has been issued. The Program's targets to 2020 include: (i) Reduce 65% non-degradable nylon bags in supermarkets, shopping mall in comparison with 2010; (ii) Reduce 50% of non-degradable nylon bags in ordinary markets in comparison with 2010 and; (iii) Collect and reuse 50% nylon waste from MSW. Later on, the Revised National Strategy for Integrated Management of Solid Waste Until 2025, and Vision Toward 2050 has also set a target to 2025, all the super-markets will provide bio-degradable nylon bags and production/import/supply of non-degradable nylon bags will be banned after 2026.

BOX 4. Country policy instruments for waste management sector – Viet Nam

Types of Policy Instruments	Category		Title of Policy (Year)
National Plan And Strategy	Sustainability		• Strategy on Sustainable Development of Viet Nam period 2011-2020 (Decision 432/QD-TTg dated 12 April, 2012) • National Strategy for Environment Protection Until 2020 and Vision Toward 2030 (Decision No. 1216/QD-TTg dated 05 Sep 2012). • National Strategy for Green Growth (Decision 1393/QD-TTg, dated September 25, 2012) and National Action Plan for Green Growth 2014-2020 (Decision 403/QD-TTg dated March 20, 2014).
	Eco-Innovation	Waste	• Revised National Strategy for Integrated Management of Solid Waste Until 2025, and Vision Toward 2050 (Decision 419/QD-TTg dated 07 May 2018). • Master plan for the construction of solid waste treatment sites in 3 key economic areas in the North, Centre and South of Viet Nam to 2020 (Decision 1440/QD-TTg dated 06 October 2008). • Master plan for the construction of the solid waste treatment site in the key economic area of Mekong Delta to 2020 (Decision 1873/QD-TTg dated 11 October 2010). • Master-plan for solid waste management in Cau river basin to 2020 (Decision 2211/QD-TTg dated November 14th, 2013). • Master-plan for solid waste management in Nhue-Day river basin to 2020 (Decision 223/QD-TTg dated February 12th, 2015). • Master plan for solid waste management in Dong Nai river basin to 2030 (Decision 07/QD-TTg dated January 6th, 2015).

Programmes And Actions	National	Waste	• Program on strengthening control on environmental pollution by nilon bags to 2020 (Decision 582/QĐ-TTg dated 11/4/2013). • National Action Program on sustainable production and consumption to 2020, vision to 2030 (Decision 76/QĐ-TTg dated 11 January 2016).
	International	Multilateral	• Decision 73/QD-TTg dated 19 December 2014 stipulating the list of allowed scraps for import. • Circular 41/2015/TT-BTNMT dated 09 September 2015 on environmental protection in scraps import.
Legislations		Waste	• Law on Environmental Protection (2014). • Decree 19/2015/NĐ-CP dated 14/02/2015 on guidance to implementation of Law on Environmental Protection. • Decree 59/2007/ND-CP on solid waste management. • Decree 38/2015/ND-CP on waste and scrap management (2015). • Decision 16/2015/QD-TTg on take-back and treatment of discarded products (2015). • Circular 36/2015/TT-BTNMT on management of hazardous waste (2015). • Inter-ministerial circular 58/2015/BYT-BTNMT on medical waste management (2015) • Circular 08/2017/TT-BXD on management of construction waste (2017).
Finance		Waste	• Law on Environmental Tax (2010). • Decree 67/2011/ND-CP on guidance for implementation of the Law on Environmental Tax (and Decree 69/2012/NĐ-CP). • Resolution 1269/2011/UBTVQH12 dated 14 July 2011 on rate of environmental tax. • Solid waste treatment investment program for the period of 2011-2020 (Decision 798/QD-TTg dated 25 May 2011). • Program on mobilization of investment on water supply and drainage and solid waste treatment (Decision 1196/QĐ-TTg dated 23/7/2014) • Regulations on support mechanism to waste-to-energy projects development in Viet Nam (Decision 31/2014/QĐ-TTg dated 05/5/2014)
Information		Waste	• Circular 07/2012/TT-BTNMT stipulating criteria, procedure on certification of environmentally friendly nylon bags. • Decision 253/QD-BTNMT dated 05th March, 2009 on program on eco-labeling.

The Law on Environmental Protection 2014 regulates that individuals/households, business and industries must carry out waste segregation at-source, reuse, recycling or energy-recovery and final disposal by themselves or transfer the waste to capable organization. Decree 38/2015/ND-CP on waste and scrap management provides detailed regulations about hazardous waste management, households/municipal solid waste; non-hazardous industrial waste and other types of wastes. The Decision 73/QD-TTg dated 19 December 2014 stipulating the list of allowed scraps for import, according to which, 07 types of plastic scraps belong to the list. The Circular 07/2012/TT-BTNMT has stipulated criteria and procedure for certification of environmentally friendly nylon bags.

With regards to economic instruments, the Law on Environmental Tax 2010 regulated that nylon bags are among 9 objects of taxation. Decree 67/2011/ND-CP and Decree 69/2012/ND-CP have stipulated in details types of plastic bags to be taxed, which include HDPE, LDPE, LLDPE while Resolution 1269/2011/UBTVQH12 regulated the tax rate of 40,000 VND/kg of nylon bags. Decree 19/2015/NĐ-CP provides incentives and assisstance to waste management activities including recycling.

2.4.1.2 Organizational setting on waste management

At national level, the Ministry of Natural Resources and Environment (MONRE) is responsible for environmental protection in general and waste management in particular. Within MONRE, the focal agency for waste management is Viet Nam Environmental Administration (VEA) and under VEA is the Department of Waste Management (DWM). There are other ministries participated in waste management such as Ministry of Construction (MOC), Ministry of Industry and Trade (MOIT), Ministry of Agriculture and Rural Development (MARD) and Ministry of Health (MOH). According to the LEP 2014, the MONRE takes overall responsibility on waste management and direct management of hazardous waste while the MOC is responsible for development of master-plans, standards for waste treatment facilities and management of C&D waste. The MOIT is responsible for development of environmental industry and industrial waste while the MARD – on agricultural and rural waste and the MOH - solid waste in hospitals and medical establishments (LEP, 2014).

At local/provincial level, under the Provincial People's Committees (PPCs) there are Department of Construction (DOC), Department of Natural Resources and Environment (DONRE) and Urban Environment Company (URENCO). Usually, the DOC is responsible for municipal solid waste (MSW) management of the province, but in some city/province (such as Ho Chi Minh City) this is carried out by the DONRE. Very important entity is the URENCO, which usually carry out waste collection, transport, and treatment. URENCO can also sub-contract other private companies for collection and transportation of waste. In some case, the PPC/DONRE directly contract private or foreign investment company to implement waste management.

2.4.1.3 Performance of waste management

Limited waste prevention and reduction measures. The generation of household waste is around 38,000 ton/day in urban area and totally about 68,000 ton/day nationwide in 2015 (MONRE, 2016). There are not much waste reduction measures applied but only the cleaner production strategy for industries. In 2015, there have been reported that only around 24% of enterprises have applied cleaner production measures (VNCPC, 2016).

At-source waste segregation has not been implemented widely. Although regulated by the LEP 2014, waste separation at-source has not been applied widely but still at some piloting scale in some cities. Recyclables like plastic, paper, metal..., hhowever, are separated by households, sold to informal waste-pickers and then transported

to recycling craft villages. In industry and health sectors, separation at-source is well implemented as around 95% hospitals have implemented this segregation nationwide (MONRE, 2011).

Waste collection has been improved in urban but not in rural area. The collection rate of MSW has increased from 80% in 2008 to 85.5% in 2017 (MOC, 2018) and vary among cities. Smaller cities have lower collection rate, for example, grade IV cities has average collection rate of 65%, while Hanoi has 98% waste collection (MONRE, 2015). In rural areas, however, the waste collection rate has not been improved and is still around 40-55% varying by localities (MOC, 2018).

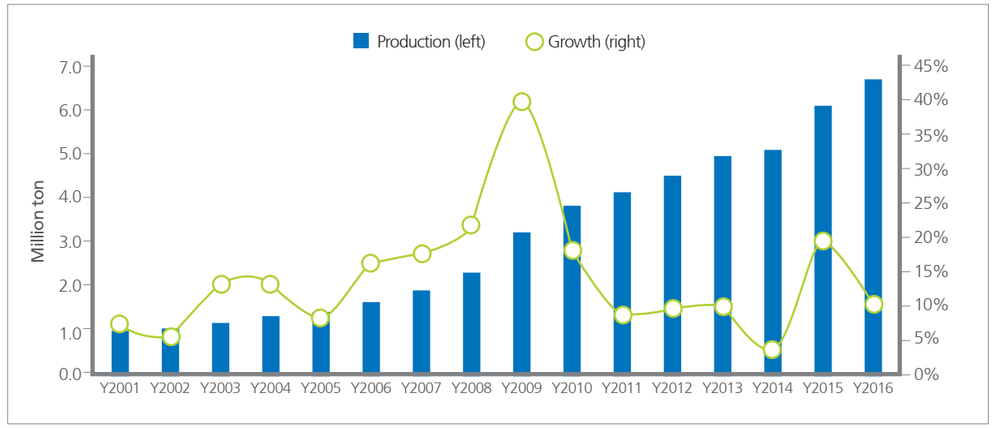
Waste recycling is carried out by informal sector with primitive and polluting technologies. Most of recycling activities are still carried out in craft villages, where recycling facilities are usually small at household scale with backward and high-polluting technologies. Serious pollution has been observed in many paper, metal, plastics and electronic waste recycling villages in Hung Yen, Bac Ninh, and Hai Duong provinces. It is estimated that around 8-12% volume of collected municipal solid wastes have been recycled by this way (MONRE, 2011). Compost production has not been developed due to low demand and low product quality.

Landfilfiling is still the main method of waste disposal, which is applied for around 70% of collected MSW. Remained 30% are processed in waste treatment facilities such as composting, incineration and recycling. Till 2015, there are around 660 landfills (excluding small landfills at commune level) with total area of 4,900ha, of which 203 landfills are sanitary (~31% of landfills). There are around 35 waste treatment facilities with total capacity of 6,500 tons/day, of which 5 facilities are incinerators, 12 composting and 18 are mixed with both incineration and composting (Thang N.T. , 2017). The government has issued support policy on waste-to-energy but until now there is only one facility in Hanoi with capacity of 70 tons of industrial waste per day.

2.4.2. Key Trends of Plastic waste disposal

Plastics production is increasing with most of raw material imported. Viet Nam has experienced remarkable economic growth since 1990. Driven by increasing demand, plastics sector has also recorded high growth of 16-18% per year in 2010-2015. In 2015, 5-6 million tons of plastic products were produced with total value around 9 billion USD, of which 39% packaging; 32% domestic; 14% construction and 9% technical products. The plastic consumption per capita has increased from 3.9 kg in 1990 to 49 kg in 2015. There are about 2.000 enterprises in plastics sector, most of them are SMEs on packaging and household plastic and located in the South (84%). Viet Nam still cannot ensure plastics material inputs of the sector and 80% of raw material (~ 4.4 million tons in 2016) have to be imported from Arab Saudi, Korea, Thailand, China (Truong T. X., 2017; VPA, 2017).

Figure 14 Plastics production and growth in Viet Nam 2001-2016



(Source: Truong T. X., 2017)

Viet Nam has been considered as one of the biggest generating countries of marine plastics waste in the world. There has not been any comprehensive study/assessment on plastics waste generation at national level in Viet Nam. According to a recent international publication, it is estimated that 275 tons of plastics waste were generated in 192 coastal countries worldwide in 2010 with 4.8-12.7 million tons entering the ocean. Viet Nam generated about 5,714 tons of plastic waste per day in 2010, of which 88% are mismanaged (equivalent to 1.83 million tons). Annually, Viet Nam discharged around 0.28-0.73 tons plastic marine debris and ranked 4th in top 5 countries in marine plastic waste generation just after China, Indonesia and the Philippines (Jambeck J.R., 2015). According to a study in Can Tho city, the average plastic waste generation rate was 17.24 g/cap/day, of which plastic packaging and plastic containers dominated with 95.64% of plastic waste. Plastic shopping bags were especially identified as the major component, accounting for 45.72% of total plastic waste (Thanh N.P. et al, 2011). According to VEA/MONRE, every household in Viet Nam usually use 5-7 nylon bags per day or 01 kg nylon bags per month; only Ha Noi and Ho Chi Minh city discharge around 80 million tons plastic waste every day (MONRE, 2017; Le K., 2018).

China's ban on waste imports has led to drastic increase of plastic waste import in Viet Nam and caused environmental issues. In October 2017, under the National Sword program, China has banned imports of 24 categories of solid waste including plastics, textiles and unsorted paper (WRRA, 2018). Due to this ban, the recyclable plastic waste import to Viet Nam has increased drastically from 18,548 tons in 2006 to 90,839 tons in 2017 and 157,880 tons just in the period Jan-May 2018 (MONRE, 2018). Thus this policy threatens Viet Nam with higher flows of plastics waste while recycling capacities in the country are still inadequate and cause pollution.

Plastic waste is mixed together with general waste while plastic recyclables are usually collected and recycled by informal sector. Plastic waste such as discarded nylon bags are mixed together with MSW and mostly disposed in

landfills. There are few waste treatment facilities which recycle nylon waste into diesel oil (DO) such as in Lam Dong and Nghe An provinces (VEA, 2017). Most of plastic recycling is implemented by household facilities in craft villages. In Minh Khai craft village (Hung Yen province), there are 725 households operating plastic recycling with processing capacity of 600-650 tons/day of waste. With primitive and backward technologies, this village has become a hot spot of environmental pollution in the country.

There are efforts to resolve plastic waste issue, however, achievements are still not as desired. Prime Minister approved the Program on control of environmental pollution from usage of nylon bags since 2013 and the MONRE has issued the Circular on criteria, procedure for licensing environmentally friendly nylon bags in 2012. Since then, authorities of many cities/provinces have issued decisions/directives on strengthening management of usage and disposal of non-degradable nylon bags, such as Ho Chi Minh city, Hai Phong, Bac Giang, Bac Ninh, Thanh Hoa, Thai Nguyen, Soc Trang… Many awareness and communication activities have been carried out in provinces. Until end May 2018, there are 43 type of nylon bags of 38 enterprises have been recognized as environmentally-friendly.

However, plastic waste generation is continuously increasing and usage of nylon bags is still very popular in daily markets nationwide. The habit of people on usage of single-use plastics has not been changed. Recycling industry is under-developed with very little improvement in technologies, with high cost but low efficiency, mainly implemented by small enterprises and households scale. Nylon waste is not separated but mixed with household waste and mostly landfilled.

2.4.3. Beyond waste management: Eco-innovation and circular economy

Innovation has been discussed widely at presence in Viet Nam. The country recognized that achievements until now in economic growth are mainly due to cheap labor and natural resources exploitation. From now on, Viet Nam should change the development paradigm in which eco-innovation and circular economy should be promoted (World Bank and MPI, 2015). In the field of plastic waste there are big potentials of eco-innovation and circular economy models to tackle the challenges, specifically: (i) Viet Nam market is growing fast with increasing demand on environmentally-friendly products including plastics; (ii) Government showed strong commitments on sustainable development, promoting eco-innovation, cleaner production, eco-labeling, etc.; (iii) With supports from revolution Industry 4.0, technology development now is faster than ever before, many start-ups and SMEs now are ready to head into eco-innovation; (iv) With open economy policy, Viet Nam has integrated widely in global economy, international cooperation has been promoted thus will enhance technology transfer and research.

In practice, there are number of initiatives carried out by communities and enterprises on reduction of nylon bags and single-use plastics, production of environmentally friendly nylon bags, changing behavior of people, etc.; some case studies are described below.

Nylon bags free island at Cu Lao Cham. Cu Lao Cham is an island located offshore of Quang Nam province in Central Vietnam with 3,000 inhabitants. Since 2009, the local Tan Hiep commune authority has appealed their citizens to follow "no nylon bag" campaign. Nylon bags are not used in the island and people use paper instead to pack products in markets. According to an assessment in 2012, there is a significant reduction of nylon bags usage in the island. This makes the island and the sea clean, brings a high prestige and thus helped to attract tourism with number of tourists increased to 106,000 people in 2012 compared to 32,000/year before 2009 (Park M. S. et al, 2017).

Replacement of nylon bags with bio-degradable bags in retailing systems. Big C super-market system has introduced the bio-degradable bags for customers to replace nylon bags in the whole system in Viet Nam since 9/2013. Their bio-degradable bags have been certified by the MONRE in 11/2012 and would be fully degraded in five years after disposal. Following Big C, other retailer systems such as Metro Cash and Carry (now Mega Market), Lotte Mart, etc. have also joined campaign for phasing out non-degradable nylon bags replaced by bio-degradable. Furthermore, Saigon Coopmart super-markets organized green consumption campaign, appealing people to buy green products and provided environmentally friendly bags to customers (Park M. S. et al, 2017).

Production of bio-degradable bags at An Phat Plastic and Green Environment Company. An Phat is a plastic company which has a very fast development in 15 years since establishment in 2002, with total revenue 156 million USD in 2017. The company manufactures high-quality plastic packaging bags exported to EU, Japan and US market. Nearly 50,000 tons of plastic bags were exported to EU in 2017, accounting for 59.3% of total revenue and production in 2018 is estimated at around 90,000 tons. The company strategy is to focus on production of bio-degradable bags, which have been certified to meet European standards by achieving the "Seeding logo" and "OK HOME COMPOST" certifications (Minh N.N.B, 2018). There were 3,800 tons of bio-degradable bags produced in 2017 and it is expected to be increased up to 10,800 tons in 2020.

2.4.4. Lessons learned

Awareness of people plays an important role in plastic waste reduction. As non-degradable, plastic waste is a big threat for the environment, especially the marine environment and ecosystem. Plastic products are convenient due to their durability and low price, therefore they are not easy to be replaced. Example from Cu Lao Cham island showed that, people should be aware with impacts caused by plastic waste and thus to change their behavior in usage of plastics, to refrain from single-use plastics and shift to more environmentally friendly products. Customers should be encouraged to participate in different campaigns against unsustainable plastics usage.

Policy and legislations on plastics waste management should be developed and successfully enforced. Law, strategy, master-plan, plan and program on plastic waste should be adopted with clear targets and solutions. Regulatory measures such as ban on certain types of plastic products (non-degradable nylon bags and single-use

plastic products) could be considered. Economic instruments such as taxes and fees could also be applied to non-degradable while incentives to be given to environmentally friendly products. In Viet Nam, the tax of 40,000 VND/kg non-degradable nylon bags (~1.8USD/kg) is still very low. The country has set the target to 2025 super-markets to be free of non-degradable nylon bags and from 2026 they should be phased out. To successfully achieve this target, the tax should be high enough to limit production of non-degradable. Enforcement of policies/legislations should be strengthened through inspection and imposing high fines to violations. Coordination/cooperation among ministries/agencies on waste management, plastic production/import, waste management should be enhanced.

Special measures should be taken after China ban on scrap import. Viet Nam and other ASEAN countries shall forecast and take measures to prevent and control the import of plastics scrap. The list of imported scraps should be reviewed and only high efficient plastic scraps might be permitted. Only those companies which have full capacity for recycling will be permitted for import licenses; transportation companies should check the import licenses before loading scraps on ships; strengthening control over import and recycling of plastic scrap.

Eco-innovation in plastic waste management should be promoted. Smart models on collection and separation of plastic waste shall be investigated toward an efficient recycling. Plastic recycling sector should be formalized with modern and state-of-the-art technologies; small facilities at household scale in craft villages should be relocated in industrial parks. Incineration with energy recovery shall be developed in parallel with investigation of other technologies such as pyrolysis.

New materials and bio-degradable bags production should be promoted. New materials should be investigated to replace single-use plastics such as bamboo… Production of environmentally friendly product such as eco- and bio-degradable nylon bags to be expanded and improved in terms of quality and prices. Technical standards and certification system for bio-degradable bags shall be developed and functioned well. Eco-labeling shall be promoted thus to provide widely information to customers. Incentive policies shall be introduced to enhance participation of enterprises and SMEs.

2.5 Indonesia

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	3,416	256 million	14:43:43	0.684 Medium	4.31	4.26	
Flag	GDP per capita	Population	Industry structure (1st:2nd:3rd)	HDI	Sustainable social index	Sustainable env. index	Geographic location

BOX 5. Country policy instruments for waste management sector – Indonesia

Types of Policy Instruments		Category		Title of Policy (Year)
National Plan And Strategy		Sustainability		• The Ministry of Finance launched the Green Planning and Budgeting Strategy for Indonesia's Sustainable Development (GPB) for 2015-2020, which provides a good foundation of fiscal policy for a comprehensive, long-term national green growth strategy (2015)
	Eco-Innovation	Building		-
		Energy	Energy Generation	• Blueprint of National Energy Management (2005) • Presidential Decree no.22/2017 – General National Energy Plan (2017)
			(Renewable) Energy	• Green Energy Policy (2004) • National Master Plan for Energy Conservation (RIKEN) (2005) • National Team for Biofuel Development and Biofuel Roadmap (2006) • National Energy Plan (2014) • Presidential Regulation No. 22 of 2017 concerning the General Plan of National Energy (RUEN) (2017) • Decree No 22 of 2017 National General Energy Plan (2017)
		Manufacturing & Industry		• Government Regulation No. 14 2015 on Master Plan of National Industry Development (RIPIN) 2015-2035. (2015)
		Tourism		• Strategic Plan Sustainable Tourism and Green Jobs for Indonesia Ministry of Tourism and Creative Economy of the Republic of Indonesia (2012) • Master Plan of National Tourism Development 2010-2015 (2010)

Types of Policy Instruments		Category	Title of Policy (Year)
National Plan And Strategy	Eco-Innovation	Transport	• Bappenas through RPJMN 2015–2019 has endorsed the general objectives of transport development over the next five years to increase service quality and safety of transportation and increase the quality of sustainable and environmentally friendly transport (2015)
		Waste	• Presidential Regulation 97/2017 regarding National Policy and Strategy on Solid Waste Management : target to reduce waste 30% - 70% in 2025 (2017) • National Plan of Action on Marine Plastic Debris 2017-2025 (May 2017)
		Water	• Indonesian National target for Wastewater Management Indonesia (2010)
		Climate Change	• Indonesia Climate Change Sectoral Road Map (2010) • Decree No 61 of 2011 National Action Plan to Reduce GHG Emissions (2011) • Decree No 71 of 2011 GHG Inventory (2011) • National Action Plan on Adaptation of Climate Change 2012 • Intended Nationally Determined Contribution (INDC) to the Paris Agreement (2015)
Programmes And Actions	National	Building	• Energy standards for Buildings (SNI) in Indonesia (2010) • Mandatory Energy Conservation of Government Office Buildings (No. 10/2005) • National Standard Competency for Energy Manager on Building (Ministerial Regulation No.41/2015) • GREENSHIP building certification (2015) • Ministry of Public Work and Housin has proposed that the national green building policy should focus on: Reducing CO2 from the building sector in 2020; Certifying 50% of total state-owned buildings as green buildings; Improving energy efficiency by 20%, water efficiency by 20% and waste reduction in low-cost houses by 20% o achieve these ambitious targets, MoPW has proposed the following timeline for2014-2019: 2 • 2014: finalization of national guidelines, preparation for cooperation among related stakeholders and public dissemination; a. 2015: provision of assistance to 7 large cities to develop local green building regulations development of computer systems for building energy audits and establishment of consultation forum for green building implementation; • 2016: capacity building for local governments related to building permits and reliability certification procedures, including certification and green building databases; • 2017-2018: provision of capacity building for local governments related to building permits and reliability certification procedure, including local green low-cost housing development plans; • 2019: establishment of green building baseline data and integration of a green building management information system (MIS) in MoPW

Types of Policy Instruments		Category		Title of Policy (Year)
Programmes And Actions	National	Energy	Energy Generation	• Regulation No. 23 of 2014 (Rev of Regulation No. 14 of 2012) Electricity Supply Business Activities • Energy Efficiency Labeling Program (2009) • Energy Efficiency Award from MEMR (2009) • Energy Management Regulation (Minister of Energy and Mineral Resources, No. 14/2012) (2012) • MEMR Decree No 1567 K/21/MEM/2018 Power Supply Business Plan of PLN 2018-2027 (2018)
			(Renewable) Energy	• Ministry of Energy and Mineral Resources regarding Utilization of Various Type of Renewable Energy to Generate Electricity (2017)
		Manufacturing & Industry		• Low Carbon Emission (LCE) Program (2013) • Energy Efficiency Labeling Program (2009) • Remove fossil fuel subsidies and introduce carbon pricing • National Standard Competency for Energy Manager on Industry (Ministerial Regulation No.41/2015) • Minister of Industry regulation no.51/M-IND/PER/6/2015 and No.41/M-IND/PER/12/2017 regarding Green Industry Standard (2015 and 2017)
		Tourism		• Presidential Regulation No 21/2016 regarding Visa Free from 15 countries in 2013 to 169 countries in 2016 (2016)
		Transport		• The Ministry of Transportation's decision No. 414/ 2014 envisages 1,240 ports, with 33 major ports, 217 collector ports, and 990 feeder ports. The Strategic Plan as adopted by RENSTRA to increase sea transportation technology development for efficiency and environmental sustainability in anticipation of climate change. (2014)
		Waste		• Adipura Program, a program that measures the urban environment management performance of cities and regencies including MSW management performance; and beyond compliance toward a sustainable city (Adipura Kencana Program) (2012) • Promote and Implement 3Rs, a program that develops 3Rs implementation both communitybased 3Rs and city-scale 3Rs (365 cities as a pilot project) and city scale 3Rs; 2012) • Waste Bank, a program that educates people to reduce their waste by conducting waste separation and waste saving for recycling purpose This is supported by Ministry Regulation no. 13/2012, which lays out guidelines for the 3Rs through Waste Banks (2012) • PROPER Program, a program of assessment and performance rating of industry in environmental management. (2012)
		Water		• Ministerial Regulation Public Work and Housing 16/PRT/M/2008) to increase accessibility to sanitation facilities and health improvement (2008) • Clean River Program (Prokasih)
		Climate Change		• Provinces formulated Local Action Plan to reduce GHG Emission (RAD-GRK) which facilitated by Bappenas, Ministry of the Environment, and Ministry of Home Affairs in 2012 • Provinces are implementing RAD-GRK in 2013 • Capacity Building of GHG Inventory for Provincial Governments through Deconcentration Fund 2012-2013 • Guideline of National GHG Inventory, developing criteria for private sector which will have obligation for reporting GHG emission, developing verification system (2013) • MEF develops \

Types of Policy Instruments		Category		Title of Policy (Year)
Programmes And Actions	National	Others		• Increased inclusive green investment in priority sectors leads to reduced emissions and healthier, more productive ecosystems. Over the five-year period, GGGI and the GoI will jointly endeavor to Mobilize at least USD 110 million of investment, leveraged through demonstrations of commercially viable business models in rural and industrial areas • Develop 60-100 MW1 of clean energy and improved sustainable infrastructure in selected special economic zones, contributing up to 1 million tons of CO2 emission reduction a year; • Reduce or avoid 400 million tons of CO2 emission in forested landscapes (non-peat) and 200 million tons of CO2 emission on peat landscapes across 1 million hectares
	Internatio-al	Multilateral		• Public Disclosure of Industrial Pollution (PROPER) (1995) • Clean Batik Initiative (2009-2013) • Efficient Air Conditioners (2013-2016) • Hand-woven Eco-textiles (2013-2017) • Lead Elimination Project (2011-2015) • Prospect Indonesia • Scope-Soybean Processing (2012-2015) • Timber Indonesia (2013-2016) • Asian Cleantech MSME Financing Network (ACMFN) (2016-2020) • ASEAN Energy Manager Accreditation Scheme (AEMAS) (2010-2014)
		Bilateral		• GoI, with financial support from the Government of Norway, has been working with GGGI to develop strategies and approaches to achieve green growth. On April 13, 2013, GoI signed a Memorandum of Understanding on mutual collaboration with GGGI to launch programs and activities for the promotion of green growth in Indonesia. The ensuing program of work, known as the GoI-GGGI Green Growth Program, was launched in June 2013. The program is led by Bappenas, with a number of national ministries and sub-national government (2013)
		Others		
Legislation		Building		• Ministry of Public Works No. 05/PRT/M/2008 on Guidelines of Supply and Open Green Space Used (2005) • The Ministry of Environmental Decree Number 8 Year 2010 on Criteria and Certfcaton of Eco-friendly Building • Jakarta Regulation No. 38/2012 on Green Buildings (2012) • National Standard Competency for Energy Manager on Building and Industry (2015) • The Regulaton of the Minister of Public Works and Public Housing No. 02/PRT/M/2015
		Energy	Energy Generation	• Law No. 30 of 2009 concerning Electricity became the basis for the issuance of Government Regulation No. 23 of 2014 concerning Amendments to Government Regulation No. 14 of 2012 on Electricity Supply Business Activities, MEMR Decree No. 1567 of 2018, and the RUKN 2015-2034 • Regulation No. 79 of 2014 regarding National Energy Policy (2014) • Ministry of Energy and Mineral Resources Regulation No.14/2012 on Energy Management
			(Renewable) Energy	• Presidential Regulation No. 70 (2012) • Mandatory Energy Conservation of Government Office Buildings (2005) • Law No. 3 year 2014 on Industry

Types of Policy Instruments	Category		Title of Policy (Year)
Legislation	Tourism		• Law No.10/2009 regarding Tourism
	Transport		-
	Waste		• Law No. 32 year 2009 about Environmental Protection and Management • Government Regulation No. 81 Year 2012 regarding Household Solid Waste and Household-like Solid Waste Management • Ministry of Public Work and Housing Regulation 3/2013 concerning Technical criteria for 3R waste treatment site (TPS 3R); Landfill closure and rehabilitation guideline; Landfill construction guideline; and Landfill • Ministry of Home Affairs Regulation 33/2010 concerning administrative aspect of waste management (2010) • Ministry of Environment Regulation No. 13 Year 2012 concerning Implementation of 3Rs through Waste Bank (2012) • Ministry of Environment Regulation concerning Environmental Standard of Leachate (2017)
	Waste		• Law No.27/2007 regarding Management of Coastal Areas and Small Islands (2007) • Presidential Instruction on Water and Energy Savings (10/2005; 2/2008; 13/2011) • Law No.32/2014 regarding Maritime Affairs (2014) • Presidential Decree of The Republic of Indonesia, No.16 of 2017 on Indonesia Ocean Policy (2017)
	Climate Change		• Law No. 16 of 2016 Government of Indonesia ratify Paris Agreement to the UNFCCC (2016) • Ministry of Environment and Forest Regulation No. P.73/ MENLHK/12/2017 concerning Guidelines for the Management and Reporting of National GHG Inventory (2017)
	Others		• Ministry of Environment and Forest Regulation no.01/2012 – Greening Indonesia Program/Program to Green Indonesia (2012) • Government Regulation no.46/2017 – Environmental Economic Instrument
Finance	Building		• Ministry of Environment and Forest provide soft loans for green investment (around 5% point below average loan rate), subject to approval from Finance Ministry and Financial Service Authority. • Government provides tax allowance for business areas that can contribute to environmental preservation (for example: clean water reservoir, waste management industry, eco-tourism, etc). • Ministry also proposed to exempt taxes on import of equipment that can reduce pollution
	Energy	Energy generation	• Income Tax Reduction for Energy Development Projects (2010)
		(Renewable) Energy	• Feed-in-Tariffs for Biomass (2013) • Electricity Purchase from Small and Medium Scale Renewable Energy and Excess Power (2012)
	Manufacturing & Industry		• Clean Technology Fund (2012)
	Tourism		-

Types of Policy Instruments	Category		Title of Policy (Year)
Finance	Transport		• In accelerating national infrastructure development PT Sarana Multi Infrasrtuktur (SMI) carries the duty of supporting the Government's infrastructure development agenda for Indonesia through partnerships with private and/or multilateral financial institutions in Public-Private Partnership (PPP) projects. Sectoral focus on Electricity & Energy Efficiency, Road and Bridge, Transportation Telecommunication, Irrigation, Oil and Gas Waste Water & Waste Management, Water Supply, Waste Water, Renewable Energy (2010)
	Waste		
	Water		
	Climate Change		• ndonesia Climate Change Trust Fund(2009)
	Others		• Environmental Soft Loan Program (1993)
Information	Building		-
	Energy	Energy Generation	-
		(Renewable) Energy	-
	Manufacturing & Industry		• Bapedal Regional Network Project (1996)
	Tourism		-
	Transport		-
	Waste		-
	Waste		-
	Climate Change		• Indonesia voluntarily pledged to reduce its emissions by 26% by 2020, and by 29% by 2030 (unconditional reduction target) against business as usual scenario using their own resources, and by 41% with international support by 2030 (conditional target). • This pledge was announced in 2009 in the RPJMN 2010 2014, and confirmed in the NDC of November 2016. The NDC identifies four priority sectors: (1) the land use sector; (2) Reducing Emissions from Deforestation and Forest Degradation (REDD+), including peatlands
	Others		• 7th Regional Environmentally Sustainable Transport (EST) Forum (2013)

Indonesia is a large archipelagic state in the world, with more than 17,000 islands and total land area of 1,919,317 square kilometers. The additional surrounding sea areas bring Indonesia's recognized territory to about 6 million square kilometers of waters, with more than 91.000 km of coastal lines.

The country is comprised of 34 provinces, 502 cities and regencies, 6,543 districts and 75,244 villages. The total Indonesian population calculated from national census was 237.64 million persons in 2010 with a population density of 127.6 people/km2. Indonesia has a population estimated at 266.79 million in 2018, whereas the 2015 of 257 million. The annual national population growth rate of Indonesia between 2010 and 2015 was an average of 1.38%. About 56.7% of Indonesia's population lives on Java. (Central Bureau Statistic, 2018).

The average production of MSW in Indonesian metropolitan and big cities was estimated between 2.48 and 3.27 liter per capita. The total MSW generated by 384 Indonesian cities was about 80,235 tons per day (or 320,940 m3 per day). It is predicted to increase five times by 2020.

Ministry Regulation of Public Work and Housing estimates 65.8 tonnes of waste is generated nationwide in 2017. Metropolitan cities generate 1,791 tonnes per day of solid waste, with other major cities producing 854 tonnes of solid waste a day. Household waste contributes as the largest share in municipal solid waste in Indonesia (approximately 40%), followed by traditional markets (Aye and Widjaya, 2006).

The approach for calculating MSW generation rates in Indonesia for small and medium size cities is outlined in the Indonesian National Standard (SNI). For large cities, waste generation rates are estimated to be greater than 0.80 kg/capita/day.

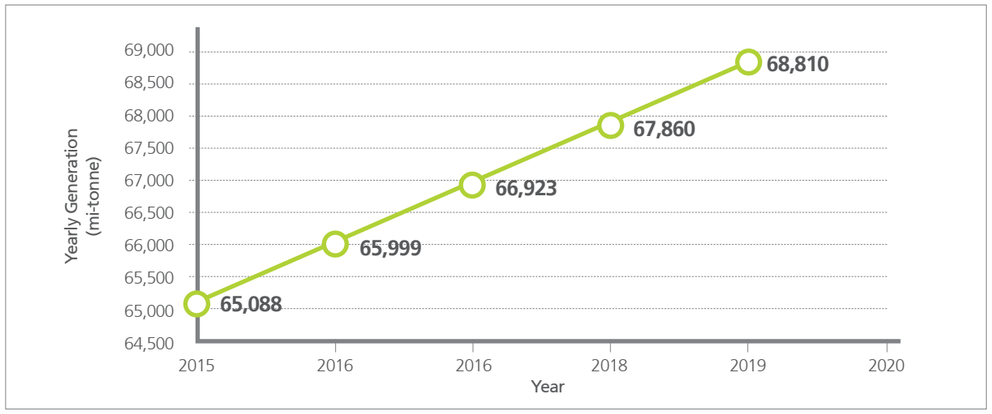
Table 4 SNI MSW Generation Rates for Small and Medium Size Cities in Indonesia

City Classification	MSW Generation Rate	
	Volume (L/person/day)	Weight (kg/person/day)
Medium (population 100,000 to 500,000)	2.75 – 3.25	0.70 - 0.80
Small (population < 100,000)	2.5 – 2.75	0.625 – 0.70

(Source: SNI, 1995)

To set up a policy and strategy for MSW management in Indonesia, the Ministry of Environment and Forest (MoEF) assumed that the national average generation rate of MSW was constant of 0.7 kg/capita/day and the population increased at a rate of 1.4% annually, as presented in the following Figure.

Figure 15 MSW projection 2015-2019

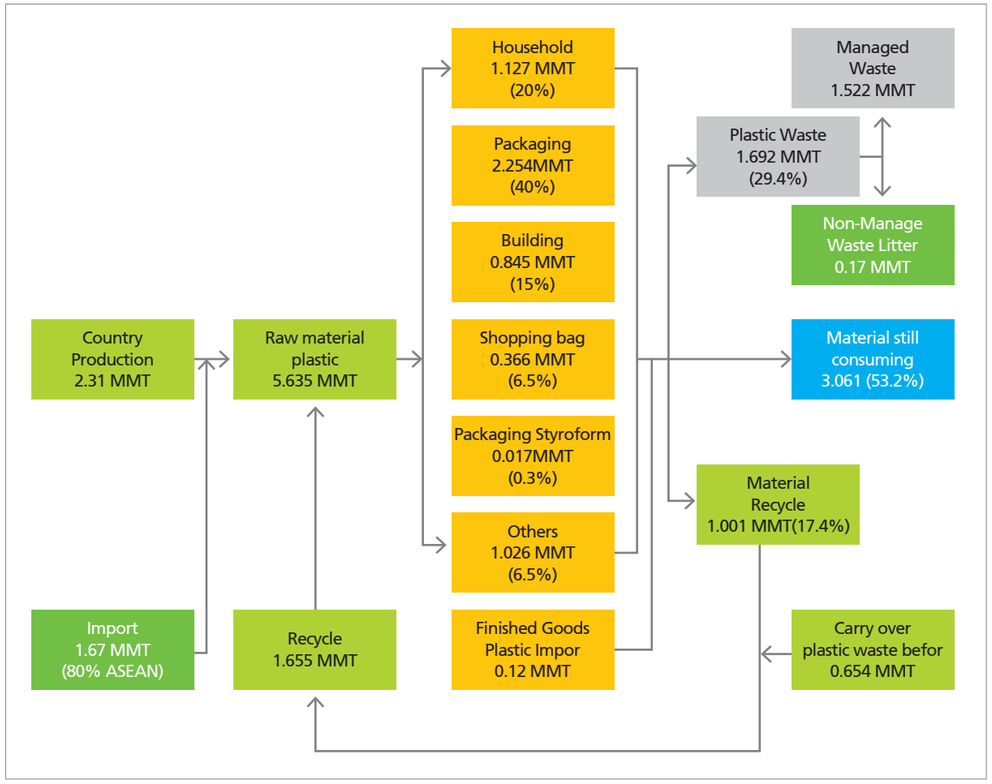


(Source: MoEF, 2016)

Ministry of Environment and Forestry stated that Indonesia generates up to 65 million tons of waste annually, with 14 percent, or 9 million tons of it consisting of plastic. Plastic pollution in Indonesia is estimated to approach 9.52 million tons by the year 2019, which is about 14 percent of the country's waste. Among of these, there are 1.3 million unmanaged plastic waste per year.

Based on Indonesian Plastic Industry Association (Inaplas) research data 2018, Indonesia produced of about 1.69 million tonnes of plastic waste in 2017, adding this with material recycling 1.001 million tonnes and carry over of previous plastic waste 0.654 million tonnes, totally about 3.3 million tonnes, and which of it 0.17 million ton is un managed. This is lower than plastic waste estimation published in the Journal Science, that Indonesia produced 3.2 million tonnes of plastic waste in 2010, with around 1.29 million tonnes of that ending up in the ocean.

Figure 16 Mass Balance Plastic in Indonesia



Source : BPS and Inaplas Data, 2018

Around 40% of plastic in Indonesia is used as packaging. Last year turnover packaging industry in Indonesia is estimated to be 6.5 Billion USD, and from total of it, 45% is flexible packaging, 15% in rigid plastic packaging, 28% in corrugated carton and paper packaging, 5% in metal can, 4% in glass, and 2% in other material.

2.5.1 Plastic waste disposal

Based on data obtained from the Inaplas and the Central Statistics Agency (BPS), plastic waste in Indonesia are 3.2 million tons and as many as 10 billion sheets per year or as many as 85,000 tons of plastic bags.

According to a 2017 article in Nature Communications Between 1.15 million and 2.41 million tons of plastic waste contaminate the oceans each year, and is estimated to contribute roughly 200,000 tonnes of waste from its rivers and streams in Indonesia.

Four Indonesian rivers (the Brantas, Solo, Serayu and Progo) emit an estimated 38,900 tonnes (range 32,300–63,700 tonnes), 32,500 tonnes (range 26,500–54,100), 17,100 tonnes (range 13,300–29,900) and 12,800 tonnes (range 9,800–22,900) tonnes of plastics per year (World Bank, 2018)

Around 40% of plastic in Indonesia is used as packaging, as each person in Indonesia disposes of 700 plastic bags per year. One more fact, consumption of bottled water continues to increase 10 percent per year.

Based to the 2016 World Economic Forum data, of all the plastic produced in Indonesia , only about 2 percent were recycled effectively, 14 percent were recycled, 14 percent were burned, 4 percent piled up on final processing site, and 32 percent polluted the environment.

About 90% MSW management systems in Indonesia rely on the landfills. Currently of about 550 landfill exist in Indonesia. The rest 10% MSW has been handled by the community through various methods, such as burning, burying, composting, and other ways such as recycling or disposing at improper sites, including water ways or drainage channels.

Based on a Adipura report 2013, the mode of handling of MSW in Indonesia is landfilling (69%), buried traditionally (10%), composted and recycled (7.5%), burned openly (5%0 and unmanaged (8.5%).

Solid waste management is one of the third most important sector in Indonesia's Nationally Determined Contribution (INDC) 2015 Paris Climate Change Conference (COP 21). Solid Waste Management Act (No. 18/2008) required the closure of all open dump sites by 2013; and requires government of national, provincial, and regency/city to contribute to financing the waste sector. This sets an ambitious goal for improvement of public service delivery given current estimates that only 45 to 70% of Indonesia's urban MSW is collected.

Long-Term National Urban Development Plan of Government of Indonesia 2015-2045, sets target of urban service standards and city waste management. Solid waste management is one of priority on the national agenda, as stated by the National Medium Term Development Plan's (RPJMN) "100-0-100" target of eliminating all slums and

providing universal access to water and sanitation, including solid waste, by 2019. The "100-0-100" target refers to 100% household access to water supply,zero slums; and 100% household access to sanitation (including waste water treatment and solid waste collection).

Responding to policies and regulations on solid waste management, the MoEF has been conducting some program related to solid waste management as follows:

- Adipura Program, a program that measures the urban environment management performance of cities and regencies including MSW management performance;
- Promote and Implement 3Rs, a program that develops 3Rs implementation both community based 3Rs and city-scale 3Rs with 365 cities as a pilot project) and city scale 3Rs;
- Waste Bank, a program that educates people to reduce their waste by conducting waste separation and waste saving for recycling purpose;
- PROPER Program, a program of assessment and performance rating of industry in environmental management.

The Government of Indonesia's ambitious plans for improved solid waste management relies on household participation to achieve its target of 30% reduction (through reduction, reuse and recycling, or "the 3R policy") in waste collected by 2025.

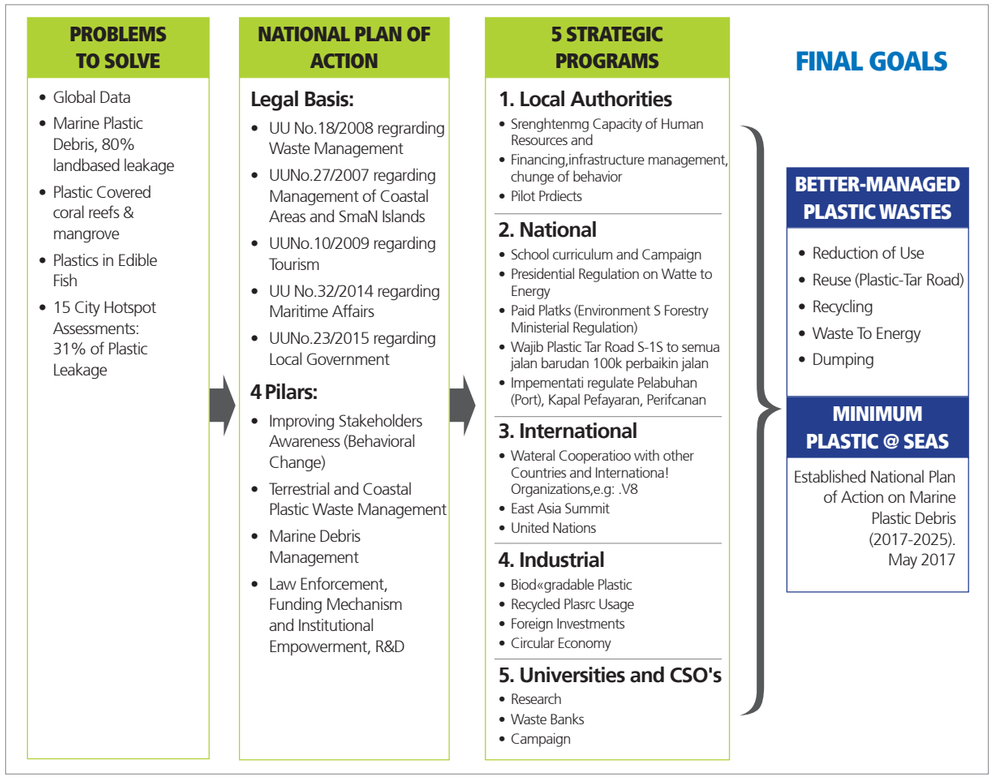
Table 5 Waste Generation Projection, Reduction and Handling Target

Indicator/Year	2017	2018	2019	2020	2021	2022	2023	2024	2025
Waste generation projection (mil tons)	65.8	66.5	67.1	67.8	68.5	69.2	69.9	70.6	70.8
Waste reduction target (mil tons)	9.80 (15%)	12 (18%)	13.4 (20%)	14 (22%)	16.4 (24%)	17.99 (26%)	18.9 (27%)	19.7 (28%)	20.9 (30%)
Waste handling target (mil tons)	47.3 (72%)	48.5 (73%)	50.3 (75%)	50.8 (75%)	50.7 (74%)	50.5 (73%)	50.3 (72%)	50.1 (71%)	49.9 (70%)

(Source: Ministry of Public Work and Housing, 2017)

In 2016, Indonesia tried to reduce plastic use by introducing a US$0.02 tax on single-use plastic bags. In addition, the government has pledged to reduce plastic and other marine waste by 70% by 2025, which is strongly linked to overall 100% urban collection targets on land. The government will provide a budget of up to $1 billion annually to execute the strategy The National Waste Management Policy and Strategy (Jakstranas) drafted by the Coordinating Ministry of Economic Affairs (Kemenko) also proposes a target of 30% waste reduction and recycling by 2025 with Plastic Waste Management Road Map as follows :

Figure 17 Plastic Waste Management Road Map



(Source: Ministry of Public Work and Housing, 2018)

5 strategies of national plan of action of Indonesia

(a) local authorities - to take care of the waste management properly and reduce the amount of plastic waste leaking to the ocean.

(b) national level - Indonesia is promoting paradigm change within the society towards plastic waste and to respect the coastal areas through education curriculum and campaign, waste to energy, paid plastic bag, plastic debris as asphalt mix for plastic-tar road,

(c) international level - Indonesia has been working with the World Bank, some donors and organize East Asia Summit Conference on marine plastic debris, on 6-7 September 2017 in Denpasar BALI, while also had executed discussions on this matter under the Indian Ocean Rim Association.

(d) industrial sector - designed to encourage these manufacturers to use recycled plastics as input materials as much as possible, while at the same time producing more biodegradable plastics.

(e) involvement of academics and community service organization (CSO) for new and efficient technologies to cope with the problem, such as recycling technologies, and waste for energy and so on into practice

June 2017, Indonesia launched the National Action Plan on Marine Debris, which calls for efforts to contro l plastic waste leakage/marine debris and raise awareness of the issue. It notes that improving municipal solid waste in coastal areas could reduce plastics leakage to the ocean by as much as 80%, and prioritizes efforts to collect and safely dispose of solid waste, including through a National Solid Waste Management (NSWM) Program.

The Marine Debris Action Plan is developed around four main pillars as follows:

(1) Reduce land-based waste leakage: Specifically, it includes support for preparation and roll-out of a Comprehensive National Marine Debris Management Strategy and Action Plan including design and implementation of a National Marine Debris Monitoring Framework and roll-out of a National Public Awareness and Household Behavioral Change Campaign.

(2) Reduce sea-based leakage of solid waste and other pollutants: It is important to ensure necessary investments in the development of "green ports" and enforcement of the International Convention for the Prevention of Pollution from Ships 73/78 (MARPOL Convention) at all Indonesian ports. The aim with this work would be to reduce illegal discharge of waste from ships at sea and design an efficient ship waste handling system at each port. Additional efforts should be invested in working with the Ministry of Marine Affairs and Fisheries to address ghost nets and discarded fishing gear.

(3) Reduce accumulated coastal and marine pollution: The aims to reduce the adverse impacts of accumulated marine debris on human health, tourism, shipping, fisheries and coastal and marine ecosystems. Specific investments would include assessment and promotion of relevant and cost-effective technologies to remove and properly dispose of accumulated debris in coastal and marine areas as well as establish mechanisms to facilitate removal, and roll out education campaigns on impacts of marine debris on health and environment.

(4) Reduce plastics production and use: The work under this pillar of the Action Plan places a mainly focus on private sector engagement and responsibility in helping to address Indonesia's marine debris challenge. Actions envisioned under this pillar include support for nationwide scale up of Indonesia's plastic bags tax pilot to include bottles as well as plastics packaging and promotion of green procurement policies. Further actions recommended include roll-out of producer 'cradle to cradle' responsibility principles, scaling up and promotion of private sector-led plastics reduction action.

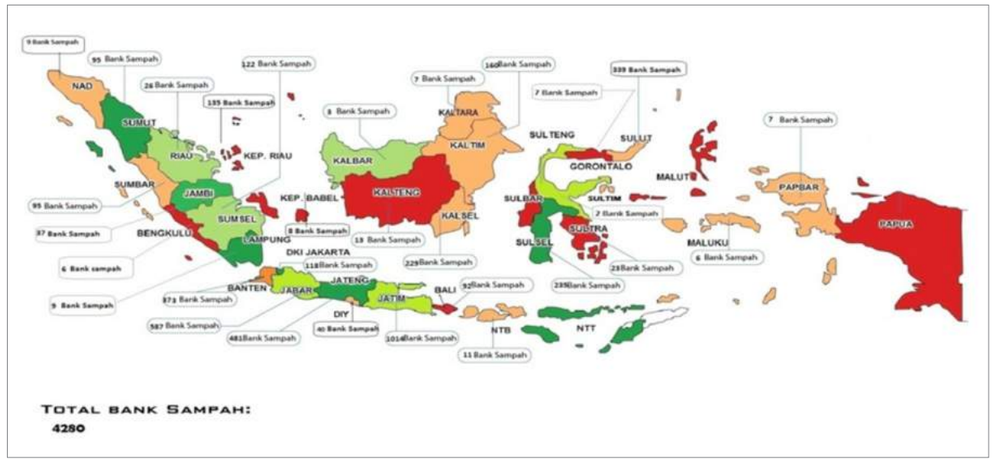
2.5.2 Plastic on Circular Economy

2.5.2.1 Waste bank

Waste banks are informal community-based establishments to collect sorted plastic and other inorganic waste that has economic value. Bank customers bring plastic and other non-organic waste to the banks, transactions are recorded preferably in a bank book that the customer holds or alternatively in lists kept by the bank. The waste banks sell the deposited material to recycling agents for reuse or recycling. Thus, the waste deposits are transformed into money that can be withdrawn when needed.

The MoEF promotes recycling through the construction of Waste Banks that help communities create money through waste recycling efforts. This is supported by Ministry of Environment Regulation no. 13/2012, which lays out guidelines for the 3Rs through Waste Banks. As of December 2012, the MEF has supported the construction of 1,195 Waste Banks which are distributed across 55 regions and cities in Indonesia. According to MEF Report the Waste Bank initiative has shown a significant increase to engage around 471 individuals in February 2012, and increase to more than 96,200 individuals in December 2012; The waste banks collectively generated around Rp. 1,65 billion (USD 183,000) by February 2012, increasing to around Rp 15.1 billion (USD 1.562 million)) by December 2012; Total of non-organic wastes processed in the Waste Banks was about 0.756 tonnes per month in February 2012, and reached approximately 2,262 tonnes per month by December 2012 (MoEF, 2012). Indonesia currently has 4280 waste bank all over the country.

Figure 18 Waste Bank Location in Indonesia, 2016



(Source: MoEF, Adipura 2014/2016 dan Primary Data Waste Bank 2016)

Figure 19 Waste Reduction through Waste Bank in Makassar, South Sulawesi

Wast Reduction through Waste Banks in Makassar

Period	Category		
	Plastics (kg)	Paper (kg)	Metal (Kg)
Jul - Dec 2015	22,002	27,014	7,691
Jan - Aug 2016	152,689	206,148	21,287
Total	174,691	233,163	28,978

(Source: Cleanliness Department of Makassar City, 2016)

2.5.2.2 Recycle

The Indonesian Act Number 18/2008 concerning solid waste treatment stipulates the importance of paradigm change in solid waste treatment that accentuate in reducing and handling of solid waste. Activity of reducing solid waste implied so that all of the society, including government, businessman and community do limitation on solid waste generation, also do recycle and reuse activity. That activity was known as 3R, Reduce, Reuse and Recycle. Based on 3R principle, many programs were implemented with the collaboration of government and private sector from social, technology, economy, public health and political perspective aspect

Indonesia manages plastic waste mostly through recycling market that involves informal sectors, such as waste pickers, garbage truck helpers, etc. and occurs at the generation point, curbside collection point and at final disposal site. The informal sectors collect various materials including cardboard, plastics, glass bottles, scrap paper, scrap metals, etc and sell them to the distributors. The distributor clean, sort, package the recyclable material, and preliminary process it before reselling. However, such kind of recycling reduces the quantity of wastes significantly for transportation to final disposal.

The quality of wastes to be recycled determines their market selling prices. The recycling business-chains players in this activity are collectors such as waste traders and scavengers, intermediaries and recycler industries.

Recycling industries or more widely known as pelletizing industries, in some cases serve dual roles, either as collectors or as end users of recycled products, depending on their business scales and the completeness of their own production means. Plastic pellet manufacturing industries were generally requiring materials in the form of homogenous scrapped plastics in terms of their packaging uniformities, such as PP-only scraps or PET-only scraps. As long as these pellet industries gave grinding machines, however, they preferred to accept items in their pressed forms. The impurity in the scrap of plastic mix of product from several different sub-collectors was frequently found such as the PVC (Polyvinyl chloride), PS (Polystyrene), iron rod, broken glasses, and aluminum rods.

The grade of quality required to produce the end-product in forms of coconut root sweepers, would be met by green, red and blue pellets, depending on the color of the sweeper frames to be produced. For the end-products in form of plastic balls and kid coin holders, however, they required used grease bottles HDPE (High-density polyethylene) pellets. Thus, the most essential thing is the homogen quality based on packaging plastics they accepted from their trusted business partners. This will play an important role for their product to be successful and in maintaining good partnerships (Damanhuri, 2009)

The selling prices of plastic waste at the sources and collectors levels in Surabaya 2018 periods are around 0.1 USD/kg to 0.2 USD/kg.

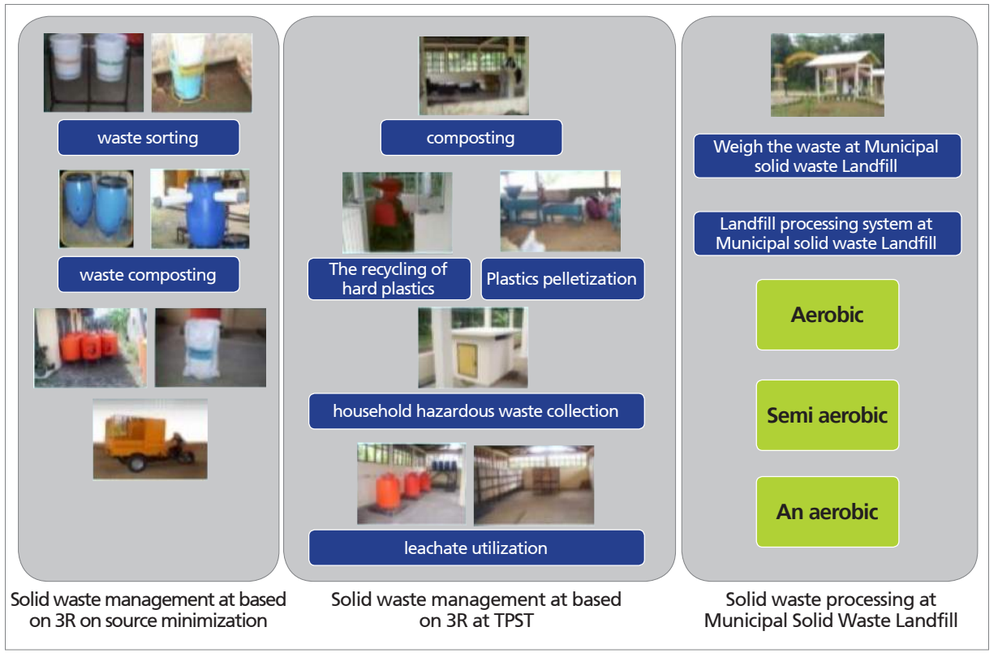
Figure 20 Map Spread Industrial Plastics and Recycling Plastic Companies in Indonesia

(Source: BPS Indonesia, 2017)

2.5.3 Eco-innovation approach

2.5.3.1 Integrated solid waste management based 3R city scale

Figure 21 Integrated solid waste management based 3R city scale (pilot project Banjar City-West Java)



(Source: Ministry of Public Work and Housing, 2018)

2.5.3.2 Plastic waste processing for building materials

The Research and Development Agency of the Ministry of Public Work and Housing carried out activities to implement waste plastic processing technology for building materials, in 2016 - 2017; Support opportunities for developing and processing plastic waste as building materials in Indonesia, research of waste-based wood-plastic composite, research of testing the reliability of wood-plastic composite materials as building materials.

The results of the testing of composite plastic wood samples (WPC) optimized counts showed that the value of water content, density, thickness changes after soaking in water for 24 hours, and hardness were able to meet SNI specifications. In addition, this sample is also able to meet the requirements of maximum formaldehyde content, as determined in JIS A 5741.

Figure 22 Plastic Waste Processing for Building Materials

(Source: Ministry of Public Work and Housing, 2018)

2.5.3.3 Development of plastic-based asphalt solution for road construction

Ministry of Public Works and Housing (PUPR) start research about asphalt plastic since 2004 and using regrind ex-shopping bag (HDPE) as additive since 2017.

Chandra Asri Petrochemical in cooperation with Ministry of Public Works and Housing to use asphalt plastic as additive for road construction.

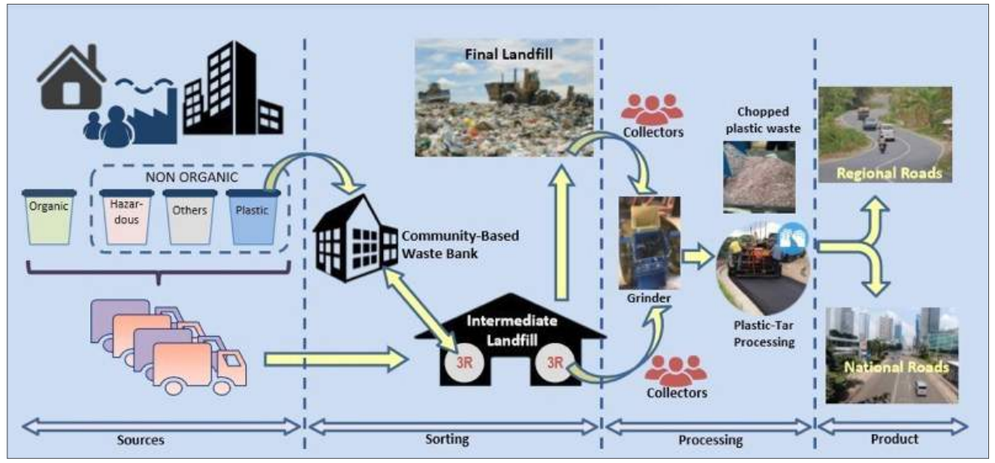
The addition of plastic waste in the asphalt mixture will: increase the resistance of the mixture to the influence of water, improve the stability of the asphalt mixture (ACWC), increase the resistance of the asphalt mixture to deformation, and increase crack resistance

PT Chandra Asri Petrochemical Tbk (CAP) and the country's Ministry of Public Work and Public Housing (PUPR) have laid an asphalt-plastic road within CAP's plant site at Cilegon, Banten Province. This asphalt-plastic program is part of CAP's sustainability initiative and a form of support for the government's target to reduce plastic waste by 70% by 2025.

The asphalt used in the road incorporates a plastic component in the form of high-density polyethylene (HDPE) recovered from plastic bags. One kilometer of road uses between 2.5 and five tonnes of plastic.

Research conducted by the Ministry of PUPR in asphalt-plastic trials in several cities indicated that the addition of a plastic component in the asphalt mix could increase asphalt deformation resistance, thus making it less prone to cracking and more durable. Indonesia sees the use of asphalt-plastic as a road material as an effective solution in tackling the plastic waste problem. 2 million waste plastic bags or about 3 million tons of plastic waste will be used to build 6,372 m2 asphalt mix road

Figure 23 Asphalt for Plastic



(Source: Coordinating Ministry for Maritime Affairs, 2017)

Figure 24 Plastic-based Asphalt Research at CAP Site Office, Cilegon (3rd July 2018)

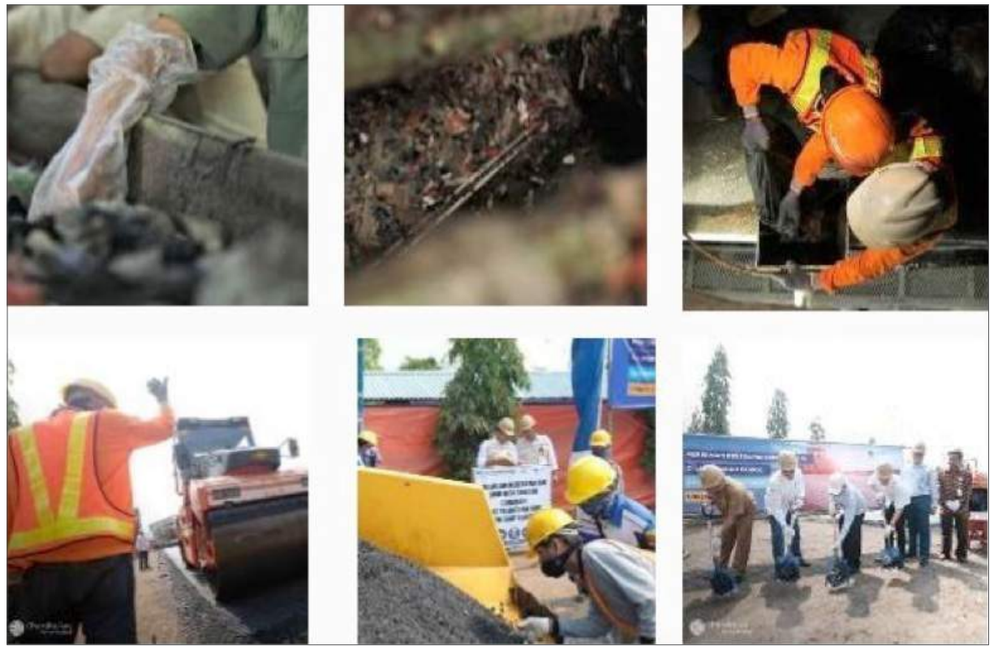


Figure 25 Indonesia's Asphalt Plastic Implementation in7 cities in Indonesia

(Source: Chandra Asri Petrochemical, 2018)

2.5.3.4 Recycle plastic bag waste into building materials (conblock)

In 2003, Balitbang, the Ministry of Public Work and Housing made plastic waste rotten to be of economic value.

Technical specifications:

(1) Plastic pellet making machine: capacity of 20-50 kg / hour

(2) Electric power requirements: • Dynamo = 2400 watts • Heater = 5000 watts

Figure 26 Recycle plastic bag waste into building materials (conblock)

Kresek | pellet making machine | making conblock from plastic pellets

(Source: Ministry of Public Work and Housing, 2018)

2.5.3.5 Plastic wood board

In 2013, the Balitbang-Ministry of PUPR developed YUTIK in areas that have the potential for wood waste and polyethylene (PE) plastic waste. Can be used as wall material. Raw material: Wood Particles (PK) Plastic waste (PE) Mixed proportion 70% PK: 30% PE.

Figure 27 Plastic Wood Board research

(Source: Chandra Asri Petrochemical, 2018)

2.6 Malaysia

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General Manager
Environmental Technology Research Centre
SIRIM

A report published by the Malaysian Investment Development Authority (MIDA) revealed that the plastics sector had 24 approved projects in the first half year of 2018, with an equivalent of foreign and domestic investments of USD245.5 million. This sees a sharp rise in total investment from the whole year of 2017 amounting to USD175.9 million[59]. Malaysia is expected to have a continuous positive economic outlook driven by high technology & capital-intensive industries in the region and this will further augment product demand, in particular for the plastic industry sector. The plastics industry registered a total sales of RM27.32 billion for 2016, representing an increase of 10.3% from RM24.77 billion for 2015[60]. However, the estimated revenue for 2017 declines to RM13.72 billion but still remain healthy with expected compounded annual growth rate at 5.27% during the forecast period from 2018-2023. Packaging is the leading application among all others applications of plastics market, and one of the major factors driving the growth of the Malaysian plastics market is increasing demand from the food, beverage and pharmaceutical industries. Additionally, the growing demand for electrical and electronic products is also expected to propel the demand in the plastic market.

Moving forward, the plastics industry is expected to face challenges in managing rising costs, particularly, the cost of labour, limitations and rising cost of employing foreign workers, higher energy cost due to removal of subsidies, competition with the emerging economies, as well as the increasing negative perception on plastic packaging; in particular for single-use plastics.

Plastics are a product of human ingenuity and innovation—one of civilization's great solutions. They're designed to be lightweight, durable, airtight, decay resistant, inexpensive, and moldable into a huge range of products. However, the plastics industry of the future is not business as usual. It's a paradox that the plastics industry is victim of its own success. Rapid growth in utilization invariably leads to greater amount of improper disposal leading to increasing environmental problems. At the global scale, the world nations have unanimously agreed that some serious actions have to be taken before it's too late, to the detrimental of our own future generations.

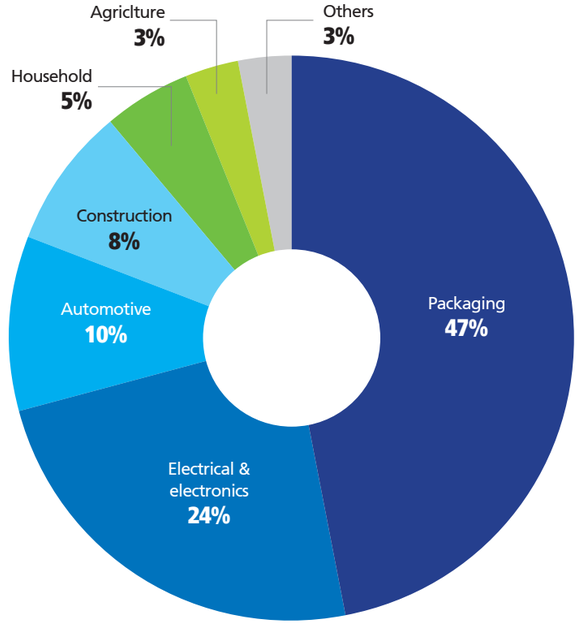
59. MIDA- Investment data (Manufacturing Sector)
60. Malaysian Plastics Manufacturing Association (MPMA) Annual Report 2017

Table 6: Key Data for the Malaysian Plastics Industry

	2012	2013	2014	2015	2016(e)
Malaysia's gross domestic product (GDP) growth	5.6%	4.7%	6.0%	5.0%	4.2%(e)
Number of plastics manufacturers	1,350	1,350	1,300	1,300	1,300
Employment	74,000	76,000	82,000	80,000	80,000
Turnover	RM 17.16b (+6.5%)	RM 17.94 (+4.5%)	RM 19.46b (+7.3%)	*RM 24.77 (+27.3%)	*RM 26.26 (+10.6%)
Export	RM 10.05b (-1%)	RM 10.69b (+6.4%)	RM 111.94b (+11.5%)	RM 12.96b (+8.5%)	RM 13.23b (+2.1%)
% of export against turnover	59%	60%	62%	52%	50%
Resin consumption	2.4m MT (+3%)	2.10m MT (+3%)	2.15m MT (2.5%)	2.22m MT (3%)	2.26m MT (2%)
Per capita consumption of resin	69kg	70kg	70kg	71kg	71kg

(Source: MPMA and Department of Statistics, 2016)"

Figure 28: Major market segment for plastic products in Malaysia (2016)



Plastic is great because it lasts so long and resists decay. Plastic is a big problem for those same reasons; nearly all the plastic ever produced still exists somewhere in the biosphere. According to a study published in the journal Science[61], Malaysia is among the top eight highest producer of mismanaged plastic waste at 0.94 million tons per year; of which 0.14 to 0.37 million tons might end up as marine litter at the coastal area. Which mean 57% of plastic waste escapes garbage collection systems entirely and is lost directly into the environment: onto roadsides or into streams, lakes, and oceans.

This augurs well with another pilot study[62] conducted by the Maritime Institute of Malaysia (MIMA) which included selected coastal areas in the Peninsular Malaysia, Sabah and Sarawak. The survey showed that plastic is the major contributor to coastal debris comprising 66% of overall debris collected whereby Cenang beach in Langkawi recorded the lowest index at 1.08 indicating that the beach is very clean. Meanwhile, Desaru beach in Johor had the highest index at 7.11 with more plastic pollution recorded. MIMA had earlier established the clean-coast index (CCI) through a study in 2010-2011 as a tool for evaluation actual coast cleanliness which also avoids assessor's bias. The focus on plastic debris as an indicator for the application of the CCI due to the longevity of plastics life span before it degrades and the impact it imposes on marine lives. The term 'plastic' here includes any artificial waste made, or partly made, of plastic, including nylon fishing lines, styrofoam remains, plastic bags in all sizes, polyurethane sheets, bottles and bottle cap, cigarette box and outer cover and include any items exceeding 2 cm in size as the index numerator.

As of to date, there is no national data on the consumption rate of plastic bags in Malaysia but some references estimated from 3 billion[63] (by making correlation with country's GDP) to a staggering value of well over 50 billion[64]lastic bags annually, derived from informal observations at supermarkets. Another estimation by the Malaysian Plastics Manufacturing Association (MPMA), at an average Malaysian uses 300 plastic bags annually (i.e.1 plastic bag a day). With total population of 30 million; this brings about an approximate 9 billion[65] plastic bags on annual basis. If a plastic bag weighs between 4 to 7g and taking a conservative approach in the calculation; the total weight of LDPE plastic bags utilized is 63,000 tons per annum.

A study conducted by the National Solid Waste Management Department in 2012 on 18 selected sites in Malaysia (covering 30% of total population) indicates LDPE type plastic waste contribute to 32% of total plastics disposed in landfills[66]. If one back calculated the value, the estimated weight correspond to close to 102.5 million plastic bags on daily basis and a whopping estimation of 37 billion pieces (equivalent to 261,705 Mton) being disposed in landfills in a year. Hence, the projected plastic bags consumption rate in Malaysia is foresee very much higher than those estimated by MPMA considering the Malaysia's current population, and urbanization impact at more developed cities.

Table 7: Plastic Waste Composition Types and Amounts

	Plastic waste composition	As discarded (MT/day)	As disposed (MT/d)
Types of plastic	Polyethylene terephthalate (PET)	463	374
	High Density Polyethylene (HDPE)	610	604
	Polyvinyl chloride (PVC)	92	90
	Low Density Polyethylene (LDPE)	782	717
	Polypropylene (PP)	263	188
	Polystyrene (PS)	293	299
	Other plastic	16	33

Malaysia is among the 193 countries agrees to adopt the December 2017 UN resolution on microplastics and marine litter, however, there is lack of concerted effort at the national level to reduce plastics production, consumption and disposal, though some state governments have been actively advocating programmes and initiatives for reduced use to total banning of plastic carrier bags and polystyrene-based food packaging.

In the second quarter of 2018, Malaysia has seen tremendous development in plastic waste management especially after the ruling of the new government. For the last couple of years, some states have been introducing the ban on free plastic bags and as a result, this has normalised waste reduction practices and encouraged consumer environmental responsibility. However, the replacement of styrofoam food packaging with packaging that are neither biodegradable nor collected for recycling has cancelled some of the benefits of the plastic bag and styrofoam ban.

The real challenge ahead is to create an effective 'after-use plastic economy' as a way forward to drastically reduce plastic leakages while sustainably conserving marine resources. Major cities have to be equipped with an integrated recycling facilities to improve disposal facilities, to minimise landfill loads, and to move up the plastic value chain which is not only limited to single use purpose. Biodegradable plastic bags should be seen as another option; taking vast opportunities of the untapped bioresources in Malaysia as the main feedstock for production of bioresin.

61. Jambeck, J.R., Andrady, A., Geyer, R., Narayan,R., Perryman,M., Siegler,T., Wilcox,C. and Lavender Law,K. (2015). Plastic waste inputs from land into the ocean. Science, 347:768-771.
62. Cheryl Rita Kaur and Ainun Jaabi (2017). Marine Plastic Pollution and Fisheries: Making sense of the environmental issue and implications. SeaViews No.5.
63. http://www.christopherteh.com/blog/2017/02/malaysia-plastic-shopping-bags/
64. Rahman M. M., Rahman H. Y., Maniam M. U., Visvanathan Y. S.(2014) Perception of Public on Free-of –Plastic (FoP) Issue, Journal of Energy & Environment. Pg.14-17
65. https://www.thestar.com.my/metro/metro-news/2018/04/06/
66. Survey on Solid Waste Composition, Characteristics & Existing Practice of Solid Waste Recycling in Malaysia (2012)

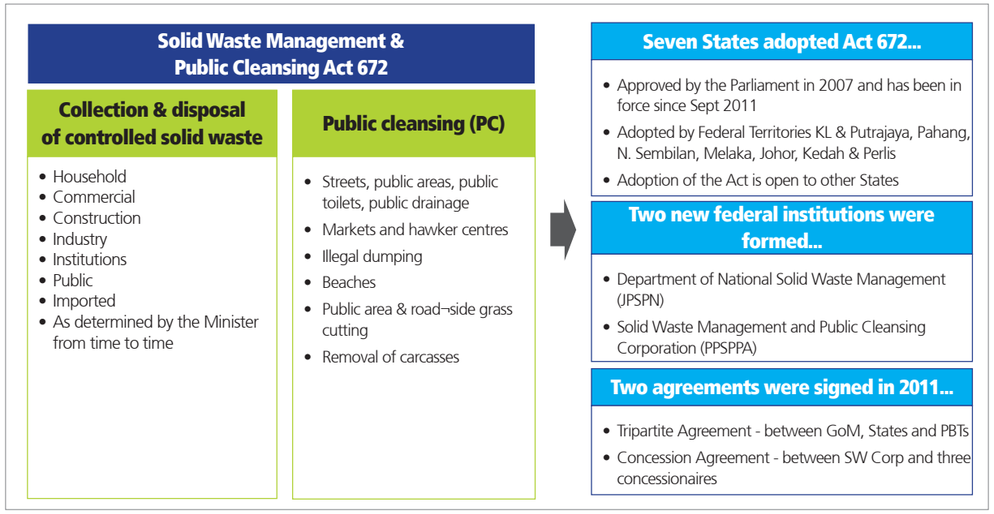
2.6.1 Waste collection and management system

BOX 6. Country policy instruments for waste management sector - Malaysia

Types of Policy Instruments	Category		Title of Policy (Year)
National Plan And Strategy	Sustainability		• Eleventh Malaysia Plan (2016-2020) • National Policy on the Environment (2002)
	Eco-Innovation	Waste	• National Strategic Plan for Solid Waste Management (2005) • Master Plan on National Waste Minimization (2006)
Programmes And Actions	National	Waste	• Food Waste Management Development Plan For Industry, Commercial And Institution Sectors (2016-2026)
	Internationa	Multilateral	-
		Bilateral	-
		Others	-
Legislation		Waste	• Act 672, Solid Waste and Public Cleansing Management Act (2007) • Special Waste Management, Regulation 7 (1) of Environmental Quality
Finance		Waste	• Waste Eco Park (WEP) incentive (2016)
Information		Waste	• International Greentech & Eco Products Exhibition & Conference Malaysia (IGEM 2018) • Voluntary labelling scheme- SIRIM Ecolabelling • Guidelines for Siting and Zoning of Industry and Residential Areas (Second Revised edition, 2012)

2.6.1.1 Legislation

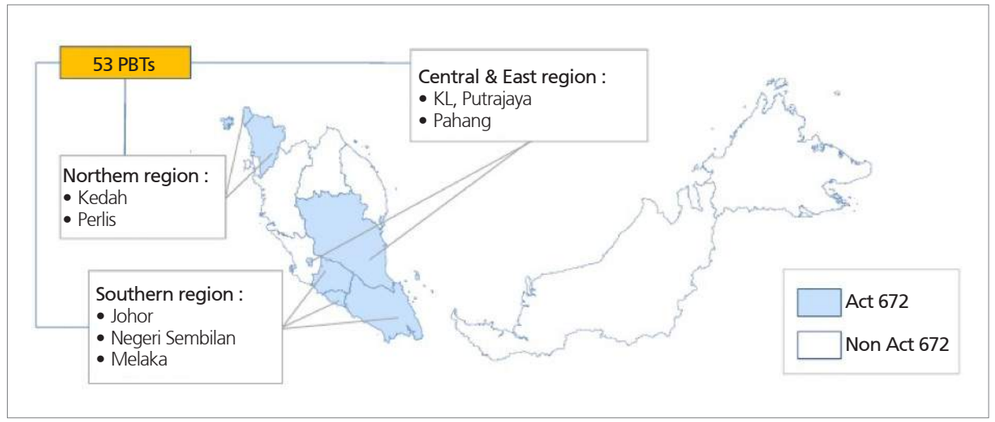
Figure 29: Legislation in Malaysia Regarding to Solid Waste Management



(Source: Solid Waste Management Lab 2015)

Pursuant to the regulatory mandates of the Solid Waste and Public Cleansing Management Act of 2007 (Act 672), the source separation scheme was first imposed in September 2011 at states and federal territories as follows: Kuala Lumpur, Johor, Putrajaya, Negeri Sembilan, Melaka, Kedah, Perlis, and Pahang also known as "Act 672 States". Act 672 was established mainly to standardise the level of solid waste management and public cleansing across all local authorities (LAs) regardless of their respective income levels and to create economic of scales for the appointment of three concessionaires, responsible to collect and dispose controlled solid wastes and for the conduct of public cleansing. Meanwhile, the responsibility for solid waste and public cleansing implementation and funding the cost for 'non Act 672 States" lies under the respective LAs within the states. Greater practice and collaboration, with added mandatory and incentives efforts, by all stakeholders are needed for successful implementation of solid waste management and also to make the new plastics circular economy a Malaysian culture and mindset by 2050.

Figure 30: Legislation and Regarding Regions in Malaysia



In general, any company intending to undertake plastic waste recycling must first obtain an Approved Permit (AP) from NSWMD before the importation process begins. This authority issues the import license for plastic waste under the HS Tariff Code of 3915 (i.e waste, parings and scrap of plastics). Companies applying for the APs must be registered with NSWMD, have a factory or premises approved by the local council, and a permit compliance letter from the Department of Environment.

2.6.1.2 Ministerial & State Government Coordination

Until recently, the Cabinet has decided to set up a joint ministerial committee comprising of ministries of Housing and Local Government (MHLG), Energy, Science, Technology, Environment and Climate Change (MESTECC), International Trade and Industry (MITI) as well as Water, Land and Natural Resources (KATS). The committee has been very aggressive in addressing issues from mitigating pollution from the plastic waste recycling industries run by

illegal operators and issues of single use plastic waste polluting the surface water and marine environment.

MESTECC has launched the Malaysia's Roadmap Towards Zero Single-Use Plastics 2018-2030 at the International Greentech and Eco Products Exhibition and Conference Malaysia 2018 event in October which targets the usage and replacement of single-use plastics in the country. The government is expected to impose pollution charges on businesses starting next year in phases and up to the 2021 grace period by giving full authority to the state governments as each state has a different level of awareness and implementation readiness to enact the charge. The pollution charge is expected to be imposed on major retailers, chain shops and restaurants that are using conventional plastic bags. The proceeds collected from the pollution charge will be ploughed back into funding awareness campaigns and the distribution of reusable plastic bags to consume.

Selangor and Penang states have already imposed an additional charge of RM0.20 per plastic bag at out-of-counter for consumers who shop at hypermarkets. Recently, the government had also banned the usage of plastic straws by default at eateries and frozen plastic imports from some countries.

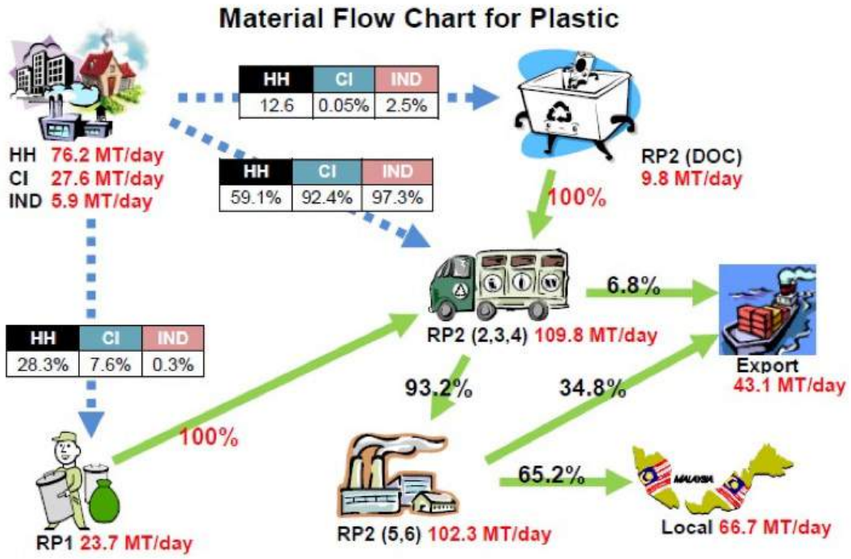
2.6.2 Key trends of plastic waste disposal

Most plastic recycling industries in Malaysia focus on plastic scraps from industries or rejects from manufacturing production. Recycling of consumer plastics to plastic pellet is rather limited in Malaysia and dependent on overseas market demand and international prices of waste plastics which directly fluctuated by the price of virgin resin and petroleum.

The total waste generated in Malaysia is estimated to be 33,130 Mt/day and approximately 3,500 Mt/day is extracted as recyclable material, while the balance primarily gets disposed in sanitary landfills or dumpsites around the country. The waste flow chart showed 93.2% of plastics as collected by traders, middle men and buy-back centres were sold to recyclers for further processing, and the remaining 6.8% was exported. For RP2 (5,6), about one third (34.8%) of recycled plastics were exported and 65.2% of processed plastic was used locally.

In Malaysia, the plastic recycling business are operating on commercial term with increase trend on importing plastic wastes for recycling. However, many illegal operators are giving the industry a bad name by failing to operate in environmentally sound manner resulting in serious pollution and health issues. This has prompted the MHLG to revoke the Approved Permits (APs) for plastic waste imports over three months and affecting 114 legal plastic waste companies in Malaysia until the ban was lifted end on October 2018. The Ministry had ordered the closing down of 24 unlicensed factories and they had been given reasonable time to dispose of the wastes at proper designated place.

Figure 31: Material Flow Chart for Plastic of Malaysia



Note:
- HH denotes 'Household', CI denotes 'Commercial and Institution', IND denotes 'Industry',
- RP1 denotes 'Recycling Player 1: Door-to-door Collector, Street Collector, Waste collection worker & Scavenger',
- RP2 DOC denotes 'Recycling Player 2: Drop off Centre',
- RP2 (2,3,4) denotes 'Recycling Player 2:Trader, Middle Man, Junk shop and etc'
- RP2 (5,6) denotes 'Recycling Player 2: Recycler'

(Source: JPSPN,2012)

2.6.3 Beyond waste management: Eco-innovation and circular economy

We have to address and find a solution to the problem of plastic waste. There are many solutions, however. One major solution is practicing better waste management and reducing the occurrence of single use plastics. This problem can be solved by using a circular economy approach, where instead of becoming waste, used plastics become feedstock. To come up with a sustainable system of producing and using plastics and plastic packaging, one has to take into account the unique opportunities and challenges that can arise from the collection, use, and reuse of the material. It signifies the need to take action to start an ambitious redesign that has a longer term view of the potential value while promoting intensive collaboration among different players.

Addressing plastics waste management issues goes beyond basic waste management infrastructure as product design, recyclability and other factors also play a role in determining the end of life of plastic products. The plastics

industry in Malaysia still stand strong in advocating anti-littering and 3Rs (Reduce, Reuse, Recycle) as most effective in addressing waste management problems. In addition, the Malaysian plastics industry is fully supportive of the Circular Economy model which closes the 'loop' in plastics waste management, making plastics a sustainable material to be used.

In general, the Malaysian plastics industry through its trade association, the Malaysian Plastics Manufacturers Association (MPMA) has been committed towards sustainability efforts for more than 20 years. MPMA's Sustainability efforts are framed as follows:

Government liaison

- MPMA actively engages various Malaysian ministries and agencies on the shaping of policies and consultation on industry-related issues.
- Some of the sustainability issues in which MPMA is heavily involved with the Government are waste management (separation at source, recycling), development of standards (Eco-label for plastic products) and education (environmental programmes for schools).

Education programmes with schools

- School programmes designed and developed by MPMA are hands-on and competition-based to effectively educate students on waste management and the 3Rs.
- Some of the signature programmes are:

- Eco-Ranger programme which educates students on the different ways to manage different types of wastes
- Eco-Innovation programme which challenges students to create innovations using recyclable materials

Public awareness programmes

- MPMA understands the importance of public programmes to mainly address the numerous misconceptions about plastics and to create awareness on proper plastics waste management.
- Some of the signature programmes are:
  - Litter-Free programmes which are conducted at public during festivities to educate the public on anti-littering and 3Rs.
  - Marine litter programmes through beach cleanups to educate the public on anti-littering and the importance of waste management in reducing marine litter.

As mentioned, the industry fully embraces the Circular Economy model and below are some of the case studies of companies practising it through their respective businesses.

Case study 1: Pallet-to-pallet

A plastic pallets producing company in Malaysia produces pallets using recyclable resins. Extending its responsibility as a responsible producer, customers can return damaged/used pallets to the producer, and on a case-by-case basis, the producer will replace the damaged/used pallets to customers. In addition, customers who are not able to find a way to dispose/manage used pallets can return them to the producer for recycling.

Case Study 2: Resource tracking system

One of the Malaysian plastics industry player is developing a tracking system for plastics products which are accessible to all players along the supply chain; from Brand Owners, to manufacturers, retailers, recyclers and the public. Through the system, number of sold plastic products and number of recovered plastic products when public return them for recycling can be tracked and accounted for, thus enabling data collection and effective management of plastic products.

Case Study 3: Car battery casing – closing the loop

One of the plastics recyclers in Malaysia has an effective recovery system for car battery casing in which the cases are collected from car workshops around the country, recycled and remanufactured into car battery cases again, which is sold the car battery manufacturers. This is an excellent showcase of circular economy within the industry which ensure minimal leakage of plastics into the environment as they are all captured and rechannelled back into the manufacturing line.

2.6.4 Lessons learned

China's ban on import of scraps have created positive impact globally for recyclables. In Malaysia, the volume of plastic waste imports rose from 288,000 tons in 2016 to 450,000 – 500,000 tons in 2017, an increase of almost 50 percent. Many industrialists in Malaysia see the plastic waste recycling as a lucrative industry with business potential of RM30 billion. To date, Malaysian Investment Development Authority (MIDA) has approved a total of 54 projects for recycling waste plastic materials with investments of RM305.2 million.

Based on current experience, too much importation of plastic scrap to support the recycling activities has disrupted the local ecosystems. Handling imports and handling domestic material are two very different channels and the latter is still uneconomical to sustain. More China's plastic recyclers are relocating its operation and directing the waste supply chains to Southeast Asia including Malaysia. This has resulted in more wastage of resources as these recycling factories uses low-efficiency production methods which require large amount of water, energy and human labour. The in-balance ecosystem has also lead to massive land, air and water pollution which reduced the quality of

life of community surrounding the area.

Malaysia, instead, should take advantage of the availability of raw materials to export high quality resins to China to improve the country's balance of trade rather than relying on Chinese investors to set up low value recycling plants in Malaysia.

Government of Malaysia also realize that they cannot afford to alienate or completely ban the plastic processing sector despite mounting pollution concerns as the revenue generated and the economic potential is huge. However, there is a need to tighten the procedures and conditions for providing the importation permit as the MHLG disclose only eight out of the 114 approved plastic factories fulfilled all of the ministry's stringent conditions. As preventive measure, the ministry has imposed the conditions for a 70% plastic waste import limitation, limiting imports to only selected well segregated post-consumer waste and restricting plastic waste imports from developing countries. Levy of RM15 per ton of imported plastic waste was imposed from October 2018 and the AP provided must tally with the approval given by the Custom department. Applicants of the AP will also be required to furnish additional criteria such as names of companies importing and exporting the plastic waste to reflect the authenticity of the business, adherence to the capacity and storage of the materials, approval from the Department of Environment as well as housekeeping of the premises are subjected to random checks by the NSWMD. There is still discussion to relocate all factories processing plastic waste to a designated heavy industrial zone due to concern of public on the potential fire and toxic hazard of the activities.

Moreover, banning would not solve the issue of marine pollution as other ASEAN countries are still importing it and the waste might also end up in Malaysia's water. Another practical option is for the developed countries to step up their own recycling efforts and stop exportation of low grade/non-recyclable plastic waste. Statistics showed that four developed nations dumped 428.5 million metric tonnes (MT) of HS Code 3915 plastic waste in the first seven months of this year with the US sending 195 million MT worth RM128.5 million. Other exporters are Japan with 104.9 million MT, the UK (95.3 million MT) and Australia (34.2 million MT).

There is also a need on regional solution to combat plastic pollution. Malaysia express its desire to participate and provide strong support in regional consultation on packaging industry regulations and standards for design, labelling, recovery and recycling. Further global meeting on standard plastic development had made characterization of plastics leaked into the environment, i.e. "is not by design" but due to pollution & poor waste management, including microplastics.

Inspired by consistent global endeavors toward sustainable waste management, this report took a closer look at cases of member countries of Asia-Europe Meeting (ASEM), such as European Union, South Korea, India, Vietnam, Indonesia and Malaysia, with respect to how these countries handle waste management, especially focusing on the reduction of plastic production and consumption.

For each country research, the report first analyzed nation's political structure of waste management and government's efforts on promoting as well as establishing rules and regulations for sustainable waste management. It is noticeable that all those case nations are deeply aware of the key challenges in waste management, which can be mainly exemplified as growth in amount of waste disposal due to urbanization and industrialization, lack of public consciousness towards the importance of proper waste management system and low collection and recycle rates. While taking those obstacles under consideration, case nations has been taking measures to structuralize both national and municipal system for waste management in a way to promote eco-innovation and sustainability.

The report then researched each case country's current trends on how plastic wastes are disposed and circulated around the cycle. As mentioned in previous chapters, most common ways to handle waste are landfill, incineration and recycling. Most countries showed comparable trends that increase in the amount of plastic waste is very drastic, and single-use plastics are the most especial cause of those rapid increase. In addition, in spite the fact that some case countries claim to have increased ratio in recycle and energy recovery from plastic waste disposal cycle, prevailing fashion among case countries' disposal is still landfill and incineration.

After researching on how plastic wastes are managed along the disposal cycle, the report subsequently took deep-dive research on how those countries can approach beyond the apparent measures on waste management, focusing on eco-innovation and circular economy. It was intriguing that, while researching countries demonstrating cases with nationwide means such as national policy strategy framework to regulate waste management, more practical and eco-innovative measures to cope with sustainable waste management system came from municipal or even private entities. Various municipal authorities from case countries developed a social campaign or waste control system that can increase the efficiency of collection and recycle ratio, and private entities developed products or materials that tackled fundamental challenges with waste management.

It is clear, from this report, that waste management has been one of the raising global concerns, especially being deeply correlated with plastic wastes aggregation. There has been more than a number of institutional and private entities undertaking the proactive role in tackling such adequate waste management with respective to eco-innovation and circular economy. Though some challenges still remain unresolved, international endeavor towards eco-innovation in waste management will gradually change not only the ASEM member countries but also the whole globe in more sustainable condition.

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