



EPR POLICY REVIEW REPORT

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EXECUTIVE SUMMARY

Malaysia generates approximately 14 million tonnes of Municipal Solid Waste (MSW) annually, out of which 43.7% consists of dry recyclables such as plastic, paper, glass, metals and tetra pack. However, the recycling rate of municipal solid waste (MSW), despite increasing over the last seven years from 10.5% to 28.06% in 2019, is relatively low and most of the generated MSW is disposed of in landfills. Owing to ubiquitous plastic pollution globally and in Malaysia, an EPR scheme is proposed for better handling of packaging waste. EPR for packaging waste has been implemented in several countries including Japan, Germany, Austria, Taiwan and others. By following 'polluter pay principle', producers or importers of packaging would be charged for the packaging they put into the Malaysian market. The EPR fee would then be used for establishing and strengthening recycling infrastructure. However, another important aspect of EPR is the change in product design to increase its recyclability.

After examining the Malaysian scenario of MSW management, dynamics between key stakeholders including Ministry of Housing and Local Government (MHLG), National Solid Waste Management Department (NSWMD), Solid Waste Management Corporation (SWCorp), Ministry of Environment and Water (KASA) and others, EPR systems implemented in other countries, this report compliments and builds on the findings of the WWF-Malaysia's report on EPR and therefore recommends formulation of a dedicated regulation for EPR in Malaysia. As proposed by WWF-Malaysia's report, the EPR scheme for Malaysia would have one, monopolistic and industry-led, producer responsibility organisation (PRO) for all types of packaging waste who will be responsible for collecting EPR fee from producers and contracting concessionary companies for collection, sorting and recycling of packaging waste. MGTC will monitor PRO in Malaysia. Moreover, it is recommended that definitive collection and recycling targets be set for the EPR system so that management of packaging is not confined to landfilling. In order to implement EPR scheme in Malaysia, a timeline of three years is suggested for formulating and passing the dedicated EPR regulation by bringing together all relevant stakeholders including packaging manufacturers, raw material suppliers, importers, fillers or consumer goods companies, waste management service providers, recyclers, public agencies and others. The dedicated regulation on EPR is recommended to be billed under the Solid Waste and Public Cleansing Management Act 2007 which has section 101 and section 102 promoting the concept of EPR. Moreover, a 5-year implementation plan for mandatory EPR is recommended where execution of EPR scheme will begin by registering producers, contracting waste management service providers and establishment of non-profit, industry-led, monopolistic PRO, to be implemented in Act 672 states first. The EPR system should gradually be made mandatory and will be applicable to non-Act 672 states as well.

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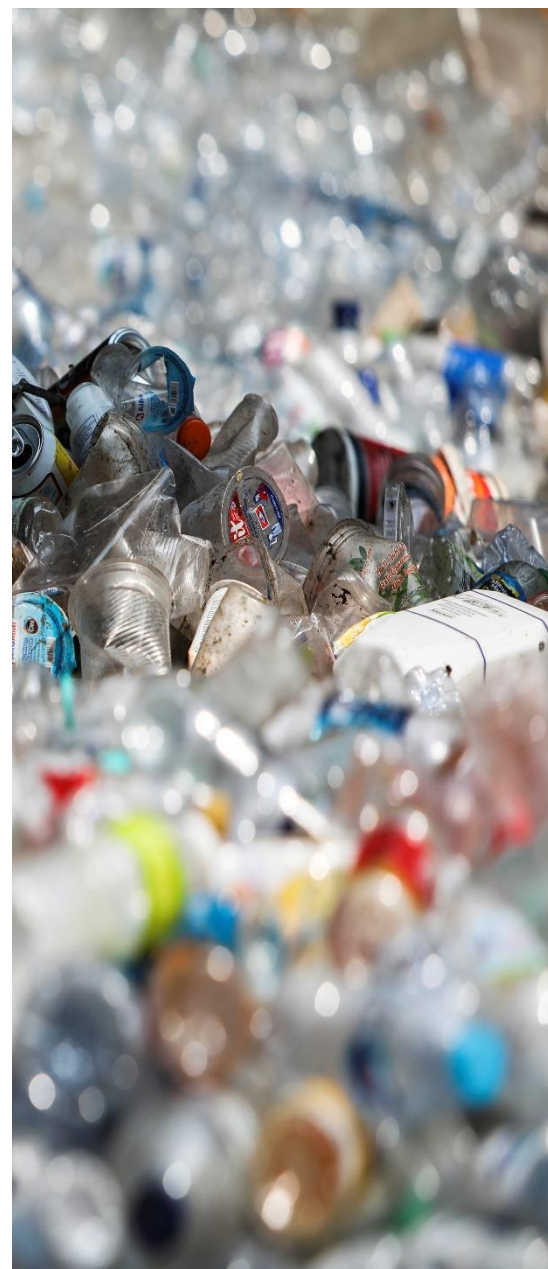
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ABBREVIATIONS

AP	Approved Permits
DOE	Department of Environment
DRS	Deposit Refund Scheme
EE	Energy Efficiency
E-Idaman	Environment Idaman
EPAT	Environmental Protection Administration Taiwan
EPR	Extended Producer Responsibility
EPS	Expanded Polystyrene
EPU	Economic Planning Unit
EU	European Union
F&N	Fraser & Neave
GITA	Green Investment Tax Allowance
HDPE	High-Density Polyethylene
KASA	Ministry of Environment and Water
KPDNDHEP	Ministry of Domestic Trade & Consumer Affairs
LDPE	Low-Density Polyethylene
LE	Large Enterprises
LLDPE	Linear-Low-Density-Polyethylene
MESTECC	Ministry of Energy, Science, Technology, Environment and Climate Change Malaysia
MGTC	Malaysian Green Technology and Climate Change Centre
MHLG	Ministry of Housing and Local Government
MIDA	Malaysian Industrial Development Authority
MITI	Ministry of International Trade and Industry
MPC	Malaysian Productivity Corporation
MSW	Municipal Solid Waste
NEA	National Environment Agency
NSWMD	National Solid Waste Management Department
PET / PETE	Polyethylene Terephthalate
PP	Polypropylene
PRO	Producer Responsibility Organisation
PS	Polystyrene
PVC	Polyvinyl Chloride
RE	Renewable Energy

RSA	Resource Sustainability Act
RVM	Reverse Vending Machine
SCP	Sustainable Consumption and Production
SDG	Sustainable Development Goals
SME	Small-Medium Enterprises
SSI	Separation at Source Initiative
SWCorp	Solid Waste Management Corporation
SWM Env	Southern Waste Management Environment
SWPCMA	Public Cleansing Management Act
TEPA	Taiwan Environment Protection Agency (TEPA)
VKS	Verpackungskoordinierungsstelle
WEEE	Waste Electrical and Electronic Equipment
WMA	Waste Management Act
WtE	Waste-to-Energy

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1. INTRODUCTION

Extended producer responsibility (EPR), the concept, was first presented by Thomas Lindhqvist (Cerar & Krošelj, 2017). It is fundamentally an environmental protection strategy which follows the ‘polluter pays principle’. EPR assigns greater responsibility to the producer and extends it further to the post-consumer stage in the life cycle of a product or packaging. Packaging materials usually have a very short lifespan once it reaches consumers and it can be composed of a variety of materials including plastic, paper, glass, metal and others. However, among the packaging waste, plastic waste is a big issue globally as the pollution of plastic can be manifested in almost every part of the world. Besides that, plastic can take almost 400 years to degrade in the environment. If no serious action is taken to combat or reduce the usage of plastics in our daily life, by 2050 it is estimated that the amount of plastic waste could reach 12 billion metric tonnes or equal to approximately 63 million blue whales in the ocean (based on mass). Furthermore, it is estimated that 8.5 million metric tonnes of plastic waste end up in the sea. Environmental problems related to plastic waste have become a major global issue and in Malaysia as well, which has been ranked as 8th among the top ten countries with mismanaged plastic waste in the world (UNEP, 2018). Ironically, Malaysia is known to be a global player in the plastic industry with around 1,300 plastic manufacturers in the country (MPMA, 2019). Malaysia's exports are about RM30 billion (USD 7.5 billion) which saw 2.26 million metric tonnes of resin used to manufacture plastics in 2016 (MESTECC, 2018).

Nevertheless, EPR is seen as a pivotal strategy in managing packaging waste. By incorporating the principles of EPR in legislations and policies, several positive outcomes can be achieved which include:

1. Efficient waste management and increasing resource circulation through;

- i. Effective collection of products and packaging at post-consumer stage.
- ii. Promote environmentally sound treatment and efficient recycling.
- iii. Divert waste from landfilling.

2. Stable financial sources to support the waste management system and improve recycling infrastructure.

- i. Resources and funds needed for collection, sorting and recycling of certain products or packaging will be contributed by producers and importers.

3. Environment friendly or Eco-design in products or packaging

- i. As producers pay fee according to the amount and types of waste they produce, and ideally also by the recyclability of their packaging, they are incentivised to reduce packaging and increase its recyclability.

The core principles of EPR include manufacturers or importers paying a disposal fee for the packaging of their goods that are placed on the market, where that fee is utilized for collection, recycling and disposal of their packaging waste, as well as on creating awareness and research and development of packaging designs. However, certain packaging materials such as transport or industrial packaging are taken back immediately by the supplier, hence are exempt from disposal fee in the European setting (EUR-Lex, 2020). The functionality of the EPR system depends on explicitly assigning the roles and responsibilities to respective stakeholders of the EPR system and legally applying the EPR fee to the designated stakeholder clearly (Bühnemann *et al.*, 2018).

The main objectives of this report are to build on to the findings of the report published by WWF-Malaysia on EPR for packaging waste in Malaysia and under the umbrella of that report, study the status quo of MSW management in Malaysia, review and examine the policies and laws related to EPR for packaging in other countries, highlight potential legal barriers to the implementation of mandatory EPR in Malaysia and to provide policy recommendations for EPR for packaging waste in Malaysia. Thus, this report assesses the Malaysian institutional structure of MSW management with the focus on plastic and packaging waste. It also enlists the stakeholders involved in the governance and management of MSW and their responsibilities. An analysis of the various EPR system implemented for packaging waste in several other countries is also presented in this report. In the end, several policy recommendations and EPR model are proposed based on lessons and experiences drawn from these countries, recommendations from the WWF EPR report in context of the Malaysian setting and based on the inputs given by key stakeholders from the government agencies, consumer brands, plastic manufacturers and recyclers.

2. MUNICIPAL SOLID WASTE IN MALAYSIA

2.1 MSW GENERATION AND COMPOSITION

Malaysians on average produce an estimate of 40,000 tonnes of MSW daily or 14 million tonnes annually (MHLG, 2019). The composition of MSW in Malaysia is shown in Figure 1. Plastic waste represents 13.2% of the total MSW but it can range between 13.2 – 24% (MHLG, 2019). Approximately, 1.8 million tonnes are plastic waste. Paper is the second highest dry recyclable that is generated in Malaysia at 8.5%. Glass, tetra pack and metals represent 3.3%, 1.6% and 2.7% of MSW respectively. Packaging waste including plastic, paper, metal, glass and others are not reported separately in Malaysia. Figure 1 shows the typical composition of MSW that is available in literature and national reports.

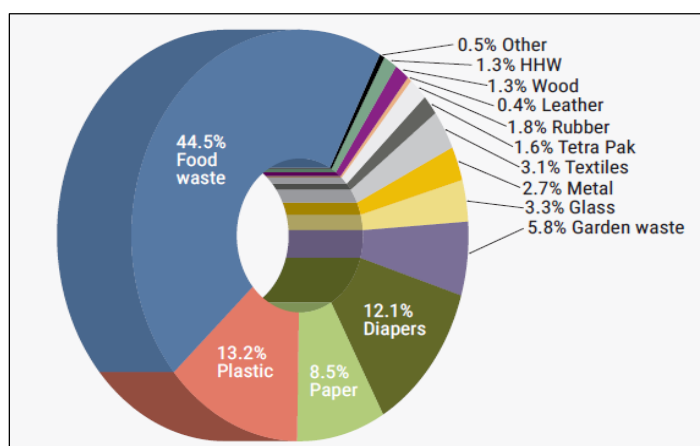


Figure 1: Composition of MSW in Malaysia (AWMO, 2017)

2.2 MSW COMPOSITION BASED ON INCOME LEVEL

Table 1 shows the composition of the MSW generated in Malaysia which varies with the economic status of the household. The percentage of dry recyclables such as glass, plastic and paper increase with the increase in socio-economic status (Agamuthu & Mehran, 2020)

Table 1: Composition of household waste based on the economic status of the household

Waste composition (%)	Socio-Economic status		
	High Income	Middle Income	Low income
Paper products	19.79	15.73	13.04
Plastic and rubber	21.05	18.61	13.01
Glass and ceramics	14.99	9.42	7.57
Food waste	24.13	29.77	31.86
Metals	8.80	12.75	9.15
Textiles	1.57	3.87	3.08
Garden waste	5.50	6.95	15.56
Wood	3.45	2.90	6.72
Total	100.00	100.00	100.00

(Agamuthu & Mehran, 2020)

2.3 MSW FLOW IN MALAYSIA

Out of the 14 million tonnes of MSW generated in Malaysia annually, the majority of waste is food waste and second highest is plastic waste. The flow shows the amount of plastic recycled is 433,080 tonnes whereas the amount of plastic disposed of in landfill or open dump is 1,366,920 tonnes. Figure 2 illustrates the flow of MSW in Malaysia.

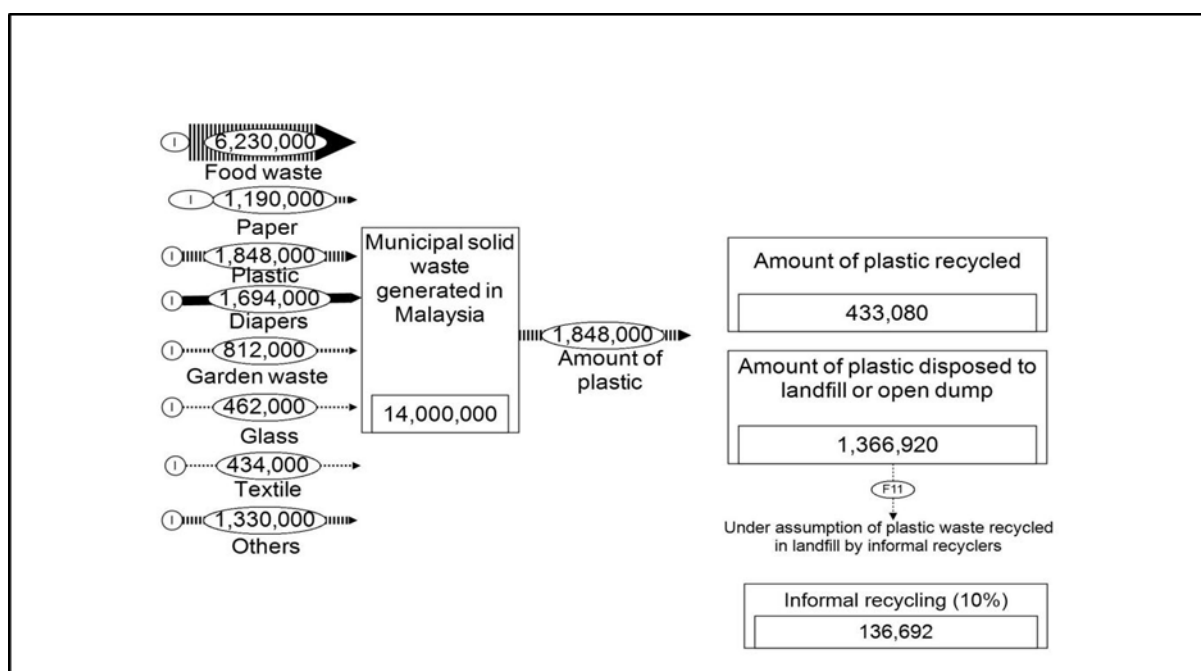


Figure 2: MSW flow in Malaysia, (Agamuthu & Mehran,2020)

2.4 PLASTIC FLOW IN MALAYSIA

The total amount of plastic waste generated in Malaysia in 2018 was 2,672,531 tonnes. The amount of plastic waste recycled from the imported plastic waste is estimated to be about 40% from total plastic waste received whereas the remaining is sent to open dump or landfill. Figure 3 depicts the plastic flow in Malaysia generated within and the amount of plastic waste imported into Malaysia.

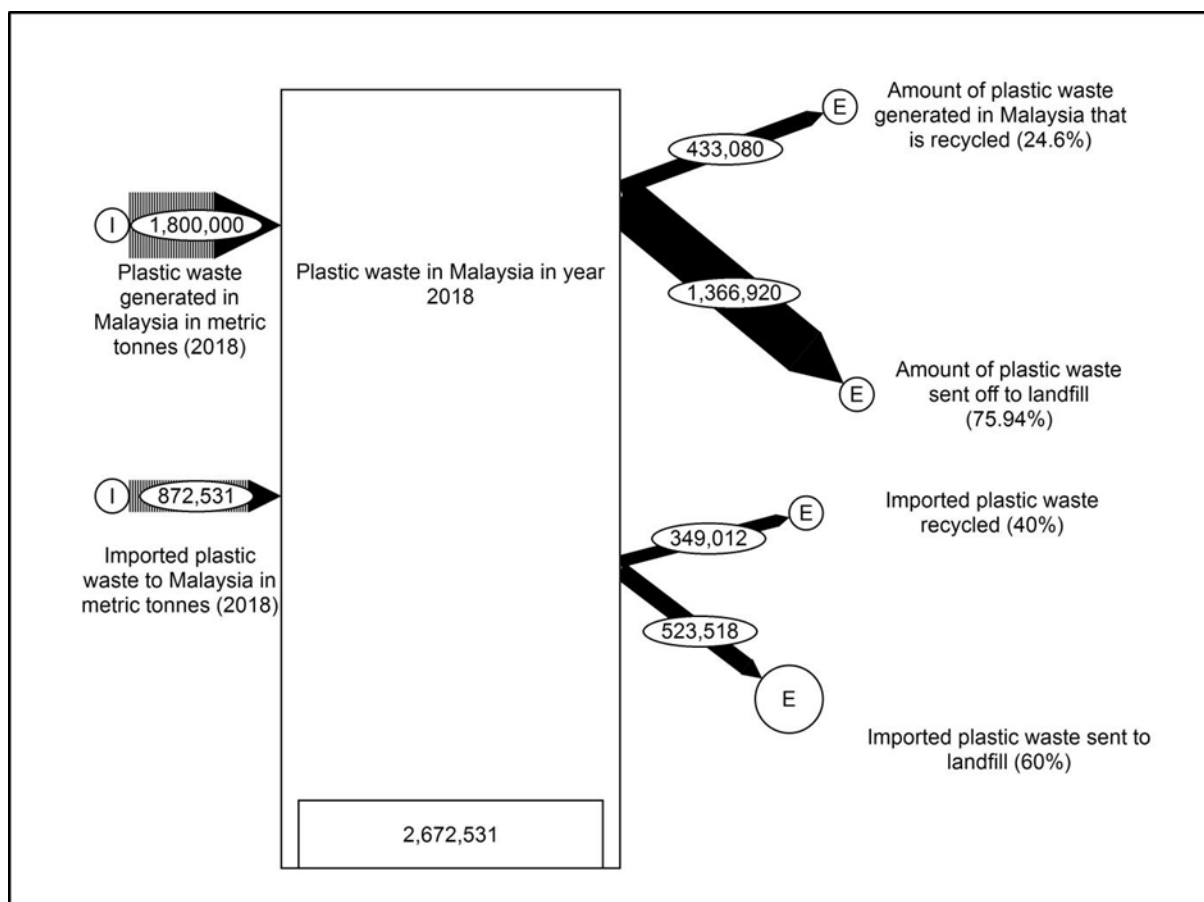


Figure 3: Plastic flow in Malaysia (2018)
(Agamuthu & Mehran, 2020)

2.5 RECYCLING RATE

The total amount of MSW recycled in Malaysia from 2017 to 2019 is tabulated in Table 2 below. It shows an increasing trend where the highest recycling rate of MSW (28.06%) was reached in 2019. In a year, Malaysia “gains” an estimated US\$1 million (RM4.14 million) in value for PET bottles collected for recycling, but “loses” US\$2 million (RM8.3 million) in value to landfills and another US\$1 million in value to leakage (The Star, 2019).

Table 2: Total of MSW recycled in Malaysia (2013 – 2019)

Year	Amount of MSW recycled (million MT/year)	Percentage of MSW recycled (%)
2013	-	10.5
2014	-	13.2
2015	-	15.7
2016	-	24.6
2017	2.86	21
2018	3.36	24.6
2019	3.88	28.06

Table 3 indicates the recycling in Malaysia according to the MSW stream. It can be seen in Table that paper is the most recycled material, followed by plastic. It is estimated that about 1.56 million metric tonnes (40.34%) of plastic waste were recycled in the year 2019 (MHLG, 2019).

Table 3: Recycling in Malaysia according to type (2017 – 2019)

MSW Stream	2017		2018		2019	
	Quantity (tonnes)	Percentage	Quantity (tonnes)	Percentage	Quantity (tonnes)	Percentage
Aluminium	248,744	8.68	18,521	0.01	499,944.4 9	12.88
Glass	180	0.01	51,630	1.54	41023.50	1.06
Iron	59,333	2.07	118,513	3.52	NA	NA
Paper	1,450,000	50.98	1,620,000	48.45	1,750,000	45.3
Plastic	1,090,000	38.19	1,560,000	46.4	1,560,000	40.34

Figure 4 shows the percentage of plastic waste according to the different categories. The percentage of plastic waste follows the order of LDPE (29%) > HDPE (27%) > PET (19%) > PS (11%) > PS (11%) > PP (10%) > PVC (4%) > others (1%).

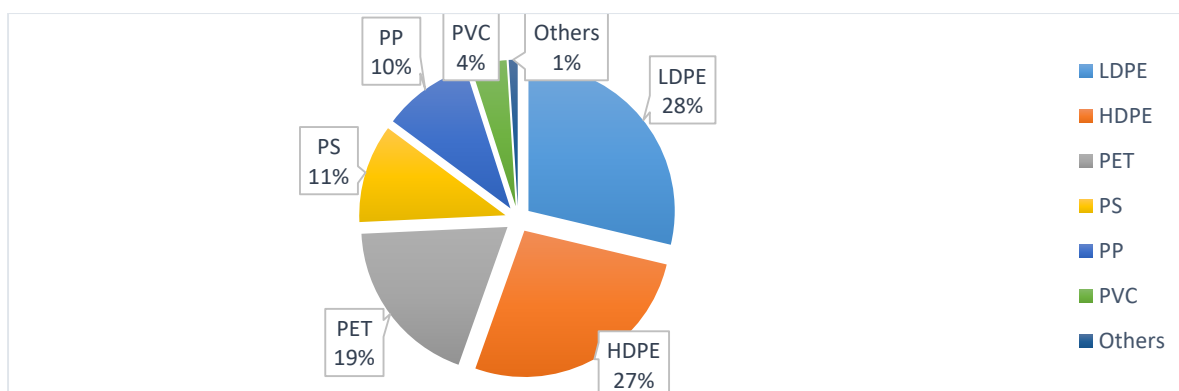


Figure 4: Percentage of plastic waste according to the different type (Sea circular report, 2020; MHLG, 2019)

The amount of post-consumer plastic waste generated and the rate of recycling is shown in Table 4. Based on the interviews by WWF, it is estimated that the recycling rate for HDPE, PET and PP is around 32% to 37% across different types of post-consumer plastic waste including rigids, flexibles and non-recyclable plastic volumes whereas for LDPE, PS, PVC and other categories the recycling rate is estimated to be less than 5.

Table 4: Estimated recycling volumes and rates (by plastic type)

Plastic type	Post-consumer plastic waste volumes in thousand tonnes/year	Recycling rate (%)
HDPE	293	37
PET	188	32
PP	113	32
LDPE	323	<5
PS	113	<5
PVC	33	<5
Others	6	<5

(WWF, 2020)

2.6 CURRENT GAPS IN SEGREGATION, COLLECTION AND RECYCLING OF MSW AND PLASTIC

There are several gaps in management of MSW and plastic waste which are listed below:

1. The MSW management in Malaysia is carried out by the federal government whereas the monitoring is by the state government reflected by the federal political system within the country and this results in different jurisdictions, legal mechanisms and stakeholders from the national level down to the municipal level which creates an unstandardised waste collection system in Malaysia (WWF, 2020).

2. Waste segregation or separation at source was made compulsory in a few states and federal territories in Malaysia from 1 September 2015. Compounds and fines could be issued to those who violate the law. Yet after five years of the implementation, there is still a lack of awareness about waste segregation. According to a recent article, the reason this programme did not succeed was due to lack of enforcement and co-mingling of waste during the collection stage, despite the effort of some households who sort their rubbish. Recently, the Housing and Local Government Minister said that a 2-year period is required for the waste segregation programme to be in full force (MHLG, 2019; Soo 2019).
3. Even though there are Environmental laws related to plastic waste management in Malaysia, their effectiveness must be supported by strong enforcement and bold leadership. For example, In July 2018, the Ministry of Energy, Science, Technology, Environment and Climate Change Malaysia (MESTECC) temporarily revoked import permits for plastic waste under HS Code 3915 and stopped the issuance of scrap plastic import permits. In October 2018, the ban was temporarily lifted and within a year, many illegal recycling factories mushroomed in the country, giving rise to mountains of plastic waste, most of which is contaminated and non-recyclable (Watson et al 2019). According to the Ministry of Housing and Local Government, only 62 Malaysian companies have valid permits to import plastic waste from overseas; however, there are more than 150 illegal recyclers nationwide (MHLG, 2019).
4. Recycling facilities/waste banks were insufficient and inappropriately located. The available facilities were recycling bins, recycling centres, silver boxes, recycling lorry and mobile collection unit (van) and charity recycling boxes. Improvement in recycling practices is possible by creating awareness, but this task requires high cost.
5. Even though the government held various awareness programs on plastic, there is still a need for more awareness programs in the education sector and also in other sectors. The problem of plastic waste and other packaging waste in Malaysia is driven by the habit of littering and mostly single-use applications. Besides that, the widespread food delivery services especially in main cities also generates high amounts of packaging waste due the layer-by-layer plastics packaging used for food packaging. A simple meal of take-away noodles with soup would comprise up to six different single-use plastic items i.e. at least three layers of packaging: one plastic packaging for the noodles, one for the soup, and another to hold the two separate packaging that contains the noodles and soup, wooden chopsticks packed in plastic, a plastic spoon and potentially a separate small bag of a chili or sambal. Furthermore, bottled drinks readily available in Malaysia are in plastic bottle form, with glass bottles usually only seen for alcoholic beverages leading to a high per capita consumption of PET bottles and other containers (WWF, 2020).
6. The recycling industry in Malaysia focuses on materials that can be easily collected and has high value (Refer to table S1 in appendix). Due to this factor, only waste materials like transparent PET bottles are being recycled in mass volume. Other waste materials

including food packaging, polystyrene products and straws, which do not have high recycling value, are scarcely recycled due to lack of technology or business viability. Besides that, the local recyclers face the challenge of ensuring the financial sustainability and quality of recycled materials. Consequently, a large generated amount of low value plastic waste is subjected to landfilling or worse leaked to the environment.

7. The existing waste management responsibility does not extend to producers. Waste management has been the financial and administrative responsibility of the government, but the system has proven to be inefficient and unable to keep up with rising plastic and packaging waste generation (WWF, 2020).
8. Absence of subsidies, incentives or rewards to any producers with eco-design products or with good recycling or EPR practice such as take-back initiative. Encouragement and recognition of those companies will definitely inspire other companies/producers/manufacturers to adopt similar commitment.

3. ANALYSIS

3.1 POLICIES RELATED TO PLASTIC/PACKAGING WASTE MANAGEMENT AND EPR IN MALAYSIA

The management of MSW in Malaysia is carried out by government agencies which include the Ministry of Housing and Local Government (MHLG), National Solid Waste Management Department (NSWMD), and Solid Waste and Public Cleansing Management Corporation (SWCorp). The Local Authorities are responsible for managing municipal solid waste from households, enterprises and various institutions. While there are no specific policies related to packaging waste in Malaysia or specifically related to EPR (Agamuthu and Dennis, 2011), following are the laws and policies that are related to MSW management which also include plastic and packaging waste.

- a) MSW is a controlled item under the Solid Waste and Public Cleansing Management Act 2007 [Act 672] by the National Solid Waste Management Department (NSWMD). Government has made it mandatory to separate household solid waste at source beginning 1 September 2015 and further extended to commercial, industrial, institutional, and construction in 2018. The implementation is enforced in the states of Kuala Lumpur, Putrajaya, Johor, Melaka, Negeri Sembilan, Pahang, Kedah and Perlis. Plastic and packaging waste had been managed grossly as MSW.
- b) The import of plastic waste under the HS Code 3915 is controlled under the Custom (Prohibition of Import) Order 2017, according to which the import requires an approved permit (AP) from the NSWMD. Besides, the Department of Environment (DOE) only allows premises that fully comply with Environmental Quality Act (EQA) 1974 to import plastic waste for recycling at their premises. The construction of recycling plant (solid waste) is subjected to the Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) Order 2015, under Activity 14(b)(ii): Any person who intends to carry out the activity is required to submit an EIA report to the DG of Environment for consideration, as mentioned under Section 34A of the Environmental Quality Act, 1974.
- c) DOE, as the Focal Point to the Basel Convention, has communicated the information to the Secretariat of the Basel Convention on the controlling of plastic waste which required special consideration (i.e., approved permit requirement) when subjected to transboundary movement.

The establishment of Separation at Source Initiative (SSI) by SWCorp under Solid Waste and Public Cleansing Management Act 2007 (Act 672), is targeted for the public and retailers to separate the waste generated at source. The three major private concessionaires, who manage the federal territories and states including E-Idaman Sdn Bhd, SWM Env Sdn Bhd, and Alam Flora Sdn Bhd, all have agreed on the SSI programs that fall under Act 672. In general, SSI requires every

household to practice waste separation according to the type of solid waste compositions at source. The waste separation is categorized as paper, plastic, other materials that can be recycled, garden waste, and bulk waste.

The introduction of the Malaysia Roadmap Towards Zero Single-Use Plastic 2018 – 2030 is aimed at addressing single-use plastics by encouraging the plastic industry to transition to eco-friendly products. This encourages the industry to thrive by adapting green technologies, while safeguarding the environment. The roadmap was a good starting point to address the significant amount of single-use plastic waste in the country. However, it is important to clarify what are the single-use plastics to be eliminated nationwide by 2030. It is important to first identify what are the problematic and unnecessary single-use plastics that should be eliminated from the market as elimination and substitution of all the single-use plastics with other alternative materials may increase our demand for other both renewable and non-renewable resources for example paper, glass and aluminium. If there is no effort in re-designing and reducing packaging, it may result in additional environmental trade-offs

In Malaysia, EPR has not yet been implemented as a separate policy. However, some elements of EPR are present in the existing national solid waste management policy and have similarities with the EPR policy, since the 1980s. Moreover, the introduction of the Solid Waste and Public Cleansing Management Act (SWPCMA) in 2007 has created a favourable environment for the implementation of EPR policy. There are some sections in two environmental Acts and in scheduled waste regulation which promote 3R (reduce, reuse, recycle) and can establish the foundation of circular economy (EPR is one of the means to achieve the goals of circular economy). There are several Acts and National Plans that touch upon EPR elements, such as in the Environmental Quality Act 1974 (section 30A and 30B) and the National Strategic Plan on Solid Waste Management in Malaysia. Moreover, both the 10th and 11th Malaysia Plans provided the guiding principles for effective and sustainable waste management for the period 2011 -2020. These plans directly or indirectly mentions sustainable waste management, which may be achieved through EPR among other initiatives.

Table 5: Regulations and sections of Malaysian environmental law that promote resource circulation

Legislations	Regulation/Section/Subsection	Description
Environmental Quality Act 1974	Section 21 (Power to specify conditions of emission, discharge, etc.)	Minister may set the limits on the emission, discharge or deposit of pollution, hazardous material, or waste
	Section 30A (Power to control use of substance and product and to state environmental labelling)	Minister may prescribe a substance to be reduced, recycled, reused or a product to contain a minimum percentage of recycled substance
	Section 51 (Regulations)	Minister may make regulations that are in accordance to Environmental Quality Act 1974
Environmental Quality (Scheduled Waste) Regulation 2005	Regulation 7 (Application for special management of scheduled wastes)	Waste generator can apply for their scheduled waste treated, disposed of, or recovered in premises or facilities other than prescribed premises or facilities
Solid Waste and Public Cleansing Management Act 2007	Section 101 (Reduction, reuse, and recycling of controlled solid waste)	Minister may require reduction, reuse, and recycling of controlled solid waste
	Section 102 (Take back system and deposit refund system)	Minister may introduce extended producer responsibility

On 21 February 2019, the Minister of Housing and Local Government (MHLG) announced the formulation of the National Cleanliness Policy (2020-2030). The policy will focus on five clusters, along with 14 comprehensive strategies, besides outlining 87 action plans to be carried out by the Federal and State governments, local authorities and the relevant agencies. The clusters outlined, under the National Cleanliness Policy, include awareness on cleanliness, the sustainability of the environment, circular economy, governance and quality and skilled human capital. The objectives of the policy are to raise awareness on the roles of the community in national cleanliness, to improve and then maintain the cleanliness of the environment, to promote the culture of recycling waste as a source of income (waste to money) and to fortify governance and enforcement for

improved effectiveness, better efficiency and integrity. The objectives were also incorporated with the country's initiative to implement the Sustainable Development Goals (SDG) 2030.

Cluster 3 of the policy is the government initiative to make Malaysia a clean country and to create a society that adopts the practice of cleanliness in order to guarantee the well-being of the people and sustainability of the environment. Implementation of EPR to promote recycling is listed under Cluster 3 and Strategy 3.4 of National cleanliness policy. The transformation from a linear economy to a circular economy based on the principles of reduce, reuse and recycle must be extended to all industrial sectors with a focus on minimising solid waste generation at source and maximising the use of resources, thereby reducing carbon dioxide emissions into the environment. The adaptation of a circular economy in the industrial sector can encourage a green economy by reducing and reusing generated waste as a resource.

There is a progressive "EPR" practice by selective producers, importers, and retailers and other relevant stakeholders to fulfil their responsibilities for collecting, recycling, and disposal of new and emerging waste streams such as e-waste in Malaysia. At the moment, the policy is not fully enforced and still on a voluntary basis. E-waste listed for EPR comprised of television, washing machine, air conditioning, refrigerator, computer, and mobile phone (UNCRD, 2018). There are voluntary initiatives from a few multinational electronics firms such as Motorola, Nokia, Dell, Apple, and Hewlett-Packard as part of their mobile phone global corporate responsibility policy.

Some of the related laws related to management of plastic packaging industry are under the purview of the Ministry of International trade and Industry, Malaysian Industrial Development Authority (MIDA), Malaysian Productivity Corporation (MPC), Malaysian External Trade Development Corporation, and for food packaging, Ministry of Health (Food Act 1983). None of the law incorporated EPR policy (see Table 6).

Table 6: Selected ministries and related acts that may be relevant to EPR

Governance	Related Acts	Description
Ministry of International trade and Industry (MITI)	<ul style="list-style-type: none"> Promotion of Investments Act 1986 Strategic trade Act 2010 Third Industrial Master Plan 	<ul style="list-style-type: none"> Responsible for international trade, industry, investment, productivity, small and medium enterprise and development financial institutions. Also responsible to plan, legislative and implement international trade and industrial policies towards achieving National economy policy and vision 2020.
National Solid waste management Department	<ul style="list-style-type: none"> 2018 Basel Convection Amendment 	<ul style="list-style-type: none"> Has the authority over the issuance of Approved Permits (AP) for importing plastics for recycling nation-wide.
Malaysian Industrial Development Authority (MIDA),	<ul style="list-style-type: none"> Malaysian Industrial Development Authority (Incorporation) Act (Act 19) Industrial Relations Act 1967 	<ul style="list-style-type: none"> Responsible for approval for petrochemicals plants manufacturing license and its associated facilities relating to the project.
Malaysian Productivity Corporation (MPC)	<ul style="list-style-type: none"> National Productivity Centre (Incorporation) Act amended A801 (1991) 	<ul style="list-style-type: none"> A statutory body under the Ministry of International Trade and Industry (MITI). Promotes productivity, quality and competitiveness to the industries and organisations in Malaysia.
Malaysian External trade Development corporation	<ul style="list-style-type: none"> Malaysian External Trade Development Corporation Act 1992 	<ul style="list-style-type: none"> Responsible for trade policy import restriction. Revoked the approved permits for plastic waste imports for three months effective 23 July 2018 after a sharp increase in plastic imports due to China's ban on scrap plastic imports.
Ministry of Health	<ul style="list-style-type: none"> Food Act of 1983 (Act 281) 	<ul style="list-style-type: none"> Regulated food packaging in Malaysia under the Food Act of 1983. (The act) Prohibits the use of recycled packaging for certain foods such as sugar, flour, and edible oil. In addition, packaging

		<p>for a product / packaging of swine-origin shall not be used for food of non-swine origin and any bottle that has previously been used for alcoholic beverage or shandy shall not be used for any food, other than alcoholic beverage and shandy. Lastly, reuse of packaging material previously used for milk, soft drink, alcoholic beverage or shandy, vegetable, fish or fruit, and polished rice, is prohibited. (<i>UN Environmental program</i>)</p>
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A joint white paper published in October 2019 by the Malaysian Plastics Manufacturers Association and Malaysian Plastic Recyclers Association, titled “An Advanced Plastics Recycling Industry for Malaysia”, promotes the introduction of EPR scheme as part of a drive to create a circular economy and spur smarter product designs [MPMA & MPRA, 2019]. Their efforts in promoting the introduction of EPR schemes are in tandem with their mission to build an ‘advanced plastic recycling industry’ that would require constant stakeholder engagement at all levels (WWF, 2020).

Another related project is the Sustainable Consumption and Production (SCP) Blueprint which was included in the Eleventh Plan. The Blueprint places Malaysia in an excellent position to pursue the new Sustainable Development Goals (SDGs) until 2030 which contain SCP as a core goal. Pathway 4 of the Sustainable Consumption and Production (SCP) Blueprint highlights “Towards a circular economy waste system”. The Eleventh Plan requests that all types of waste will be managed in a holistic manner based on a life cycle approach which extends beyond merely disposing of the waste. The responsibilities of consumers and industries as the waste holders and waste generators have to be mobilised. The ultimate goal of this pathway is to phase out of conventional landfilling by 2030. This will require the full-scale adoption of waste reduction, reuse and recycling measures. Some of the strategies that is highlighted in pathway 4 of SCP blueprint is:

Enforcing the Solid Waste and Public Cleansing Act (2007) will increase recycling rates in Malaysia.

- A rollback of sales, conversion and transport packaging will include the obligation to either reuse or recycle packaging.
- Industry will have to set up and finance the system to meet the return and recycling obligations of packers and distributors including packaging of imported goods. They can use a third party to establish a nationwide collection and recycling system.

- Consumers have to separate wastes such as paper, glass, metals, plastics and compounds at the source and to use the collection points provided.
- Recycling will be made easier by specifications on packaging materials, for example through labelling on packaging with the potential to be recycled.
- Certain materials will be banned for packaging purposes; the size of packaging and the number of packaging compounds can be limited.

(The national SCP Blueprint, 2016)

The Green Technology Master Plan 2017 - 2030 has set a clear future initiative of establishing an EPR system for resource circulation compared to other national policies. However, it does not go into detail in formulating the EPR system and it is more focused on energy efficiency and other environmental aspects than on resource circulation. Even the waste sector part of this policy elucidates more in waste-to-energy than on EPR.

According to National Entrepreneurship Policy, there are two main initiatives that can help with proliferation of waste management technology in form of financial support for entrepreneurs related to waste management in Malaysia which include tax incentive for green technology sector in form of “Green Investment Tax Allowance (GITA)” and research grants. The research grant can promote collaboration between entrepreneurs, researchers and industry and drive demand driven innovation projects. For recycling initiatives, the “Demand-Driven Innovation Project by Public Private Research”, can provide scientific and technological solutions for problems faced by entrepreneurs and industry and the finances to develop recycling technologies for flexible plastic or plastic with low recycling capabilities.

There is also an initiative to acquire the “social company” status by meeting one of the four criteria where “35% of raw materials or production resources spent to achieve environmental missions” could be implied to sustainable consumption and production and sustainable management of waste. Among the targets of National Entrepreneurship Policy, recycling and advanced waste treatment or holistically EPR system can contribute to the achievement of job generation targets by SMEs of 72% by 2025 and 80% by 2030 as advance treatment of waste provides more jobs in the society and also requires skilled workers. However, as there aren’t any explicit goals or targets that merge the increase of entrepreneurship and resource circulation or environmental sustainability in National Entrepreneurship Policy, therefore, this policy may hamper other environment related policies if new businesses are established on other social and market factors and environmental factors are ignored.

National Policy on Climate Change could indirectly be utilized for resource circulation, for the implementation of resource circulation leads to reduced GHG emissions from waste and manufacturing sectors. Out of five principles of national policy on climate change, the second principle is aimed at “conservation of environment and natural resources” and requires execution

of initiatives for contributing towards conservation of environment and sustainable utilization of natural resources.

Additionally, there are ten strategic thrusts based on those five principles and the strategic thrusts for principle two include “adopt balanced adaptation and mitigation measures to strengthen environmental conservation and promote sustainability of natural resources” and “consolidate the energy policy incorporating management practices that enhances renewable energy (RE) and energy efficiency (EE), where the former is relevant to implementation of EPR in Malaysia. The key actions include identifying and recommending alternatives for the low carbon economy for the waste management sector (KA4 – ST2). It also includes incorporating initiatives such as deploying financial and technical assistance for natural resources and environment and waste management (KA13 – ST4).

3.2 DYNAMICS BETWEEN THE STAKEHOLDERS IN MUNICIPAL SOLID WASTE MANAGEMENT

The dynamics between stakeholders of MSW management in Malaysia is tabulated in Table 7 below.

Table 7: Dynamics between the stakeholders in MSW Management

Stakeholders	Responsibility towards Solid waste Management
Ministry of Housing and Local Government (MHLG)	<ul style="list-style-type: none"> ● Responsible for the enforcement of local government legislation in Peninsular Malaysia, separation at source (SAS) policies and solid waste management, but only has jurisdiction over Act 672 States. ● Responsible for ensuring the compliance of recyclers with any environmental regulation and scheduled waste management together with Ministry of Environment and Water (KASA) ● Has jurisdiction over the federal National Solid Waste Management Department (NSWMD) and Solid Waste Management Corporation (SWCorp).
National Solid Waste Management Department (NSWMD/JSPN)	<ul style="list-style-type: none"> ● Is the federal department under the jurisdiction of MHLG. ● Responsible for coordinating between federal and state governments, and local authorities for the implementation of national solid waste management and public cleansing policies. ● Has the authority over the issuance of Approved Permits (AP) for importing plastics for recycling nation-wide. ● Responsible for the enforcement of policies on solid waste management and public cleansing policies, under the direction of MHLG.

	<ul style="list-style-type: none"> Enforces national 3R (Reduce, Reuse, Recycle) policies with MHLG and SWCorp.
Solid Waste Management Corporation (SWCorp)	<ul style="list-style-type: none"> The Federal agency set up under Act 673 (Solid Waste and Public Cleansing Management Corporation Act 2007) to enforce Act 672 and national policies on solid waste management and public cleanliness. Responsible for monitoring the operations and compliance of concessionaires in Act 672 States. Also responsible to publish a compendium on Malaysia's solid waste management and also collect data on the national recycling rate on an annual basis. Enforces policies on solid waste management and public cleansing policies, and compliance of concessionaires on MSW management in Act States only. Promotes national 3R campaigns and public awareness on SAS, together with MHLG and NSWMD.
Ministry of Environment and Water (KASA)	<ul style="list-style-type: none"> Focused on reducing pollution and reduction related to plastic waste. Works with MHLG, state governments and local authorities for the implementation of Malaysia's Roadmap Towards Zero Single-Use Plastics 2018 – 2030 and Circular Economy Roadmap for Plastic. Also responsible for jurisdiction over other environmental matters.
Department of Environment (DOE)	<ul style="list-style-type: none"> Responsible for national policies on the environment. Works under the jurisdiction of KASA. Responsible for the implementation and enforcement of the Environmental Quality Act and thereby enforces regulations relating to environmental safety and operations on recyclable processors. Responsible for the approvals and enforcement for processing operations related to scheduled waste.
Ministry of Domestic Trade & Consumer Affairs (KPDNDHEP)	<ul style="list-style-type: none"> Responsible for domestic trade and enforces the Consumer Protection Act 1999 and Price Control and Anti-Profiteering Act 2011. Tracks data on local FMCG input within the domestic market. Has jurisdiction on setting price controls, especially for key consumer goods such as plastic and packaging material.

Economic Planning Unit (EPU) Prime Minister's Department	<ul style="list-style-type: none"> Responsible for developing the overall plans for a comprehensive socioeconomic development towards sustainable and inclusive growth.
Concessionaries/contractors for waste collection	<ul style="list-style-type: none"> Waste sorting, collection, transportation and recycling are carried out by licensed waste management companies (concessionaires contracted under Act 672 by Act States or independently by Non-Act States/ or contractors operating under the concessionaires or contracted by individual buildings. Provides household waste and recyclables collection, and public cleansing services under Act 672 and SWCorp regulations.

3.3 EPR POLICIES, LAWS AND REGULATIONS IN OTHER COUNTRIES

EPR schemes are either explicitly implemented in a country such as Germany, Austria etc. or it may be part of MSW or other waste related regulations such as Taiwan. Regardless, EPR schemes have significantly improved recycling rate of packaging waste in those countries and have been completely or partly funded by relevant packaging producers. Selected countries that implement EPR schemes are tabulated in Table 8 below. Figures 6 and 7 depict the EPR schemes in Japan and Taiwan.

European Union's (EU) directive on packaging and packaging waste (Directive 94/62/EC) asks member states to implement measures for collecting and recycling packaging waste. While the EU's directive on EPR is focused on WEEE (Waste Electrical and Electronic Equipment), batteries, vehicles and accumulators, the packaging and packaging waste directive indirectly applies the principles of EPR (Extended Producer Responsibility) on packaging waste (EUR-Lex, 2020). Germany, Belgium, Austria and other EU members have enforced packaging directive in their respective countries by incorporating its elements in their national legislations.

On the other hand, Singapore announced the implementation of EPR scheme for packaging waste management by 2025. The National Environment Agency (NEA) will be implementing a Deposit Refund Scheme (DRS) for beverage containers by 2022 as the first phase of the EPR approach for packaging waste management. Mandatory reporting of packaging data and 3R plans for packaging is introduced in 2020 and legislated under the Resource Sustainability Act. This builds on an existing mandatory waste reporting framework for large malls and hotels, which will also be expanded to all large industrial and commercial premises, including large convention and exhibition centres, in 2020. For the mandatory packaging reporting framework, for a start, producers of packaged products and supermarkets with an annual turnover of more than \$10 million will be required to report data on packaging that they put on the market and submit their 3R plans for packaging. The mandatory packaging reporting framework will also lay the foundation

for an EPR framework for managing packaging waste, including plastics. This ensures producers are responsible for the collection and recycling of the materials they use to package their products.

In Taiwan, the fees collected from producers is fed into the Recycling Fund, which subsidizes collection and recycling by licensed enterprises. In 2001, the Waste Disposal Act was revised again, expanding regulations under Article 10-1 to clarify responsibilities of manufacturers, importers and recyclers under the 4-in-1 Recycling Program (EPA, 2012). Online reporting systems are available for manufacturers and importers, recyclers, collectors, auditing and certification groups, and local EPBs. To read more, please refer to table S2 in the appendix.

Table 8: Countries with EPR schemes and policies

Country	Year	EPR Model	Dedicated Law	Additional Information
Japan	1995	Single PRO designated by the government (Japan Containers and Packaging Recycling Association)	Containers and Packaging Recycling Act	Manufacturers of containers, all manufacturers using containers and wrapping for shipping their products, retailers and wholesalers using containers and wrapping for selling merchandise, importers who import and sell merchandise in containers or wrapping, and importers of containers are obliged for fee payments
South Korea	2003	EPR Scheme in Korea is a Take-back scheme with recycling targets. Korea Environment Corporation's (KECO) role is to contribute to eco-friendly national development through the improvement of the environment and	Non-profit Corporation Aggregate under the Civil Law Act - Public Service Corporation - Act on the Establishment and Operation of Public Service Corporations Packaging Recycling Cooperative - Article 27 of the Act on the Promotion of Saving	EPR in Korea is subjected to target recycling rates which are set for each category of product, and any producer that fails to meet their targets is obliged to pay an additional recycling fee to cover the shortfall

		promotion of resource recycling.	and Recycling of Resources	
Singapore	N.A.	N.A	Resource Sustainability Act (RSA) EPR framework for packaging waste management will be implemented no later than 2025	Deposit Refund Scheme (DRS) for beverage containers to be implemented by 2022 Mandatory reporting of packaging data and 3R plans for packaging will be introduced in 2020
Taiwan	1988	Environmental Protection Administration registers producers and importers Manufacturers and importers have to pay a recycling fee to Environmental Protection Administration Taiwan (EPAT) and offer collection of waste for recycling from consumers	Waste Disposal Act and the Resource Recycling Act; 1990s, 1998	MSW management policies is incorporated with EPR concept which requires manufacturers and importers of new products to fund recycling
Indonesia	N.A.	N.A.	The government regulation no. 1/2012 on 3Rs and EPR President Regulation No.97/2017 on Policy and National Strategy of MSW	While Indonesia has EPR regulation, it has not been implemented. Limited funding, meagre cultural and social conditions and other factors have hampered execution of EPR
South Africa	2000	Industry-led voluntary EPR scheme, each PRO	In the final stages of drafting regulation for EPR	Industry-led voluntary EPR practiced since 2003 (started with paper waste). Covers

		dedicated to respective packaging material		MSW materials including packaging waste, plastic waste and paper waste etc. While the packaging industry has submitted an EPR plan upon government's invitation, industry wants to lead the EPR scheme
Germany	1990	Multiple PROs function in a competitive market	Packaging Act 2019	Approximately 28 years were taken to a mature EPR system in Germany, where it started from single, non-profit PRO to for-profit multiple PROs who are contracted by respective counties. Recycling rates under the new Packaging Act 2019 for each packaging material has increased
Austria	1993	Several PROs operate but each PRO is allotted one region to keep the market competitive and accessible to all PROs. This process is repeated every 5 years	Packaging Ordinance 1993 and Waste Management Act (WMA) 1990	EPR system is monitored and coordinated by a neutral player, "Verpackungskoordinierungsstelle (VKS)" established under the WMA. PROs fund the operations of VKS, as well as the collection, sorting and recycling of packaging waste
Belgium	1996	Two PROs, each dedicated to household packaging waste and commercial and industrial packaging respectively	Framework legislation on the management of material cycles and waste Cooperation agreement on packaging waste	Companies producing more than 300 kg of consumer packaging annually are required to join the Fost Plus (PRO for household packaging)

(Source: Bünemann *et al.*, 2020a; Bünemann *et al.*, 2020b; Mogiliv, 2017; JCPRA, 2012; Chung, 2008)

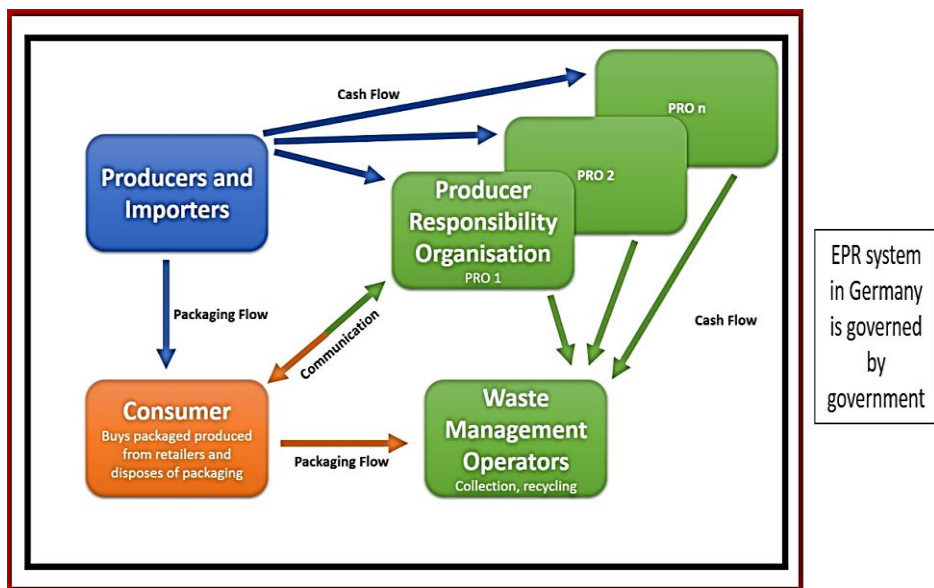
Packaging waste focused EPR schemes practiced in the above mentioned countries include all types of packaging waste. Table 9 highlights the material of packaging waste covered by EPR schemes in respective countries

(Note that packaging waste material given in Table 9 represents some of packaging waste covered in respective EPR schemes but the schemes may include more material).

Table 9: Type of packaging waste included in EPR schemes in different countries

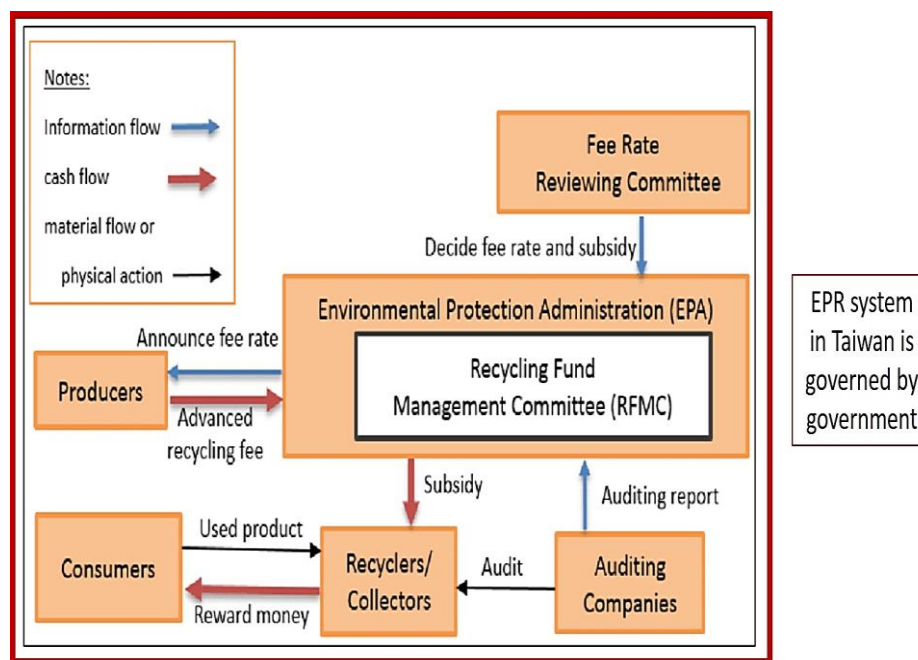
Countries	Packaging Waste and Other MSW Streams Covered
Austria	All packaging waste: glass, paper, plastic and metal
Belgium	Paper and cardboard packaging, composites packaging, plastic packaging
Germany	All packaging waste: paper, cartons and cardboard, plastics, aluminium, ferrous metals, beverage cartons, glass, other composites
Japan	Glass bottles, PET bottles, paper containers and wrapping, plastic containers and wrapping
Singapore	Paper carrier bags, glass beverage bottles, plastic carrier bags, plastic beverage bottles, plastic packaging rigid, plastic packaging flexible, composite (plastic aluminium sachets), metal beverage can, metal food can and other metal packaging waste, paper product packaging and other paper packaging waste
South Africa	Paper waste and paper packaging, glass, metal packaging, plastic packaging (PET, PP, LDPE, LLDPE, HDPE, HIPS, ESP), PVC plastic
South Korea	Paper box, metal can, glass bottle, synthetic resin packaging material
Taiwan	Metal containers, aluminium containers, glass containers, and plastic containers

(Source: Bünemann et al., 2020a; Bünemann et al., 2020b; EEA, 2019; NEA, 2021; ENV, n.d.; EPA, 2012)



EPR system in Germany is governed by government

Figure 6: For-profit multiple PRO based EPR system for packaging waste in Germany (Adapted from Bünemann et al., 2020a)



EPR system in Taiwan is governed by government

Figure 7: EPR in Taiwan (Chung, 2008)

The lessons learnt from the implementation of EPR in some of the abovementioned countries are given below.

3.3.1 LESSON LEARNT FROM EPR IN JAPAN

- Japan has introduced a mandatory EPR policy for packaging since 1995, which is working well with regard to waste collection and public awareness. The waste collection and infrastructure are considerably good. However, most of the collected packaging waste is predominantly not recycled but incinerated and a very minor amount of waste is disposed of in landfills. The majority of plastic is incinerated and less than 5% is sent to landfills.
- Besides that, Japan also does not have collection targets. The lack of a shared target fosters only partial optimization of the system and indifference among the involved stakeholders regarding the system, as no collection target is incentivized
- There is no strong market for recycling plastic waste in Japan. Current recycling rate of plastic is only 23% (Greenpeace, 2019)
- Currently there are no mandatory guidelines on recyclables available.
- Lack of product design considerations. There are, however, some guidelines and initiatives established by industry associations.

3.3.2 LESSON LEARNT FROM EPR IN SOUTH KOREA

- Recycling rates for paper, plastic, metals, construction waste and e-waste are very high in Korea (>90%). There are about 5972 recycling companies in 2018.
- Korea has enough resource recovery facilities in place to handle various separate waste streams.
- Producers and importers of EPR items collect and recycle products or packaging at the end of their life cycles, or pay the relevant fees for the Producer Responsibility Organisations (PROs) to do so on their behalf. Producers and importers also facilitate recycling by developing recycling technology, using resource efficient design techniques, restricting the use of hazardous substances, and producing or importing products that are easier to recycle. Producers or importers have the option of setting up a PRO to carry out their recycling responsibilities on their behalf.
- The Republic of Korea Ministry of Environment also allocated a total of 103.6 billion KRW (around USD 94.18 million) in 2016 with an interest rate of 1.51% for a maximum period of 10 years for the waste recycling investment.

3.3.3 LESSON LEARNT FROM EPR IN SINGAPORE

- The bold leadership of the government of Singapore can be foreseen through the introduction of mandatory reporting of packaging data and 3R plans for packaging, which will be introduced in 2020 and legislated under the Resource Sustainability Act.

- The mandatory packaging reporting framework will also lay the foundation for an EPR framework for managing packaging waste, including plastics. This will ensure producers are responsible for the collection and recycling of the materials they use to package their products.
- Overall recycling rate for Singapore is 59% (2019) and plastic recycling rate is only 4% (NEA, 2019).
- One of the recent recycling initiatives by NEA and F&N (Fraser & Neave) is to introduce smart Reverse Vending Machines (RVMs) across Singapore. This aims to encourage Singaporeans to adopt an eco-conscious lifestyle by offering them a convenient and rewarding way to recycle.
- Singapore's National Recycling Programme makes sure every public housing complex has a recycling bin in its vicinity – the large blue ones are for recycling and the big green ones for regular household garbage.

3.3.4 LESSON LEARNT FROM EPR IN TAIWAN

- In Taiwan, MSW management policies are incorporated with the EPR concept which requires manufacturers and importers of new products to fund recycling.
- The introduction of the 4 in 1 recycling program in 1997 and mandatory separation at source since 2005 shows a very progressive trend in overall recycling rate in Taiwan. The overall recycling rate is 54% and plastic recycling rate and plastic recycling rate is 73% (EPA, 2020)
- Taiwan Environmental Protection Agency (TEPA) established the official Recycling Fund Management Board. The responsible plastic manufacturer/producer/ importer will pay the advance recycling fee whereby the rate is fixed by TEPA. TEPA will subsidize the collecting and recycling system.
- The imposition of higher recycling fees for single use plastic and green rate incentive rate for packaging with design labels that can be recycled easily also contribute to development of eco-friendlier products in Taiwan.
- TEPA also support and subsidize the establishment of Collecting Stations in Local communities, Designated Stores with recycling facilities, NGOs and Recycling Enterprises and Scavengers to increase the recycling rate in Taiwan.

3.3.5 LESSONS LEARNT FROM EPR IN GERMANY

- Germany manifests that improving the effectiveness of the EPR system is a continuous effort as the installation of a central registry and successfully avoiding free-riders in the EPR system took approximately 28 years. Nevertheless, in those 28 years or so, the capacity of the waste sector, including recycling, has advanced greatly.
- However, owing to changing consumption behaviour such as e-commerce and takeaway, and living conditions (single households etc.), packaging waste increased to 18.7 million

tonnes in 2017 (from 15.6 million tonnes in 1991). In order to manage packaging from e-commerce in the country, German Packaging Act or also called VerpackG was launched in 2019. This law is applicable on start-ups, SMEs, or large enterprises as well and is based on the principles of EPR (The German Packaging Act, n.d). Any domestic or foreign companies in e-commerce selling physical goods to customers in Germany are obliged to pay recycling fees under the Packaging Act and must obtain a Packaging License from the German Recycling Scheme.

- The annual collection of lightweight packaging and glass packaging waste by PROs is 2.5 million tonnes and 2 million tonnes. The sorting of lightweight packaging is carried out in approximately 45 sorting facilities in the country.
- On the other hand, approximately 5.8 million tonnes of paper, cartons and cardboard packaging waste was collected from households in 2014.
- Total revenue generated by collection, sorting and recovery of packaging waste by PROs is 1 billion Euro annually.
- EPR systems in Germany require official reporting of packaging waste (quantity) recycled annually. In 2017, 1.87 million tonnes of glass, 1.2 million tonnes of paper, carton, cardboard boxes, 0.07 million tonnes of aluminium, 0.27 million tonnes of tinplate, 0.14 million tonnes of beverage cartons went through the recycling value chain.
- Lastly, 1.2 million tonnes of plastics were recovered where 0.46 million tonnes went through mechanical recycling.

3.4 CHALLENGES IN IMPLEMENTING EPR IN MALAYSIA

Currently, the implementation of EPR to manage the plastic and packaging waste is not possible as there is no explicit legal framework for EPR. The manufacturers may face challenges because this law will possibly add additional cost to their current expenditure and furthermore, most manufacturers are not familiar with the EPR system.

1. Lack of Dedicated EPR or Packaging Waste Policy or Regulation

One of the major gaps in the implementation of EPR for packaging waste in Malaysia is the absence of dedicated policies and/or regulations on EPR for packaging waste. Unlike countries like Germany, Austria and others where reporting of MSW composition includes packaging waste generation and composition (instead of reporting typical MSW streams such as plastic, metal, glass, paper etc.), Malaysia does not have anything similar to these countries. It can be contended that the emphasis of recycling and increasing national recycling rate in the national policies have played their part in improving Malaysia's recycling rate from 5% in 2005 to 28% in 2019.

2. Financing the implementation of EPR policies (regulation)

If a new policy is to be introduced into our current waste management system, there is a need for sufficient funding. However, the government budget often does not have enough resources to include such costs. Furthermore, there is a need for proper recycling centres or facilities before

mandatory EPR policy takes place. A successful implementation also means there is an efficient waste collection system whereby there might be a need for separate collection of recyclables.

3. Lack of standardization in current waste management system

The government had started to govern the management of solid waste through federalisation and privatisation in 2000. As for privatisation consist of three concession private bodies, that are Environment Idaman Sdn Bhd (E-Idaman Sdn Bhd), Southern Waste Management Environment Sdn Bhd (SWM Env Sdn Bhd) and Alam Flora Sdn Bhd. These three private bodies respectively covering Peninsular Malaysia which E-Idaman Sdn Bhd responsible in managing Kedah and Perlis, meanwhile SWM Env Sdn Bhd covering Negeri Sembilan, Melaka, and Johor and lastly, Alam Flora Sdn Bhd for Kuala Lumpur, Putrajaya, and Pahang that eventually take over the states of Kelantan and Terengganu. Besides Sabah and Sarawak, the states of Selangor, Perak, and Pulau Pinang are still managed by the local authorities for the management of solid waste.

4. Challenges in implementation of EPR system

Due to weak governance, the implementation of the National Solid Waste Management Policy has not been successful. Similar weak governance among respective stakeholders of EPR system in Malaysia may also hamper the implementation of EPR system for packaging waste. Therefore, a coordinated, participatory, and diligent cooperation of all involved stakeholders may be required for successful implementation of the EPR system.

5. Potential Implementation of “Pay as you Throw” Initiative

While the “pay as you throw” initiative may be an effective measure to reduce waste generation, it may negatively impact the EPR system implementation in Malaysia. Pay as you throw” initiative is part of the National Solid Waste Management Policy 2016 and of the Green Technology Master Plan’s policy planning for the waste sector. Although it is not implemented in Malaysia yet, it may cause an outcry in consumers as they would be participating in EPR system by potentially paying additionally for packaged goods (albeit minimal amount) and would also have to pay for waste generation if “pay as you throw” is implemented.

6. Over Reliance on Waste-to-Energy Option

Green Technology Master Plan targets establishing 3 waste-to-energy (WtE) plants by 2030. As seen in European countries, long term contracts with WtE infrastructures demands a certain quantity of MSW (combustible waste) for a certain period of time by local municipalities and has impeded the proliferation of recycling in those countries (Schneider & Ragossing, 2015). Thus, WtE may act as a barrier for the implementation of EPR unless EPR targets also include energy recovery. However, the principles of EPR and circular economy prefer closing the loop and enhancing recycling while WtE results in loss of resource and raw material from the environment still needs to be extracted for new production.

4. EPR RECOMMENDATIONS FOR MALAYSIA

4.1 POLICY AND REGULATION RECOMMENDATIONS

Countries with dedicated regulations for EPR have had successful implementation of EPR systems. While their legislation may have started as packaging ordinances or similar packaging related laws, they were further revised and were devoted to EPR for packaging specifically. Therefore, in order to learn from the experience of other countries, it is recommended that Malaysia should aim towards formulating a dedicated EPR regulation for packaging waste. This recommendation section is based on the analysis carried out on EPR systems implemented in other countries (see subsection 3.3). The dedicated regulation on EPR in Malaysia should have following elements:

1. Unambiguous objectives of EPR regulation
2. Setting quantitative targets for collection and recycling of each stream of packaging waste
3. Clearly outlines the stakeholders and their responsibilities in the EPR system including PRO
4. Explicitly defines which producers and importers will be obliged for paying EPR fee
5. Promotes the creation of information system and reporting platform for packaging waste
6. Clearly defines the calculation method for determining the amount of packaging recycled (for example, packaging waste entering recycling facility or the amount of secondary material extracted from packaging waste out of total amount of packaging waste)
7. Sets fines and penalties for obliged producers and importers failing to fulfil their responsibilities or to contribute financially
8. Formulating clear plan on utilization accumulated EPR funds; the funds could be used for establishing or strengthening recycling infrastructure in Malaysia
9. Integration of informal sector (if required)

The dedicated EPR regulation is recommended to be under the Solid Waste and Public Cleansing Management Act 2007 regulated by Ministry of Housing and Local Government as it has section 102 “Take back system and deposit refund system” where it authorizes the minister, “by order published in the Gazette”, to establish take back system (1) that:

- i. “Necessitates that specified products or goods at the end of their intended use shall be taken back by the manufacturer, assembler, importer or dealer and that the manufacturer, assembler, importer or dealer shall be obliged on their own account and cost to recycle or dispose any products or goods taken back in a specified manner
- ii. Necessitates that any person shall deliver specified products or goods to the manufacturer, assembler, importer or dealer

- iii. Necessitates any dealer of specified products or goods to receive and store specified products or goods to be taken back”

and (2) authorizes Minister, “by order published in the Gazette”, for establishing deposit refund system and determining:

- i. “The specified products or goods
- ii. The deposit refund amount
- iii. The labelling of the products or goods
- iv. The obligations of the dealers of the products or goods”
- v. Moreover, section 101 of Solid Waste and Public Cleansing Management Act 2007 gives authority to the Minister, “by order published in the Gazette”, to require:
- vi. “Any solid waste generator to reduce the generation of controlled solid waste in any manner or method”
- vii. “Any person to use environmentally friendly material” – which could be implied as recycled material or secondary raw material
- viii. “Any person to use specified amount of recycled material for specified products” to form legal basis for packaging manufacturers to utilizes certain amount of secondary raw material (depending on the quality of secondary raw material and expected quality of final packaging)
- ix. “Any person to limit the generation, import, use, discharge or disposal of specified products or materials” could form the legal foundation for reducing landfilling and other treatment of packaging waste. Thus, prioritize maximum recycling of packaging waste. This could be implemented once the EPR system or recycling technology has matured in Malaysia.
- x. “The implementation of coding and labelling systems for any product or material to promote recycling”
- xi. “The use of any method or manner for the purpose of reducing the adverse impact of the controlled solid waste on the environment”, thereby promoting recycling and resource circulation since recycling poses limited to no adverse effects on the environment as compared to waste management technologies.
- xii. “The use of any method or manner for the purpose of reduction, reuse and recycling of the controlled solid waste”

Lastly, for the EPR policy, the National Green Technology Master Plan 2017 - 2030 has set an unambiguous future initiative of establishing an EPR system for resource circulation. While it does not go into detail of formulating the EPR system or setting a timeline for the implementation, it explicitly targets setting of EPR system in Malaysia. Thus, the EPR system for packaging waste could be approached under the umbrella of the National Green Technology Master Plan. Similarly, as EPR is one of the initiatives identified to transition to Circular Economy, the upcoming circular economy roadmap for plastics by KASA could explicitly include EPR which could also aid the

propagation of EPR scheme at policy level. After consultations, with different ministries and other stakeholders, it was learnt that EPR scheme is going to be an important part of the circular economy roadmap, which was also suggested in WWF Malaysia’s report on EPR for packaging waste.

Since the EPR system shifts operational and financial responsibilities from the public sector to producers and importers of packaging, it provides necessary infrastructure (sorting and recycling centres) and finances (as the waste management sector in developing countries is underfunded) for sustainable management of packaging waste. Hence, if implemented correctly and efficiently, the EPR system can reduce (and potentially eliminate) plastic pollution, improve resource circulation and reduce extraction of raw material from nature which are principles of circular economy and sustainability.

4.2 ROLES AND RESPONSIBILITIES OF STAKEHOLDERS

There are quite a number of agencies that must collaborate in order to implement the EPR policy for packaging waste in Malaysia.

Table 10: Stakeholders and their roles in proposed EPR Scheme for Malaysia

Stakeholders	Roles and Responsibilities
National EPR Advisory	<ul style="list-style-type: none"> ● Will be comprised of MHLG, NSWMD, KASA, DOE, SWCorp ● Will be the national authority to govern plastic and packaging waste management in the country. ● Will ensure strategic guidance and funding required for implementation of EPR policy. ● To prepare a legal framework for the implementation of EPR on plastic and packaging waste. ● To engage with various stakeholders to get input on the implementation of EPR policy for plastic packaging and packaging waste. ● Establish an online EPR Management system for efficient reporting and monitoring.
Ministry of Housing and Local Government (MHLG)	<ul style="list-style-type: none"> ● Responsible for the enforcement of EPR policy over Act 672 States. ● MHLG will also be responsible for ensuring the compliance of recyclers with any environmental regulation, together with KASA (Ministry of Environment and Water) and DOE (Department of Environment) ● Will be the national EPR Advisory committee.

<p>National Solid Waste Management Department (NSWMD)</p>	<ul style="list-style-type: none"> • Will be responsible for coordinating between federal and state governments, and local authorities on the implementation of EPR policy for plastic packaging waste for both Act and non-Act 672 states • NSWMD will also be responsible for the enforcement of EPR policies under the direction of MHLG • Will enforce national 3R (Reduce, Reuse, Recycle) policies with MHLG and SWCorp. • Give license for collection, sorting, recycling and treatment of packaging waste to waste management operators that fulfill the standards and requirement set under the EPR system
<p>Solid Waste Management Corporation (SWCorp)</p>	<ul style="list-style-type: none"> • To carry out the registration of waste management actors with the PRO. • SWCorp, along with MHLG will be responsible for enforcement of the EPR system and to monitor the operations and compliance of concessionaires in Act 672 States related to EPR policies. • Prepare relevant reports on the data collected on plastic recycling and other relevant info related to EPR. • Will also be responsible for promoting and creating awareness about EPR policy and EPR system in Malaysia together with MHLG and NSWMD.
<p>Ministry of Environment and Water (KASA)</p>	<ul style="list-style-type: none"> • Will work together with MHLG on the implementation and legal framework aspect of EPR. • Will also be responsible for jurisdiction over other environmental matters. • KASA would be responsible for penalizing stakeholders who will not fulfil their duties.
<p>Department of Environment (DOE)</p>	<ul style="list-style-type: none"> • Will scrutinize, approve and monitor new recycling establishments for packaging waste.
<p>PRO</p>	<ul style="list-style-type: none"> • Will be responsible to contract producer, waste management service providers and other relevant stakeholders • will monitor whether individual or collective recycling targets are being met • Submit monthly & annual reports by coordinating with SWCorp

	<ul style="list-style-type: none"> ● Will financially support EPR system and will also be responsible of collecting EPR fees and must ensure that the collected EPR fees will only fund domestic packaging waste management, not for imported waste ● PROs also must educate and create awareness to other producers and manufacturers on the implementation of EPR and the related policies, rules and regulation.
Waste management concessionaires/contractors	<ul style="list-style-type: none"> ● Responsible for the collection, segregation, recovery and recycling of packaging waste, receive funds from PROs for the collection, sorting and recycling of packaging waste, meeting targets and operational standards for the PRO and manufacturers and producers. ● Engage informal waste collectors and create the opportunity for them to participate in the formalized waste management.
Recyclers	<ul style="list-style-type: none"> ● Recycle the collected packaging waste ● Report the data on recyclable waste to the National EPR Advisory committee and PRO ● To approach the PRO with an efficient plan of recycling / recovering packaging materials and receive funds from PRO according to the waste management scheme proposed. ● Will drive efficiencies in resource recovery. ● Involve and uplift existing marginalized communities, currently involved in the waste management process. ● To meet the environmental standards and performance for recycling. ● Maintain high quality recycling standards.
NGO's -WWF	<ul style="list-style-type: none"> ● To assist the national advisory team for the implementation of a voluntary EPR scheme and subsequently a mandatory EPR policy ● Provide guidance for preparation on EPR framework
Ministry of Domestic Trade & Consumer Affairs	<ul style="list-style-type: none"> ● Responsible for domestic trade and enforces Price Control for packaging and plastic products. ● Tracks data on local FMCG input within the domestic market. ● Responsible for EPR scheme that involves a price-premium that will be passed on to consumers.

<p>Economic Planning Unit (EPU) Prime Minister's Department</p>	<ul style="list-style-type: none"> • EPU is developing the 12th Malaysia Plan in coordination with other relevant ministries, which will include Circular Economy and EPR as a policy tool. • EPU also has a role to be the national guiding body for circular economy in Malaysia
<p>Malaysian Green Technology and Climate Change Centre (MGTC)</p>	<ul style="list-style-type: none"> • MGTC is proposed to monitor the PRO since it is assigned to propel the nation towards Green Growth, Climate Change Mitigation and Climate Resilience and Adaptation

(Adapted from Guideline Document Uniform Framework for Extended Producers Responsibility, 2016; WWF, 2020)

4.3 EPR MODEL

The EPR model presented below is an extension of EPR model proposed in WWF-Malaysia's report on EPR (Figure 22 of the report) which recommended an industry-led, single non-profit PRO who will be main operator of EPR system in Malaysia (See the appendix for summary of WWF-Malaysia's report on EPR). The elements of the EPR model given below were chosen based on the examination of EPR systems implemented in Germany, Austria, South Africa, Belgium, Japan and other countries which are mentioned in section 3.3. Figure 8 shows the flow diagram of the EPR scheme that could be executed for packaging waste in Malaysia.

1. EPR model for packaging waste in Malaysia would include a single PRO for all types of packaging waste. So, the entire EPR system will be monitored by that PRO.
2. Obligated companies will have to register with the PRO and pay EPR fee depending on the amount and type of packaging waste they introduce into the Malaysian market.
3. PRO will contract concessionary companies in Malaysia to collect, sort and recycle packaging waste on behalf of the obliged companies.
4. Consumers may have to pay a small fee for purchasing packaged products. Packaging, once discarded, will be collected by contracted concessionary companies.
5. Waste service providers will then collect, sort and recycle packaging waste. Non-recyclable packaging waste would be sent for other treatment and processing such as energy recovery, co-processing for cement kilns and road laying process.
6. Raw material suppliers or packaging manufacturers will buy and use recycled material in their packaging and products.

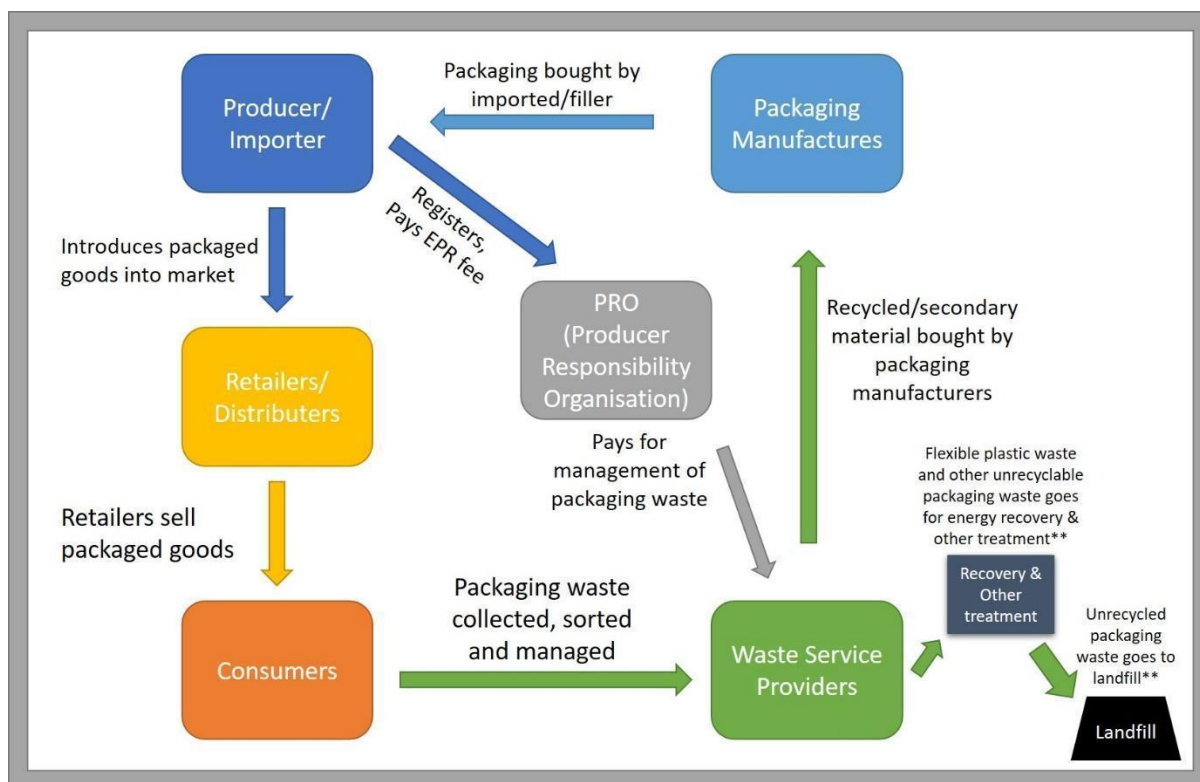


Figure 8: Flowchart of EPR scheme for packaging waste in Malaysia

*** note until redesigning of packaging and/or advancement of recycling technologies, there will be some non-recyclable waste which will be sent for energy recovery and other treatment and will need to be disposed of properly*

It is recommended that the importers or consumer good companies pay EPR fees for the packaging they put into the Malaysian market. These stakeholders will have reliable information on the quantity and type of packaging they introduce into the market. Several key points should be considered before selecting EPR fee for each type of packaging material and these include:

- Amount of packaging
- Material types of packaging
- Recyclability of packaging material – EPR fee should be higher for packaging material which has lower recyclability
- Maturity of recycling technology for respective packaging material in Malaysia

4.3.1 TIMELINE FOR DRAFTING EPR REGULATION

The first step of the formation of a bill or a legislation is a proposal submitted by a ministry. Then a committee is set by Attorney General Chambers of Malaysia to draft the contents of the bill or legislation. Once it is formulated, only the title of the bill is presented by a minister in Dewan Rakyat which is referred as “First Reading”. At this stage, the debate and discussion are not allowed by the members of parliament. The next stage is the most important stage in passing a bill, known as “Second Stage”, where parliamentary debate is conducted on the contents and the principles of the bill in Dewan Rakyat (Second Reading). This stage is followed by “Committee Stage” where a

committee is formed to discuss and propose amendments on the bill in a less formal setting. After the completion of the discussion, if there are no objections, the Dewan Rakyat members will be notified that the bill has passed through three stages, thus it will be passed to Dewan Negara. The similar process of debate undergoes in Dewan Negara (Third Reading) but the discussion or debate does not last more than a year before it is moved to Yang Di-Pertuan Agong, the head of the state. If the Yang Di-Pertuan Agong does not agree with the bill, the bill is sent back to parliament for revisions. When the bill is passed for the second time to Yang Di-Pertuan Agong for his consensus, and Agong's approval the bill becomes law. However, according to Article 66(4A) of the Federal Constitution, the bill will still become law even if Yang Di-Pertuan Agong's consensus does not reach parliament within the 30 days (Tham, 2018; Mahmood, 2017). The tentative timeline for formulating and passing the EPR regulation in Malaysia is shown in Table 11 below.

Table 11: Timeline of establishing EPR regulation for packaging waste

Timeline	Recommended Actions
0 – 3 months	Stakeholder meeting 1 including public agencies or ministries, packaging material manufacturers, fillers, importers, consumer goods companies, retailers, distributors, recyclers, waste management service providers to bring together all participants and compile key findings
3 – 6 months	Stakeholder meeting 2 to finalize/gather the suggestions of all stakeholders for EPR framework
6 – 9 months	Proposal submitted by MHLG the Dewan Rakyat
9 – 18 months	Drafting of EPR regulation by the committee set by Attorney General Chambers of Malaysia to create dedicated legislation for EPR for packaging waste defining obliged companies and producers, their responsibilities, targets, exemptions and register of EPR scheme
18 – 24 months	First three readings of the EPR regulation
24 – 36 months	Approval and gazetting of EPR regulation and setting recycling targets

4.3.2 TIMELINE FOR IMPLEMENTATION OF EPR REGULATION

The timeline for executing EPR regulation and relevant initiatives are shown in Table 12 below. The EPR system referred here is based on the proposed EPR system by WWF-Malaysia (see page number 69 – 70 for detailed timeline of EPR implementation).

Table 12: Timeline of implementing EPR regulation

Timeline	Recommended Actions	Objectives	Type of EPR system
1 st Year	<ul style="list-style-type: none"> Establishment of voluntary, industry-led, non-profit PRO for packaging Registration of obliged producers with PRO by MGTC PRO contracting municipalities / waste management companies Creating awareness among public by PRO, SWCorp along with MHLG and MSWMD 	Capacity Building	Voluntary
2 nd Year	<ul style="list-style-type: none"> Expand the registration of obliged producers with PRO by MGTC Creating awareness among public by PRO, SWCorp along with MHLG and MSWMD Initiation of voluntary packaging waste collection and management system in Act 672 states by PRO contracted collectors and waste service providers 	Execution of EPR system	Voluntary / Mandatory
3 rd Year	<ul style="list-style-type: none"> Review of EPR scheme and the performance of PRO, obliged producers, set targets, performance of waste collectors, recyclers and other relevant stakeholders in the EPR system in Malaysia by MHLG or KASA or both Amendments in EPR system (if necessary) under the supervision of MHLG or KASA Creating awareness among public by PRO, SWCorp along with MHLG and MSWMD Renewal of contracts (if required) by PRO 	Revise and improve EPR scheme	Voluntary / Mandatory
4 th Year	<ul style="list-style-type: none"> Meeting with relevant stakeholders to be co-chaired by KASA and MHLG Creating awareness among public by PRO, SWCorp along with MHLG and MSWMD Legal and formal implementation of EPR in Act 672 states under the supervision of MHLG, NSWMD 	EPR scheme is made compulsory	Mandatory
5 th Year	<ul style="list-style-type: none"> Review of EPR scheme in Malaysia by MHLG or KASA or both Amendments in EPR system (if necessary) under the supervision of MHLG or KASA Nationwide implementation of EPR system for packaging waste under the supervision of MHLG 	EPR scheme is made compulsory	Mandatory

5. WAY FORWARD AND CALL FOR ACTION

1. **Capacity building and training** of producers (including SMEs and LEs) and Malaysian public are vital to successful implementation of the EPR system in Malaysia. The importance of EPR, the role of producers, economic and environmental benefits of EPR must be clearly communicated with producers. Moreover, widespread education and training programs must be launched for the public to create awareness and provide guidance on source separation, importance of recycling, their role as waste generators in the waste management value chain and others.
2. **Dissemination of EPR information** should be in four languages including English, Bahasa, Chinese, and Tamil to reach every possible producer and citizen who will have an important role to play in the EPR system.
3. **Stringent enforcement of waste separation at source** must be carried out on an urgent basis. Without source separation, the EPR system may be jeopardized to a great deal due to generation of contaminated co-mingled waste.
4. **Data collection of all types of generated packaging waste in Malaysia.** MSW generation data is usually obtained through estimation in Malaysia but real and empirical data collection is of paramount importance in the implementation of EPR scheme in Malaysia.
5. **Create an EPR Roadmap** as a guide and reference for all stakeholders.
6. **Use of waste banks in Malaysia** before the instigation of EPR system in Malaysia.
7. **Introduce the Reverse Vending Machine (RVM)** to encourage recycling.
8. **Establish high-level inter-agency/ministry multi-stakeholder platforms, national advisory committee and task forces** represented by key ministries, industries, companies including SMEs, civil societies and academic institutions for discussions on harmonising EPR implementation.
9. **Incentivisation of collection and recycling of packaging waste** such that government may offer subsidy per tonne of packaging waste collected and recycled, whereas consumers also pay for packaging in form of increased cost of product
10. **EPR systems may be supported by landfill tax.** However, this approach must be implemented with caution as illegal dumping of waste may become the norm and without the change in packaging design, landfill tax may do more harm than benefit.
11. Current waste management is failing the implementation of resource circulation and if the status quo is not changed, it would also fail the execution of the EPR system in Malaysia. Therefore, **a revamp of the waste management system is recommended.** In addition, the assessment of performance of waste concessionaires must be carried out

based on collection and recycling quota set in the EPR system. The renewal of contract or awarding of new contracts should be based on performance and the capacity to achieve it.

12. The government should take the first initiative in implementing the EPR scheme. **Bold leadership is required by the Government of Malaysia** for a mandatory EPR scheme guided by a dedicated EPR regulation to achieve large scale collection and economies of scale by having all obliged companies contributing to the EPR scheme.

6. CONCLUSION

The generation of MSW in Malaysia is increasing annually, whereas the recycling rate is relatively low. Therefore, the majority of packaging waste is disposed of in landfills. Plastic is the second main component of MSW in Malaysia, followed by paper. However, only 24.6% of plastic waste is recycled. Hence, to reduce the loss of resources and improve recycling rate, EPR for packaging waste is being considered in Malaysia. There are several countries including Taiwan, South Korea, Japan, Germany, Belgium and others that have successfully implemented EPR schemes for packaging waste in their respective countries. Based on the findings of analysis of EPR schemes in selected countries, one industry-led, non-profit PRO is proposed for Malaysia which is also in line with the recommendations from the WWF-Malaysia's report, and this EPR system could be implemented under a newly formulated regulation dedicated for EPR. Till date, there is no dedicated policies or regulations for EPR in Malaysia, except the national Green Technology Master Plan which proposes EPR for the waste management sector. However, the concept of EPR and elements of EPR are covered in several policies and legislations in Malaysia.

Hence, it is recommended that MHLG to be the lead ministry in proposing the EPR dedicated regulation to the *Dewan Rakyat*. It is proposed that EPR regulation be formulated under the national Solid Waste and Public Cleansing Management Act 2007 that has Section 101 and Section 102 which promote the concept of EPR. Concurrently, a voluntary EPR system may be implemented in Malaysia as recommended by WWF-Malaysia's report. As for policy, the circular economy roadmap for plastics should incorporate the EPR scheme since EPR is one of the key tools for achieving circular economy. The recommendations on roles and responsibilities for different agencies under mandatory EPR includes registration of waste service providers by SWCorp, contracting of waste service providers and registration of packaging producers and importers by the PRO, enforcement and review of EPR systems carried out by the National EPR Advisory Committee. Similarly, the education and public awareness campaigns could be carried by the PRO, SWCorp along with MHLG and MSWMD.

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8. APPENDIX

8.1. FUTURE AREAS OF RESEARCH

Several future areas for research came to surface after the meeting with stakeholders. These are listed below:

1. Study the industry's willingness or readiness to participate in the EPR scheme.
2. Compare the notes of the timeline of the EPR implementation with KASA since KASA is formulating a circular economy roadmap which will include all elements of EPR.
3. Will the industry-led EPR system be suitable for Malaysia? Several ministries have put the emphasis on the big enterprises to take care of their own waste and lead the market.
4. Circular Economy of organic waste may be more suitable and more game changing as more than 50% of MSW is organic waste.
5. Actual and real data on the recycling industry of different MSW components is required including glass, plastic, paper, metal and others.

8.2 WWF-MALAYSIA'S REPORT ON EPR FOR PACKAGING WASTE IN MALAYSIA

The following points were extracted from WWF-Malaysia's report on EPR for packaging waste in Malaysia which were used as the foundation for recommending the EPR system for Malaysia.

1. Mandatory EPR scheme will provide valuable funds for the underfunded waste management sector in Malaysia.
2. Proposed EPR scheme must include all types of packaging material such as glass, metal, composites, paper etc. This way material substitution in packaging manufacturing may be discouraged.
3. Non-profit, singular PRO is recommended for establishing EPR system which will be comprised of stakeholders from various stages of packaging value chain.
4. The EPR must be defined based on the material used in packaging where high recycling value packaging must have lesser fee than the low recycling value packaging. EPR fee would be paid by all obliged companies.
5. EPR system including PRO must be monitored by Ministry of Environment and Water and Ministry of Housing and Local Government. Would be responsible of strict monitoring, controls, penalties etc.
6. Formulating and implementing a legal framework for a mandatory EPR system, whereas dialogues and cooperation between authorities and industry players are required.

7. Before establishment of actual PRO and EPR system, a short-term PRO must be established. It will play a vital role in bringing together voluntary companies, organisations and policy makers for negotiation and cooperation to come up with a setup of compulsory EPR system, as well as its regulatory, organisational, and control mechanisms.
8. Continuous evaluation, revision and optimisation must be carried out once EPR system is fully implemented.
9. Packaging waste generating from MSW from households, commercial area, offices, schools etc. would be covered in EPR system for packaging waste.
10. Obligated companies are producers or importers of packaged products. (Raw material suppliers, resin producers, packaging material converters, are not obliged companies).
11. The responsibilities of PRO include:
 - a. Registration of all obliged companies
 - b. Collection and administration of all funds
 - c. Opening tender and contracting waste service providers (for collection, sorting and recycling)
 - d. Documentation (of collection, sorting and recycling of packaging waste)
 - e. Educating and creating awareness among consumers of packaged products
 - f. Controlling the services related to waste management
 - g. Financing all relevant tasks
 - h. Documentation and verification (to prove that all required tasks have been completed)
 - i. Identifying free riders and registering all relevant companies
12. In mandatory EPR system, identifying and managing obliged companies and waste service providers is vital as it can eliminate free riders and corruption and promotes effective utilization of finances. There are two main registrations in the EPR system; registering the obliged companies based on the amount of packaging they put in the market and registering the waste management service providers.
13. Confidentiality of data is of paramount importance.
14. The registration of waste service providers should also be based on the sustainability (such as carrying certificates etc.).
15. A government authority must be dedicated to oversee the operations and flow of finances performed by the PRO. A report may be submitted on an annual or biannual basis by the PRO to the government authority.
16. Penalties, fines and appropriate measures must be put in place for the non-compliant stakeholders in the EPR system.
17. Mandatory EPR system – provides a reliable financial basis for large-scale collection, sorting, and recycling of packaging which is vital for establishing sufficient businesses along the value chain.
18. New, separate legislation for EPR is recommended due to the complexity created by Act 672.

19. All packaging materials (plastic, metal, paper, composites) from MSW, as well as, service packaging and non-packaging plastic items. So that less valued plastic items can be managed sustainably through the proposed EPR system.
20. The companies putting packaged products in the Malaysian market would be obliged to pay EPR fee, as well as, companies putting other listed non-packaging plastic items in Malaysian market. Moreover, companies selling service packaging to restaurants, street vendors etc. would also be obliged instead of restaurants, street vendors and others.
21. All obliged companies would be required to pay the EPR fee based on the amount of packaging they put on the market. A modulated fee is proposed where packaging material with higher recyclability is going to have a lower fee than the material with lower recyclability. Similarly, higher fees would be charged to packaging material with challenging recyclability (having multilayer packaging) to discourage the usage of such material, as well as to provide financial input to build required systems to recycle such material.
22. A non-profit PRO is recommended for Malaysia. However, it is further recommended that a compulsory EPR system is required for ensuring holistic waste management where this PRO will be the sole operator and responsible for implementation of EPR scheme. This PRO is recommended to be led by the industry involving all stakeholders from the entire supply chain and also establish a platform for facilitating and connecting these stakeholders to improve the sustainability of packaging such as bringing together recyclers and packaging manufacturers to improve the product design to enhance its recyclability. Industry-led PRO will be composed of three group members including the obliged companies, other stakeholders in the packaging value chain (who will be charged membership fee for the operation of PRO) and the advisory board (comprised of ministries, municipalities, academic institutions, NGOs and others and they will not be charged membership fee).
23. It is recommended that separate collection of packaging waste be carried out and in the first phase of the implementation, the informal sector is allowed to collect this waste and transport to respective facilities (informal sector is suggested to be incorporated in next phases of EPR implementations).
24. It is also recommended that PRO would be responsible for establishing a sorting facility such as MRF or aggregators and this facility should have “mass-based gate fee”.
25. Recycling and recovery quota are suggested to be set after establishment of a reliable segregation at source and collection system throughout the country.
26. Malaysian Green Technology and Climate Change Centre (MGTC) should monitor the PRO as it is assigned to propel the nation towards Green Growth, Climate Change Mitigation, and Climate Resilience and Adaptation.
27. The registration of waste service providers is proposed to be carried out by SWCorp as they have ground information about already established companies in the waste sector.
28. KASA and KPKT are proposed to be responsible for penalising the stakeholders who will not fulfil their duties.

29. KPKT and SWCorp are proposed to monitor the EPR system in Malaysia.

8.3 TYPES OF PLASTICS GENERATED IN MALAYSIA

Table S1: Types of plastics

Types of plastics	Examples of products	Recyclable in Malaysia
Polyethylene Terephthalate (PET/PETE)	Water Bottles, Cookie Jars	Yes
High-Density Polyethylene (HDPE)	Milk Containers, Buckets, Shampoo Bottles	Yes
Polyvinyl Chloride (PVC)	Pipes, Synthetic Leather	No
Low-Density Polyethylene (LDPE)	Bubble Wrap, Plastic Bags,	No
Polypropylene (PP)	Disposable Food Containers, Bottle Caps	Yes
Polystyrene (PS)	Disposable Cups, Plates, Cutlery	No
Others	Miscellaneous Plastic, Nylon	No

8.4 EPR INFORMATION ON FOUR ASIAN COUNTRIES

Table S2: Information on EPR in four Asian Countries

	Japan	Korea	Singapore	Taiwan
Country information	<p>Japan is an island country in East Asia located in the northwest Pacific Ocean</p> <p>Population: 126.3 million (2019).</p> <p>Country group: Develop/advanced country, high economic development</p>	<p>Korea is The Republic of Korea, an upper middle-income country located in the southern part of the Korean Peninsula.</p> <p>Population: 51.71 million (2019)</p> <p>Country group:</p>	<p>Singapore is a sovereign island city-state in maritime Southeast Asia.</p> <p>Population: 5.704 million (2019)</p> <p>Country group: Develop/advanced country, high</p>	<p>Taiwan is republic of China and is East Asia countries located in northwest of China.</p> <p>Population: 23.84 million (2021)</p> <p>Country group:</p>

		Develop/advanced country, high economic development	economic development	Develop/advanced country, high economic development
Legal framework	EPR system for packaging in 1995 via its Containers and Packaging Recycling Act . The act was revised in 2006. (JCPRA, 2012)	EPR for packaging waste is under the following law: Non-profit Corporation Aggregate under the- Civil Law Act - Public Service Corporation- Act on the Establishment and Operation of Public Service Corporations Packaging Recycling Cooperative- Article 27 of the Act on the Promotion of Saving and Recycling of Resource. (Joo, 2014)	Singapore’s Resource Sustainability Act (RSA). Extended Producer Responsibility (EPR) framework for packaging waste management, which will be implemented no later than 2025. (Bea & Low, 2019)	Waste Disposal Act EPR was first established in Taiwan when the Waste Disposal Act was amended in 1988. Since then, new regulations and systems, including Taiwan’s signature “4-in-1 Recycling Program,” have been implemented. Latest revision has been made in year 2001. (EPA, 2012).
Policy on EPR	Containers and Packaging Recycling Act 1995 mandates fee payments from all manufacturers using containers and wrapping for shipping	Korea introduces EPR in year 2003. EPR was introduced to promote the reduction, reuse and recycling of waste by encouraging manufacturers to	-Singapore to implement EPR for packaging waste management by 2025. -The National Environment Agency (NEA) will be	-In Taiwan, MSW management policies is incorporated with EPR concept which requires manufacturers and importers of

	<p>their products, retailers and wholesalers using containers and wrapping for selling merchandise, Manufacturers of containers, importers who import and sell merchandise in containers or wrapping, and importers of containers.</p> <p>The fees are calculated based on the amount in kg of packaging material, are assessed on a yearly basis. Some exclusion is applied to small companies which includes manufactures with net sales of 240 million Yen (2.2 million USD) or less and those with 20 employees or less, as well as commercial and services with net sales of 70 million Yen (0.68 million USD) or less, and 5 employees or less. (JCPRA, 2012)</p>	<p>consider the environment at every stage of the product cycle, from product design to manufacturing, distribution, consumption and disposal. Every year, the Ministry of Environment announces a mandatory recycling rate for each product covered under the EPR system.</p> <p>-The EPR Scheme in Korea is basically Take-back scheme with recycling targets.</p> <p>EPR in Korea is subjected to target recycling rates which are set for each category of product, and any producer that fails to meet their targets is obliged to pay an additional recycling fee to cover the</p>	<p>implementing a Deposit Refund Scheme (DRS) for beverage containers by 2022 as the first phase of the Extended Producer Responsibility (EPR) approach for packaging waste management.</p> <p>-Mandatory reporting of packaging data and 3R plans for packaging will be introduced in 2020 and legislated under the Resource Sustainability Act.</p> <p>This builds on an existing mandatory waste reporting framework for large malls and hotels, which will also be expanded to all large industrial and commercial premises, including large convention and</p>	<p>new products to fund recycling.</p> <p>- In July 1997 the requirement changed with another amendment to the WDA that established the 4-in-1 Recycling Program.</p> <p>- Manufacturers and importers have to pay a recycling fee to Environmental Protection Administration Taiwan (EPAT) and offer collection of waste for recycling from consumers.</p> <p>The fees would feed into the Recycling Fund, which subsidizes collection and recycling by licensed enterprises.</p> <p>-In 2001, the Waste Disposal Act was revised again, expanding</p>
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	<p>-The Act determines the separate collection of packaging types like plastic containers and wrapping, PET bottles, glass and paper containers and wrapping. (Figure 6)</p> <p>(Yamakawa, 2014)</p>	<p>shortfall (Heo & Jung, 2014). EPR is mandatory for: Manufacture whose previous year revenues are KRW 1 billion (0.905million USD) or higher, and importers whose previous year revenues are KRW 0.3 billion (0.271 million USD) or higher</p> <p>OR</p> <p>Manufacture whose previous year sales volumes are 4 tons or higher, and importers whose previous year import volumes are 1 tons or higher.</p>	<p>exhibition centres, in 2020. For the mandatory packaging reporting framework, for a start, producers of packaged products and supermarkets with an annual turnover of more than \$10 million will be required to report data on packaging that they put on the market and their 3R plans for packaging.</p> <p>-The mandatory packaging reporting framework will also lay the foundation for an EPR framework for managing packaging waste, including plastics. This ensures producers are responsible for the collection and recycling of the materials</p>	<p>regulations under Article 10-1 to clarify responsibilities of manufacturers, importers and recyclers under the 4-in-1 Program. (EPA, 2012).</p> <p>- Under the 4-in-1 Recycling Program, online reporting systems are available for manufacturers and importers, recyclers, collectors, auditing and certification groups, and local EPBs.</p>
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			they use to package their products.	
Private/Government agencies involved for the implementation/enforcement of EPR system	<p>-The Japan Containers and Packaging Recycling Association (JCPRA)</p> <p>-Ministry of the Environment, - Ministry of the Economy, Trade and Industry</p> <p>- Ministry of Finance</p> <p>- Ministry of health, Labor and Welfare</p> <p>- Ministry of Agriculture, Forestry and Fisheries.</p> <p>-The national government is the supervisory authority of the system</p>	<p>-The Korean government, -Ministry of Environment of Korea</p> <p>Korea packaging recycling corporate</p> <p>-Korean Environment Corporation</p>	<p>-National Environment Agency</p> <p>- Ministry of Environment and Water Resources</p>	<p>-Taiwan Environment Protection Agency (TEPA)</p> <p>- Recycling Fund Management Board (RFMB) is a “bureau” of the Taiwan EPA that collects fees and distributes monies for specific recyclable products.</p> <p>Fee Rate Reviewing Committee (FRRC) - composed of representatives of government, academia, consumer groups, manufacturers and other sectors.</p>
Mandatory/Voluntary	Mandatory since year 1995	Mandatory for recycling since 2003	Yet to implement	Mandatory
Waste management system	-Waste management in Japan is carried out the municipalities carried out according to the	Waste management in South Korea involves waste generation reduction and	-Waste management in Singapore has a policy for waste management, which is to	MSW management in Taiwan is carried out by the municipalities.

	<p>Waste Cleaning Act.</p> <p>It also emphasize on efficient and sanitary collection of waste and recycling waste where possible.</p> <p>-In 2000's Basic Act for establishing sound material cycle society/Basic Recycling Act was established in Japan which is the framework for the principles of waste management, which includes reducing resources consumption and the responsibilities of stakeholders and citizen in managing waste.</p> <p>-The operation of municipalities is supervised by government organization.</p> <p>The ultimate waste treatment method in Japan is through incineration.</p> <p>- For curbside collection, residents purchase a licensed bag for each different fraction of waste.</p>	<p>ensuring maximum recycling of the waste. This includes the appropriate treatment, transport, and disposal of the collected waste.</p> <p>-The waste management in is under South Korea's Waste Management Law. This law aimed to reduce general waste under the waste hierarchy.</p> <p>Besides that, Waste Management Law imposed a volume-based waste fee system, effective for waste produced by both household and industrial activities.</p> <p>-Korea has a well-developed monitoring system for waste generation and treatment, with mandatory reporting by</p>	<p>incinerate waste which are not recovered, reused or recycled.</p> <p>-Singapore has our very own waste management system, which includes 4 waste-to-energy (WTE) incineration plants and an off-shore landfill.</p> <p>-MSW is collected by the Public waste collectors (PWCs) are appointed by NEA through open tenders to serve domestic and trade premises in Singapore by geographical sectors.</p> <p>-Currently, three PWCs operate in Singapore and serve in the six sectors.</p> <p>- The Environmental Public Health Act (EPHA) was amended on 1</p>	<p>-TEPA launched the policy of "waste minimization and resource recovery" in 2003 to promote zero waste, green manufacturing, green consumption, source minimization, resource recovery, and reuse.</p> <p>-Taiwan Environmental Protection Agency (TEPA) adapt incineration as the priority for waste treatment, followed by landfilling.</p> <p>-In 2005, Taiwan adopted a two-phase program under the Waste Disposal Act, which required people to separate waste into recyclables, and food waste.</p> <p>-The Mandatory waste sorting</p>
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		businesses and local authorities and a web-based online information system through which waste transfers, treatment processes and process results are reported and managed in real time.(KORA, 2003)	April 2014 to enable the mandatory reporting of waste data and submission of waste reduction plans by any owner for industrial and commercial waste.	policy implemented from 1 st January, 2005. A warning will be issued for the first non-compliance. A penalty of NT\$1,200 - 6,000 will be imposed on the second violation. - Per-Bag Trash Fees implemented in several areas. Pay as you throw, Per-Bag trash fee is NT\$ 0.36/L, however, collect recyclables and food waste.
EPR system model	Figure S1	Figure S2	Figure S3	Figure 7
Recycling of plastic/packaging waste	-Japan plastic recycling rate is 23%. (Greenpeace, 2019). The majority of plastic is incinerated and less than 5% is sent to landfills. Small plastic packaging and mixed plastics are predominately not collected separately	-Recycling rates for paper, plastic, metals, construction waste and e-waste are very high in Korea (>90%). -5972 recycling companies in 2018. -Resource recovery facilities	-Overall recycling rate for Singapore is 59% (2019) and plastic recycling rate is only 4% (NEA, 2019) . - Singapore's integrated solid waste management system focuses on two key	The overall recycling rate is 54% and plastic recycling rate and plastic recycling rate is 73% (EPA, 2020) - Taiwan implement 4 in 1 recycling program in 1997 and mandatory

	<p>or sorted, but incinerated.</p> <p>-By the end of 2017, Japan exported more than 50% of its collected plastic waste (mainly PET bottles) to China however after the Chinese government issued a ban on the import of plastic waste, the Japanese government decided to expand the national plastics recycling industry massively through subsidies, because the domestic treatment prices for plastic waste had increased tremendously.</p> <p>-After china issued the ban on plastic waste, Japan government decided to fund new, innovative recycling plants. In February 2019, Japan government discussed the draft for a framework directive regarding the handling of plastic waste. The</p>	<p>are in place to handle various separate waste stream.</p> <p>- Producers and importers of EPR items collect and recycle products or packaging at the end of their life cycles, or pay the relevant fees for the PROs to do so on their behalf. Producers and importers are also facilitate recycling by developing technology, using resource efficient design techniques, restricting the use of hazardous substances, and producing or importing products that are easier to recycle. Producers or importers have the option of setting up a PRO to carry out their recycling responsibilities on their behalf.</p>	<p>thrusts – waste minimisation and recycling, or simply the 3Rs (Reduce, Reuse, Recycle).</p> <p>-One of the recent recycling initiative by NEA and F&N is to introduce a smart Reverse Vending Machines (RVMs) across Singapore. This aims to encourage Singaporeans to adopt an eco-conscious lifestyle by offering them a convenient and rewarding way to recycle.</p> <p>-The NRP adopts a collection system in which paper, plastic, glass and metal recyclables are deposited into the blue recycling bin for collection by the PWCs.</p> <p>-Singapore’s National Recycling</p>	<p>separation at source since 2005</p> <p>- TEPA established the official Recycling Fund Management Board. The responsible plastic manufacturer/pr oducer/ importer will pay the advance recycling fee whereby the rate is fixed by TEPA. TEPA will subsidize the collecting and recycling system.</p> <p>- TEPA also impose higher recycling fees for single use plastic and green rate incentive rate for packaging with design label that can be easily removed.</p> <p>-Plastic waste subjected to recycling in Taiwan is: Waste PET containers, waste PVC containers, waste PP/PE</p>
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	<p>directive targeted a 25% reduction of all plastic waste. By 2035, all plastic waste generated in Japan should be either recycled or recovered through other processes like energy recovery (Still on drafting stage).</p>	<p>The EPR system primarily covers the following plastic packaging: PET bottles and synthetic resin packaging. -The Republic of Korea Ministry of Environment allocated a total of 103.6 billion KRW (around USD 94.18 million) in 2016 with an interest rate of 1.51% for a maximum period of 10 years for the waste recycling investment.</p>	<p>Programme makes sure every public housing complex has a recycling bin in its vicinity – the large blue ones are for recycling and the big green ones for regular household garbage. - The recyclables in the recycling bins in HDB estates are collected thrice a week for 660L recycling bins and once a week for 1800L/2200L side-loader recycling bins, while the private landed properties are provided with weekly collection of recyclables.</p>	<p>containers, waste expandable PS containers, waste un-expandable PS containers. - The collection of recyclables is carried out by Local Governments Use recycling truck collects on recycling day, TEPA Subsidize the establishment of Collecting Stations in Local communities, Designated Stores with recycling facilities, NGOs and Recycling Enterprises and Scavengers.</p>
<p>Issues to implementing an EPR system</p>	<p>Japan has introduced an EPR system for packaging, which is working well in regard to waste collection and public awareness. The waste</p>	<p>Recycling of packaging waste is relatively high and resource facilities also available. There is no issue at Korea for EPR implementation.</p>	<p>-Yet to implement -Framework for implementation of EPR policy is in place -Implementation to take place in year 2025.</p>	<p>Recycling rate is high for various type recyclable waste including plastic waste. Mandatory charge from producers and incentives to</p>

	<p>collection and infrastructure is considerably good however most of the collected packaging waste is predominantly not recycled but incinerated and a very minor amount waste is disposed of in landfills.</p> <p>-Lack of collection targets. The lack of a shared target fosters only partial optimization of the system and indifference among the involved stakeholders regarding the system, as no collection target is incentivized</p> <p>There is no strong market for the recycling plastic waste in Japan.</p> <p>Current rate of recycling is only 23% (Greenpeace, 2019)</p> <p>- Currently no mandatory guidelines on recyclable</p>			<p>citizens and MSW sanitation fleets is the key advantage for successful implementation of EPR in Taiwan.</p>
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		Product design considerations. There are, however, some guidelines and initiatives started by industry associations.			
Overall practice	EPR	Very good EPR practice.	Very good EPR practice and recycling rate is high.	-	-Overall EPR practice is good and recycling rate is high.

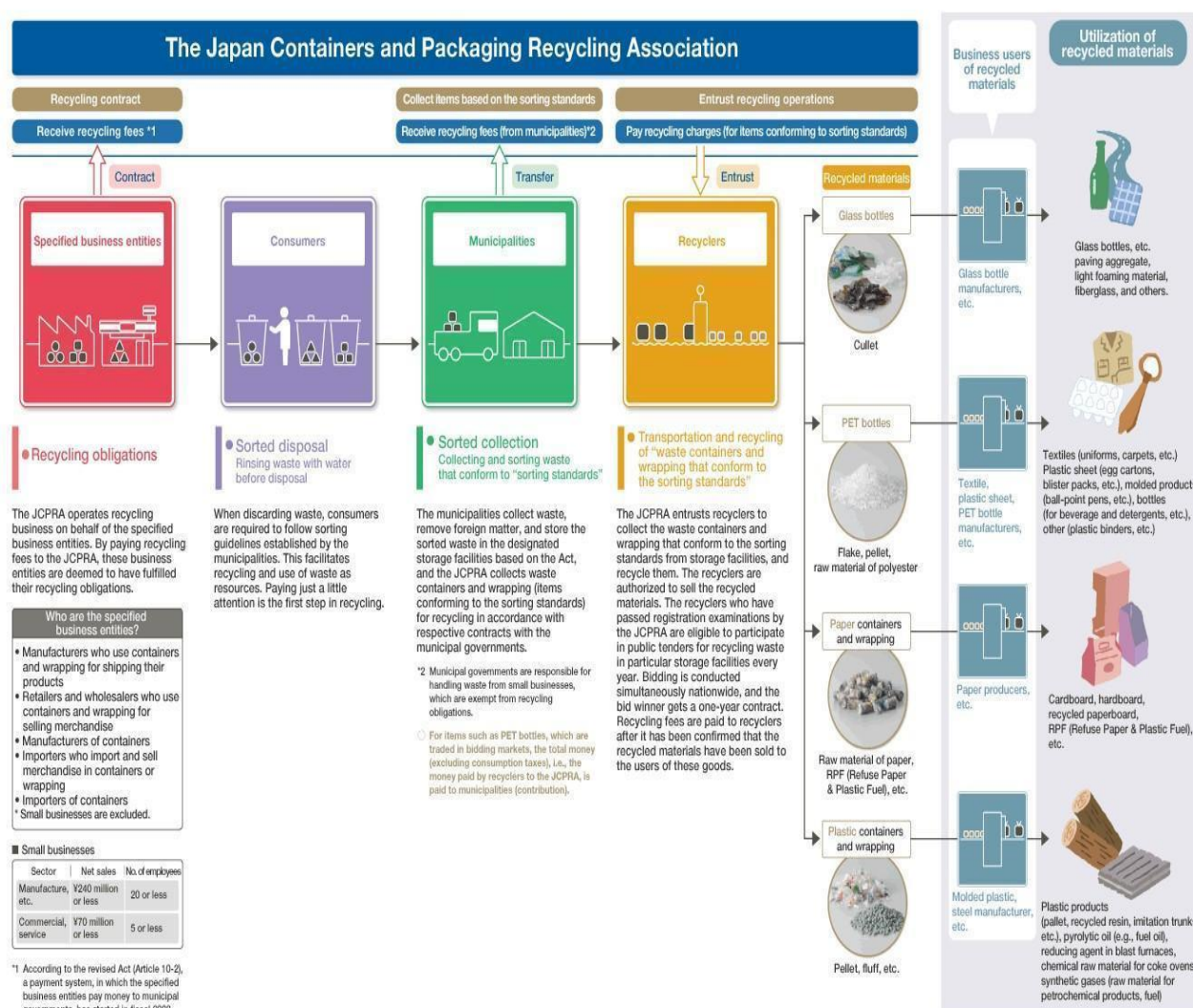


Figure S1: EPR system in Japan (JCPRA, 2012)

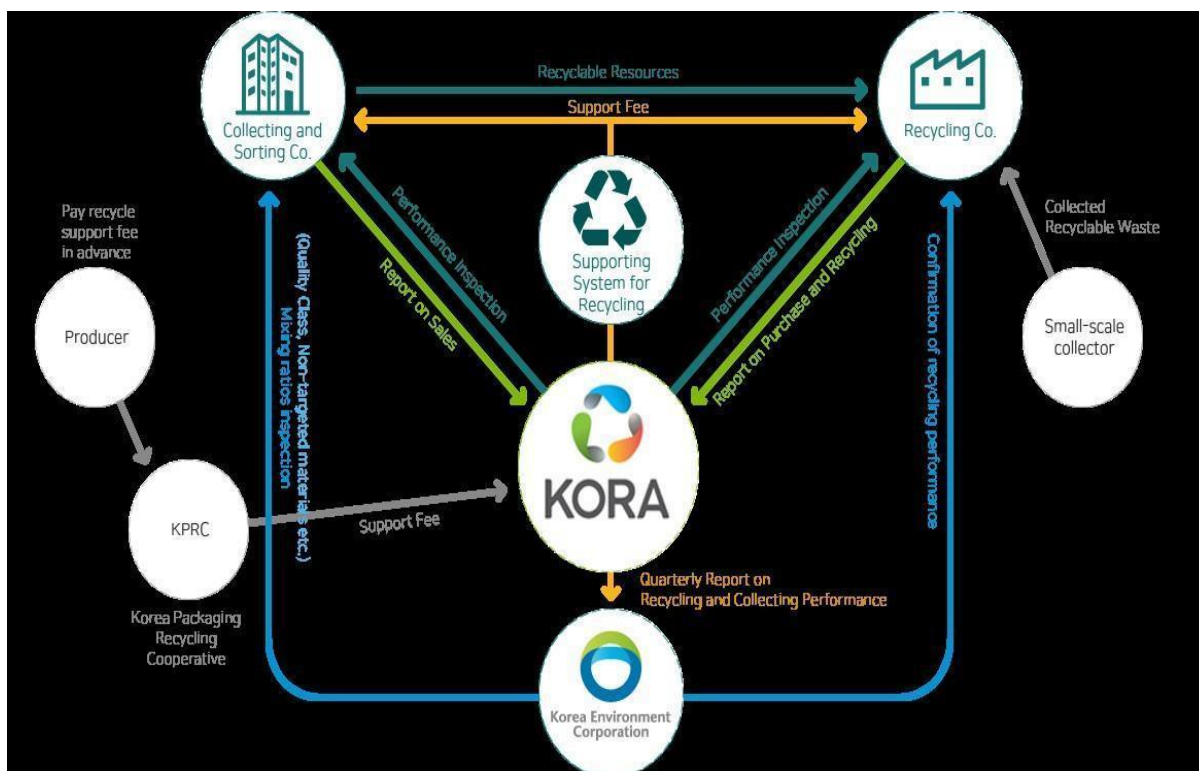


Figure S2: EPR System in Korea (KORA, 2003)

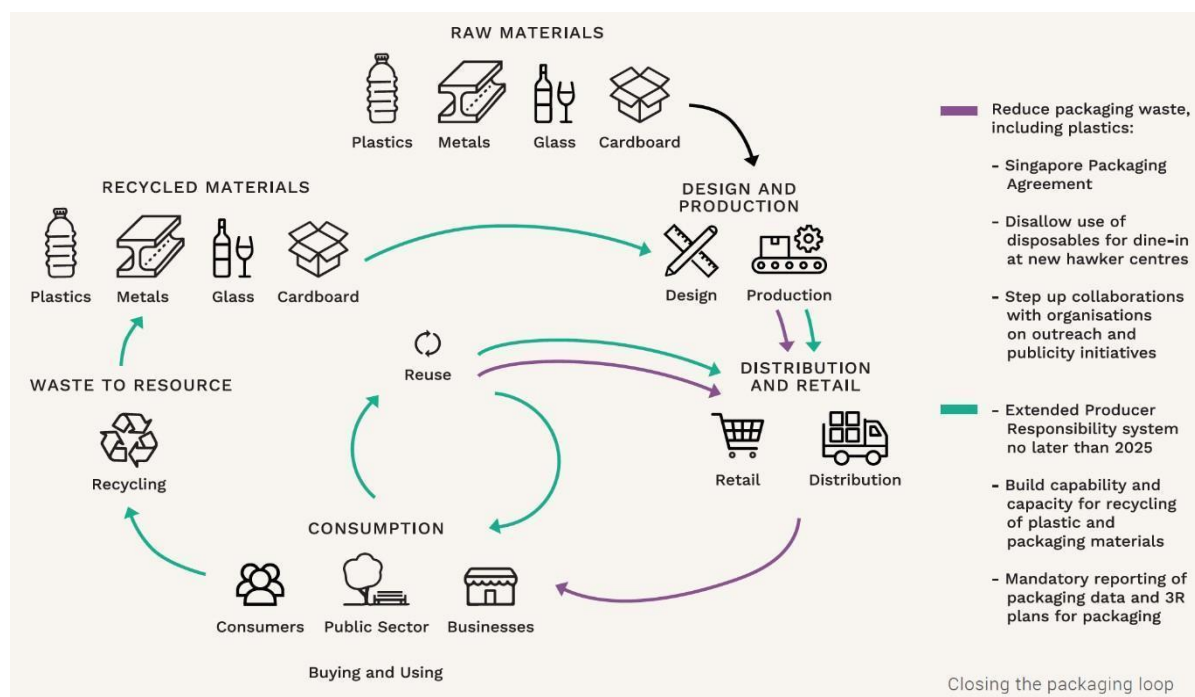


Figure S3: Packaging waste management and EPR implementation in Singapore (Ministry of the Environment and Water Resources (MEWR), 2019)

8.5 EPR POLICY IN EUROPEAN UNION

- European Union’s (EU) directive on packaging and packaging waste (Directive 94/62/EC) asks member states to implement measures for collecting and recycling packaging waste.
- While EU’s directive on EPR is focused on WEEE (Waste Electrical and Electronic Equipment), batteries, vehicles and accumulators, the packaging and packaging waste directive indirectly applies principles of EPR (Extended Producer Responsibility) on packaging waste.
- Some member states of EU have voluntary or compulsory EPR system on several waste streams such as plastic bags, farm plastics, newspapers and others.

8.5.1 DIRECTIVE ON PACKAGING AND PACKAGING WASTE

- Uses economic instruments including EPR to avoid the generation of packaging waste.
- Increase reusable packaging to improve the reuse of packaging material without compromising the safety of consumers or contamination of food.
- Execute following measures:
 - i. Targets
 - ii. Deposit-return schemes
 - iii. Minimum percentages of reusable packaging placed on market for each type of packaging
 - iv. Economic incentives
- Depending on the packaging material, there are several targets set by EU that each member state must achieve by 2025 and 2030, respectively.

8.5.2 TARGETS

- Overall recycling goal of packaging waste is 65% by 31 December 2025, and is 70% by 31 December 2030. The targets for specific packaging waste streams are given in the Table S3 below.

Table S3: Targets for Recycling Packaging Waste by 2025 and 2030

Packaging Waste Stream	Targets for 2025	Targets for 2030
Plastic	50%	55%
Wood	25%	30%
Ferrous Metals	70%	80%
Aluminium	50%	60%
Glass	70%	75%
Paper and Cardboard	75%	85%

8.5.3 PACKAGING RECOVERY SYSTEM

- A system for return and/or collection, as well as for reuse and recycling of packaging and packaging waste must be established in member states in EU.

8.5.4 PRODUCER RESPONSIBILITY

- EPR schemes must be formulated for all packaging waste by the end of 2024.
- EPR schemes offer financing or financing and organization of the collection and/or return of packaging waste and channel packaging waste towards most appropriate management option and/or for reuse and recycling.
- EPR schemes must be devised under the umbrella of Waste Framework Directive (2008/98/EC) which promotes designing, production and commercialization of packaging for reuse and higher quality recycling.
- EPR and all other incentives and initiatives aim at reducing the impact of packaging waste on the environment.

8.5.5 INFORMATION SYSTEMS AND REPORTING

- Decision 2005/270/EC, an implementation act, establishes the format, rules for the collection, verification and reporting of data which should be provided by member states of EU on yearly basis in order to monitor the implementation of 94/62/EC.
- It also endorses the usage of waste, that is entering a recycling facility, for calculation of recycling targets.
- Offers an improved system for quality control on reported data.
- All information given above is based on EUR-Lex (2020).

8.6 EPR IN GERMANY

This section is based on the reference Bünemann et al., (2020). Germany was among the pioneers for establishing the EPR system for packaging in the 1990s. Table 2 tabulates the legislations that were formulated for packaging waste and details the main points. Before passing the Packaging Ordinance in 1991, an association was established for implementation of EPR in the country and was known to be Dual System Germany or DSD (German Acronym). Under the system of EPR, producers and importers were obligated to contribute financially in accordance with the quantity of packaging introduced in the German market.

While DSD was responsible for collection and sorting of packaging waste from sales, raw material suppliers, packaging material manufacturers or converters referred as “guarantors” were also founded to create market for individual packaging material flows. Their main responsibility was to receive sorted waste fractions and recycle them as appropriate. The manufactures of respective

materials such as plastic, carton were among the main shareholders of formed guarantors of those materials.

Table S4: Legislations for Packaging Waste and their major revisions in Germany

Year	Legislation Title / Major Revisions	Description
1991	Packaging Ordinance	<ul style="list-style-type: none"> • Covered packaging waste from households, commerce and industry. • Responsibility on producers and distributors for taking back packaging for reuse or recycle. • Grouped packaging was removed by distributor and recycled by retailer. • Sales packaging was taken back by distributor in the absence of EPR system. • Implemented EPR system required producers and distributors to pay for the disposal of their packaging. • Targets were set for collection, sorting / sending for material recycling, and for recycling rates.
1998	Tenders given out and methods of rate determination modified	<ul style="list-style-type: none"> • Tender of waste management services needed to go out. • Relevant companies needed to meet recovery quota verifiably by their take-schemes. • Methods for calculation of sorting and collection rates were modified – quota was determined based on the total quantity of licensed packaging manufactured.
2002	Compulsory deposit-refund system	<ul style="list-style-type: none"> • Compulsory deposit-refund system (DRS) introduced for single-use beverage containers from 2003 onwards
2005	New organisation established	<ul style="list-style-type: none"> • Founded a new organisation for simplifying the DRS system
2006	Setting new targets and terms	<ul style="list-style-type: none"> • New targets and terms were decided.
2008	Participation in the EPR system increased	<ul style="list-style-type: none"> • Fillers and producers in a producer responsibility organisation (PRO) were obliged for participation in the system. Companies with their own take-back schemes or were participating in an industry scale system solution were allowed to exempt.
2013	Clarification of terms	<ul style="list-style-type: none"> • Certain terms were clarified
2015	Strict criteria for exemption set	<ul style="list-style-type: none"> • Firms with their own take-back systems were not allowed to exempt from EPR system any longer. • The conditions for exemption from system were made stricter.
2019	Packaging Act	<ul style="list-style-type: none"> • Clarification of certain terms. • Recycling rates were increased. • For improving monitoring, central packaging register was launched. • Introduction of incentives for enhancing the recyclability of packaging. • More power was assigned to municipalities.

Since the ratification of Packaging Ordinance, DSD was responsible for licensing and for running EPR system. It was a non-profit organisation. However, from 2003 onwards, new PROs were added, which ended the monopoly of DSD and also made EPR system a for-profit PRO based system. Due to this change, there had to be a single packaging collection system in each area (This system is still in use today). Figure S4 shows the EPR packaging system in Germany.

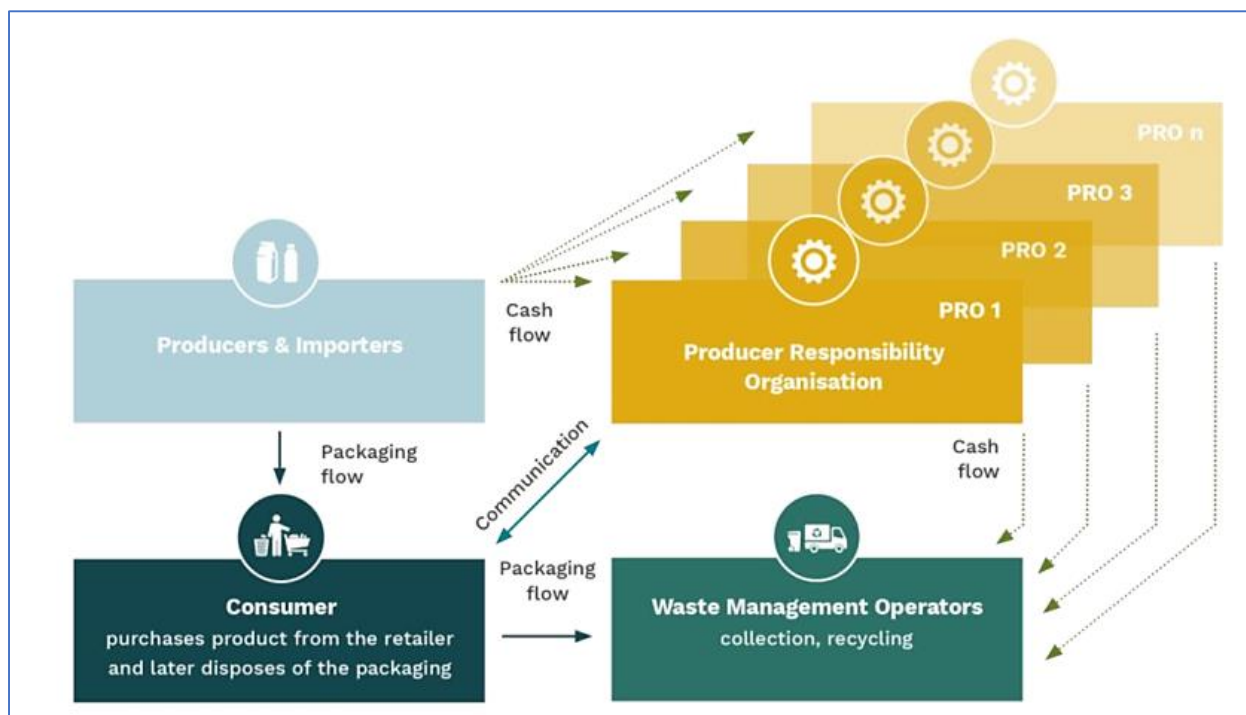


Figure S4: Several PROs for implementing EPR system for packaging waste in Germany

Each PRO enters into contracts with certain obliged companies within the system. Once the waste has been collected, each PRO takes responsibility for an amount of waste corresponding to the amount licensed and paid by the obliged countries for which it is the contracted PRO.

Unfortunately, several obliged companies exploited the situation of having more than one PRO by not licensing their packaging with a PRO.

8.6.1 ECONOMICS

- After the nationwide implementation of EPR system in 1993, EPR system faced a severe financial difficulty as a maximum fee of DM 0.02 / item was applied to every packaging regardless of material and weight. Moreover, recycling plastic packaging was also subjected to additional levy. However, it led to a new fee system where each item was charged with license fee depending on the material and weight of packaging waste.

8.6.2 PACKAGING ACT 2019

- It brought together all the regulations concerning major issues of managing the packaging and is incongruent with EU's Directive on Packaging and Packaging Waste. It added additional elements to Germany's EPR system by introducing:

Central Agency

- i. Central agency or Central agency packaging register was established to enhance the transparency and to monitor compliance with EPR principles
 - ii. Central agency registers manufacturers or importers
 - iii. Receives reported data from manufacturers, importers and PROs and verifies it, in order to monitor and enforce the performance of obliged companies towards EPR system
- New Packaging Act set recycling targets for each material of packaging waste. Table S5 enlists the recycling targets until 2022.

Table S5: Recycling targets for packaging waste under Packaging Act 2019

Material	Target under Packaging Ordinance (applied up to end of 2018)	Target as of 1 Jan 2019	Target as of 1 Jan 2022
Paper, Cartons and Cardboard	70%	85%*	90%
Plastics	60%	90%	90%
Aluminium	60%	80%*	90%
Ferrous Metals	70%	80%*	90%
Beverage Cartons	60%	75%*	80%
Glass	75%	80%*	90%
Other Composites	60%	55%	70%
Mechanical Recycling (Plastics)	36%*	58.5%	63%

* Target has already been met

8.6.3 MINIMUM CRITERIA

- When determining recyclability, the available recyclable content of a packaging should be taken as the minimum starting point for further considerations. In determining the available recyclable content, at least the following three requirements must be taken into account:
 - a. The existence of a sorting and recycling infrastructure that allows for high-quality mechanical recycling for this packaging,
 - b. the sortability of the packaging as well as, where applicable, the separability of its components,
 - c. incompatibilities of packaging components or substances contained therein that might render a successful recycling impossible with currently used technology”. This means that the starting point for the consideration is the part of the packaging that is potentially recyclable. For instance, only 99% of a PET-bottle is considered recyclable, since the sleeve is not. These 99% are thus considered the minimum

starting point and the 3 mentioned criteria are then applied to determine recyclability.

- d. The minimum standard includes a number of specific provisions, including:
 - i. • Definitions of specific types of packaging and their recyclability.
 - ii. • A summary of different groups/types of packaging, along with a list of specific elements that make materials unsuitable for recycling.
- e. The standard has the status of an official regulation in Germany and is increasingly applied in other countries, too.

8.7 ASIA AND THE PACIFIC

Legislations related to MSW management, 3R and take-back systems for selective waste streams are given below in Table S6. This section is based on the reference UNCRD (2017).

Table S6: Legislations for MSW, recycling and take-back scheme in Asia

Country	Waste Management Law	Framework strategy and law on resource circulation and 3Rs	Law for recycling and take-back scheme for specific end-of-life products
China	Law of the People's Republic of China on the Prevention and Control of Environment Pollution Caused by Solid Wastes (2015 Amendment)	Circular Economy Promotion Law of the People's Republic of China (2008)	Regulation on the Administration of the Recovery and Disposal of Waste Electrical and Electronic Products (2009, Order of the State Council of the People's Republic of China (No. 551))
India	Solid Waste Management Rules, 2016 Plastic Waste Management Rules, 2016	Waste Management Rules are based on 5Rs strategies that include resource circulation and the 3Rs principles	E-waste (Management) Rules, 2016
Indonesia	Law no.18/2008 on MSW Management: 3R as the principle approach for waste management Law no, 32/2009 on Hazardous Wastes	The government regulation no. 1/2012 on 3Rs and EPR President Regulation No.97/2017 on Policy and National Strategy of MSW	
Japan	Waste Management and Public Cleansing Law	Basic act and fundamental plan for establishing sound material cycle society	Container Packaging Resource Recycling Act (1995) Home Appliance Recycling Act (1998)
Malaysia	Solid Waste and Public Cleansing Management Act 2007	There are 8 Regulations on 3R within the Solid waste Act	There are 8 Regulations within the Solid waste Act

The Philippines	Ecological Solid Waste Management Act of 2000 (RA 9003)	Ecological Solid Waste Management Act of 2000 (RA 9003)	
Singapore	Environmental Public Health (General Waste Collection)	Sustainable Singapore Blueprint setting waste recycling rate target of 70% in 2030 with a goal of becoming a Zero Waste Nation	
Thailand	Maintenance of Public Sanitary and Order Act. B.E. 2535 (1992) and B.E.2560 (2017)	National Solid Waste Management Master Plan, Action Plan “Thailand Zero Waste, 2016”	Regulation on National Waste Management System 2007, Draft WEEE Act., Draft Waste Management Act, Draft Promotion of 3Rs and Utilization of Waste
Viet Nam	Decree 38/2015/ND-CP on management of wastes and scrap	National Strategy on Integrated Solid Waste Management to 2025, vision to 2050 (Being revised)	Regulation for takeback and treatment of discarded products: Prime Minister Decision 16/2015/QĐ- TTg dated 22 May 2015 (Small appliances, home appliances, lubricant oils, used tyres, ELVs)

Apart from Japan who has extensive list of EPR related legislations, Indonesia has specific EPR based provisions for packaging waste; Law on Rubbish Management (Law No. 18, 2008) “Article 15. Producers shall manage the produced package and/or products which could not decompose or difficult to decompose by natural process.” On the other hand, Singapore has voluntary based “Singapore Packaging Agreement (2007)”. Overall, majority of Asian and the Pacific countries have EPR based legislations and policies for Electronic Waste (E-Waste) or WEEE.

8.7.1 KEY ISSUES HIGHLIGHTED BY UNCRD REPORT

- Several key issues were raised in UNCRD report based on the country reports of Asian and the Pacific countries. They are listed as follows;

1. EPR Interpretation

- i. Some countries introduce EPR as voluntary initiative for environmental management, recycling and take-back activity. An example is Singapore Packaging Agreement.

2. Unidentifiable Producers

- i. Identification of producers becomes problematic due to usage of repaired or second-hand, or non-branded or counterfeit products in developing countries.

3. Competition with Informal Waste Management Sector

- i. Lower operating costs and subsequent higher cash payments for informal sector in comparison to formal sector makes implementation of EPR economically impracticable in developing countries.

4. Infeasible Take-back Scheme

- i. Different country of origin and sale of some products may thwart the responsibility of take-back scheme of those products.

5. Waste Collection and Treatment Infrastructure

- i. Status quo of recycling infrastructure, which is small scaled, and environmentally and health wise unsound in most developing countries, may require significant upgrade in physical infrastructure

8.8 EPR IN SOUTH AFRICA

This section is based on the reference Bünemann *et al.* (2020).

The example of voluntary and industry-led EPR system for packaging can be observed in South Africa. There are several EPR schemes dedicated to different streams of package waste which have been emerging since the start of 2000s. Owing to these schemes, improvement in collection and recycling rate of respective material is seen. Even though, there is still room for more improvement. Those EPR schemes are applicable to polyolefins (LLDPE, LDPE, HDPE, PP), PET, PS, vinyl, paper, metals and glass. Either with the cooperation of relevant stakeholders or in relevant value chains, several PROs have been established by from concerned industries, and those stakeholders include retailers, consumer goods companies and waste management operators. PROs gather voluntary EPR fees from their members and, at times, in conjunction with voluntary grants. PROs utilize the generated revenue for supporting the activities including collection, sorting, recycling the recyclable material, that are carried out by informal waste workers and small and medium-sized enterprises.

In 2017, the consultation of development of a compulsory EPR system had begun. While ‘Section 28 Notice’ was withdrawn at the end of 2019, which was intended for formulating plans for an EPR system to be financed through tax collection from producers and was supposed to be managed by the government, ‘Section 18 Notice – Extended Producer Responsibility Scheme’ is in the final stages of consultation. It replaces ‘Section 28 Notice’ and aims to provide for a more cooperative relationship between industry and government.

8.8.1 EPR IN NATIONAL LEGISLATION

- Main regulation on waste management in South Africa is National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008). It took effect in 2009 and was later amended in 2014. It targets all aspects of waste hierarchy including waste avoidance, waste minimization, reduce, reuse, recycle, and waste recovery. It classifies the treatment and safe disposal of waste as the least preferred option. To practically achieve the goals set by Waste Act, National Waste Management Strategy was formulated in 2011. This strategy has eight quantifiable objectives such as diverting 25% of waste from landfill, 95% of waste collection rate in the cities and 75% of waste collection rate in rural areas, creating 69,000 new jobs, and establishing 2,600 small and medium-sized enterprises and association in the waste service and recycling industries. A draft of 2019 Revised and Updated National Waste Management Strategy was published at the end of 2019 for public consultation. Its main focus is on circular economy and closing the loop of resource extraction and waste disposal. This strategy envisions to support innovation and partnership with the private sector and collaboration with other government departments, instead of top-down approach.
- Waste Act defines EPR as a set of actions which assigns more responsibility, financial or physical, to a 'person' for a commodity after its intended use, and recommends waste minimization initiatives, arrangement of finances for promotion of waste reduction, reuse, recycling and recovery, awareness creating initiatives for raising public awareness about negative health and environmental impacts of waste generation. The term person refers to a company and is consistent with previous laws. Minister of Environmental Affairs is given the power by Article 18 of Waste Act by consulting with Minister of Trade and Industry to classify a product or class of products, determine its EPR measures and categorize a person or group of persons. The Minister of Environmental Affairs has the authority to add certain requirements for the execution of EPR scheme including financial and institutional provisions for waste minimisation initiatives, to set percentage recovery rate for the products and to require labelling of respective products. Nevertheless, prior consultation with relevant producers be held before any amendments, along with considering scientific evidence.
- In order to understand EPR scheme in South Africa, it is important to consider Industry Waste Management Plans. Although it is not part of government policy anymore, it still plays its part in implementation of EPR system in the country. It encourages private sector to collaborate with each other to set collective targets and achieve those targets with mutually agreed initiatives, possibly by setting voluntary EPR schemes.
- Initially, Section 28 Notice proposed that the funds collected through levy imposed on products or group of products by relevant industries, be released to government who then will give these funds to PRO and PROs will disseminate the funds to relevant companies to fulfil their duties under the Industrial Waste Management Plans. However, industry wanted to collect and manage the fund instead of management of funds by government and PROs. Owing to this,

and due to other points, Section 18 Notice was formulated which proposed payment of funds by manufacturers which would be handled by industry. This policy document was under preparation and got delayed due to COVID-19 pandemic. It was expected to be ratified and implemented by end of 2020 or start of 2021.

- Several industry-led EPR systems are being executed for packaging waste in South Africa. Table S7 enlists PROs and respective industries below.

Table S7: PROs for voluntary EPR schemes for packaging waste in South Africa

PRO	Operational Since	Packaging materials	Details
PET Recycling Company (PETCO)	2004	<ul style="list-style-type: none"> • PET (beverage, empty bottles for private use, thermoformed containers) 	<ul style="list-style-type: none"> • Professional operational team of 10 people, 12 non-executive directors representing every stage of the value chain in the industry. • A voluntary EPR fee is collected, paid on a rand / tonne basis by converters manufacturing bottles from PET resin, bottlers who fill PET bottles and PET importers. • Grants are also paid by brand owners, resin producers and retailers. The revenue collected is used to: <ol style="list-style-type: none"> 1. Support recyclers, particularly during adverse economic cycles 2. Support, train and mentor reclaimers and waste entrepreneurs 3. Fund consumer education and empowerment initiatives, joint venture projects and the drafting of recycling guidance across the industry.
The Polyolefin Responsibility Organisation (POLYCO)	2011	<ol style="list-style-type: none"> 1. LDPE (films, bags, etc.) 2. LLDPE (films, bags, etc.) 3. HDPE (boxes, bottles, containers, bags, etc.) 4. PP (food packaging) 	<ul style="list-style-type: none"> • Not-for-profit industry body • Voluntary EPR fee per tonne for polyolefins • Paid by 11 members (polyolefin packaging converters). • Funding support for collection and recycling companies provided through grants or interest-free loans and e.g., the Packa-Ching scheme (recyclables collected in informal settlements by mobile units with payments made electronically)

Polystyrene Association of South Africa	2007 / 2009	<ol style="list-style-type: none"> Expanded Polystyrene (ESP) High Impact Polystyrene (HIPS) 	<ul style="list-style-type: none"> Non-profit PRO funded by converters of polystyrene. 10 full members and 5 associate members, including raw material suppliers, manufacturers, recyclers and retailers. Provides funding for recycling projects
South African Vinyl Association (SAVA)	N.A.	1. Polyvinyl Chloride (PVC)	<ul style="list-style-type: none"> A representative body of the South African vinyl industry rather than a PRO Has drawn up a Product Stewardship Commitment, including recycling targets It has 21 members
The Glass Recycling Company (TGRC)	2005	1. Glass	<ul style="list-style-type: none"> Voluntary industry initiative with 18 members (manufacturers, consumer goods companies) Brand owners pay EPR fees per tonne of glass bought from glass manufacturers Manufacturers buy recyclable glass for recycling Provides funding for 'glass banks' (big containers for glass collection in public spaces)
Fibre Circle (PAMDEV)	2016	<ol style="list-style-type: none"> Paper Paper packaging Liquid packaging board 	<ul style="list-style-type: none"> The PRO for the paper and packaging industry's voluntary EPR scheme Involves paper manufacturers, importers, brand owners and retailers Aims to increase separation at source. Supports raising awareness and job/business creation in collection and recycling
RecyclePaperZA	2003	<ol style="list-style-type: none"> Newspapers Magazines Corrugated/solid cases/craft papers Office/graphics papers Mixed other papers 	<ul style="list-style-type: none"> Provides information about paper recycling Currently has 10 members Previously known as Paper Recycling Association of South Africa (PRASA) prior to change of name in 2018
METPAC-SA	2017	1. Metal packaging (aluminium, steel, tinplate)	<ul style="list-style-type: none"> Industry body Has 17 members

The collection and recycling rate of each packaging material is given in Table S8 below. Respective PROs are responsible for managing their packaging waste.

Table S8: Collection and recycling rate of packaging waste

Packaging Material	Collection Rate	Recycling/Recovery Rate	Year
Metal	75.8%	N.A.	2017
Paper and Paper Packaging	71.7%	54.8%	2018
Glass	80%	42%	2018
Polystyrene	20.41%	67.9%	2017
Polyethylene Terephthalate	61%	63%	2018

8.8.2 LESSON LEARNT FROM EPR SYSTEM IN SOUTH AFRICA

- In addition to two contractors and ten employees comprising a professional team for PRO of PET, it has twelve non-executive directors that represent stakeholders from industries such as ‘resin manufacturers, converters, bottlers, collectors and recyclers, consumer good companies, retailers.’ EPR systems that has PROs who bring all relevant stakeholders together.
- The operations of PETCO, PRO for PET, include:
 - a) Collecting voluntary EPR fees from PET manufacturers and imports
 - b) Coordinating with consumer goods companies to offer accumulated EPR fees as voluntary grants for funding
 - c) 70 to 80% of revenue generated is utilized for establishing additional recycling projects
 - d) Each kg of PET bought by recycling companies from collectors is funded by PETCO
 - e) PETCO monitors the PET market and keeps an eye on price of each kg of PET
 - f) Basic bailing, weighing, transportation and protection equipment can be provided by PETCO to start-ups
 - g) Long term contracts with foreign recyclers to encourage their investment in local PET recycling plants for achieving higher recycling rates (PETCO signed five-year contracts with recyclers)
 - h) Setting ambitious growth targets for recycling market (8 to 10% each year)
 - i) In case of reaching targets, performance related payments made to recyclers
 - j) Invest in schemes to increase the demand for recycled PET (First few years saw conversion of PET into fibre-based products. Which was managed by incentivising

the export of recycled material. Concurrently, bottle to bottle recycling plants were established to diversify the recycling products)

- k) Design for Recycling Guide was formulated
- l) Conducting educational and awareness-raising activities

8.8.3 PACKAGING SOUTH AFRICA PLAN

- South African packaging industry formulated an all-inclusive EPR plan and submitted to Department of Environmental Affairs after government’s invitation to paper and packaging industry. This plan is compulsory, industry-led and contains managed model, along with collection and management of funds to be carried out by relevant industry.
- According to the plan, the funds collected through EPR fee would be used for following activities:
 - a) For potential new market entrants (through Black Industrialist Programme)
 - b) For EPR Plan Municipal Initiative Fund which would financially support source segregation, establishment of new facilities for materials recovery, and obtaining equipment at municipal level
 - c) For communications and marketing campaigns on collection and recycling
 - d) Integrating informal sector
 - e) Stimulating end-use market and business development

Informal sector in South Africa did not want to be formalized but rather recognized and integrated according to a study.

South African setting prefers industry managed plan, instead of government managed plan.

8.9 AUSTRIA

This section is based on the reference Mogiliv (2017).

Table S9: Legislations relevant to EPR in Austria

Year	Regulation / Legislation	Description
1990	Waste Management Act (WMA)	Waste management act implemented
1993	Packaging Ordinance 1993	EPR scheme based on WMA and packaging ordinance

Austrian chamber of commerce led the foundation of first collection and recycling system for packaging waste, called “ARA system”.

ARA is a non-profit PRO and acted as monopolist in the beginning. The owners of ARA are Austrian companies.

ARA require producers and distributors of packaging to:

1. Come into contract with them
2. Pay EPR fee (depending on material) to cover the cost associated with treatment of packaging waste according to applicable law

ARA or PRO is responsible for compulsory collection and recycling and to reach set rates of collection and recycling. This stipulate is a vital part of packaging ordinance and ARA or PRO is responsible for upgrading the existing collection of packaging waste from glass and paper to glass, paper, plastics and metals.

Convenient and simple infrastructural initiatives were instrumental in success by introducing different coloured waste collection bins and having high density of collection points (mainly kerbside collection).

All involved communities had to be contracted with PRO and those contracts were flexible to encourage the acceptance of new system. Some of the examples include flexibility of infrastructure ownership either by PRO or community, allowance of operation for waste collection and recycling by the communities, financially support by PRO for services of waste consultancy and others.

Open market conditions were introduced for the implementation of EPR for packaging waste in Austria.

Depending on the market share of PROs, lottery of “collection district” was used to allot regions and the amount of packaging waste from respective regions. In order to avoid confusion and promote operations by all PROs, each PRO was assigned to one region only. This practice is repeated every 5 years.

The website of the Federal Ministry of Agriculture, Forestry, Environment, and Water Management (BMLFUW) shares the monthly market share where PROs account the expenses with waste collectors, municipalities etc.

8.9.1 ESTABLISHMENT OF VKS

- In 2014, BMLFUW founded a company, VKS, for supervision and coordination of several initiatives taken for EPR system in Austria under the stipulate of WMA.
- A contract with VKS was made compulsory for getting an approval from BMLFUW for all PROs. These PROs would have to bear all the expenses of VKS as per their contract.
- VKS acts as a neutral stakeholder in the EPR system of Austria for packaging waste. It also acts as supporter of PRO which is contracted under civil law. VKS monitors and maintains fair competition but does not have authority as a legal court.
- The responsibility of VKS include:
 - a) Coordinate between participants for coming up with single opinion and decision and act as intermediary between PROS and relevant stakeholders.

- b) Coordinate the contracts and agreements with communities which had to be arranged by each competitor with identical content otherwise.
- c) In case of a conflict of interest between competitors, VKS will act as mediator.
- d) Coordinate and organize a mutual system for assigning the payment of expenses of waste collection. To also look for any hint of unfair competition.
- e) Establish the sorting analysis of packaging waste to obtain a neutral result of net collected packaging waste, as well as to provide necessary data for monitoring the performance of collection system such as collection quota and recycling quota.
- f) Coordinate the consumer information for separate collection and prevention of packaging waste.
- g) To provide an online registry system for companies with commercial packaging waste, to allow access to companies for PROs services and to avoid certain administrative efforts including registration, templates, reports to ministry and others.
- h) PROs for packaging waste have to pay 0.5% of their licensing revenues for waste prevention measures. VKS administrates these subsidies as trustee and organises the selection of the best waste prevention projects by an independent jury.

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