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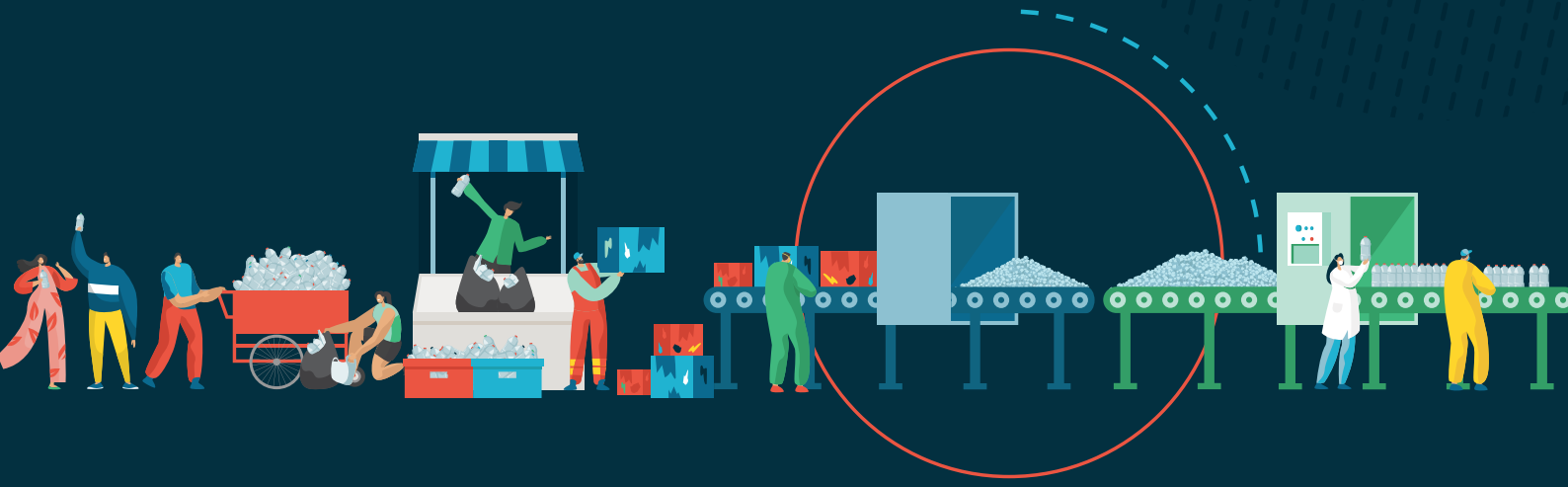

FULL CIRCLE

Accelerating the Circular Economy for Post-Consumer PET Bottles in Southeast Asia

Commissioned by

Coca-Cola

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Foreword

Plastic waste has fast emerged as one of the biggest social and environmental issues facing the world today.

All of us at The Coca-Cola Company are determined to step up and be part of the solution. With that in mind, we announced last year a commitment called World Without Waste underpinned by a bold, ambitious goal: to help collect and recycle a bottle or can for every one we sell globally by 2030.

Collaboration towards a circular economy is at the heart of this vision. Regardless of where it comes from, we want every package to have more than one life. To achieve this, we will continue to focus on designing our packaging to be 100% recyclable across our portfolio while partnering with local communities, NGOs, industry and consumers to collect and recycle packaging and help ensure it doesn't end up where it doesn't belong.

Working to help create a World Without Waste isn't easy and involves many moving parts. And, as with any strategy, we have to get clear on the starting point. Specifically, in this case, we have to understand the baseline when it comes to collection and recycling rates for our packaging. In many parts of the world, such data doesn't exist or it is not readily available.

That's why we commissioned this report from GA Circular. It focuses on Southeast Asia – a crucially important focal point for the global ocean plastic challenge. It focuses on PET – a type of recyclable plastic commonly used in beverage and other food-grade packaging and one that offers significant potential for circular economy solutions.

The report synthesizes GA Circular's on-the-ground research from ASEAN's six biggest countries and delivers a first-of-its-kind analysis of collection-for-recycling rates for PET plastic in key ASEAN cities. The report examines the existing recycling and collection challenges and opportunities in Southeast Asia and frames up a circular economy roadmap for post-consumer PET plastic packaging specifically tailored for the region. It concludes with a concrete set of recommendations geared towards interventions with the highest impact.

At Coca-Cola, we are committed to executing these recommendations with our partners, and we have already begun to move in earnest. It is our hope that this report also helps to drive broader understanding, coordination and momentum in our shared efforts to tackle marine plastic pollution in Southeast Asia and globally.

Imagine if we all – across multiple sectors – put our combined expertise and resources into solving this problem. Imagine if we all worked to help keep packaging out of the places where it doesn't belong.

There's so much more we can do together and, clearly, the time to act is now.

Michael Goltzman
Vice President, Global Policy and Sustainability
The Coca-Cola Company

In Support of "Full Circle: Accelerating the Circular Economy for Post-Consumer PET Bottles in Southeast Asia"

The findings of this report have clear and consequential implications for accelerating plastic action in Southeast Asia. They underscore the urgent need to scale up the region's infrastructure for collecting and recycling PET bottle packaging, a staggering source of mismanaged plastic waste. And more importantly, they identify highly valuable opportunities – investments, innovations, and systemic policy changes – that must be leveraged in order to achieve concrete progress.

KRISTIN HUGHES - DIRECTOR OF THE GLOBAL PLASTIC ACTION PARTNERSHIP

To accelerate the Circular Economy in Vietnam and throughout Southeast Asia, it is crucial to know where we want to go and what we must achieve in order to reach our goals. This is exactly what this report by GA Circular lays out. PRO Vietnam, as the first industry-led PRO within Southeast Asia, understands the urgency to boost the value chain for post-consumer packaging and aims to lead the transition to a Circular Economy in Vietnam.

FAUSTO TAZZI - CEO OF LA VIE - NESTLE WATERS VIETNAM AS FOUNDING MEMBER AND VICE-CHAIRMAN OF PRO VIETNAM

I commend GA Circular for this very comprehensive and well written report, and I endorse the roadmap and key action steps outlined out for Southeast Asia and Malaysia specifically. To accelerate the Circular Economy for PET bottles in this region, it is crucial to learn from best case practices globally - and especially from countries that have similar realities, such as South Africa and Mexico. The industry-led Packaging Recovery Organisations in South Africa and Mexico have successfully boosted the value chains of PET bottles and created robust recycling industries that are protected from global shocks and import bans. This will be an excellent model for Malaysia to adopt and implement.

HO DE LEONG - WASTE MANAGEMENT ASSOCIATION OF MALAYSIA (WMAM), CHAIRMAN & SWM ENVIRONMENT SDN BHD, CHIEF EXECUTIVE OFFICER

Heng Hiap Industries are proud to have contributed a small part to this excellent and thorough report on the recycling landscape in Malaysia specifically, and Southeast Asia in general. We recognise the challenge of obtaining precise statistics relating to the relatively under-developed industry, however, we feel that the numbers stated in this report are as accurate as they can be, and where their accuracy cannot be substantiated, they are reasonable assumptions. We fully endorse the content of this report and applaud the expertise and professionalism demonstrated by the GA Circular team that put this report together, as well as the initiative by The Coca-Cola Company in commissioning the report.

KIAN HOE SEAH - HENG HIAP INDUSTRIES, MANAGING DIRECTOR

PET is the most recycled plastic in the world. Despite the obvious advantages of recycling, too much of it is still not recycled and leaks into our environment. This report details the realities and reasons for the current state, and then details solutions that should be considered by package designers and manufacturers, beverage companies, retailers, recyclers, and national and local governments. The solutions illuminate a pathway to better recycling and less plastic in our environment. I congratulate Coca-Cola and the GA Circular team for their contribution to our understanding and potential solutions to this global opportunity to a circular economy for PET bottles in Asia.

DAVID CLARK - AMCOR, VICE PRESIDENT, SUSTAINABILITY

This is probably one of the most important pieces of research conducted in Southeast Asia on municipal waste and provides a firm bedrock on which others can build.

RICHARD JONES - INDORAMA VENTURES PCL, SENIOR VICE PRESIDENT

This report makes clear that the informal sector plays a critical role in improving collection and keeping trash out of the ocean in Southeast Asia. To make this happen, we need companies to drive safe and effective informal sector collection by providing the right financial incentives and other forms of support.

CHEVER VOLTMER - OCEAN CONSERVANCY, PLASTICS INITIATIVE DIRECTOR

The report is a serious attempt that summarises the findings of in-depth country assessments of PET bottles in 6 Southeast Asian countries by GA Circular. Based on the identified shortcomings, the report also provides a roadmap on how to improve the situation.

SABINE STRNAD - SUSTAINABLE STEWARDSHIP, SENIOR CONSULTANT

Even as opportunities to introduce "reusable packaging" are explored globally, we must remember that the recycling industry is the singular opportunity for diversion away from the environment for PET bottles and packaging of a single-use nature, thus it is critical that we develop a robust recycling industry in Southeast Asia. The most effective response to the challenges currently facing the post-consumer PET landscape in Southeast Asia is one that effectively and continually boosts the collection and recycling operations currently in place. This report highlights a series of priority actions to transform the post-consumer PET landscape in Southeast Asia in order to achieve upwards of 90% collection-for-recycling rates by 2030.

MARC ALLEN - ENGECO, TECHNICAL DIRECTOR

Glossary

STAGES OF THE POST-CONSUMER VALUE CHAIN IN SOUTHEAST ASIA, AND KEY STAKEHOLDER GROUPS

CONSUMPTION

Consumers
In this report, refers to consumers of bottled beverages.

Bulk Waste Generators (BWGs)
Buildings such as government offices, schools and universities, shopping malls, office buildings, apartment complexes, hotels and hostels, places of worship and large commercial establishments which generate a significant amount of waste as compared to individual households. BWGs are generally defined country to country based on an average waste generation amount (e.g. exceeding 50kg per day).

COLLECTION

INFORMAL SECTOR

Waste Collectors (WCs)
The people that collect waste (mixed or separated) from households, bulk waste generators or other establishments. They are formally employed by the public or private waste collection sectors and their formal source of income is from the collection and transportation of mixed waste. For this job, they are considered formal workers. Whilst not their job, these people often actively sift through the mixed waste in the carts or trucks to pick out recyclable materials to sell for extra personal income. When they engage in this behaviour, they are considered informal sector workers. As their picking out and sales of recyclables is the focus of this report, for the purposes of this report they are considered informal sector workers.

Recyclables Collectors (RCs)
These are self-employed people who use bags, small push-carts or small motorised vehicles to buy recyclable materials from households, bulk waste generators or other establishments through the relationships they have built. They sell the material to junk shops as a primary source of income. They may also pick up recyclables from mixed waste or litter. However, the majority of the material they handle is based on buying from households, other establishments and bulk waste generators.

Street Material Pickers (SMPs)
Street material pickers are those who pick up recyclable materials from the open environment (in the city) or from a garbage bin. They may also do some buying, but they are primarily picking, which is why they are called street material pickers.

Landfill Material Pickers (LMPs)
Landfill material pickers are those who pick up recyclables from landfills. These people are often referred to as scavengers. However, landfill material pickers is the terminology used by GA Circular and within this report.

FORMAL SECTOR

Waste Banks, Material Recovery Facilities, and other Formal Collection Centres
Waste Banks are community establishments where people can deposit segregated recyclable materials in exchange for money or credit - similar to a bank account. From here, the materials are sold to junk shops, aggregators or processors/recyclers. Waste Banks are unique to Indonesia. Material Recovery Facilities (MRFs) are unique to the Philippines and are set up by some local government units to implement source separation and separate collection of waste. Other collection centres include places such as charities or places of worship (e.g. mosques, temples) which collect recyclables primarily via donation. The collected recyclables are then sold as a source of income for the non-profit entity. This group was only surveyed in Greater KL.

STAGES OF THE POST-CONSUMER VALUE CHAIN IN SOUTHEAST ASIA, AND KEY STAKEHOLDER GROUPS

AGGREGATION

Junk Shops (JSs)
Informal or formally registered businesses involved in buying recyclable materials from informal and formal sectors including recycling collectors, waste collectors and material pickers. Junk shops vary in size from small to large, with the smaller ones often selling to larger junk shops. Junk shops sell recyclable materials to aggregators.

Aggregators
Informal or formally registered businesses involved in buying materials from junk shops, aggregating high quantities, and selling to processors and/or recycling factories.

PROCESSING & RECYCLING

Processors
Informal or formally registered businesses engaged in the process of converting the recovered PET packaging into flakes. Processors either export this material or sell it to a local recycler. The recycler will then convert the flakes into usable applications such as food grade pellets, non-food grade pellets and polyester fibre.

Recyclers
Informal or formally registered businesses engaged in the process of converting the flakes into food- or non-food grade pellets, fibre or other applications. The finished product is either exported or sold locally. In many cases the recycler also has processing capabilities in-house to convert collected PET packaging into flakes.

Glossary

DEFINITIONS OF KEY TERMS USED

MATERIAL FLOW DEFINITIONS

PET Bottles
For the purposes of this report, the term PET Bottles is used to refer to PET beverage packaging. The report excludes any non-beverage applications, such as cooking oil containers and food packaging. PET bottles are used primarily for soft drinks and packaging applications.

Market Input
The total amount of PET bottles entering the market, not including caps and sleeves that are not PET.

Collected-For-Recycling Rate
What: Denotes the tonnes or percentage of PET collected through the informal and formal waste material collection sector within the country which is then sold on to Processors and/or Recyclers within the country or for export, as compared to the total market input (products sold in the market). The collected-for-recycling rates already factor in removal of contaminants, and caps and labels.

Why: Given imports and exports of material for recycling, the collected-for-recycling rate denotes local collection which is sold to processors/recyclers, not necessarily within the country. I.e. a country can have a collected-for-recycling rate of 75%, even though none of the material is recycled locally due to the lack of a robust local recycling industry. Secondly, given recycling yield is less and varies, the collected-for-recycling rate is not equal to the share of after-use plastics that is actually recycled, which further explains the use of collected-for-recycling instead of recycling rate.

Environmental Leakage Rate
The proportion of material out of the total market input that ends up in the environment (such as plastic in the waterways).

Landfill Rate
The proportion of material out of the total market input that stays at the landfill after material picking by landfill material pickers and environmental leakage due to poor landfill management.

MATERIALS

PET
PET is an acronym for polyethylene terephthalate. The PET polymer is clear, strong, lightweight, safe and 100% recyclable. PET used for packaging accounts for 23% of the global usage of the PET polymer. 54% of all PET production is for fibre, e.g. for the textiles industry, where it is commonly referred to as polyester. Other industry uses include the automotive and electronics industries.

Recycled PET (rPET)
rPET is the acronym for recycled PET. rPET is not to be confused with RefillablePET which is usually referred to as REFPET in short form.

Virgin PET (vPET)
vPET is the acronym for virgin PET.

Polyester
For the purposes of this report, polyester refers to synthetic fibres made from PET. These are typically used in the textile industry.

Renewable Plastics
Renewable plastics, or biobased plastics, are made are made wholly or partially from renewable biological resources. For example, sugar cane is processed to produce ethylene, which can then be used to manufacture polyethylene, the building block of PET. Renewable (or biobased) plastics are not to be confused with biodegradable plastics, as some renewable plastics are made to be biodegradable based on international standards via composting (such as PLA) and others are not biodegradable (such as biobased PET).

Polylactic Acid or Polylactide (PLA)
PLA is a renewable (or biobased) plastic. It is created from fermented plant starch, which produces lactic acid and subsequently polylactic acid (PLA). PLA is certified biodegradable under industrial composting.

TOOLS TO DRIVE MATERIAL COLLECTION

Packaging Recovery Organisation (PRO)
An industry-led packaging recovery organisation (PRO) is a setup in which packaging producers are responsible for organizing and funding the collection, sorting, and/or recycling of post-consumer packaging materials.

Voluntary PRO
A voluntary PRO is an industry-led packaging recovery organisation (PRO) which is voluntarily set up by industry, as opposed to being set up by industry due to a government mandate.

Extended Producer Responsibility (EPR)
A combination of tools that places the responsibility of material collection and recycling on the producer of the material. This can involve both physical and/or financial responsibility to treat and dispose of post-consumer products.

Deposit Refund System (DRS)
DRS is a tool available to implement mandatory EPR obligations. DRS can also be implemented on a voluntary basis by industry. DRS either consists of manual take-back and/or it is supported by reverse vending machines. The point of redemption can be located at a retailer or at redemption centers and take-back points. The deposit (the incentive) is usually clearly labeled. The deposit is refunded to the consumer when the empty package is returned.

Recycling Targets
Recycling Targets are a tool available for mandatory EPR obligations. Recycling targets require producers to hit annual recycling targets for specific types of packaging. Targets are usually set in percentage points. Can also be known as Product Take-Back requirements. Recycling Targets are often implemented together with other economic tools such as Advanced Fees, DRS or Taxation.

Recycled Content Targets
Recycling Targets are a tool available for mandatory EPR obligations; however, targets can also be implemented outside the EPR as part of other government policies. Recycled content targets require producers to use a specific percentage of recycled packaging content (e.g. 30% food-grade rPET in their packaging). It can be used alongside other design changes such as lightweighting.

Taxation (Packaging Tax)
A tax based on the amount of packaging produced by the industry (packaging tax) or amount of packaging consumed (product tax). Implemented by the government and run as a state enterprise solution that is not controlled by the industry. Packaging taxes can be implemented as a punitive measure for not meeting other EPR obligations such as recycling rate targets or recycled content usage targets.

Buy-back (Direct Acquisition of Packaging)
Whereby a company or industry invests in creating a collection system for a specific material type to meet its recycling obligations.

MISCELLANEOUS TERMS

Southeast Asia and ASEAN
Southeast Asia includes 10 countries: Indonesia, Singapore, Malaysia, the Philippines, Vietnam, Thailand, Myanmar, Brunei, Cambodia and Laos. Of these, the six most populated countries are studied in this report: Indonesia, the Philippines, Vietnam, Thailand, Myanmar and Malaysia. Southeast Asia is also commonly referred to as ASEAN in public. However, ASEAN is only used within this report when it refers to the regional organisation (the governing body) for the 10 Member States - for example, in referring to the ASEAN regional bloc.

Post-Consumer
Post-consumer in this report refers to the item (i.e. packaging) used and disposed of by the end consumer, which, in the case of PET bottles, is usually a member of the public. Industrial/ factory waste PET is specifically excluded from this definition.

Tonnes
Tonnes in this report refers to metric tonnes (i.e. 1,000kg).

Acknowledgements

GA CIRCULAR CORE PROJECT TEAM

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- PT Polindo Utama Recyclers
- Slangum Jaya Recyclers
- Association of Plastic Recycling in Indonesia (ADUPI)
- PRAISE
- Indonesian Waste Platform (IPI)

THE PHILIPPINES

- CENRO, Parañaque
- Can Asia
- Top Lun Recyclers
- Leonel Waste Management Corporation
- Philippine Alliance for Recycling Materials Sustainability (PARMS)
- Philippine Plastics Industry Association (PPIA)

VIETNAM

- ENDA
- Japan International Cooperation Agency (JICA)
- Ministry of Natural Resources and Environment
- Shun An Recycler, HCMC

THAILAND

- Bangkok Metropolitan Administration
- Haad Thip PCL
- Indorama Ventures
- Ministry of Natural Resources and Environment, Phuket Office
- PJT Technology Co., Ltd
- Phuket City Environmental Protection Community
- Phuket Provincial Authority
- Plastics Industry Club, Federation of Thai Industries
- Plastics Institute of Thailand
- Pollution Control Department
- Prince of Songkla University, PSU Phuket Campus
- SEEK, Phuket - Nick Anthony, Debra Mierczak, Peter Harris
- Thailand Institute of Packaging and Recycling Management for Sustainable Environment
- ThaiNamthip Limited

MYANMAR

- Duck Feather Recycler, Yangon
- Pollution Control and Cleaning Department (PCCD), Yangon

MALAYSIA

- Ministry of Urban Wellbeing, Housing and Local Government (KPKT)
- Department of National Solid Waste Management (JPSPN)
- SWCorp
- Waste Management Association of Malaysia (WMAM)
- SWM Environment Sdn Bhd
- Green Concept Technology Sdn Bhd
- Glowmore Express Sdn Bhd
- Heng Hiap Industries Sdn Bhd
- Nebula Waste Management Sdn Bhd
- I-CYCLE Sdn Bhd
- Malaysian Plastics Manufacturers' Association (MPMA)
- Kampung Darul Ehsan Berhad (KDEB) Waste Management
- EPIC
- Reef Check Malaysia
- EcoKnights

INTERNATIONAL

- UN Environment Programme Asia Pacific Office
- Interafval, Belgium
- ECOCE, Mexico
- PETSTAR, Mexico
- PETCO, South Africa
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Executive Summary

Executive Summary

In recent years, the global momentum for rethinking the way plastic packaging is produced, consumed and disposed of has grown faster than ever. The largely linear approach to the way plastic packaging enters and exits our lives for fleeting moments has reached its limits and the challenges have become apparent. In 2016, the Ellen MacArthur Foundation quantified that US$80 billion to $120 billion worth of plastic packaging was lost from the global economy each year due to the packaging not being collected for recycling. A year earlier, another baseline quantification determined that 8 million to 12 million tonnes of plastic leak into the oceans each year, with eight of the top 10 countries for plastic leakage being in Asia.

Whilst these are global statistics, it has quickly become apparent that Asia, as the world's largest consumer of plastic packaging and the largest contributor to marine leakage, is where bold vision and effective action is needed to stem this profound environmental damage and the loss of this valuable resource. This can only be addressed when there is a baseline from which to drive informed action and measure progress.

This report is the first to provide a systematic and comparative baseline of the flow of plastics packaging from production to end-states by studying PET bottles (one of the most recyclable forms of plastic packaging) in six countries in Southeast Asia. These six countries are Indonesia, the Philippines, Vietnam, Thailand, Myanmar, and Malaysia, which account for a total population of more than 600 million people, more than the population of all the European Union's 28 countries. Five of these six countries are among the top 10 global contributors to ocean plastic leakage. These six countries in Southeast Asia are, therefore, a focal point in global efforts to create the narrative for vision and action on changing the linear economy approach to plastic packaging.

This report is the first to identify the root causes of the challenging realities concerning post-consumer plastic packaging in Southeast Asia today and to provide a roadmap to transform the post-consumer PET landscape in Southeast Asia.

Detailed baseline data collection, analytical work and frequent interactions with stakeholders across the plastics value chain and experts throughout Southeast Asia and globally, revealed **five key findings and five recommended priority actions** to accelerate the circular economy for PET bottles in Southeast Asia.

FIVE KEY FINDINGS

1

In the six countries studied, the average Collected-for-recycling rate for PET bottles is 54% at the city level.

This baseline research (2018) shows that the average collected-for-recycling rate for PET bottles in nine key cities in Southeast Asia is 54%. The average landfill rate is 36%, and environmental leakage rate is 10%. There is a wide variation in these rates across the cities.

Extrapolating this information to the country level, the estimated average collected-for-recycling rate across the six countries studied is 26%, with another 26% going to landfills and the remaining 48% leaking into the environment. Comparing across the six countries, cities in countries with lower GDP per capita have higher collected-for-recycling rates than the cities in countries with higher GDP per capita.

2

The PET bottles that do not get recycled represent a loss in value of US$199 million.

Across the six Southeast Asian countries studied, a cumulative US$199 million worth of PET bottles is leaking into the environment or ending up in landfills each year.

3

The informal sector is responsible for 97% of the PET bottles collected for recycling in the cities studied.

The informal sector is the backbone of collection. The informal sector's significance rises out of the limited success of formal collection and recycling systems implemented to date in Southeast Asia.

4

Six underlying reasons account for the low Collected-for-recycling rates for PET bottles.

There are six underlying reasons for the low collected-for-recycling rates for PET in Southeast Asia:

1. Prices of post-consumer material are insufficient to drive informal sector collection;
2. Lack of value creation mechanisms and developed local end markets;
3. Current packaging design hinders value creation;
4. Poor waste collection coverage leads to material leakage;
5. Lack of source separation and separate collection leads to poor access to recyclable material;
6. Existing collection efforts in Southeast Asia have typically been short-term.

5

Status quo will result in a drop in PET bottle Collected-for-recycling rates.

Continued reliance on only the informal sector is expected to reduce collected-for-recycling rates in the future. This is because as cities and countries develop, the average cost of living increases, thus collecting and selling PET becomes very challenging in the face of rising standards of living and the informal sector, therefore, moves onto other trades and jobs.

It is expected that Asia Pacific will be the fastest global growth market for PET. The consumption of PET bottles is projected to almost double between 2018 and 2030 in the six Southeast Asian countries studied, from 886,000 tonnes to 1.52 million tonnes. Thus, even if the informal sector remained the same size and collected the same quantities per person, the collected-for-recycling rates would almost halve purely due to the doubling of market input.

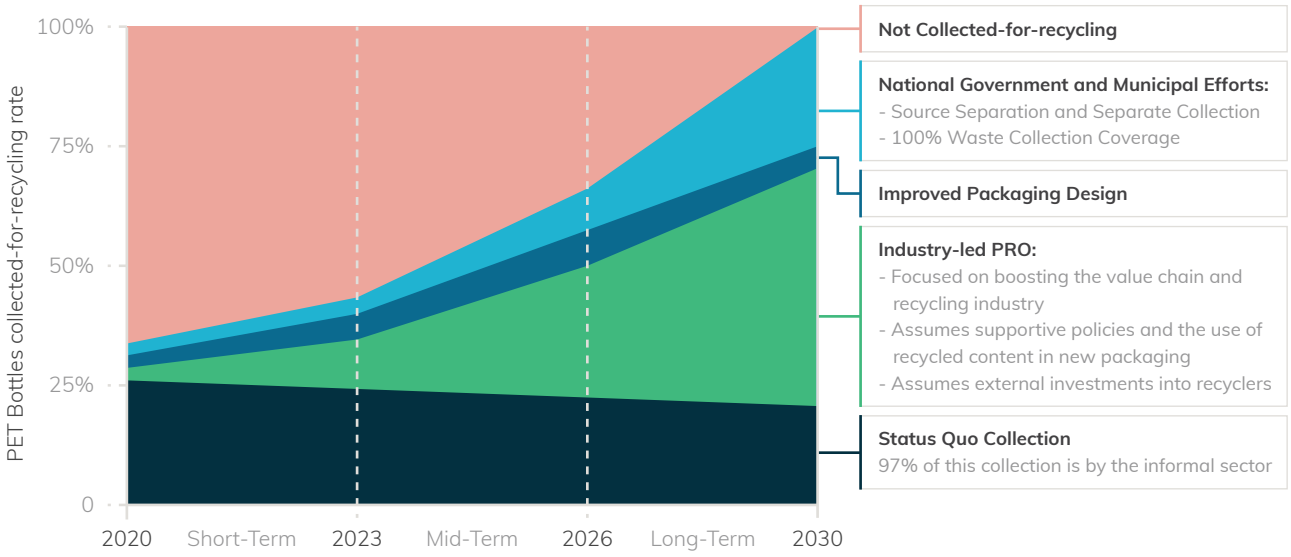
RECOMMENDED PRIORITY ACTIONS

The most effective response to the challenges currently facing the post-consumer PET landscape in Southeast Asia is one that effectively and continually boosts the collection and recycling operations currently in place. For the first time, a series of priority actions have been identified to transform the post-consumer PET landscape in Southeast Asia.

These priority actions and the related key actors are as follows:

Action	*Key actors*
Industry-led PRO focused on boosting the value chain, coupled with supporting policies and investments.	- Packaging and consumer goods industries as a collective effort - Supported by national governments, recyclers, investors, and funding institutions
Improved packaging design to improve the economics of recyclability by phasing out coloured PET and PVC labels, and using easier-to-remove label formats.	- Packaging and consumer goods industries - Individual company efforts in the short-term, collective industry effort in the mid- and long-term
National government and municipal efforts to impact source separation and separate collection, national recycling targets, and reach 100% waste collection coverage.	- National governments and municipalities

FIGURE 1: ACHIEVING A 100% COLLECTED-FOR-RECYCLING RATE OF PET BOTTLES IN SOUTHEAST ASIA



Source: GA Circular Analysis (see Appendix G for details).

ACTIONS OF EACH KEY STAKEHOLDER

BY PACKAGING AND CONSUMER GOODS INDUSTRIES

Phase out coloured PET and the phase out of PVC in PET bottles to improve the economics of PET bottle recycling and ensure that the PET bottles that are collected for recycling can be used for a wider variety of end-use applications. Coloured PET bottles are a major challenge to the PET recycling value chain as the added pigments contaminate the recycling process. Colouring PET bottles reduces its value in the Southeast Asian recycling market by an average of US$84 per tonne, with the total price differential ranging between US$21-$172 per tonne. On average, 15.4% of PET in the six Southeast Asian countries studied is coloured PET. A total of 128,161 tonnes per year of coloured PET bottles entered the market across the six Southeast Asian countries studied. Usage of PVC sleeves for PET bottles are also a major contaminant in PET bottle recycling, particularly in food-grade applications.

Take the best aspects of various tools under mandatory and voluntary EPR frameworks and run voluntary Packaging Recovery Organisations (PROs) in each country focused on boosting the value chain and the domestic recycling industry. The packaging and consumer goods industries are well placed to lead efforts to build the value chain through pulling material through the value chain and developing local end-use markets. It is recommended that a coalition of companies from the packaging and consumer goods industries set up a non-profit entity in the form of a Packaging Recovery Organisation (PRO) in each country. This research outlines the recommended industry-led voluntary PRO approach for Southeast Asian countries. It is informed by knowledge garnered from the more than 68 developed and developing countries and from the in-depth study of PROs in Mexico (ECOCE), South Africa (PETCO), Belgium (Fost Plus) and Japan (JCPRA).

RECYCLERS, INVESTORS AND FUNDING INSTITUTIONS

Accelerate investments in food-grade rPET production capacity within Southeast Asia to meet the anticipated 2030 demand. Current food-grade rPET production capacity in Southeast Asia is estimated to be between 10,000 and 30,000 tonnes per year. Several major multinational consumer goods companies have committed to using up to 50% rPET content in packaging by 2030. Assuming a conservatively lower 25% rPET content usage in PET packaging in 2030, demand of at least 380,000 tonnes of food-grade rPET across these six Southeast Asia countries is expected by 2030. Given that 20% of this demand can be supplied by adding post-consumer PET flakes during the process of making virgin PET, the remaining 80% (304,000 tonnes) will need to be achieved through an increase in the production capacity of food-grade rPET pellets. This is equivalent to at least 10 plants with a production output of 30,000 tonnes per year of rPET that need to be added by 2030 - i.e. one additional plant per year.

BY NATIONAL GOVERNMENTS AND MUNICIPALITIES

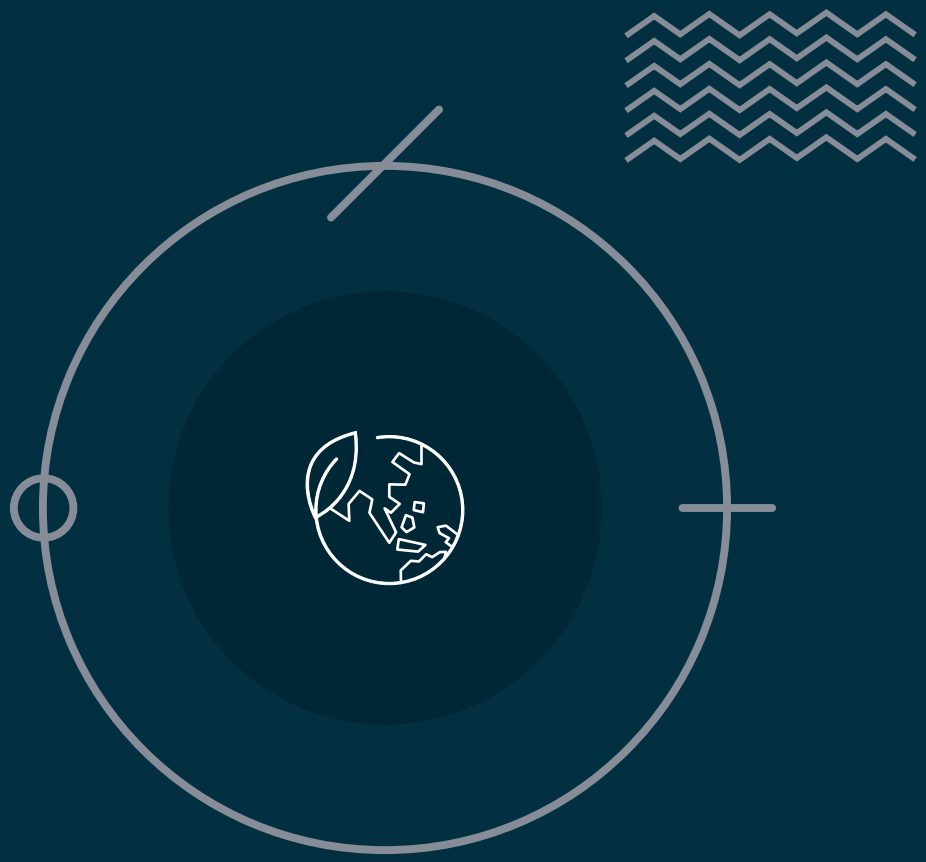
Develop and enact enabling legislation and policy to drive the circular economy. These policies would include those that assist in building the value chain, such as those governing the use of recycled content and standards for food-grade applications. This would also include those that push material through the value chain by enabling better material access, such as those enforcing source separation and separate collection. Before any EPR implementation, governments should also undertake a detailed study of different EPR tools, their advantages and disadvantages and their projected impact on the local product market, recycling markets and the informal sector. It is critical that any chosen EPR tools focus on boosting the value chain.

Review economic and administrative incentives for the development of a local recycling industry. Governments could consider provision of economic incentives to support a circular economy, e.g. tax incentives for producers which use a minimum of 30% recycled content in packaging, or levies for producers that use less than 30% recycled content.

Increase waste collection coverage and efficiency. Undertake sustained source separation and separate collection efforts, and increase waste collection coverage to 100%. Governments and municipalities need to recognise their critical role in making post-consumer material accessible and of higher value for recycling, and that any separation efforts will take time to scale from city level to country level.

Through these actions by key enablers, an accelerated circular economy for post-consumer PET bottles in Southeast Asia is 100% achievable.

Preface



Preface

This report is the first to provide a systematic and comparative baseline of the flow of plastic packaging from production to end-destination. It focuses on PET bottles (one of the most recyclable forms of plastic packaging) in six countries in Southeast Asia. The report scope does not include other plastic or non-plastic packaging types; however, many of the findings and solutions can be applied to other packaging materials throughout Southeast Asia. This report is also the first attempt to identify the root causes of the challenging realities concerning post-consumer PET bottles in Southeast Asia today and to provide solutions to drive circularity.

The six countries studied are Indonesia, Philippines, Vietnam, Thailand, Myanmar, and Malaysia and they account for a total population of more than 600 million people, more than the population of all the EU's 28 countries.

The countries studied account for 3.8% of global PET bottle consumption, but are the source of 29% of global plastic leakage into the world's oceans.

Five of these six countries are among the top 10 global contributors to ocean plastic leakage.[1] This is particularly concerning since the total consumption of PET bottles across these countries is set to almost double from 886,000 tonnes in 2018 to 1.52 million tonnes by 2030.

While country-specific data sets on municipal solid waste exist across most Southeast Asian countries, several challenges remain among these data sets with regard to PET bottles and other packaging:

- **Lack of key rates i.e. collected-for-recycling rates, landfill rates and environmental leakage rates for each country;**
- **Lack of a consistent data collection methodology which is comparable across the countries;**
- **Lack of available data sets on domestic value chains and material flow of PET across each of the countries.**

Without these baseline data sets which include the above consumption and post-consumption information, it is challenging to create suitable regional and country-specific strategies to increase collection and recycling rates for PET bottles. Also, such consistent and comparable baseline data sets are needed to enable companies to measure progress towards their global commitments.

FIGURE 2: CITIES AND COUNTRIES STUDIED FOR THIS REPORT

This report therefore seeks to address this data and knowledge gap by providing baseline research for PET bottles in nine key cities across Southeast Asia: Jakarta in Indonesia (the DKI Jakarta Region), Parañaque of Metro Manila in the Philippines, Ho Chi Minh City and Hanoi in Vietnam, Bangkok and Phuket in Thailand, Yangon and Mandalay in Myanmar, and Greater Kuala Lumpur in Malaysia.

As noted in the glossary, the term PET bottles in this report refers to PET used primarily for beverage applications and excludes any non-beverage applications, such as cooking oil bottles and food container packaging. See Appendix A for further information regarding PET bottles, packaging use in Southeast Asia and recyclability of PET bottles.

Current Realities

IN SOUTHEAST ASIA

1

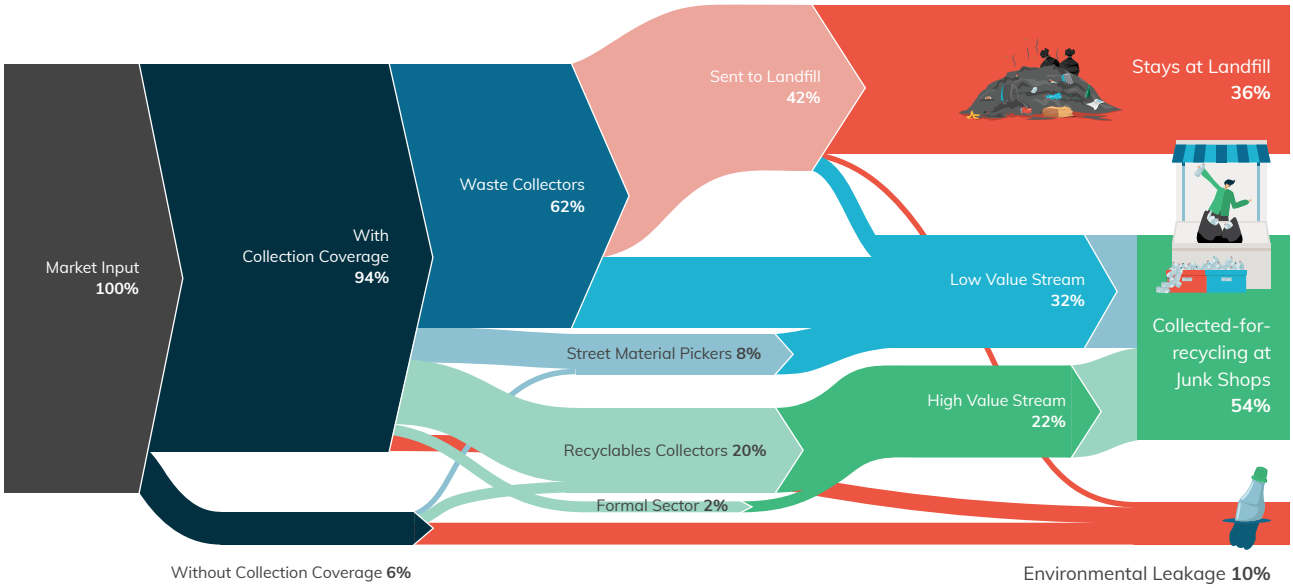
Current Realities in Southeast Asia

54% of the PET bottles sold in the cities studied are collected for recycling, whilst it is estimated that the average collected-for-recycling rate across the six countries is 26%. The informal sector is responsible for 97% of this collection for recycling. As these countries develop, the collected-for-recycling rates are projected to decrease, primarily due to a reduction in informal sector workers. In the six countries studied, an estimated US$199 million worth of post-consumer PET bottles are currently lost each year to landfills and environmental leakage.

1.1 54% OF THE PET BOTTLES SOLD IN THE CITIES STUDIED ARE COLLECTED-FOR-RECYCLING

At a city level, the average PET collected-for-recycling rate across the nine key Southeast Asian cities studied is 54%, while 36% stays in landfills and 10% leaks into the environment.

FIGURE 3: KEY FLOWS AND END DESTINATION OF POST-CONSUMER PET BOTTLES IN 9 SOUTHEAST ASIAN CITIES[2]



Source: GA Circular analysis - for details please refer to Appendix B

PET can either be consumed in areas with waste collection coverage or no collection coverage. A minority of households from both the areas with and without collection coverage segregate and sell/donate their recyclables to recyclables collectors or formal segregation systems. This material is not mixed with other waste, and is therefore classified as a 'high-value stream'.

A majority of households dispose of their recyclables mixed in with their other waste. This mixed waste is collected by waste collectors who sort through the collected waste for recyclables to sell to junk shops. However, since they deal with high volumes of mixed waste, they are unable to pick out all the recyclables present. The rest of the recyclables that are not picked out by formal waste collectors go to landfills.

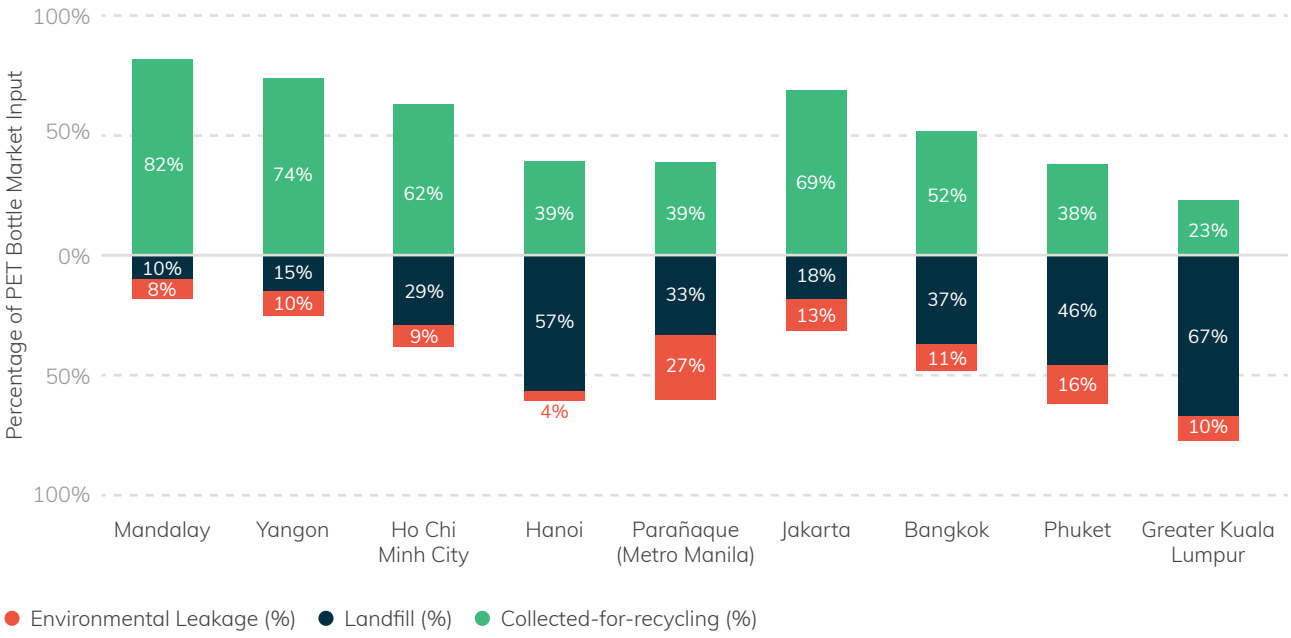
Street material pickers pick up some recyclables from open dumpsites, streets and rivers/canals and sell these to junk shops. At landfills, landfill material pickers perform this same role.

As the material sold by waste collectors, street material pickers, and landfill material pickers has been pulled out from mixed waste, it is more contaminated and is classified as the 'low-value stream'. Junk shops aggregate and sell recyclables to larger aggregators, who then sell to recycling factories.

Environmental leakage happens through three major routes: uncollected waste and littering from areas without collection coverage, littering by consumers in areas with collection coverage, and leakage from poorly managed landfill sites.

As seen in figure 4, there is a wide variation in collected-for-recycling, landfill, and environmental leakage rates across the cities. Mandalay in Myanmar for example has a much higher collected-for-recycling rate (82%) compared with Greater Kuala Lumpur in Malaysia (23%). Whilst these rates depend on global macroeconomic factors such as oil and virgin plastic prices, they are largely dependent on local factors in Southeast Asian countries as discussed in sections 1 and 2 of this report.

FIGURE 4: END DESTINATION OF POST-CONSUMER PET BOTTLES IN 9 SOUTHEAST ASIAN CITIES[3]

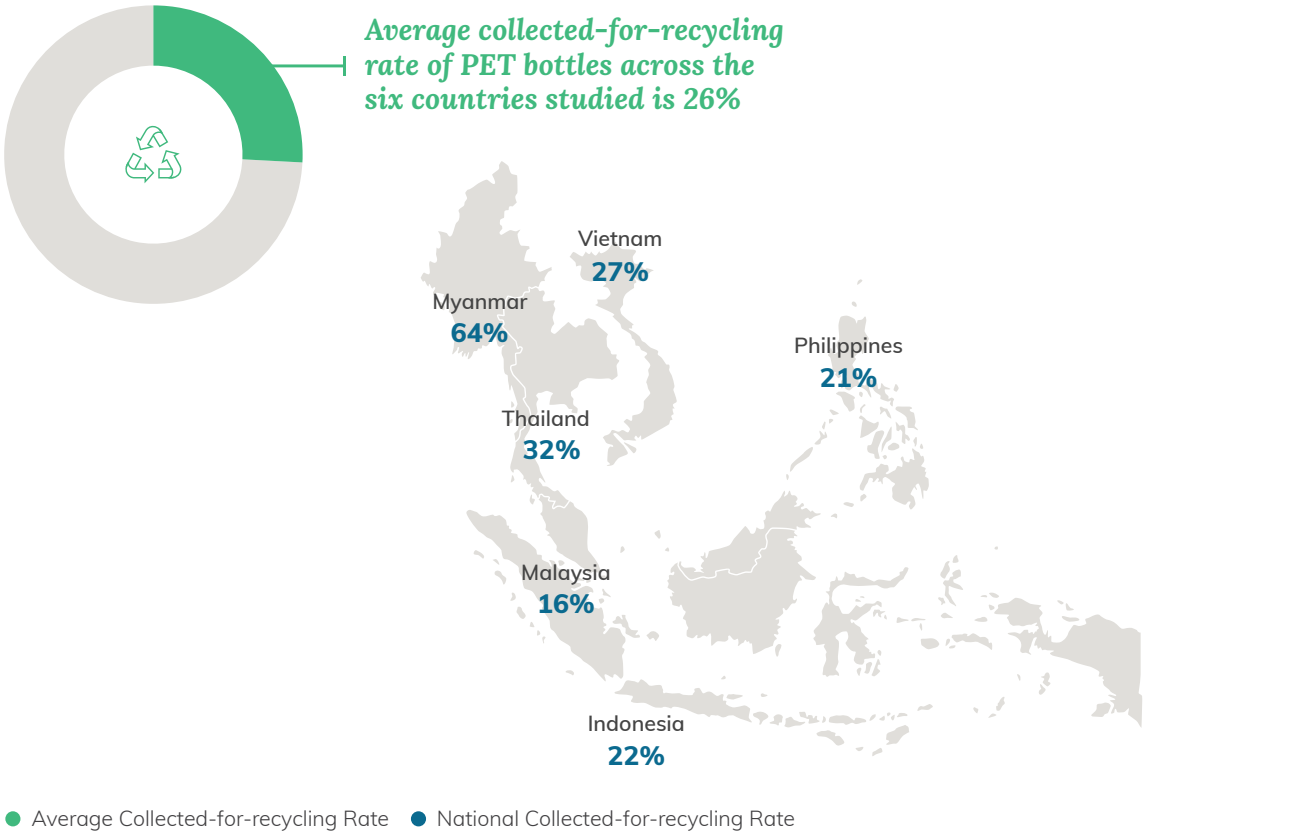


1.2 AN ESTIMATED 26% OF THE PET BOTTLES SOLD IN THE COUNTRIES STUDIED IS COLLECTED FOR RECYCLING

Using the data gathered from these key cities, the GA Circular research team estimated the national level collected-for-recycling rates. The country rates are lower than the city rates because, despite rural areas typically having lower packaging consumption, they also have significantly poorer waste collection coverage and lower informal sector involvement when compared to urban areas. The estimated average PET collected-for-recycling rate across the six countries studied is 26%, with 26% going to landfills and 48% leaking into the environment.

The figure below summarises the collected-for-recycling rates for each of the six countries studied. The national rates presented have a larger margin of error than the city rates as the city rates have been calculated based on primary data while the national rates have been estimated based on data from the cities and the rural-urban composition of the country factoring waste collection coverage, consumption and informal sector involvement.

FIGURE 5: ESTIMATED NATIONAL COLLECTED-FOR-RECYCLING RATES FOR THE SIX SOUTHEAST ASIAN COUNTRIES STUDIED[4]



Note: Estimation is based on extrapolation of the city-level rates, accounting for urban-rural consumption differences along with waste collection coverage and informal sector activity. As they have been arrived at by extrapolation, the country rates have an error margin of +/- 15%

Source: GA Circular analysis - for further details please refer to Appendix B.

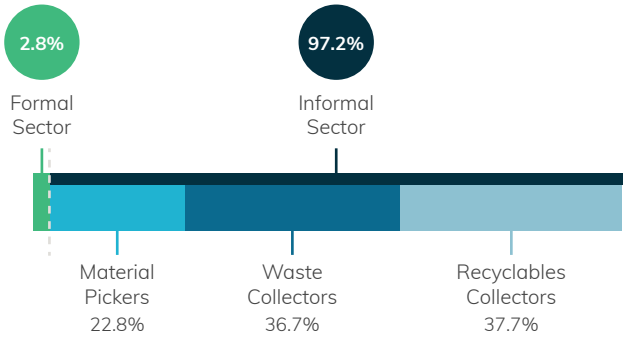
1.3 THE COLLECTED-FOR-RECYCLING RATES IN THE COUNTRIES STUDIED ARE LOWER THAN THE GLOBAL AVERAGE

'The New Plastics Economy: Rethinking the Future of Plastics' report estimated a global PET packaging collected-for-recycling rate of 55% as of 2012. Based on various trade and industry data analysed as part of this research, it is expected that in 2020, 53% of the global PET packaging produced will be collected annually.

Thus, the estimated collected-for-recycling rate of 26% for the Southeast Asian countries studied is about half the global average. The collected-for-recycling rate at the city level of the nine cities studied at 54% is on par with the global average.

1.4 THE INFORMAL SECTOR IS RESPONSIBLE FOR 97% OF COLLECTION-FOR-RECYCLING

FIGURE 6: BREAKDOWN OF PET COLLECTED FOR RECYCLING BY THE FORMAL AND INFORMAL SECTORS[5]



The informal sector is the backbone of collection for PET bottles in the six Southeast Asian countries. The collection of PET bottles and other recyclable materials is reliant on the informal sector, as shown in the diagram below, where 97.2% of the PET bottles which are collected for recycling are handled by the informal sector. The informal sector plays a significant role in Southeast Asia due to a low barrier to entry, relatively high material value for used PET bottles and easy accessibility of recyclables as the majority of the region uses push-carts for the first stage of household waste collection rather than garbage trucks.

Across the countries studied, there are broadly three categories of informal sector workers.

RECYCLABLES COLLECTORS

Image: A recyclables collector in the Philippines using a cart[6]

Recyclables Collectors are self-employed people who use bags, small push-carts or small motorised vehicles to buy recyclable materials from households, bulk waste generators or other establishments through the relationships they have built. They sell the material to junk shops as a primary source of income. They may also pick up recyclables from mixed waste or litter. However, the majority of the material that they handle is based on buying from households, other establishments and bulk waste generators.

Recyclables Collectors comprise 37.7% of the collection system for PET bottles in the six Southeast Asian countries. However, despite an average recyclables collector selling a greater quantity of recyclables than the average waste collector (another category of informal sector worker - see right), his/her take-home income is usually lower. This is because unlike waste collectors, recyclables collectors do not have a fixed salary for mixed waste collection and they often have to buy recyclables from households or establishments, whereas waste collectors do have a fixed salary for mixed waste collection and do not need to buy the materials.

WASTE COLLECTORS

Image: A formal waste collector with a push-cart in Vietnam[7]

Waste Collectors are the people who collect waste (mixed or separated) from households, offices or establishments. They are formally employed by the public or private waste collection sectors and their formal source of income is from the collection and transportation of mixed waste. For this job, they are considered formal workers. Whilst not their job, these people often actively sift through the mixed waste in the carts or trucks to pick out recyclable materials for extra personal income. When picking out recyclable materials is not part of their job scope and they sell for extra personal income, they are considered informal sector workers.

Waste collectors comprise 36.7% of the collection system for PET bottles.

MATERIAL PICKERS

Image: A woman sorting through waste in Dela Reina, Philippines[8]

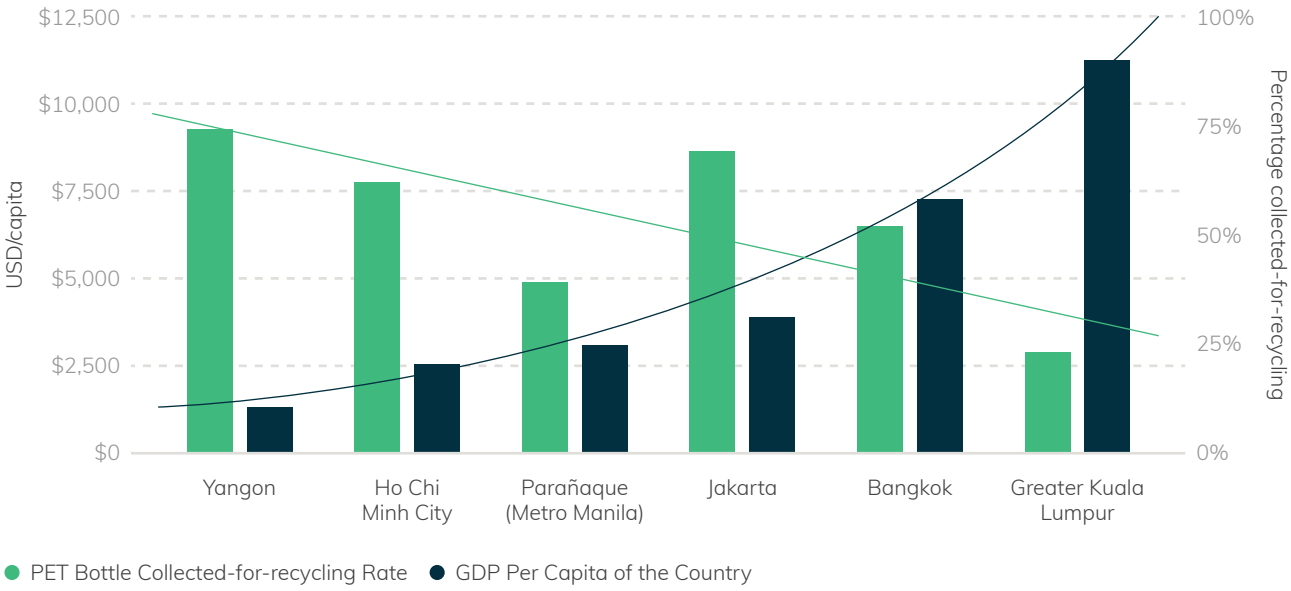
Material Pickers include both street material pickers and landfill material pickers who pick up recyclable materials from the environment (e.g. litter on the street, from landfills) and not directly from the source. Material picking is therefore a very labour intensive exercise and often dangerous. Street material pickers are those who pick up recyclable materials from the open environment (in the city), or from a garbage bin. They may also do some buying direct from households or bulk waste generators, but they are primarily picking, which is why they are called street material pickers. Landfill material pickers are those who pick up recyclables from landfills. Due to health and safety concerns of picking recyclables from landfills it is often illegal to pick from landfills in countries in Southeast Asia. However, the practice still continues due to weak enforcement. These people are often referred to as scavengers; however, material pickers (street or landfill) is the terminology used by GA Circular and within this report.

Material pickers comprise 22.8% of the collection system for PET bottles.

1.5 AS COUNTRIES DEVELOP, THE COLLECTED-FOR-RECYCLING RATE DECREASES

In a developed region such as the EU, countries with lower GDP per capita tend to have lower collected-for-recycling rates of PET as compared to those with higher GDP per capita. However, this trend is reversed in the countries studied. When the collected-for-recycling rates of the largest cities in the six countries studied are compared against the GDP per capita of each country, it can be observed that the cities in countries with lower GDP per capita have higher collected-for-recycling rates. For example, Yangon in Myanmar with the lowest GDP per capita of US$1,298 of the six countries has the highest PET collected-for-recycling rate of 74% whereas Kuala Lumpur in Malaysia with the highest GDP per capita of US$11,239 has the lowest collected-for-recycling rate of 23%.

FIGURE 7: COMPARISON OF GDP PER CAPITA VS. VS. PET BOTTLE COLLECTED-FOR-RECYCLING RATES IN KEY CITIES OF SIX SOUTHEAST ASIAN COUNTRIES STUDIED[9]



Note: The largest city has been selected in the situation where more than one city in the country was studied. As countries develop, maintaining the status quo will result in declining collected-for-recycling rates.

The heavy reliance on the informal sector is one of the primary factors causing this trend. The impact of continued reliance on the informal sector can be easily observed by comparing cities at different stages of economic development. The reason behind this relationship is that as cities and countries develop, the average cost of living increases. Collecting and selling PET no longer remains sustainable in the face of rising standards and costs of living and the informal sector therefore moves onto other trades and jobs. This is validated by data, where residents in Greater Kuala Lumpur have an average income of US$688 / month (country GDP of US$11,239) but only five informal sector workers for every 10,000 residents, while Ho Chi Minh City residents have an average income of US$250 / month (country GDP of US$2,564) and double the concentration of informal workers (10 for every 10,000 residents).[10] In summary, more affluent cities are typically found to have less informal sector workers in the recycling value chain.

Bangkok, meanwhile, is currently in a unique situation where despite the relatively higher GDP per capita compared to the other five Southeast Asian countries, the presence of a stronger recycling industry demanding post-consumer PET has helped maintain a higher street price for post-consumer PET, and thus the collected-for-recycling rate has continued to hold up.

Without intervention, the rising cost of living in the countries studied will likely lead to a decrease in the number of informal sector workers and a subsequent drop in the collected-for-recycling rates.

1.6 US $199 MILLION WORTH OF PET BOTTLES ARE LOST PER YEAR ACROSS THE SIX SOUTHEAST ASIAN COUNTRIES

Across the six Southeast Asian countries studied, a cumulative US$199 million worth of PET bottles (based on PET sales price from junk shops to aggregators) are leaking into the environment or ending up in landfills each year.[11] This represents a net economic loss as PET bottles are leaking into the environment or ending up in landfills and are no longer available for recycling. This economic loss of material is compounded by negative externalities of PET bottles which include cost of landfilling the packaging, cost of cleaning up environmental leakage and finally the environmental impact of plastic packaging in the environment which can be measured through the potential damage caused to natural ecosystems and industries dependent on them such as tourism.

In the absence of interventions, the landfilling and leakage of post-consumer PET bottles will likely increase due to increasing consumption in each of the countries.

TABLE 1: VALUE OF PET BOTTLES THAT ARE COLLECTED FOR RECYCLING, LOST TO LANDFILLS AND LOST TO ENVIRONMENTAL LEAKAGE

	Recycling i.e. GAIN (+) Millions USD/year	Landfills i.e. LOSS (-) Millions USD/year	Leakage i.e. LOSS (-) Millions USD/year
Myanmar	$3	$1	$1
Vietnam	$12	$12	$20
The Philippines	$10	$5	$33
Indonesia	$18	$20	$43
Thailand	$30	$34	$27
Malaysia	$1	$2	$1
TOTAL	**$73 GAIN**	**$199 LOSS**	

Note: The material values are based on average selling prices from junk shops to next buyer (aggregators/processors/recyclers)[12] for the tonnage collected for recycling, landfilled and leaked. Thus, values stated exclude the loss in value that occurs for PET bottles from the pre-consumer to the post-consumer stage.

1.7 CONSUMPTION OF PET BOTTLES IS EXPECTED TO GROW

An increase in the level of development for Southeast Asian countries will lead to an increase in the amount of packaging introduced in the market. The six Southeast Asian countries consumed 886,000 tonnes of PET packaging in total in 2018. Based on modelling and analysis from industry data, our research team estimates the total consumption of PET bottles across these six Southeast Asian countries is set to almost double from 886,000 tonnes in 2018 to 1.52 million tonnes by 2030.[13]

1.8 BOTTLE-TO-BOTTLE PET MUST INCREASE TO SATISFY PUBLIC COMMITMENTS

While sourcing for specific trade-level data on end-use applications of post-consumer PET processed in Southeast Asia was out of the scope of this report, interviews with stakeholders from the packaging and recycling industries indicate that the global demand for recycled PET (rPET) polymer used for food-grade bottles has been steadily increasing and is expected to grow by approximately 20.3% compound annual growth rate (CAGR) between 2015 and 2030 compared to a 5.9% CAGR in PET polymer growth globally between 2015 and 2030.[14] Demand for post-consumer PET for fibre and other non-bottle applications is expected to grow by 7.7% CAGR during this period.[15]

Buyers of food-grade rPET in Southeast Asia can expect to face a few levels of competition for the recycled food-grade rPET. The first level of competition will be the global demand for rPET vs rPET fibre. This level of competition is expected to be especially fierce as buyers of rPET fibre in the textile industry have been observed to pay a higher premium compared to buyers of food-grade rPET. This is because the products of the textile industry have higher margins per unit compared to beverage products and have lower additional processing costs. The second level of competition will be for global food-grade rPET vs non-food-grade rPET. The third level of competition will be for food-grade rPET globally vs in Southeast Asia. The final and the fourth level of competition will be for food-grade rPET among each of the Southeast Asian countries.

Sensing this opportunity, recyclers are increasing their investments in food-grade and non-food-grade rPET production capacity within Southeast Asia. During the course of the research, it was observed on-ground across the six Southeast Asian countries that commitments towards increasing the share of recycled PET content in packaging are beginning to be turned into action. Publicly announced investments in bottle-to-bottle PET recycling plants in Southeast Asia have been made by both FENC and Coca-Cola in the Philippines and by Veolia in Indonesia.

Underlying Reasons

FOR THE LOW RATES OF COLLECTION FOR RECYCLING

2

Underlying Reasons for the Low Rates of Collection for Recycling

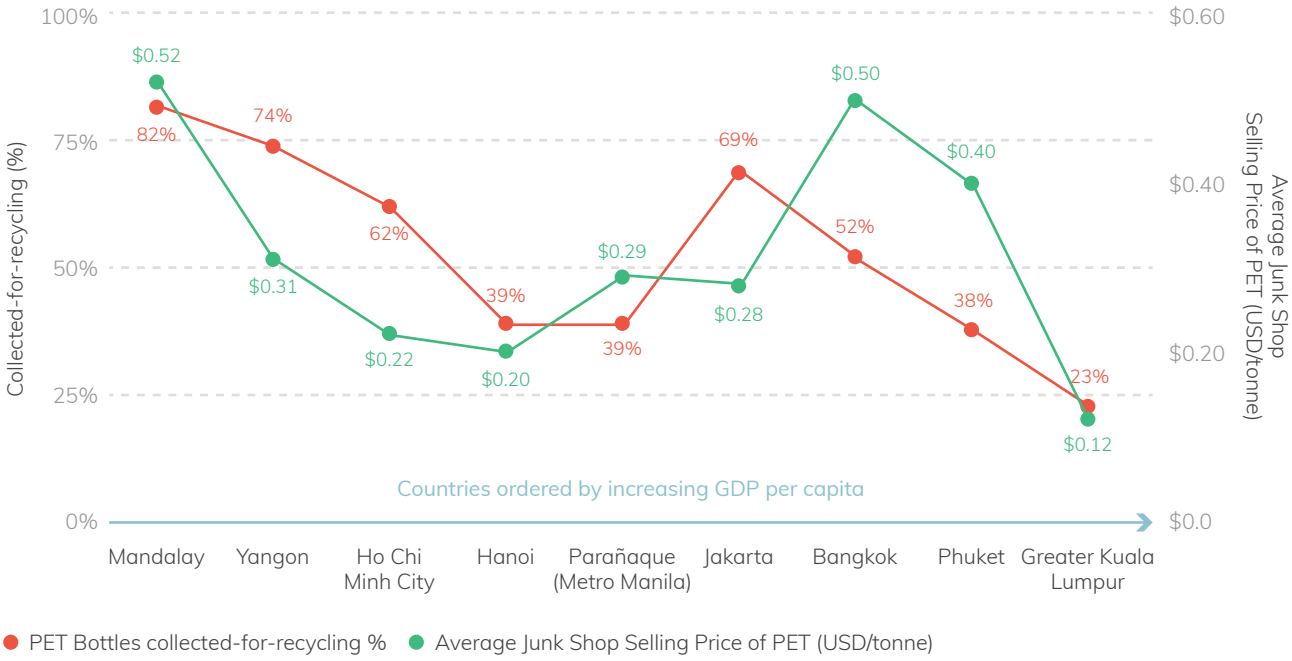
The six underlying reasons for the low collected-for-recycling rates for PET in Southeast Asia:

1. Price of post-consumer material is insufficient to drive informal sector collection;
2. Lack of value creation mechanisms and developed local end markets;
3. Current packaging design hinders value creation;
4. Poor waste collection coverage leading to material leakage;
5. Lack of source separation and separate collection of waste leading to poor access to material;
6. Existing collection efforts in Southeast Asia have typically been short-term.

2.1 PRICE OF POST-CONSUMER MATERIAL IS INSUFFICIENT TO DRIVE HIGH COLLECTION BY THE INFORMAL SECTOR

Due to the reliance on the informal sector for collection and the price elasticity of post-consumer PET bottles, the material price offered by recyclers is one of the major determinants of increased or decreased collection via a trickle-down effect to the informal sector.

FIGURE 8: COLLECTED-FOR-RECYCLING RATES AND SELLING PRICE OF PET BOTTLES IN KEY SOUTHEAST ASIAN CITIES (ORDERED BY LEVEL OF DEVELOPMENT (GDP))[16]



Note: The selling price of PET is the price at which junk shops sell to aggregators. The data points in the figure are based on primary data collected through 2017- 2018 from junk shops across the cities studied. They are reflective of the prices at the time of the study in each country.

Material prices offered for post-consumer PET across the value chain depend on levels of contamination, processing costs, logistics costs and transportation costs to ship the collected material to the aggregator and then onto the recycler.

Therefore, there is a wide variation in prices depending on the level of source separation efforts, proximity to the recycling factory, and the local labour and fuel costs. Proximity to recyclers and recycling capacity significantly increases the prices offered through the value chain. This is visible in Thailand which, whilst it has a higher GDP, is estimated to have the highest installed capacity for post-consumer PET recycling among all the six Southeast Asian countries and thus commands higher prices for post-consumer PET on the street. A junk shop in Bangkok receives US$0.50 per kg of post-consumer PET compared to the average of US$0.31 per kg received by junk shops for post-consumer PET across the nine cities studied (see Figure 9). Thus, despite the relatively higher GDP per capita compared to the other five Southeast Asian countries, the presence of a larger recycling industry demanding post-consumer PET has helped maintain a higher street price for post-consumer PET and thus the collected-for-recycling rate has continued to hold up.

This is also visible in Myanmar where a junk shop in Yangon receives the equivalent of US$0.31 per kg of PET sold, while a junk shop in Mandalay, which is closer to the border with China (and therefore closer to the recycler), gets the equivalent of US$0.52 per kg of PET. Note that at the point of this research the impact of China's National Sword policy was not yet being felt in the post-consumer plastic markets of Myanmar and thus demand in China for post-consumer PET from Mandalay was high.

In summary, the presence of a stronger recycling industry demanding post-consumer PET helps maintain higher street prices for post-consumer PET, and this helps to hold up collected-for-recycling rates. When prices are not attractive enough for the informal sector to collect the material, the collected-for-recycling rates tend to be lower. This is a hint to the intervention needed in Southeast Asian countries to increase collected-for-recycling rates.

In addition to the absolute price of the material, the perceived value and price fluctuations also play a role in determining the collection behaviour of the informal sector. The market prices of the end products of PET recycling are typically volatile, resulting in the recyclers going through high-profitability, low-profitability, and loss-making phases. This affects the prices of PET bought and sold by the informal collection sector, which consequently affects the tonnage collected. During loss-making periods, recyclers reduce the amount of PET they buy or stop buying material entirely. In particularly challenging periods, recyclers either go bankrupt or preemptively close their businesses. This causes the value-chain to suffer significantly, sometimes reducing the price of PET to an extent where informal collectors refuse to buy or sell the material.

Currently, aggregators, processors and/or recyclers in Southeast Asia are willing to pay the equivalent of US$0.12 - US$0.52 per kg of PET from junk shops. These price points are sufficient to incentivise the collection of PET by a majority of informal sector workers. Across all the cities studied, 65% to 70%[17] of all informal sector workers on average buy and sell PET on a daily basis. Despite this, the incentives for PET are not high enough to incentivise the collection of more than 54% of the total PET market input in these cities.

2.2 LACK OF VALUE CREATION MECHANISMS & DEVELOPED LOCAL END MARKETS

Though a PET recycling industry exists in Southeast Asia, due to the poor quantity and quality of the post-consumer PET collected locally, these recyclers have typically been heavily reliant on imports to meet their feedstock requirements. Post-consumer imports from developed countries, such as the G7 countries (Canada, France, Germany, Italy, Japan, United Kingdom and United States) have been accessible in large, cheap and consistent quantities compared to domestically sourced feedstock. These imports are lower in contamination rates and thus higher in quality.

This reliance on imports has meant that local collection systems are not well developed and, therefore, the post-consumer PET from the local markets does not have strong end-use markets. However, this is expected to change with recent import restrictions and quality standards placed by several Southeast Asian countries on post-consumer waste imports in the wake of China's National Sword policy which included import restrictions and tightening of quality standards for post-consumer plastics. See box 1 below for further details of National Sword policy and its impact on PET recycling in Southeast Asia.

Box 1: Impact of China's National Sword Policy on PET recycling in SouthEast Asia – the dawning of a new era

BACKGROUND ON NATIONAL SWORD

Until recently, China was the world's largest importer of recyclable materials. In 2016, China imported 45 million tonnes of recyclable materials from across the world (half the global exports of recyclables). This amounted to US$18 billion in material value.[18] In 2017, China accounted for 51% of the world's plastic scrap imports.

Over the past decade, China has undertaken policy steps to curb the dumping of waste into its borders together with genuine recyclables. One of the first import policy steps was in 2013 when the Chinese government adopted a policy known as Operation Green Fence to prohibit the import of unwashed and contaminated recyclable materials and increase the environmental standard of all the shipments of recyclable materials entering China.

On 1st January 2018, China began officially implementing its National Sword policy to further crackdown on the illegal smuggling of foreign waste into China, targeting industrial waste, electronic scrap, and plastics. Prior to this, China accepted recyclable materials with purity levels ranging from 90% to 95%. The new National Sword policy requires that all recyclable materials arriving in the country must have purity levels greater than 99.5%. Due to these stricter contamination limits, a majority of recyclables that were shipped into China from developed countries (such as the G7 countries) were no longer allowed as they did not meet the contamination standards.

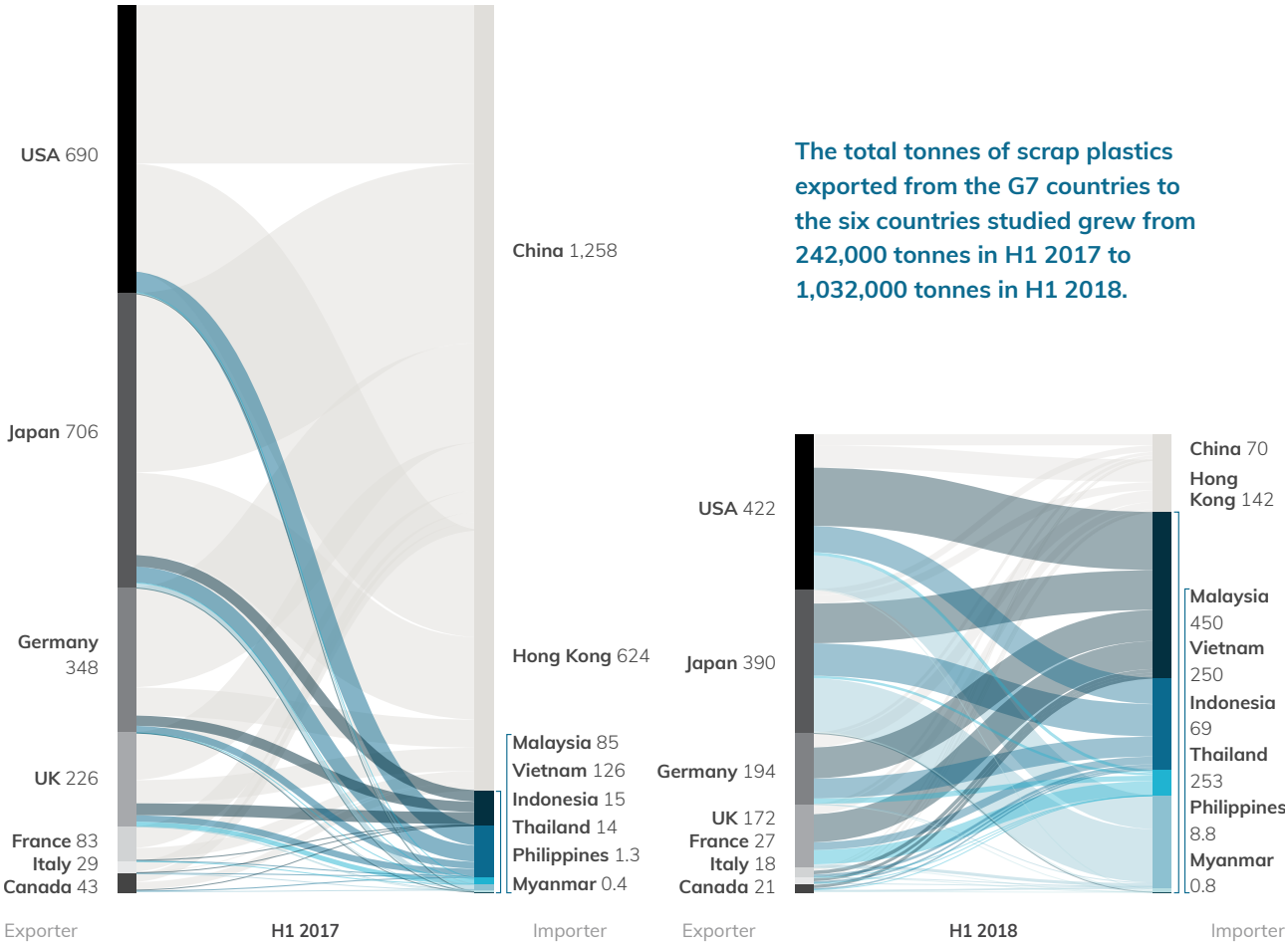
IMPACT ON PLASTICS

As a direct impact of the National Sword policy, by 2018 the import of scrap plastics into China reduced by 99.1% compared to 2017 levels.[19] This has resulted in a global glut of recyclable commodities (including PET), depressed prices and expansion of processing markets in other lesser-developed countries, with a sizeable proportion of this diversion going into Southeast Asian countries - mainly into Malaysia, Thailand, Vietnam and Indonesia.

Following the National Sword policy, exports from the G7 to China, Hong Kong, and Southeast Asia reduced by 40% overall. However, despite this reduction, the total tonnes of scrap plastics exported from the G7 countries to the six countries studied grew from around 242,000 tonnes in H1 2017 to around 1,032,000 tonnes in H1 2018.[20]

In H1 2017, the six countries studied only accounted for around 11% of the scrap plastic exports from the G7 countries. This grew to 83% in H2 2018, with Malaysia, Thailand, Vietnam, and Indonesia seeing the biggest increases. These four countries have been quickly overwhelmed by the volume and have since cut back on imports and announced plans to place severe restrictions on scrap plastic imports or plans to enforce a complete import ban in the coming two to five years.

FIGURE 9: EXPORTS OF SCRAP PLASTICS FROM G7 COUNTRIES TO CHINA AND SOUTHEAST ASIA



Note: All figures in thousand tonnes per year

OPPORTUNITY FOR PET RECYCLING

As a new normal from the National Sword policy emerges, a combination of steps such as the ones outlined in section three of this report can enable the PET processing and recycling industry in the six Southeast Asian countries to take advantage of the National Sword policy.

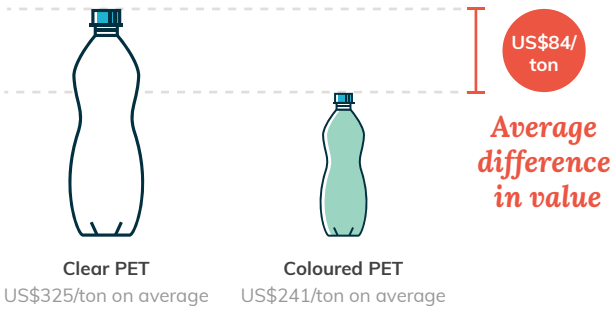
This will result in:

1. More investments into solid waste management infrastructure such as sorting, collection and secondary processing capabilities to produce higher quality feedstock for recyclers with very low contamination rates
2. More investments into domestic processing and recycling capacities
3. Increased domestic collection of post-consumer PET, higher collected-for-recycling rates and more developed end-use markets for domestic post-consumer PET

2.3 CURRENT PACKAGING DESIGN HINDERS VALUE CREATION

2.3.1 COLOURED PET

FIGURE 10: VALUE DIFFERENCE BETWEEN CLEAR AND COLOURED PET[24]

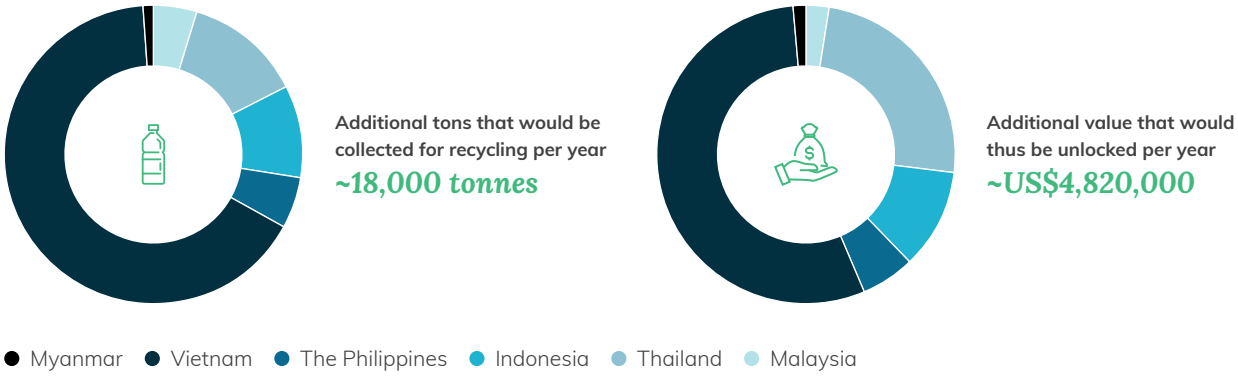


Note: The values are based on selling prices of clear and coloured PET at the junk shop to aggregator transaction stage.

Coloured PET bottles are a major challenge to the PET recycling value chain as the added pigments contaminate the recycling process. Choosing to manufacture a PET bottle coloured instead of clear reduces its value in the Southeast Asian recycling market by an average of US$84 per tonne, with the total price differential ranging between US$21-$172[21] per tonne across the six Southeast Asian countries. On average 15.61% (138,455 tonnes) of PET bottles sold per year in the six Southeast Asian countries is coloured PET.[22]

If all of this PET were instead clear, at current collected-for-recycling rates, an estimated additional 17,892 tonnes of PET would be collected-for-recycling by the existing informal sector[23] (i.e. with no additional initiatives apart from the phasing-out of coloured PET). To put this into perspective, the value of this additional amount is US$4.8 million per year based on the price of clear PET bottles sold by junk shops to aggregators. The tonnage and US dollar value upsides are conservative when considering the additional benefits of phasing out coloured PET for the collection sector, in terms of removing the need for coloured vs clear sorting and the associated staff and manpower, which will enable greater efficiency in collection. Many countries globally, such as Japan, have already taken steps to phase out and ban the usage of coloured PET bottles in order to increase collection and recycling rates.

FIGURE 11: ADDITIONAL TONS THAT WOULD BE COLLECTED FOR RECYCLING, AND VALUE THAT WOULD THUS BE UNLOCKED IF COLOURED PET BOTTLES WERE PHASED OUT[25]



Note: Based on current estimated collected-for-recycling-rates of clear PET bottles in each country.

2.3.2 PVC LABELS/SLEEVES

Usage of PVC labels/sleeves for PET bottles are also a major contaminant in PET bottle recycling, particularly in food-grade applications. All recyclers interviewed in Southeast Asia stated PVC contamination challenges.

The negative impact of PVC in PET bottle recycling has been known for many years in the field. As both PVC and PET have a density higher than water, PVC impurities that are not taken out in the separation process in a processing unit will automatically end up in the PET fraction obtained after flotation and are thus sent for mechanical recycling together. In addition, the melt temperature of PVC is much lower than that of PET. This means that at the temperatures applied in the mechanical recycling of PET in a molten state, PVC contamination is at temperatures much higher than its melting point for a prolonged time. In such conditions, it is typical that degradation starts to occur, leading to chain scissions and/or the release of functional groups in the polymer. In the case of PVC, hydrochloric acid is released, chemically breaking the polymer chains. The decomposed PVC assumes a yellow to brown discolouration and the occurrence of black spots in the obtained rPET. The resulting rPET is unacceptable and has inferior material properties.

Even with PVC contamination as low as 0.005% (just one bottle of PVC in 20,000 PET bottles), the obtained rPET is not usable for most applications, and is especially unsuitable for food-grade applications.[26] It often contains vinyl chloride monomers, which are carcinogenic to humans, and many additives, including phthalates which have been the subject of concerns relating to negative effects on human health and the environment.[27]

TABLE 2: DENSITY AND MELTING POINT OF PET AND PVC

Plastic Type	Density (kg/m^3)	Melting Point (°C)
Polyethylene terephthalate (PET)	1,350–1,390	255
Polyvinyl chloride (PVC)	1,100-1,450	210

Several large multinational consumer goods companies have already phased out PVC from their manufacturing processes. However, there are many companies that still use PVC for PET bottle sleeve applications and PVC for other packaging applications, such as detergent and shampoo bottles. Thus, an industry-wide standard banning the use of PVC as a sleeve for PET bottles and in other consumer packaging would ensure the PET bottles that are collected for recycling can be used for a wider variety of end-use applications.

2.3.3 LABEL FIXTURES, MULTI-LAYERED BOTTLES, SILICONE AND FUTURE CHALLENGES

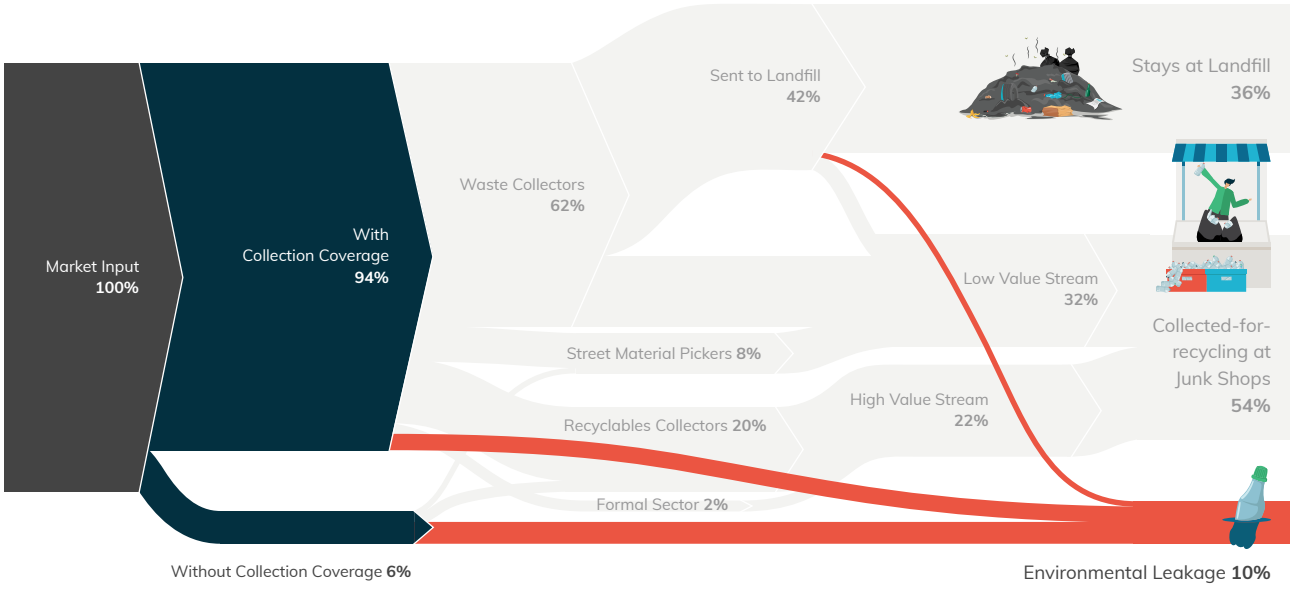
Other challenges for the value chain is related to the methods by which the labels are affixed to the bottles, the use of multi-layered bottles and the use of silicone material. With regards to label fixtures, value chain stakeholders interviewed as part of this research said that they would prefer labels that could be easily removed, such as perforation-based labels, instead of those that are affixed to the bottle using strong adhesives/glue.

Renewable plastics and emerging renewable alternatives to fossil fuel-based PET are also likely to impact PET recycling processes and economics in the future. These are discussed further in Appendix C.

2.4 POOR COLLECTION COVERAGE LEADS TO MATERIAL LEAKAGE

The waste collection coverage in Southeast Asia is low, ranging from 76%-100% in developed, more urbanised areas to 10%-55% on average in lower income, rural areas.[28] Whilst the informal section does collect some packaging materials from households and household waste which is dumped due to lack of municipal waste collection coverage, the collection by the informal sector is low. As highlighted in Section 1, this study estimates that in the nine cities, 10% of PET bottles is leaked into the environment, 40% of which is due to lack of waste collection coverage (Figure 12). Meanwhile, at a country level for the six Southeast Asian countries, the environmental leakage of PET bottles is much higher due to the poorer waste collection coverage rate of 10%-55% in rural areas.

FIGURE 12: ENVIRONMENTAL LEAKAGE DUE TO POOR COLLECTION COVERAGE



2.5 LACK OF SOURCE SEPARATION DECREASES BOTH MATERIAL ACCESS AND VALUE

The significance of the informal sector for collected-for-recycling rates in Southeast Asian countries rises out of the limited success of formal collection and recycling systems implemented in Southeast Asia. Formal collection and recycling systems typically include separation at source, separate collection of recyclable and non-recyclable streams of waste, and Material Recovery Facilities (MRFs) or their equivalent processing these segregated recyclable materials. There are some localised examples of such systems in the countries studied. For example, DKI Jakarta has an estimated 674[29] functioning waste banks and 15 TPS 3Rs (a combination of a transfer station and a Material Recovery Facility), and 56% of the barangays (sub-districts) in Metro Manila in the Philippines have functioning MRFs.[30] However, a nationwide implementation of these systems remains elusive.

Of the six countries studied, only Malaysia and the Philippines have national-level legislation mandating source separation and separate collection. The legislation mandating source separation and separate collection of waste in Malaysia is the Solid Waste and Public Cleansing Management Act (SWMA) 2007 Act 672. The act also mandates a system where recyclables are collected on one specific day of the week, separate from general waste. Similarly, the Philippines' RA 9003 Ecological Solid Waste Management Act of 2000 mandates source separation and separate collection of waste at the Local Government Unit (LGU)

level. This act instructs LGUs to establish solid waste management programs within their jurisdictions and include proper separation of solid waste. See Appendix D for further information about source separation.

Execution of the legislations, however, have not been effective due to the uneven execution and enforcement. Implementation of source separation and separate collection in Malaysia is only mandatory in selected areas that account for 35% of the national population.[31,32] Only 31%[33] of the barangays in the Philippines are served by an MRF.

Contamination with organic waste is a major reason for the loss in value of post-consumer PET bottles in unsegregated or mixed waste. Packaging in mixed waste also requires an additional step of sorting at transfer stations or collection points which increases labour costs. As none of the nine cities had well-enforced source separation, it was not possible as part of this study to directly compare the impact of separation on post-consumer PET collection. However, based on interviews with formal and informal waste collectors, it was noted that a minority of households across each of the cities do segregate their recyclables and when segregated, the value of PET increases by about 39%.[34] Based on interviews with recyclers in Thailand, it is clear that recyclers pay a premium on imported post-consumer PET bottles that have been source-separated and separately collected (from Japan, Australia and New Zealand) over domestically available post-consumer PET bottles.

Whilst source separation and separate collection of recyclables have shown to drive higher collection and premiums for post-consumer PET bottles, large scale enforcement remains the key barrier to overcome in order to achieve source separation and separate collection at scale in Southeast Asia.

2.6 EXISTING COLLECTION EFFORTS IN SOUTHEAST ASIA HAVE TYPICALLY BEEN SHORT-TERM AND INEFFECTIVE

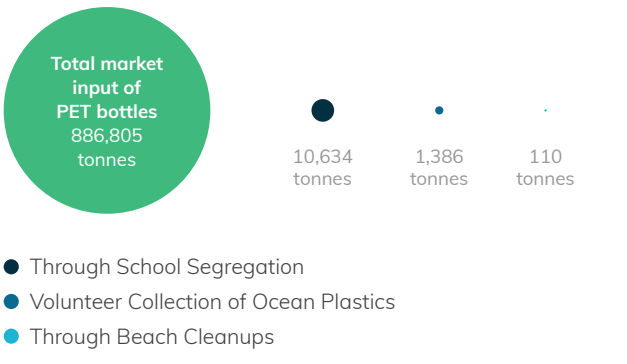
Multiple short-term and small-scale programs have been initiated by the industry in the past to tackle plastic leakage and to increase collected-for-recycling rates. However, most of these efforts ceased within one to three years and/or have not 'moved the needle' in terms of significant increases in collected-for-recycling rates or diversion rates from landfill and leakage.

Such efforts include:

- School, retail dropoff boxes and office source separation and collection efforts;
- Offering a small financial incentive to consumers to segregate and return brand specific packaging (often limited to one or two brands only and with limited locations for drop off);
- Beach cleanups involving corporate and public volunteers;
- Video advertisements for source separation and anti-littering.

Whilst commendable in many cases, these efforts collect a very small amount of materials when compared to the actual market inputs of the packaging materials. The graph below puts into perspective the amount of tonnes of material that could be recovered through some typical short-term solutions that the industry has attempted thus far. As can be seen, these initiatives are a 'drop in the ocean' relative to the amount of PET bottles consumed.

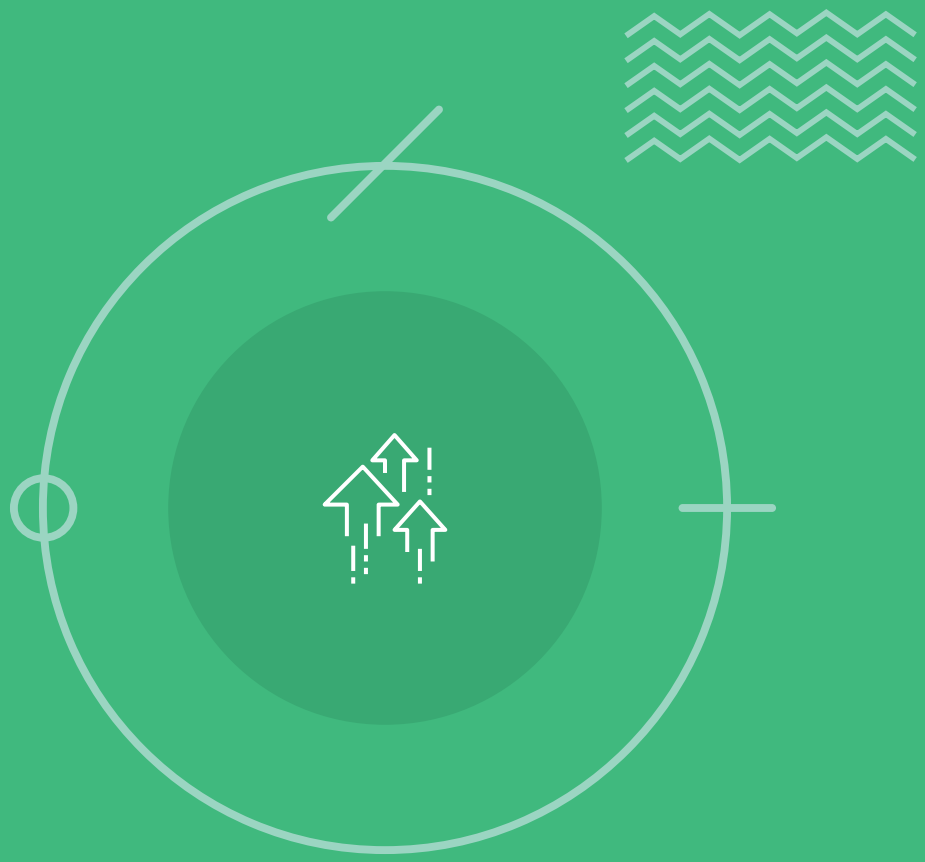
FIGURE 13: EXTRAPOLATED AMOUNTS OF PET THAT COULD BE COLLECTED FOR RECYCLING THROUGH SHORT-TERM EFFORTS COMPARED TO MARKET INPUTS OF PET BOTTLES[35]



The Road Ahead:

ACCELERATING THE CIRCULAR ECONOMY

3



The Road Ahead: Circular Economy Solutions for Southeast Asia

The recycling industry is the singular opportunity to divert PET bottles and single-use packaging away from the environment. The key findings and insights suggest that the current collected-for-recycling rates and actual processing and recycling of post-consumer PET are far from optimal and, worse still if left unattended to, they are likely to deteriorate. Increasing consumption of PET, fragile collection mechanisms, high dependencies on the informal sector, weak or absent policy support and market volatility in the trade of scrap plastics are all factors that systematically weaken and challenge the market economics of the recycling industry. Even as opportunities to introduce "reusable packaging" are explored, the recycling industry is the singular opportunity to divert PET bottles and single-use packaging away from the environment. The limited capacity and poor conditions of landfills coupled with high incidence of leakage into waterways, together call for an urgent but long-term response to remedy the post-consumer PET landscape in Southeast Asia. The existence of an unbroken and financially sustainable value chain that allows for the flow of materials towards recycling gives hope and provides a starting point to address and counter the challenges facing post-consumer PET.

Small steps don't take us far. Design changes such as source reduction and lightweighting that reduce the quantity of material being used are some of the industry's responses to the challenges presented by rising quantities of post-consumer plastic. However, these are measures that must be pursued globally irrespective of the state of the post-consumer PET market. Moreover, some recyclers suggest that lightweighting reduces the recycling potential of PET beverage containers as the bottles become so light that they are worth less per bottle. Even as the consumer goods and packaging industries explore changes to packaging design, it is also important to ensure that the consumer product companies start viewing end-of-life challenges posed by packaging material as a business liability to be managed. Efforts by individual businesses help to shine light on the urgency for a solution. In testing and pioneering potential solutions, the increasing levels of leakage and material losses call for more deliberate and wide reaching efforts to improve recyclability.

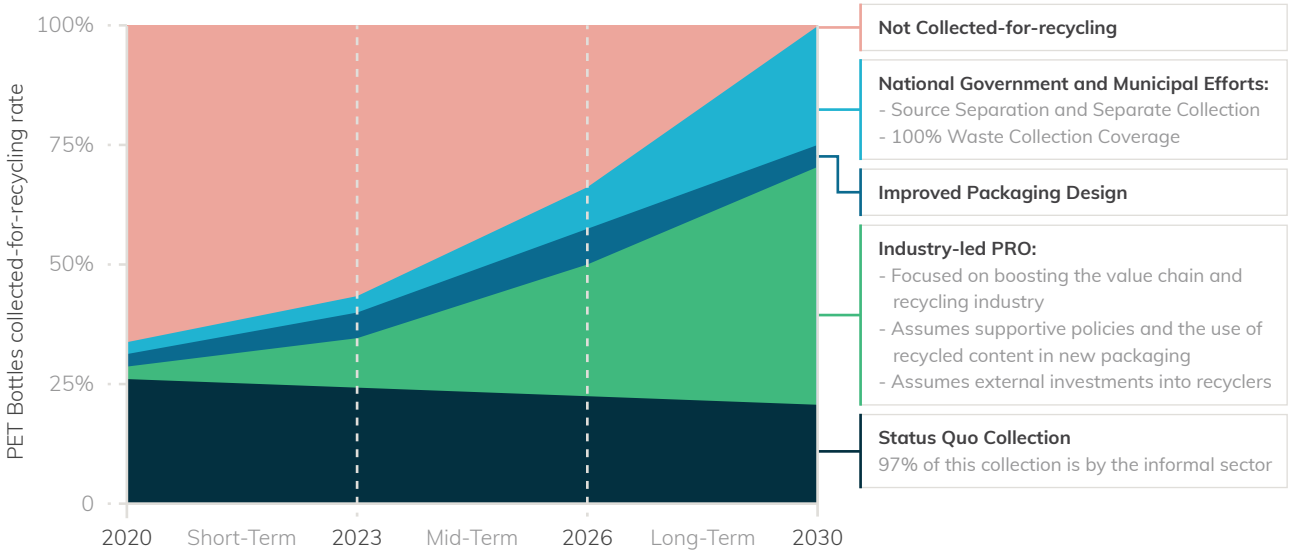
Designing for recyclability is a good start. Packaging design initiatives by individual companies that improve the recyclability of post-consumer PET, such as phasing out coloured PET and the exclusion of materials like PVC, positively support the collected-for-recycling rates. These efforts when adopted by the entire industry significantly improve the recyclability of PET and therefore increase the value commanded by PET recyclate.

However, the most effective solution is one that effectively and continually boosts the collection and recycling operations currently in place. In order to significantly increase the collected-for-recycling rates, a more comprehensive solution is called for - one that not only responds to the global commitments by industry to collect back all packaging put out in the respective markets but also responds to the current realities in Southeast Asia. The most effective response to the challenges currently facing the post-consumer PET landscape in Southeast Asia is one that effectively and continually boosts the collection and recycling operations currently in place. For the first time, a series of priority actions have been identified through this report to transform the post-consumer PET landscape in Southeast Asia.

These priority actions and the related key actors are as follows.

Action	*Key actors*
Industry-led PRO focused on boosting the value chain, coupled with supporting policies and investments.	- Packaging and consumer goods industries as a collective effort - Supported by national governments, recyclers, investors, and funding institutions
• Using a **price incentive** and related measures to boost the value chain and domestic recycling industry.	- Packaging and consumer goods industries as a collective effort
• **Packaging-specific policy instruments** that support industry efforts and ensure the growth of local recycling industry.	- National governments
• The **use of recycled content** in the production of new packaging, therefore creating a demand for recyclate.	- Packaging and consumer goods companies
• Investments into improving domestic **recycling capacity** and improved recycling technology.	- Recyclers, investors, and funding institutions
Improved packaging design to improve the economics of recyclability by phasing out coloured PET and PVC labels, and using easier-to-remove label formats.	- Packaging and consumer goods industries - Individual company efforts in the short-term, collective industry effort in the mid- and long-term
National government and municipal efforts to impact source separation and separate collection, national recycling targets, and reach 100% waste collection coverage.	- National governments and municipalities

REFER TO FIGURE 1: ACTIONS TO ACHIEVE 100% COLLECTED-FOR-RECYCLING RATE



Source: GA Circular Analysis (see Appendix G for details).

3.1 BOOSTING THE VALUE CHAIN AND THE RECYCLING INDUSTRY

By stimulating a stable and reliable end market for post-consumer PET using a collected bottle price incentive to recyclers tied to volume and end-use targets, the existing post-consumer recyclables market can be jolted into increased activity. This increased activity would then sustainably increase the volumes of post-consumer PET being diverted away from landfills and leakage.

A monetary incentive is provided to recyclers. A formal agreement is entered into with one or more recyclers operating within the local market to buy and recycle a larger quantity of post-consumer PET than currently achieved. The monetary incentive is pegged to achievement of volume targets. In the situation where recyclers are not operating within the local market, agreements could be entered into with recyclers in nearby Southeast Asian markets, provided that import and export bans or policies do not prohibit such agreements. Another option is to enter into agreements with processors within the local country; however, it is preferred to enter into agreements with recyclers.

The price incentive stabilises the value-chain. Seasonal variations and fickle end markets are a cause of considerable market volatility in Southeast Asia which in turn results in wide fluctuations in collected-for-recycling rates. By introducing stability to the recyclers, the price incentive cushions the impact of the price volatility and protects the recycling businesses from massive business losses and, in some instances, bankruptcy. The monetary incentive is lower during times where material prices are much more profitable for recyclers.

The objective is to increase domestic collection of post-consumer PET. The processor/recycler uses the monetary incentive to offset the increased buying price paid to aggregators from the target market in order to increase the volume of material purchased. Higher buying prices can also be used as an incentive for better quality (single stream, low contamination) post-consumer material.

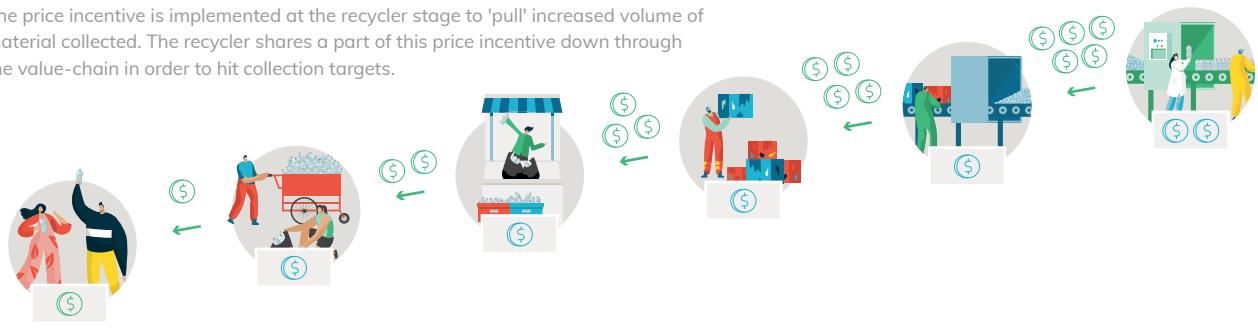
This guarantees offtake for aggregators. The aggregators in turn **transmit more stable prices to the informal sector.** By working within the existing value chain and ensuring that the price incentive has a trickle-down effect, this approach will provide price stability to an otherwise volatile market. By working within the market structure, this approach aims to build strong, continuous demand for better and improved quality of post-consumer PET.

The increase in quality and quantity of feedstock fueled by the monetary incentive then allows for the contracted **recyclers to increase processing capacity** and scale, and to **expand into more diverse recyclate products** (flakes to pellets to resin) by improving and scaling recycling technology. By doing so, **opportunities for domestic offtake expand**, adding stability to the industry and reducing reliance on the export market. This leads to more consistent performance by recyclers, **enabling access to banking and finance** to further expand their operations and geographical coverage.

The approach sets the wheels in motion for a long-term, sustainable solution that is both inclusive (operates alongside the informal and formal collection of materials) and supportive of government efforts towards source separation and separate collection.

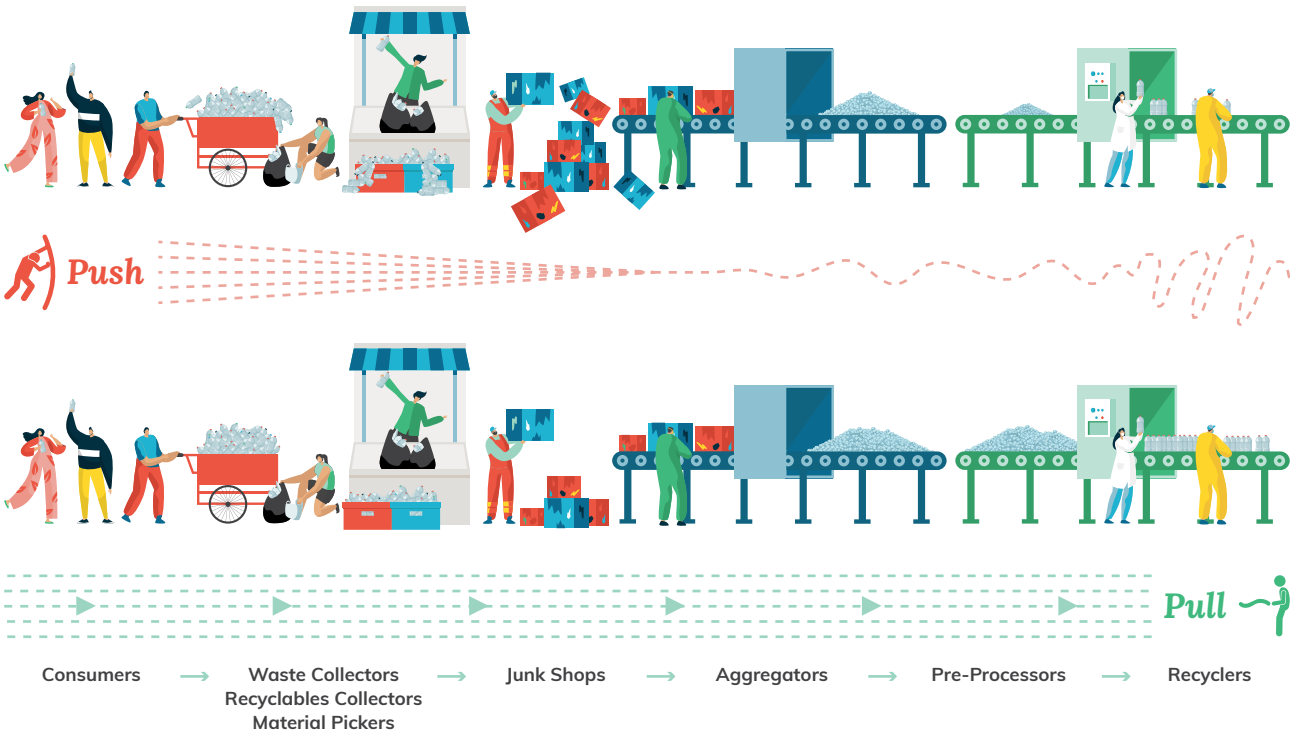
FIGURE 14: FLOW OF MONETARY INCENTIVE THROUGH THE VALUE CHAIN

The price incentive is implemented at the recycler stage to 'pull' increased volume of material collected. The recycler shares a part of this price incentive down through the value-chain in order to hit collection targets.



Portion of price incentive retained by stakeholder Portion of price incentive passed on to the previous stage in the value chain

FIGURE 15: PUSH VS PULL MECHANISMS



HOW IS THE PRICE INCENTIVE IMPLEMENTED?

The monetary incentive agreements with recyclers are via a **tendering process**, whereby the tender outlines the additional tonnage that the industry is targeting for that year (or another time period). Recyclers must submit a business plan illustrating how they will collect new material from both existing and new geographical areas in order to increase overall collected-for-recycling rates. The recyclers are also required to meet strict environmental and social standards.

Tenders shall be awarded to businesses that show a plan to not only collect increased volumes of post-consumer materials (without simply redirecting from current sources) but also better and higher quality of feedstock. In doing so, it is ensured that the monetary incentive drives post-consumer material towards better and more lucrative end markets. The monetary incentive is only paid out once recyclers have hit their monthly or quarterly targets, but the contracted term will be for a longer period so as to allow for recyclers to enact necessary changes to drive collection. Domestic market forces and global prices will be used to adjust the monetary incentive upwards or downwards to ensure stability.

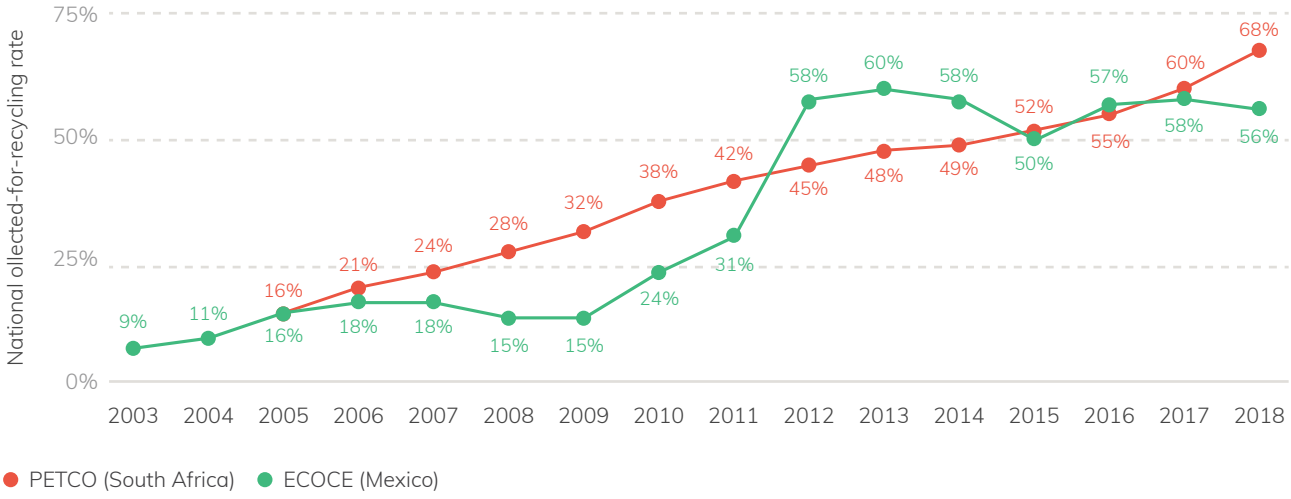
"PUSH" VS "PULL"

A well-functioning recycling industry ensures that the volumes of recyclable PET diverted away from landfills and leakage as a result of consumer behaviour change and improved segregation at source are actually captured and put back into use. Attempts to push post-consumer PET through forced segregation and one-off campaigns only result in excess material build up when the existing processing/recycling capacity and/or offtake potential is maxed out, eventually causing a glut. The consequences of not working with the entire value chain with a "pulling" price incentive approach as recommended are worsened when the value chain participants decide to stop collecting/buying PET due to depressed prices. Consumers get discouraged and the entire system breaks down.

- **Using 'pull' as the primary lever is more advantageous than using 'push'.**
- **Pulling the material with an incentive leads to efficiencies in the value chain.**
- **Only pushing, on the other hand, leads to bottlenecks in the value chain.**
- **The PRO will focus the vast majority of its efforts on pull.**

Box 2: South Africa and Mexico are best case practices of boosting the value chain and recycling industry

FIGURE 16: NATIONAL COLLECTION-FOR-RECYCLING RATES FOR PET BOTTLES IN MEXICO AND SOUTH AFRICA[36, 37, 38]



Note: Rates rounded to nearest %.

Since the early 2000s, consumer goods and packaging industries within Mexico and South Africa have set up systems that use market forces to pull material through the value chain. Over the past 15+ years, these systems have increased the national PET bottle collected-for-recycling rate from 16% to 68% in South Africa and from 9% to 56% in Mexico. While both these systems have focused primarily on PET, their core principles are applicable across all packaging types.

In the early 2000s, the local recycling industries in Mexico and South Africa were limited. This led to reduced value for PET, and subsequently, low collected-for-recycling rates. Since a strong local recycling industry was not present, most of the materials collected were exported. Post-consumer PET was primarily intended for either polyester textile manufacturing or other low-value applications. The weak prices of post-consumer PET bottles were not sufficient to achieve a high collection of post-consumer PET bottles.

To address this situation, independent non-profit entities were set up by the industries in both these countries. In Mexico, the association of carbonated beverage companies (ANPRAC) created "Ecology and Corporate Commitment" (known in Mexico as "ECOCE") in 2002. At the time of its creation, ECOCE's sole focus was on post-consumer PET, but this focus has since expanded to include other packaging materials such as aluminium cans and beverage cartons. In 2004, the obliged industry in South Africa, working with the full value chain of PET from PET resin producers, bottlers, brand owners and the retail sector, set up the PET Recycling Company South Africa ("PETCO") as an independent non-profit entity.

In the early years, both ECOCE and PETCO used material price incentives to drive collection for recycling. The price incentive was intended to enable a higher price for post-consumer PET bottles than the status quo, thus building the market for post-consumer PET bottles and increasing collection rates. Since large formal recyclers were largely absent, ECOCE began by partnering with Avangard, a large PET aggregator with connections to an extensive network of informal

collectors. In the following years, ECOCE expanded to include other aggregators and processors in this system. PETCO, on the other hand, did not work with aggregators, and focussed on building relationships with recyclers from other countries. PETCO used long-term contracts to attract the recyclers to invest in the setup of local PET recycling plants in South Africa. The strategy for PETCO was to enter into five-year contracts with recyclers with ambitious targets for recycling market growth (8%-10% per year). The price incentive is paid by PETCO to the recyclers upon the growth targets being met.

In addition to the price incentive mechanism, both ECOCE and PETCO implemented secondary, supporting activities. These included social benefit activities such as education for the children of the informal sector workers, health and safety training for the workers and promoted consumer awareness and behaviour change through a series of campaigns targeted towards the public.

In the later years, ECOCE focussed on developing local rPET capacity to strengthen the value chain and price points of PET and phasing out the price incentive. PETCO, on the other hand, focussed on adding more recyclers to the system and continued their price incentive mechanism. Avangard, ECOCE's early partner, received external investment to form PetStar which is now the world's largest food-grade PET recycling plant. The first stage of PetStar opened in 2009, and by 2011 the PET price incentive was gradually phased out. Similarly, other large recycling plants were also set up in Mexico. Through the initial efforts of providing a price incentive and then creating local demand for post-consumer PET, ECOCE has been instrumental in increasing the overall collected-for-recycling rate of PET in Mexico from ~9% in 2002 to 56% in 2018. In the initial years of PETCO, the recyclers who were contracted were primarily making fibre products. This led to the local market becoming saturated by 2009. PETCO added an additional incentive to recyclers to export fibre to ease the local market supply pressure and encouraged the setup of bottle-to-bottle recycling plants. Due to the stability and financial incentives provided by PETCO, South Africa was the first African country to use recycled PET in Coca-Cola bottles. PETCO has been able to consistently increase the collected-for-recycling rate for PET bottles in South Africa from 16% in 2004 to 68% in 2018, which is one of the highest rates globally amongst developing countries. It is also one of the most cost-effective systems amongst developed and developing countries.

Since removing the price incentive, collected-for-recycling rates in Mexico have remained between 50% and 60%. The rates in South Africa during the same period have increased from 42% to 68%. Based on interviews with stakeholders on-ground in Mexico, a price incentive may be reintroduced in certain geographic areas in the country that currently have low collection for recycling in order to increase the collected-for-recycling rates by pulling material through the value chain.

FIGURE 17: HIGHLIGHTS OF SOUTH AFRICA'S PETCO AND MEXICO'S ECOCE SYSTEMS FOR PET BOTTLE COLLECTION AND RECYCLING[39, 40]

***South Africa* (PETCO)**

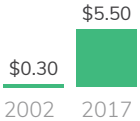
40%
PET recycled into food grade bottles in 2017 (i.e. bottle-to-bottle)

64,000
Income opportunities created in recycling since PETCO formation

93,235 tonnes
PET collected and recycled locally in 2017

100%
PET bottles recycled locally in 2017

***Mexico* (ECOCE)**



Increase in value of PET recyclate (granules)

$339 million
Invested in recycling infrastructure

16
PET recycling plants created

312,000 tonnes
Total recycling capacity created

3.2 WHAT EACH STAKEHOLDER CAN DO:

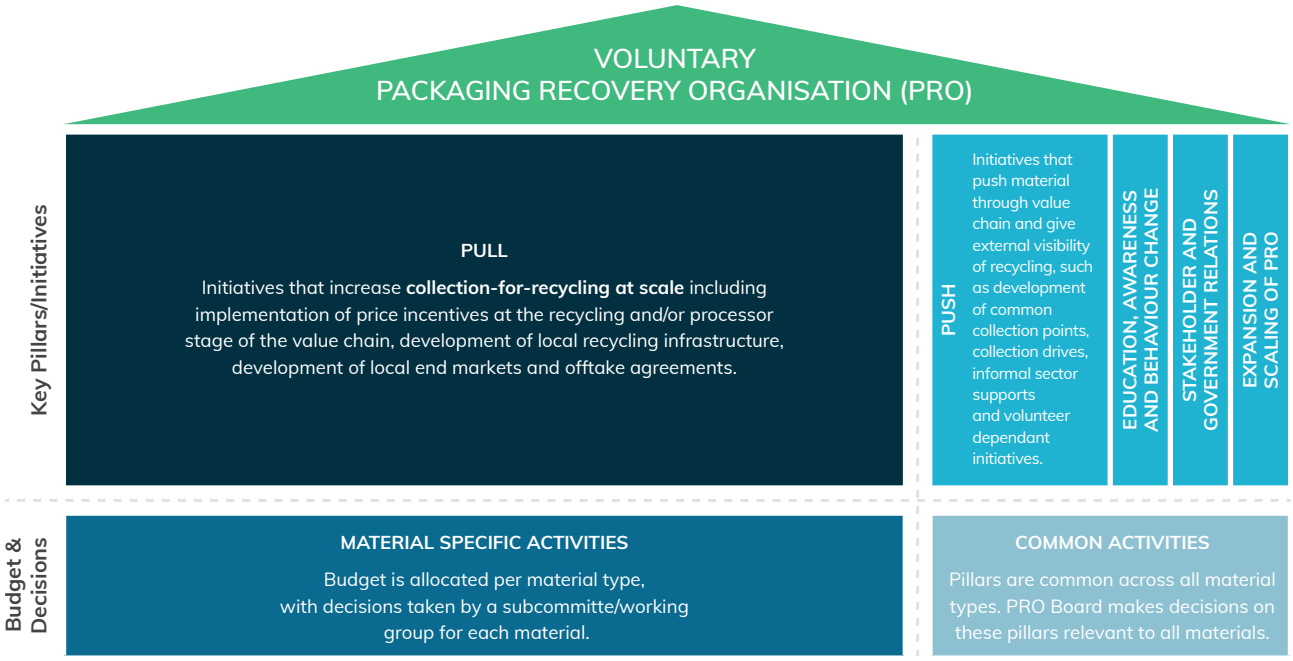
3.2.1 PACKAGING & CONSUMER GOODS INDUSTRIES

Today, frameworks with mandatory tools or voluntary industry-led systems (along similar guiding principles to EPR) for collection and recycling of packaging exist in more than 68 developed and developing countries around the world.[41] The packaging and consumer goods industries (and upstream industries in some cases) have decades of experience of operating under these systems and these efforts have consistently proven to increase collection and recycling rates of different types of packaging at scale.

The packaging and consumer goods industries are thus well placed to lead efforts to build the value chain through pulling material through the value chain and developing local end-use markets. It is recommended that a coalition of companies from the packaging and consumer goods industries set up a non-profit entity in the form of a Packaging Recovery Organisation (PRO) in each country.

The below diagram outlines a voluntary Packaging Recovery Organisation (PRO) model for Southeast Asia which is customised to the current context of Southeast Asia, and additionally informed by insights from dozens of developed and developing countries around the world and from the in-depth study of four PROs: ECOCE (Mexico), PETCO (South Africa), Fost Plus (Belgium) and JCPRA (Japan). See Appendix E for a detailed analysis of these PROs.

FIGURE 18: KEY PILLARS OF SUCCESS FOR THE VOLUNTARY PROS IN SOUTHEAST ASIA[42]



Note: The size of each pillar denotes relative focus and impact on collected-for-recycling rates. The focus (i.e. size of pillar) may adjust for different packaging materials. The focus illustrated here is for PET packaging.

The size of each pillar within the diagram denotes the relative focus and impact of that pillar in increasing the collected-for-recycling rates. As highlighted earlier, a focus on pulling PET packaging material through the value chain is a must, and thus forms more than two-thirds of the focus and budget allocation of the PRO.

The PRO could focus only on PET packaging or could focus on multiple packaging materials. There are synergies and thus cost effectiveness to be gained by the PRO focusing on multiple or all packaging materials, as many of the activities of the PRO (education, awareness and behaviour change; stakeholder engagement and scaling the PRO efforts) apply to all

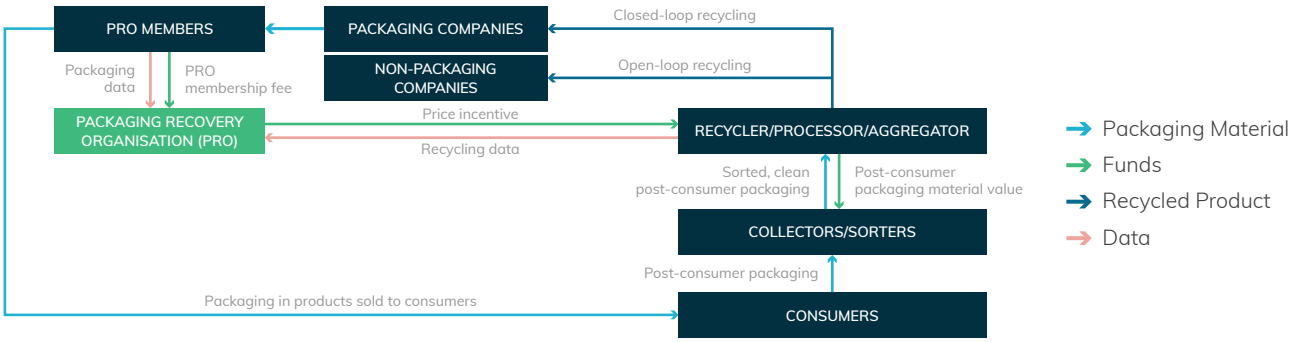
the materials. It must be noted that the relative focus and impact of each PRO pillar may be different for other packaging materials. For example, aluminium packaging has high post-consumer value and less price fluctuations and thus would likely not require a price incentive to be implemented along the value chain and instead would benefit more from efforts to increase recycling capacity and push initiatives which make the material more accessible for collection, such as education and source separation. Packaging with lower post-consumer value which doesn't have any or many processors or recyclers handling the material, such as flexible packaging, would first need its value chain and processing and recycling realities and capacities analysed in order to determine the correct set of actions. One of the early actions would be to enable recycling technologies to be setup, as material cannot be pulled through the value chain unless there are recyclers in place.

Member companies can assign representatives (typically country General Managers) to be on the board of the PRO to provide strategic oversight, with the board setting the vision and annual targets that determine the scale of operations, geographical scope and budget of the PRO.

Annual strategy and budgets for common activities – such as education and awareness programs, behaviour-change campaigns, stakeholder and government relations, and scaling of PRO operations across the country – are set and allocated across all the packaging types. The setting of annual strategy and budgets for collection and recovery initiatives should be under the purview of subcommittees for each packaging type. Annual reporting on types and tonnage of packaging market inputs and quarterly reporting of materials recycled through PRO partners enables tracking of progress towards annual targets. It must be noted that PRO itself does not own or handle any of the post-consumer materials - it only acts as a clearing house of funds as well as data.

The schematic below shows the proposed mechanism of how the PRO operates.

FIGURE 19: SCHEMATIC OF PRO OPERATION[43]



Keys to success for the PRO include:

- Creation of price incentive agreements and/or price floor agreements with recyclers to ensure that recyclers can continue to operate during challenging economic periods (such as during recessions or significant material price fluctuations) in recognition that recycling is a commodity business undergoing significant cycles;
- Off-take agreements with recyclers to ensure high usage of recycled content in packaging through sustaining constant demand;
- More than 50% of the consumer goods and industries participating in the PRO. It is ideal to also have upstream industries such as polymer production and bottling involved and downstream industries such as retail involved.

The efforts by industry to boost the value chain will be more effective when supported by the government. Key areas of government support include:

- Economic incentives for the development of a local recycling industry;
- Development and enforcement of supportive legislation and standards for a circular economy, including recycled content policy and standards for food-grade applications, source separation and separate collection and trade policies related to import and export of packaging materials;
- Provision of economic incentives to support a circular economy, e.g. tax incentives for producers which use a minimum of 30% recycled content in packaging, or levies for producers that use less than 30% recycled content;
- Government recognition of voluntary industry efforts (i.e. voluntary PRO) under law.

3.2 WHAT EACH STAKEHOLDER CAN DO:

3.2.2 NATIONAL GOVERNMENTS & MUNICIPALITIES

National governments can accelerate the circular economy for post-consumer PET and other post-consumer packaging through enabling policies, which include both packaging-specific and general recycling policies. For example, a recycled content policy with its associated targets is a packaging-specific policy which assists to pull material through the value chain. It is a more immediate and shorter-term policy. Meanwhile, source separation and separate collection is not packaging specific and is instead related to all municipal solid waste. It is a push strategy whereby it makes packaging material more accessible and of better quality for the value chain, but it doesn't ensure that the material makes its way through the value chain to recyclers and end-use products. It is also a longer-term plan in that it requires more time to achieve successful enforcement of the policy. With regards to source separation and separate collection, municipalities have a key role to play with regards to implementing source separation and separate collection and achieving 100% waste collection coverage.

National governments additionally have an important role to play with regards to other key levers, such as education and awareness to drive behaviour change. All the levers and actions which should be taken by national governments and municipalities have not been the focus of this report, but merit further investigation in a subsequent report.

Relevant policies to be enacted and enforced by national governments

The most pertinent policies to support the post-consumer packaging value chain in Southeast Asia and which enable a circular economy are highlighted below. These are policies which increase the ability of the industry to collect, process and recycle post-consumer packaging and support increased added value to the material. Such policies can bring major economic benefits, contributing to innovation, growth and job creation.[44] It must be noted that as with any policy, enforcement of the above policies by government is critical to achieve the objective of boosting the value chain.

A full discussion of all policies, their nuances and suitability to Southeast Asia is out of the scope of this report. For a detailed analysis of packaging policy interventions, benchmarking, and gap analysis and recommendations for Southeast Asian countries, please see 'The Role of Packaging Regulations & Standards in Driving the Circular Economy' by GA Circular or other relevant policy reports.

PACKAGING-SPECIFIC POLICIES

1. Recycled Content Policy and Targets
Policies and standards governing the use and application of recycled content positively support the end-use market for packaging. Enabling and requiring recycled content usage helps to pull material through the value chain. There are global efforts to create policies requiring or supporting the use of recycled content. For example, under the EU's Single-Use Plastics Directive, there will be a binding target of at least 25% of recycled plastic for PET beverage bottles from 2025 onwards, and by 2030 all plastic bottles will be required to comprise of at least 30% recycled content.

The two key recycled content policies which will support the value chain in Southeast Asian countries are:

a. **Food application recycled content restrictions.** Given the widespread use of packaging in the food industry, incorporation of recycled content back into food packaging would require: (i) food safety and religious standards (such as Halal standards) to be met; and (ii) removal of blanket regulations that limit usage of all recycled material in food-grade applications.

b. **Recycled content targets.** By requiring a minimum amount of recycled content to be included in packaging, a regulation can require producers to rely more heavily on the recycled materials and promote the development of the recycling market.

The main challenges that have been observed with the use of recycled content in the six Southeast Asian countries are: (I) the quality of the recycled content given the high contamination rates of post-consumer PET packaging; (II) whether the recycling technologies used are adequately sound for producing food-grade rPET; and (III) meeting religious certifications such as Halal standards. As yet, none of the six countries within Southeast Asia have any minimum recycled content targets for packaging or for PET in food- or non-food-grade applications. Food application recycled content restrictions vary significantly across the six countries and across the whole Southeast Asian region.
For example:

- Thailand's Notification of the Ministry of Public Health (No. 295) B.E. 2548 (2005)[45] prohibits the use of plastic containers made from reused plastic except for packing fruits with a peel.
- In Malaysia, the use of recycled packaging for certain foods such as sugar, flour, and edible oil is prohibited. In addition, packaging used for a product of swine origin is not allowed to be recycled and used for food of non-swine origin and any bottle that has previously been used for alcoholic beverage or shandy is not allowed to be recycled and used for any foods or beverages, other than alcoholic beverages.
- Vietnam's food plastic packaging requirements do not specifically limit the use of recycled content in food-contact packaging as long as the criteria covered in the food packaging regulation QCVN 12-1:2011/BYT are met.

Numerous PET recyclers interviewed as part of this study shared their desire to develop food-grade PET recycling lines in order to add further value to the material and thus their businesses. However, most of these recyclers are concerned by the lack of clarity with regards to food application recycled content standards. Given the demand for food-grade recycled content by packaging and FMCG companies, increased intrinsic value in the material once processed into food-grade flakes or pellets and their role in enabling circularity, it is important for governments in Southeast Asia to provide supportive and clear policies and standards with regards to recycled content for food applications.

2. Extended Producer Responsibility
An extended producer responsibility (EPR) policy assigns the cost and sometimes the responsibilities of managing post-consumer packaging on the producers of such packaging. An EPR scheme essentially attempts to shift direct financial responsibility fully or partially away from the municipality and taxpayer to accomplish two primary goals:

a. Offset/manage the increased costs of waste management due to packaging waste; and

b. Incentivise the producer to manage these costs by improving the design and marketing of their products.

Obligations on the producer could include (I) a collection ("take-back") of product packaging or (II) a financial responsibility for the costs of proper waste management of the packaging collected/ managed or (III) rules or targets governing the methods of waste management of recovered packaging, for example specifying minimum required rates of reuse or recycling. Various EPR tools can be used either on a stand-alone basis or in combination with other such tools. They are more successfully implemented when backed by mandatory reporting on the amount and nature of packaging introduced by a producer into the market to enable tracking of progress on an annual basis. Please see Appendix F for a detailed description of some of the relevant EPR tools.

EPR schemes implemented in individual countries vary widely across packaging types covered (plastics vs. other materials), the nature of responsibilities placed on producers and the context within which these schemes operate. EPR has been a key mechanism for enabling member states within the European Union as well as Japan to increase collection and recycling rates for packaging.

Still relatively new to the Southeast Asian context, EPR policies are being increasingly contemplated by national governments in an attempt to increase industry engagement with respect to the proper management of packaging waste. Only two of the six Southeast Asian countries (Indonesia and Malaysia) included in this study have in place the legislative framework that allows for the enactment of EPR policies. Even so, neither of these countries has specified the actions required by producers to ensure the proper collection and treatment of the packaging put into the market.

The challenges anticipated with respect to EPR in Southeast Asia are multifold. First, the absence of cost structures for collection and recycling to inform what would, if any, be the cost or financial obligation that could be assigned to producers. The absence of collection and recycling infrastructure could imply that the governments would require producers to bear the cost of developing the infrastructure, which could be a significant financial challenge. The obligations imposed by a government could be unevenly applied, exempting local/domestic companies and creating unfair market conditions. Along the same vein, some packaging types may be unfairly targeted over others via an EPR regulation, e.g. an EPR policy that imposes requirements on PET packaging in particular may inadvertently exempt other less recyclable packaging types.

When governments consider mandatory EPR regulations and tools in each of the Southeast Asian countries, and/or when companies and industries explore industry-led efforts, it is recommended that the tool(s):

Encourages participation of the entirety of the packaging and consumer goods industries. The tool(s) should enable participation of all types of packaging providers and users i.e. if a tool only involves rigid packaging companies and users, then another tool should be used to involve flexible packaging companies and users.

Supports the existing informal sector and enables transition towards more formal sectors. As the collection-for-recycling rates in Southeast Asia are heavily reliant on the informal industry and the informal sector is dependent on post-consumer packaging materials for their livelihoods, it is important that solutions are inclusive. Solutions should support informal sector workers to have better safety, working conditions and incomes. Solutions which exclude the informal sector are both less likely to succeed and will have adverse effects on the informal sector.

Directly supports the growth of a domestic recycling industry. As highlighted in this report, it is important to develop a local recycling industry to limit the effect of events such as import bans, global material price fluctuations and economic crises.

Considers the recyclability of the materials considered. By taking into account the available recycling technology for each of the packaging types, a well thought out EPR scheme will incentivise recovery for recycling, investment in developing a recycling solution or reduction in the amount of unrecyclable material introduced into the market.

Limits fraud and has high governance standards. The tool should have low potential for double counting and fraud, and high levels of transparency and reporting. Some EPR tools used throughout the world have been particularly susceptible to fraud, such as deposit refund systems.

Increases consumer education and awareness on packaging source separation and anti-littering. The tool should drive consumer education and awareness on separation and anti-littering behaviours through complementing existing government or community programs, or if needed, through running more targeted programs.

A well-considered EPR policy would take into account the local realities and identify how best to ensure that post-consumer packaging is not only recovered but also recycled, without challenging the product market nor the recycling industry. In the absence of regulations, producers of packaging (including companies from packaging, consumer goods and retail industries) can choose to make voluntary commitments and implement initiatives to collect and recycle packaging either as an individual company or as an industry group. These tools may be applied either as an individual obligation or as a collective obligation. Typically, the latter approach requires some form of collective organisation to be established. This could, for example, be a separate company, as contemplated in section related to the PRO above.

Given the above considerations, EPR tools that are recommended for Southeast Asian countries include recycling targets (take-back requirements) and recycled content targets. EPR tools that we believe have limited application in the context of the six Southeast Asian countries are Deposit Refund Systems (DRS) and taxation. The limitations of DRS and taxation will be discussed in the next section (section 3.3). Please see Appendix F for a detailed description of different mandatory and voluntary tools, together with their advantages and challenges.

3. Export and Import Policies

Export and import policies have been in the spotlight with the recent China National Sword policy and subsequent import bans by many Southeast Asian countries. As highlighted in section 2, the China National Sword policy led to a sharp increase in post-consumer plastics imported to many Southeast Asian countries, particularly Malaysia, Thailand and Vietnam. This then caused the governments of many Southeast Asian countries to start curtailing the import of plastic waste through the halting of import licences of plastic waste and outright bans of plastic waste imports.

Import bans and restrictions can raise some challenges. The banning of imports into a country where the domestic supply of post-consumer packaging is limited in terms of quantity and/or quality can cripple or significantly impede the financial sustainability and operations of the existing recycling industry. It can also impede their future growth. This is because most processors and recyclers within Southeast Asian countries have been reliant on imports. It is thus a necessity that import bans be phased in over time in parallel with the local recycling industry sourcing greater proportions of feedstock locally - i.e. **the timing of import bans is critical.**

Export restrictions can be implemented to ensure that domestic post-consumer material is not exported and is instead provided to local industry, thus promoting local recycling industry growth.

MUNICIPAL SOLID WASTE MANAGEMENT POLICIES (I.E. GENERAL POLICIES THAT IMPACT POST-CONSUMER PACKAGING)

1. Source Separation and Separate Collection

Source separation and separate collection enable more post-consumer packaging to be available for recycling and at a higher quality. Whilst source separation and separate collection are separate policies, they will be discussed together, as one policy cannot exist successfully without the other. Source separation regulations and guidelines require the waste generators (households and other bulk waste generators) to segregate their waste at source into two streams (recyclables and others), three streams (organics, recyclables and others/reject) or a larger number of streams. Separate collection regulations require private or public waste collection companies to collect each waste stream separately and make adherence to these regulations conditional for contract renewal or participation in public tenders.

Enforcement of source separation and separate collection of waste would lead to high rates of clean separately collected packaging materials, thus increasing the value of the material as highlighted in section 2 and expanding the possible end-use applications. Assuming a success rate of 80% source separation and separate collection across only the nine cities studied in this research, approximately 49,493 tonnes of additional PET bottles will be collected for recycling per year. This would also benefit the existing informal sector workers who would then have easier access to the separated recyclable materials instead of having to manually separate them from mixed waste.

2. National Targets

National targets assist to: provide a future vision/direction for action; coordinate actions amongst various value chain stakeholders; encourage the establishment of industries (for example, recycling rate goals encourage the establishment of recycling infrastructure among other things); and provide a metric of success with which progress can be measured.

Targets need to have clear definitions to enable sound actions, reporting and tracking. For example, a recycling target must define recycling, i.e. what is and is not included in recycling, as in some countries, recycling includes waste to energy whilst in most it does not.

Municipalities: Strategies to increase waste collection coverage and efficiency

As highlighted in section 2.4, the waste collection coverage throughout Southeast Asia is low, ranging from 76% to 100% in developed, more urbanised areas to 10% to 55% on average in lower-income, rural areas.[46] With overall municipal waste generation rates forecast to increase on average by 31%[47] across these six Southeast Asian countries from 2016 to 2030, the existing waste collection systems are not equipped to deal with either the increase in waste generation or the need to increase the collection coverage.

The key reason for poor waste collection coverage is a lack of funding available for municipal waste management budgets. The World Bank estimates that currently only 40% of operations and maintenance costs of waste management in Indonesian cities are recovered.[48] Key challenges to municipalities that prevent sustainable financing for waste collection are: (I) low waste management service fees for waste generators such as households; (II) heavily subsidised or often free landfill fees for waste collectors; (III) collection models that are locked into long-term linear economy approaches which do not prioritise recycling over energy recovery or landfilling; and (IV) heavy dependence on national budget allocation to overcome funding gaps.

Municipalities recognize that waste management can be the single highest budget item for a local administration and that investments and better operations will involve much higher service fees for waste generators compared with present arrangements. However, local governments are concerned about the unpopularity of raising fees before the improved quality of the service has been demonstrated. At the same time, it is not sustainable to continue the current situation of heavy subsidies, increasing land acquisition costs, lack of suitable investment capital, poor revenue generation and expect improved performance in the future.

Given these issues, the following strategies for municipalities to increase waste collection coverage and efficiency are discussed:

1. Mandating Source Separation and Separate Collection
2. Supporting the Informal Sector in Municipalities
3. Modulated Service Fees for Waste Generators

1. Mandating Source Separation & Separate Collection
The merits of source separation and separate collection policies in making material more accessible and of higher value have been discussed in earlier sections. Determining the economics of setting up city-wide source separation and separate collection of municipal solid waste is out of the scope of this study. However, based on interviews with the officials in the city of Depok, Indonesia, and additional analysis conducted by GA Circular, it is apparent that implementing source separation and separate collection does not burden the municipality with extra costs. Source separation and separate collection would actually provide the city with savings if the true cost of landfilling was accounted for via an accurate tipping fee.[49] Thus, in this case, source separation and separate collection provide an opportunity for both increased recycling rates and cost efficiencies.

The example of Depok in Box 3 highlights the key enablers of success for source separation and separate collection.

2. Supporting the Informal Sector in Municipalities
Considering Southeast Asia's heavy reliance on the informal sector for collection of recyclables, municipal-level policies recognising the enormous role of the informal sector in the waste value chain will be important and necessary. Depending on the municipality, the informal sector can include employees working in private or public formal waste collection companies, street material pickers, junk shops and/or scrap traders.

In India, the National Action Plan for Climate Change (2000) and the National Environment Policy (2006) both recognize the informal sector's contribution to the environment and carbon reduction and extend to them the right to collect and recycle waste. At the local level in Indian cities like Pune and Bengaluru, efforts have been made to provide informal sector workers with identity cards that not only allow access for door-to-door collection, but also help them access bank loans, health and education opportunities.

Supporting the informal sector in the six Southeast Asian countries can be in the form of recognition of their role and efforts, health and safety training and education programs, financial inclusion programs and incentives to encourage micro-entrepreneurship in recyclables collection and sorting.

Box 3: Case study of source separation and separate collection in Depok, Indonesia

In 2012, the Depok city administration launched a concerted effort to achieve source separation and separate collection to combat its overflowing landfill, landslides over recent years, and leachate leaking into waterways. The effort covers 100,000 households (25% of the city) out of the approximately 400,000 households in Depok. Achieving success has leveraged on key enablers including: city-level regulations requiring household separation, enforcement of separation, reallocation of police to catch and fine any littering, and a new collection schedule and different vehicles for the different material collection.[50]

Households were mandated to segregate their waste into organic (to be sent to compost), inorganic (to be sent for recycling), and residue (sent to landfill). The city administration refused to transport waste that was not separated and took measures to start prosecuting people who dumped waste illegally. This has led to between 140-160 tonnes of material diverted from the landfill per day. The effort in Depok is continuing amongst the 100,000 households as of August 2019. Efforts to expand the coverage of households from 25% to 30%-40% of the city are being explored.[51]

3. Modulated Service Fees for Waste Generators

The waste management service fee schemes across the six Southeast Asian countries are traditional schemes where services (waste collection, sorting, landfilling) are financed via general taxes or via a fixed recurring fee in utility bills of waste generators together with other supply services as electricity, regardless of the produced waste amount. The cost is usually calculated based on living or work space or the number of household members.

Modulated service fees for waste management on the other hand incentivise recycling and penalise residual or mixed waste generation and therefore are an important economic strategy to increasing source separation and recycling, and reducing overall waste generation. One application of the modulated service fees is the Pay-As-You-Throw (PAYT) system which is based on the "polluter pays" principle. In the EU, PAYT systems are typically within the mandate of municipalities. These systems work by charging citizens a fee based on the weight or volume of mixed waste they produce, thus imposing costs on wasteful behaviour. Weight-based PAYT systems require significant investment in both time and money to setup infrastructure for weighing and administration. In comparison, volume-based PAYT systems, often implemented by using pre-paid garbage bags, bins of different sizes or differentiating the fee based on the collection frequency are relatively easier and less expensive to implement.

A detailed comparison of different PAYT systems in seven municipalities from seven European countries shows that PAYT has the potential to adapt well to local conditions, to encourage (residual) waste reductions, to increase considerable recycling and home composting, and to be well-received by stakeholders.[52]

A blanket increase in the waste management service fee for waste generators is likely to be both unpopular and unlikely to achieve the desired target of waste reduction in the six Southeast Asian countries. Therefore more innovative approaches which use modulated service fee systems such as PAYT could be considered by municipalities.

3.2 WHAT EACH STAKEHOLDER CAN DO:

3.2.3 RECYCLERS, INVESTORS AND FUNDING INSTITUTIONS: ENABLING INCREASED RECYCLING CAPACITY

Whilst a detailed analysis of recycling capacity in Southeast Asia was outside the scope of this research, based on interviews and research conducted, a high-level analysis has been completed as to the increased capacity required within Southeast Asia with regards to food-grade rPET. A more detailed analysis of food-grade and non-food-grade rPET recycling capacity is recommended as a separate study.

FOOD-GRADE rPET RECYCLING CAPACITY

Based on estimates by this research team, the current food-grade rPET production capacity in Southeast Asia is expected to be anywhere between 10,000 and 30,000 tonnes per year. The majority of this food-grade rPET is being produced in Thailand and Indonesia. In comparison, individual countries in Asia Pacific such as Australia, Japan and Taiwan have installed food-grade rPET production capacity of 17,000 tonnes, 75,000 tonnes and 90,000 tonnes per year, respectively.

As highlighted in an earlier section, PET bottle usage in the six Southeast Asia countries is expected to reach 1.52 million tonnes by 2030. Several major multinational consumer goods companies have committed to using up to 50% recycled PET content in packaging by that year. However, not all companies using PET bottles are expected to have such ambitious commitments. Therefore, conservatively assuming a lower 25% rPET content usage in all PET bottles in 2030, a demand of at least 380,000 tonnes of food-grade rPET across these six Southeast Asia countries is to be expected by 2030.

Industry experts advise that 20% of this demand can be achieved through introducing flakes from post-consumer bottles during the process of making virgin PET (i.e. the PET bottles produced through this process will be based on 20% rPET content and 80% virgin PET content). The other 80% of this demand will need to be achieved through an increase in production capacity of food-grade rPET pellets in the region. This represents an increase in rPET pellet production capacity of 304,000 tonnes, or 10.1 times from 2019 to 2030. This is equivalent to at least 10 plants with a production output of 30,000 tonnes per year of rPET that need to be added by 2030 - i.e. one additional plant per year.

For food-grade rPET production, thus far Veolia has announced a 25,000 tonnes per year capacity plant in Indonesia and Coca-Cola has announced a 16,000 tonnes per year capacity plant in the Philippines. Both plants are expected to be operational by the end of 2020. This still leaves a very large gap of at least 309,000 tonnes of food-grade rPET production capacity that is needed to achieve 25% food-grade rPET content in PET bottles across the six Southeast Asian countries if all the rPET were to be sourced locally. While processors and recyclers are increasing their investments in food-grade rPET production capacity within Southeast Asia, this process needs to be accelerated to be able to meet the anticipated 2030 demand and to accelerate the circular economy for post-consumer PET bottles in Southeast Asia.

TABLE 3: PRODUCTION CAPACITY REQUIRED FOR FOOD-GRADE rPET IN SIX SOUTHEAST ASIAN COUNTRIES FOR PET BOTTLE

As of 2018		
PET Usage (Tonnes)	886,000	
rPET Production Capacity (Pellets)	Up to 30,000	
Maximum possible rPET content usage % in six Southeast Asian countries based on local supply *	3.4%	
2030 Projections & Goals	**At conservative rPET content usage of 25%**	**At 50% rPET content usage**
PET Usage (Tonnes)	1,520,000	1,520,000
Equivalent rPET tonnage to be used in packaging	380,000	760,000
Flakes from collected bottles introduced during the process of making virgin PET (Up to 20% of the rPET content)	76,000	152,000
rPET Production Capacity (Pellets) Required (Remaining 80%)	304,000	608,000
INCREASE IN rPET PRODUCTION CAPACITY (PELLETS) REQUIRED FROM 2018 TO 2030	**10.1**	**20.3**

Note: * Local supply is used to provide an indicative % recycled content range. In reality, some purchase of rPET pellets is occurring from outside the six Southeast Asian countries for usage within the six countries.

3.3 LIMITATIONS OF OTHER APPROACHES

In order to solve the growing challenge of packaging waste, the focus needs to be on implementing the most effective and efficient systems/tools in terms of achieving collection, recycling and recycled content goals. The systems/tools also need to be suitable for the local realities in each of the Southeast Asian countries.

3.3.1 MUNICIPAL SOURCE SEPARATION AND SEPARATE COLLECTION, AND 100% WASTE COLLECTION COVERAGE ARE LONG-TERM SOLUTIONS

A sustainable long-term solution to the challenge of packaging recycling is for governments and municipalities in Southeast Asia to enforce source separation and separate collection of municipal solid waste. In addition to this, waste collection coverage also needs to be expanded to reach 100% of the population.

However, implementation of these practices typically involves a longer time frame and significant political will. As such, there are only a few examples of this being enforced at scale in cities in Asia. Some cities within India are relevant case studies for municipalities to learn from, particularly Bengaluru which has thus far achieved source separation and separate collection for 60% of households[53] since segregation laws were discussed in 2012, and compulsory segregation was implemented in February 2017.[54] As seen from this example, the process to effectively change the status quo took seven years for one city.

When looking at a country-wide program, Act 672 in Malaysia mandated source separation and separate collection. It became law in 2011; however, implementation and enforcement only began in 2014-2015. Currently, only eight out of the 13 states and two out of three federal territories in Malaysia are enforcing this policy. As of 2018, 18% of household respondents who live in the Federal Territory of KL (where the law is mandated) carry out source separation.[55]

As seen from these examples, while Integrated Solid Waste Management is a key pillar in the long-term success of the circular economy, it does not lend itself to an effective short-term solution.

3.3.2 DEPOSIT REFUND SYSTEMS IN DEVELOPING COUNTRIES REQUIRE CAREFUL EVALUATION

Deposit Refund Systems (DRS), sometimes also known as Container Deposit Systems (CDS), were designed in the 1970s to tackle the growing problem of packaging litter in the environment. Due to this background, DRS have typically focussed on beverage product packaging for products consumed out of home, including PET bottles, aluminium cans, glass bottles, and, in rare cases, beverage cartons. Under DRS, manufacturers add a deposit amount to the sale price of the product. This deposit is refunded to the consumer once they return the beverage container. Usually, a non-profit organisation is set up to be in charge of DRS implementation. In some cases, the government decides to run the DRS directly. A consumer can return the empty containers at collection points such as supermarkets or dedicated drop-off points. From these locations, the DRS organisation collects and aggregates the empty containers before selling them to the recycler. DRS has been very successful in increasing the collected-for-recycling rates of PET in developed countries. For example, the return rates of PET bottles in 2016 through the DRS in Norway and the Netherlands were 96% and 95%, respectively.

DRS is extremely effective in increasing the actual and perceived value of the material (e.g. a PET bottle); however, multiple factors need to be evaluated before an implementation of DRS in developing Southeast Asian markets can be considered. These include:

- DRS typically relies on supermarkets or other large establishments to function as the collection points. However, the sale of most consumer goods in developing Southeast Asia happens through small and medium businesses that may not be suitable or capable to function as collection points. The points of sale are also far more numerous in developing countries. Therefore, DRS would need to carefully evaluate both the physical infrastructure needed for the collection points and the geographical spread and density required to ensure sufficient coverage. With these additional considerations, the economics of the system would need to be further analysed to ensure that it is cost effective.
- DRS requires sound auditing processes to be set in place to minimise fraud, something that has been a challenge in developed markets. Given the informal and unregulated nature of many Southeast Asian countries, and the likelihood of DRS requiring a larger number of collection points due to the nature of product sales in these markets, fraud is likely to be a larger challenge.
- DRS typically does not cover all material types. Common material types not usually covered in traditional DRS include flexibles, HDPE, PP, and PS. As noted in the EPR section above, it is recommended that EPR tools/policies cover all packaging types. A tool or policy that imposes requirements only on PET packaging may inadvertently exempt other less recyclable packaging types. The market response to such an added cost on PET packaging but not on other packaging could lead to other less recyclable types of packaging becoming more prominent. Thus, if a DRS is launched, it is recommended that it be launched in parallel with other tools/policies which cover the full packaging spectrum.
- The material types covered by DRS are typically the ones that are already most collected by the existing informal sector in Southeast Asia. Thus a DRS has the potential to adversely affect the informal sector in Southeast Asia by reducing the amount of materials available for them to collect. This could lead to lower incomes for the informal sector and thus workers leaving the informal sector in search of other jobs, which could in turn lead to lower collected-for-recycling rates, especially for the material types not covered under DRS.

It must be noted that the principle of DRS (in terms of increasing the actual and perceived value of the packaging material) has been incorporated into the recommended approach and actions of section 3 'boosting the value chain'; however, it has been done in a method that considers the local realities of the six developing Southeast Asian countries. The recommended approach of 'boosting the value chain' increases the actual and perceived value of the packaging material by injecting additional value at the recycler stage which then flows down the value chain, and incorporates and benefits the informal sector workers rather than excluding them.

3.3.3 PACKAGING TAXES MAY NOT LEAD TO INCREASED COLLECTION FOR RECYCLING IF POORLY DESIGNED

As highlighted in sections 3 and 3.1, the best interventions will focus on boosting the value chain. A packaging tax, which is a tax based on the amount of packaging produced by the industry, is usually implemented by the government and run as a state enterprise solution that is not controlled by the industry. Any funds collected from a packaging tax typically do not need to be dedicated to solutions which increase collected-for-recycling rates and/or which boost the recycling industry. In these cases, a packaging tax is ineffective because it does not solve the issue.

If the packaging tax were to only be applied to certain types of packaging and not others (particularly if it were to be applied to more recyclable packaging and not be applied to less recyclable forms of packaging), it could adversely impact the existing value chain. The market response to such taxes would also lead to certain types of packaging becoming more prominent than others. If the existing infrastructure is not equipped to handle these material types, it could lead to lower collected-for-recycling rates and/or higher environmental leakage.

See appendix F for a more detailed description and analysis of packaging taxes and other tools within EPR.

3.4 THE ROAD AHEAD: KEY PRIORITY ACTIONS AND ROADMAP

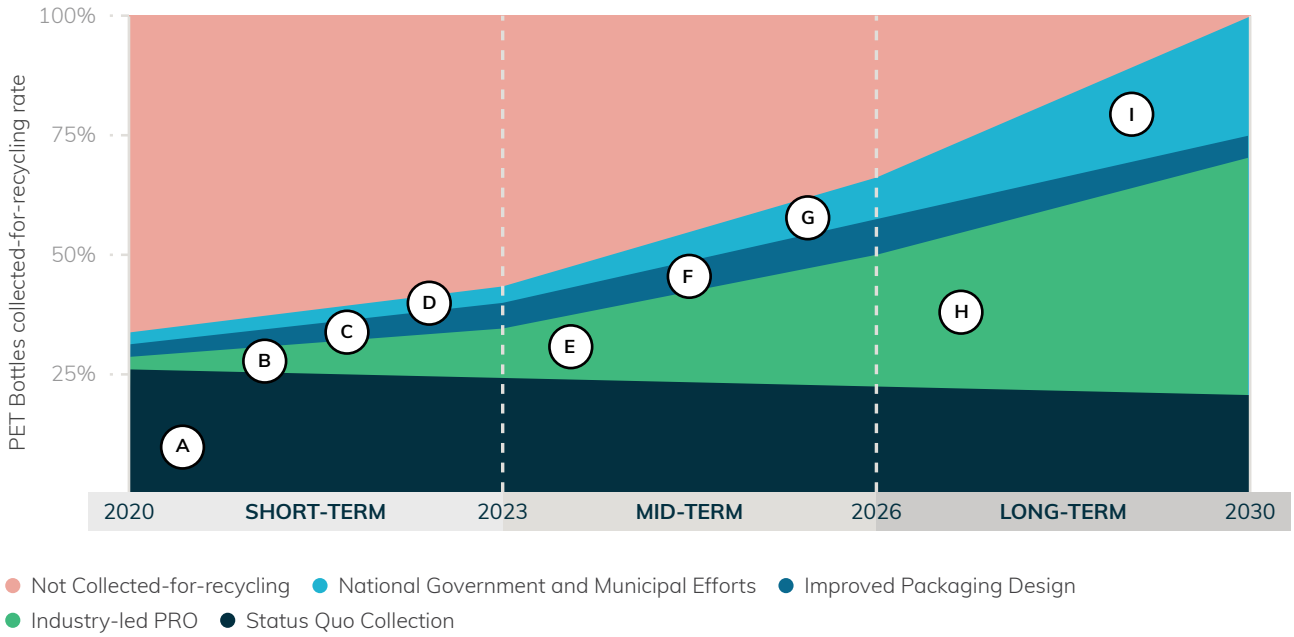
A circular economy for PET packaging is 100% possible. The key priority actions and enablers to accelerate the circular economy for post-consumer PET bottles in Southeast Asia are summarised here.

FIGURE 20: KEY PRIORITY ACTIONS AND ENABLERS TO ACCELERATE THE CIRCULAR ECONOMY FOR POST-CONSUMER PET BOTTLES IN SOUTHEAST ASIA

INDUSTRY	NATIONAL GOVERNMENTS AND MUNICIPALITIES	RECYCLERS, INVESTORS AND FUNDING INSTITUTIONS
✓ Immediately implement design changes to PET bottles, including the phase out of coloured PET bottle packaging and banning of PVC labels, and PVC used in primary packaging. Additionally, label formats must be easier for the value chain to remove e.g. roll-on instead of self-adhesive and sleeves must have a perforation strip.	✓ Develop and enact enabling legislation and policy for a circular economy, particularly: - Policies which assist to build the value chain - e.g. recycling content policy and standards for food-grade applications. - Policies which push material through the value chain by enabling better material access - e.g. source separation and separate collection.	✓ Accelerate investments in food-grade rPET production capacity within Southeast Asia to meet the anticipated 2030 demand. This demand is equivalent to at least 10 plants with a production output of 30,000 tonnes per year of rPET that need to be added by 2030 - i.e. one additional plant per year.
✓ Lead efforts to build the value chain through pulling material through the value chain. This can be achieved as an industry via a voluntary Packaging Recovery Organisation (PRO).	✓ Review economic and administrative incentives for the development of a local recycling industry. Consider provision of economic incentives to support a circular economy, e.g. tax incentives for producers which use a minimum of 30% recycled content in packaging, or levies for producers that use less than 30% recycled content.	✓ Conduct a detailed study of the recycling capacity required in each of the markets to achieve bottle grade rPET content goals and overall PET collection for recycling goals.
✓ Boost demand for recycled PET through offtake agreements and use of recycled content in packaging.	✓ Undertake sustained source separation and separate collection efforts, recognising: their critical role in making material accessible and of higher value for recycling; and that efforts will take time to scale from city level to country level.	
✓ Support with ancillary push efforts such as increasing collection/drop-off points, donate balers, scales, trolleys and other 'tools of the trade'. Support the informal sector with training on sorting and business skills. Do public awareness and behaviour change campaigns particularly related to educating the public about the value of the material, need for source separation and to not litter. The effectiveness of these ancillary efforts is limited if done on their own without value chain pull efforts.	✓ Undertake a detailed study of different EPR tools, their advantages and disadvantages and their projected impact on the local product market and recycling markets before implementing any tools. It is critical that any chosen EPR tool(s) boost the value chain and do not adversely impact the livelihoods of the informal sector.	

The key priority actions and enablers to accelerate the circular economy for post-consumer PET bottles in Southeast Asia are broken down into key actions for the short-term (2020-2023), mid-term (2024-2026) and long-term (2027-2030).

FIGURE 21: ROADMAP ACTIONS TO ACCELERATE THE CIRCULAR ECONOMY FOR POST-CONSUMER PET BOTTLES IN SOUTHEAST ASIA, ENABLING ACHIEVEMENT OF 100% COLLECTED-FOR-RECYCLING RATE



(A) As highlighted throughout this report, without intervention, the status quo collection by the informal sector is likely to gradually decline in the coming years. This is primarily due to the increasing cost of living leading to informal sector workers being unable to sustain themselves by trading in recyclables and therefore moving to other jobs. It is compounded by the doubling of total PET bottle market input to the six countries.

Short-term actions (2020-2023):

B Voluntary, industry-led PROs are implemented in each of the six countries, along with supportive policies.

- In the short-term, these PROs focus on establishing relationships with local recyclers and implementation of a price incentive for PET bottles with potentially multiple recyclers in each country. In the absence of local recyclers within the country, regional recyclers could be considered. Supporting this price incentive, PROs also implement push initiatives such as increasing collection/drop-off points, donating balers, scales, trolleys and other 'tools of the trade', social benefit programmes for the informal sector, and consumer behaviour change campaigns.
- The PRO's contracts with existing recyclers enable and require the recyclers to expand their capacity. The PRO's efforts within each country encourages and enables other PET recyclers to setup operations within the country.
- The industry-led PRO is supported by changes in key packaging policies and incentives to better enable a circular economy for PET bottle packaging, such as:

- Policies and standards to allow food-grade recycled content.
- Economic and administrative incentives for the development of a local recycling industry.
- Recycled content targets and incentives and disincentives e.g. tax incentives for producers which use a minimum of 30% recycled content in packaging, or levies for producers that use less than 30% recycled content as of a specific date in the future (e.g. 2025).

C Gains in PET collected-for-recycling rate are driven by the large consumer goods companies implementing improved packaging design standards, such as the phase out of coloured PET, phase out of PVC sleeves, and adding perforation on bottle sleeves to become easily removable.

D In the short-term, national government and municipal efforts focus on passing laws that mandate source separation and separate collection of waste, in addition to establishing implementation and enforcement mechanisms in key cities within the country as a proof of concept.

Mid-term actions (2024-2026):

E PROs focus on expansion of the price incentive implementation to other cities within the countries. This leads to a faster rate of increase in the tons of PET collected-for-recycling.

F Smaller and medium-sized consumer goods companies also align with the improved design standards and practices.

G National government and municipal efforts have led to the successful enforcement of source separation and separate collection in multiple cities in each country. Waste collection infrastructure is also improved with the target of reaching 100% coverage by 2030.

Long-term actions (2027-2030):

H The industry-led PRO within each country expands implementation of the price incentive to cover all regions within the six countries. This leads to significant quantities of PET being collected for recycling.

I National government and municipal efforts lead to source separation and separate collection being enforced across most regions within the six countries and waste collection coverage reaches 100%.

Appendices

APPENDIX A: PET PACKAGING - GLOBAL RECYCLING AND STATUS QUO IN SOUTHEAST ASIA

PET PACKAGING

PET is an acronym for polyethylene terephthalate. PET used for packaging accounts for 23% of the global usage of the PET polymer. 54% of all PET production is for fibre e.g. for the textiles industry, where it is commonly referred to as polyester. Other industry uses include the automotive and electronics industries. PET polymer used in packaging accounted for 17.1 million tonnes (4.2%) out of the 407 million tonnes of primary plastics produced globally in 2015. Driven mainly by increasing demand in emerging and transitional economies, the market for PET packaging will grow 3.8% annually during the period 2016–21 to reach 21.1 million tonnes by 2021.

For the purposes of this report, the term 'PET bottles' is used to refer to PET used for beverage packaging. The report excludes any non-beverage applications, such as cooking oil containers and food packaging. PET beverage packaging is used primarily for soft drinks and water applications.

RECYCLABILITY OF PET PACKAGING

The PET polymer is clear, strong, lightweight, safe and 100% recyclable. PET packaging is unique from a sustainability point of view for several reasons: it is recyclable; it has an existing recycling industry and a variety of end uses once recycled; it is supported by global recycling and recycled content usage commitments by the packaging and consumer goods industries.

Recycled PET is known as rPET. As with virgin PET, rPET can be used to make many new products, including polyester staple fibre or filament used for apparel, home textiles (carpets, pillows, sheets), automotive parts (carpets, sound insulation, boot linings, seat covers), industrial end-use items (geotextiles and roof insulation) and new PET packaging and bottles for both food and non-food products. It is generally blended in a ratio of virgin to recycled, depending on the functional or esthetic tolerance required.

Recyclate derived from PET packaging (also known as recycled PET or rPET) accounts for 12.1% of the global polyester production. Technology developments over the past decade have led to numerous companies around the world using 100% recycled PET content in bottles. This neatly closes the recycling loop and enables 'cradle to cradle' packaging solutions. Recent research has also shown that carbon dioxide emissions in the making of rPET were found to be 79% lower than for new virgin PET material.[56] When recycled, a PET bottle also incurs lower carbon dioxide emissions per liter of product delivered than a lightweight glass container with high recycled content.[57]

GROWING ENVIRONMENTAL CONCERNS

The New Plastics Economy: Rethinking the Future of Plastics report estimated a global PET packaging collected-for-recycling rate of 55%, as of 2012, which after assuming a ~20% yield loss would lead to a global recycling rate of 44%. It is expected that in 2020, this global recycling rate would increase to 53%. However, only 5% will be recycled in a closed loop back into recycled PET (rPET) for food-grade PET packaging

PET packaging collected-for-recycling rates are not necessarily dependent on the level of development of the countries. Even within developed nations, PET collected-for-recycling rates vary widely. For example, the PET packaging collected-for-recycling rate in the US is 29.9% (based on latest available data which is for 2015)[58], while in Germany it is 93.5% (2016).[59]

GLOBAL COMMITMENTS BY PET PACKAGING MANUFACTURERS & USERS

Several global consumer goods companies have in recent years announced commitments towards sustainable packaging, including the usage of recycled content in PET bottles. For example, Danone's 2025 global commitment includes reaching 50% recycled material in water and beverage bottles and 100% for evian bottles. As of 2017, Danone used 14% recycled PET in water and beverage bottles.[60] Similarly, Coca-Cola's World Without Waste global strategy includes a commitment to reach at least 50% recycled content in its packaging by 2030. As of 2018, the percentage of recycled material used by Coca-Cola in PET packaging globally stood at 9%.[61]

The New Plastics Economy Global Commitment was announced in 2018 and endorsed by more than 150 businesses from across the plastic packaging value chain. Consumer packaged goods companies and retailers that are part of this Global Commitment, including Danone and Coca-Cola, have committed to an average of 25% recycled content in all plastic packaging by 2025, roughly tenfold the estimated current global average.

PACKAGING CONSUMPTION TRENDS IN SOUTHEAST ASIA

Six of the top Southeast Asian countries by population (Indonesia, Philippines, Vietnam, Thailand, Myanmar and Malaysia) consumed 886,000 tonnes of PET

packaging in total in 2018.[62] Based on modeling and analysis from industry data, our research team estimates the total consumption of PET bottles across these six Southeast Asian countries is set to almost double from 886,000 tonnes in 2018 to 1.52 million tonnes by 2030.

In five of the six Southeast Asian countries studied (i.e. Indonesia, Philippines, Vietnam, Thailand and Malaysia[63]), PET packaging (at 23.3%) is still less than half the share of flexible packaging (at 59.7%) in the overall plastic packaging market in terms of packaging units sold. More flexible packaging units are consumed than PET packaging units in four of these five countries with the exception of Thailand.

SOUTHEAST ASIA'S CONTRIBUTION TO OCEAN PLASTIC LEAKAGE

Five Southeast Asian countries (Indonesia, the Philippines, Vietnam, Thailand and Malaysia) have been identified as among the top 10 countries globally contributing to plastic waste entering waterways and thus the oceans.[64] Together with Myanmar, these six countries contribute to 29% of the total mismanaged plastic waste globally.

FIGURE 22: PET BOTTLE MARKET INPUTS ACROSS THE SIX LARGEST SOUTHEAST ASIAN COUNTRIES (FORECAST)

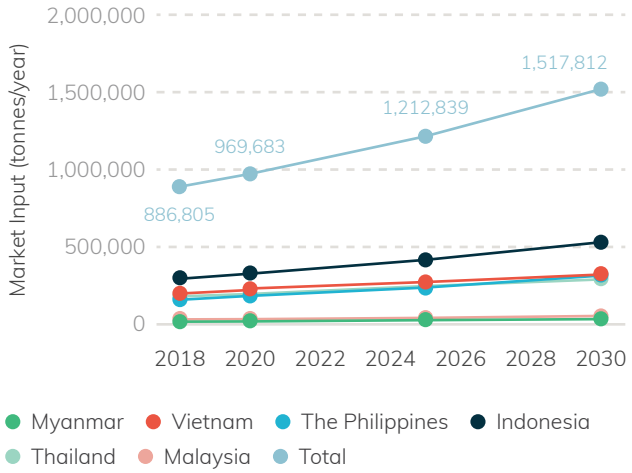


FIGURE 23: CONSUMPTION OF PLASTIC PACKAGING AS PERCENTAGE OF TOTAL UNITS SOLD WITHIN FIVE SOUTHEAST ASIAN COUNTRIES (INDONESIA, THE PHILIPPINES, VIETNAM, THAILAND AND MALAYSIA) IN 2017[65]

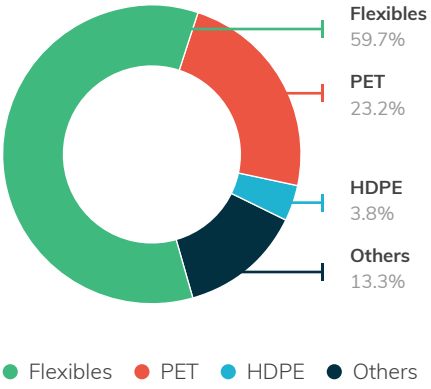
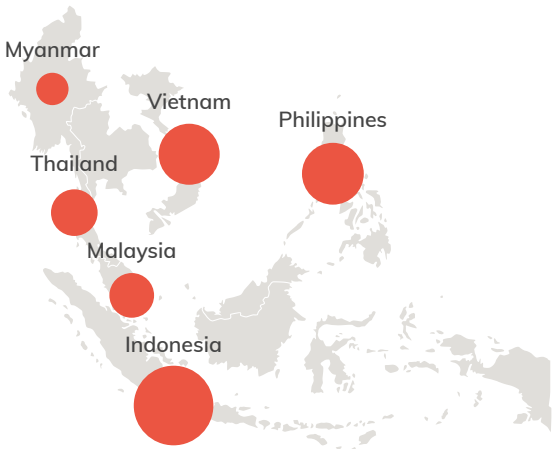
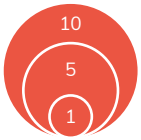


FIGURE 24: MISMANAGED PLASTIC WASTE IN THE SIX SOUTHEAST ASIAN COUNTRIES CONTRIBUTES TO 29% OF TOTAL MISMANAGED PLASTIC WASTE GLOBALLY[66]

Six ASEAN countries
contribute to
29%
of the total mismanaged plastic waste globally



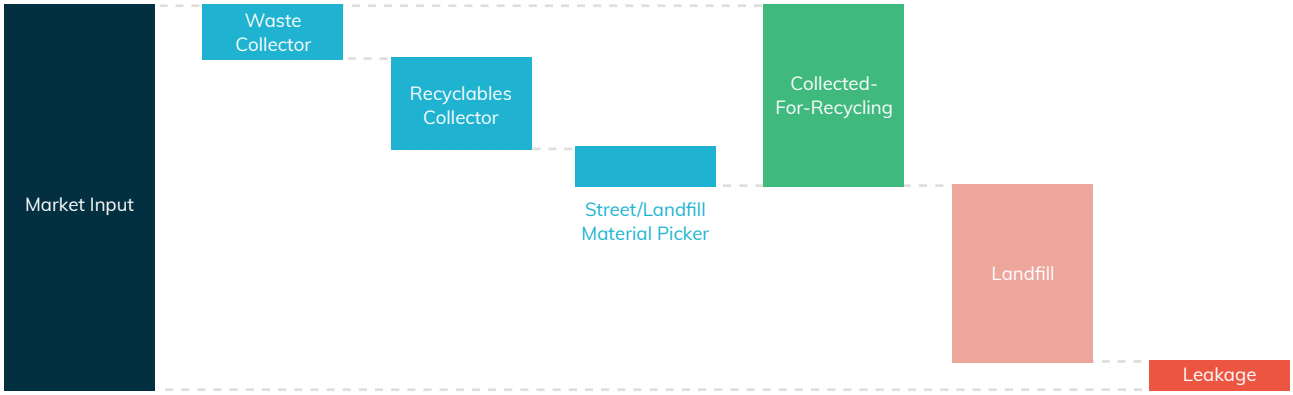
Ocean-bound plastic waste
2010, in million tons



APPENDIX B: METHODOLOGY

The standardised methodology developed by GA Circular to collect and analyse primary data has enabled, for the first time, a systematic and comparable baseline for the key outputs of collected-for-recycling, landfill and leakage rates across the nine cities and six countries for PET bottles. The rates have been calculated based on primary data collected on-ground across the nine cities and the six countries from the full spectrum of stakeholders across the value chain.

FIGURE 25: DEFINITIONS FOR PET BOTTLE MATERIAL FLOWS IN EACH OF THE SIX SOUTHEAST ASIAN COUNTRIES[67]



Market Input
The total amount of PET bottles entering the market, not including caps and sleeves that are not PET.

Waste Collector
The people that collect waste (mixed or separated) from households, offices, or establishments. These people may also sift through rubbish from their waste trucks and pick out recyclables. They may be employed by the government or private waste collection companies.

Recyclables Collector
The people that buy recyclables from households or other establishments and sell this to Junk Shops as a primary source of income. They may also pick recyclables out from mixed waste or litter.

Street/Landfill Material Picker
Street Material Pickers are those who pick up recyclable materials from the open environment (in the city), or from a garbage bin. This Street Material Picker may also do some buying, but they are primarily picking, which is why they are called a Street Material Picker.

Landfill Material Pickers are those who pick up recyclables from landfills. These people are often referred to as scavengers, however Landfill Material Pickers is the terminology used by GA Circular and within this report.

Collected-for-recycling
This refers to the total amount of PET collected for recycling by Junk Shops. This includes PET sold to Junk Shops by Waste Collectors, Recyclables Collectors, and Material Pickers.

The collected-for-recycling rates already factor in removal of contaminants (eg dirt and water) and caps and labels.

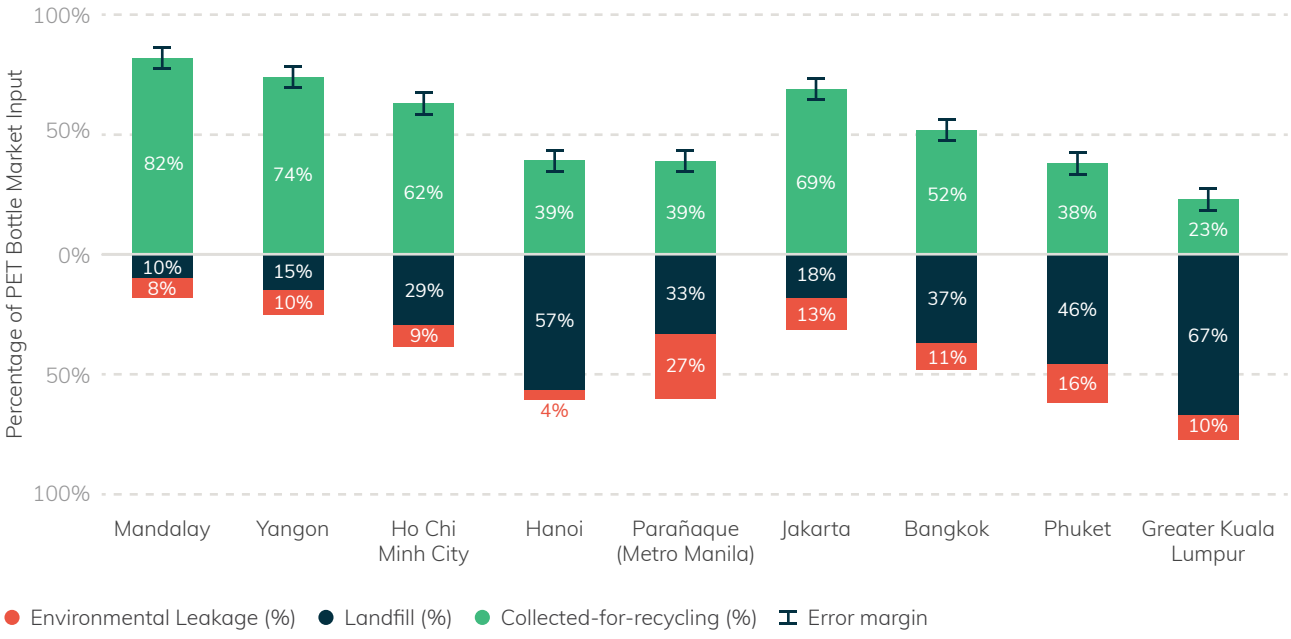
Landfill
This refers to PET that is collected from households and establishments and sent to landfill by waste collectors.

Leakage
This refers to PET that is leaked into the environment, including streets, and waterways.

This is also referred to as environmental leakage. This can happen as a result of littering or open dumping of waste.

This report defines the collected-for-recycling rate as the ratio of the total tonnes of material collected for recycling from a particular area over the course of a year over the total market input of the material into the area over the same time period. This rate excludes the weight of caps and labels that are not made out of PET. Variables that have been factored into these calculations include contamination rates in the collected PET and seasonal fluctuations in the tonnage handled by the informal sector. The figure below summarises the key rates across the nine cities studied. The collected-for-recycling rates at the city level have an error margin of ± 5%.

FIGURE 26: END DESTINATION OF POST-CONSUMER PET BOTTLES IN NINE CITIES ACROSS SOUTHEAST ASIA



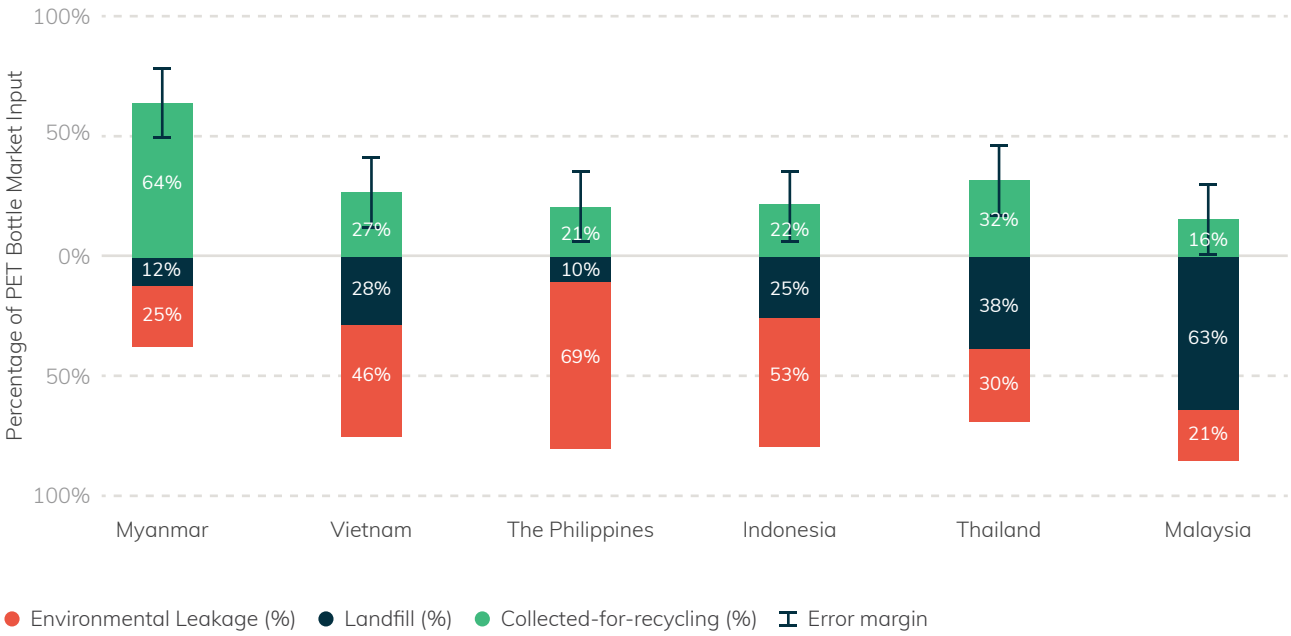
The cumulative collected-for-recycling, landfill, and leakage rates for the nine cities studied are presented in the table below.

TABLE 4: CALCULATIONS TO DETERMINE THE COLLECTED-FOR-RECYCLING RATE OF PET BOTTLES IN THE SIX SOUTHEAST ASIAN COUNTRIES STUDIED

Stage		Cumulative across 6 countries studied		Key Rates		Source/Comments
		Tonnes/ year	%			
Market Input	Market Input of PET Bottles	167,787	100.00%			Derived based on industry data
Consumption Location	PET Bottles Consumed in areas with waste collection coverage	157,768	94.03%			Derived based on data on waste collection coverage from national/local governments and local NGOs or universities
	PET Bottles Consumed in areas without waste collection coverage	10,018	5.97%			
Collection and Transport to Landfill	Collected with Mixed Waste by Waste Collectors intended for transport to landfill	104,209	62.11%			Calculated based on primary data collected from Waste Collectors in the nine cities by the research team
	Sent to landfill by Waste Collectors (some amount is pulled out and sold for recycling)	70,927	42.27%			
	Leaked into the environment due to lack of waste collection coverage	6,714	4.00%	10.05%	Leakage Rate	Calculated based on values for PET bottle consumption in areas without collection coverage and the portions of this picked out or bought by Recyclables Collectors, Street Material Pickers, and the Formal Sector.
	Littered into the environment due to consumer behaviour	6,749	4.02%			Assumption for each city based on stakeholder interviews
	Leaked into the environment from poorly managed landfills and open dumpsites	3,400	2.03%			Calculated using data on landfills from the 'Stemming the Tide' report by Ocean Conservancy
	Stays at Landfill after leakage and collection by Landfill Material Pickers	60,119	35.83%	35.83%	Landfill Rate	Calculated based on the above values
Collected-for-Recycling	Collected-for-Recycling from Landfills by Landfill Material Pickers	7,408	4.41%			Calculated based on primary data collected by the research team from Landfill Material Pickers, Recyclables Collectors, Street Material Pickers, Waste Collectors, and Formal Sector Collection (eg. Waste Banks in Jakarta, MRFs in Metro Manila)
	Collected-for-Recycling from the cities by Recyclables Collectors	34,246	20.41%			
	Collected-for-Recycling from the cities by Street Material Pickers	13,288	7.92%			
	Collected-for-Recycling from the cities by Waste Collectors (i.e. what they pull out from the PET collected with mixed waste)	33,282	19.84%			
	Collected-for-Recycling from the cities by Formal Sector	2,581	1.54%			
Sale to Junk Shops	Total low-value stream PET Bottles sold to Junk Shops	53,977	32.17%	54.12%	Collected-for-Recycling Rate	Calculated based on the above values
	Total high-value stream PET Bottles sold to Junk Shops	36,827	21.95%			Calculated based on the above values

Using the data gathered from these key cities, the GA Circular research team estimated national level collected-for-recycling rates by accounting for the different urban-rural composition[68] of areas outside the key cities studied, the relative waste collection coverages between different areas, and the presence of the informal sector. The collected-for-recycling rates at the country level have an error margin of ± 15%. The country rates are lower than the corresponding city rates due to lower waste collection coverage and smaller presence of the informal sector in non-urban areas.

FIGURE 27: END DESTINATION OF POST-CONSUMER PET BOTTLES IN SIX COUNTRIES ACROSS SOUTHEAST ASIA



APPENDIX C: IMPACT OF RENEWABLE PLASTICS ON PET RECYCLING AND EMERGING RENEWABLE ALTERNATIVES TO PET

Renewable plastics are made in whole or partially from renewable biological resources. For example, sugar cane is processed to produce ethylene, which can then be used to manufacture polyethylene, the building block of PET. Starch can be processed to produce lactic acid and subsequently polylactic acid (PLA), another widely used renewable plastic. The properties of renewable plastics can vary considerably from material to material.

IMPACT OF RENEWABLE PLASTICS ON PET RECYCLING VALUE CHAINS[69]

PLA, is a versatile renewable plastic that features barrier properties and is available in high-performance grades that are a replacement for plastics used in packaging applications such as PS (polystyrene) and PP (polypropylene). European Bioplastics, the association of the bioplastics industry in Europe, estimates global production capacities of PLA to grow by 60% by 2023 compared to 2018.[70]

Since PLA bottles look and feel similar to PET bottles, recyclers often consider material identification between the two difficult. So, both at the level of consumers and of manual sorting, separation is not possible unless an extra element is introduced, for example via labelling. PLA is denser than water so in the flotation tank any PLA fragments will eventually follow the PET stream towards mechanical recycling. Because of this, the possibility of mixing PLA bottles and PET bottles together exists. As a result, there is concern in the recycling community that PLA bottles, at high enough levels, would contaminate the PET recycling stream due to chemical and thermal property differences. These differences could affect downstream processing and final product properties. The inclusion of PLA bottles is therefore considered to take away value in the PET recycle stream by creating problems with sortation efficiency, accuracy, and potential yield loss.[71]

Recent research in Europe is a helpful benchmark to understand the potential impact of PLA in PET streams in Southeast Asia. European countries on average have significantly higher levels of source separation and the collection infrastructure in more developed countries is supported by optical recognition technologies. For example, near-infrared (NIR) spectroscopy scanners in sorting facilities can separate PET from PLA at an efficiency of 86%-99.6%. Starting from the latest available European consumption data on PLA (from 2015) and a forecast consumption of PLA (in 2021), the level of PLA estimated to occur in the bottle and the mixed plastics fractions from household waste have been calculated as per the below table.

TABLE 5: PRODUCTION OF PET VERSUS PLA FROM 2015 TO 2021[72, 73]

Application	PET (tonnes)		PLA (tonnes)		PLA/PET Ratio	
Year	2015	2021	2016	2021	2015/ 2016	2021
Bottles	3,300,000	3,900,000	2,900*	4,200*	0.09%*	0.1%*

Note: * Lower end estimates

The overall numbers in the table reflect the fact that production of both PET and PLA is expected to increase towards 2021, with the increase of PLA relatively higher than that of PET. This is reflected in the expected slight increase of the concentrations of PLA in PET.

Issues with respect to transparency and discoloration of rPET in the presence of PLA are evident from PLA contamination of 0.1% or even lower. By 2021, the PLA / PET ratio in the bottle and mixed plastics fraction is expected to hit this 0.1% threshold and begin to negatively impact rPET quality. Therefore, further removal of PLA through separate streams may be very well required in the recycling chain in order to assure high-quality rPET.

Thus questions still remain on whether PLA bottles can be sorted effectively in the current infrastructure even in developed EU countries where sorting is mandatory and supported by using optical recognition technologies. If the status quo on collection and sorting of PET continues, PLA bottles can therefore be expected to become a contaminant in PET streams in Southeast Asia in the future.

AN UPCOMING RENEWABLE ALTERNATIVE TO PET[74]

Renewable plastics, including renewable PET bottles have begun to enter commercial production and are expected to establish significant market share over the next five years in Asia Pacific. Intentions to increase global production capacities for renewable PET, however, have not been realised at the rate predicted in previous years. Instead, the focus has shifted to the development of PEF (polyethylene furanoate), a new polymer that is expected to enter the market in 2023. PEF is comparable to PET in terms of functionality and unlike fossil fuel-based PET, PEF is 100% from renewable sources. The most particular feature of PEF is its enhanced barrier properties, for instance, for carbon dioxide and oxygen, making the material ideal for soft drink bottles and food packaging. Currently, PEF is not available on the global market, but is expected to be available imminently given the announced startup of Synvina in Antwerp, a joint venture of BASF and Avantium.

The impact of PEF on the mechanical recycling of PET has been investigated: one source states that contamination of up to at least 2% has been demonstrated not to lead to any negative impact on rPET quality, e.g., no negative impact on haze, colour and other properties. In this context, it is relevant to learn that Synvina has proactively approached the EPBP (European PET Bottle Platform, a voluntary industry initiative comprising of technical experts in the field of PET production, design and recycling), to assess the impact of PEF on the existing recycling chain of PET bottles, and has obtained a conditional 'approval' for market entrance from this entity. Based on dedicated studies, the EPBP concluded that until a market penetration of 2% is reached there will be no issues with PEF ending up in PET streams. For larger market penetrations, either additional tests or the development of a separate collection and recycling system for PEF bottles will need to be in place in order to further anticipate any negative impact on rPET quality.

TABLE 6: MELTING POINT OF PET, PLA AND PEF[75]

Plastic Type	Density (kg/m^3)	Melting Point (°C)
Polyethylene terephthalate (PET)	1,350–1,390	255
Polylactic acid (PLA)	1,200-1,450	155-165
Polyethylene furanoate (PEF)	1,400-1,550	225

APPENDIX D: SOURCE SEPARATION AND SEPARATE COLLECTION

SOURCE SEPARATION

Source separation is the separation of the waste into its recyclable and non-recyclable components, as opposed to a mixed stream comprising of all municipal waste. A source separation policy calls for the separation of waste at the point of disposal or collection to allow for improved recovery of material and reduced contamination. This is especially favourable in the case of packaging materials where clean and sorted packaging could be recovered for reuse, recycling or energy recovery in a more efficient manner. A source separation policy must go hand in hand with some form of a separate collection policy.

SEPARATE COLLECTION

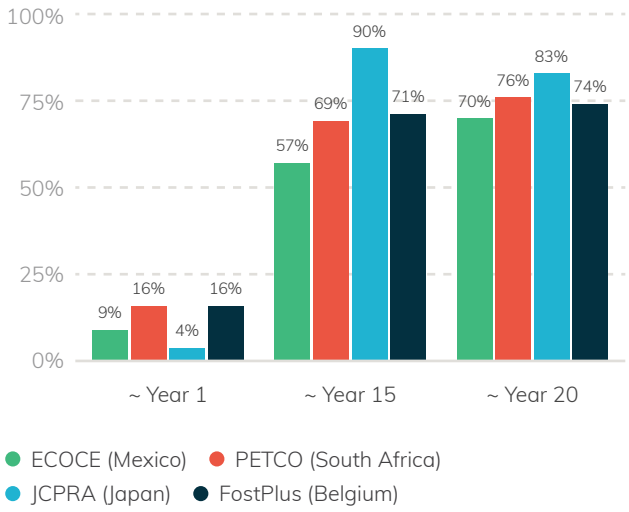
Separate collection is the collection of separated waste, as separate streams, without commingling them, for further separation and allocation to different recovery solutions. Separate collection of packaging waste not only channels such waste into the appropriate recovery streams, it also allows for the collector (formal or informal) to recover the value retained in the discarded packaging material.

EFFECTIVE IMPLEMENTATION

Convenience and incentive to consumers/waste separators along with awareness play a big role in ensuring that the above two policies are effective. The level of convenience is determined by existing infrastructure such as door-to-door collection, curbside collection and collection centres. Incentives provided to the consumers/waste separators include reduced cost of collection for separated waste, deposit refund, compensation for recyclable materials. Awareness campaigns include providing information regarding the available infrastructure, how to best use it, as well as the building appreciation for the intrinsic value retained in packaging materials.

APPENDIX E: PERFORMANCE OF INDUSTRY-LED, VOLUNTARY, AND MANDATORY PROS

FIGURE 28: NATIONAL COLLECTION-FOR-RECYCLING RATES FOR PET BEVERAGE BOTTLES IN MEXICO, SOUTH AFRICA, JAPAN, AND BELGIUM[76, 77, 78, 79, 80, 81]



Note: Rates are rounded to nearest % for ease of reading. Where data for the year was not available, the nearest year of available data has been used. Year 20 for ECOCE (Mexico) and PETCO (South Africa) are based on targets for 2022 and 2024 respectively. All other years are actuals.

Four PROs were chosen for benchmarking and to obtain knowledge and insights for Southeast Asia. The benchmarking criteria were: (I) successful track record in increasing packaging recycling rates (including for PET); (II) ability to include other packaging types or work successfully alongside PROs focusing on other packaging types in the country; (III) maturity in terms of years; (IV) level of government recognition.

The four PROs are: Fost Plus (Belgium), JCPRA (Japan), PETCO (South Africa) and ECOCE (Mexico). While FostPlus and JCPRA have achieved high collected-for-recycling rates through a government-mandated system, ECOCE and PETCO rely on a voluntary, industry-led model.

The chart on the left shows the increase in the rate of collected-for-recycling of PET bottles for these four PROs.

The table below summarises the key features and key information gathered from the 4 PROs:

TABLE 7: SUMMARY OF MANDATORY & VOLUNTARY INDUSTRY-LED PRO SYSTEMS[82, 83, 84, 85, 86]

	Mexico	South Africa	Japan	Belgium
PRO	ECOCE	PETCO	JCPRA	FOSTPLUS
Date Established	2002	2004	1995	1994
Voluntary or Mandatory	Voluntary, industry-led	Voluntary, industry-led	Legislation mandated	Legislation mandated
PET Market Input (Tonnes in 2017)	768,000 (450,000 by member companies)	167,000	587,350	44,000[87] (42,500 by member companies)
PET Collected-for-recycling (2017)	445,000	96,650	541,250	70,500
PET Collected-for-recycling (2017)	58% nationwide	65% nationwide	92.2% nationwide	82.9% nationwide
PRO membership fee per kilogram for PET bottles (2017)	US$0.02/kg	US$0.03-0.05/kg	US$0.01/kg	US$0.24/kg
Budget available to PRO through participation fee only (2017)	~ US$6-7 million	~ US$6 million	US$6.4 million	US$10.4 million
Informal Sector Participation	Yes	Yes	No	No
Revenue	Companies pay an annual fee based on material type and tonnage.	Companies pay a quarterly fee for PET based on tonnage.	Companies pay an annual fee based on material type and tonnage.	Companies pay an annual fee based on material type and tonnage. Material sales also provides revenue
Cost Model	Price incentive to recyclers based on actual annual costs required to achieve profitable collection and recycling.	Price incentive to recyclers negotiated and then contracted - with the option to review in conditions of flux.	Price incentive to recyclers based on estimated costs. Surplus amounts go partially back to companies and partially to municipalities to incentivise higher quality separation.	Operational costs of waste collection are covered through the system. Revenue from material sales is used to partially offset these costs.
Partners	Aggregators, Recyclers, Informal Collectors	Recyclers, Informal Collectors	Municipalities, Recyclers	Municipalities, Recyclers
Material Streams	PET, HDPE, Flexible Plastics, Glass, Metal, Beverage Cartons	PET. Other materials are currently covered by other PROs	All post-consumer packaging materials	All post-consumer packaging materials
Key Learnings	• Pulling the material through price incentive at the recycling stage of the value chain, and developing local recycling infrastructure and offtake agreements. • Having more than 50% of the PET industry represented under the ECOCE. • Getting ECOCE member and fee contribution recognised by government as fulfilling producer responsibility.	• Pulling the material through price incentive at the recycling stage of the value chain, and developing local recycling infrastructure and offtake agreements. • Having more than 50% of the PET industry represented under the PETCO.	• Design harmonisation among producers (for e.g. phasing out coloured PET) • Municipalities support JCPRA efforts by enforcing source separation. In return, municipalities are incentivised economically to have high-quality separation of packaging waste.	• Municipalities support Fost Plus by enforcing source separation which lowers the overall cost of sorting recyclables from mixed waste and therefore makes recycling more profitable. • Having single PRO which oversees EPR obligations for all packaging types makes it cost effective compared to having multiple PROs.

APPENDIX F: ANALYSIS OF TOOLS UNDER MANDATORY EPR AND VOLUNTARY INDUSTRY-LED EFFORTS

The tables below list multiple tools available under mandatory EPR systems and voluntary industry-led efforts and elaborates on their respective advantages and challenges.

TABLE 8: TOOLS AVAILABLE FOR MANDATORY EPR OBLIGATIONS[88]

Tools	Description	Advantages	Challenges
Advanced Fees	Under Advanced Fees, fees are levied on products at purchase based on the estimated costs of collection and treatment. Compliance schemes in the form of an organisation is setup where packaging producers are responsible for organizing and funding (partially or fully) the collection, sorting, recycling and recovery of used packaging materials. Compliance schemes are typically established by a group of obliged industry companies that own and operate them on a not-for-profit basis under a recovery organisation.	Industry has control over the implementation of the recycling strategy. Business focus (particularly in not-for-profit systems) can lead to more efficiency than state-run systems. Recycling targets are typically met reliably, if the system is set up well.	Competition between multiple recovery organizations can lead to inefficiencies resulting in lower recovery rates. So it is important to have ideally only one recovery organisation operating at a national level which covers all major packaging types. Collection targets towards 90% require highly educated and motivated consumers with highly developed and consumer-friendly infrastructure.
Deposit Refund System (DRS)	DRS either consists of manual take-back and/or it is supported by reverse vending machines. The point of redemption can be located at a retailer or at redemption centers and take-back points. The deposit (the incentive) is usually clearly labeled. The deposit is refunded to the consumer when the empty package is returned.	Direct consumer incentive to return packaging and addresses littering of beverage packaging. Leads to high collection and recycling of beverage containers within a short time.	Typically does not include all material types. Detailed auditing of the system could be a challenge in ASEAN countries. Could adversely affect informal sector - leading to reduced recycling. Any implementation is recommended to be in tandem with other tools/policies which cover the full packaging spectrum.
Recycling Targets (also known as Product Take-Back Requirements)	Recycling targets require producers to hit annual recycling targets for specific types of packaging. Targets are usually set in percentage points. Often implemented together with other economic tools such as Advanced Fees, DRS or Taxation.	Provides a clear, objective measure of success. Incentivises the industry to ensure the entire value chain is working collectively to meet the targets.	It is important to know what a certain percentage means in weight collected and the collection rate required to achieve the recycling rate target. Recycling targets will fail in the absence of independent, auditable reporting.
Recycled Content Targets	Recycled content targets require producers to use a specific percentage of recycled packaging content (for e.g. 30% food-grade rPET in their packaging. It can be used alongside other design changes such as lightweighting. Often combined with other economic tools such as Advanced Fees or Taxation.	Encourages the entire industry to adopt the targets thus preventing free riders. If implemented well, can improve domestic collection and recycling industry.	Does not necessarily lead to an increase of domestic recycling rates as recycled content can be sourced from international markets. Expected to be challenging for countries with low collection rates to jump straight to high collection rates for food-grade recycled plastic.
Certificate Trading	The recycling industry offers packaging material providers, fillers and packers with guaranteed recycling capacities. Any filler, packer or importer can buy the certificates needed to ensure that the equivalent of the packaging material placed in the market will have a recycling facility where it can be recycled.	If this system is properly implemented and enforced, it may ensure recycling facilities and sufficient recycling infrastructure.	It may produce false reporting and fraudulent behavior. Does not support collection.
Taxation	A tax based on the amount of packaging produced by the industry (packaging tax) or amount of packaging consumed (product tax). Implemented by the government and run as a state enterprise solution that is not controlled by the industry. Packaging taxes can be implemented as a punitive measure for not meeting other EPR obligations such as recycling rate targets or recycled content usage targets.	No separate schemes needed to be setup and run by industry. Taxes charged directly to consumers may create awareness on the recycling issue.	The tax collected might not be spent towards improving waste collection and recycling infrastructure.

TABLE 9: TOOLS AVAILABLE FOR VOLUNTARY MEASURES BY INDUSTRY[89]

Tools	Description	Advantages	Challenges
Buy-back (direct acquisition of packaging)	A company voluntarily invests in creating a collection system for a specific material type to meet its recycling obligations.	Single company initiative - can move faster. Works when the company has a significant market share which justifies the large investment in recycling.	Not an industry-led system thus has limitations on the increase in recycling rate that can be achieved. Government may decide to impose a blanket plastic tax since other plastic streams are not covered. Only works for certain materials. No ability to address overall plastics challenge.
Voluntary industry-led Packaging Recovery Organisation (PRO)	A voluntary, industry-led initiative where major consumer goods companies contribute to a pool of funds which are then used to implement effective and targeted recycling initiatives. An industry-led packaging recovery organisation (PRO) is setup where packaging producers are responsible for organizing and funding the collection, sorting, recycling and recovery of used packaging materials.	Works with existing informal sector. Allows industry flexibility to create its own initiatives across all packaging / material streams. Industry can set targets proactively without government intervention.	Voluntary nature means that some companies will be able to freeload off the work of the participating companies.
Deposit Refund System (DRS)	As mentioned in the main section of the report, DRS can also be implemented on a voluntary basis by industry. DRS either consists of manual take-back and/or it is supported by reverse vending machines. The point of redemption can be located at a retailer or at redemption centers and take-back points. The deposit (the incentive) is usually clearly labeled. The deposit is refunded to the consumer when the empty package is returned.	Direct consumer incentive to return packaging and addresses littering of beverage packaging. Leads to high collection and recycling of beverage containers within a short time.	Typically does not include all material types. Detailed auditing of the system could be a challenge in ASEAN countries. Could adversely affect informal sector - leading to reduced recycling.

APPENDIX G: KEY ANALYTICAL ASSUMPTIONS FOR RECOMMENDED ROADMAP

The recommended roadmap described in this report to achieve 100% collected-for-recycling rates of PET bottles in Southeast Asia is the result of detailed research, analysis and stakeholder interviews. By its very nature, the roadmap requires assumptions which are laid out below. The time periods are short-term (2020-2023), mid-term (2024-2026) and long-term (2027-2030) as highlighted in sections 3.0 and 3.4.

The industry-led PRO, coupled with supportive policies and investments, contributes directly to 50% of the collected-for-recycling rate by 2030:
The 50% contribution is based on the success stories and growth trajectories of PROs in comparable developing countries such as Mexico and South Africa. Mexico's PRO (ECOCE) increased the country-wide collected-for-recycling rate for PET bottles from 9% to 60% (i.e. 51 percentage points) in the first 10 years of operation, while South Africa increased it from 16% to 52% (i.e. 36 percentage points) over the first 10 years. However, both Mexico and South Africa did not have a strong local recycling industry for PET prior to the establishment of the PROs.

It must be noted that the modelling assumes supportive policies and external investments as per the recommendations in this pillar. In both Mexico and South Africa, beyond the price incentive and related measures to boost the value chain and domestic recycling industry, all the supporting policies and investments recommended as part of this pillar have existed. This includes:

- **Investments in domestic recycling capacity,** e.g. US$339 million has been invested into PET recyclers in Mexico, per section 3.1 of this report.
- **Supportive policies and the use of recycled content** in the production of new packaging, therefore creating a demand for recyclate. South Africa and Mexico use recycled content in both food and non-food applications. If use of recycled content in packaging were not possible, the collected-for-recycling rates due to PRO efforts would be reduced as there would be less demand for recyclate. As part of this, member companies of the PRO sign offtake agreements with recyclers that partner with the PROs. These offtake agreements help companies meet their commitments to use recycled content in their packaging and, as above, contribute to the increase in the collection-for-recycling rate due to the PRO.

Southeast Asia has three advantages over Mexico and South Africa:

1. A higher status quo collection-for-recycling rate for PET bottles (26% in Southeast Asia compared to Mexico's 9% and South Africa's 16% before the PROs began operations) meaning that there is less inertia;
2. A more developed local PET recycling industry, which enables stronger pull efforts to boost the value chain;
3. A stronger demand for recycled content in Southeast Asia is projected until 2030 compared to South Africa and Mexico in the early 2000s.

It has thus been determined that the actions of the PROs between 2020 and 2030 in the six Southeast Asian countries can **directly contribute to 50% of the collected-for-recycling rate in 2030.**

National government and municipal efforts contribute to 25% of the collection-for-recycling rate in 2030, with the majority of these gains in the long-term:
As illustrated throughout this report in sections 2.4, 2.5 and 3.2.2, the key challenge faced by national governments and municipalities is a funding gap for waste management. This challenges the achievement of 100% waste collection coverage and many municipalities perceive that it affects the implementation of source separation and separate collection programs. As highlighted in section 3.3.1, source separation and separate collection have taken between two and seven years to achieve success in many Southeast Asia and Indian cities.

Thus, in the short- and mid-term, implementation and enforcement of source separation and separate collection begin in tier 1 cities in each country over the first years from 2020 to 2026, whereby the focus is a proof of concept and proven roll out levers for each country. As the funding gap will require time to be closed, waste collection coverage is gradually increased from the status quo in these cities in tandem with the source separation and separate collection programmes.

As the funding gap will require time to be closed, the scale up of waste collection to achieve 100% waste collection coverage along with some supporting source separation and separate collection programs are projected to have the greatest gains in the long-term (between 2027 and 2030).

Improved packaging design contributes more in the short- and mid-term:

As illustrated in section 2.3 of this report, across the six countries studied, an estimated 15% of PET bottles are coloured. Currently, these bottles are valued US$84/tonne less on average than clear PET. This leads to lower collection rates for coloured PET than clear PET and other challenges as listed in section 2.3. If all this PET were to become clear PET, this would lead to increased collection by the existing informal sector, even without any other supporting initiatives.

Other design challenges that limit the current collected-for-recycling rates are PVC sleeves that contaminate the recycling process due to the difficulty of separating PVC from PET after the flaking stage and poorly designed labels that are difficult to remove manually by informal sector workers. If these elements were to be redesigned, it would lead to better operational efficiencies, and consequently, better prices for post-consumer PET and higher collected-for-recycling rates. It is projected that fast short-term gains in the collected-for-recycling rate can be achieved based on large companies implementing improved packaging design (both phase out of coloured PET and phase out of PVC sleeves and any PVC in other packaging applications). This enables the existing informal sector workers to collect and sell more PET bottles than the status quo. In the mid-term, the small and medium-sized companies should also implement these standards, making it easier for the collection, sorting, and processing of PET bottles. In the long-term, since the improved design practices become status quo, further gains do not come from design alone. Key roles will be played by the industry-led PROs and national governments/municipalities as described in the previous sections.

The long-term role of packaging design is to ensure that packaging materials and design are consistently updated to match new developments in collection and recycling technologies, and thus minor further gains are projected for the long term (2027-2030).

Disclaimer

The facts set out in this report are obtained from sources which we believe to be reliable. However, we accept no legal liability of any kind for the publication of content, nor any information contained therein nor conclusions drawn by any party from it.

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For queries or requests please contact the research team via email at reports@gacircular.com

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About GA Circular

Established in 2011, GA Circular is a research and strategy advisory firm specialising in waste management and recycling. We envision a world without waste. We are based in Singapore and operate across Asia, specifically in Southeast Asia and Southwest Asia.

VALUE PROPOSITION

Proven Track Record

Our team has delivered projects throughout Asia and has more than 25 years of collective experience in the fields of waste management and recycling.

Research and Strategy Expertise

Our expertise lies in determining baseline material flow and value chain studies, policy evaluations, extended producer responsibility guidance, source separation pilots, waste audits, informal sector research, recycling technology feasibility, behaviour change campaigns and technical advisory for packaging recovery organisations (PROs).

Extensive Networks and Relationships Across Asia

Our networks and relationships extend across Asia, especially in Southeast Asia, with key stakeholders including: national and local government, packaging, consumer goods, petrochemical and recycling industries, industry coalitions, informal sector, recyclers, NGOs, multilateral institutions and academia.

Strong and Diverse Team

Our team's technical expertise in environmental engineering, economics, business and policy together with on-ground expertise in Asia make GA Circular a valuable partner in tackling the global challenges of packaging and food waste.

FIVE INTERLINKING SERVICES

Research and Data Analytics

Research and data analytics services include regional and local waste management landscape research, stakeholder mapping, material flow analysis, identifying existing value chain analysis, reviewing relevant local government regulations and global trends.

Strategy and Policy Advisory

Strategy and policy advisory services include development of business strategies and government policy frameworks for intervention and risk reduction plans in alignment with material flow analysis, waste composition studies, local requirements and regulations. Specific strategies or policies include packaging and food waste reduction, packaging and food recyclability, waste collection and recycling targets and key performance indicators, technology recommendations for recycling and financial investments required

Technical Assistance

Technical assistance services includes feasibility analysis, business model design and implementation of six months to a multi-year deployments for waste management and recycling infrastructure investments and extended producer responsibility (EPR) systems

Packaging Recovery Organisations

Packaging Recovery Organisation (PRO) services include workshops and strategy development (business model, roadmap and economics) for the formation of PROs in Southeast Asian countries and technical assistance in implementing value creation mechanisms for the value chain.

Stakeholder Engagement

Stakeholder engagement services includes designing stakeholder engagement and communications strategy for collection, recycling and other circular economy initiatives.

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