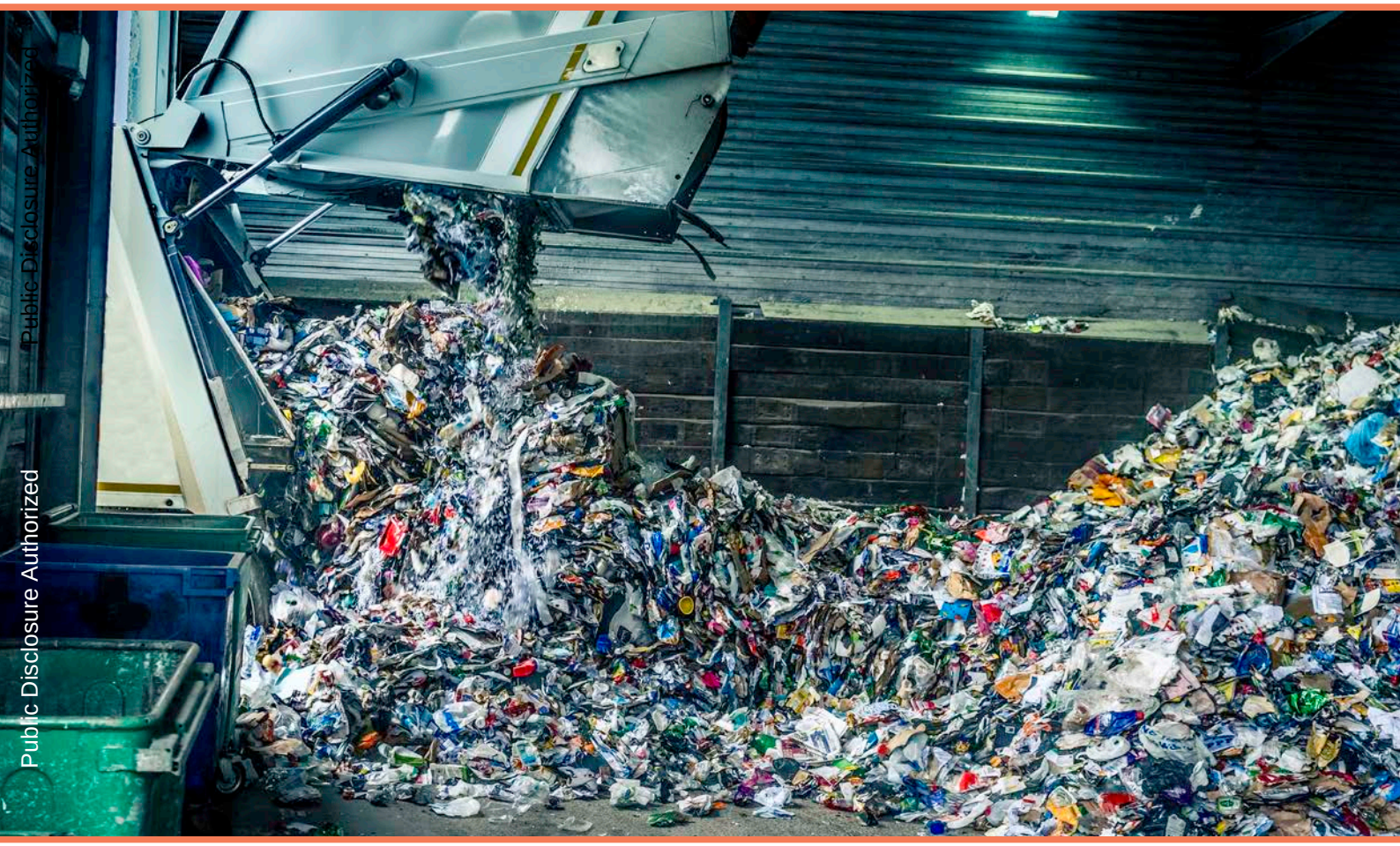
East Asia and Pacific Region: **MARINE PLASTICS SERIES**

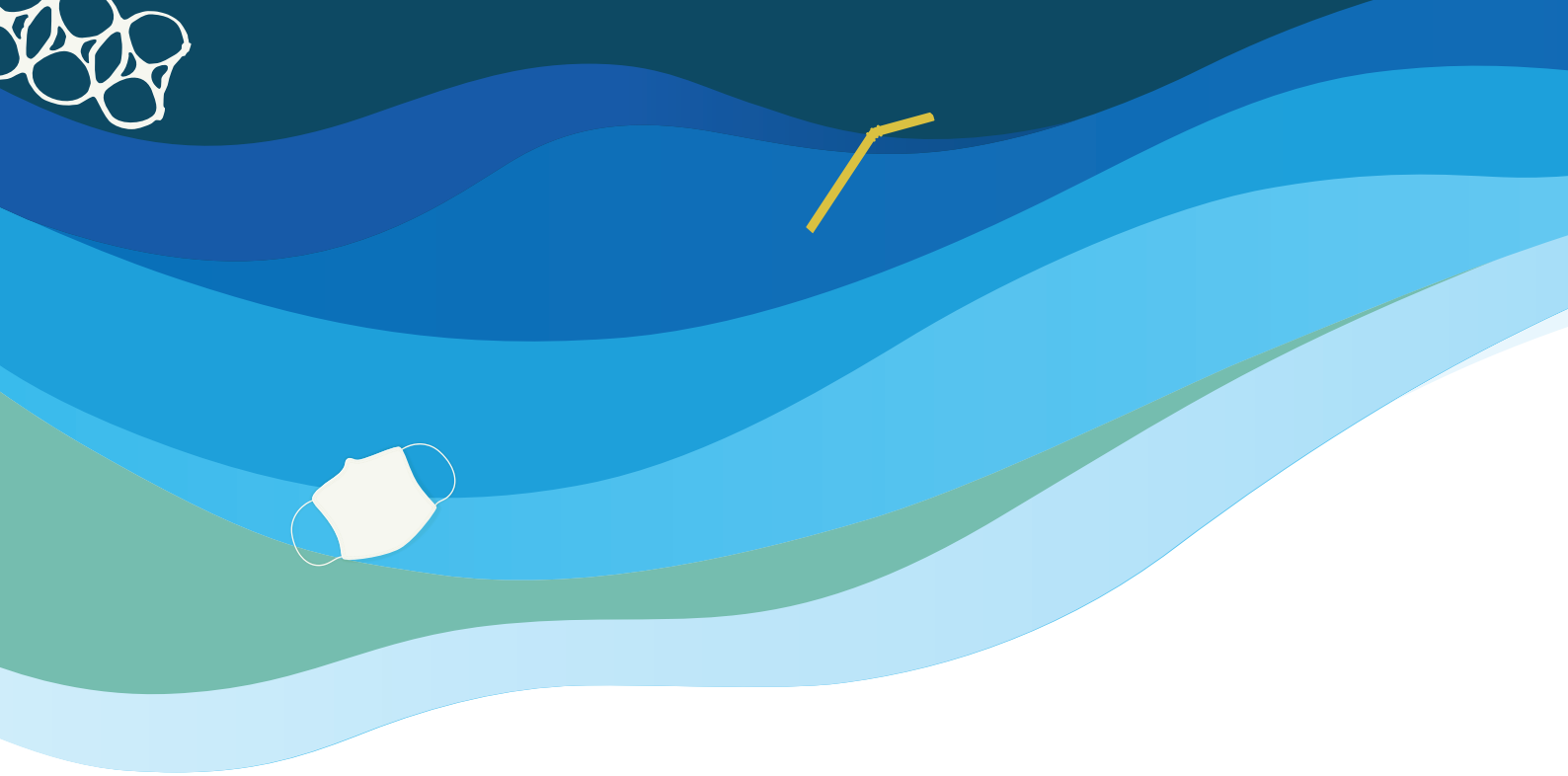
Market Study for Thailand:

PLASTICS CIRCULARITY OPPORTUNITIES AND BARRIERS



WORLD BANK GROUP
THE WORLD BANK IBRD • IDA
IFC International Finance Corporation

PROBLUE
Administered by THE WORLD BANK IBRD • IDA | WORLD BANK GROUP



1818 H Street NW, Washington, DC 20433
Telephone: 202-473-1000; Internet: www.worldbank.org

Citation

World Bank Group 2021. *Market Study for Thailand: Plastics Circularity Opportunities and Barriers.* Marine Plastics Series, East Asia and Pacific Region. Washington DC.

Rights and Permissions

Market Study for Thailand:

PLASTICS CIRCULARITY OPPORTUNITIES AND BARRIERS

WORLD BANK GROUP
THE WORLD BANK IBRD • IDA
IFC International Finance Corporation

PROBLUE
Administered by THE WORLD BANK IBRD • IDA | WORLD BANK GROUP

GA CIRCULAR

กรมควบคุมมลพิษ
POLLUTION CONTROL DEPARTMENT

CONTENTS

FIGURES

TABLES

BOXES

ACKNOWLEDGMENTS

Market Study for Thailand: Plastics Circularity Opportunities and Barriers is a private sector focused market assessment of plastics value chains and the recycling market in Thailand with the overall goal of identifying the opportunities and barriers for plastics circularity in the country.

The study was conducted by a team from GA Circular - Ashwin Subramaniam, Laura Allen, Sumangali Krishnan, Amirul Adli, Pornchalearm Deejai, Joshua Tan and Le Xiang Poh. The work was managed by a World Bank Group team comprised of Waraporn Hirunwatsiri, Navneet Chadha, Anjali Acharya, Kate Philp, Rattanyu Dechjejaruwat, Piyarat Kittiwat, and Poonyanuch Chockanapitaksa, under the leadership and guidance of Birgit Hansl and Mona Sur. Delphine Arri, Tuyen D. Nguyen and Etienne Raffi Kechichian provided peer review. Cover and report design undertaken by creative designer Sarah Hollis.

The study team would like to thank all the private and public sector stakeholders who participated during the study, with special acknowledgement to the Plastics Institute of Thailand and the Thailand Public Private Partnership for Plastic and Waste Management (PPP Plastic) for their support. The study has been enabled and supported by the Ministry of Natural Resources and Environment, Thailand.

Funding for this study was provided by PROBLUE, an umbrella multi donor trust fund, housed at the World Bank, that supports the sustainable and integrated development of marine and coastal resources in healthy oceans.

Contributing Organizations

We are very grateful for the contributions, inputs and detailed insights provided by the below private sector organizations and government departments during the course of this study:

Private Sector Organizations (in alphabetical order)

- BASF
- Best Polymer
- Billion Enterprise
- Dow Chemicals
- EcoBlue Limited
- Envicco Ltd
- GEPP Sa-Ard.
- Indorama Ventures
- Interface
- Lidl Group
- PTT Global Chemical PLC
- PTT MCC Biochem
- SCG Group
- Semsuk PLC
- Siam City Cement / INSEE Cement (Ecocycle)
- Suez
- Teijin Polyester
- Thai Bev
- Thai Beverage Recycle
- Thailand PPP Plastic
- Thai Retailers Association
- Union J Plus
- Unilever
- Watsons
- Wongpanit Group
- Zing Whor Thai

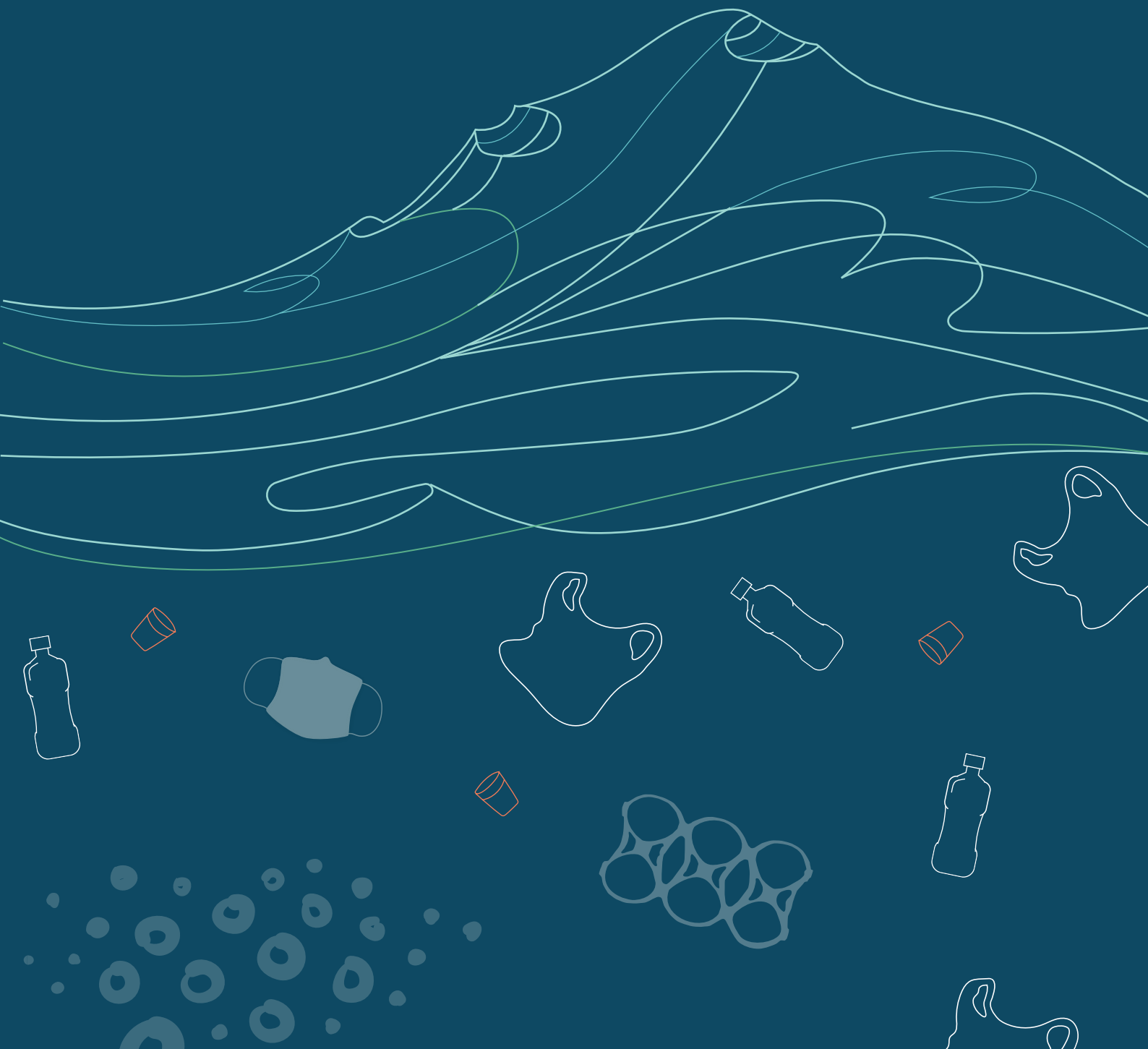
Government Departments & Other Stakeholders (in alphabetical order)

- Customs Department
- Department of Foreign Trade
- Department of Industrial Works
- Department of Local Administration
- Department of Marine and Coastal Resources
- Food and Drug Administration
- IUCN
- Mae Fah Luang University
- Ministry of Interior
- Ministry of Natural Resources & Environment
- Office of NESDEC
- Plastics Institute of Thailand
- Pollution Control Department
- Rayong Provincial Office
- Thailand Industrial Standards Institute
- Tourism Authority of Thailand
- UN Environment
- UN Global Compact Network
- University of Thai Chamber of Commerce

ABBREVIATIONS AND ACRONYMS

BMA	Bangkok Metropolitan Agency
BOI	Board of Investment
CFR	Collected For Recycling
EHS	Environmental, Health and Safety
EPR	Extended Producer Responsibility
HDPE; rHDPE	High Density Polyethylene; Recycled High Density Polyethylene
ISWM	Integrated Solid Waste Management
LLDPE; rLLDPE	Linear Low Density Polyethylene; Recycled Linear Low Density Polyethylene
LDPE; rLDPE	Low Density Polyethylene; Recycled Low Density Polyethylene
MFA	Materials Flow Analysis
MRF	Material Recovery Facility
MSW	Municipal Solid Waste
MVRP	Most Valuable Recycled Product
OPEX	Operational Expenditure
PBAT	Poly Butylene Adipate Terephthalate
PBS	Poly Butylene Succinate
PCD	Pollution Control Department, Thailand
PET; rPET	Polyethylene Terephthalate; Recycled Polyethylene Terephthalate
PHA	Poly Hydroxy Alkanoates
PIT	Plastics Institute of Thailand
PLA	Poly Lactic Acid
POY	Partially Oriented Yarn
PRO	Producer Responsibility Organization
PP; rPP	Polypropylene; Recycled Polypropylene
PS	Polystyrene
PSF	Polyester Staple Fiber
PTT	Thai state-owned, SET-listed petrochemicals company
PTT	Poly Trimethylene Terephthalate
PVC	Polyvinyl Chloride
RDF	Refuse Derived Fuel
SCG	Siam Cement Group or its subsidiaries
SWM	Solid Waste Management
TPD	Tonnes Per Day
TPC - ET	Thermoplastic Polyester Elastomers
TPM	Tonnes Per Month
TPY	Tonnes Per Year

EXECUTIVE SUMMARY



EXECUTIVE SUMMARY

Plastics are an integral and important part of the global and Thai economies. Since the 1950s the use of plastic products has expanded twenty-fold owing to their low cost, various functional properties, durability and wide range of applications. In 2018, global plastics production reached 360 million tonnes. Plastics are commonly used in a wide range of industries including packaging, consumer goods, electronics, automotive and aviation manufacturing, textiles and agriculture. Thailand's petrochemical sector is the largest in the Southeast Asian region and the 16th largest in the world. In 2018, Thailand produced 11.8 million tonnes of downstream petrochemical products, including plastic resins. Thailand's plastics industry contributed 1,100 billion baht (USD 36.9 billion) to the national economy in 2018, representing 6.71% of Thailand's GDP.

Mismanaged plastic waste has growing economic and environmental consequences.

Mismanaged plastic waste from land-based sources, especially in the form of packaging, generates significant economic costs globally and in Thailand by reducing the productivity of vital natural systems and clogging urban infrastructure. 8 to 12 million tonnes of plastics leak into the world's oceans each year. Asia is responsible for over 80% of marine leakage and 8 of the top 10 contributing countries are from this region, with Thailand ranking number 6. Globally, the cost of such after-use externalities for plastic packaging, plus the cost associated with greenhouse gas emissions from its production, is conservatively estimated at USD 40 billion annually — exceeding the plastic packaging industry's profit pool. USD 80-120 billion worth of plastic packaging is lost from the global economy each year due to lack of recycling or suboptimal value creation where recycling does exist. All this has led to increased global awareness towards plastic waste management, elevating the topic of plastic pollution into the mainstream consumer consciousness in Thailand.

Thailand is taking regional leadership and setting ambitious national goals.

In 2019, Thailand ratified two landmark ASEAN-level agreements, committing to protect the marine environment and strengthen regional cooperation in addressing marine debris issues: the Bangkok Declaration on Combating Marine Debris and the ASEAN Framework of Action on Marine Debris. On 17th April 2019, the Thai government acknowledged the National Roadmap on Plastic Waste Management 2018-2030 as a policy framework to manage the plastic waste problem in Thailand. Major private companies in Thailand are also taking the lead on plastics circularity based on the principles of wise use of natural resources, reusing and recycling.

There is a need for a private sector focused market assessment of plastics circularity in Thailand.

To successfully implement its ambitious sustainable plastic waste management goals, the Government of Thailand encourages private sector participation and support in its efforts. Much of the nation's recycling occurs separate from the solid waste management (SWM) system via upstream diversion by the informal sector

KEY FINDINGS

Thailand recycled about **17.6% of the key plastic resins** in 2018. This falls short of the National Plastic Waste Management Roadmap 2018-2030 target of 22% for 2018.

2.88 million tonnes per year of plastics are disposed of (i.e not recycled) and 87% of the material value of plastics is lost.

Several structural challenges cause a market failure for plastics recycling leading to a plastic material value loss of **USD 3.6-4.0 billion/year**.

(e.g. pickers, collectors, junk shops and aggregators) leading to a parallel economy for recyclables collection. Therefore, in line with the terms of reference for the study, this report will define the current state-of-play for the local waste plastics recycling industry, including demand and supply volumes, market opportunity, and growth drivers and constraints. An evaluation of SWM infrastructure and its costs, while a relevant parallel study, is not within the scope of this study. Where available, secondary research on the informal sector is used to identify its role in recyclables collection and to address challenges. This study also identifies the major private sector players in the Thai plastics value chain and outlines the market drivers and challenges in scaling-up recycling. It also recommends priority actions for the government and private sector stakeholders to increase plastics recycling in order to mitigate the growing environmental challenges of mismanaged plastic waste and unlock new economic growth opportunities for Thailand.

The focus of this report is on the recycling aspect of the circular economy for plastics, as a lever to divert plastic wastes away from landfills and the open environment and increase the re-introduction of plastics into the industrial system. This study focuses on identifying scalable private sector investment solutions, primarily in plastic recycling. Reduction at source and refill / reuse aspects of the circular economy for plastics are not included in the scope.

A detailed mapping of plastic value chains for Polyethylene Terephthalate (PET), High Density Poly Ethylene (HDPE), Low-density polyethylene (LDPE), and Polypropylene (PP) resins in Thailand reveals that interest in domestic recycling is increasing, demand for recycled plastic is growing and more investments are being made to add or upgrade recycling facilities. This is in line with a global 2020 petrochemicals industry assessment by S&P Global Platts, which shows that despite unfavorable economics, global recycled plastics volumes reached nearly 20 million tons in 2020, or 8% of total virgin demand. This is up from just under 18 million tons in 2019, or 7% of total virgin demand. Among resin producers, some integration between resin manufacturing and recycling businesses already exists in Thailand, however equal opportunities are not available to all private sector recyclers and more needs to be done to eliminate the demand vs supply gap for recycled resins.

A case in point is in the packaging industry. Given that packaging is the largest end-use industry for plastics worldwide and in Thailand, global commitments by leading brand owners to increase recycled content usage in their packaging has spurred demand for food-grade recycled resins, which command high margins amongst recycled products. However, most suppliers of recycled resins in Thailand are small to medium enterprises who are challenged by a lack of scale, management systems, process technologies

and informal supply networks that work on cash terms and are not integrated. Additionally, competition from the low cost of virgin plastics — which do not reflect the full extent of negative post-consumer use externalities — restrictions on the usage of recycled resins in food-contact applications, contaminated feedstock and lack of design for recycling standards prevents recyclers from being able to capitalize on a local market and maximize their margins. Only recyclers whose businesses are well-integrated with virgin resin production can best maximize this growing global demand by exporting food-contact resins.

Therefore, addressing this gap in demand from large brand owners and supply from stand-alone, small and medium-sized suppliers will require various measures including: support in reducing capital investment risk, short-term demand-side incentives to establish a steady secondary market for recycled plastics, sharing of know-how, best-in-class innovations, technologies and processes, and creating an environment for recycled plastics that boosts local demand and unlocks market value. These measures would be a turning point in enabling equal opportunities and the growth of a resilient plastics recycling industry in Thailand with high-quality outputs, highly retained material value and the ability to replace primary materials one-to-one.

Detailed baseline data collection, analytical work and engagement with private sector stakeholders across the plastics value chain, government stakeholders and other experts in Thailand, revealed three key quantitative findings and six recommended interventions along with 27 priority actions to accelerate plastics circularity in Thailand.

Three Key Findings on CFR Rates and Material Value Loss:

1 Thailand recycled about 17.6% of the key plastic resins in 2018. This falls short of the National Plastic Waste Management Roadmap 2018-2030 target of 22% for 2018.

3.49 million tonnes per year (TPY) of the key resins assessed in this study, Polyethylene Terephthalate (PET), Polyethylene (both HDPE and LDPE) and Polypropylene (PP), are consumed in Thailand (see Figure 1). Of this, 616,000 TPY (17.6%) are recycled. PET packaging has the highest collection for recycling rates of all four resins. This is because the number of end-uses for PET packaging is limited compared to other resins, which simplifies the collection process. Collectors can easily identify PET packaging, which is primarily used for food and beverage products (e.g. PET bottles). On the other hand, PE and PP are used for a wide range of applications such as electronics, automotive and construction, and this complicates the collection process. The technology and relatively high capacities for processing PET packaging into various applications, as well as the demand from global end-use markets for recycled PET, including some high-end applications, already exists in Thailand (although the recycling capacities are still lower than optimal). This gives PET packaging recycling a "head start" when compared to the recycling for other resins. Some of the recycled products from PET, such as rPSF and rPOY, can be readily

Figure 1.
ESTIMATED CFR RATES FOR EACH RESIN AS OF 2018

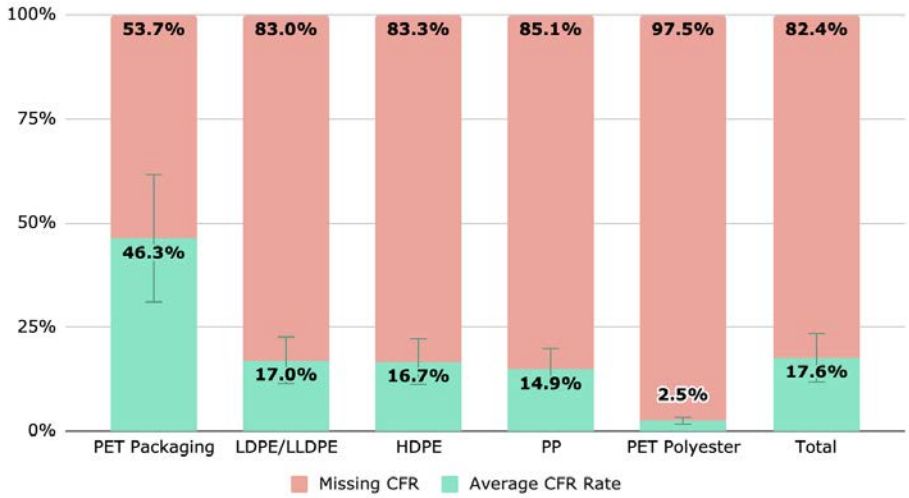
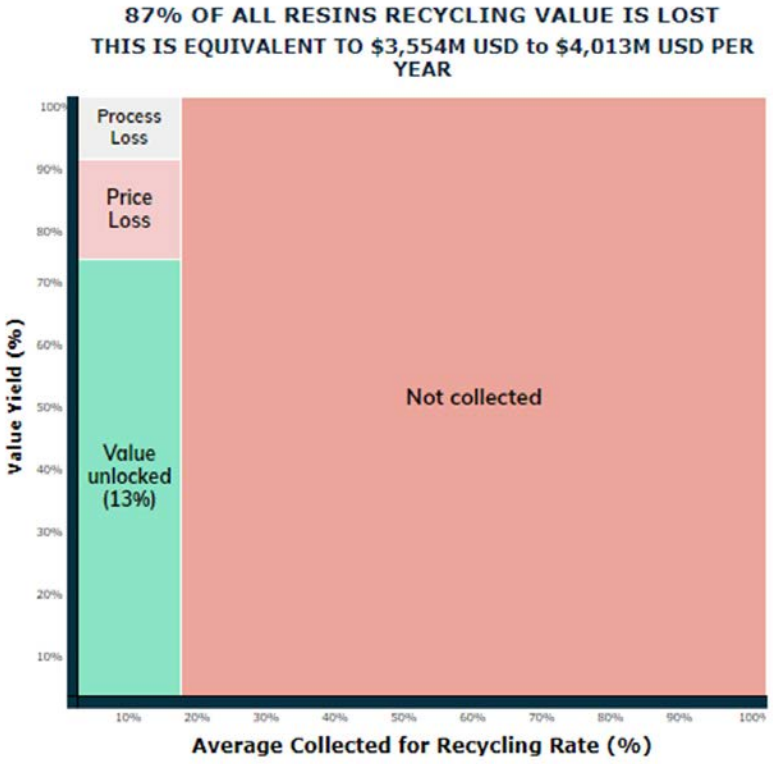


Figure 2.
MATERIAL VALUE LOSS ANALYSIS FOR ALL KEY RESINS (PET, PP, HDPE AND LDPE/LLDPE)



Data based on 2018 volumes.

absorbed by the fiber industry in Thailand, thus rPET is well-integrated within the industrial ecosystem.

2 2.88 million tonnes per year of plastics are disposed of (i.e not recycled) and 87% of the material value of plastics is lost.

If all the resins in Thailand covered in this study were to be recycled into the most valuable recycled products, the total material value that could be unlocked from recycling would equal USD 4.3 billion / year. However, due to a 17.6% recycling rate and a value yield of 73.6% for the resins which are recycled, only 13.0% of the total material value of plastics or USD 564 million / year is unlocked, as shown in Figure 2. This results in USD 3.6-4.0 billion / year of material value from recycling being lost to the Thai economy. This value represents the addressable market opportunity for plastics circularity for Thailand.

3 Several structural challenges cause a market failure for plastics recycling leading to a plastic material value loss of USD 3.6-4.0 billion/year.

This loss of USD 3.6-4.0 billion / year is a result of various structural challenges that impact the recycling rate and value yield ranging from a lack of Extended Producer Responsibility (EPR) framework for various industries that consume plastics, lack of local demand for recycled plastics, linear municipal waste systems that prioritize collection over recycling and different sets of fiscal benefits and incentives for the recycling industry compared to the virgin plastics industry. Other factors that exacerbate the market failure for plastics recycling include the full exposure of the recycling industry to oil and virgin plastic price drops, inability to capitalize on growing demand for food-grade recycled products, import restrictions on high-quality, recyclable scrap plastics, and the lack of internalization of the costs of plastic waste mismanagement among plastic producers. These challenges have been exposed and

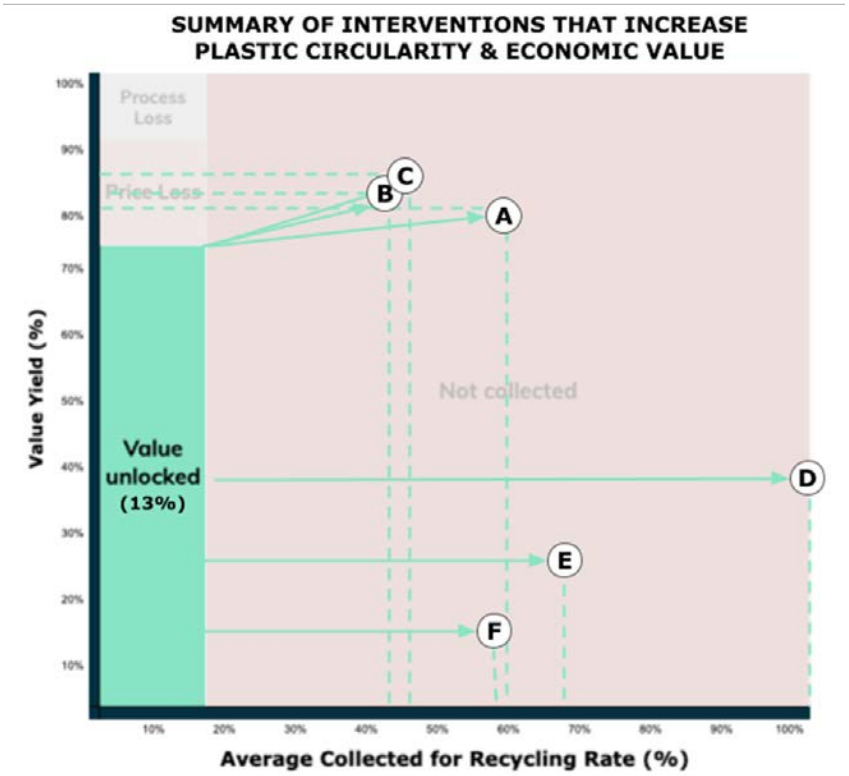
amplified due to the ongoing COVID-19 pandemic — changes in consumption patterns have led to supply reductions in the recycling industry and low oil prices and economic slowdown have resulted in a significant drop in demand for recycled products.

A margin analysis on recycling each type of resin would shed light on additional benefits that activities or incentives in the plastics value chain would bring compared to the additional costs incurred by those same activities or incentives. However, such a margin analysis was beyond the scope of this study and is recommended to be done on a case-by-case basis as part of in-depth, pre-feasibility studies by investors in the waste management or recycling sectors to promote an enabling market. Such analyzes would be particularly relevant to addressing the very low collection-for-recycling rates, especially for non-PET — which is the main driver for unlocking value — and, from a business-case perspective, would show the net value accounting for costs and reasonable profit margin.

RECOMMENDED INTERVENTIONS AND PRIORITY ACTIONS

This study identifies 6 recommended interventions and 27 cross-cutting actions to enable Thailand to increase its recycling rates up to 100% (from 17.6%) in line with the National Roadmap on Plastic Waste Management 2018-2030. These interventions could also enable Thailand to increase the value yield of plastics recycling up to 86% (from 73.6%) and unlock maximum material value from recycling plastics (Figure 3). Each of the recommended interventions for the government and private sectors have the potential to unlock material value between USD 1.1-2.6 billion / year. These interventions could lay the foundation for plastics circularity, strengthen demand for recycled plastics and build a resilient recycling industry in Thailand.

Figure 3.
SUMMARY OF RECOMMENDED INTERVENTIONS AND THEIR IMPACT ON INCREASING CFR RATE AND VALUE YIELDS



These 6 recommended interventions are:

- **A.** Increase waste collection and sorting efficiency of post-consumer plastics
- **B.** Set recycled content targets across all major end-use applications
- **C.** Mandate "design for recycling" standards for plastics
- **D.** Encourage increase in recycling capacities (mechanical and chemical)
- **E.** Create industry-specific requirements to increase plastic waste collection and recycling rates
- **F.** Restrict disposal of plastics & illegal dumping

The study team — in consideration of stakeholder feedback pertaining to the practicality of implementation in the next 1-5 years time frame, potential to comprehensively support growth of plastics recycling and unlock material value — identified 8 priority actions (see Figure 4).

Figure 4.
SUMMARY OF RECOMMENDED INTERVENTIONS AND PRIORITY ACTIONS

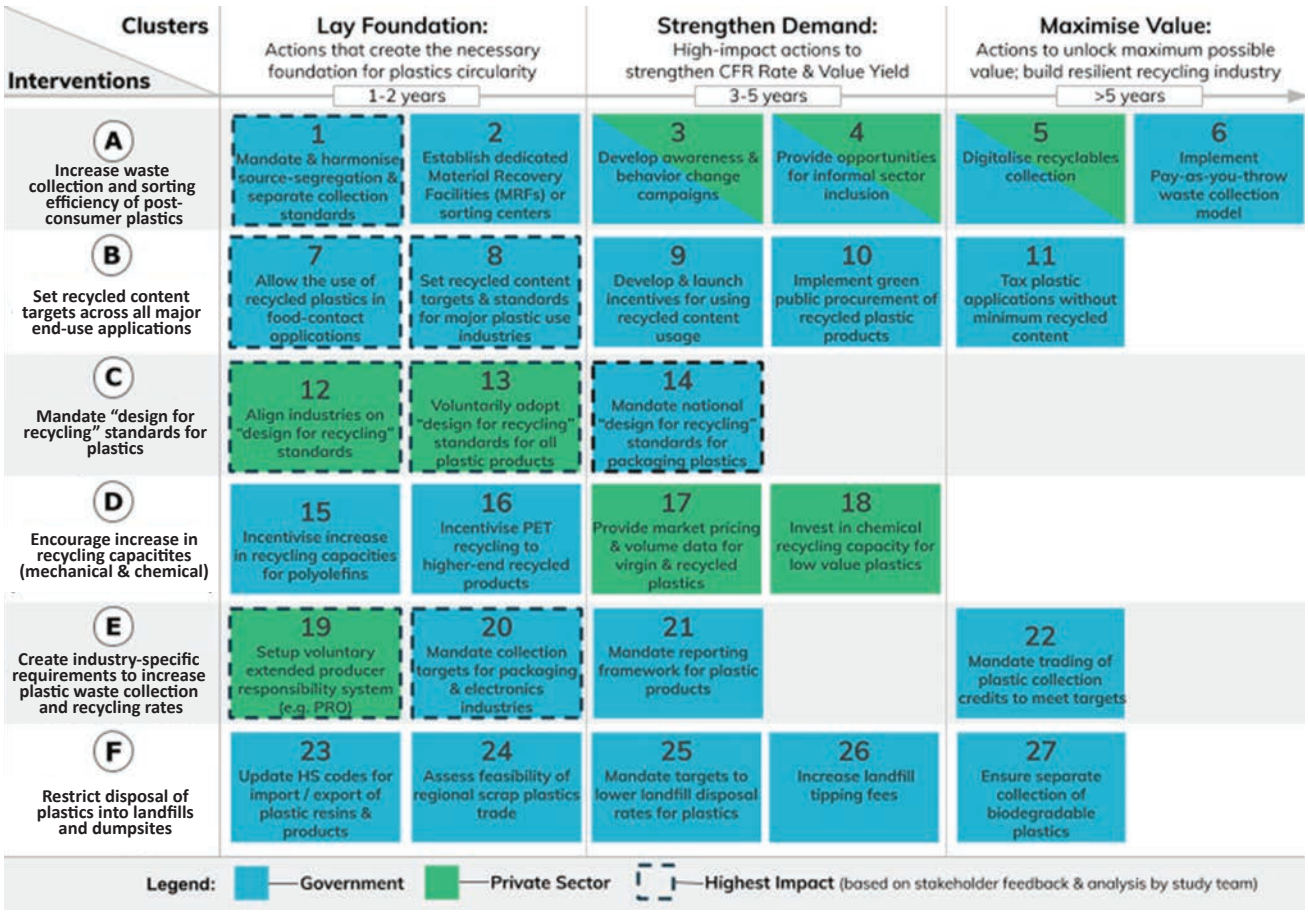
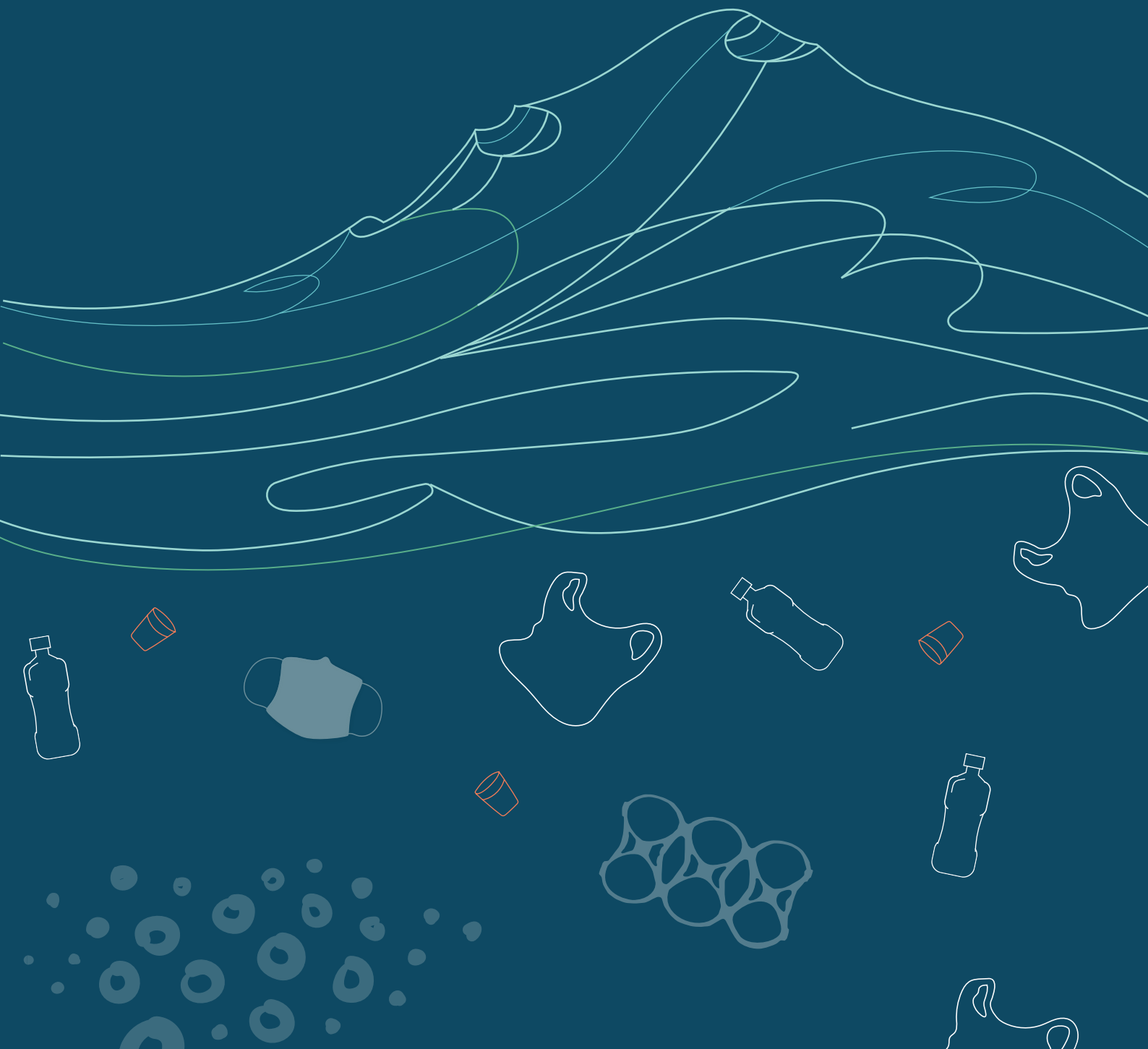


Photo: Chanchai Phetdikhai / Shutterstock

SECTION 1:

WHY PLASTICS CIRCULARITY IS NEEDED



SECTION 1:

WHY PLASTICS CIRCULARITY IS NEEDED

1.1 PROJECT BACKGROUND

A world without plastics would be unimaginable today. In the 1950s, plastic materials were born as a solution for the substitution of scarce and expensive resources and in the past half-century their use has expanded twenty-fold owing to their low cost, various functional properties, durability and wide range of applications. In 2018, global plastics production almost reached 360 million tonnes.[1] Today, plastics are commonly used in a wide range of industries including packaging, consumer goods, electronics, automotive and aviation manufacturing, textiles and agriculture.

The petrochemical industry began in Thailand with the first petrochemical investment wave in the 1980s. A relatively large domestic demand enabled the industry to capitalize on economies of scale and growth. Currently Thailand is in its third petrochemical wave (2004-present) during which it has seen a focus on increased competitiveness, asset integration and strategic alliances. It has also seen companies focus on the growing demand for diversified intermediate and downstream petrochemical products including plastic resins.

In 2018, the Thai petrochemical sector had a total production capacity of 33.3 million tonnes, making it the largest in the Southeast Asian region and the 16th largest in the world. Output was divided between upstream products (12.4 million tonnes), intermediate products (7.7 million tonnes), downstream products which included plastics resins (11.8 million tonnes) and other chemicals (1.4 million tonnes).[2] In the same year, plastic resins exported by Thailand grew by 8.1% and plastics products exported grew by 3.0%. Thailand's plastics industry also contributed 1,100 billion baht (USD 36.9 billion) to the national economy in 2018, representing 6.71% of Thailand's GDP.[3]

The growth of the plastics industry worldwide and in Thailand has brought wide ranging benefits to society. However rapid urbanization and mismanaged plastic waste and litter from land-based sources generates significant economic costs by reducing the productivity of vital natural systems such as the ocean and clogging urban infrastructure. Globally, the cost of such after-use externalities for plastic packaging, plus the cost associated with greenhouse gas emissions from its production, is conservatively estimated at USD 40 billion annually — exceeding the plastic packaging industry's profit pool.[4]

1 Plastics – the Facts 2019
2 Petroleum Institute of Thailand (2018 Thailand Petroleum and Petrochemical Complex Capacity)
3 Plastics Institute of Thailand and Plastics Intelligence Center
4 Ellen Macarthur Foundation New Plastics Economy: Rethinking the Future of Plastics (2016)

Specifically, for plastic packaging, 95% of material value, or USD 80–120 billion annually, is lost to the global economy after single use.[5] Single-use or short-use consumer packaging contributes around 40-50% of marine plastic pollution. Approximately 5 to 13 million tonnes of plastic waste enter the oceans every year and there could be about 250 million tonnes of plastics in the world's oceans in less than 10 years.[6] Several countries in East Asia and Pacific are top generators of mismanaged plastic waste with disproportionate impacts on livelihoods of vulnerable coastal communities and tourism, fishing and shipping industries. In particular, Thailand is estimated to be in the top 6 countries globally contributing to marine plastic pollution[7] and, as the chair of ASEAN in 2019, led and prioritized actions to combat marine plastics and continues to do so.

To address this challenge, Thailand took leadership in 2019 that resulted in the ratification of two landmark ASEAN-level agreements committing to protect the marine environment and strengthen regional cooperation in addressing marine debris issues – the Bangkok Declaration on Combating Marine Debris and the ASEAN Framework of Action on Marine Debris. On 17th April 2019, the Thai government acknowledged the National Roadmap on Plastic Waste Management 2018-2030 for use as a policy framework to deal with the plastic waste problem in Thailand (details of the national roadmap can be found in the appendix). The objective of the roadmap is to reduce and stop the use of plastic and replace it with environmentally friendly materials. Major private companies in Thailand are also taking the lead on plastics circularity based on the principles of wise use of natural resources, reusing and recycling. Several countries in the region, including Thailand, have also banned imports of plastic scrap from other countries.

To successfully implement its ambitious sustainable plastic management goals, the Government of Thailand encourages private sector participation and support in its efforts. The private sector can lead the transition from current take-make-waste linear models to circular economy approaches in collaboration with the public sector and other stakeholders. Private sector actors are well equipped to close material loops and drive plastics circularity through innovations in product design, business models, recycling technologies and project financing under an enabling business environment. Many leading global brands and multinational retailers using plastics have already made voluntary public commitments to transition to fully reusable, recyclable or compostable packaging by 2025. Upstream petrochemical companies manufacturing plastics are also investing in recycling companies and substituting virgin plastics with recycled materials to respond to this new market demand while reducing energy consumption and avoiding greenhouse gas emissions.

This study is a private sector focused market assessment of plastics value chains and the recycling market in Thailand with the overall goal of identifying the opportunities and barriers for plastics circularity in the country. The recommended interventions and actions to increase plastics circularity in Thailand will also support the National Roadmap on Plastic Waste Management 2018-2030. More specifically, it can help achieve target #2 of the road map which calls for "100% plastic waste to Circular Economy" by 2027 through providing a series of tools for the private sector and government to implement to achieve the target.

1.2 PROJECT OBJECTIVES

The primary objectives of this study are to:

1. Engage with the private sector players in the Thai plastics value chain and understand the market drivers and challenges in scaling up circular economy approaches.
2. Define the current state-of-play for the local waste plastics recycling industry, including demand and supply volumes, market opportunity, and growth drivers and constraints and.
3. Review local regulations and benchmark with applicable best practices to identify opportunities as well as gaps that could be limiting broader adoption of plastics circularity.
4. Summarize key findings based on the private-sector focused plastics value chain and recycling market analysis and recommend priority actions.

5 Ellen Macarthur Foundation New Plastics Economy: Rethinking the Future of Plastics (2016)

6 Jenna Jambeck, "Plastic waste inputs from land into the ocean"

7 Jenna Jambeck, "Plastic waste inputs from land into the ocean"

1.3 FRAMING THE OBJECTIVES

For the purposes of this study, the project objectives have been framed into 5 main problem statements, each of which are explored in the following sections in this study:

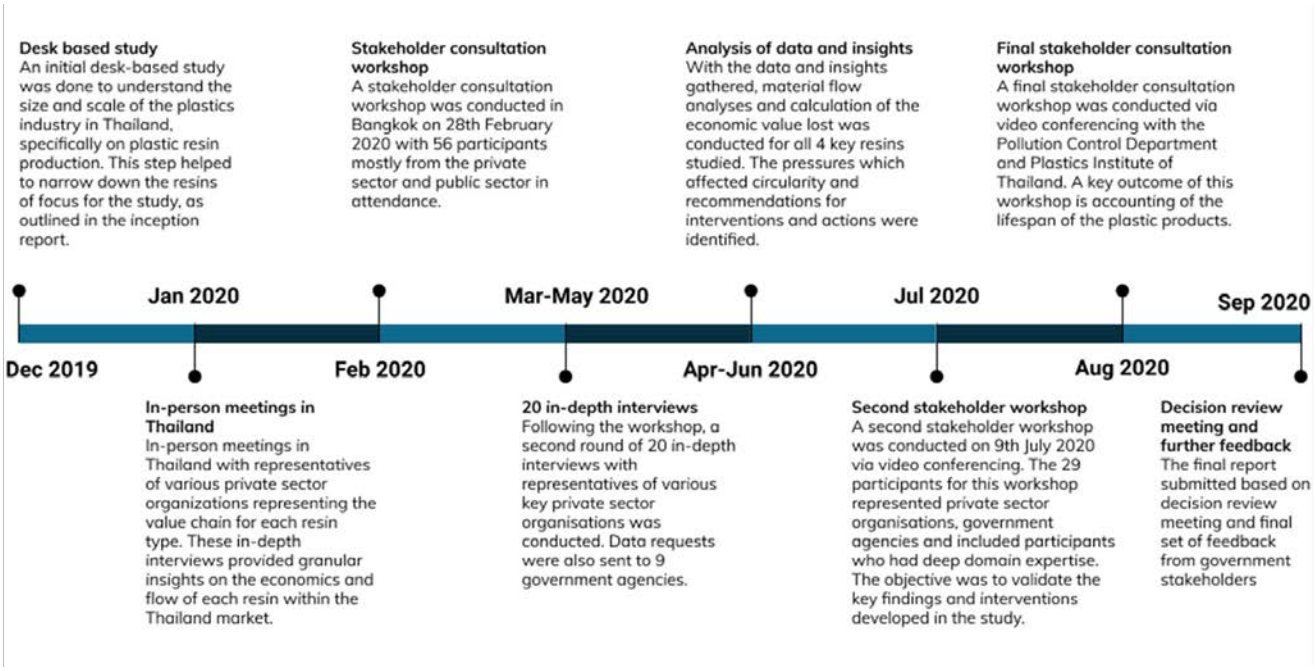
1. What is plastics circularity in the context of Thailand? This is addressed in Sections 1.4, 1.5 and 1.6.
2. What is the existing plastics value chain in Thailand across production, collection, recycling, wastage, imports and exports in Thailand? This is addressed in Section 2.
3. What are the factors and barriers affecting plastics recovery or recycling across the value chains for different resins and the size of the addressable opportunity? This is addressed in Sections 2 and 3.
4. What are the existing policies and regulatory environments impacting plastics circularity in Thailand? This is addressed in Section 3.
5. What are the policy and private sector interventions needed to enable plastics recycling in Thailand and how much material value can be unlocked through these interventions? This is addressed in Section 4.

1.4 METHODOLOGY OF STUDY

This study was conducted from January 2020 to August 2020 and followed the framework outlined in the terms of reference document, technical proposal and the inception report. Several additional sources of information, not specifically outlined in the terms of reference, were also gathered and used to inform various sections of the study. The study team also attempted to go beyond the scope outlined in the technical proposal to give further insights and granularity. For example, 26 private sector stakeholders across all the plastic value chain categories were contacted during the course of this study, well beyond the expected engagements at the onset of the study. See Figure 5 for an overview of the stages of this study.

First, a desk-based study was done to understand the size and scale of the plastics industry in Thailand, specifically on plastic resin production. This included reviewing publicly available reports and presentations by Plastics Institute of Thailand, annual reports / sustainability reports of major petrochemical and resin manufacturing companies and plastic convertors in Thailand. This step helped to narrow down the resins of focus for the study, as outlined in the inception report. Based on this, a further value chain of each resin was also determined.

Figure 5.
TIMELINE OF STUDY (NOT TO SCALE)



Second, a series of in-person interviews were held in Thailand with representatives of various private sector organizations representing the value chain for each resin type. These in-depth interviews provided granular insights on the economics and flow of each resin within the Thailand market and assisted in the identification of the major private sector companies across the value chains. Taken together these first two steps enabled the research team to create the first version of the material flow analysis (MFA) and preliminary insights on each resin type, which was then further used to inform different aspects of the study.

Third, a stakeholder consultation workshop was conducted in Bangkok on 28th February 2020 with 56 participants from the private sector including PTTGC, SCG, Indorama, Thailand PPP Plastics, Federation of Thai Industries (FTI), public sector including key national-level departments under Ministry of Natural Resources and Environment (Pollution Control Department, Department of Marine and Coastal Resources), Ministry of Industry (Plastics Institute of Thailand, Department of Industrial Works), Ministry of Interior (Department of Local Administration), Ministry of Finance (Department of Customs), provincial-level departments (Rayong Provincial Office), environmental think tanks (Thailand Environment Institute), international development partners (UN Environment) and academia. The preliminary material flow analysis and insights were presented for feedback and moderated breakout sessions were conducted during the workshop to provide insights in a group setting. See appendices for the list of participants for this stakeholder consultation workshop.

Fourth, following the workshop, a second round of 20 in-depth interviews with representatives of various key private sector organizations was conducted. This included several companies which were not in the first round of interviews and some companies which were not present in the first workshop. During this second round, 3 in-depth interviews were also conducted with policy experts from the EU and Thailand to inform the enabling environment section of this study.

Fifth, with the insights gathered through the above steps, the study entered a critical period of further data collection and analysis. A series of data requests was sent to 9 government agencies and departments in Thailand. As several government agencies and departments own the necessary data sets, often with an overlap in ownership, a wide net was cast to access these data sets.

Photo: Inside Creative House / Shutterstock

This study focuses on understanding the material value plastic recycling currently generates, the further economic potential from the private side that it could generate, and ways to mandate or encourage the use of recycled plastics by producers.

This study focuses on understanding the material value plastic recycling currently generates, the further economic potential from the private side that it could generate, and ways to mandate or encourage the use of recycled plastics by producers. In the context of solid waste management (SWM) in developing countries in Southeast Asia, plastic waste management is seen as the responsibility of all stakeholders, not just that of the local government units or municipalities that manage waste.

In an optimal municipal SWM system, the infrastructure of SWM, its operational costs and the positive impact from the diversion of plastics for recycling would be interconnected. In Thailand however, much of the recycling happens separate from the SWM system via upstream diversion directly by the informal sector (e.g. pickers, collectors junk shops and aggregators) leading to a parallel economy for recyclables collection. Any valuable plastics that remain in the SWM stream are picked out (informally) at various points of SWM flow, such as from trucks, transfer stations and dumpsites. Therefore, in line with the terms of reference of the study,

this study attempts to define the current state-of-play for the local waste plastics recycling industry, including demand and supply volumes, market opportunity, and growth drivers and constraints. An evaluation of SWM infrastructure and its costs, while a relevant parallel study, is therefore not within the scope of this study. Where available, secondary research on the informal sector has been used to identify their role in recyclables collection and to address challenges in order to recognize and better integrate the informal sector. While a basic assessment of the SWM costs in Bangkok was carried out as part of this study, a systematic assessment of national-level SWM infrastructure, operational costs of SWM and identifying the linkages between informal sector and SWM was out of scope of this study as outlined above.

With the data and insights gathered, an updated MFA was generated for each resin type studied. The methodology used to calculate the MFAs involves calculations using a mix of data gathered from private sector stakeholder interviews, government datasets and the public domain. For the resin production and import / export data, this study used data from the Plastics Institute of Thailand (PIT). For the breakdown in plastics usage, data from the PIT and other industry stakeholders was used. For the collected-for-recycling rates, data from the private sector stakeholders and the Pollution Control Department (PCD) was used as reference. The MFA for each resin, together with resin price data, was then used to analyze the economic impact of recycling in terms of value unlocked and the potential value that could be unlocked. A detailed explanation of both the tools — the MFA and the Material Value Loss Analysis, is provided in Section 2.1 of this report.

It must be noted that the PCD, with Thailand PPP Plastic and Chulalongkorn University as the implementation partners, carried out an MFA exercise in 2019 that specifically focused only on 8 specific single-use plastic products. The MFA conducted under this study has a fundamentally different objective and approach to the one by the PCD. This makes methodological comparisons between the two MFA inconsequential. Please refer to the appendices for a full breakdown of the methodological differences.

All data used in the MFA as part of this study are for 2018 as it was the latest complete data set available as of early 2020. Hence, it does not reflect the significant changes in the recycling landscape due to COVID-19. Also, as factoring in of the import and export data of final products made from PET Packaging, PP, HDPE and LDPE was out of scope of this study, this data is not included in the MFA.

The economic analyzes on plastics recycling carried out under this study are not meant to be a margin analysis for recycling each type of resin. A margin analysis (which was out of scope of this study) on recycling each type of resin would shed light on additional benefits that activities or incentives in the plastics value chain would bring compared to the additional costs incurred by those same activities or incentives. Such an analysis would be particularly relevant to addressing the very low collection-for-recycling rates, especially for non-PET — which is the main driver for unlocking value — and, from a business-case perspective, would show the net value accounting for costs and reasonable profit margin. Recyclers engaged during this study were reluctant to share price-sensitive information or detailed operational costs. Due to the different levels of upstream and downstream integration among recyclers, each recycling business unit is expected to have different margins depending on their business model, and this forbids modeling for estimations of margins. The study team recommends any margin analysis to be done on a case-by-case basis as part of in-depth, pre-feasibility studies by investors in the waste management or recycling sectors to promote an enabling market.

Also, the COVID-19 pandemic has caused severe setbacks to the ongoing global movement to tackle plastic waste, with recyclers across several countries, including Thailand, showing on average a 50% drop in demand for their products, 21% drop in sales prices and many recyclers and businesses across the plastics value chain at the risk of insolvency.[8] This study was started just as the pandemic began to take effect in Thailand and it was observed to cause disruptions across the businesses of almost all the recycling value chain businesses engaged in the study. As the pandemic and its impact is still evolving, the economic analyzes done as part of this study does not factor in the business impact of COVID-19 on the plastics recycling sector.

Sixth, a second stakeholder consultation workshop was conducted on 9th July 2020 via video conferencing. The 29 participants for this workshop were specifically selected to represent a smaller subset of stakeholders from the first workshop and represented private sector organizations across the value chain, government

8 Safeguarding the Plastic Recycling Value Chain: Insights from COVID-19 impact in South and Southeast Asia

> A circular economy is an industrial system that is restorative or regenerative by intention and design. It replaces the 'end-of-life' concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products, systems and, within this, business models.

agencies and departments and included participants who provided a deep domain expertise. The objective of this second workshop was to validate the key findings and interventions developed in the study and to further refine the findings.

Finally, a third and final stakeholder consultation workshop was conducted on 14th August 2020 via video conferencing with 5 senior representatives from the Pollution Control Department (under Ministry of Environment and Natural Resources) and PIT (under Ministry of Industry) to provide further one-to-one feedback to the study team. During this meeting, it was suggested by PIT to factor in the lifespan of the plastic products in the MFAs using PIT data. This update to the MFAs was duly completed following the meeting with the MFA and the economic analyzes were also updated.

In summary, the study was developed using the below sources and tools:

- Publicly available reports and presentations by relevant private sector organizations and government departments / agencies
- In-depth interviews with 20 private sector stakeholders and 3 policy experts
- Three rounds of in-depth stakeholder consultation workshops with a total of 90 participants from private, public and non-governmental sectors across the 3 workshops
- Material flow analyzes and economic analyzes of the major plastic resin types custom-developed and for the purposes of this study and benchmarked against global examples of similar analyzes
- Quantitative and qualitative data from various private sector stakeholders, government departments / agencies and global plastic resin market pricing providers

1.5 DEFINING PLASTICS CIRCULARITY

A circular economy is based on the principles of designing out waste and pollution, keeping products and materials in use and regenerating natural systems. This is different to the current economic system of a linear economy where material and fuel resources are used to make products, which are then consumed and thrown away (i.e. take-make-waste). The definition of circular economy used for this study is the one developed by the Ellen MacArthur Foundation that has also been widely adopted by governments and major private sector organizations in the global plastics value chain.[9]

"A circular economy is an industrial system that is restorative or regenerative by intention and design. It replaces the 'end-of-life' concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products, systems and, within this, business models."

The focus of this report is on the recycling aspect of the circular economy for plastics, as a lever to divert plastic wastes away from landfills and the open environment and to increase the re-introduction of the plastics into the industrial system. Reduction at source and refill / reuse aspects of the circular economy for plastics were not included in the scope as the focus was on identifying scalable private sector investment solutions, which are primarily in plastic recycling.

A further elaboration of this definition and definitions of other relevant terms can be found in the appendix.

9 Ellen MacArthur Foundation Global Commitment

1.6 SCOPE OF STUDY

This study balances the needs of having a comprehensive coverage of the plastics sector and a focused review of the enabling policy environment, the opportunities and barriers for plastics circularity. Therefore, as outlined in the inception report submitted as part of this engagement, the boundaries of the investigation are limited to four of the most commonly consumed resins and the five industries which consume the largest amount of plastics in Thailand. This section will briefly explain the rationale behind the selection of these resins and industries.

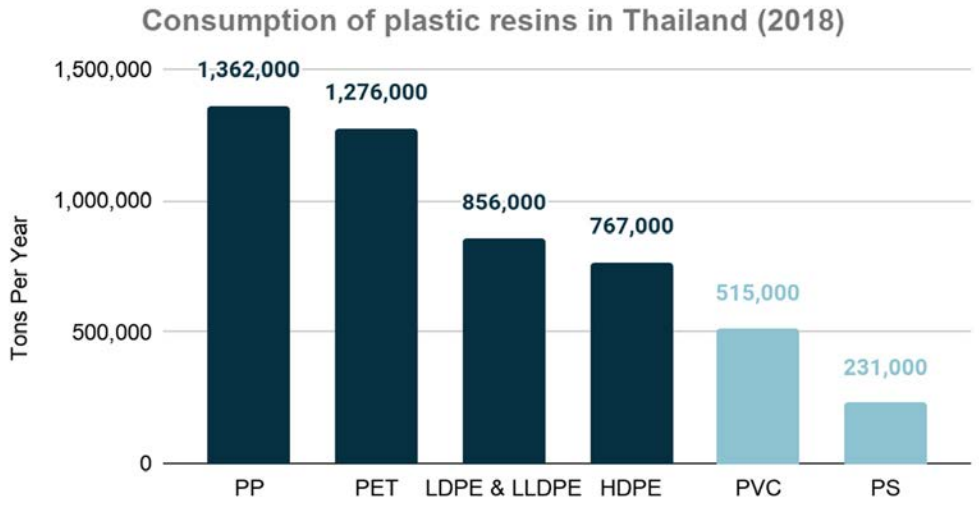
Firstly, the four resins chosen as the focus for this study are PP, PET, LDPE/LLDPE and HDPE. This is based on 2018 data from the Plastics Institute of Thailand (PIT) (see Figure 6), which shows that these are the most widely consumed resins in Thailand and represent 78% of all resins consumed in Thailand.

PVC is widely used in the building and construction industry in making siding and window frames, flooring, roofing, insulation for electrical cables and in water and sewage pipes. It has a long application lifetime (between 10-20 years) as compared to products made from HDPE, LDPE, PP and PET which have much shorter application lifetimes, including single-use applications. Also, as usage of PVC plastic is largely confined to the building and construction industry, it is expected that PVC is treated as construction and demolition (C&D) waste and therefore likely to be better managed, unlike HDPE, LDPE, PP and PET which are widely disposed of as part of municipal solid waste. PS products with single-use applications such as styrofoam food boxes and single-use plastic cups are already slated to be banned in Thailand as per the National Roadmap on Plastic Waste Management 2018 -2030. Therefore, PVC and PS are not considered for the purposes of this study.

Next, a breakdown of the industries which use plastics the most is required as the consumption behavior and collection factors of plastics are different. For example, plastics in packaging applications tend to be single layer or multi-material material and disposed of in the Municipal Solid Waste (MSW) system while plastics in automotive, building and construction applications are typically used as composites and collected as industrial waste. Similarly, regulations differ between different industries and products, hence this study needs to have a broad enough perspective to consider the different policy realities.

However, from a policy perspective analyzing all the industries which use plastics will lead to an overly broad analysis as plastics consumption is concentrated in a few industries. This is described in Figure 7 which shows the breakdown of plastics usage between the major industries in Thailand. The five biggest industries are Packaging (42%), Electrical and Electronics (16%),

Figure 6.
BREAKDOWN OF RESIN CONSUMPTION IN THAILAND FOR 2018 (BEFORE ACCOUNTING FOR PRODUCT LIFESPANS AND IMPORT / EXPORT OF SEMI-FINISHED PRODUCTS)



Source: Plastics Institute of Thailand

Figure 7.
BREAKDOWN OF THAILAND'S PLASTICS END USE INDUSTRIES (THE BOX HIGHLIGHTS THE INDUSTRIES ASSESSED FOR THE POLICY ASSESSMENT ASPECT OF THIS STUDY)

END USE INDUSTRY	TONS	% OF TOTAL
Packaging	2,323,000	42%
Electricals and Electronics	870,000	16%
Construction	791,000	14%
Automotive	391,000	7%
Filament	365,000	7%
Housewares	216,000	4%
Safety & Security	153,000	3%
Agriculture	114,000	2%
Footwear	101,000	2%
Recreation	98,000	2%
Others	60,000	1%
Medical Devices	54,000	1%
TOTAL	**5,536,000**	**100%**

86% of consumption

Source: Plastics Institute of Thailand

Construction (14%), Automotive (7%) and Filament (7%). These industries cumulatively account for 86% of plastics consumption. These five industries are chosen for the policy assessment section of this study. To clarify, for the material flow and economic analyzes sections of the study, resins consumed across all end-use industries in Thailand have been assessed.

1.7 CIRCULARITY COMMITMENTS OF MAJOR PLASTICS STAKEHOLDERS

This study will not be complete without an understanding of the commitments key stakeholders in Thailand have already made towards supporting plastics circularity. Therefore, this study team reviewed the number of public commitments made by key stakeholders in Thailand's plastics value chain. The four following circularity commitments reviewed are:

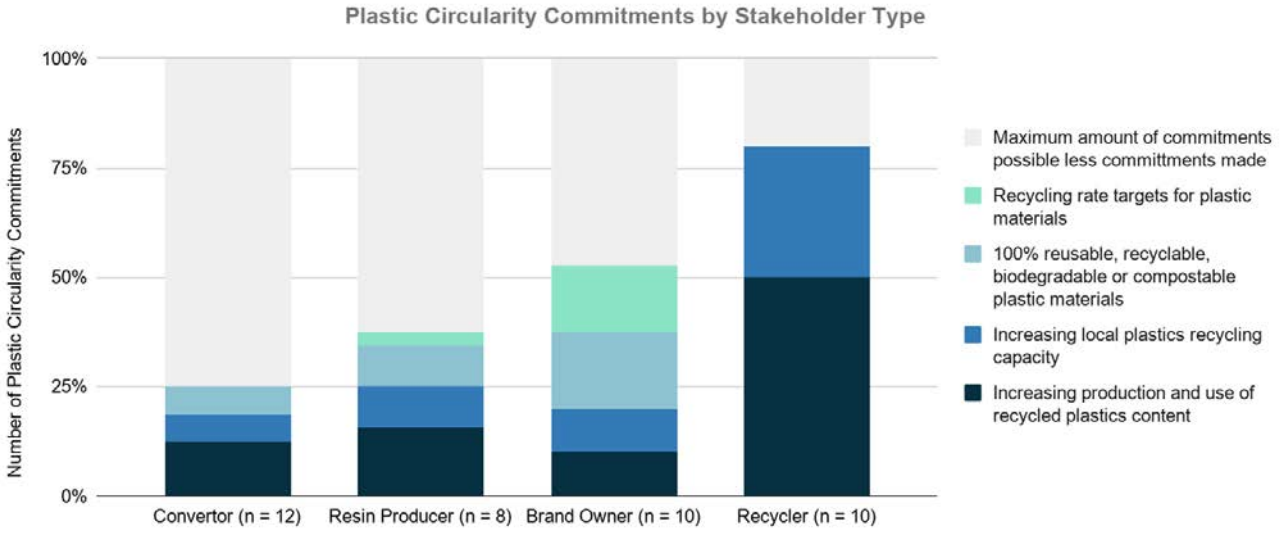
1. Moving towards 100% reusable, recyclable, biodegradable or compostable plastics materials
2. Recycling rate targets for plastics materials (this commitment is especially important given Thailand's national plastics recycling rate target of 100% by 2027 as per the national roadmap)
3. Increasing local plastics recycling capacity
4. Increasing production and use of recycled plastics content

While this review does not analyze the scale or efficacy of the commitments, it is still useful as it shows the direction the industry is heading towards and what each stakeholder has been communicating.

Photo: Nokuro / Shutterstock

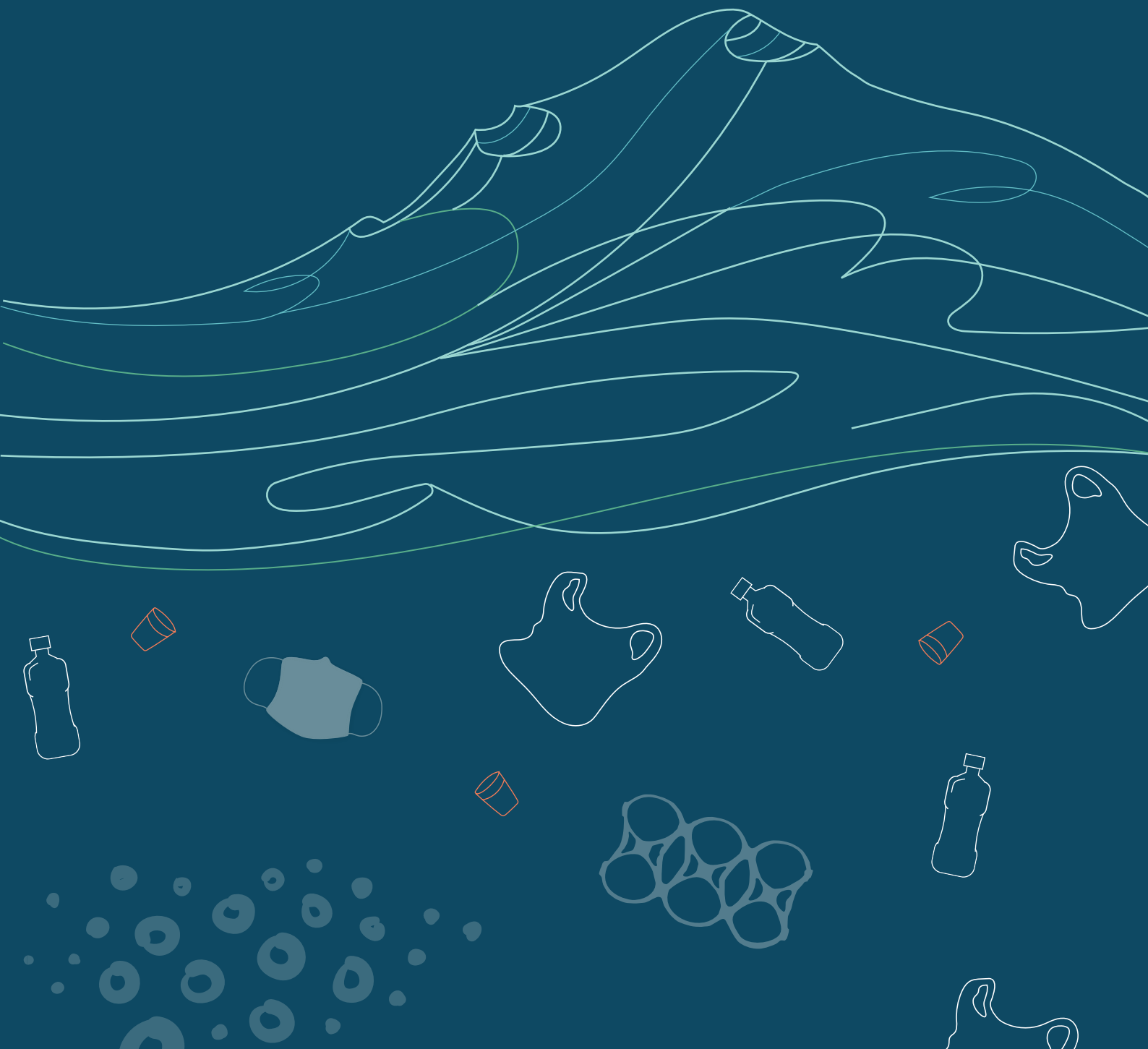
As shown in Figure 8, recyclers have the highest proportion of commitments made. This is because recycling is their primary business focus and commitments 1 and 2 are not applicable in their industry. Of the rest, brand owners have made the most commitments as they are the most consumer-facing stakeholder, meaning they have the most incentive to make commitments to win over consumers. This review shows that for any future private sector engagement efforts on plastics circularity in Thailand, recyclers and brand owners are most likely to engage as they are most primed to affect change, followed by resin producers and converters.

Figure 8.
PLASTICS CIRCULARITY COMMITMENTS BY STAKEHOLDER TYPE



SECTION 2:

THAILAND DISPOSES 2.88 MILLION TONNES OF PLASTICS AND LOSES 87% OF THE MATERIAL VALUE



SECTION 2:

THAILAND DISPOSES 2.88 MILLION TONNES OF PLASTICS AND LOSES 87% OF THE MATERIAL VALUE

Section 2.1 introduces the two tools used to assess the current plastics circularity situation in Thailand for each resin material flow analysis (MFA) and the material value loss analysis. Section 2.2 analyzes each of the key resins in detail using the two tools. It also highlights the findings relevant to increasing circularity.

2.1 TOOLS USED TO ASSESS PLASTICS CIRCULARITY

2.1.1. Material Flow Analysis (MFA)

The MFA conducted for each resin as part of this study covers the amounts of resin traveling through each stage of the value chain from resin production to consumption, and finally to post-consumption destinations. Moving from left to right, Figure 9 helps to visualize how much of the resins flow across the stages and enables an understanding of factors affecting circularity at each stage.

The three stages are:

1 **Production: On the left, the MFA starts with the amount of resin produced (black box).**

Imports and exports of this resin (gray box) and the semi-finished products the resins are made into (dark blue box) are factored into the total amount of plastic products consumed locally. The total amount of plastic products consumed locally represents 100% of what can be recycled for that resin. This does not, however, account for the total amount of imports and exports for finished products containing plastics as the HS codes for finished products are not categorized under plastics. This missing data on net imports / exports of finished plastic products is a limitation of this MFA.

2 **At Disposal: After consumption, the plastic products are then either collected for recycling (green box) or disposed of at the landfill, used for energy recovery or leaked into the environment (orange box).**

The lifespan of the plastic products is factored by removing products produced in 2018 but disposed of in future years and including products produced before 2018 and disposed of in 2018. This calculation uses the following steps:

- Firstly, determine the proportion of materials disposed of in year 0 (year of manufacture) until end of lifespan by understanding the typical lifespan of plastic products for each end-use application and the proportion of end-use applications for each resin (details in the appendix). This is summarized in Figure 10.

Figure 9.
THE MATERIAL FLOW ANALYSIS (MFA) APPROACH USED FOR EACH RESIN

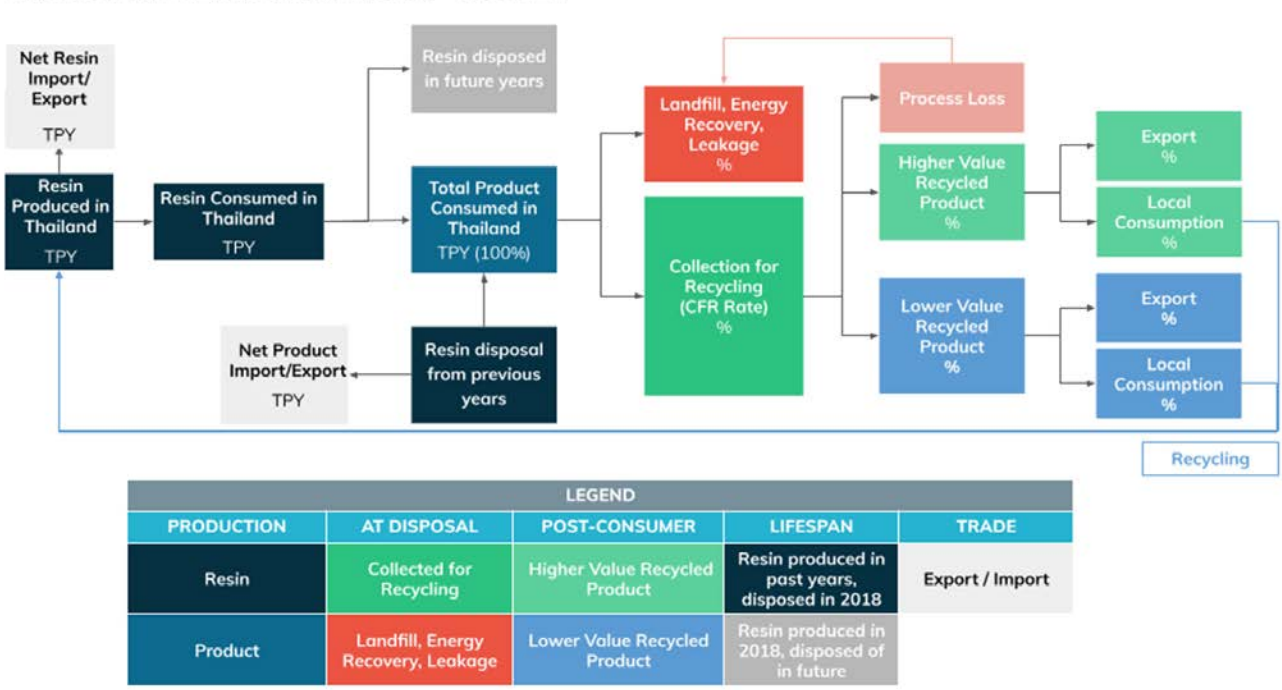
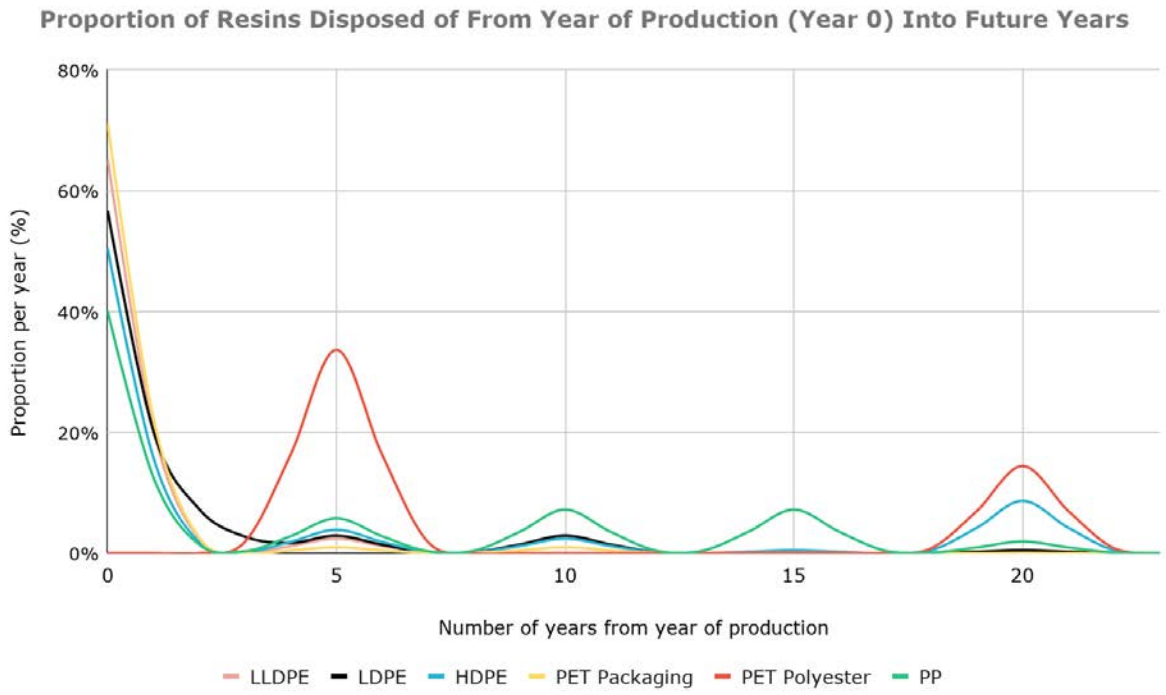


Figure 10.
NORMAL DISTRIBUTION CURVES SHOW AVERAGE LIFESPAN OF PLASTIC PRODUCTS FROM DIFFERENT RESINS



Source: Plastics Institute of Thailand, GA Circular modeling

- Secondly, calculate the amount of plastic products disposed of in 2018 but produced before 2018 using the above chart and historical production numbers provided by the PIT: Multiply the amount of resin consumed in each year (for all the past years prior to 2018 for which the PIT data is available) with the corresponding proportion of products estimated to be disposed of in 2018. For example, the amount of PET Polyester consumed in 2013 is multiplied by the proportion of PET polyester that will be disposed of in 5 years. The figures for each year are then summed up for a total estimated amount to be disposed of in 2018.
- Lastly, the proportion of materials produced in 2018 but estimated to be disposed of in future years is removed to arrive at a final figure for the total amount of resins disposed in 2018 as final products in Thailand.

3 | Post-Consumer: The products of recycling are shown in the last section on the right.

The products of recycling may be of higher value, such as food-grade resin (light green box), or of lower value, like resin used strapping (light blue box). These products are then either exported or reused locally in domestic plastics production. Any process losses go to the landfill, energy recovery or environmental leakage (orange box).

Photo: Meryll / Shutterstock

2.1.2. Material Value Loss Analysis (i.e. recycling value loss)

Analysis of the plastic **material value loss** (used interchangeably with the term **recycling value loss** in this study) assesses the value loss when the resins are not recycled into the Most Valuable Recycled Product (MVRP) for that particular resin or when the resins are not recycled at all (e.g. when disposed of in a landfill). The above MFA tool, performed for each resin, informs the analysis of this material value loss, which is shown using a graphical method (Figure 11) and has 2 key values:

1. Collection for Recycling (CFR) Rate: Represented by the X-Axis
2. Value Yield (product of Volume Yield and Price Yield): Represented by the Y-axis

The size of the green boxes represents the value unlocked through recycling. All areas outside of the green boxes indicate the lost recycling value. Red arrows depict the pressures that lower the value unlocked (i.e. pressure through lower CFR Rate and pressure through lower Value Yield).

The graphical method in Figure 11 was benchmarked and developed based on the methodology used by the Ellen MacArthur Foundation to assess the material value lost from single-use plastic packaging applications globally. It was modified specifically for the purposes of this study and for the context in Thailand.[10]

The World Bank is developing the tools to help countries identify the "Pathways out of Plastic Pollution," which is expected to be completed in FY21. The scope of this work has been extended both geographically and technically to reflect high uptake within the World Bank Group (WBG, which includes both the World Bank and IFC) and demand from countries. The model will be piloted in Indonesia, will follow a comprehensive approach to the valuation of damages from plastic and its alternatives, and will include five country case studies in the lifecycle valuation of plastics and alternatives, together with policy analyzes in 10 countries. It is expected that the material value analysis done in this study can provide valuable inputs for the development of the pathways of plastic pollution in Thailand.

10 Ellen Macarthur Foundation New Plastics Economy: Rethinking the Future of Plastics (2016)

Figure 11.
METHODOLOGY OVERVIEW OF HOW TO CALCULATE THE MATERIAL VALUE LOSS

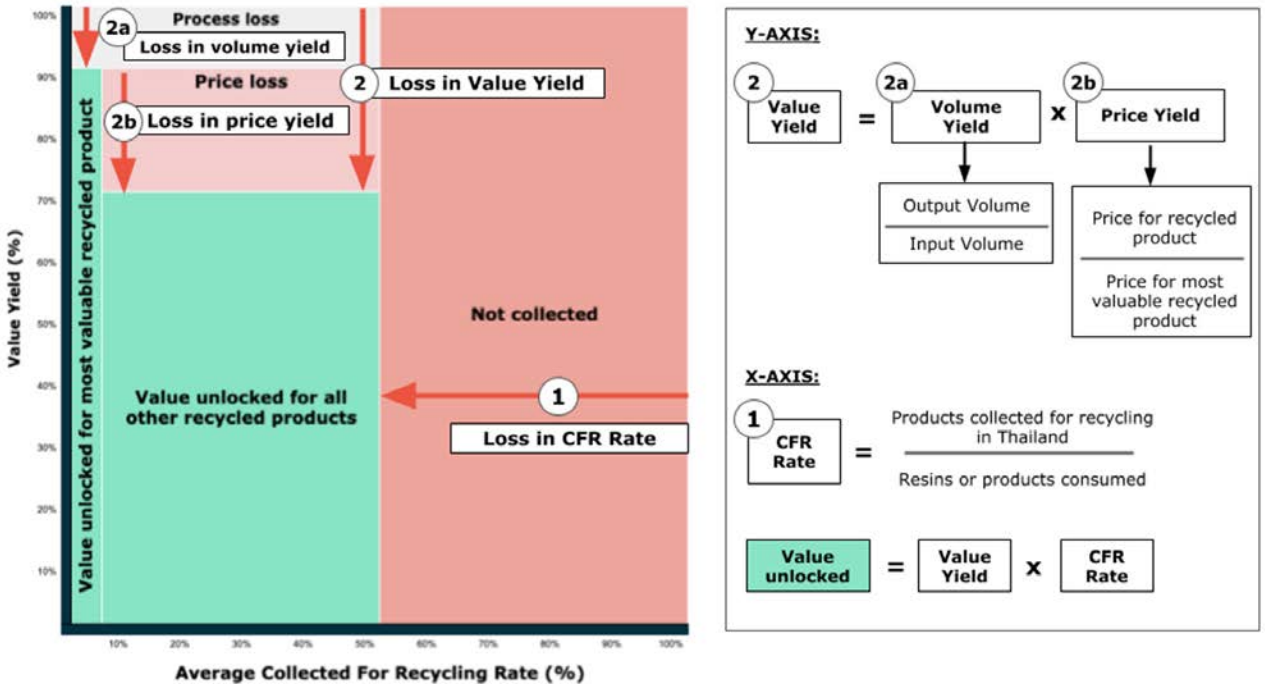


Figure 11 Notes:

1. *The material value analysis does not include:*
   a. *the costs that could be saved from not having to collect and dispose of the non-recycled resins as waste under the MSW collection system*
   b. *the cost of setting up and operationalizing municipal solid waste management infrastructure to support the transition towards plastics circularity*

   This analysis should therefore be considered as providing the potential benefits from plastics recycling and not the "net" opportunity. This is in line with the methodology used by the Ellen Macarthur Foundation which does not factor in upfront investment costs, operational costs for circular approaches towards solid waste management or cost savings through reduction in collection and disposal of plastic waste.

   Multilayer, multi-material flexibles form an important part of the packaging mix for consumer goods brands. However they are not being commercially collected or recycled at scale unlike rigids and mono-material flexibles (a small proportion of these multi-material flexibles in Thailand are currently sent for energy recovery via co-processing in cement plants or waste-to-energy facilities while most end up in landfills, dumpsites or leak into the open environment). As scalable private sector investment solutions for recycling these multilayer, multi-material flexibles have not yet been commercialized in the context of Southeast Asia, a breakdown of the key resins into multilayer, multi-material flexibles and a dedicated assessment of material value analysis for this category of flexibles was out of scope.

2. *The below criteria were used to ensure reliable and consistent prices for recycled products were used:*
   a. *Prices need to be representative of the industry, i.e. source of prices must be an any of the following: (i) industry association, (ii) independent market pricing provider, (iii) from 2 or more independent recyclers.*
   b. *Prices need to be available for various categories of end products (for e.g. HDPE's end products are rHPDE natural, rHDPE pipe grade, rHDPE injection mold black, rHDPE colored, rHDPE food grade, etc.).*
   c. *Prices need to be available for a period of 3 months within 2019 so that the average of the 3 months can be used. This is to avoid price anomalies.*

   Currently there are no independent, industry-level price information sources available for recycled products in Thailand. Therefore, local prices have been used for PET recycled products where available from 2 independent recyclers and have also been benchmarked with global prices, as many PET recycled products compete in the global market and therefore global pricing provides an accurate picture of the market opportunity. For the other resins, local prices have been unavailable based on the above criteria. Part of this is due to the large number of informal recyclers for polyolefins and because formal recyclers were unable to share sensitive price information. Therefore, for these resins, global prices meeting the above criteria were used.

   100% rates for CFR and Value Yield are not practically possible. However, 100% rates have been used in both axes in order to align this study with the national government's target of "100% plastics recycled applying circular economy principles" as part of the 2018-2030 Plastic Waste Management Roadmap.

   The term MVRP for each resin refers to the recycled product which has the most value in the global recycled plastics market out of all the possible options that the resin can be recycled into. For this calculation, MVRP takes into account a weighted average of the various possible recycled products, with the proportions of each type of recycled product representing a best case scenario of maximal value unlocked for the resin to take into consideration that it is not realistic to expect 100% of resins to be recycled into the recycled product which has the most value (e.g. food-grade PET for post-consumer PET). It must be noted that profitability of the MVRP can at times be lower than other lower value products, depending on market conditions.

3. *A complete breakdown of the data sources and key assumptions for material value loss analysis calculations for each resin can be found in the appendix.*

2.2 RESINS IN FOCUS

2.2.1. PET

General Characteristics of PET

PET is clear, tough and has good gas and moisture barrier properties. It is widely used in:

- Plastic bottles for soft drinks, water, juice, sports drinks, etc.
- Food jars for peanut butter, sauces, condiments, etc.
- Ovenable film and microwavable food trays
- Textiles, monofilament, carpet, strapping, films and engineering moldings

Cleaned, recycled PET flakes and pellets are in high demand globally for use back into bottles as well as for spinning fiber for carpet yarns and textiles (see Figure 12). PET can be recycled into the following:

- rFiber — Fiber for carpet, fleece jackets, comforter fill and bags, etc. through rPSF (Recycled Polyester Staple Fiber) and rPOY (Recycled Partially Oriented Yarn)
- rPET (food-grade) — Containers for food, beverages bottles
- rPET (non-food-grade) — Films, sheets, strapping

Major Pet Producers And Recyclers In Thailand

Figure 13 shows the respective amounts of virgin PET production and recycled PET production for the major producers and large recyclers reviewed under this study.

Figure 12.
EXAMPLE OF BREAKDOWN OF THE VALUE OF RECYCLED PRODUCTS FROM PET (BOTTLE TO BOTTLE rPET RESIN CAN BE CONSIDERED THE MOST VALUABLE RECYCLED PRODUCT)

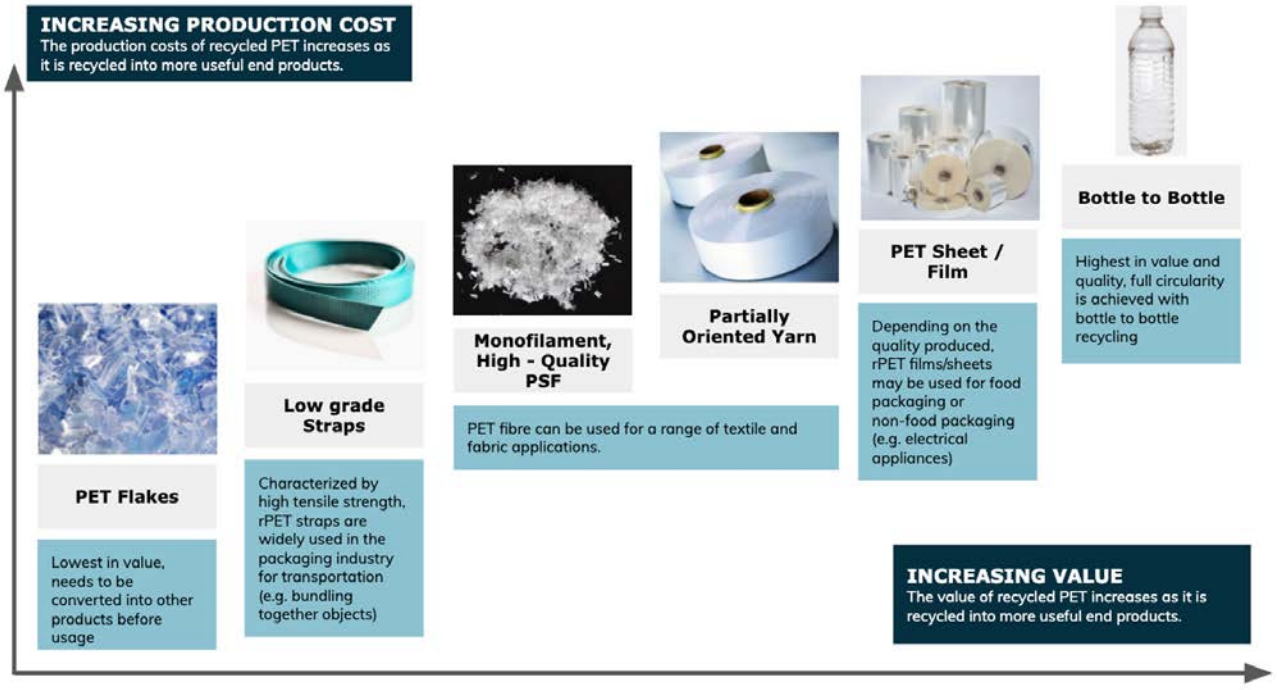
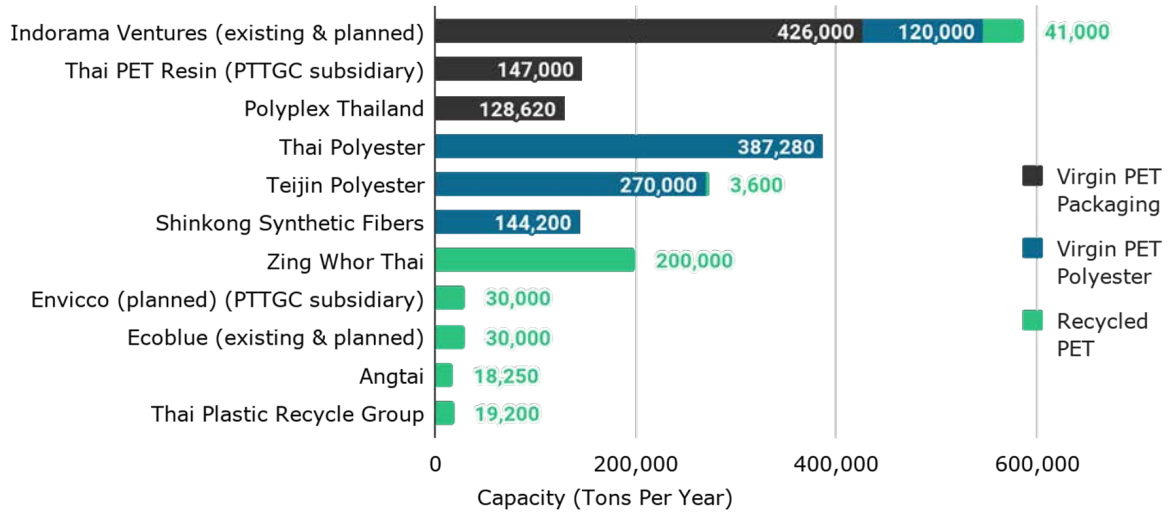
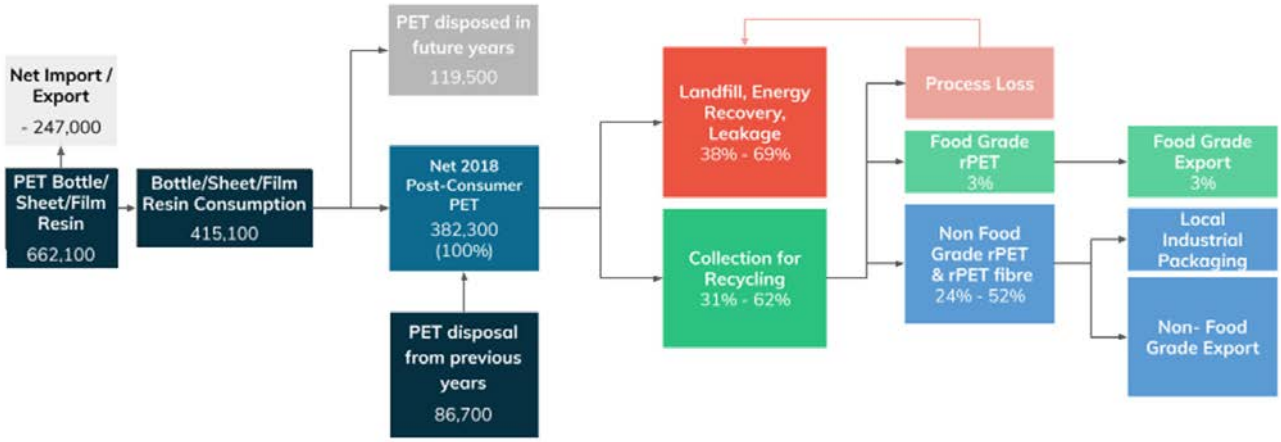


Figure 13.
MAJOR PRIVATE SECTOR STAKEHOLDERS FOR PET RESIN (2020)



Sources: Private sector stakeholder interviews, financial reports and site visits by the study team.
Note: This is not an exhaustive list of all PET producers and recyclers in Thailand.

Figure 14.
MATERIAL FLOW ANALYSIS OF PET PACKAGING RESIN IN THAILAND (2018)



Note: All figures are in tonnes per year.

Figure 15.
MATERIAL FLOW ANALYSIS OF PET POLYESTER RESIN IN THAILAND (2018, TONNES PER YEAR)

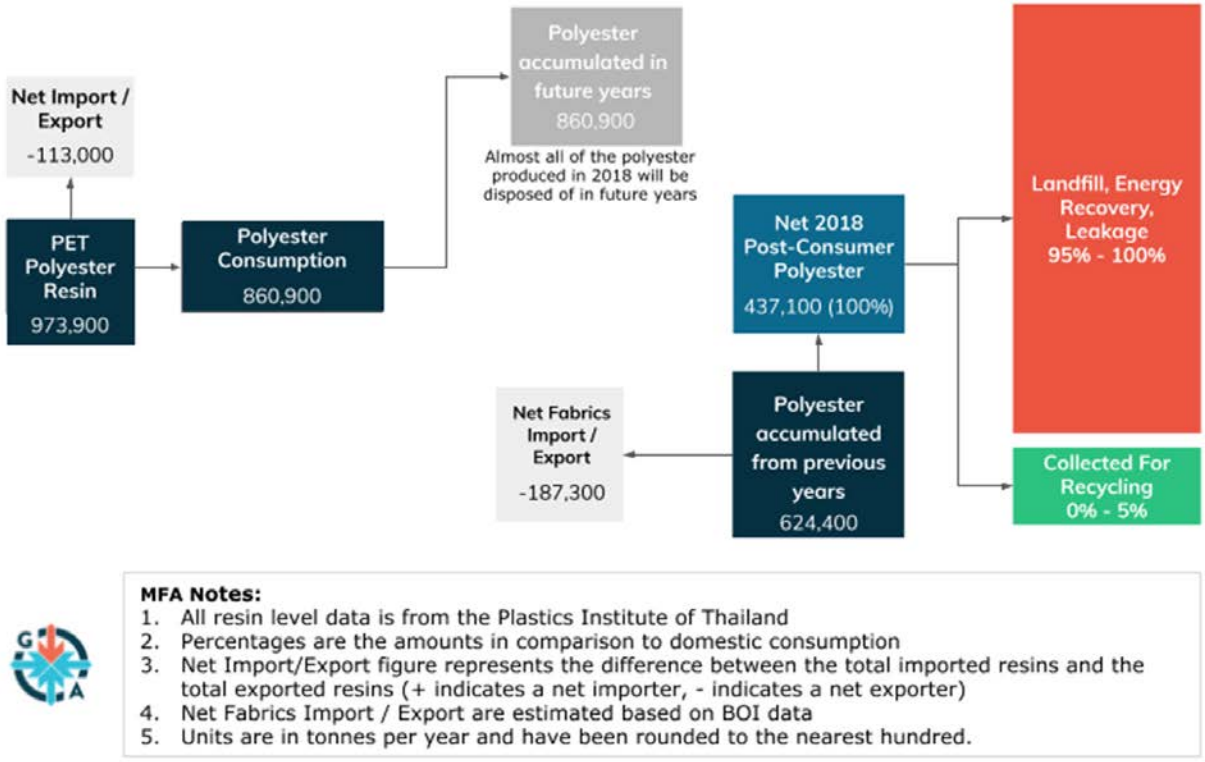


Figure 15 Notes:

1. *Data source for resin production, imports and exports: Plastics Institute of Thailand*
2. *Data source for accumulation in future years and disposal from previous years: Plastics Institute of Thailand, GA Circular modeling*
3. *Data sources for consumption: Plastics Institute of Thailand, stakeholder interviews with convertors, brand owners, GA Circular modeling based on above data sources*
4. *Data source for Collection for Recycling and its breakdown: Stakeholder interviews with processors and recyclers, GA Circular modeling*
5. *Based on BOI data, 30% of all man-made and cotton yarn produced in Thailand was exported.[11] This MFA assumes that this percentage can be applied for the two major PET polyester semi-finished products (yarn and fiber).*
6. *Industry sources shared some of the recycled PET bottles are currently being used in food-grade sheets within Thailand. This usage would be about 50,000-100,000 TPY however it fluctuates (for example, it reduces when virgin PET prices are low) and has therefore not been shown in this figure.*
7. *Due to the limited scope of the project and data availability, some aspects of the flow were not able to be examined. For example, for plastics that were not recycled, the proportions which ended up between Landfill, Leakage and Energy Recovery were not determined.*
8. *Most of these values have wide fluctuations. The values shown in this chart are our best average estimates of the realities.*

There are three key messages from the MFAs of PET packaging and Polyester in Thailand:

1. The CFR rate for PET packaging (including bottles, sheet and films) varies widely between 31% to 62%, while the recycling of PET sheets and films in Thailand is ~0%. Thus, any CFR rate for PET packaging is almost fully due to bottles. The wide range of recycling rate is mainly due to stakeholders such as aggregators and recyclers responding to price fluctuations. As prices drop, aggregators and recyclers slow collection as it gets less profitable to do business. When prices rise, collection increases again as these stakeholders take advantage of the higher prices. No definitive industry-derived annual CFR rate values exist in Thailand.
2. A very small amount (~3%) of the PET packaging is recycled as food-grade rPET and even this 3% is fully exported. This is important as food-grade rPET has the highest value in the market and achieves circularity (i.e bottle-to-bottle recycling).

11 Board of Investment (BOI) Thailand report on the textile industry (2017)

Furthermore, it is more resistant to drops in prices for virgin PET as demand for food-grade rPET is on the rise due to sustainability commitments of global food and beverage corporations. However, a major obstacle preventing the production of food-grade rPET is the ban on use of recycled PET content in food packaging in Thailand.

3. Only a minimal amount of PET polyester used in textiles and fiber applications is recycled. One of the main reasons is due to the various blended products that polyester fiber gets turned into (for example, blended with nylon or cotton) which makes it technically challenging to separate the polyester content during recycling. Technologies to recycle blended polyester products are still in the early stages of development globally and are not present in Thailand.

Material Value Loss Analysis for PET

The material value loss for PET has been broken down into two parts — PET Packaging and PET Polyester, as granular data is available specifically for PET packaging due the relatively well-developed recycling industry for PET bottles.

Figure 16 represents the value unlocked for PET packaging based on the above MFA for PET. The key findings are:

- Average CFR is 46.3% and Value Yield is 79.1%. This unlocks 36.6% of material value. The CFR value includes all PET Packaging (e.g. bottles, films and sheets).
- Therefore, an average of 63.4% of the recycling value of PET packaging is lost. This is equivalent to USD 269-395 million of recycling value lost per year.

Figure 16.
MATERIAL VALUE LOSS ANALYSIS FOR PET PACKAGING (BASED ON 2018 VOLUMES)

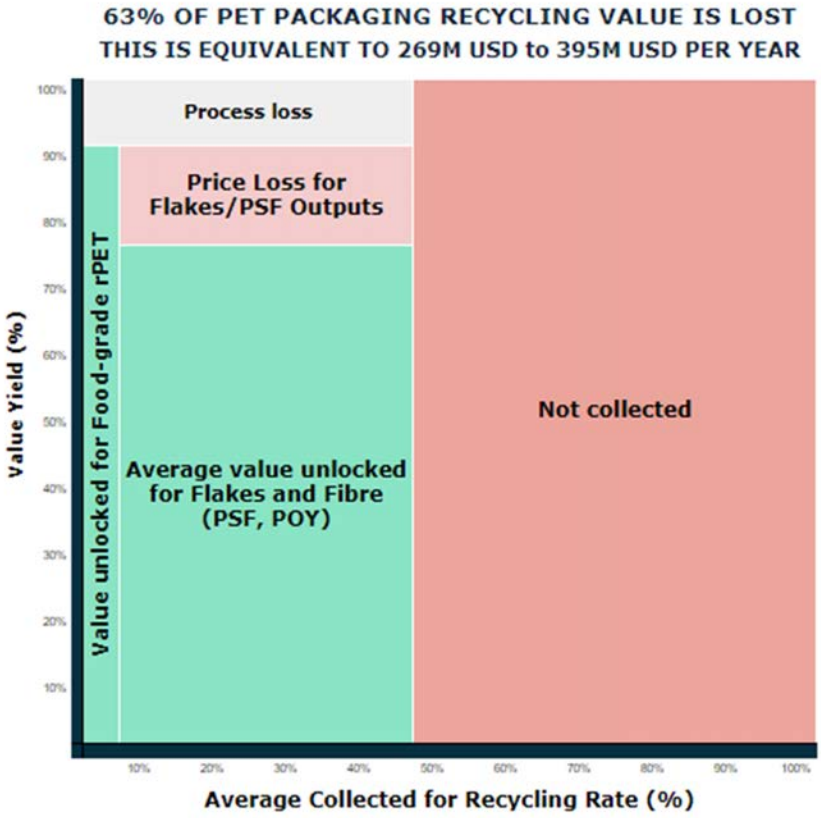


Figure 16 Notes:

1. *Value yield = volume yield x price yield where volume yield = output volumes / input volumes, and price yield = weighted average USD per tonne of reprocessed PET / USD per tonne of most valuable recycled product from PET.*
2. *MVRP for PET polyester is a mix of food-grade rPET, rPET flakes, rPOY and rPSF used in apparel applications.*
3. *Current situation for PET packaging is an average of 88% volume yield (as process losses are approximately 12%) and 90% price yield, thus giving a 79% value yield.*
4. *Total volume of PET packaging of 382,300 TPY, and most valuable recycled product price of USD 1,250 / ton.*
5. *CFR rate only includes PET packaging (i.e. not other contaminants).*
6. *Process losses only includes PET packaging (i.e. not other contaminants).*
7. *All percentages used here are weighted average values.*

Figure 17 represents the value unlocked for PET polyester based on the above MFA for PET. The key findings are:

- Average CFR is 2.5%, resulting from recycling of carpet tiles in Thailand at a very small scale. Value Yield is 80.5% as the recycled carpet tiles can be used back in fiber application, which has a relatively high value. Together, the CFR and Value Yield unlock just 2.0% of material value, mainly due to the low CFR.
- Therefore, an average of 98.0% of the recycling value of PET polyester is lost. This is equivalent to USD 574-598 million of material value lost per year.

2.2.2. PP

General Characteristics of PP

PP is a tough, rigid and crystalline thermoplastic produced from propene (or propylene) monomers. Its good barrier properties, high strength, good surface finish and low cost make PP ideal for several packaging applications. PP is among the cheapest plastics available today. It is widely used in:

- Packaging Applications: used for both rigid and flexible packaging

Figure 17.
MATERIAL VALUE LOSS ANALYSIS FOR PET POLYESTER (BASED ON 2018 VOLUMES)

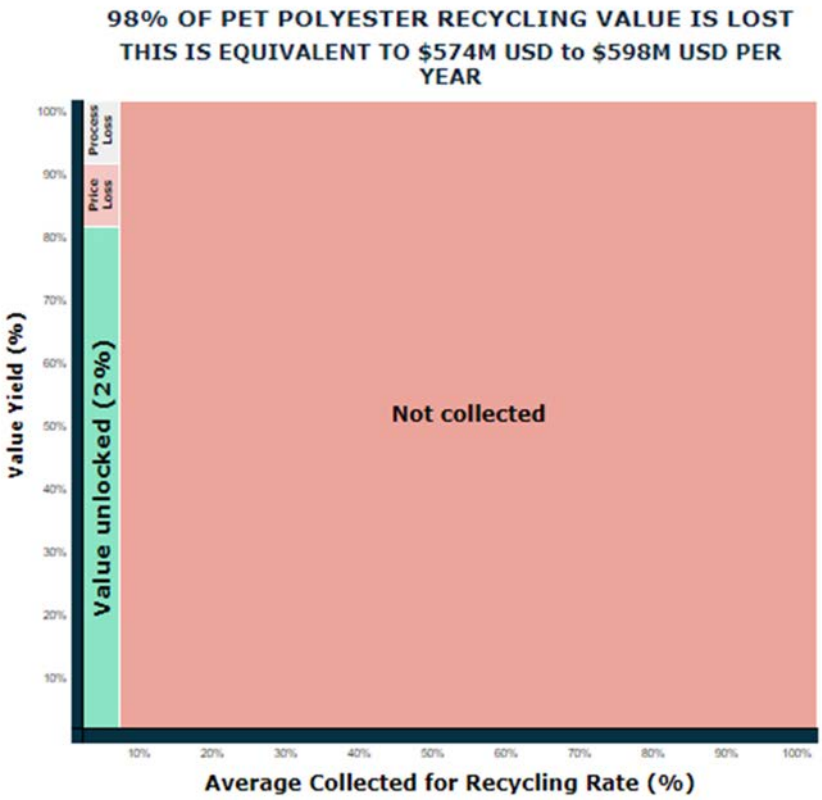


Figure 17 Notes:

1. *Value yield = volume yield x price yield where volume yield = output volumes / input volumes, and price yield = weighted average USD per tonne of reprocessed PET / USD per tonne of most valuable recycled product from PET.*
2. *MVRP for PET polyester is a mix of rPOY and rPSF used in apparel applications.*
3. *Current situation for PET polyester is an average of 88% volume yield (as process losses are approximately 12%) and 91% price yield, thus giving a 80.5% value yield.*
4. *Total volume of PET polyester is 437,100 TPY, and most valuable recycled product price of USD 1,042 / ton.*
5. *CFR rate only includes PET polyester (i.e. not other contaminants).*
6. *CFR rate has been rounded to the nearest 5% for the purposes of this figure only.*
7. *Process losses only includes PET polyester (i.e. not other contaminants).*
8. *All percentages used here are weighted average values.*

- Automotive Applications: battery cases and trays, bumpers, fender liners, interior trim, instrumental panels and door trims.
- Fibers and Fabrics: A large volume of PP utilized in strapping, filament and staple fibers

PP can be recycled into the following:

- rPP for packaging applications
- rPP for industrial application: automotive, electronics and furniture industries

Major PP Producers and Recyclers in Thailand

Figure 18 shows the respective amounts of virgin PP production and recycled PP production for the major producers and large recyclers reviewed under this study.

There are three key messages from the MFA of PP in Thailand:

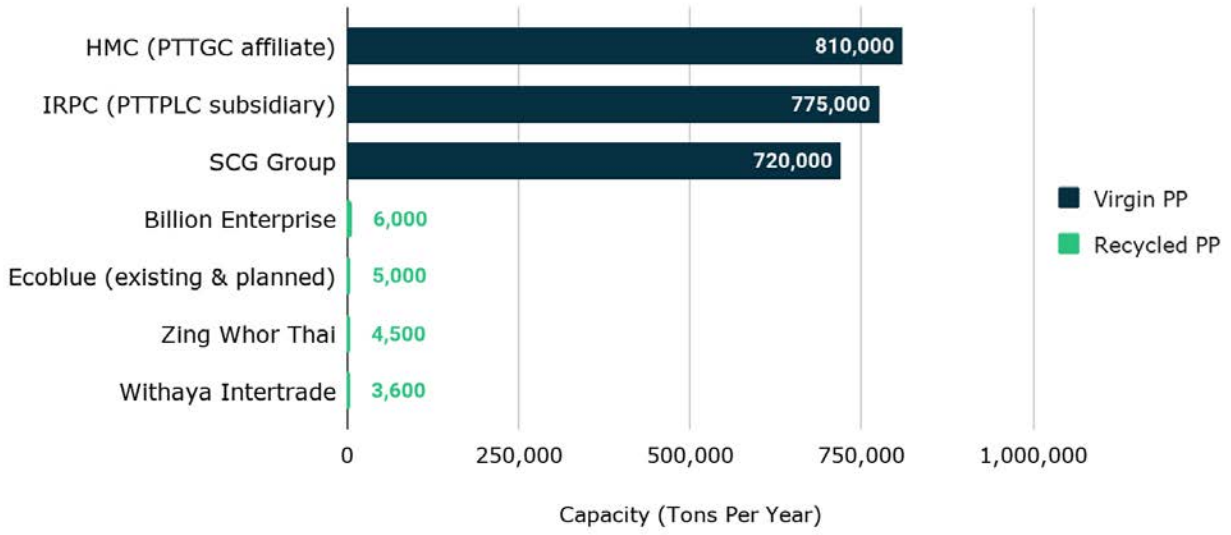
1. PP has a CFR rate of about 10%-20%. The low end (10%) was calculated based on the data from a MFA done by the PCD. However, PCD'S MFA only analyzed the behavior of consumer products and did not account for collection for recycling rates of industrial PP packaging, which tend to be much higher. Hence, based on recycling industry sources, an assumption of increased collection rates by 10% is made to adjust for post-industrial packaging recycling.
2. A high proportion of PP is used in film packaging applications, which includes food packaging. These PP products are contaminated and therefore have low value yields and remain uncollected.
3. PP components that are non-recyclable are used in composite products in industrial applications (e.g. in electronics, automotives). The composite nature of the products mean that an additional step of dismantling and separation is required before it can be collected for recycling. This requires dedicated facilities (e.g. dedicated car bumper recycling facilities) which currently do not exist.

Material Value Loss Analysis for PP

Figure 20 represents the value unlocked for PP based on the above MFA for PP. The key findings are:

- Average CFR is 14.9% and Value Yield is 66.8%. This unlocks 10.0% of material value.
- An average of 90.0% of the recycling value of PP is lost. This is equivalent to USD 1,188-1,281 million of recycling value lost per year.

Figure 18.
PRIVATE SECTOR STAKEHOLDERS FOR PP RESIN (2020)



Sources: Private sector stakeholder interviews, financial reports and site visits by the study team.
Note: This is not an exhaustive list of all PP producers and recyclers in Thailand.

Figure 19.
MATERIAL FLOW ANALYSIS OF PP RESIN IN THAILAND (2018, TONNES PER YEAR)

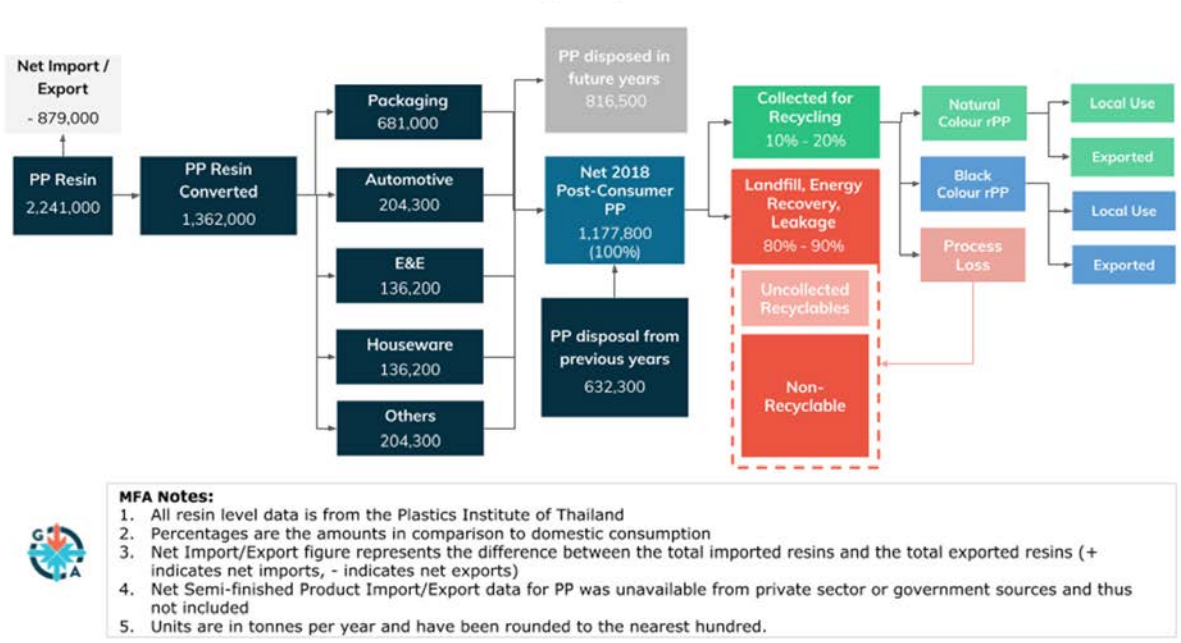


Figure 19 Notes:

1. *Data source for resin production, imports and exports: Plastics Institute of Thailand*
2. *Data source for accumulation in future years and disposal from previous years: Plastics Institute of Thailand, GA Circular modeling*
3. *Data sources for consumption: Plastics Institute of Thailand, stakeholder interviews with convertors, brand owners, GA Circular modeling based on above data sources*
4. *Data source for Collection for Recycling and its breakdown: Stakeholder interviews with processors and recyclers, GA Circular modeling*
5. *Due to the limited scope of the project and data availability, some aspects of the flow were not able to be examined. For example, for plastics that were not recycled, the proportions which ended up between Landfill, Leakage, and Energy Recovery were not determined.*
6. *Most of these values have wide fluctuations. The values shown in this chart are our best average estimates of the realities.*

Figure 20.
MATERIAL VALUE LOSS ANALYSIS FOR PP (2018 VOLUMES)

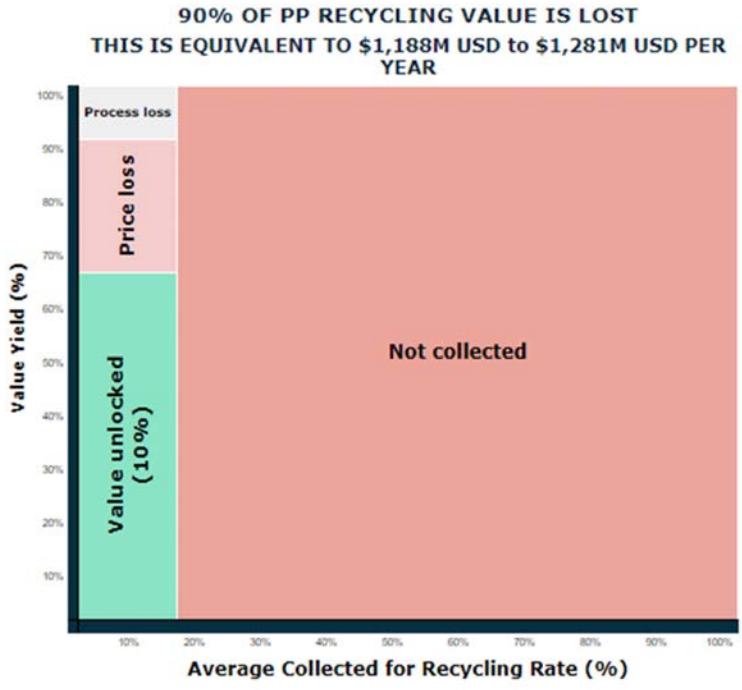


Figure 20 Notes:

1. *Value yield = volume yield x price yield where volume yield = output volumes / input volumes, and price yield = weighted average USD per tonne of reprocessed PP / USD per tonne of most valuable recycled product from PP.*
2. *MVRP for PP is rPP food-grade pellets which are being manufactured in some countries but not yet in Thailand. As only some of Thailand's PP can be turned into rPP food-grade, a weighted average of the different products is used to calculate the MVRP price for rPP.*
3. *Current situation for PP is an average of 88% volume yield (as process losses are approximately 12%) and 76% price yield, thus giving a 67% value yield.*
4. *Total volume of PP is 1,177,800 TPY, and most valuable recycled product price of USD 1,164 / ton.*
5. *CFR rate only includes PP (i.e. not other contaminants).*
6. *Process losses only includes PP (i.e. not other contaminants).*
7. *All percentages used here are weighted average values.*

2.2.3. HDPE

General Characteristics of HDPE

HDPE is a thermoplastic polymer produced from the monomer ethylene. It is known for its high strength to density ratio, making it suitable for a very wide variety of rigid plastic applications. While it can also be used for film packaging applications (especially where a stronger film is needed), its opacity means that LDPE/LLDPE is preferred in most cases.

- Packaging Applications: shampoo bottles, milk jugs, plastic shopping bags
- Automotive Applications: fuel tanks, inner and outer protective covers

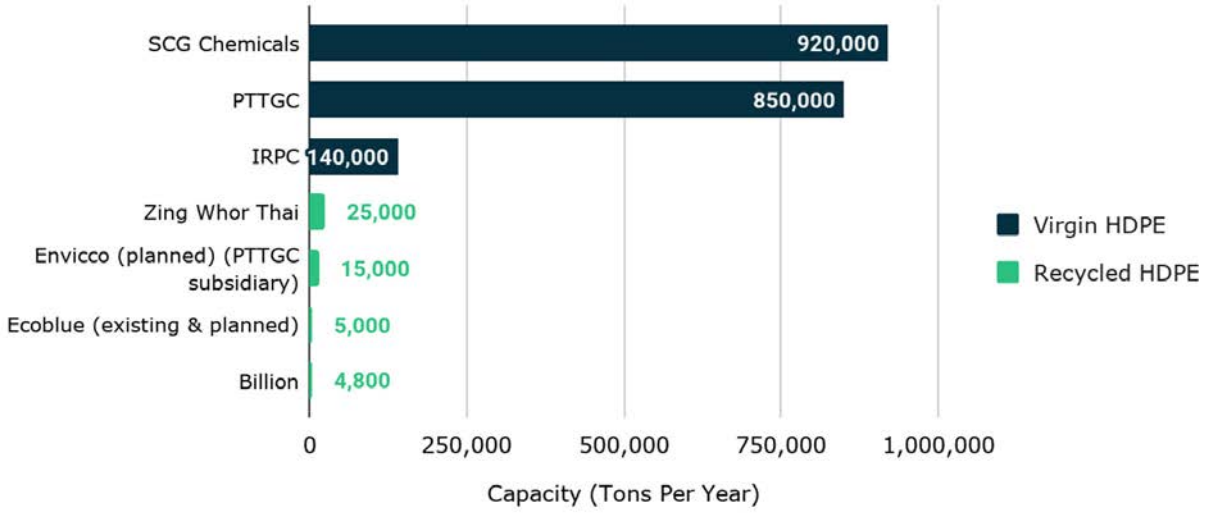
HDPE can be recycled into the following:

- rHDPE for packaging applications: shampoo bottles, plastic bags
- rHDPE for industrial application: automotive and electronics components

Major HDPE Producers and Recyclers in Thailand

Figure 21 shows the respective amounts of virgin HDPE production and recycled HDPE production for the major producers and large recyclers reviewed under this study.

Figure 21.
PRIVATE SECTOR STAKEHOLDERS FOR HDPE RESIN (2020)



Source: Private sector stakeholder interviews, financial reports and site visits by the study team.
Note: This is not an exhaustive list of all HDPE producers and recyclers in Thailand.

Figure 22.
MATERIAL FLOW ANALYSIS OF HDPE RESIN IN THAILAND (2018, TONNES PER YEAR)

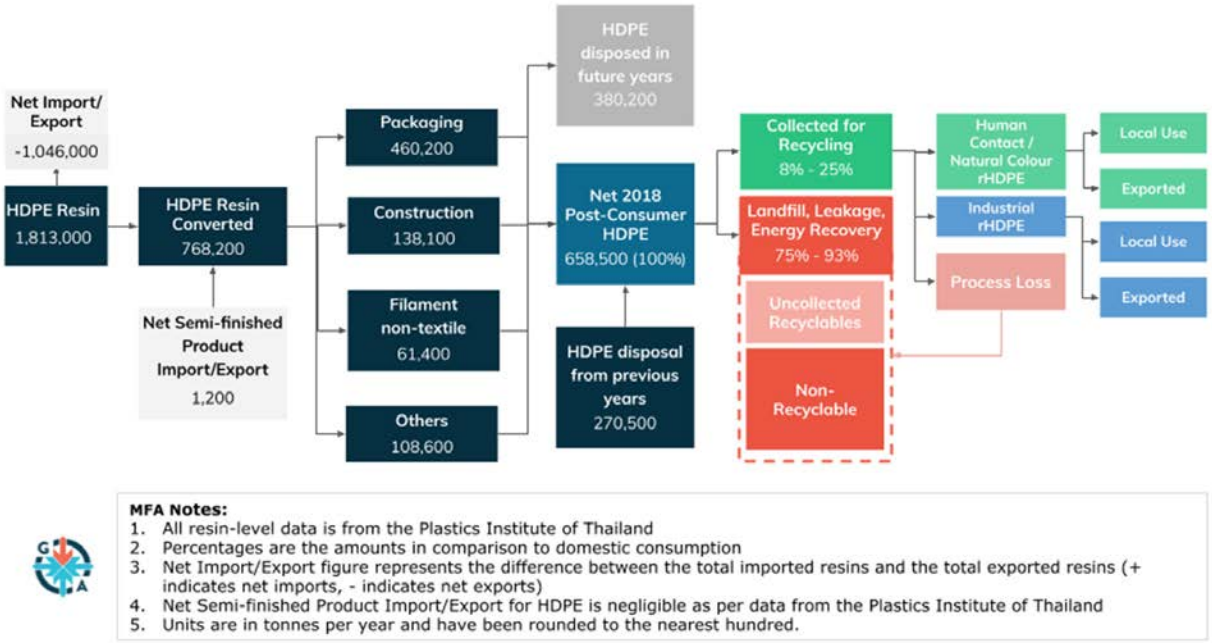


Figure 22 Notes:

1. *Data source for resin production, imports and exports: Plastics Institute of Thailand*
2. *Data source for accumulation in future years and disposal from previous years: Plastics Institute of Thailand, GA Circular modeling*
3. *Data sources for consumption: Plastics Institute of Thailand, stakeholder interviews with convertors, brand owners, GA Circular modeling based on above data sources*
4. *Data source for Collection for Recycling and its breakdown: Stakeholder interviews with processors and recyclers, GA Circular modeling*
5. *Due to the limited scope of the project and data availability, some aspects of the flow were not able to be examined. For plastics that were not recycled, the proportions which ended up between Landfill, Leakage and Energy Recovery were not determined.*
6. *In reality, most of these values have wide fluctuations. The values shown in this chart are our best average estimates of the realities.*

There are three key messages from the MFA of HDPE in Thailand:

1. The CFR rate for HDPE is 8% - 25%. Similar to the calculations for PP, the low end of the range (8%) was calculated based on the PCD's MFA, which was based on a range of consumer products. An additional 17% was added to estimate a higher range to account for the recycling of HDPE from industrial sources based upon verifications with a major resin producer and recycler.[12] Additionally, the range of collection for recycling rates (8% - 25%) estimates was also verified through stakeholder interviews as a reasonable estimation.
2. Like PP, a high proportion of HDPE is used in film packaging applications, which includes food packaging and plastic garbage bags. These HDPE products are contaminated and therefore have low value yields and remain uncollected.
3. HDPE that is used in composite components with other materials is classified as non-recyclable as it is difficult to separate from other materials in the composite. Unless designed to be dismantled easily, HDPE used in components such as this will remain unrecyclable and be classified as residual waste even if the product is stripped for parts.

Material Value Loss Analysis for HDPE

Figure 23 represents the value unlocked for HDPE based on the above MFA for HDPE. The key findings are:

- Average CFR is 16.7% and Value Yield is 63.8%. This unlocks 10.7% of material value.
- An average of 89.3% of the recycling value of HDPE is lost. This is equivalent to USD 906 - 1,020 million of recycling value lost per year.

12 HDPE containers are used for many industrial applications such as in plumbing pipes, large containers for fuel, lubricants, agricultural chemicals such as fertilizers and pesticides. HDPE products from these industrial applications are typically not mixed with other streams of MSW which make it more profitable to collect and recycle them compared to HDPE from mixed MSW.

Figure 23.
MATERIAL VALUE LOSS ANALYSIS FOR HDPE (2018 VOLUMES)

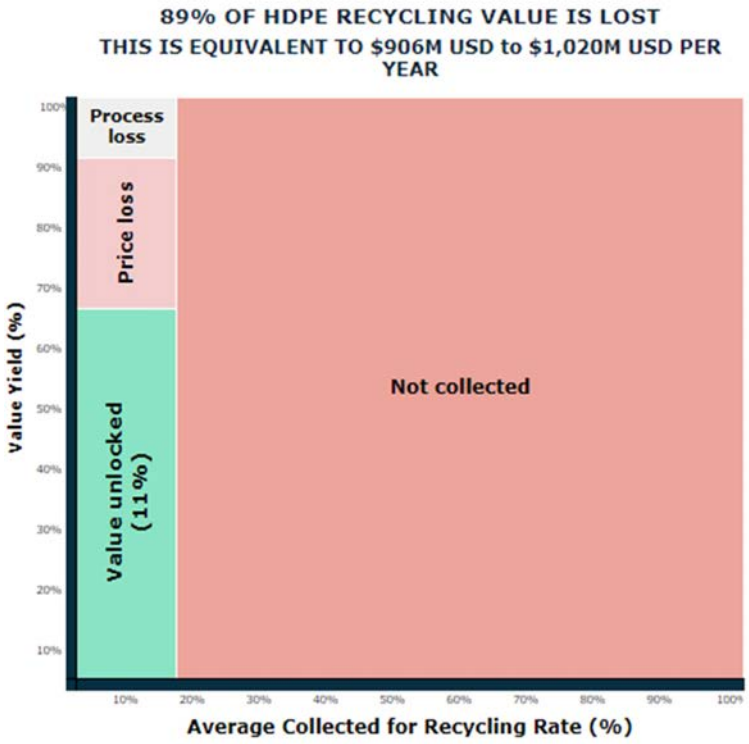


Figure 23 Notes:

1. *Value yield = volume yield x price yield where volume yield = output volumes / input volumes, and price yield = weighted average USD per tonne of reprocessed HDPE / USD per tonne of most valuable recycled product from HDPE.*
2. *MVRP for HDPE is rHDPE food-grade pellets which are being manufactured in some countries but not yet in Thailand. As only some of Thailand's HDPE can be turned into rHDPE food-grade, a weighted average of the different products is used to calculate the MVRP price for rHDPE.*
3. *Current situation for HDPE is an average of 88% volume yield (as process losses are approximately 12%) and 73% price yield, thus giving a 64% value yield.*
4. *Total volume of HDPE is 658,500 TPY, and most valuable recycled product price of USD 1,206 / ton.*
5. *CFR rate only includes HDPE (i.e. not other contaminants).*
6. *Process losses only includes HDPE (i.e. not other contaminants).*
7. *All percentages used here are weighted average values.*

2.2.4. LDPE/LLDPE

General Characteristics of LDPE

LDPE is a thermoplastic polymer produced from the monomer ethylene. While it has a slightly lower density, the ability to make it transparent means that it is used mainly in film applications for both packaging and non-packaging applications.

Some products that can be made from LDPE are:

- Meat and poultry wrapping
- Dairy products
- Snacks and sweets
- Frozen food bags
- Baked goods

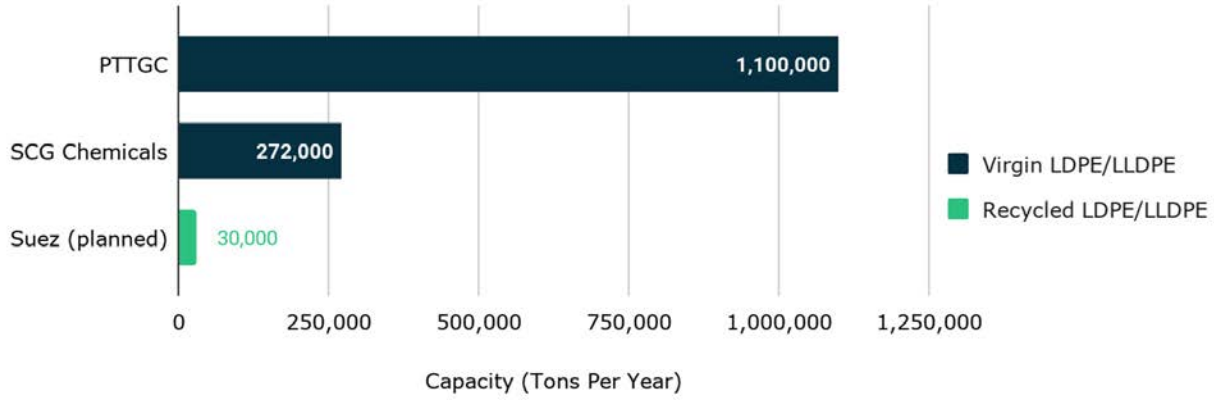
LDPE can be recycled into the following:

- Plastic lumber, furniture
- Trash bags, sheeting, films (for agriculture)
- Flooring

Major LDPE Producers and Recyclers in Thailand

Figure 24 shows the respective amounts of virgin LDPE/LLDPE production and recycled LDPE/LLDPE production for the major producers and large recyclers reviewed under this study.

Figure 24.
MAJOR PRIVATE SECTOR STAKEHOLDERS FOR LDPE/LLDPE RESIN (2020)



Sources: Private sector stakeholder interviews, financial reports and site visits by the study team.
Note: this is not an exhaustive list of all LDPE/LLDPE producers and recyclers in Thailand.

Figure 25.
MATERIAL FLOW ANALYSIS OF LDPE/LLDPE RESIN IN THAILAND (2018, TONNES PER YEAR)

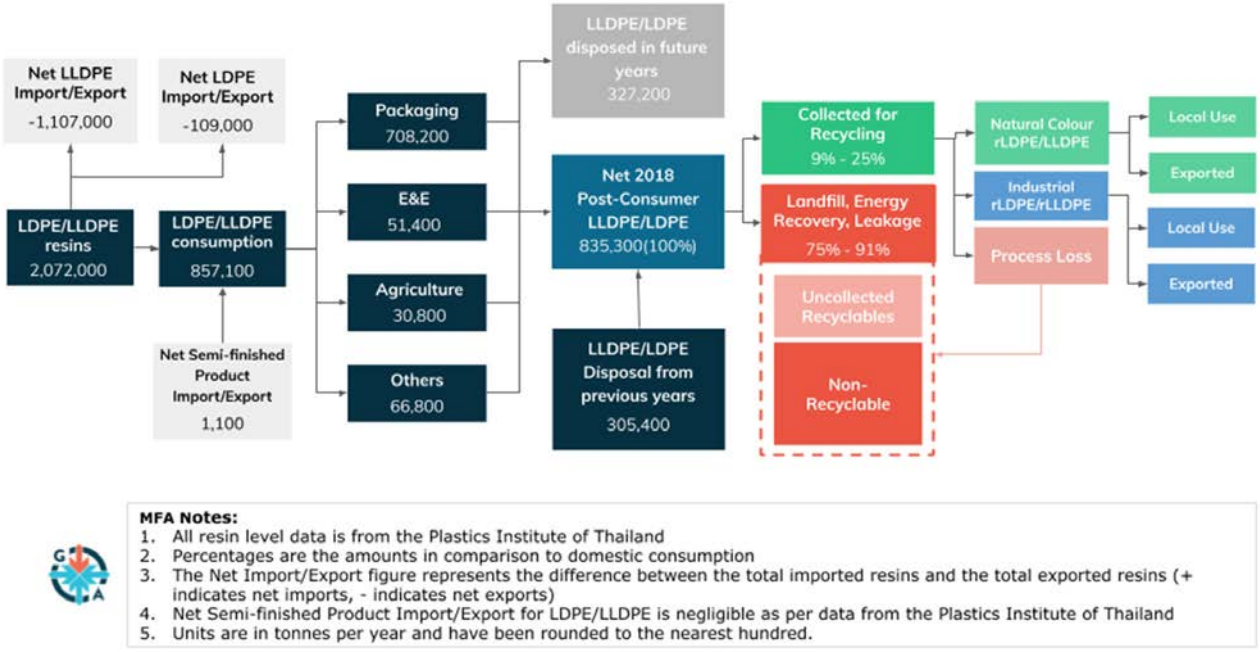


Figure 25 Notes:

1. *Data source for resin production, imports and exports: Plastics Institute of Thailand*
2. *Data source for accumulation in future years and disposal from previous years: Plastics Institute of Thailand, GA Circular modeling*
3. *Data sources for consumption: Plastics Institute of Thailand, stakeholder interviews with convertors, brand owners, GA Circular modeling based on above data sources*
4. *Data source for Collection for Recycling and its breakdown: Stakeholder interviews with processors and recyclers, GA Circular modeling*
5. *Due to the limited scope of the project and data availability, some aspects of the flow were not able to be examined. For example, for plastics that were not recycled, the proportions which ended up between Landfill, Leakage and Energy Recovery were not determined.*
6. *Most of these values have wide fluctuations. The values shown in this chart are our best average estimates of the realities.*

There are three key messages from the MFA of LDPE/LLDPE:

1. The CFR rate for LDPE/LLDPE is between 9% and 25%. Like PP and HDPE, the low end is calculated using data from the PCD's MFA while the high end accounts for collection of post-industrial waste. This study estimates a similar recycling rate as HDPE and this has been verified by stakeholders interviewed.
2. The majority of LDPE/LLDPE collected for recycling is typically cling wrap that is used to wrap and collate goods packed on pallets during transport and storage. These wraps rarely come into contact with contaminants and so, unlike film applications of PP and HDPE, the film applications of industrial / commercial grade LDPE/LLDPE can be more readily processed by recyclers if adequate quantities of waste films can be collected. However, a key challenge for LDPE/LLDPE is the lack of an existing collection network, large-scale aggregators and low rLDPE prices. A major LDPE/LLDPE recycler interviewed shared the challenge of having to source from over 200 suppliers within Thailand with wide ranging quality standards to achieve minimum feedstock.
3. LDPE/LLDPE that is used in composite components with other materials are classified as non-recyclable as it is difficult to separate from other materials in the composite components. Unless designed to be dismantled easily, LDPE/LLDPE used in components such as these will remain unrecyclable and be classified as residual waste even if the product is stripped for parts.

Material Value Loss Analysis for LDPE/LLDPE

Figure 26 represents the value unlocked for LDPE based on the above MFA for LDPE/LLDPE. The key findings are:

- Average CFR is 17.0% and Value Yield is 82.7%. This unlocks 14.1% of material value.
- An average of 85.9% of the recycling value of LDPE/LLDPE is lost. This is equivalent to USD 616-718 million of recycling value lost per year.

Figure 26.
MATERIAL VALUE LOSS ANALYSIS FOR LDPE/LLDPE (2018 VOLUMES)

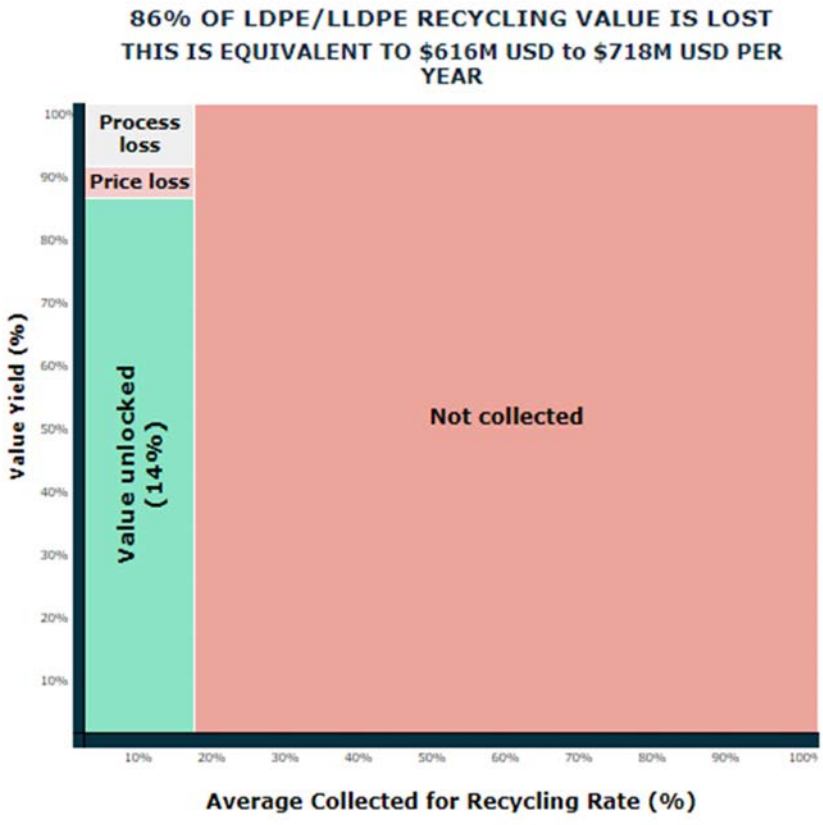


Figure 26 Notes:

1. *Value yield = volume yield x price yield where volume yield = output volumes / input volumes, and price yield = weighted average USD per tonne of reprocessed LDPE or LLDPE / USD per tonne of most valuable recycled product from LDPE or LLDPE.*
2. *MVRP for LDPE and LLPDE is rLDPE natural pellets. As only some of Thailand's LDPE/LLDPE can be turned into rLDPE natural pellets, a weighted average of the different products is used to calculate the MVRP price for rLDPE.*
3. *Current situation for LDPE or LLDPE is an average of 88% volume yield (as process losses are approximately 12%) and 94% price yield, thus giving a 83% value yield.*
4. *Total volume of LDPE and LLDPE is 835,300 TPY, and most valuable recycled product price of USD 798 / ton.*
5. *CFR rate only includes LDPE or LLDPE (i.e. not other contaminants).*
6. *Process losses only includes LDPE or LLDPE (i.e. not other contaminants).*
7. *All percentages used here are weighted average values.*

2.3 SUMMARY

2.3.1. MFA for all Resins

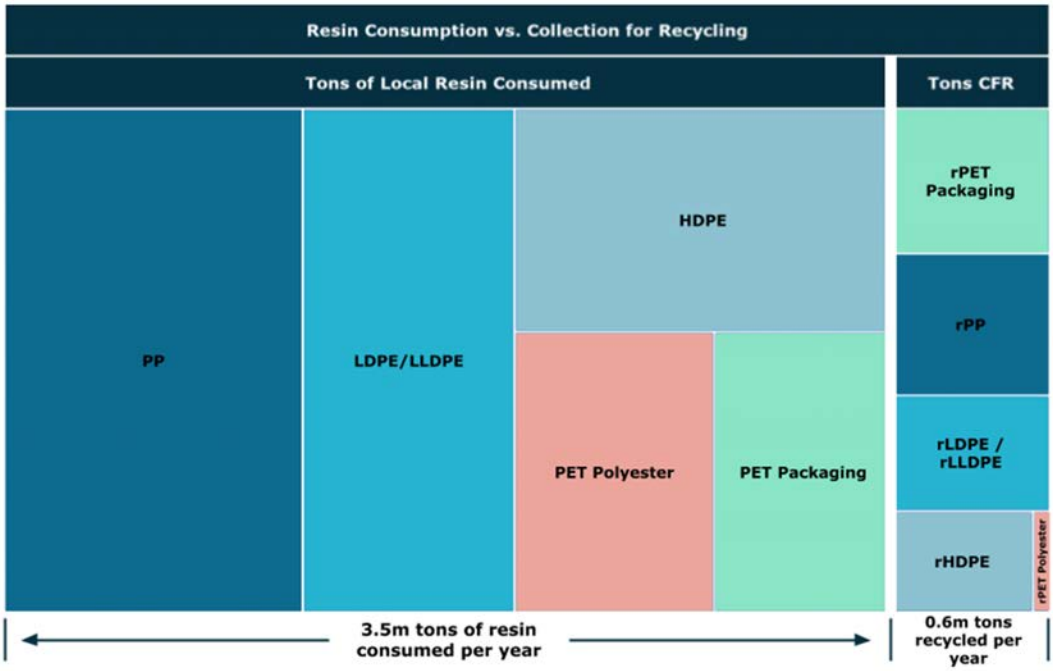
Key insights from comparing the MFA between the resins show:

1 PET packaging has the highest CFR rates of all four resins. This is due to several factors:

- The number of end-use applications that are used by PET packaging is limited compared to other materials, which simplifies the collection process. PET is used primarily for food and beverage packaging, hence collectors are able to easily identify them (e.g. PET plastic bottles). The other resins, however, can be used in a wide range of applications such as electronics, automotive and construction components, and this complicates the process of collection.
- The technology and relatively high capacities for processing PET packaging into various applications, as well as the demand from global end-use markets for recycled PET, including some high-end applications, already exists in Thailand (although the recycling capacities are still lower than optimal). This gives PET packaging recycling a "head start" when compared to the recycling for other resins.
- The recycled products from PET such as rPSF and rPOY can be readily absorbed by the fiber industry in Thailand and thus rPET is well-integrated with the current industrial ecosystem
- PET packaging has a much lower consumption amount than the other resins (about 382,300 TPY for PET packaging versus 681,000 TPY for PP packaging, 460,200 TPY for HDPE packaging and 708,200 TPY for LDPE/LLDPE packaging).

Figure 27.
ESTIMATED CFR RATES FOR EACH RESIN (2018)

Figure 28.
ESTIMATED TOTAL COLLECTED FOR RECYCLING OUT OF TOTAL CONSUMPTION FOR EACH RESIN



---

2 | The weighted average of the CFR rates of all the key resins is 17.6%.

This is behind the National Plastic Waste Management Road Map 2018-2030 CFR target for 2018 of 22%.

3 | 3.49 million TPY of the key resins are consumed in Thailand.

Of this, 616,000 TPY are recycled while 2.88 million TPY are not recycled.

2.3.2. Material Value Loss Analysis for all Resins

To support the sense of urgency needed to address this plastics circularity gap, Figure 29 summarizes the net material value lost each year in Thailand due to this gap.

- Thailand unlocks USD 564 million / year from recycling various plastic resins. This is a relatively sizable sub-sector of the petrochemical industry.
- Thailand has the potential to unlock material value up to USD 4.3 billion / year from recycling various plastic resins.
- Currently only 13% of the possible value from recycling is being unlocked, leading to a loss of 87% of the value. This is equivalent to a loss of USD 3.6-4.0 / year and this is the addressable market opportunity for plastics circularity for Thailand.

Photo: franz12 / Shutterstock

Figure 29.
ESTIMATED MATERIAL VALUE UNLOCKED VS MATERIAL VALUE LOST (2018)

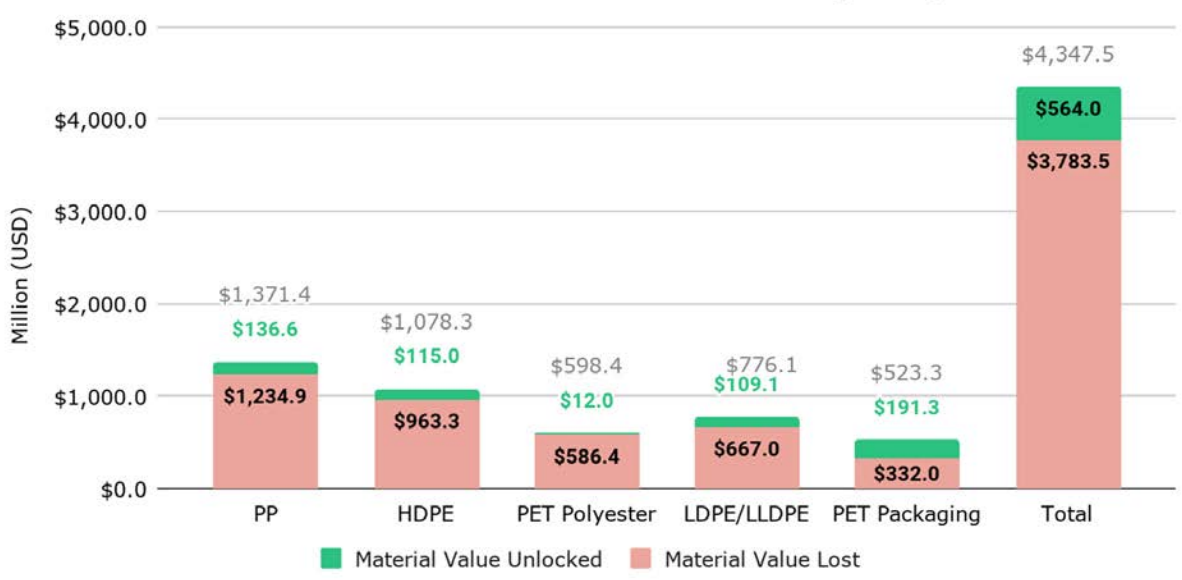
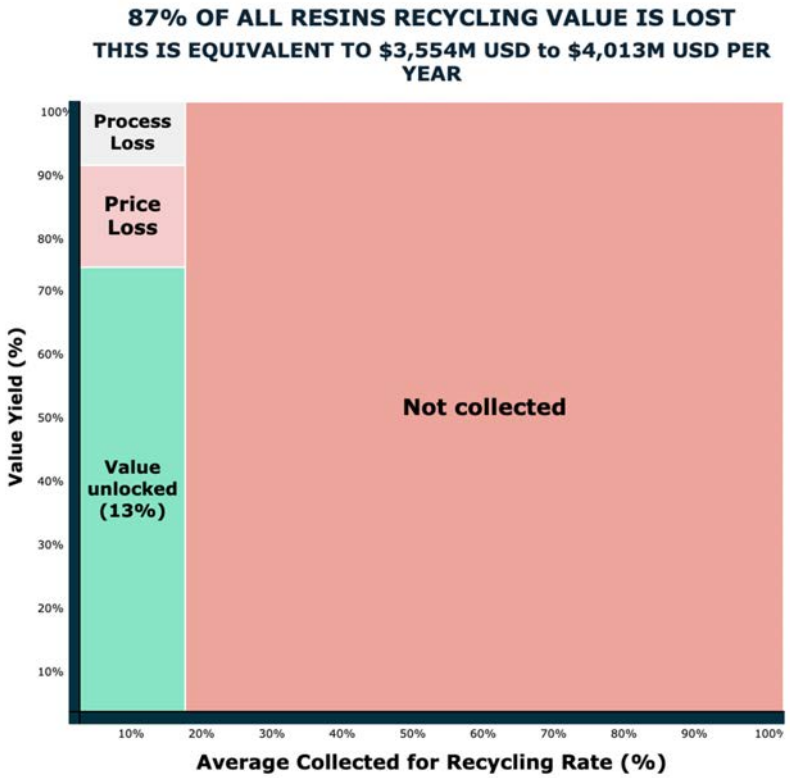
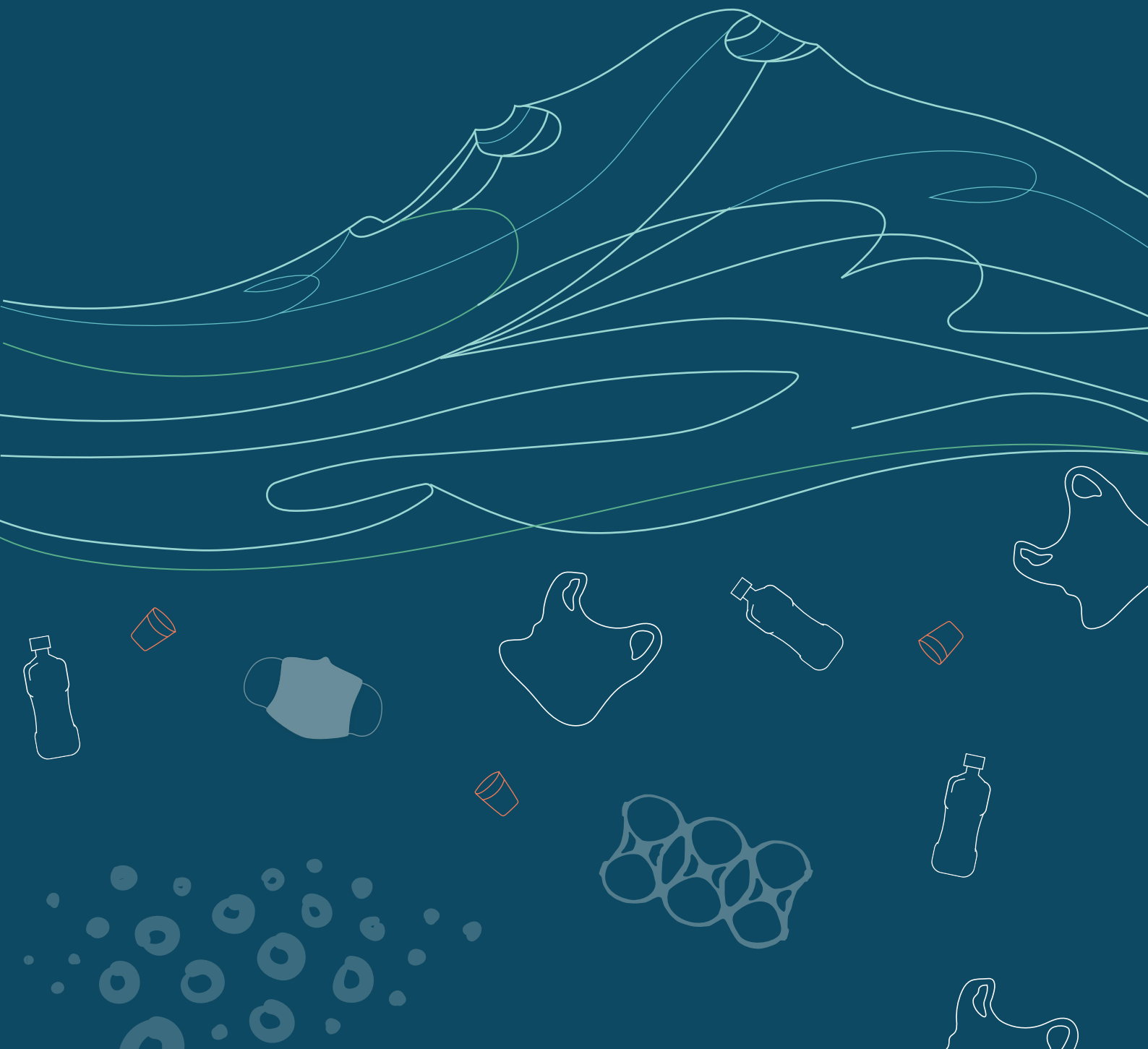


Figure 30.
MATERIAL VALUE LOSS ANALYSIS FOR ALL KEY RESINS (PET, PP, HDPE AND LDPE/LLDPE), 2018 VOLUMES



SECTION 3:

WHY 87% OF MATERIAL VALUE OF PLASTICS IS LOST



SECTION 3:

WHY 87% OF MATERIAL VALUE OF PLASTICS IS LOST

As seen in the previous section, 2.88 million TPY of plastics consumed in Thailand is not recycled and, as a result, 87% of the material value is lost. This section presents the two main categories of pressures that cause this material value loss: Pressures that impact CFR (covered in Section 3.1) and pressures that impact Value Yield (covered in Section 3.2)

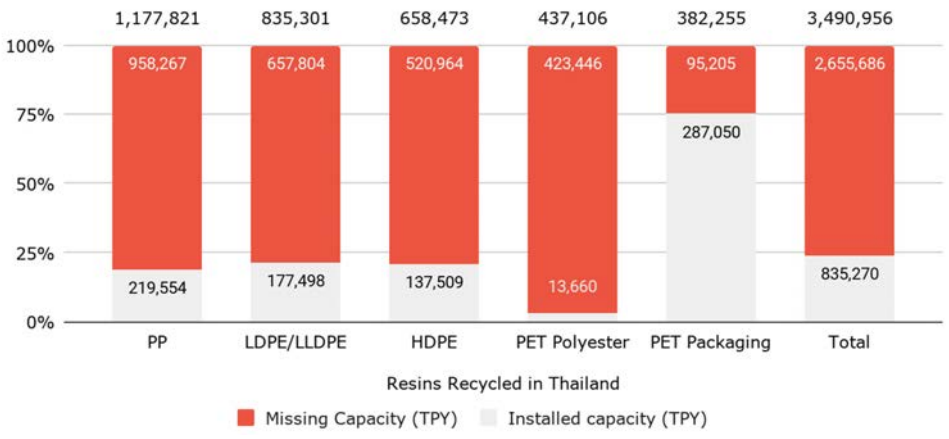
While the CFR and Value Yield data used in this study is based on volumes from 2018, COVID-19 has had a significant negative impact on the health of the recycling industry impacting both CFR and Value Yield. Section 3.3 covers the impact of COVID-19 on the recycling industry in Thailand. Bioplastics and energy recovery of plastics are, as yet, having an insignificant impact on loss of material value of plastics and this is covered in Section 3.4.

3.1 PRESSURES IMPACTING CFR RATE

3.1.1. Lack of local demand for recycled plastics across all key resins

The current gap in recycling capacity in Thailand is equivalent to 2.66 million TPY or 76% of the total resins consumed. The gap is least pronounced for PET packaging (25% gap), most pronounced for PET polyester (97% gap), with the remaining resins — PP (81% gap), HDPE (79% gap) and LDPE/LLDPE (79% gap) — close behind. Based on publicly available data, the newly announced investments for recycling across all the key resins add up to 107,000 TPY, or 4% of the gap that needs to be overcome. This gap in recycling capacity is symptomatic of the low demand of recycled plastics from within the local market in Thailand.

Figure 31.
MISSING CAPACITY VS INSTALLED CAPACITY FOR RECYCLING OF MAJOR RESINS IN THAILAND



Lack of local demand for recycled plastics, especially for recycled plastics with high value end-use applications, leads to poor financial value and margins, resulting in a lower **CFR rate**. Industry sources shared that PET packaging recycling capacity has grown an average of 15% year-on-year since 2016 and remains the most widely invested resin type for recycling in Thailand. Capacity growth is lower for all other resins and for PET polyester. A primary reason for this is the maturity of the PET recycling market and strong local polyester industry which demands rPET. Global demand for recycled resins in food-grade applications is expected to increase substantially in the next 10 years and the overall lack of installed capacity prevents Thailand from competing in this high margin market.

Linked to the lack of local demand for recycled plastics is the fact that Thailand currently lacks an EPR policy framework that clarifies the responsibilities of all key stakeholders in the value chain for different industries, sets binding targets for collection, recycling or recovery, and prescribes a framework for operationalizing the EPR through economic tools. Well-designed EPR schemes can play a key role to provide the necessary funding for extended and improved separate collection of plastics. In some countries with very high recycling rates, most separate collection and treatment costs for packaging waste are financed through contributions paid by the producers.[13] Without an EPR policy in place, industries are not obliged or incentivized to increase the CFR rate.

See Box 1 for examples of enabling policies from benchmark countries that support increase in recycling capacity and implementation of EPR (further details can be found in Appendix 4).

13 EU Strategy for Plastics in the Circular Economy 2018

BOX 1.
POLICIES SUPPORTING INCREASED RECYCLING CAPACITY AND IMPLEMENTATION OF EPR

PACKAGING

The EU's Single Use Plastics Directive requires all EU member states to recycle at least 55% of all plastics packaging by 2030. Single-use plastic drink bottles have an even higher targeted CFR rate of 77% by 2025 and 90% by 2029.

This Directive also requires EU member states to implement Extended Producer Responsibility (EPR) schemes covering the costs of collection, transport, and treatment, litter clean-up, and awareness-raising measures for food containers, packets and wrappers, cups for beverages, beverage containers with a capacity of up to three liters, lightweight plastic carrier bags and fishing gear by 31 December 2024.

Many EU member states already have such EPR schemes for packaging in place for over 20 years, allowing the EU to reach a 42% CFR rate for plastic packaging as of 2017.

India's draft 2019 National Resource Efficiency Policy sets targets for packaging recycling including a 100% recycling rate for PET packaging by 2025 and 75% recycling and reuse rates for other plastics by 2030. Additionally, the Uniform Framework for EPR in India 2020 outlines options for producers of packaging in India to set up EPR via a fee-based model or a Producer Responsibility Organization (PRO) model.

ELECTRONICS

The EU's Waste Electrical and Electronic Equipment (WEEE) Directive 2012/19/EU provides for the creation of collection schemes where consumers return their WEEE free of charge.

Under Japan's Home Appliance Recycling Law, manufacturers are required to take back home appliances that they have manufactured or imported from retailers and recycle them. The law assigns responsibilities for each stakeholder across the product life cycle. It compels stakeholders such as retailers and manufacturers to provide for collection infrastructure such as drop-off sites and take-back services. For stakeholders who do not have the ability to provide collection systems, such as households, recycling fees are mandated to be paid to help fund the collection system.

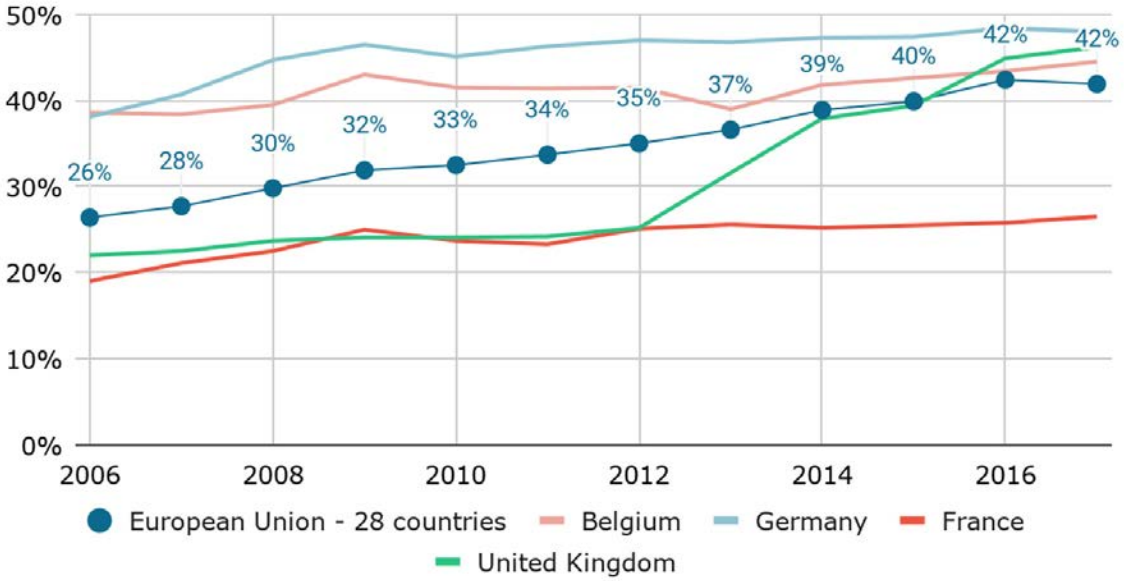
CONSTRUCTION

Singapore's BCA Green Mark Scheme encourages the use of sustainable materials in construction and the provision of recyclables collection infrastructure.

FILAMENT

The EU's First Circular Economy Package (2018) requires Member States to ensure that textiles are collected separately by 2025.

Figure 32.
PLASTIC PACKAGING RECYCLING RATES IN THE EU



Source: Eurostat

3.1.2. High reliance on informal sector to drive collection

Most of the collection of post-consumer resins in Thailand are collected by the informal sector. Taking Bangkok as an example of urban areas in Thailand, the collection of materials by the informal sector across all 50 districts of the city allows the Bangkok Metropolitan Authority (BMA) to save about THB 500 million (USD 15.8 million) / year in avoided waste management costs, including landfills.[14] For context, these savings are 8.3% of the THB 6 billion / year (USD 184 million) that is spent on waste management per year by the BMA. These savings are also nearly equivalent to the THB 504 million / year (USD 16 million) that the BMA collects from residents. These estimated cost savings indicate a strong financial incentive for the BMA to support informal actors in continuing and improving their role in reducing and managing plastic waste in Bangkok.[15]

There is also an incentive for private companies managing waste transfer stations to support informal actors, particularly waste pickers inside the transfer stations, to reduce the volume of waste. In the Sai Mai transfer station in Bangkok, which receives waste from up to 18 districts within Bangkok, informal waste pickers collect roughly 2 tons of plastic waste / day. They collect this waste from among the municipal solid waste that is unloaded in the transfer station, for which the BMA pays them THB 735 / ton. Despite these contributions, the informal sector continues to lack recognition. Thailand's 1992 Public Health Act states that unlicensed collecting, transporting or disposal of solid waste is illegal, thus putting all informal waste workers in a precarious legal position.[16]

The significance of the informal sector is due to the absence of any scalable formal avenues of collection of resins for recycling (e.g. source segregation of recyclables, dedicated materials recovery facilities for recyclables). This, in effect, creates a parallel system of recyclables collection alongside formal MSW collection wherein materials amassed by the informal collectors as well as by formal collectors are traded through the informal network of junk shops to end up at the factories of processors and recyclers.

14 UNESCAP, "Closing the Loop" Sai Mai District, Bangkok Case Study, 2018

15 UNESCAP, "Closing the Loop" Sai Mai District, Bangkok Case Study, 2018

16 UNESCAP, "Closing the Loop" Sai Mai District, Bangkok Case Study, 2018

This parallel economy of recyclables collection is important because there are three challenges pertaining to the informal sector that impact CFR. The informal sector:

1. Prioritizes higher value plastics over lower value plastics.
2. Prefers to find better paying jobs than working in recyclables collection.
3. Lacks legal recognition and lacks safety or other equipment that could increase their workplace safety and productivity.

Figure 33 shows a 3-year price chart from a major aggregator in Thailand to whom the informal sell. This indicates that rigid plastics consistently receive much higher prices than flexible plastics. Even within the rigids, PET and HDPE receive higher prices compared to PP. This highlights that, as long as collection is left completely to market forces, only higher value plastics will be prioritized by the informal sector at the expense of flexibles are other lower value plastics, which lowers the CFR rate for plastic products with film and strap applications.

Film and strap products from HDPE, LDPE and PP have lower value than rigid resins due to three key factors: 1) it takes more effort to collect 1 kg of the material due to the typically low weight of the material for each product as compared to rigids; 2) they are more contaminated than rigids due to the nature of their end-use application in MSW in food packaging or as garbage bags; 3) they cost more to clean.

Previous studies in Thailand as well as other Southeast Asian countries conducted by this study team in 2017 and 2018 discovered that falling prices of recyclables, coupled with increasing costs of living, has made collecting recyclables challenging for informal workers.[17] If recyclables collection was prioritized and carried out by the formal waste collection system, the CFR rates would be expected to increase as cities develop. However, this is not the case across Southeast Asia. As a result, CFR rates are typically lower in more developed cities (see Figure 34). Therefore, it can be expected that a continued reliance on the informal sector will result in drops in **CFR rate** as GDP per capita grows in Thailand.

The ongoing COVID-19 pandemic exacerbates the impacts of a reliance on the informal sector. A major aggregator in Thailand, interviewed in May 2020, reported a 20-25% drop in PET supply and a 50% drop in HDPE and LDPE supply, primarily due to lockdown across Thailand and the consequent inability of the informal sector to enter the streets and collect recyclables. This indicates that the informal sector are key stakeholders in the collection of post-consumer materials in Thailand and support should be provided to enable their continued collection through better working conditions and safety practices, or they may move out of the trade entirely.

17 Full Circle: Accelerating the Circular Economy for Post-consumer PET Bottles in Southeast Asia (2019)

Figure 33.
COMPARISON OF INFORMAL SECTOR (JUNK SHOPS, INFORMAL COLLECTORS) SALES PRICES TO MAJOR AGGREGATOR IN THAILAND

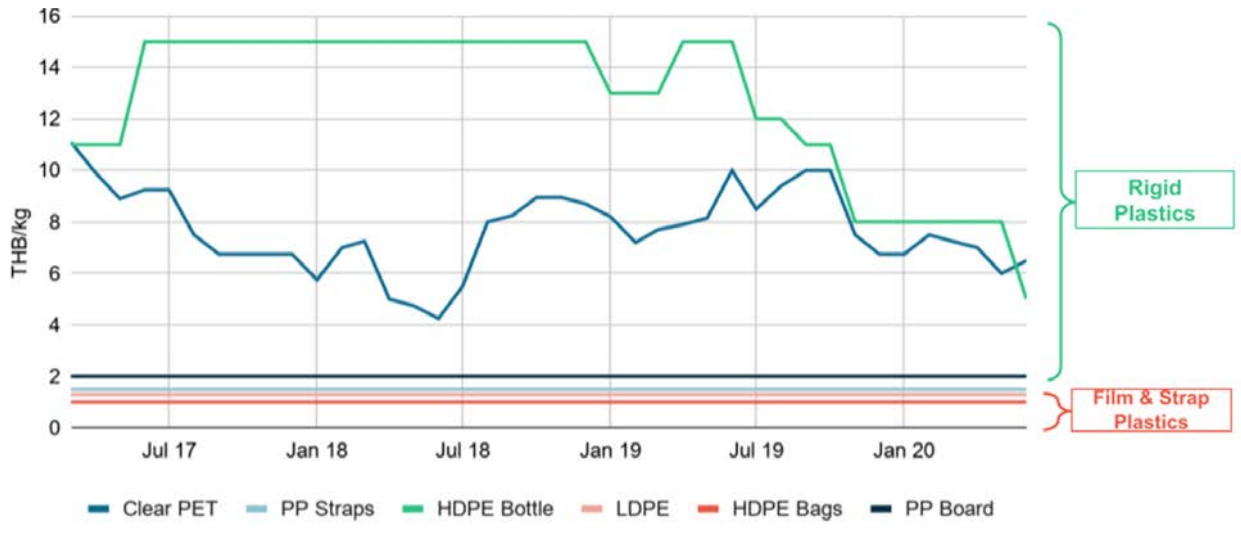
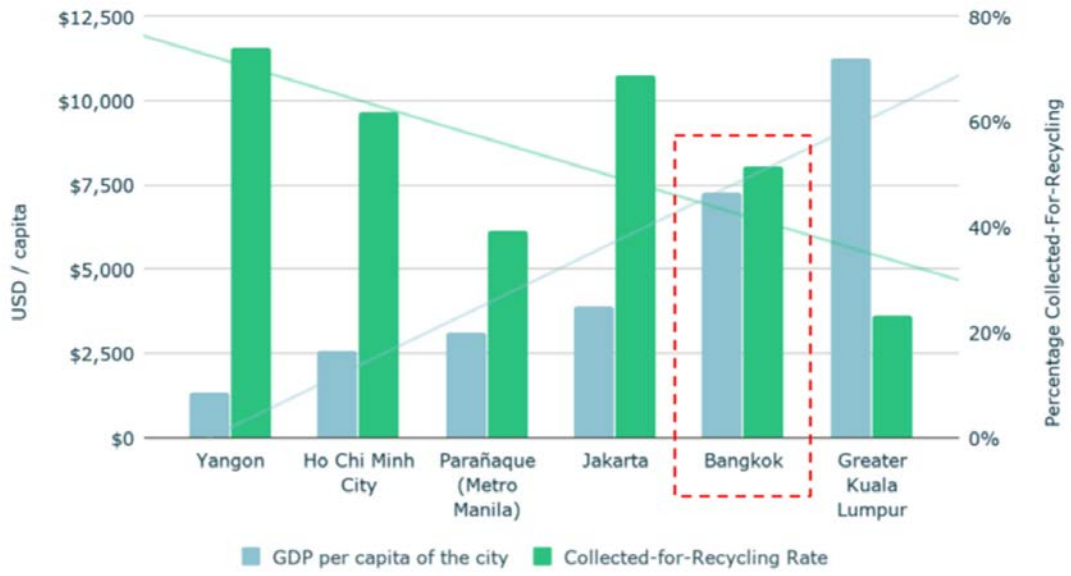


Figure 34.
CORRELATION BETWEEN GDP PER CAPITA AND CFR RATES SUGGESTS THE HEAVY RELIANCE ON INFORMAL SECTOR



Examples of enabling policies from benchmark countries that support recognition and integration of informal sector (further details can be found in Appendix 4):

Guidelines document for Uniform Framework for Extended Producers Responsibility in India 2020, under Plastic Waste Management Rules 2016:

- The guiding principles promote the increased circularity of plastics through incentivizing source separation recycling programs. This includes, directly and indirectly supporting improvements in the working conditions and incomes of informal recyclers.
- The principles call for any informal sector stakeholders such as waste pickers, junk shops and aggregators to be formalized and further strengthened for proper functioning of the EPR model.
- Under the guidelines, waste management agencies are required to engage informal waste pickers and create opportunities for them to participate in the formalized waste management systems with:
  - Adequate environmental, health and safe working conditions
  - Occupational recognition, respect and dignity
  - Appropriate and fair business models
  - Auditing waste management operations;
  - Communication, education and inclusion initiatives for waste workers
  - Other activities involving integration of the informal sector into the formal sector

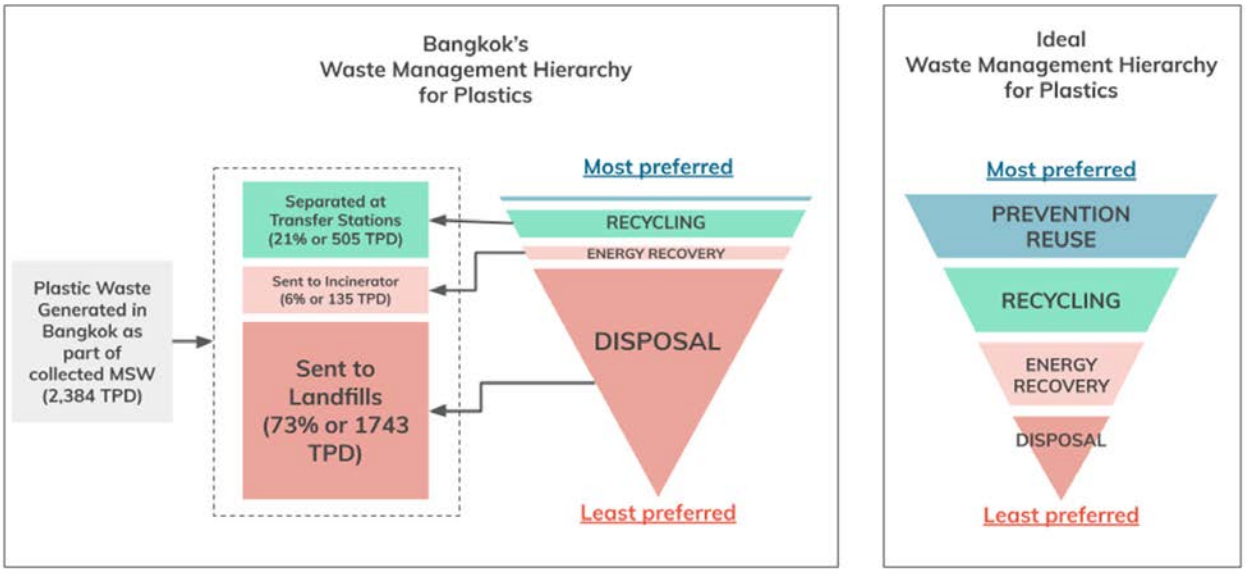
3.1.3. MSW system is built for collection, not circularity

The existing MSW system in Thailand is designed to collect and dispose of waste mostly into landfills and some into incinerators. Taking Bangkok as a proxy for urban areas in Thailand, based on the latest statistics and breakdowns available as of 2016, BMA collects ~10,130 TPD of MSW (this does not account for recyclable plastics that have already been collected by the informal waste sector).[18]

All 50 district BMA offices manage MSW collection for each household, community, building and commercial area. District offices provide disposal bins to communities and buildings. Targeting to achieve 100% collection coverage, BMA has outsourced collection and waste transfer to landfills to the private sector. As greater collection coverage has been the main target over the years, Bangkok, in particular, and Thailand, in general, have not yet developed an integrated SWM (ISWM)

18 Climate and Clean Air Coalition, "Solid Waste Management City Profile Bangkok"

Figure 35.
BANGKOK'S PLASTICS WASTE MANAGEMENT HIERARCHY (LEFT); IDEAL PLASTICS WASTE MANAGEMENT HIERARCHY (RIGHT)



system based on circularity principles. ISWM refers to the strategic approach to sustainable management of solid wastes covering all sources and all aspects, including source segregation, separate collection and transfer, sorting, recycling, recovery and disposal in an integrated manner, with an emphasis on maximizing resource use efficiency.

24% of all MSW collected by BMA in Bangkok is plastics or approximately 2,400 TPD. Of these plastics collected, 73% is currently sent to landfills via transfer stations and 6% to an incineration plant for energy recovery. Only 21% of collected plastics are separated at transfer stations for recycling, causing a lopsided waste management hierarchy for plastics, with disposal comprising a vast majority of plastics waste management.[19]

The MSW infrastructure is not fully designed for circularity and no specific landfill reduction targets or recycling targets for major waste categories have been set for municipal administrations. As a result, the quality of plastics collected is low because they are already mixed with general waste at source and contaminated with other waste streams by the time they reach transfer stations. This lack of an ISWM system is a major obstacle to achieving plastics circularity, leading to lower amounts of plastics being extracted, thus reducing **CFR rate**. It also results in recyclers spending more time and resources to process the current feedstock, thus reducing both **volume yield** and **price yield**, and therefore the **value yield**.

See Box 2 for examples of enabling policies from benchmark countries that support the transition to a circular MSW system (further details can be found in Appendix 4).

3.1.4. Recycling industry receives a different set of fiscal incentives and subsidies compared to the petrochemical industry

Through the last four decades of Thailand's petrochemical industry, Thailand's Board of Investment (BOI) has offered a wide range of tax and non-tax incentives for projects that meet national development objectives. As of 2019, BOI's tax-based incentives for the petrochemical and plastics industry include:

1. Exemption of import duties on machinery and raw materials.
2. Five-year corporate income tax exemption for projects that manufacture petrochemicals and/or plastic packaging with special properties (e.g. multilayer plastic packaging, aseptic plastic packaging, etc.).
3. Non-tax incentives including permission to own land, bring expatriates and take or remit foreign currency abroad.[20]

19 Climate and Clean Air Coalition, "Solid Waste Management City Profile Bangkok"

20 Thailand's Petrochemical Industry

BOX 2.
POLICIES SUPPORTING TRANSITION TO A CIRCULAR MSW SYSTEM

PACKAGING

The EU's First Circular Economy Action Plan (2018) sets a common EU target for recycling 65% of municipal waste by 2035; a binding landfill target to reduce landfill to maximum of 10% of municipal waste by 2035; a ban on the landfilling of separately collected waste; separate collection obligations are strengthened beyond recyclables and extended to hazardous household waste (by end 2022), bio-waste (by end 2023) and textiles (by end 2025). The action plan recognizes that if the waste segregation is not done at source, it will be difficult to expect producers to implement EPR, especially for low-value plastics.

The EU Landfill Directive aims to phase out landfilling for recyclable material by 2025. The EU Strategy for Plastics in the Circular Economy encourages EU member states, as well as regional and local authorities in the EU, to internalize the environmental costs of landfilling and incineration through high or gradually rising fees, taxes or other economic instruments

In India, the draft 2019 National Resource Efficiency Policy sets targets for a ban on the disposal of recyclable waste including plastics to landfills by 2025. India's Plastic Waste Management Rules 2016 encourages local urban bodies to recover energy from low grade plastics through cement kilns, waste-to-energy plants or waste-to-oil plants. In response, the cement industry is beginning to substitute coal for Refuse Derived Fuel (RDF) containing plastics, with a goal to reach a Thermal Substitution Rate of coal to RDF of 25% by 2025 and 30% by 2030.

CONSTRUCTION

Japan's Construction Material Recycling Law requires contractors to sort and recycle wastes generated in demolition work of a building.

In the EU, landfill bans are recommended as part of the Construction and Demolition Waste Management Protocol.

In comparison, projects that manufacture plastic products from recycled plastics (i.e. the recycling industry) receive fewer incentives — the major one being a 3-year corporate income tax exemption contingent on recyclers using only domestic plastic raw materials. [21]

A major recycler interviewed for this study reported that while BOI has started promoting recycling as a business activity, it does not allow washing as a promoted activity. This is detrimental to the promotion of recycling as the washing step is a key cost and operational component of any recycling process. A large aggregator who supplies the feedstock to several recyclers in Thailand reported never receiving any tax incentives throughout decades of operation. Additionally, high quality recycled products such as rPET and rHDPE for food-grade applications do not receive any local demand due to product bans on food-grade recycled plastics and lack of any recycled content policies.

Therefore, in comparison to local virgin resin production, recycled resins receive a different set of fiscal incentives and benefits due to unaddressed market failures and existing policy misalignments. This creates an unfair playing field, dampening the growth in recycling capacity, thus negatively impacting **CFR rate**. The disparity makes more competition for virgin resin prices compared to recycled resin prices, which lowers the **price yield** of locally produced recycled resins.

Examples of enabling policies from benchmark countries that support the recycling industry (further details can be found in Appendix 4):

- Under the EU Strategy for Plastics in the Circular Economy, more than €5.5 billion has been allocated to improve waste management across Europe. This is expected to create 5.8 million TPY of additional waste recycling capacity. An example of this is the over €1.5 million to support the Walloon Region of Belgium, for the ERDF Technopoly Recyclage project implementing an innovative process for recycling rigid plastic waste at the landfill itself.
- Under the EU's Horizon 2020 funding, more than €250 million for research and development linked to plastics in the circular economy has been allocated. An additional €100 million by 2020 has been devoted to financing priority actions, including the development of smarter and more recyclable plastics materials, more efficient recycling processes

21 2019 Guide to Board of Investment Thailand

Photo: Prapat Aowsakorn / Shutterstock

and the removal of hazardous substances and contaminants from recycled plastics.

- Under the European Fund for Strategic Investments, €7.5 million loan was granted to GreenFiber International SA to finance a recycling and circular economy project. An estimated 280 full-time jobs will be created and more than 50,000 tonnes of waste are expected to be collected and processed per year.
- Japan follows a policy of the mainstreaming of ESG / SDG financing. Under this policy, which covers not only circular economy but also climate change, several guidelines have been developed, including guidance on company assessment and information disclosure. A high-level panel on ESG finance consisting of top business leaders was also established.

Despite these enabling polices, Japanese and EU commercial banks note that traditional financial assessment methods and tools are not equipped to accurately validate all circular economy business models. For example, Product-as-a-Service is based on contracts instead of assets, making them riskier for banks — who often prefer hard assets as security for their lending — to finance. Also, many circular solutions require collaboration across value chains. Ideally, banks would finance the value chain, but at present, they are more likely to finance single companies.[22]

22 Report on Sustainable Finance for a Circular Economy

3.1.5. Lack of market data (price and trade volume data) in the recycling value chain and detailed production data for packaging

Plastics Institute of Thailand (PIT), a specialized government-led institute under the Ministry of Industry, maintains an extensive database on virgin resin production, exports, imports and consumption in Thailand. PIT also provides regular market intelligence and monthly price charts for virgin resins.

However, Thailand lacks independent and authoritative sources of up-to-date price and market information for recyclable materials, especially at the processor and recycler stages of the value chain. The volumes (tonnage) and prices of post-consumer resins moving through the value chain are unclear, thus hindering market liquidity and investments into recycling capacity. This puts negative pressure on the **CFR rate**. It also makes it challenging for recycled products to be sold without causing a significant movement in the price and with minimum loss of value. This lack of market data poses an obstacle for new players looking to enter the recycling market or for existing recyclers to grow their capacities as it makes it harder to predict the cycles of the volatile trading market for recycled products.

To enable positive interventions in the recycling market, participants in the market — such as local authorities, waste management companies, recyclers, re-processors and social economy businesses — need information on weekly and monthly pricing trends, size of contracts and

current market conditions for recovered materials. The only up-to-date price information source for recyclable materials in Thailand is provided at the aggregator stage by Wongpanit, a large aggregator. This source, however, is not independent and does not include any trade volume data.

Also, while packaging is a significant end-use industry for all the major plastic types, a detailed breakdown of the amounts of packaging producers place in the market each year is not available in Thailand.

Examples of enabling policies from benchmark countries that support market data for recycled products and detailed production data for packaging (further details can be found in Appendix 4):

- Countries in the EU, as well as Japan and Singapore, have all mandated producers of packaging and packaged products to collect data on the types and amounts of packaging they place on the market each year. They must report the packaging data to either a relevant industry-led producer responsibility organization or to the government as the first step towards more sustainable packaging waste management. This reporting lays the foundation for an Extended Producer Responsibility (EPR) framework for managing packaging waste.
- As EPR frameworks were implemented and demand for recycled plastics started to grow, market intelligence firms such as IHS Markit, ICIS, S&P Platts, Wood Mackenzie began offering market data services for recycled products in regions such as Europe and North America.

3.1.6. Polyolefin recycling is fragmented, and small recyclers constantly switch their lines

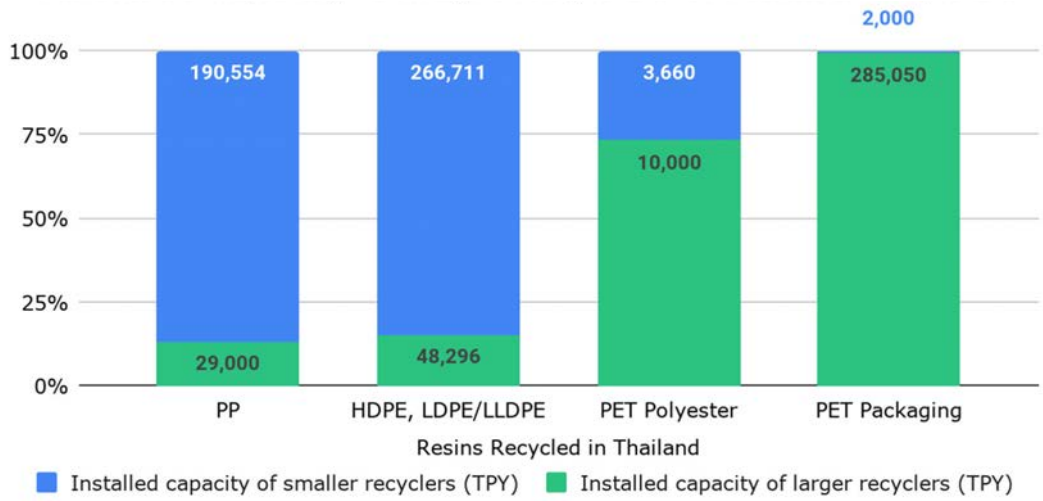
The installed capacity for polyolefin resins (i.e. PP, HDPE and LDPE/LLDPE) recycling is significantly lower than that of PET packaging, as seen in the earlier section of this report. Also, the end-use products of these polyolefins are typically geared toward lower value recycled products when compared to that of PET packaging, with the notable exception of products of recyclers such as EcoBlue, Indorama, Suez[23] (planned) and Envicco (planned). The composition of these polyolefins allows them to be easily recycled into low quality end-use products with a basic equipment setup while using the same machinery. Many smaller recyclers[24] in Thailand have followed suit, setting up their operations to take advantage of this flexibility.

This is important as it means these smaller recyclers constantly switch between resins, resulting in two key impacts. First, these recyclers are unable to secure long-term contracts from buyers in the packaging industry due to their operational setup, quality of their end products and inability to provide consistent feedstock. This, to some extent, impacts the price yield and thus the value yield. Secondly and more importantly, these resins compete against each other for recycling, cannibalizing the CFR rate for polyolefins. For example, if demand for rPP experiences significant

23 Planned refers to the fact that these recyclers are still in the process of setting up their recycling capacity.

24 Smaller recyclers are defined for the purposes of this study as recyclers with a capacity lower than 3,000 Tons Per Year.

Figure 36.
SMALLER RECYCLERS DOMINATE IN RECYCLING POLYOLEFINS (HDPE, LDPE/LLDPE AND PP) IN THAILAND (AS OF 2018)



increase over a quarter, the CFR rates for the other resins (e.g HDPE, LDPE) might face a sharp decline in that quarter as recyclers switch to PP recycling to take advantage of the higher price.

See Box 3 for examples of enabling policies from benchmark countries that support increase in recycling capacity and implementation of EPR to encourage recycling of lower value plastics (further details can be found in Appendix 4).

3.2 PRESSURES IMPACTING VALUE YIELD

3.2.1. Recyclables are of low quality due to lack of design for recycling and source segregation

Recyclers interviewed for this study reported a contamination rate of up to 26% of the feedstock they receive from within Thailand. This includes contaminants due to poor segregation practices and poor packaging design. Figure 37 provides examples of products with poor design for recycling.

Sorting of recyclables at source is currently done on the spot by formal waste collectors as a secondary income stream, which is outside their primary scope of work. Informal waste collectors also access the recyclables, either directly from source or from collection points, before the formal waste collectors get to access it. These recyclables are then sold to junk shops, which are also considered to be part of the informal sector as most junk shops are not registered businesses.

Collection of recyclables via this method is inefficient. This method does not return a high amount of materials (due to the collection not being a function of their primary role) and the materials recovered by waste collectors tend to be highly contaminated from being mixed with other wastes in MSW.

Contamination due to lack of source segregation and poor design for recycling lowers both the volume yield and price yield, and thus also lowers the **value yield**.

BOX 3.
POLICIES SUPPORTING INCREASE IN RECYCLING OF LOWER VALUE PLASTICS

PACKAGING

The new legislative measures introduced in the EU since 2018 through the Plastics Strategy and the Single Use Plastics Directive oblige the plastics industry to take immediate and decisive steps in production and waste management of all types of plastics packaging.

The EU's Single Use Plastics Directive requires all EU member states to recycle at least 55% of all plastics packaging by 2030.

Understanding that setting targets alone is not enough, the Single Use Plastics Directive also requires EU member states to implement Extended Producer Responsibility (EPR) schemes covering the costs of collection, transport, and treatment, clean-up litter and awareness-raising measures for food containers, packets and wrappers, cups for beverages, beverage containers with a capacity of up to three liters, lightweight plastic carrier bags and fishing gear by 31 December 2024. The Single Use Plastics Directive put special emphasis on lower value plastics such as polyolefins used on food-contact packaging.

ALL INDUSTRIES

The EU acknowledged that more and better plastics recycling is also held back by insufficient volumes and quality of separate collection and sorting, especially for lower quality post-consumer plastics such as flexible polyolefins. To encourage more standardized and effective practices across the EU, the Commission will issue new guidance on separate collection and sorting of waste.

As part of the First Circular Economy Packaging 2018, the EU amended four existing legislations: Waste Framework Directive, Landfilling Directive, Packaging Waste Directive, Directives on End-of-Life Vehicles and Electrical and Electronic equipment (WEEE) to set:

- A common EU target for recycling 65% of municipal waste by 2035
- A common EU target for recycling 70% of packaging waste by 2030
- Specific recycling targets for plastics: 55 %
- A binding landfill target to reduce landfill to maximum of 10% of municipal waste by 2035
- These amendments to the four legislations include clearer obligations for national authorities to step up separate collection, targets to encourage investment in recycling capacity and to avoid infrastructural overcapacity for processing mixed waste.

Figure 37.
EXAMPLES OF PRODUCTS WITH POOR DESIGN FOR RECYCLING

Left to right: PET bottles with PVC labels; Printed PET cups; PP cups with PET caps; Printed HDPE body with aluminum top; Colored bottles with full body labels and pumps with metal springs.

Source: EcoBlue Limited, Thailand

See Box 4 for examples of enabling policies from benchmark countries that support design for recycling (further details can be found in Appendix 4).

3.2.2. Full exposure to drops in global and local virgin demand and prices

The prices of recycled products are directly affected by changing prices of their virgin counterparts, which in turn is affected by global oil price volatility. Taken over the last 3-year period, most of the recycled resins have seen a steady drop in global prices since peaking around mid-2018.[25] Based on industry interviews in Thailand, plastics recycling tends to be competitive when the oil prices are around USD 70-80 / barrel, which was last reached in September 2018. As of April 2020, the oil prices are 76% lower at USD 17 / barrel.

25 See Appendix for price charts showing virgin resins, recycled resins and oil prices for all key plastic resins.

BOX 4.
POLICIES SUPPORTING DESIGN FOR RECYCLING

ELECTRONICS

The EU Ecodesign Directive, part of the Circular Electronics Initiative, requires devices be built for energy efficiency and durability, reparability, upgradability, maintenance, reuse and recycling.

PACKAGING

The EU Strategy for Plastics in the Circular Economy requires all plastics packaging placed on the EU market to be reusable or recyclable by 2030.

The EU Commission is also initiating work on new harmonized rules to ensure all plastics packaging placed on the EU market can be reused or recycled in a cost-effective manner by 2030.

AUTOMOTIVE

As part of the EU's End-of-Life Vehicles (ELV) Directive, automobiles should be designed to facilitate proper dismantling and to allow components and materials to be reused, recycled and/or recovered.

Japan's Automobile Recycling Law sets out roles and responsibilities for each key stakeholder in the recycling of ELV. Vehicle owners are required to pay an annual 'Recycling Fee' which helps fund collection and recycling of ELV.

ALL INDUSTRIES

The EU Strategy for Plastics in the Circular Economy encourages industries to improve dialogue and cooperation across the value chain, on material and product design aspects.

When competing on the basis of price alone, recyclers report that their recycled products need to be between 15-30% cheaper than virgin resin-based products to be competitive. When virgin resin prices fall below or equal to recycled resin prices, manufacturers switch back to virgin resins, as has been the case over the last 12 months. The only exception that some recyclers in Thailand have reported is the continued demand for recycled PET resin from overseas markets, which is bought by:

- Bottler clients in European markets
- Major international food and beverage companies in other parts of the world such as North America and Australia that have committed to using post-consumer resin in their packaging
- Suppliers to apparel companies that have a commitment to incorporate more recycled content into their products

Countries in the EU as well as India have started to take steps to reduce the impact of the oil price volatility on their recycling industries by mandating recycled content requirements. For example, the EU has mandated incorporation of 25% recycled plastics into drinking bottles by 2025 and 30% by 2030. This goal pushes companies to use 10 million tonnes of recycled plastics in their packaging by 2025 – quadrupling the current demand. Similarly, in the UK, the government has proposed a tax on the production and import of plastic packaging with less than 30% recycled content from April 2022.[26]

Given the current coupling between virgin plastic prices and recycled plastic prices, the market-driven status quo of plastics recycling is simply not sustainable when oil prices are below USD 70-80 / barrel. Structural and systemic corrective measures, especially supporting legislations, are needed to ensure the recycling industry remains competitive against virgin plastic prices. Without government intervention in Thailand, Thai recyclers will remain fully exposed to global drops in oil and virgin plastics prices, thus reducing the price yield of recycled plastics in Thailand therefore reducing the **value yield**.

See Box 5 for examples of enabling policies from benchmark countries that reduce recycling industry's exposure to price volatility and stimulate local demand.

3.2.3. Inability to capitalize on growing demand for food-grade recycled products

Food-grade and food contact recycled resins are growing in demand globally. Given that packaging is the largest end-use industry for plastics, global commitments by leading brand owners to increase recycled content usage in their packaging has spurred this demand growth. Food contact packaging applications require the highest quality of post-consumer resin, resulting in more operational costs per ton. For example, the production of food-grade rPET involves processes such as Solid State Polymerization which increases the intrinsic viscosity of waste PET back to virgin levels. To enable this process, a more intensive cleaning process is required. In contrast, recycling of waste PET into rPET fiber though extrusion lowers the intrinsic viscosity of the resin, which results in a lower quality material.

One of the main advantages of this growing demand is that the price of food-grade resins, such as food-grade rPET, has begun a partial decoupling from virgin PET prices beginning in April 2018. This is primarily because members of the European Federation of Bottled Waters, an industry association of bottlers in Europe, pledged publicly in May 2018 to include at least 25% of rPET into the production of new bottles by 2025, as an EU average. In addition, the European bottlers pledged specific PET tonnage towards the EU target of using 10 million tonnes of recycled plastics in the EU market. The industry in the EU pledged to only use recycled content of high-quality food-grade rPET proven to induce no safety and quality risks. This pledge was taken in anticipation of the EU's Single Use Plastics Directive which has since passed, mandating a target of 25% rPET usage in bottles by 2025 and 30% by 2030.

Thus, food-grade rPET prices have remained strong even as virgin PET prices faced significant losses in the second half of 2018 onwards, as shown in Figure 38. This is significant as other recycled products (e.g. rPET flakes) experienced a decline in prices in the same time period (i.e. they continue to be coupled to virgin PET prices). The EU's recycled content requirement and subsequent start of decoupling of food-grade rPET prices is a clear example of why a strong push to mandate recycled content in packaging is needed in Thailand.

In Thailand, production of food-grade rPET remains minimal (~3%) and is all made for export. This lack of local demand for food-trade recycled products means Thai recyclers are unable to capitalize on the higher

26 EU Waste Regulation Blazing a trail for Circular Economy Packaging

BOX 5.
POLICIES THAT REDUCE PRICE VOLATILITY AND STIMULATE LOCAL DEMAND FOR RECYCLING

PACKAGING

The EU Single-Use Plastics Directive specifically requires all PET plastic bottles to meet a 25% recycled content target by 2025 and 30% recycled content target by 2030.

UK recently announced that the tax on plastic packaging containing less than 30% recycled content will come into force in April 2022 and will be set at £200 / tonne

ALL INDUSTRIES

The EU proposed a €0.80 / kg tax covering every kg of non-recycled plastics produced in the EU. The EU Strategy for Plastics in the Circular Economy outlined plans for future targeted sectoral interventions for uptake of recycled plastic content, such as in construction and automotive sectors.

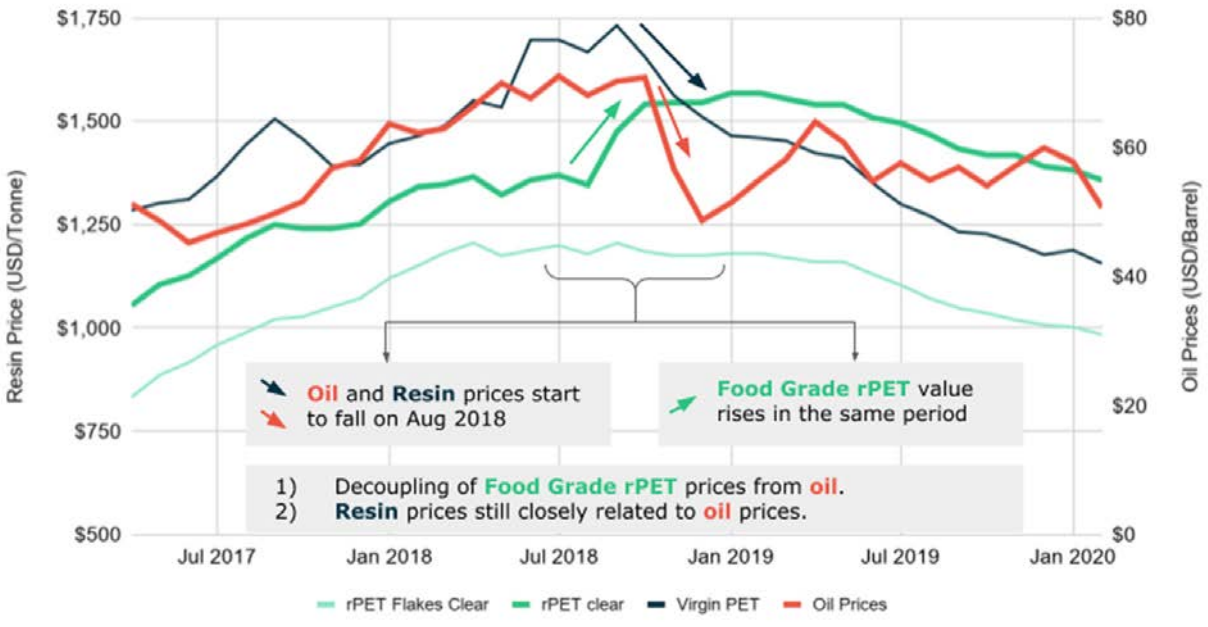
Under the EU Strategy for Plastics in the Circular Economy, the European Commission calls on stakeholders to come forward with voluntary pledges to boost the uptake of recycled plastics. The objective is to ensure that by 2025, 10 million tonnes of recycled plastics find their way into new products on the EU market.

Given China's National Sword Policy and subsequent scrap plastic import bans in several countries that restrict key export routes for plastics waste collected for recycling, the EU recognizes the urgent need to develop a European market for recycled plastics. The EU has pledged to work with the European Committee for Standardization and with the industry to develop quality standards for sorted plastic waste and recycled plastics.

The EU is integrating recycled content in Ecolabel and Green Public Procurement criteria. The French government initiative Objective to Recycle Plastics (ORPLAST) and Italy's new rules on public procurement are two good examples of what could be done at the national level. The ORPLAST project of the Environment Agency (ADEME) in France supports 33 industry projects for the reincorporation of recycled plastics by helping manufacturers to study and invest in the use of recycled material, combined with a grant to fill the gap between the price of fossil plastics and the price of recycled ones.

Maharashtra state in India will soon requires all manufacturers of industrial plastics to use 25% recycled content.

Figure 38.
GLOBAL PRICE COMPARISON OF VIRGIN PET AND RECYCLED PET



Source: Industry data

margins and are also more exposed to global price volatility, thus reducing **value yield**.

In interviews with recyclers in Thailand working to expand or build new food-grade rPET recycling capacity, recyclers expressed a growing demand of rPET from EU bottlers as a major factor in moving forward with CAPEX investment decisions.

This lack of local demand for high-end applications also prevents smaller scale recyclers from making CAPEX investments like purchasing the expensive equipment required for high-quality recycled packaging to meet requirements of global brands. Smaller recyclers are typically unable to meet the large offtake quantities required by global buyers and thus rely on local demand, which is currently non-existent.

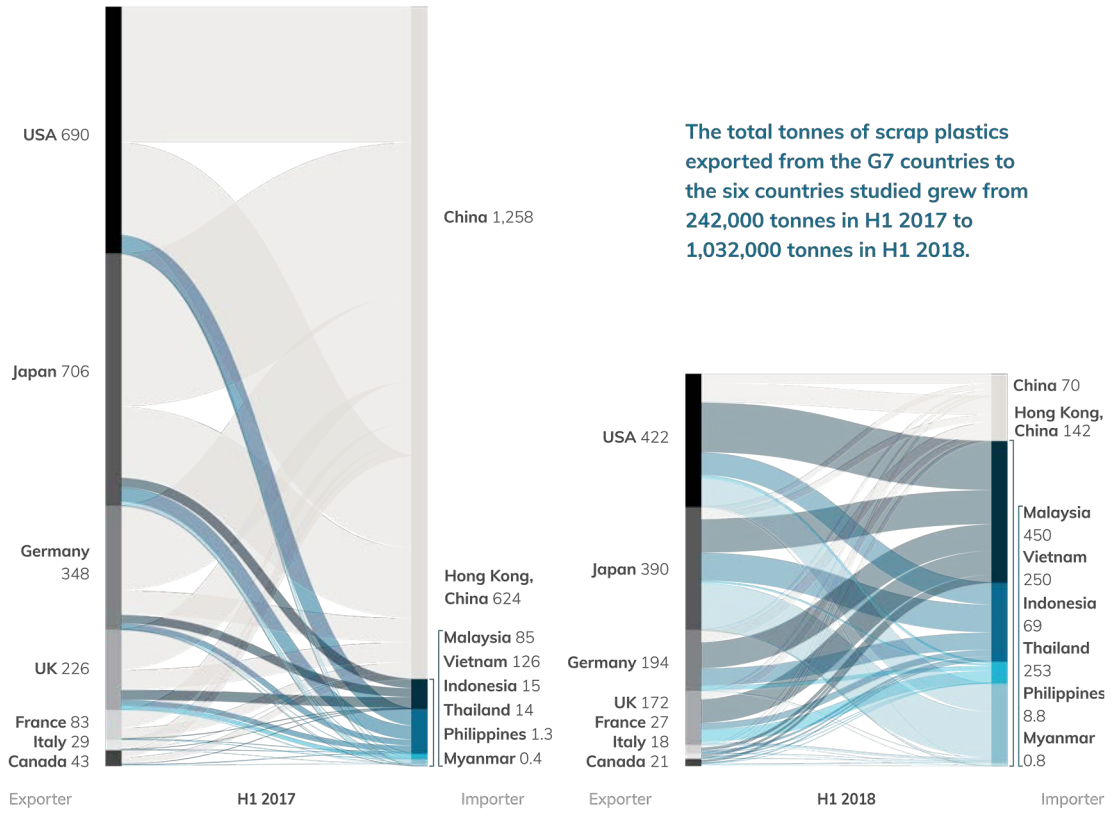
3.2.4. Import ban on high-quality, recyclable scrap plastics

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 amounts to USD 18 billion in material value. In 2017, China accounted for 51% of the world's plastic scrap imports. Due to the growing plastic scrap import and plastic waste leakage into the environment, China has undertaken policy steps over the past decade to curb the dumping of waste and genuine recyclables into its borders.

On 1st January 2018, China officially implemented its National Sword policy to further crackdown on the illegal smuggling of foreign waste into China, targeting industrial waste, electronic scrap and plastics. This resulted in a global glut of recyclable commodities, depressed prices and expansion of processing markets in other lesser-developed countries, with a sizable proportion of this diversion going into Southeast Asian countries — including Thailand.[27] In the first half of 2018, Thailand imported 253,000 TPY of scrap plastics in comparison to the first half of 2017 when it only imported 14,000 TPY.

27 GA Circular, Full Circle: Accelerating the Circular Economy for Post-Consumer PET Bottles in Southeast Asia

Figure 39.
SHIFT IN THE FLOW OF SCRAP PLASTICS AS A RESULT OF CHINA'S NATIONAL SWORD POLICY



Source: GA Analysis based on UN Comtrade data
Note: All figures in thousand tonnes per year.

Thus, overwhelmed by the increased volume of scrap plastics and the potential threat of waste dumping into its borders, Thailand took steps to cut back on imports in 2018. At present, the government has stopped issuing new licenses to scrap plastic importers and will be moving to enforce a complete import ban by 2021 on any scrap plastics that have not been processed.

Based on stakeholder interviews with recyclers, these import restrictions have disrupted recycling value chains. Smaller and new recyclers entering the market can no longer rely on high-quality imported feedstock of sorted, recyclable plastics to complement their locally sourced feedstock, especially in the case of lower value plastics such as HDPE, PP and LDPE/LLDPE. As a result, larger and more established recyclers who have existing value chains setup in Thailand dominate the local access to post-consumer materials, making it harder and more expensive for smaller or new recyclers to source feedstock. This has reduced the price yield for smaller and newer recyclers, thus reducing the value yield.

While recyclers admit that the import restrictions have pushed up the supply of locally sourced feedstock, the net increase in CFR rate is expected to have been minimal. For example, a major PET recycler estimated the net increase in CFR rate after import restrictions to have been only 2%. At the same time, lack of imports has prevented all recyclers (big or small) from being able to optimize their capacities, blend the high-quality imported feedstock with domestic feedstock and produce higher value products. This has reduced both the volume yield and price yield, and thus the value yield.

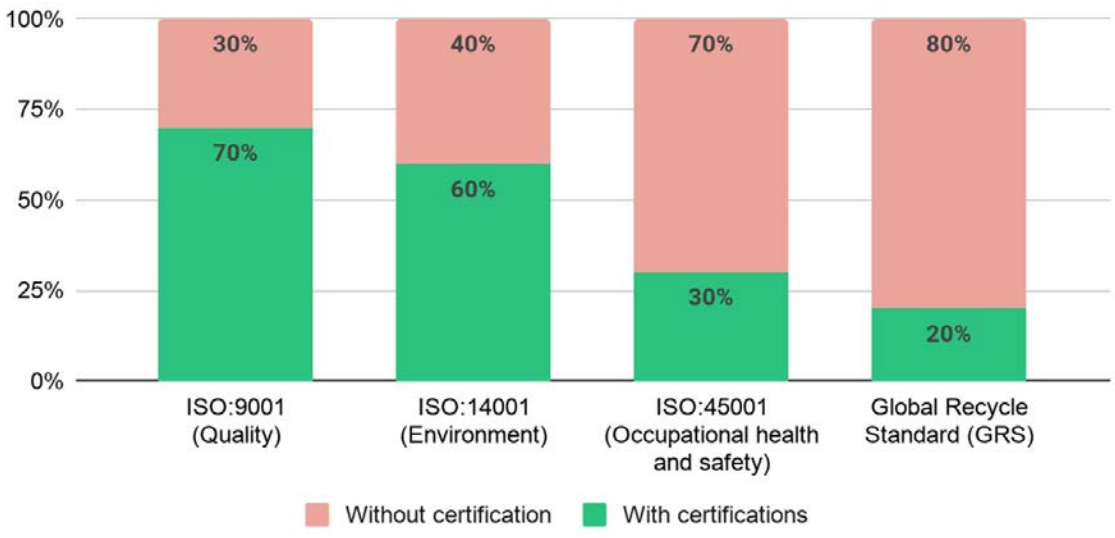
3.2.5. Missing global Environmental, Health and Safety (EHS) standards

Based on publicly available data of a sample of 10 large recyclers that represent a total of 453,000 TPY of installed and planned recycling capacity (47% of total expected recycling capacity in Thailand), a majority of the larger recyclers in Thailand have global quality standards (70%) and global environmental standards (60%), as measured by the relevant standards such as ISO and Global Recycle Standards (GRS). However, only 30% meet global occupational health and safety standards and only 20% have GRS for their recycled plastics produced.

Stakeholders in the recycling industry have reported that implementing all the necessary global EHS standards is an expensive investment and often not prioritized.

Increasingly, consumer goods companies that have set commitments to include recycled plastics are looking for suppliers of recycled products to meet third-party certified standards for recycled content, chain of custody, social and environmental practices, and chemical restriction. This requires recyclers to go beyond quality certifications (i.e. beyond ISO:9001), have third-party certifications that verify the recycled content

Figure 40.
ENVIRONMENTAL, HEALTH AND SAFETY (EHS) STANDARDS CERTIFICATIONS OF A SAMPLE OF LARGE RECYCLERS



of their products (both finished and intermediate) and to verify responsible social, environmental and chemical practices in their production. The objectives of these Chain of Custody (CoC) standards and certifications are to define requirements that ensure accurate content claims, good working conditions, no child labor, recognition of the workers' right to collective bargaining and minimize harmful environmental and chemical impacts in the value chain and production process.[28]

The relatively high proportion of the large recyclers in Thailand that do not have all of the ISO:14001, ISO:45001 and GRS standards means the smaller recyclers are even less likely to achieve these standards. Recyclers are therefore unable to maximize the price yields and thus the **value yields**.

3.3 FURTHER NEGATIVE IMPACTS DUE TO COVID-19

While an assessment of the impact of COVID-19 on recycled plastics was not part of the scope of work for this study, some initial insights on the pandemic's short-term and expected longer-term impact on the recycling industry in Thailand are provided in this section.

3.3.1. Supply reductions due to changes in consumption patterns

The consumption streams, which have traditionally provided comparatively cleaner feedstock (such as food service, hotel channels and office buildings), were closed during the lockdown period in Thailand (end March 2020 until early May 2020). Meanwhile, consumption shifted to households, which generally have lower levels of segregation, making collection and trading of materials significantly more challenging for recyclables collectors, street material pickers and junk shops.

Household consumption behavior changed significantly. For example, the food delivery sector in Thailand grew an estimated 33% in just one month and some businesses reported monthly growth numbers of as much as 300%. This growth fueled increases in plastics generation within homes. Plastics packaging consumption increased by 15% in April, from 5,500 TPD in 2019 to 6,300 TPD.[29] Bangkok's increase was more extreme at 62% (from an average of 2,115 TPD in 2019 to 3,432 TPD in April 2020), due, most likely, to higher concentrations of food and beverage delivery. Even though these numbers suggest there is more feedstock available, it has been widely reported that contaminated items, from takeaway bags to containers, bottles and cups, made up more than 80% of the plastic waste.[30] This is corroborated by interviews with value chain stakeholders who reported that segregating out the plastic packaging to sell for recycling is extremely challenging due to the high food waste volumes.

For a major aggregator in Thailand, feedstock supply quantities dropped 20-50% during the COVID-19 period, and while there are some improvements now that the lockdown has ended, supply volumes are still well below pre-COVID-19 levels. Some of the reduced supply is due to less informal collectors operating during the period, but based on stakeholder interviews, most of it is due to changes in consumption.

28 CoC certification management system certifies an unbroken chain of organizations legally owning the material throughout the supply chain, from the certified recycler output into the final product.

29 ChannelNewsAsia: Food delivery increases Thailand plastic waste during Covid

30 The Jakarta Post (from Reuters): Plastic piles up in Thailand as pandemic efforts sideline pollution fight

Figure 41.
FEEDSTOCK SUPPLY REDUCTIONS EXPERIENCED BY A MAJOR AGGREGATOR IN THAILAND, AS COMPARED TO PRE-COVID-19

SUPPLY REDUCTIONS EXPERIENCED BY A MAJOR AGGREGATOR IN THAILAND		
	As of Mid-May 2020	As of Mid-June 2020
PET	↓ 20-25%	15% increase by June, but then reduced by 10%
HDPE/ LDPE	↓ 50%	↓ 40%
PP	↓ 20-25%	↓ 20%

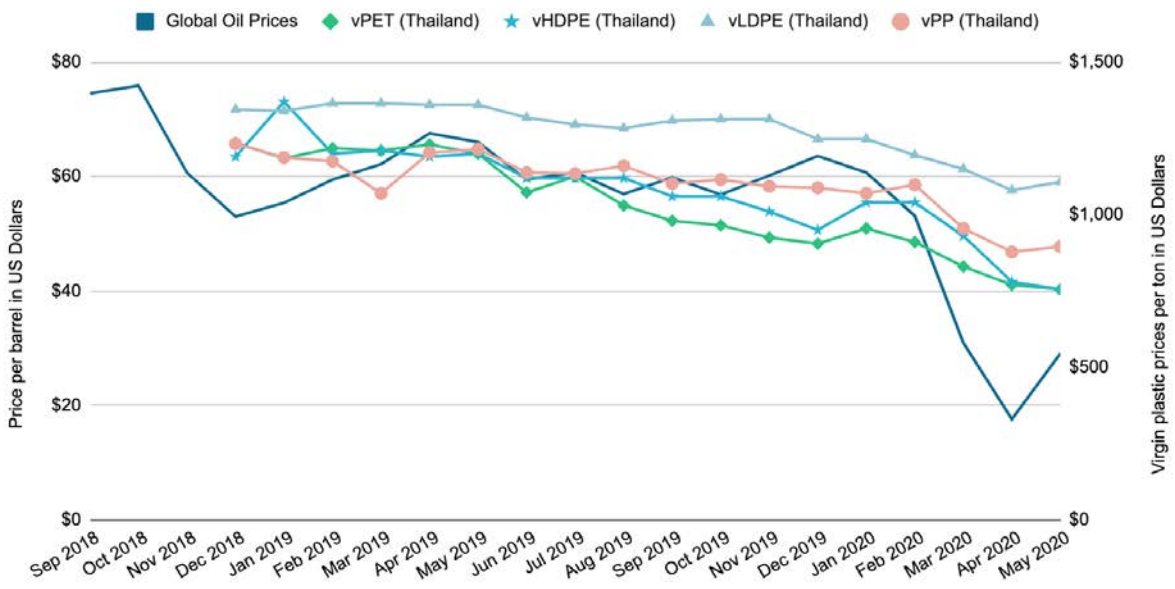
3.3.2. Significant reductions in demand due to low oil prices and economic slowdown

In 2019, virgin prices in Thailand dropped as a result of global oil price reductions and the economic situation in the country. In mid-2019, PET and HDPE started to fall significantly, followed by LDPE declines from November 2019 and steep declines for PP in Feb 2020. These reductions continued to grow from March to May 2020 as oil prices hit their lowest point of USD 18 / barrel — the lowest oil price seen for more than 15 years.

As of April/May 2020, virgin resin prices in Thailand are now 29.5% lower than the same period in 2019. These falling virgin prices put downwards pressure on recycler sales prices and led to manufacturers changing from recycled plastics to virgin plastics.

The lockdowns, continued restrictions and poor economic outlook induced by COVID-19 have further reduced recylate demand. PET experienced the biggest demand decreases due to the slowdown in key industries like textiles, apparel and garments, and ancillary sectors like automotive and household

Figure 42.
REDUCTIONS IN GLOBAL CRUDE OIL PRICES ARE REDUCING VIRGIN PLASTIC PRICES



Sources: International Monetary Fund and U.S. Energy Information Administration (Global Crude Oil Prices), Plastic Institute of Thailand (Virgin resin prices)

Figure 43.
THAILAND VIRGIN PRICE COMPARISON YoY

	April/May 2019 (USD/Ton)	April/May 2020 (USD/ton)	% Price reduction (YoY)
All Resins Average	$1,245	$878	30%
PET	$1,215	$763	37%
HDPE	$1,166	$768	34%
LDPE	$1,360	$1,094	20%
PP	$1,209	$886	27%

Source: Plastic Institute of Thailand (Virgin resin prices).

Figure 44.
DEMAND REDUCTIONS EXPERIENCED BY A MAJOR AGGREGATOR IN THAILAND, AS COMPARED TO PRE-COVID-19

SUPPLY REDUCTIONS EXPERIENCED BY A MAJOR AGGREGATOR IN THAILAND		
	As of Mid-May 2020	As of Mid-June 2020
PET	↓ 70%	Slight increase compared to May, then dropped slightly again
HDPE/ LDPE	Slight reduction	0%
PP		

products. One of Thailand's largest aggregators has experienced a 70% drop in demand since February 2020.

3.4 MINIMAL IMPACT BY BIOPLASTICS AND ENERGY RECOVERY ON LOSS OF MATERIAL VALUE

3.4.1. Bioplastics consumption is growing in Thailand, but remains insignificant to impact recycled plastics demand

Until 2015, bioplastics remained a very niche subcategory of the global plastics industry. However, recent attempts by governments around the world to curb the use of single-use plastics and fossil-fuel derived plastics has given an opportunity for the emergence of bioplastics. With this in mind, Thailand has ambitions to become a major regional bioplastics hub in line with the expected growth in the global bioplastics industry. Globally, an estimated 2 million TPY of different types of bioplastics is produced. In comparison to fossil-fuel derived plastics, this is only 1-2%.

In terms of local bioplastics resin production, Thailand has an installed capacity of approximately 95,000 TPY of PLA and PBS. The two main resin manufacturers are Total Corbion, which has a 75,000 TPY capacity for PLA, and PTT MCC (a subsidiary of PTTGC), which has a 20,000 TPY capacity for PBS. Based on industry interviews with bioplastics industry representatives in Thailand, it is estimated that only 10-20% of the bioplastics resin produced in Thailand is used domestically. The remaining resin is exported to markets around the world including the United States, Europe, Japan, Korea and China. It is also estimated that the resin producers operated at between 60-70% of their installed capacity in 2019. This represents less than 0.5% of all the conventional plastic resins (PET, PE, PP, PVC, PS) consumed in Thailand.

In Thailand bioplastics are primarily used in single use applications for packaging and/or food contact applications such as beverage cups, straws, cutlery, tea bags and carry bags. Bioplastics are typically not suitable for more durable applications such as automotive parts because of the nature of the end product's long-term use and lifespan. Bioplastics are also entering the non-woven fabric market such as face masks, but these applications are still limited.

To understand bioplastics in the context of plastics recycling, it is important to understand their sources and biodegradability together with plastics based on conventional, fossil resources.

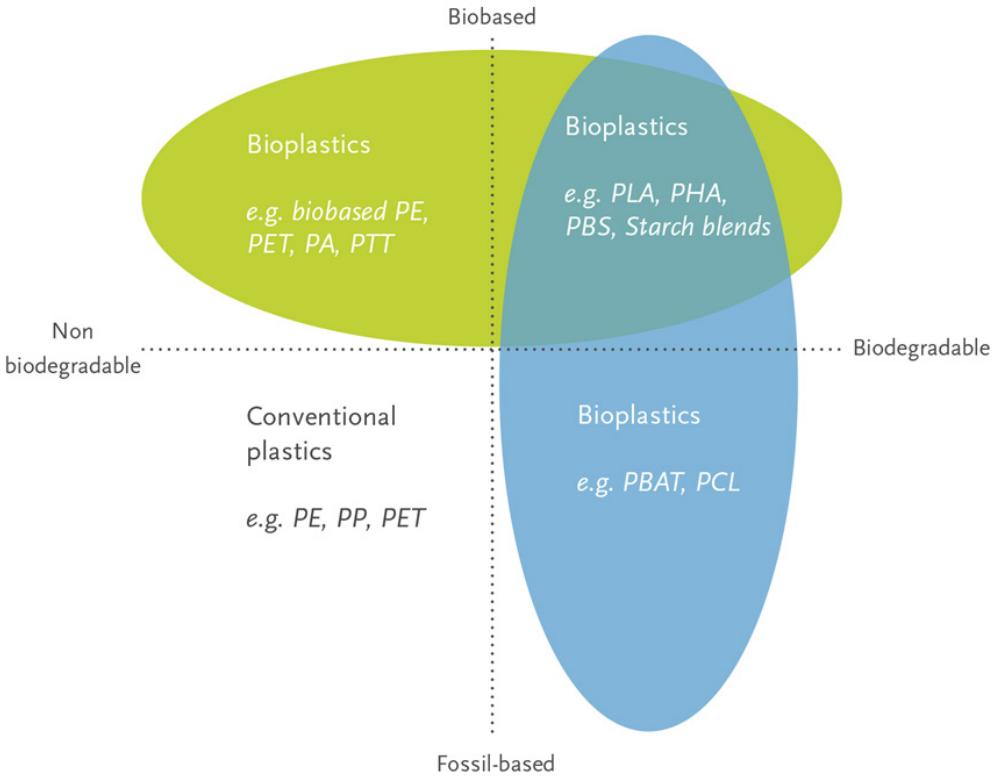
All plastics can be categorized into four main groups:

1. Biobased or partially biobased non-biodegradable plastics such as biobased PE, PP, PET (so-called drop-ins) and biobased technical performance polymers such as PTT, TPC-ET
2. Plastics that are both biobased and biodegradable, such as PLA, PHA, PBS
3. Plastics that are based on fossil resources and are biodegradable, such as PBAT
4. Plastics that are based on fossil resources and are non-biodegradable, such as conventional PET, PP, HDPE, LDPE

Biobased plastics can contribute to lowering greenhouse gas emissions and the demand for fossil resources when substituted for the fossil counterparts. Together with a high recycling rate and the substitution of the fossil fuel inputs by sustainable biobased resources, biobased plastics can provide an attractive vision for a circular economy.[31]

31 Biobased plastics in a circular economy, CE Delft (2017)

Figure 45.
OVERVIEW OF TYPES OF PLASTIC



Source: European Bioplastics

Thai Industrial Standards Institute recently published standards for compostable plastics. Beginning 1st January 2020, the government banned the production, import and sale of oxo-degradable plastics. However, several challenges remain including a lack of a HS product code for oxo-degradable plastics, which prevents the import of oxo-degradable plastics. These is also a lack of standards on plastic bag production, which enables plastic bag manufacturers to use oxo-degradable plastics.

Thailand also lacks a large-scale industrial composting infrastructure network for organic materials from municipal or commercial waste (except for one facility in Bangkok). The approximately 9,500 to 19,000 TPY of bioplastics that gets consumed within Thailand is mostly sent to landfills with no composting intervention. To biodegrade, bioplastics such as PLA and PBS require a list of specific industrial composting conditions (~60 °C, in the presence of O2 and moisture) and presence of organic substrate such as a mixture of soil and sludge. These conditions are challenging to replicate in sanitary landfills and are non-existent in unsanitary landfills. Given the absence of industrial composting facilities in Thailand, most bioplastics consumed in the country do not biodegrade in the post-consumer stage.

Thailand's bioplastics production is expected to increase to 350,000 TPY by 2030, and more government support to grow the domestic demand for bioplastics is also expected. Bioplastics are therefore likely to have a more important role in sustainable packaging sourcing decisions for major brand owners in the future. Even if all the necessary supporting policies and standards were in place in Thailand, bioplastics will only be a realistic alternative for single-use applications when source-segregation and separate collection of municipal and commercial waste is completed in tandem with the industrial composting of organic waste.

3.4.2. Current or future waste-to-energy (WTE) plans are very small in scale to divert plastics discarded in Thailand to energy recovery

As of 2018, approximately 210 MW of installed capacity of WTE production from MSW exist in Thailand.[32] This WTE is derived from the 3,600 TPD of MSW being sent to WTE plants across Thailand.[33] Based on industry interviews, plastic films through sorted municipal waste from transfer stations or through mixed municipal waste from landfills are increasingly becoming a feedstock for RDF (Refuse Derived Fuel) production. RDF is an alternative energy source for cement or waste-to-energy plants and the estimated market demand for RDF in Thailand is 400,000 TPY. It is estimated that between 40-60% of the feedstock for this RDF production is low-value plastic waste. Considering plastics are 19% of MSW sent to landfill and incinerators[34] 244,000 TPY of plastics was sent to energy recovery in 2018 (only 7% of the major plastic resins consumed in Thailand).

Co-processing non-recyclable plastics into RDF is currently the only viable alternative to divert contaminated plastics away from landfills. However, it must be noted that conversion of plastics to RDF is not a truly circular process and should be seen as an interim measure in the absence of scalable technologies to recycle flexible plastics contaminated in the MSW stream.

Thailand's goal as part of the Alternative Energy Development Plan (AEDP) is to target 500 MW of installed capacity of WTE production from MSW by 2036. This will require increasing the feedstock of MSW from 3,600 TPD to approximately 7,000 TPD. Under the AEDP plans, the amount of plastics sent to energy recovery is expected to increase to 474,000 TPY of plastics sent to energy recovery by 2036, or just 6% of the major plastic resins consumed in Thailand in 2036.[35]

Based on Thailand's national alternative energy targets, RDF and energy recovery of plastics are not expected to significantly divert discarded plastics in Thailand. This bodes well from a plastics circularity point of view, as energy recovery is not expected to "eat into" the plastics that can be recycled. However, it must be noted that an assessment of the environmental impact, energy use and life cycle analysis of co-processing of mixed or flexible plastics for use in cement or waste-to-energy industries versus other alternatives must be carried out before the scale up of such projects.

32 Modeling done for this study based on PCD data shared for this study.

33 PCD data shared for this study.

34 Bangkok Metropolitan Administration, "Solid Waste Management in Bangkok"

35 GA Circular modeling; Based on a modeling of 5% YOY growth rate of plastics consumption

Figure 46.
CURRENT AND EXPECTED DIVERSION OF PLASTICS INTO WASTE-TO-ENERGY IN THAILAND

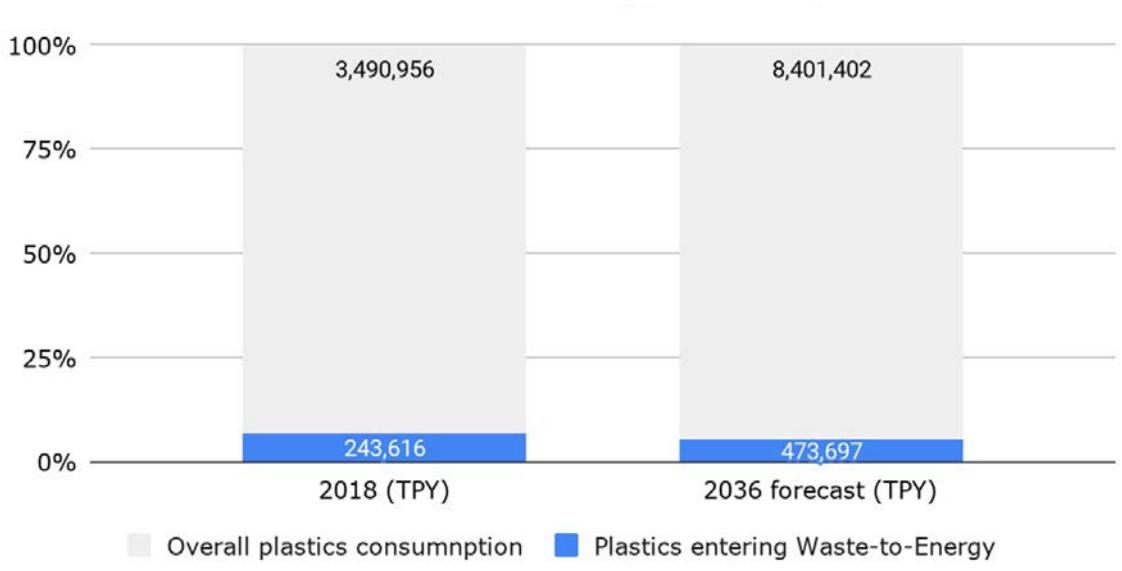
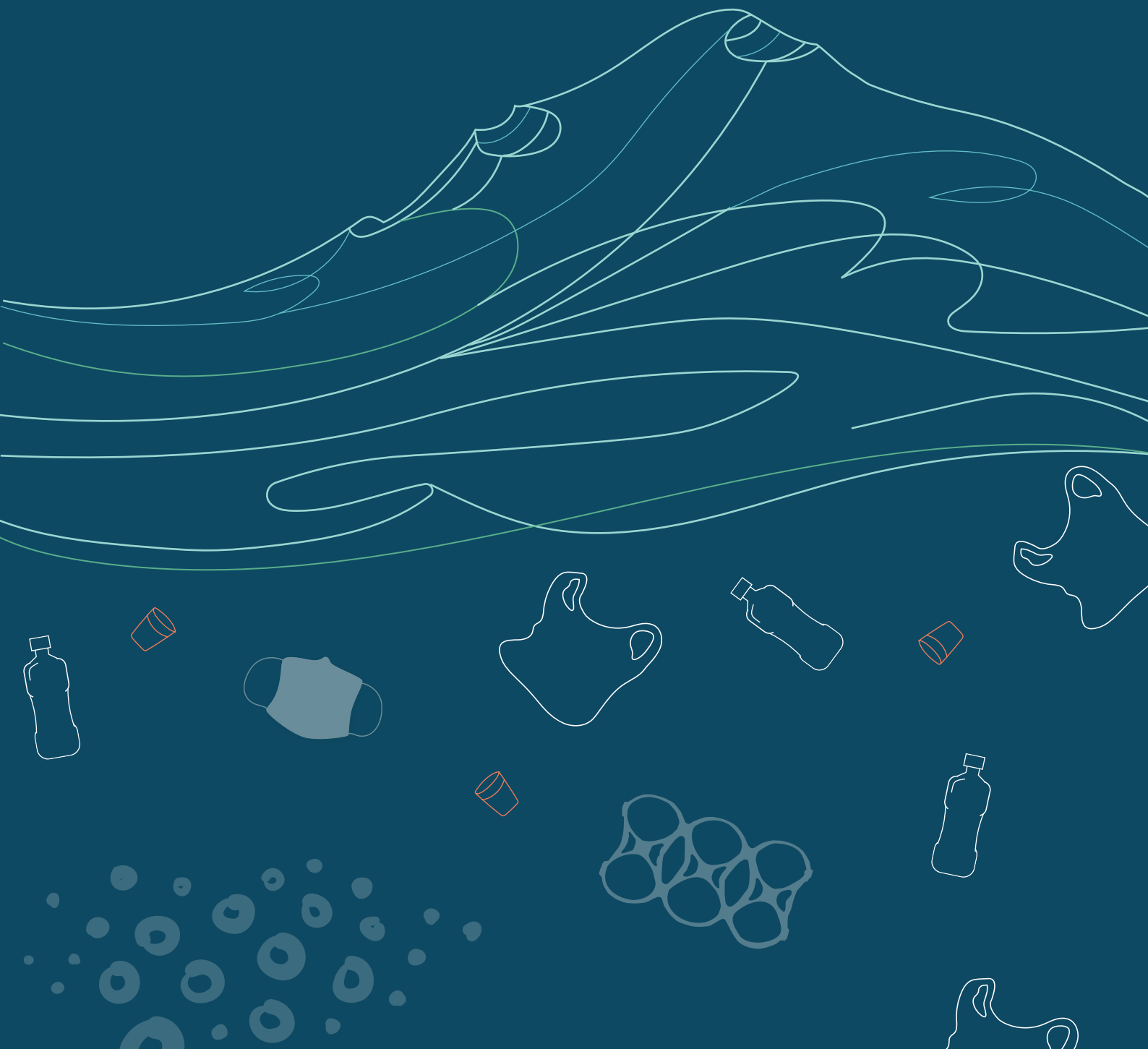


Photo: Gigira / Shutterstock

SECTION 4:

INTERVENTIONS TO UNLOCK ADDITIONAL MATERIAL VALUE



SECTION 4:

INTERVENTIONS TO UNLOCK ADDITIONAL MATERIAL VALUE

As seen in the previous section, various pressures impact the CFR rate and Value Yield for plastics recycling in Thailand, resulting in 2.88 million TPY of plastics not being recycled and a loss of 87% of the material value (equivalent to USD 3.6-4.0 billion / year). This section provides a broad set of recommended interventions to stem this loss by laying a strong foundation for the recycling industry, strengthen the demand for recycled products and transform Thailand's plastics recycling industry into a globally competitive and resilient industry.

Section 4.1 provides an overview of the two categories of interventions needed to increase the material value unlocked. Sections 4.2 and 4.3 go into the detailed actions under each of these two categories of interventions. Section 4.4 summarizes the interventions and actions in terms of their potential to unlock material value and lays a roadmap of the priority actions that need to be taken.

4.1 OVERVIEW

There are two categories of interventions needed to increase the material value unlocked via the circularity of plastics in Thailand:

1 **Interventions that increase Value Yield and CFR rate — Each of these interventions contain actions that release pressure both horizontally and vertically.**

They enable the area of value unlocked to increase diagonally to the top right. Any actions that increase Value Yield are primarily driven by economics and value creation. It is important to prioritize these actions first as it creates the incentive for increased recycling to occur. Enabling the value chain to understand and realize the value of recycling is a foundational step towards improving circularity.

2 **Interventions that increase CFR Rate — Each of these interventions contain actions that release pressure on the horizontal axis.**

They enable the area of value unlocked to increase horizontally to the right. These actions are longer term in nature and more systemic across the waste management and recycling value chains.

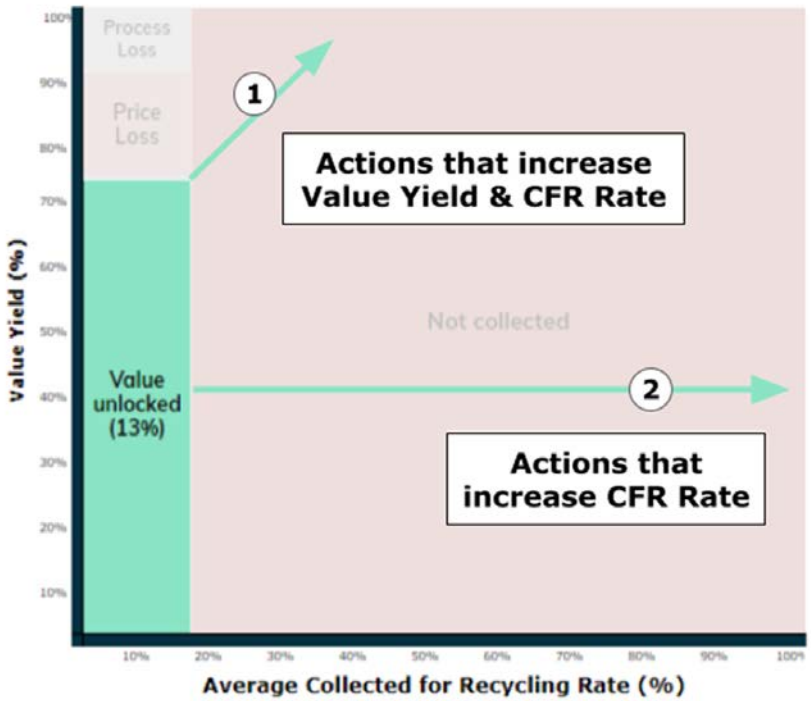
Notes:

- All the actions recommended below have implications in increasing both CFR rate and Value Yield to a small or large extent.
- Most of the actions are interdependent on each other. However, for the purposes of this study, they have been isolated and classified into the above-mentioned categories.
- Many of the recommended interventions and actions require cost estimates of infrastructure needs along with barriers, but these estimations are out of scope as the key objective of this study is to define the addressable market size of the private sector plastics circularity opportunity. Therefore, once the recommendations of this study are taken forward, a future action should be to conduct a CAPEX and OPEX cost estimation of infrastructure needs along with barriers for each of the prioritized actions.

To assist with prioritization of the actions based on timing, each of the actions under the interventions have been classified under 3 clusters:

1. Lay the Foundation — Actions under this cluster create the necessary foundation for plastics circularity in Thailand. Suggested timing to implement actions in this cluster: 1-2 years.
2. Strengthen the Demand (for recycled products) — Actions under this cluster are high-impact actions that strengthen the demand for recycled products by strengthening CFR Rate and Value Yield. Suggested timing to implement actions in this cluster: 3-5 years.
3. Maximize the Value — Actions under this cluster help to unlock the maximum possible value from plastics recycling and help build a resilient recycling industry. Suggested timing to implement actions in this cluster: beyond 5 years.

Figure 47.
SUMMARY OF TWO CATEGORIES OF ACTION TO INCREASE THE MATERIAL VALUE UNLOCKED BY PLASTICS CIRCULARITY



4.2 INTERVENTIONS THAT INCREASE VALUE YIELD AND CFR RATE

A. Increase waste collection and sorting efficiency of post-consumer plastics

With a net CFR rate of just 17.6% across all plastics resins in Thailand, sorting efficiency needs to increase across the post-consumer plastics value chain starting from the point of waste generation, collection, transport and sorting. The actions outlined in Table 1 are key strategies for implementing an ISWM system.

Table 1.
CLUSTER / TIMING, ACTIONS AND RATIONALE FOR INTERVENTION "A: INCREASE WASTE COLLECTION AND SORTING EFFICIENCY OF POST-CONSUMER PLASTICS"

Cluster & Timing	Action	Rationale
Lay the Foundation (1-2 years)	1. Mandate and harmonize source-segregation & separate collection standards	Plastics converters in Thailand have consistently reported having challenges sourcing for food-grade recycled plastics due to high contamination rates. At a bare minimum, segregating MSW between wet (organic) and dry (inorganic) waste will significantly reduce contamination as organic waste is the main contaminant of recyclables recovered from the MSW system. Separate collection also ensures higher operational efficiencies for waste collectors. This action will be more successful if investments are also made in organic waste treatment to create value from organic waste. Harmonized, nation-wide standards for source-segregation and separate collection reduce the cost of collection for recyclers and increase yield.
	2. Establish dedicated Material Recovery Facilities (MRFs) or sorting centers (as part of the waste collection system)	Today, sorting of recyclables in Thailand happens at each collection site and at transfer stations and is neither efficient nor effective. MRFs provide economies of scale to sort and segregate dry waste in their respective categories, which can then be sent to their respective recyclers. MRFs also provide secure jobs for workers from the informal collection sector and can be operated as micro-enterprises. Additionally, MRFs improve productivity and quality by integrating technologies such as optical sorting systems (especially in times like COVID-19 when worker numbers fall).
Strengthen the Demand (3-5 years)	3. Develop awareness and behavior change campaigns	Awareness & behavior change campaigns that focus on litter prevention, source segregation (e.g. dry vs wet waste) and recycling are critical for the success of plastics circularity. Voluntary EPR systems (e.g. PRO) and other companies from consumer-facing industries which use plastics can partner with the government to identify behaviors to be addressed, levers for changing the behaviors and to ensure consistent messaging and communication. The communications should be backed up with infrastructure that enables citizens to participate in the solutions. For example, the Indian government launched Swachhata App—a mobile application for consumers to post their complaints about their city's waste management. The app has more than 8 million downloads and is used in over 2,750 cities. In one city, Mysore, up to 90% of consumer waste management complaints through the app are resolved by the city.[36]

36 Ocean Conservancy: Plastics Policy Playbook

Cluster & Timing	Action	Rationale
	4. Provide opportunities for informal sector inclusion	Most of the post-consumer resins in Thailand are collected by the informal sector. This is due to the absence of any scalable formal avenues of collection of resins for recycling (e.g. source segregation of recyclables). Given Thailand's continued reliance on the informal sector, CFR rate for plastics is projected to drop as GDP per capita grows. The informal sector can be included through any of the five best case practices for informal sector inclusion identified by The Ocean Conservancy: (a) NGO-supported micro-enterprises; (b) cooperatives and collectives; (c) franchisee development; (d) supplier development; (e) independent waste banks.[37] Voluntary EPR models developed by industry should also ensure they integrate the informal sector and, where possible, avoid models that divert recyclables from the informal sector. Strengthen support for the informal waste management sector by registering informal waste workers officially, providing them with ID cards and investing in capacity building to strengthen their ability to collect waste more efficiently. The establishment of cooperatives should be supported, potentially by a government subcontractor. Promote the welfare and living standards of informal waste pickers – perks and initiatives could include annual health check-ups, life insurance and annual bonuses for collecting more than a certain amount. Consider using health as an entry point for engaging with the informal sector by establishing a health initiative and providing a complimentary service to informal workers to provide a platform for further engagement and capacity building. Encourage the private companies managing transfer stations to meet with the informal waste pickers who work in their premises to discuss solutions for improving the working conditions and enable them to more effectively divert waste from landfills, thereby also reducing landfill fees for the private companies and saving them money.[38] Develop positive financial incentives to encourage the formal and informal sectors to recycle more, such as subsidies, pay-as-you-throw programs and kerbside reward schemes.
Maximize the Value (Beyond 5 years)	5. Digitalize recyclables collection	Demand for ethically sourced recyclables is expected to increase as brands increase their commitments to use recycled content. This requires increased transparency of the plastics value chain in Thailand by tracing the flow of materials through the informal collectors, junk shops, aggregators and recyclers via digital tools and thereby increasing the value of plastics. This also enables more efficient routing of transport logistics for aggregators and recyclers.

37 Ocean Conservancy: Plastics Policy Playbook

38 UNESCAP, "Closing the Loop" Sai Mai District, Bangkok Case Study, 2018

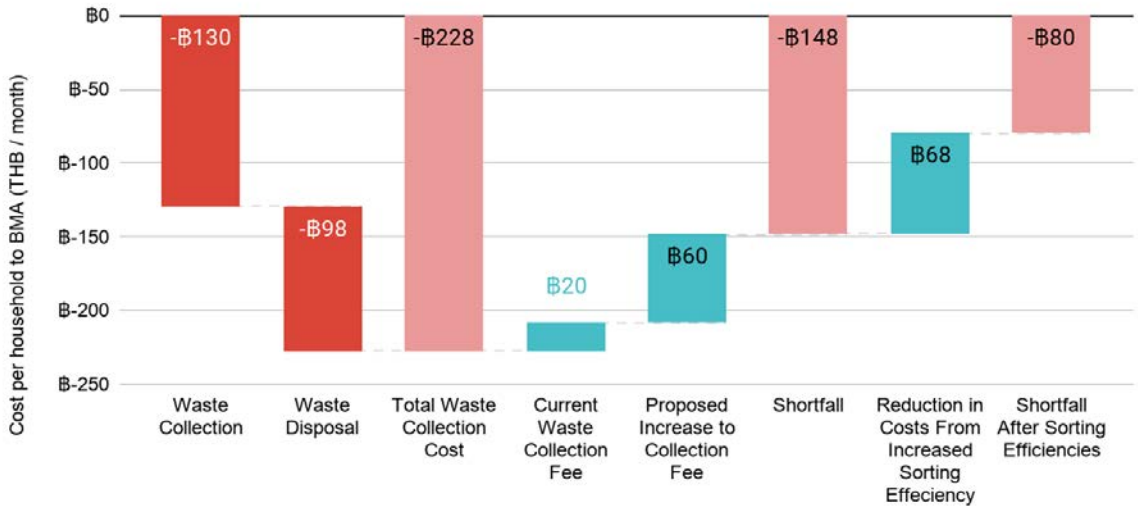
Cluster & Timing	Action	Rationale
	6. Implement Pay-as-you-throw (PAYT) waste collection model	PAYT is a usage-pricing model in which users are charged based on how much waste they throw away. This gives incentives to individual households to reduce the amount of waste disposed of. Faced with a direct form of unit pricing for the waste they produced, households are motivated to source-segregate or recycle as much of their waste so that they are able to save from paying the fees associated with the PAYT system. In this way, waste disposal resembles other utilities more closely, where the customer pays the amount for the services provided. Three key components need to be in place for effective implementation of a PAYT / SAYR scheme: (a) user identification system; (b) measuring the volume of waste generated; (c) provision of a publicly acceptable charging scheme.[39]

An important additional benefit of increasing sorting efficiency is the reduction in total waste collection costs (OPEX costs) for local governments. Taking Bangkok as a proxy for urban areas in Thailand, Figure 49 indicates the high levels of shortfall in funding that BMA experiences per household due to its current linear system. The household waste collection fee in Bangkok has not changed since 2005 and the rate no longer reflects the actual costs, which have gone up to THB 228 / month for each household. This THB 228 / month per household comprises THB 130 for waste collection and THB 98 for its management. While the whole process costs the BMA about THB 6 billion / year (USD 184 million), it collects only THB 504 million / year (USD 16 million) from residents, or less than 10% of the cost.[40]

Increasing sorting efficiency can reduce the total waste collection costs (OPEX costs) in Bangkok by up to 30%.[41] This is primarily due to:

- Reduced landfill tipping fee costs due to diversion
- Increased efficiency of transport logistics (fuel, routing) and reduced manpower costs due to diversion of trucks going into landfills

Figure 48.
IMPACT OF SORTING EFFICIENCIES IN COST MODEL FOR BANGKOK'S MSW (BASED ON COST PER HOUSEHOLD)



39 Singapore Solid Waste Management Technology Roadmap, National Climate Change Secretariat

40 BMA likely to delay new rubbish collection fee.

41 Modeling by GA Circular.

This increased efficiency reduces the shortfall for BMA by THB 68 / month for each household, thus saving the BMA a total of THB 2 billion / year (USD 55 million).[42]

B. Set recycled content targets across all major end-use applications

With only 616,000 TPY out of 3.49 million TPY of plastics resins consumed getting recycled, Thailand lacks a strong secondary market for recycled plastics. Additionally, it is estimated that more than 50% of the recycled products produced within Thailand are exported as low value recycled products. This reliance on export markets for demand has exposed the recycling industry to the full brunt of the global price volatility inherent in the recycling industry. Setting recycled content targets enables the growth of a strong domestic market for recycled plastics through increasing the demand for post-consumer resin. Therefore, increased demand will lead to increased prices of post-consumer plastics, which will motivate an increased amount of collection to capitalize on the better prices.

42 Modeling by GA Circular.

Table 2.
CLUSTER / TIMING, ACTIONS AND RATIONALE FOR INTERVENTION "B: SET RECYCLED CONTENT TARGETS ACROSS ALL MAJOR END-USE APPLICATIONS"

Cluster & Timing	Action	Rationale
Lay the Foundation (1-2 years)	7. Allow the use of recycled plastics in food-contact applications	Food-grade recycled plastics command the highest margins across all the major grades of recycled products from PET, HDPE, LDPE and PP resins. Additionally, major multinational companies have set targets for using up to 50% recycled resin in their packaging and demand for food-grade resins is growing in Thailand in PET, HDPE and is expected to grow soon in PP. However, only 3% of PET consumed in Thailand ends up in food-grade applications and that too is fully exported. The potential for a large domestic market for recycled plastics in food-contact applications is currently untapped.
	8. Set recycled content targets and standards for major plastic use industries (i.e. packaging, electronics, filament sectors)	Recycled content targets enable the gradual decoupling of recycled products from virgin prices. They guarantee a domestic demand and encourage investments into the plastics recycling industry. Packaging, electronics and filament applications use a large proportion of mono-material plastics that do not have high structural performance requirements of automotive and construction applications. As a result, plastics used in these applications should be targeted for recycled content targets. Setting recycled content targets is critical not only for consumer facing industries, such as consumer goods packaging, but also for industries where the end application is not customer facing and where the buyer is indifferent to the use of virgin or recycled (for example agriculture, filament industries). In such applications, pricing is the buyers' only decision-making criteria. Currently, recycled plastics in Thailand are always sold at a discount to virgin plastics. Based on recycling industry sources, more than 80% of the plastic waste would fall into the category of such applications. If plastics circularity is to be accelerated in Thailand this should be a critical focus area. Implementing national standards for recycled products can also promote acceptance of recycled products as consumers feel confident about product performance and safety.

Cluster & Timing	Action	Rationale
Strengthen the Demand (3-5 years)	9. Develop and launch incentives for using recycled content	The government can stimulate demand while mitigating some of the infrastructural costs of incorporating post-consumer resin (PCR) into plastic products through introducing tax benefits for plastic products, which contain PCR content above a certain percentage (e.g. above 30% PCR). Brand owners and the rest of the value chain will be encouraged to include PCR content in their products.
	10. Implement green public procurement of recycled plastic products	The government can have a large impact on demand through consuming recycled resins. For example, as outlined in the EU's "Green Public Procurement Manual on Plastic Waste Prevention," governments may specify packaging bought or used by the government must contain at least 75% recycled content. This increases the demand for packaging that meets that criteria.
Maximize the Value (Beyond 5 years)	11. Tax plastic applications without minimum recycled content	Once recycled content targets are set, and other actions under "Lay the Foundation" cluster in this table have been implemented, virgin material taxes should be levied on plastic products that do not clear the recycled content target. For example, the UK's plastic packaging tax comes into effect in 2022, it will result in an additional tax of £200/tonne for plastic products that do not have at least 30% PCR content. Similarly, to encourage production and demand for recycled plastics from within the EU, the European Commission proposed a €0.80 / kg tax for all non-recycled plastic produced in the EU[43], generating an estimated €5.9 billion / year for the EU budget.

Recycled content targets should be complemented with longer-term measures to discourage the use of 100% virgin plastics in industries where recycled plastics can technically replace virgin plastics without any impact on product performance (e.g. in applications that use rigid PET and HDPE packaging).

C. Mandate "design for recycling" standards for all plastics, especially for packaging

Packaging constitutes 42% of all plastics consumed in Thailand. Without fundamental redesign and innovation, 30% of plastic packaging will never be reused or recycled.[44] This amounts to at least 440,000 TPY of plastic packaging that will remain locked away from any possible reuse or recycling.

In Thailand, the packaging segment includes small-format packaging, such as sachets, tear-offs, lids and sweet wrappers; multi-material packaging made of several materials stuck together to enhance packaging functionality; uncommon plastic packaging materials of which only relatively low volumes are put on the packaging market, such as polyvinyl chloride (PVC), polystyrene (PS) and expanded polystyrene (EPS); and highly nutrient-contaminated packaging, such as fast-food packaging.[45]

43 ICIS - EU Commission proposing €0.80/kg tax on production of all non-recycled plastics

44 Ellen Macarthur Foundation, "New Plastics Economy: Catalyzing Action"

45 Ellen MacArthur Foundation, "New Plastics Economy: Catalysing Action"

Table 3.
CLUSTER / TIMING, ACTIONS AND RATIONALE FOR INTERVENTION "C: MANDATE "DESIGN FOR RECYCLING" STANDARDS FOR ALL PLASTICS, ESPECIALLY FOR PACKAGING"

Cluster & Timing	Action	Rationale
Lay the Foundation (1-2 years)	12. Align industries on "design for recycling" standards	Aggregators and collectors have consistently reported that several non-packaging plastic products are locked away from ever getting recycled due to product design (e.g. use of adhesives instead of screws in industrial plastic products). These stakeholders often reach out to producers requesting design changes, but have not been successful in Thailand where there are no guidelines or requirements for reparability / availability of spare parts, modular design, ease-of-disassembly / design for recycling, or for declaration of substances that are a problem for recycling. If value is to be unlocked from non-packaging plastic applications, "design for recycling" will need to be mandated at some level.
	13. Voluntarily adopt "design for recycling" standards for all plastic products	Interviewed recyclers reported a contamination rate of up to 26% of the rigid plastics feedstock they receive from Thailand. This includes contaminants due to poor segregation practices and poor packaging design. One example of a design for recycling standard would be the phase-out of PVC labels for PET bottles. This action can start with voluntary standards adopted by plastics producers and brand owners (for example, producers of packaging). Especially in the case of multi-layer, multi-material flexible packaging, voluntary steps and standards are needed towards adopting mono-material replacements for multi-material packaging and to increase the separability of multi-material films. Stakeholders from the flexible packaging industry in Thailand reported that multilayer films in the market are composed of different materials (e.g. PET, Nylon, CPP (cast polypropylene), LDPE, LLDPE, aluminum foil) and that collection, sorting and recycling of wastes from such multi-layer, multi-material films is still very rare. The recently developed Biaxially-oriented Polyethylene (BOPE), for instance, allows for stronger mono-material PE flexible packaging, reducing the need for other polymers or materials.[46]
Strengthen the Demand (3-5 years)	14. Mandate national "design for recycling" standards for packaging plastics	National mandates for industrial design standards for high-volume plastic applications such as packaging plastics will eventually create a level-playing field wherein investments and changes towards design for recycling become mainstream and there are no free riders.

46 Flexible Films Market in Europe, State of Play 2020 by Plastics Recyclers Europe

4.3 INTERVENTIONS THAT INCREASE CFR RATE

D. Encourage increase in recycling capacities (mechanical and chemical)

It will not be possible to increase the CFR rate in Thailand without adding recycling capacity. This requires several actions which are interlinked.

Table 4.
CLUSTER / TIMING, ACTIONS AND RATIONALE FOR INTERVENTION "D: ENCOURAGE INCREASE IN RECYCLING CAPACITIES (MECHANICAL AND CHEMICAL)"

Cluster & Timing	Action	Rationale
Lay the Foundation (1-2 years)	15. Incentivize increase in recycling capacities for polyolefins (PP, PE)	Resins with wide ranging single-use applications such as PP, HDPE and LDPE/LLDPE have gaps for recycling capacity: PP (81% gap), HDPE (79% gap) and LDPE/LLDPE (79% gap). Thus PP, HDPE and LDPE/LLDPE must be prioritized for investments.
	16. Incentivize PET recycling to higher-end recycled products	Only 3% of PET packaging resin consumed is turned into food-grade rPET resin and all of this is exported due to the ban on food-grade recycled product usage in Thailand. Additionally, bales of post-consumer PET available from within Thailand are unable to meet the quality standards to end up in higher-end use applications such as POY or food-grade bottles.
Strengthen the Demand (3-5 years)	17. Provide market pricing and volume data for virgin and recycled plastics	Market data on pricing and volumes for recycled products encourages market liquidity and gives confidence for new recyclers to enter the market, for current recyclers to grow their capacities and for global plastics producers to buy recycled products from Thailand. Market data also makes it easier to better anticipate the volatile pricing cycles for recycled products. Market intelligence firms such as IHS Markit, ICIS, S&P Platts, Wood Mackenzie already offer market data services for recycled products in regions such as Europe and North America.
	18. Invest in chemical recycling capacity for low value plastics	Chemical recycling converts waste plastics into cracker feedstocks that could displace naphtha or natural gas liquids (NGL) demand. This type of recycling treats mixed polymer streams that mechanical recycling technologies cannot handle. Outputs of chemical recycling are more resilient to lower oil prices, remaining profitable down to $50/barrel[47] as compared to mechanical recycling (the economics of mechanical recycling begin to break down at below $70-$80/barrel).

47 McKinsey, "Recycling and the future of the plastics industry"

Cluster & Timing	Action	Rationale
	18. Invest in chemical recycling capacity for low value plastics *(continued)*	Chemical recycling technologies are still largely at the pre-commercial stage and the scalability, financial viability, environmental impact assessments and other risks of chemical recycling have not yet been fully demonstrated, especially in a Southeast Asian context. Nevertheless, these technologies are generating interest as a replacement for unsustainable feedstock sources.[48] Commercial technologies are already beginning to enter Southeast Asian countries such as Indonesia and Malaysia.[49] Chemical recycling is especially relevant for PE and PP flexible films in Thailand and applicable chemical recycling technologies that can be considered fall under 2 broad categories: (a)monomer recycling (solvent based); (b)plastic-to-fuel (PTF) recycling.[50] One example of a potential chemical recycling solution that can be replicated in Thailand is Multicycle[51], an EU project that uses the CreaSolv technology to identify potential chemical recycling solutions for plastics in mixed waste.

A series of incentives are needed to encourage increase in recycling capacities, including:

- Increased BOI support to all recyclers. For example, extending the tax exemption for plastics recyclers from 3 years to at least 5 years to bring them in line with incentives for virgin plastics manufacturers. Some interviewed stakeholders recommended tax exemption for plastics recyclers to be increased up to 8 years.
- Specific BOI support for growing mechanical recycling capacities for PP, HDPE and LDPE/LLDPE.
- Requiring all recipients of BOI incentives to have necessary environmental, health and safety practices and standards in place such as wastewater treatment.
- Expanding the scope of incentives to also include incentives for material washing process, an important but expensive process in recycling to extract the most value.

A good market pricing and volume data service for recycled products in Thailand should include:

- Graphs and tables showing historical weekly price moves for long-term perspective for both virgin and various grades of recycled products (bales, flakes, pellets)
- Monthly import and export data on plastics scrap, virgin resins and recycled products
- Recent spot deals including commodity, price, location, volume
- Plant data including production and capacity, plant maintenance and shutdowns
- Weekly market overview and outlook including a brief commentary on the other regional markets
- Supply and demand analysis of domestic and international supply and demand
- News on force majeures and other plant disruptions, closures, openings and expansions

E. Create industry-specific requirements to increase plastic waste collection and recycling rates

One of the main challenges to plastics circularity in Thailand is the lack of industry-specific collection / take-back requirements for the major end-use industries. This lack of extended producer responsibility (EPR) results in the CFR rate being completely left to market forces. The prices for recycled products are thus always under constant cost pressure from virgin plastics providing little incentive to increase the CFR rates. Thus, CFR rates need to be decoupled from this cost pressure on recycled plastics.

48 Flexible Films Market in Europe, State of Play 2020 by Plastics Recyclers Europe

49 Plastics Energy Press Release on Malaysia; Plastics Energy Press Release on Indonesia

50 A Circular Solution to Plastic Waste by BCG

51 MULTICYCLE

Table 5.
CLUSTER / TIMING, ACTIONS AND RATIONALE FOR INTERVENTION "E: CREATE INDUSTRY-SPECIFIC REQUIREMENTS TO INCREASE PLASTIC WASTE COLLECTION AND RECYCLING RATES"

Cluster & Timing	Action	Rationale
Lay the Foundation (1-2 years)	19. Set up voluntary extended producer responsibility system (e.g. PRO)	Private sector companies, especially in the packaging and electronics sectors, have decades of experience in several countries and regions in operating PROs. Industry-led pre-competitive PROs provide the private sector with the flexibility to implement various economic tools to increase CFR while ensuring that the funds collected are directed towards collection systems.
	20. Mandate collection targets specifically for packaging and electronics industries	Packaging and electronics account for 42% and 16% of the end-use industries in Thailand and their products generally have a 1-5 year lifespan (i.e. shorter lifespan compared to construction, automotive and filament industries). Collection targets also minimize the challenge of free-riders and require the entire obliged industry to participate in increasing CFR. The targets should be calibrated based on how recyclable the resins and products are and how developed the recycling infrastructure is. These collection targets will, in effect, mandate EPR. When mandating collection targets, it is important to ensure the design and implementation of specific economic models of the EPR system is not prescriptive and is, instead, left to the respective industry. This ensures the funds collected from the industry remain in the hands of the respective industry to make the necessary interventions. Also, the targets must encourage eco-modulation within the economic model of the EPR to accelerate progress. For example, in developing the economic model for the EPR system, industry must be required to pay a higher fee for lower-value, non-recyclable plastics (such as multi-material, multi-layer flexible packaging) as compared to higher value, recyclable plastics (such as rigid PET, HDPE and PP bottles and containers). The voluntary EPR system (above action) can be an excellent testing ground for designing and implementing the economic model at a national level.
Strengthen the Demand (3-5 years)	21. Mandate reporting framework for plastic products	The PIT has an effective data collection system in place at the resin level. This should be extended to the product level where producers and retailers declare the number of plastic products (e.g. packaging) they introduce into the market by polymer used, tonnage and end-use sector. This allows for an accurate understanding of plastic products entering the country each year, instead of using elaborate models. For example, Singapore will require all companies putting packaging into the country to declare the plastic resin type and tonnage from 2021 onwards. Accurate reporting of consumption of resins and plastics products (especially for packaging products) is an important first step towards setting EPR targets for the industry.
Maximize the Value (Beyond 5 years)	22. Mandate trading of plastic collection credits to meet targets	Trading of plastics collection credits ensures a market-based mechanism where producers are not required to collect their own packaging but are required to ensure that an equivalent amount of packaging waste has been collected to meet their obligation.

F. Restrict disposal of plastics and illegal dumping

A majority of the 82.4% of the non-recycled plastics in Thailand, ends up in sanitary landfills, dump sites or worse, leaks into the environment across the country.

One of the first steps towards becoming a resource efficient society should be to eradicate the landfilling of any waste that can be used as a resource. This requires a phase out of recyclable and other recoverable waste from landfills.

Table 6.
CLUSTER / TIMING, ACTIONS AND RATIONALE FOR INTERVENTION "F: RESTRICT DISPOSAL OF PLASTICS AND ILLEGAL DUMPING"

Cluster & Timing	Action	Rationale
Lay the Foundation (1-2 years)	23. Update HS codes for import / export of plastic resins and products (to 6- or 8-character HS codes)	Import / export data based on 6 to 8-character HS codes enable an accurate breakdown of the trade of resins and products, thus ensuring consumption data can be more accurately recorded, and more realistic and accurate EPR targets can be set for the industry. This will also help to make trade in plastic resins and products more transparent and better regulated.
	24. Assess feasibility of regional scrap plastics trade	Smaller recyclers and new recyclers entering the Thailand market can no longer rely on imported feedstock to complement their locally sourced feedstock, especially in the case of lower value plastics such as HDPE, PP and LDPE/ LLDPE, due to import restrictions on plastic waste. Larger and more established recyclers who have existing value chains set up in Thailand dominate the local access to post-consumer materials, making it harder and more expensive for smaller or new recyclers to source feedstock. This has reduced the price yield for smaller and newer recyclers (as imported plastic waste tends to be less contaminated), thus reducing the value yield. Also, the existing import restrictions were set up primarily to solve the problem of illegal dumping of plastics, but these import restrictions alone do not solve the problem. Several recyclers in Thailand have not followed the existing strict pollution norms in Thailand, thereby undercutting those recyclers who incur high investment and operating costs for complying with the pollution norms. A well-managed regional scrap plastics trade could be a key factor for recycling firms to access feedstock and to invest in larger capacity if consistent quantity and quality of raw materials could be secured (e.g. well sorted and cleaner plastic waste that follow environmental, health and safety standards). Such a regional scrap plastics trade of high quality, recyclable plastics will provide recyclers with much-needed flexibility to optimize their feedstock. Zero dumping of scrap plastics can be ensured by strengthening the monitoring mechanism on pollution norms for all recycling companies and awarding necessary licenses or permits only to companies that have setup necessary systems to follow pollution norms. Action 23 on updating HS codes used in import / export of scrap plastics to 6 or 8 characters is critical to ensure any regional trade of plastic scrap is transparent and better regulated, while also ensuring that its management is safer for human health and the environment.

Photo: V.stock / Shutterstock

Cluster & Timing	Action	Rationale
Strengthen the Demand (3-5 years)	25. Mandate targets to lower landfill disposal rates for plastics	Setting reduction targets for landfill disposal rate encourages local governments to support alternative treatment options, including recycling and energy recovery.
	26. Increase landfill tipping fees	Landfill tipping fees in Thailand remain low at 300 ฿ / ton[52] when compared to benchmark standards. Landfilling thus remains economically attractive for waste collectors and lowers the incentive for investing in processes to divert plastics to energy recovery or recycling.
Maximize the Value (Beyond 5 years)	27. Ensure separate collection of biodegradable plastics	While biodegradable plastics can be a useful alternative for plastics, which are of lower value or harder to recycle (e.g. multilayer, multi-material films), they can become a contaminant if they end up in existing recycling processes. Furthermore, if the consumption of biodegradable plastics in Thailand is scaled up significantly, separate collection and treatment of biodegradable plastics together with organic waste is needed. One example where this is done effectively is Taiwan where food waste is segregated from MSW using compostable plastic bags which are then composted in an industrial composting facility. Similarly, in the EU, one of the main uses of compostable plastics has been for bio waste bags which are used to make collection of food waste more user friendly, thereby maximizing participation and capture. Compostable bags for collection of source-separated food waste are largely used in Norway, Italy, Spain, the UK and Ireland. The compostable bags are designed to enter an industrial composting facility together with the food waste.[53] Italy and France have banned ultra-thin fossil fuel-based plastic bags and mandated the use of bio-based compostable bags instead. Italy has combined it with waste goals, improved separation and higher quality compost.[54]

52 Somrat, "Status of Waste Management and Future Policy Directions for Renewable Energy From Waste and Biomass in Thailand"

53 Relevance of biodegradable and compostable consumer plastic products and packaging in a circular economy (March 2020)

54 BioPlastics News

4.4 SUMMARY OF INTERVENTIONS

Based on the model developed by this study team, the below increases in CFR rate and Value Yields are possible by implementing the above-mentioned interventions. Note: Details on the model are found in the appendix.

4.4.1. Each intervention has the potential to unlock between USD 1.1 billion to USD 2.6 billion/year

Each of the interventions, taken alone, has the potential to increase the recycling value unlocked by between USD 1.1 billion to USD 2.6 billion / year.

Figure 49.
RECOMMENDED INTERVENTIONS AND THEIR IMPACT ON INCREASING CFR RATE AND VALUE YIELDS

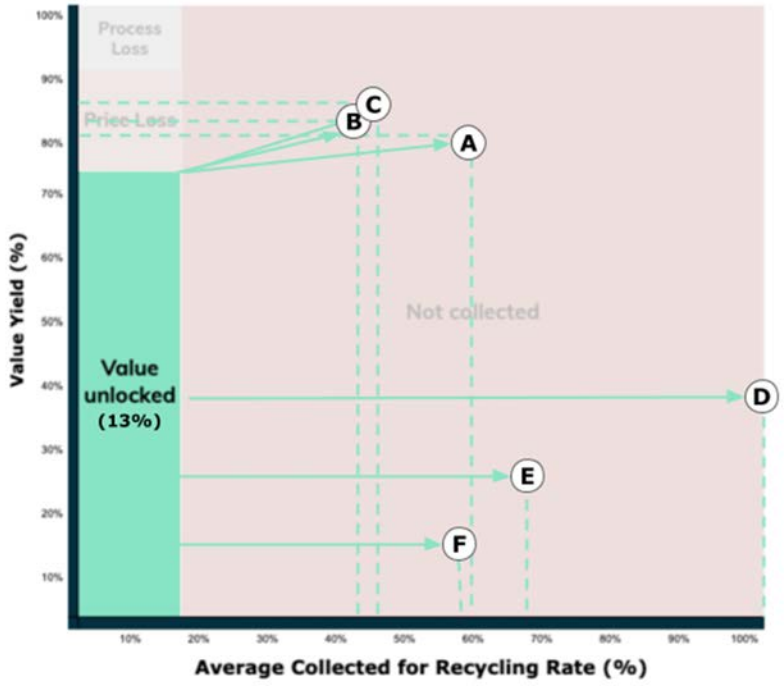


Figure 50.
RECOMMENDED ACTIONS AND THEIR IMPACT ON INCREASING CFR RATE AND VALUE YIELDS

SUMMARY OF INTERVENTIONS	INCREASE IN VALUE YIELD	INCREASE IN CFR RATE	MATERIAL VALUE UNLOCKED
1. Interventions that increase CFR Rate and Value Yield			
A. Increase waste collection and sorting efficiency of post-consumer plastics	7%	41%	USD 1.5 billion
B. Set recycled content targets across all major end-use applications	11%	26%	USD 1.1 billion
C. Mandate "design for recycling" standards for plastics, especially for packaging	13%	30%	USD 1.2 billion
2. Interventions that increase CFR Rate			
D. Encourage increase in recycling capacities (mechanical and chemical)	-	82%	USD 2.6 billion
E. Create industry-specific requirements to increase plastic waste collection and recycling rates	-	49%	USD 1.6 billion
F. Restrict disposal of plastics and illegal dumping	-	41%	USD 1.3 billion

4.4.2. 8 priority actions towards unlocking material value

Based on the clustering of actions shown above, the Figure 51 summarizes all the actions by interventions and clusters. It also highlights who (i.e. government or private sector or both) is mainly responsible for undertaking each of the actions.

The study team — in consideration of stakeholder feedback pertaining to the practicality of implementation in the next 1-5 years time frame, potential to comprehensively support growth of plastics recycling and unlock material value — identified the 8 priority actions in Figure 52 (from among the 27 total actions in Figure 51).

Figure 51.
SUMMARY OF INTERVENTIONS AND ASSOCIATED ACTIONS PER CLUSTER TIMELINE AND HIGHLIGHTING ACTIONS OF HIGHEST IMPACT

Interventions \ Clusters	Lay Foundation: Actions that create the necessary foundation for plastics circularity (1-2 years)		Strengthen Demand: High-impact actions to strengthen CFR Rate & Value Yield (3-5 years)		Maximise Value: Actions to unlock maximum possible value; build resilient recycling industry (>5 years)	
A Increase waste collection and sorting efficiency of post-consumer plastics	1 Mandate & harmonise source-segregation & separate collection standards	2 Establish dedicated Material Recovery Facilities (MRFs) or sorting centers	3 Develop awareness & behavior change campaigns	4 Provide opportunities for informal sector inclusion	5 Digitalise recyclables collection	6 Implement Pay-as-you-throw waste collection model
B Set recycled content targets across all major end-use applications	7 Allow the use of recycled plastics in food-contact applications	8 Set recycled content targets & standards for major plastic use industries	9 Develop & launch incentives for using recycled content usage	10 Implement green public procurement of recycled plastic products	11 Tax plastic applications without minimum recycled content	
C Mandate "design for recycling" standards for plastics	12 Align industries on "design for recycling" standards	13 Voluntarily adopt "design for recycling" standards for all plastic products	14 Mandate national "design for recycling" standards for packaging plastics			
D Encourage increase in recycling capacitites (mechanical & chemical)	15 Incentivise increase in recycling capacities for polyolefins	16 Incentivise PET recycling to higher-end recycled products	17 Provide market pricing & volume data for virgin & recycled plastics	18 Invest in chemical recycling capacity for low value plastics		
E Create industry-specific requirements to increase plastic waste collection and recycling rates	19 Setup voluntary extended producer responsibility system (e.g. PRO)	20 Mandate collection targets for packaging & electronics industries	21 Mandate reporting framework for plastic products		22 Mandate trading of plastic collection credits to meet targets	
F Restrict disposal of plastics into landfills and dumpsites	23 Update HS codes for import / export of plastic resins & products	24 Assess feasibility of regional scrap plastics trade	25 Mandate targets to lower landfill disposal rates for plastics	26 Increase landfill tipping fees	27 Ensure separate collection of biodegradable plastics	

Legend: Government — Private Sector — Highest Impact (based on stakeholder feedback & analysis by study team)

Figure 52.
SUMMARY OF THE 8 PRIORITY ACTIONS UNDER THIS STUDY BASED ON STAKEHOLDER FEEDBACK

Action #	Priority Actions Based on Stakeholder Feedback	Lead Stakeholder for the Action
1	Mandate and harmonize source-segregation and separate collection standards	Government
7	Allow the use of recycled plastics in food-contact applications	
8	Set recycled content targets and standards for major plastic use industries	
14	Mandate national "design for recycling" standards for packaging plastics	
20	Mandate collection targets for packaging and electronics industries	
12	Align industries on "design for recycling" standards	Private Sector
13	Voluntarily adopt "design for recycling" standards for all plastic products	
19	Setup voluntary extended producer responsibility system (e.g. PRO)	

FEBRUARY 2021

WORLD BANK GROUP

THE WORLD BANK
IBRD • IDA

IFC International Finance Corporation

PROBLUE

Administered by
THE WORLD BANK
IBRD • IDA | WORLD BANK GROUP