

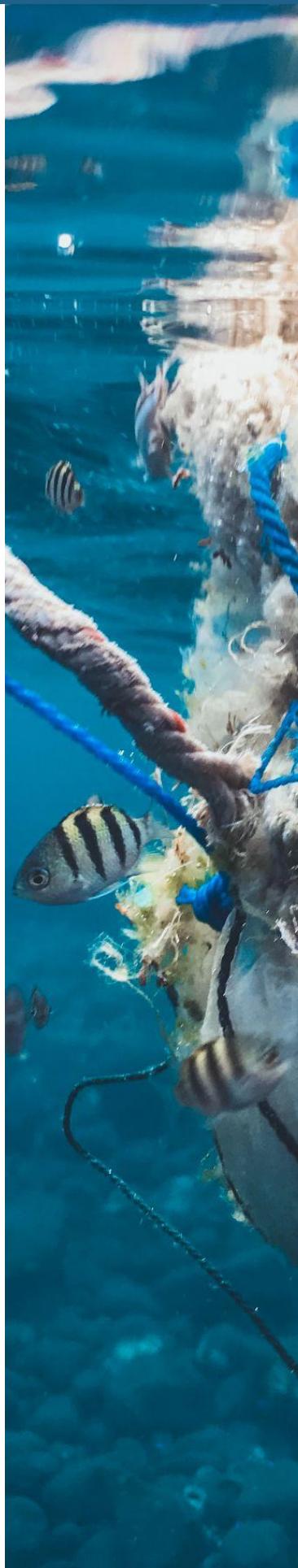
JANUARY 2023

Mapping Local Plastic Recycling Supply Chains: Insights from Selected Cities in Thailand



Contents

Introduction	06
‣ Background	
‣ Research Objectives	
‣ Scope and Methodology	
The national picture	09
‣ National regulation	
Overview of selected wastesheds	12
‣ Current supply chains	
‣ Collection: Stakeholders and processes	
‣ Aggregation: Stakeholders and processes	
‣ Recycling: Stakeholders and processes	
Insights on local plastic recycling supply chain in Bangkok	16
Insights on local plastic recycling supply chain in Chon Buri	18
Insights on local plastic recycling supply chain in Rayong	20
Analysis of pricing and pricing transparency along the value chain	22
Evaluation of current supply chains	27
‣ Supply chain assessment	
‣ The need for intervention	
‣ Collection and aggregation	
‣ Plastic recycling and reprocessing	
‣ Municipal solid waste treatment	
Recommendations for interventions	31
‣ Improve collection rates of plastics	
‣ Improve sorting of polymers and quality for recycling	
‣ Increase demand from plastic recycler	
Conclusion	34
References	35
Appendices	36
Acknowledgements	39



Glossary

Aggregation / consolidation point	Location at which waste materials are consolidated (bulked) into larger amounts for onward transport. Activities vary by site and may allow for consolidation only, or include some pre-processing e.g., sorting or picking of valuable material.
Collected for recycling (CFR)	The CFR rate is calculated using the amount of plastic collected vs. the overall amount of plastic actually recycled. Some plastics that are collected as part of the mixed solid waste are landfilled or sent to WtE. Other plastics collected for recycling may be rejected during sorting or become residues during recycling.
Extended Producer Responsibility (EPR)	A policy approach under which producers are made responsible (either financially or physically) for the end-of-life management of the products and/or packaging they sell.
Formal recyclers	Typically large recycling sites with large-scale equipment that hold suitable business and waste permits and licenses for their operations.
Formal sector	Collective term for municipal (or licensed collectors) and fully permitted/licensed aggregators and recyclers.
Informal recycler	Typically small recycling facilities that operate without full licenses and permits.
Informal sector	Collective term for informal waste workers and typically smaller-scale aggregators and recyclers that operate without full licenses and permits.
Informal waste worker (IWW)	People who earn an income from managing waste but are not formally employed to do so. Roles include collection (including picking), sorting, and other pre-processing and recycling.
Infrastructure (e.g., plastic infrastructure, waste infrastructure)	Equipment and facilities used to aggregate, sort, and/or treat waste materials.
Junk shops	Typically small spaces, often in the houses of the owners. Materials may be brought to the site by local collectors, with owners sometimes also undertaking collection themselves. Usually run informally without licenses or permits.
Landfill	Landfill mainly describes permitted landfill disposal facilities and sanitary waste dumps permitted by the authorities. Some data sets might also include illegal dumping and unsanitary landfills.
Municipal solid waste (MSW)	Within this report we use the term 'municipal solid waste' to describe waste generated by smaller sized properties such as households, small businesses, and schools. It generally excludes waste from larger businesses, industrial sites, and from construction.
Municipal waste worker (MWW)	An individual working on behalf of the local government, either employed directly by them or by their (private or semi-private) collection contractor.
Pay-as-you-throw	A policy through which properties are charged based on the amount of waste they present for collection. In some cases, charging for separately presented recyclables is lower than residual waste.
Plastic leakage	Refers to plastic waste that is not kept within managed (formal or informal) systems and 'leaks' into the environment.
Plastic recycling supply chains	A formal or informal system through which discarded plastics can be recycled. Typically includes collection, aggregation, pre-processing, reprocessing, and manufacture into new goods.
Plastic waste	Plastic packaging or products that have been discarded by the user.

Pre-processing	Preparing material for recycling (e.g., can include sorting, label removal, washing, and shredding).
Recyclables	Waste materials collected for recycling.
Recyclate	Material that is recycled e.g., rPET and rHDPE.
Recycling/reprocessing	The process of transforming waste into a new output product so the material can be used again.
Refuse-derived fuel (RDF)	Fuel created from certain types of waste, such as municipal solid waste and other combustible refuse.
<i>Saleng</i>	Local term used in Thailand for informal waste collectors.
Waste/recycling cooperative	While cooperative arrangements can vary, the broad meaning is an umbrella organization with a legal structure that unites individual waste workers and coordinates work undertaken. Cooperatives are usually controlled by workers and provide them with shared benefits and profits.
Waste-to-Energy (WtE)	This mainly includes formal, permitted waste-to-energy plants with heat and electricity recovery, where known. Data sets might also include some basic incineration plants without energy recovery, depending on data sets available.
Waste Transfer Station	Municipal aggregation points that are usually used to transfer waste. They are spread throughout cities to help allow for efficient collection and have no equipment or very basic equipment. They are not designed for waste extraction but are often used by informal waste workers for final extraction before landfill.
Wasteshed	A geographical region having a common solid waste disposal system or designated by the governing institutions as an appropriate area within which to develop a common recycling program.

General abbreviations

CFR	Collected for recycling
EPR	Extended producer responsibility
KT/yr	Kilo tonnes (or thousand tonnes) per year. Metric tonnes are used.
MRF	Material recovery facility
MSW	Municipal solid waste
MT/yr	Mega tonnes (or million tonnes) per year. Metric tonnes are used.
MWW	Municipal waste worker
TTS	Temporary transfer stations
T/d	Tonnes per day. Metric tonnes are used.
T/yr	Tonnes per year. Metric tonnes are used.
WtE	Waste-to-Energy

Polymer abbreviations

HDPE	High-density polyethylene
LDPE	Low-density polyethylene
LLDPE	Linear low-density polyethylene
PET	Polyethylene terephthalate
PP	Polypropylene
PS	Polystyrene
PVC	Polyvinyl chloride
r (e.g., rPET, rPP)	Recycled plastic of that polymer

Introduction



BACKGROUND

Though many urban areas of India, Indonesia, Thailand, and Vietnam have municipally managed waste collection coverage, there remains a high reliance on the informal sector for the collection, aggregation, and recycling of plastic and other valuable materials. The informal sector plays a critical role in the management of material, with workers benefiting directly economically, though this often comes with risks to their health and welfare. Leaving recycling activities to the informal sector results in supply chain insecurity for recyclers and is often a barrier to investment in local plastic supply chain infrastructure. In addition, there tends to be a focus on collecting the most valuable polymers only, leaving large amounts of plastic waste uncollected or leaked into the environment.

The opportunity to improve the management of plastic waste and recover the inherent value is vast in India, Indonesia, Thailand, and Vietnam. There is scope to increase the amount and consistency of recycled plastic supply, preserve the material value within these countries, and reduce dependency on polymer and plastic waste imports. This should concurrently result in an improvement of the welfare of informal workers and the health of communities and the regional environment.

For local plastic supply chains to be effective, several conditions must be in place. These include demand from buyers for recyclates, which needs to be matched by supply of good quality plastic waste; the right regulatory and policy framework and respective implementation measures; and transparent pricing at each stage to incentivize the investment of time and resources. Handling practices at each stage of the plastic recycling supply chain need to be efficient and conducted in a socially- and environmentally-friendly manner. In addition, supply chains must have the ability to scale, to increase the quantity and range of plastic collected for recycling to meet the growing demand for high-quality recycled plastic from local sources rather than imports.

Solutions cannot be achieved by one organization or individual in isolation. Change will require dedication, collaboration, and cohesively planned investment from multiple influencers of local plastic recycling supply chains.

RESEARCH OBJECTIVES

Plastic recycling supply chains are often local and unique as they rely on many informal transactions driven by local conditions, traditions and cultures, as well as local and regional infrastructure and markets. While there are a range of existing studies on national waste flows, few explore the plastic supply chains in more localized contexts. Recognizing this need, The Circulate Initiative, in partnership with Anthesis Group, conducted a detailed assessment of wastesheds in four countries, India, Indonesia, Thailand, and Vietnam.

This document presents the outcomes of this study, which was undertaken in 2022 to map local plastic recycling supply chains and their corresponding infrastructure in selected wastesheds in India, Indonesia, Thailand, and Vietnam.

The objectives were to:

- › Understand the supply chains for secondary plastics at a local level, including the key actors, infrastructure, and influencing regulations.
- › Understand the economics for secondary plastic at each stage of the local plastic supply chains and the key factors influencing prices.
- › Identify where interventions to improve supply chains could be made.

¹ Though both have established basic supply chains, Chon Buri and Rayong were selected in addition to Bangkok in Thailand as it was thought entrepreneurial actions by local supply chain actors made them interesting areas of study.

² Da Nang is the name of a region as well as a city. This study only focused on exploring local plastic recycling supply chains in Da Nang city, not the wider region.

SCOPE AND METHODOLOGY

The study focused on municipal waste (generated primarily by households and small businesses) as this is where many of the local environmental issues are occurring and where there appears to be the most potential to scale up plastic waste collection and recycling.

The wasteshed areas were selected to include:

- › The capital city of each country (capital).
- › Mega or large cities with existing and functional plastic recycling supply chains e.g., having a number of existing plastics recycling plants (established).
- › Cities or regions with considerable plastic waste generation and emerging plastic recycling supply chains e.g., they might have waste collection, but limited sorting and recycling capacity (emerging).

It should be noted that wastesheds broadly reflect the boundaries of the selected cities; however, there is some fluidity. Aggregation and recycling activities sometimes cross boundaries and, where appropriate, relevant infrastructure and key players outside the city boundaries were included in the assessment to provide a better understanding of the wasteshed material flows.

The polymers selected for this study include PET, LDPE, HDPE, and PP. Combined, these are expected to make up around 85% of plastic packaging and food-service plastic. Rigid plastics using PET, HDPE, and PP dominate the post-consumer recycling industry today, whereas flexible packaging using LDPE and some PP or combinations thereof are expected to require further interventions to enter recycling cycles.

Table 1: Cities that were selected for plastic waste supply chain mapping.

	INDIA	INDONESIA	THAILAND	Vietnam
Capital	Delhi	Greater Jakarta	Bangkok	Hanoi
Established	Mumbai	Surabaya	Chon Buri Rayong ¹	Ho Chi Minh City
Emerging	Chennai	Makassar	-	Da Nang ²

Information regarding plastic supply chains in each wasteshed was gathered through a review of publicly available literature, as well as interviews conducted with local supply chain actors (59 collectors, 45 aggregators, and 21 recyclers across the four countries). Anthesis Group, the lead research partner for the study, was supported by in-country partners in each country to carry out the local interviews. The in-country partners were Evergreen Labs for Vietnam, PRO India for India, Rebel (with Waste4Change) for Indonesia, and the Stockholm Environment Institute (SEI) for Thailand.

Additional interviews were conducted with organizations privy to local arrangements (such as local plastics associations, municipal waste management organizations, waste operators, and producer responsibility organizations) to gain additional insight and to help corroborate the findings.

The status of plastic recycling in these countries and the nature of informal supply chains means that it is not possible to accurately trace tonnages through the supply chain, to list all active actors, or to undertake a detailed pricing and economic assessment for all wastesheds.

This report provides another step towards understanding wastesheds and relies on primary and secondary information that has been reviewed, analyzed, and extrapolated for this project to provide an informed view for debate and discussion. The data provided should be understood as being the best estimates at this point in time, to be improved on and ratified once waste data monitoring and tracking systems, as part of Extended Producer Responsibility (EPR) and other policy measures, have been implemented. This report focuses on creating a better understanding of the wastesheds and suggests potential interventions to grow plastics recycling and reduce environmental impact.



The National Picture

COUNTRY OVERVIEW³



Population

70 MILLION



Total Municipal Solid Waste (MSW) generation

16.7 MT/YR



Plastic waste generation (in MSW)

3.6 MT/YR



Plastic waste recycled (in MSW)

0.4 MT/YR

Thailand is one of the largest countries in Asia – around half of its population live in urban areas and cities, mostly in big metropolises like Bangkok or Nonthaburi city.⁴

The petrochemical sector is the largest in Southeast Asia – Thailand produced 11.8 MT of petrochemical products in 2018, including plastic resins. The plastics industry contributed THB 1,100 billion (USD 36.9 billion) to the national economy in 2018, comprising 6.71% of Thailand's GDP.⁵ Despite high domestic demand, it is estimated that only approximately 20% of plastic waste generated is collected for recycling,⁶ with 250 KT/yr imported into Thailand per year to support manufacturing activities.⁷

Uncollected plastic waste and unsanitary disposal facilities result in an estimated 428 KT/yr of mismanaged plastic waste in Thailand.⁸

NATIONAL REGULATION

Currently, most decision-making processes concerning waste handling and budgetary management are centralized in national government ministries, including the Ministry of Natural Resources and Environment (MONRE), the Pollution Control Department (PCD), and the Department of Local Administration (DLA).

Operational capacities and responsibilities are determined locally. For example, local governments are responsible for implementing national policies and directives. Local administrations are also at the forefront of tackling plastic pollution. Municipalities are responsible for funding or providing public collection services to the entire population, reporting on their performance, and providing their inputs to the Producer Responsibility Organization (PRO) about needs on the ground.

Several challenges have resulted in inefficient management of plastic waste. For example, limited powers given by the constituent legislation, the lack of financial resources, as well as the lack of cooperation and coordinated actions amongst the relevant government departments and agencies.⁹

—

³ Population figure: World Bank – *Data Bank*, data for 2021.

MSW generation: PCD - *Thailand's Roadmap on Plastic Waste Management 2018-2030* (2018).

Plastic waste generation: Data from BMA provided to Anthesis Group by local partner SEI.

Plastic waste recycled: Calculated by Anthesis Group based on the plastic waste collection estimates above and assumptions gathered from interviews with local value chain participants.

⁴ Statista – *Thailand Statistics and Facts* (2021).

⁵ World Bank – *Market Study for Thailand: Plastics Circularity Opportunities and Barriers* (2021).

⁶ Estimates made by Anthesis Group based on plastic within municipal waste generation and tonnages recycled.

⁷ Rujivanarom, P – *Thailand's Plastic Waste Conundrum* (2021).

—

⁸ World Bank – *Plastic Waste Material Flow Analysis for Thailand* (2022).

⁹ IUCN and Mar Plastics – *The legal, policy and institutional frameworks governing marine plastics in Thailand* (2020).

The key policies influencing plastic are summarized in Figure 1. They include a recent government policy that started implementation in June 2022, which lifted a ban on using recycled plastic packaging for food. This could drive more recycling activity via the creation of new local markets for recycled food packaging.

In addition, the Rayong Public Private Partnership for sustainable plastic and waste management (PPP Plastics) was established in 2018, with the main goal of supporting and driving the roadmap on plastic waste management. The Rayong model is a collaboration between schools, communities, and government agencies and entrepreneurs. The recycling entrepreneurs aim to educate the public to separate clean plastic waste at the household level to increase the amount of plastic that flows into the recycling system.¹⁰

Most of the regulations impact actors involved in collection, sorting, and aggregation as many regulations are focused on moving towards a more formalized system. While this will bring benefits to the informal sector by increasing wages and improving quality of life, it may reduce the availability of good quality material for recyclers, as the informal sectors are very efficient in collecting high-quality recyclables. Actors further up the supply chain, at the recycling stage, will likely be affected by higher prices of plastic packaging material. These stakeholders will also need to branch out into new areas of recycling e.g., flexibles and films, as well as biodegradable plastics, which are encouraged by the government to reduce the impact of plastic pollution. However, biodegradable plastics can also lead to microplastic pollution if these are not collected as part of the organic waste stream for industrial composting etc.



¹⁰ Thailand Environment Institute (TEI) – Role of Public Private Partnership for Sustainable Plastic and Waste Management (PPP Plastics) for solving the plastic waste problem in Thailand (2021).

Figure 1: Summary of key national legislation in Thailand.

Thailand's 3Rs Strategy

Description: Underlying focus is on resource efficiency, sustainable consumption, proper disposal and promoting the 3Rs strategy.

Expected impact: A more formal market with a reduction of valuable scraps may negatively impact collection, sorting and aggregation.



2016

Royal Decree No. 702

Description: Additional tax deduction of 25% for the production of biodegradable plastic products.

Expected impact: It is expected to reduced plastics use and encourage plastics manufacturers to shift into producing biodegradable plastics.



2017

Notification B.E.2560

Description: Specifies the provision of separate containers for waste, setting dates, times and routes for MSW collection and the duty to educate the public in waste reduction and segregation.

Expected impact: It is expected to increase demand for MSW collection at source which could benefit all actors in the supply chain.



2020

Notification No. 435 B.E. 2565

Description: The notification lifted a ban on the use of recycled materials for food containers to promote the circular economy.

Expected impact: This could drive more recycling activity as there can now be a local market for recycled food packaging.



2021

The 12th National Economic & Social Development Plan

Description: The 4th target of the 12th Plan looks at increasing efficiency in solid waste disposal. >75% of waste generated by communities is properly treated or reused; >30% of communities' hazardous waste is correctly disposed; and all industrial waste is treated by proper management systems.

Expected impact: A more formalized and efficient sector may increase prices at every step of the plastic waste recycling value chain



2022

2030

Roadmap on plastic waste management

Description: The principles of the roadmap are: a life cycle approach, the 3Rs, fostering public-private partnerships, circular economy and responsible production and consumption.

Expected impact: The roadmap may boost the formalization of the sector, turning more informal waste collectors into formal collectors, improving working conditions and quality of life. May also lead to increased prices of recyclable plastic materials.



Status of policy

Announced

Being rolled out

Fully implemented

Stakeholders impacted by policy

Brands, plastic manufacturers

Plastic recyclers

Collection, sorting and aggregation

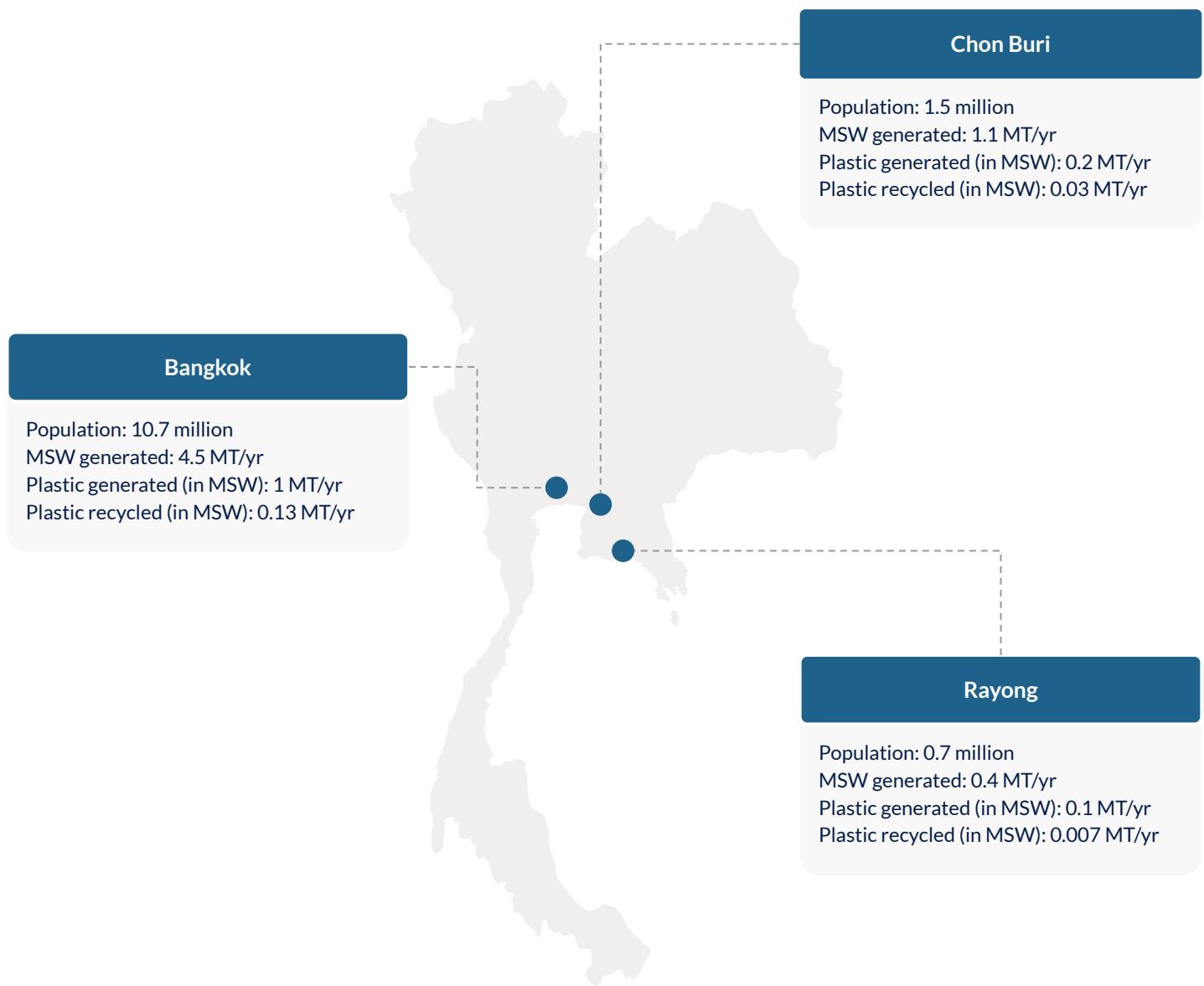
Recyclate / R-polymer buyers

Overview of Selected Wastesheds

The regions selected for plastic waste mapping in Thailand are:

- **Bangkok:** The country's capital and largest city. Bangkok has an established formal and informal collection ecosystem with plastic being traded via junk shops and aggregators before entering well-established formal plastic recycling infrastructure.
- **Chon Buri:** A province and city located directly on the coast of the Gulf of Thailand. Chon Buri has experienced rapid population and industrial growth, though many inhabitants remain unregistered with the local government, making waste estimates difficult. The city relies on informal workers to collect material for recycling and has limited formal waste recycling infrastructure when compared to the other two wastesheds.
- **Rayong:** A province and city on the south coast of the gulf. Rayong is an industrial city and tourist destination known for its national parks and beaches. Collection of plastic waste is informal and is mainly sourced through picking by informal collectors; however, efforts are being made to improve source segregation via public/private partnerships.

Figure 2: Key statistics for the areas selected for plastic waste mapping in Thailand.



CURRENT SUPPLY CHAINS

This section describes how local plastic recycling supply chains typically operate within the selected wastesheds before providing a detailed outline of waste flows, key actors, and infrastructure in the three wastesheds.

Collection: Stakeholders and processes

Collection of plastic waste for recycling is delivered through the informal sector in all wastesheds, though the approach varies. In Bangkok, formal collectors often retrieve recyclables from their waste trucks to sell to nearby aggregators or junk shops to earn a side income on top of their formal salary. However, this practice is not expected as part of their formal role. Informal collectors (*salengs*) buy recyclable materials, including plastic waste where available, mainly from middle- and high-income households in the central business district. They also gather plastic waste from picking of materials (without payment) from waste bins, waste transfer stations, landfills, and other public areas where waste is discarded and accessible.

Survey responses indicate collectors in Bangkok have a more defined geographical area of operation within the city than the other two wastesheds in Thailand. They tend to focus on 1-3 districts and specifically target residential and small commercial sources of waste, which is likely due to the size of the city and the efforts to move aggregation and junk shops outside the city. Collectors in Chon Buri stay within the town and focus on sourcing waste from bins. In Rayong, the collectors have a wider range of sources (industrial, landfill, construction sites), which could reflect the fact that Rayong is a smaller city with a more industrial focus. Most collectors tend to operate within a 5-10 km range across all the regions.

Informal collectors reported taking steps to prepare material for recycling to help achieve higher prices, including the removal of bottle sleeves. This indicates that local collectors have a clear understanding of how quality requirements drive pricing. In contrast, some aggregators reported contamination of up to 30%. This could indicate that they buy cheaper mixed material from collectors who cannot or do not improve the quality of the material, or that collectors are purposefully increasing the weight with non-target material to get paid more per load.

Collection of MSW is managed by the local government administrations. There has been some activity to encourage separation of recyclable waste at source for collection but this is still at early development stages. Household behavior remains a key barrier to improving local plastic waste recycling supply chains, and key reasons for recyclable material not being separated include a lack of time and space.¹¹

Aggregation: Stakeholders and processes

Municipally collected waste is aggregated via transfer stations, which are primarily operated by private waste companies contracted by the city authorities. The informal and formal sectors overlap at this stage of the supply chain, though there is typically no formal separation of material at these sites. Informal workers are allowed to pick recyclable plastic waste from the sites or buy it from the workers at the transfer stations or landfills.

The plastic waste is then sold to private aggregators, who consolidate the smaller amounts from individual waste pickers, before the recyclables are transported to recycling facilities. Any materials that municipal collectors have separately collected are also managed via this route.

Private aggregators (waste shops or junk shops in Thailand) are mostly formal in that they hold permits from the local authorities to conduct business activities on their premises, but most do not have an industrial permit allowing them to process plastic waste.

Space limitations in Bangkok restrict the amount of material that can be consolidated by individual aggregators. As a result, plastic waste often moves through at least two stages of aggregation, from smaller local aggregators to larger aggregators before reaching recycling facilities. In addition, aggregators in Bangkok typically source their plastic waste from within their district or adjacent districts, while in Chon Buri and Rayong it is sourced from within the respective provinces. Compared to Bangkok, where small aggregators are available within a proximity of around 1-3 km, in Rayong and Chon Buri the distance between aggregators is much larger.

—

¹¹ Anecdotal information from interviews with local value chain participants.

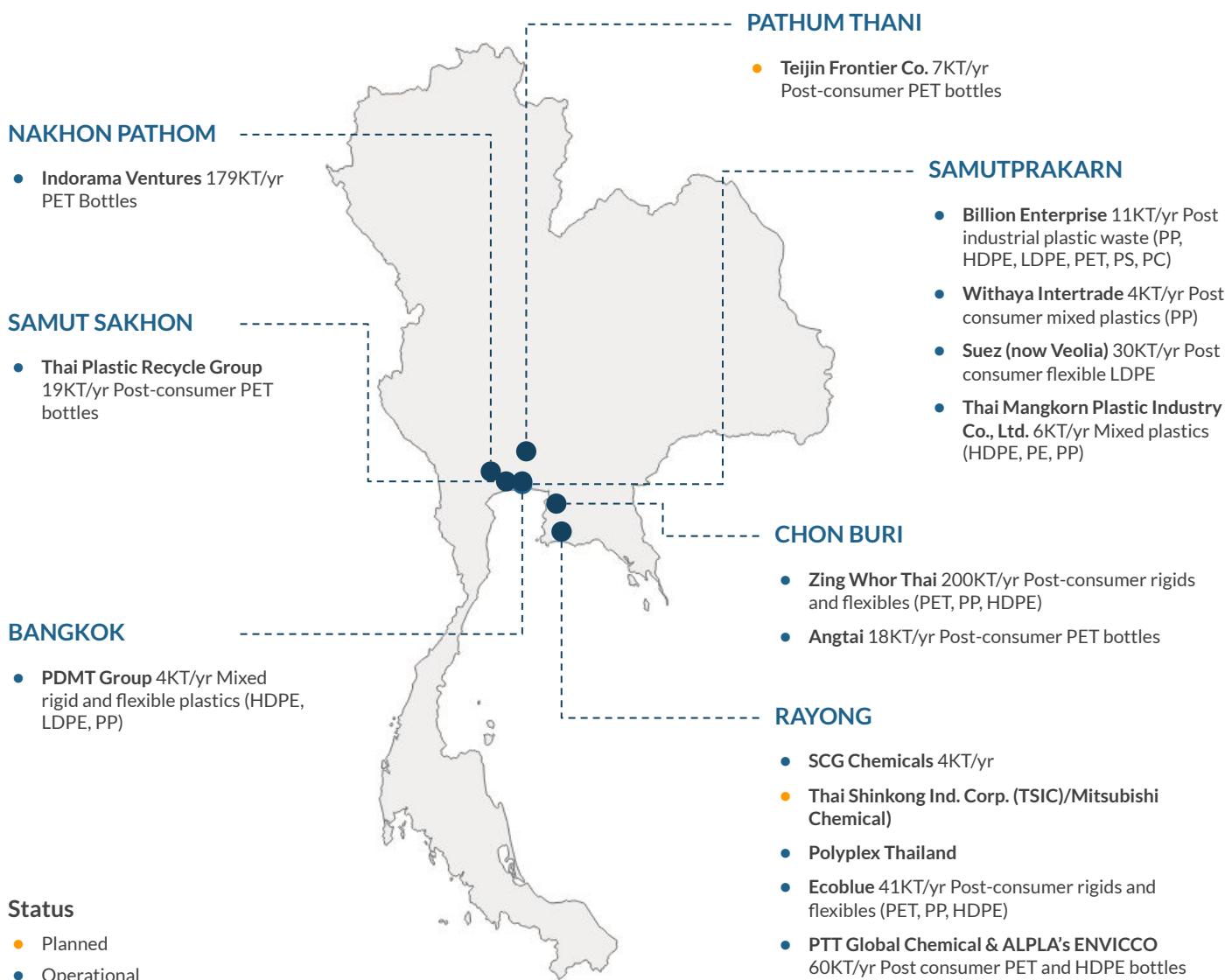
Despite space limitations, waste shop owners interviewed in Bangkok accepted a wide range of plastic material e.g., old plastic furniture and packaging. In Chon Buri and Rayong, a more limited range was accepted (e.g., PET, PVC, and HDPE).

The multiple aggregators add value to the traded plastic material by reducing contamination and preparing single polymer fractions. The research indicated that there is clear communication between collectors and aggregators about what is acceptable, and this sets the price.

Recycling: Stakeholders and processes

Informal reprocessing is much less prevalent in Thailand than in the other countries covered in this research (India, Indonesia, and Vietnam). There is well-established formal recycling infrastructure for PET, HDPE, and other rigid plastics, with operators holding appropriate licenses for their operations. Government data indicates that there are 62 recyclers in Bangkok, 61 recyclers in Chon Buri, and 26 recyclers in Rayong.¹²

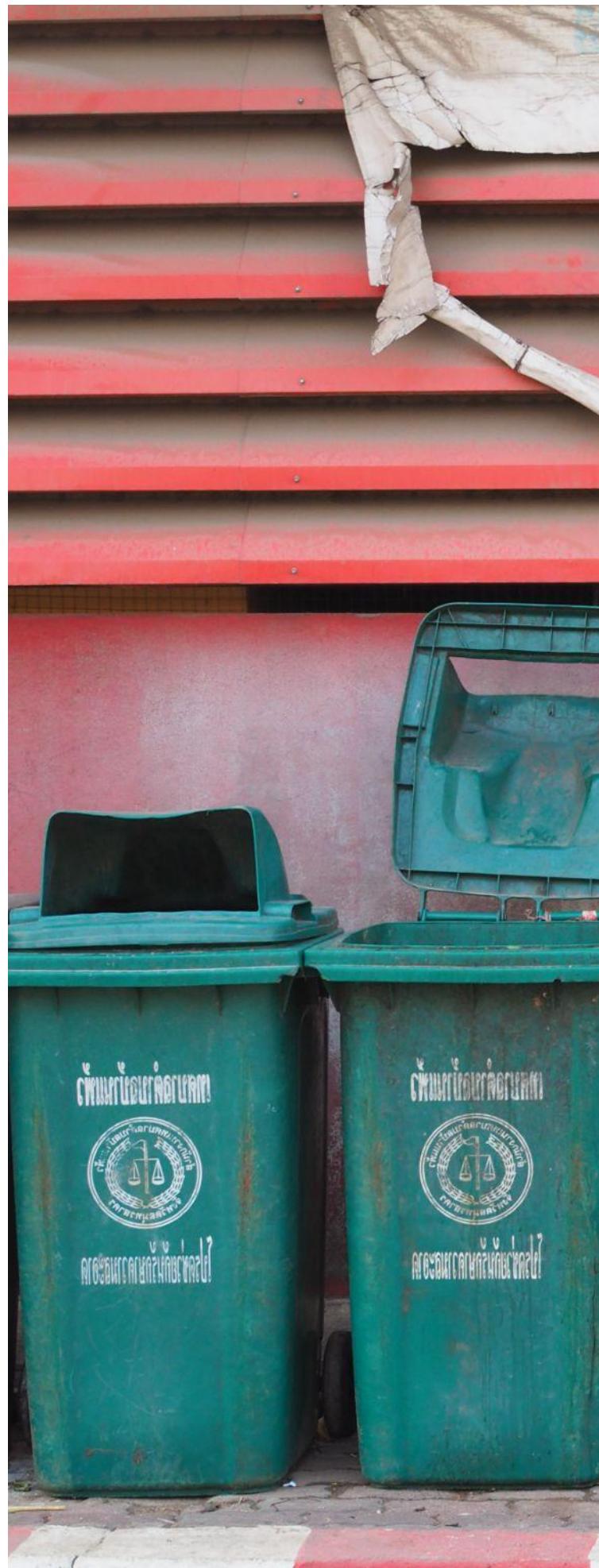
Figure 3: Overview of formal plastic recycling facilities in the vicinity of Bangkok, Chon Buri and Rayong that were identified during the mapping research.



¹² Data provided by SEI based on information extracted from OIE – Directory (2019).

The highest demand from recyclers is for PET and the national recycling rate for PET bottles is estimated to be over 80%, with existing drop-off points for PET bottles at major malls and other locations helping to boost this rate.¹³ There is also increasing demand for rigid PP from domestic recyclers responding to growing demand for recycled polymers. There has historically been low demand from recyclers for LDPE and other films as these materials are more difficult to recycle into high-quality items, but some domestic capability, mainly for post-industrial PE films, is being developed near Bangkok.

In addition, many companies have their own in-house recycling facilities (e.g., ThaiBev etc.) or develop and participate in take-back collection systems, which increases in-country reprocessing capabilities. For example, Coca-Cola in Thailand sponsored the 'Coke Recycle Me with Trash Lucky' campaign in 2021, where consumers were able to return empty bottles and cans for recycling via parcel delivery, or Trash Lucky drop-off points for recycling via Indorama Ventures etc. This campaign is being repeated from October 2022 to March 2023 across Bangkok to coincide with Thailand permitting the use of rPET for packaging manufacturing. The campaign accepts rigids such as PET, HDPE, and PP, as well as flexible LDPE films from bubble and bottle wraps, fruit, and ziplock bags.¹⁴



¹³ Bring Back Recycle - Recycling Drop Off (2021).

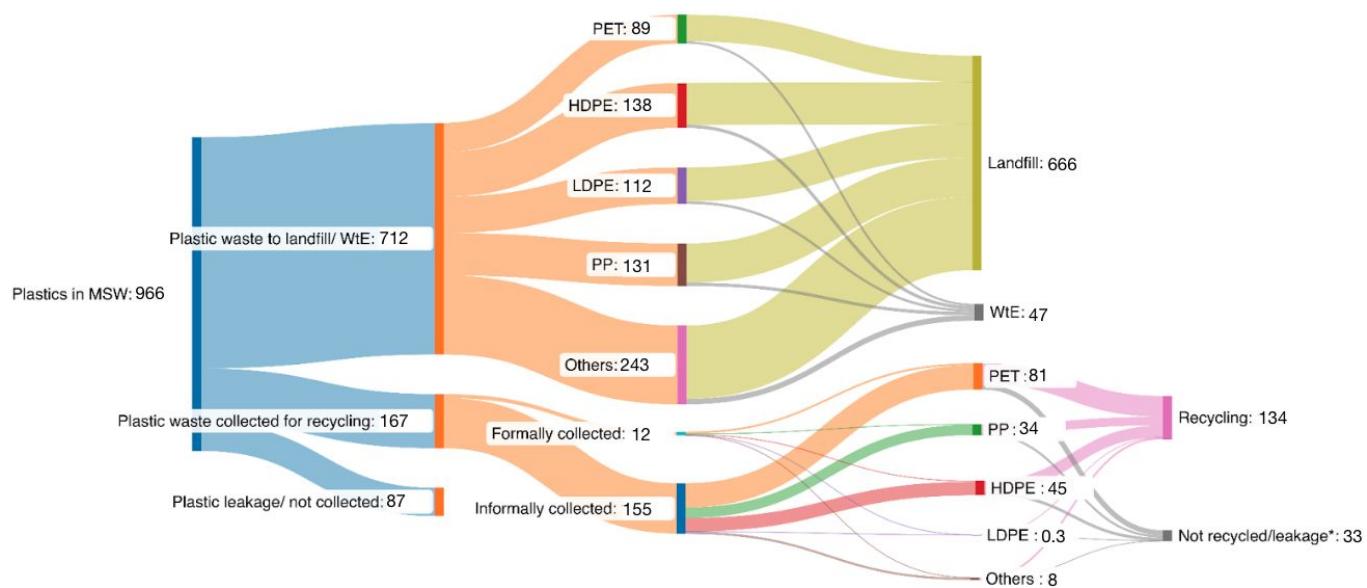
¹⁴ Trash Lucky – Coca-Cola Recycle Me 2022 Campaign (2022).

Insights on local plastic recycling supply chains in Bangkok



In Bangkok, it is estimated that around 15% or 134 KT/yr of plastic waste is being recycled each year. The informal sector collects more than 90% of the plastic going to recycling. PET contributes to nearly half the plastic recycled, followed by HDPE and PP. Only very small amounts of LDPE are collected and if these cannot be sold for recycling, they are often leaked to the environment. The majority of plastic waste goes to landfills or WtE facilities as part of the mixed waste stream.

Figure 4: Flow of plastic within municipal solid waste in Bangkok (thousand tonnes per year). Figures are rounded to the nearest whole number and may not sum because of rounding. *'Not recycled/ leakage' refers to plastic waste collected, but not recycled due to contamination or the collectors being unable to sell low-value plastics to aggregators.

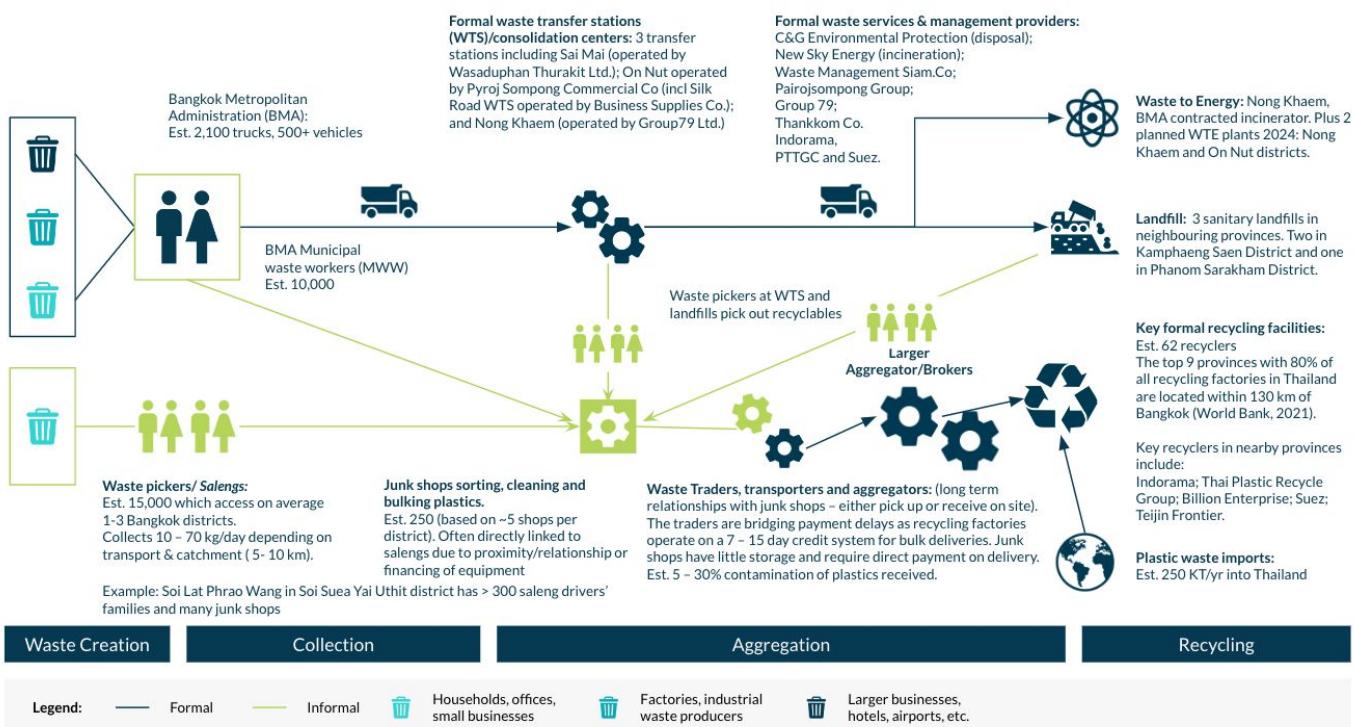


The Bangkok Metropolitan Administration (BMA) leads MSW collection and has short (1-4 years) and longer term (up to 10 years) contracts with private formal waste management providers delivering transfer, landfill disposal, RDF production, and WtE services. Contracts agreed for residual waste treatment include a 2015-2025 contract with Pyroj Sompong Commercial Co Ltd for the treatment of 600 T/d at the On Nut Waste Disposal Center, a rolling contract with Group 79 Co Ltd that has been in place since 1988 for landfill at the Nong Khaem Solid Waste Disposal Center, plus a contract with Chai Wat Transport Co Ltd for incineration of 500 T/d at the same site.

The majority of municipally-collected waste is sent to landfills in neighboring provinces, with key operators being Pairojsompong Group and Group 79 Co Ltd. A small amount of waste is currently sent to WtE facilities, though this is expected to grow in future with the development of two new sites in the Nong Khaem and On Nut districts. These are due to become operational in 2024 and will each treat around 1,000 T/d of waste as fuel.¹⁵ Both projects are still under consideration by the Office of the National Anti-Corruption Commission (NACC).

¹⁵ National News Bureau of Thailand - MEA to construct waste-to-energy plants in Bangkok (2021).

Figure 5: The plastic waste supply chain in Bangkok.



Newer trucks used by BMA to collect municipal waste have a section for recyclable material. However, anecdotal feedback from local supply chain actors suggests that the material collected is not separately managed through a formal system but is traded with informal workers at the transfer station, entering the informal system for aggregation and recycling.

BMA is no longer issuing new commercial and environmental permits for any new aggregators in Bangkok. It wants to focus on cleaning up the city and reducing the number of junk shops. Space in the capital city is limited and comes at a price, so the view is that it could be used for housing or commercial activities other than waste management.

There are a large number of formal recyclers located close to Bangkok with key facilities in nearby provinces, including Indorama Ventures, a 179 KT/yr recycling facility for PET bottles producing PET flake to be used in fiber, sheet and bottle applications. PDMT Group and Suez also both run local recycling facilities. PDMT Group's center has a capacity of 3.6 KT/yr and can process both mixed rigid and flexible plastics, including HDPE, LDPE, and PP. In 2020, Suez opened one of Thailand's largest recycling facilities in Samutprakarn (near Bangkok), capable of processing 30 KT/yr of LDPE films.

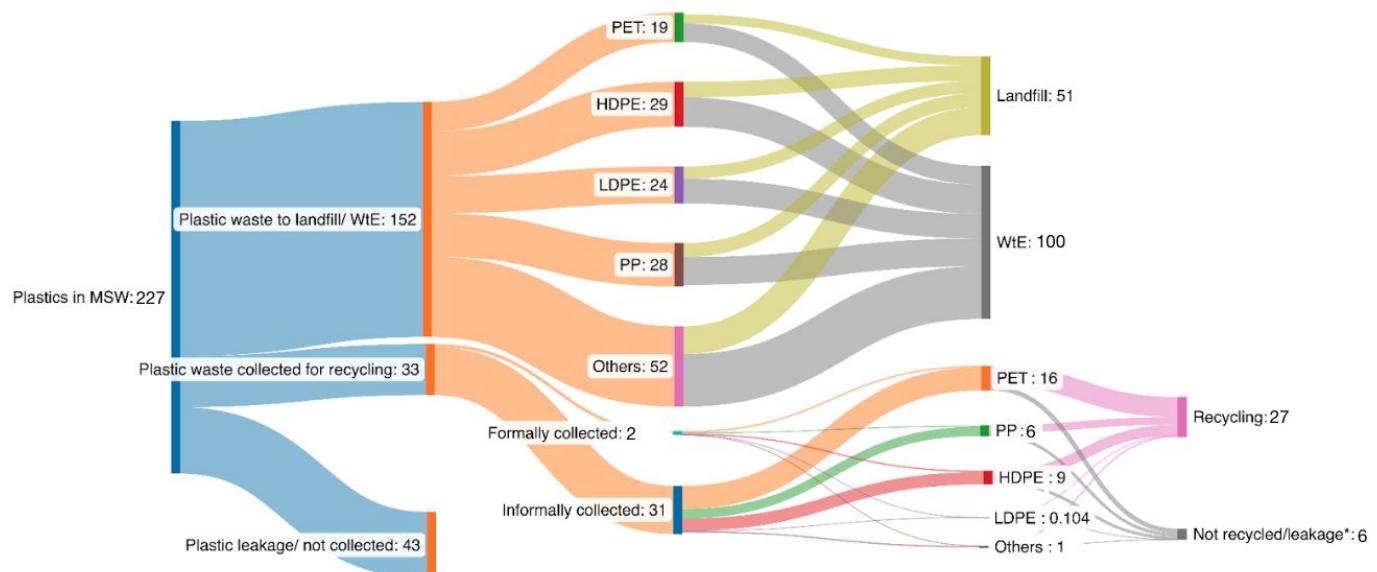
BMA is educating households to increase segregation of recyclables at source; however, this is at a very early stage. Increased collection of PE films will need to be driven by demand from the recycling sector to make it a worthwhile waste format to collect. There have been trials to collect post-consumer PE films and pouches in the past; however, these have been abandoned as the recycling facility was not built. Aggregators stated that it takes time to build up new supply chains and that they would require long-term commitments from recyclers before starting to handle PE films.

Insights on local plastic recycling supply chains in Chon Buri



In Chon Buri, around 14% or 27 KT/yr of plastic waste is recycled each year. Rigid plastics are recycled in the greatest amounts (PET, HDPE, and PP), and only very small amounts of LDPE are recycled as, typically, this waste stream is sent to landfills or WtE facilities, or leaked into the environment.

Figure 6: Flow of plastic within municipal solid waste in Chon Buri (thousand tonnes per year). Figures are rounded to the nearest whole number and may not sum because of rounding. *Not recycled/leakaged* refers to plastic waste collected, but not recycled due to contamination or the collectors being unable to sell low-value plastics to aggregators.

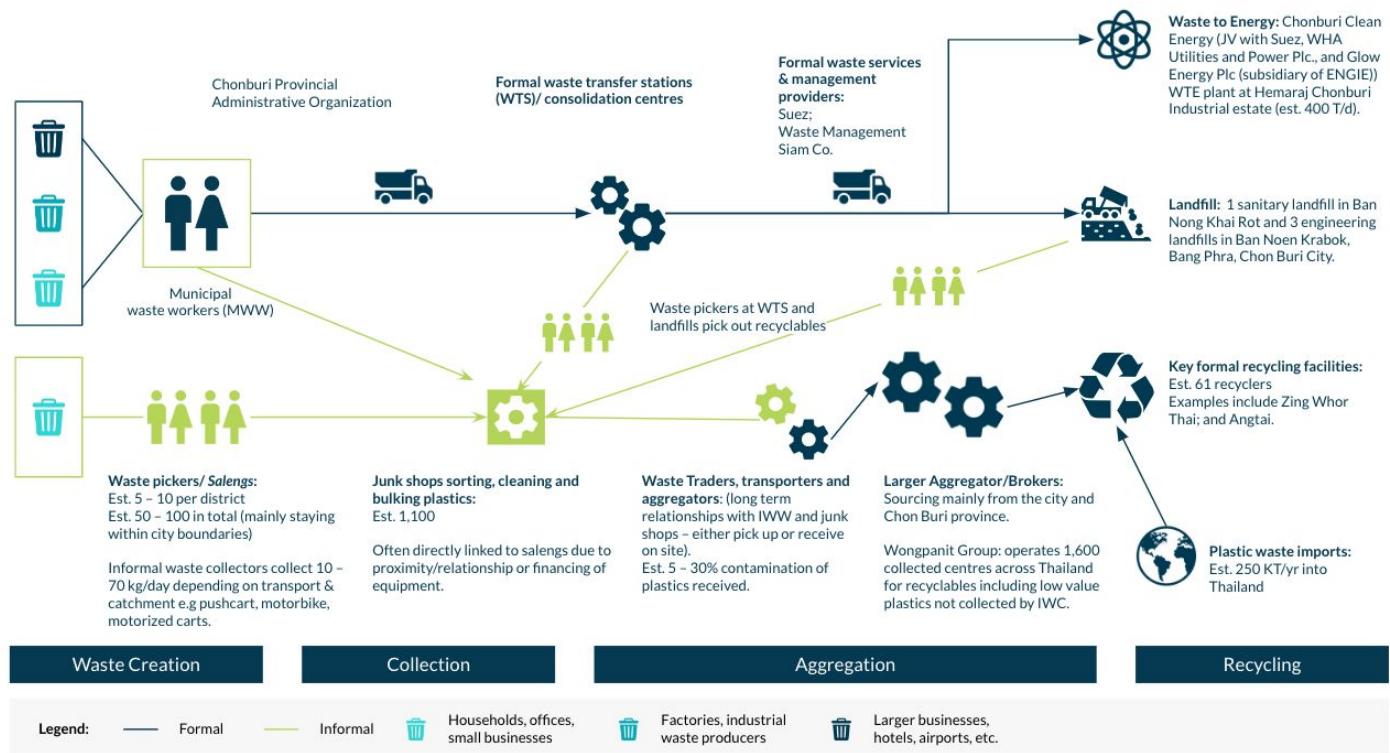


The Chonburi Provincial Administration Organization undertakes collections of municipal waste. Formal aggregation is undertaken by contracted companies, such as Suez and Waste Management Siam Co, which are responsible for transporting waste to one of the four local landfill sites.

It is estimated that around 100 KT/yr is currently sent to WtE, with a key local site being Chonburi Clean Energy, which has a capacity of over 400 T/d (est. 100 KT/yr) and started operation late in 2019.¹⁶

¹⁶ Suez – Chonburi Clean Energy (CCE) inaugurates its waste-to-energy power plant (2019).

Figure 7: The plastic waste supply chain in Chon Buri.



There are many aggregators in Chon Buri, which results in competition for material. Collectors find out which junk shops have the highest daily prices and challenge the price with their local aggregators. Wongpanit Group, one of Thailand's largest waste aggregators, has a franchise in most large cities in Thailand and reports material prices nationally and locally, influencing the price set by smaller aggregators across the country. The franchise model is free of charge to enter and attempts to promote best practice across the country to enable access to fairer pay and improve working conditions and security for informal workers.¹⁷

Key formal recycling facilities include Zing Whor Thai and Angtai. Zing Whor Thai has a processing capacity of 200 KT/yr and can process a range of plastics, including 125 KT/yr PET flakes and pellets. Angtai has a processing capacity of 18 KT/yr and mainly recycles post-consumer PET bottles.

Overall, Chon Buri's plastic recycling supply chain relies on the informal sector. As the main aggregator, Wongpanit's model has made a positive impact on plastics recycling in involving the informal workers. However, there is still an opportunity for the local administration to promote source segregation or work in public/private partnerships to further increase recycling across the city and province.

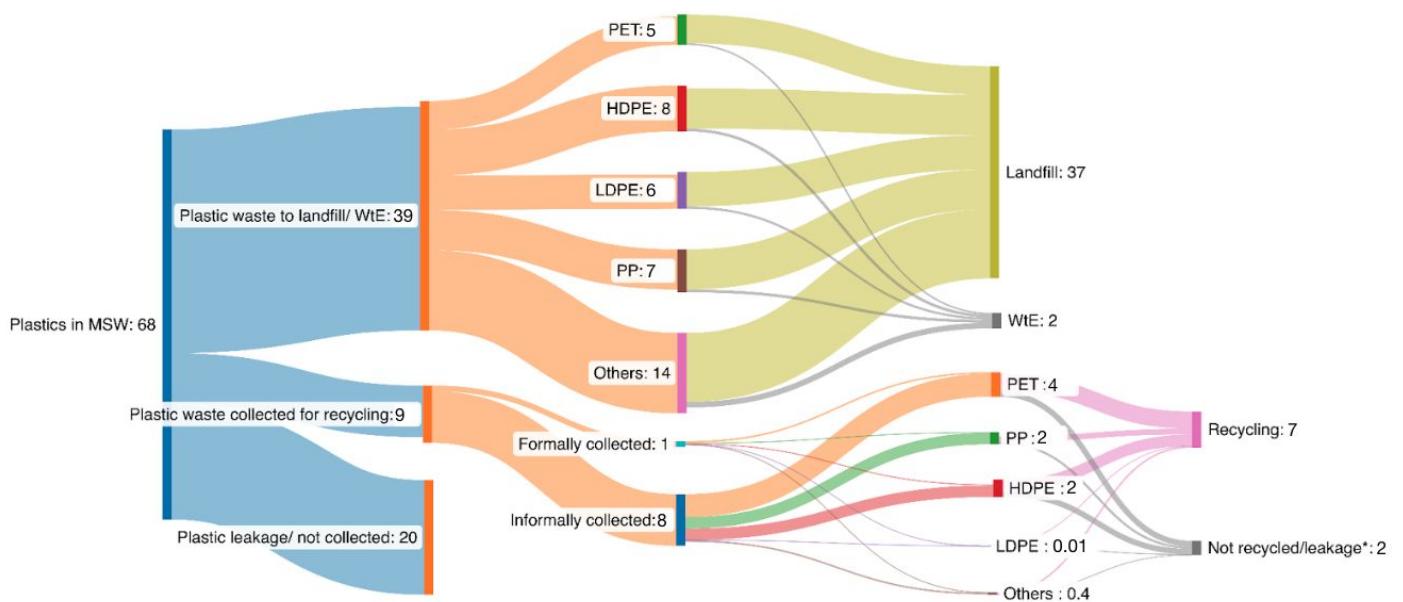
¹⁷ Interviews with local value chain participants, October 2022.

Insights on local plastic recycling supply chains in Rayong



Rayong has the lowest amount of municipal waste generated of the three wastesheds, with around 7 KT/yr (14%) being recycled. The majority of the plastics that are collected for recycling is informally collected. The rest of that plastics collected in MSW is sent to landfills and WtE plants.

Figure 8: Flow of plastic within municipal solid waste in Rayong (thousand tonnes per year). Figures are rounded to the nearest whole number and may not sum because of rounding. *'Not recycled/leakage' refers to plastic waste collected, but not recycled due to contamination or the collectors being unable to sell low-value plastics to aggregators.



The Rayong Provincial Administration Organization is responsible for the organization of waste management in Rayong, acting as the collection operator. After waste is collected, it is aggregated at transfer stations and transported to one of two landfill sites in Khao Bot Village and Phra Samut Chedi. Some of the plastic that is left in the collected MSW is treated via WtE. The Rayong Provincial Administration Organization and Global Power Synergy Public Company Limited (GPSC) run a WtE plant, which is located next to the Integrated Solid Waste Disposal Center in Rayong. The plant has been operational since 2021 and can process 300-500 T/d. The plant also has a sorting unit to help convert waste into RDF for use in cement kilns.¹⁸

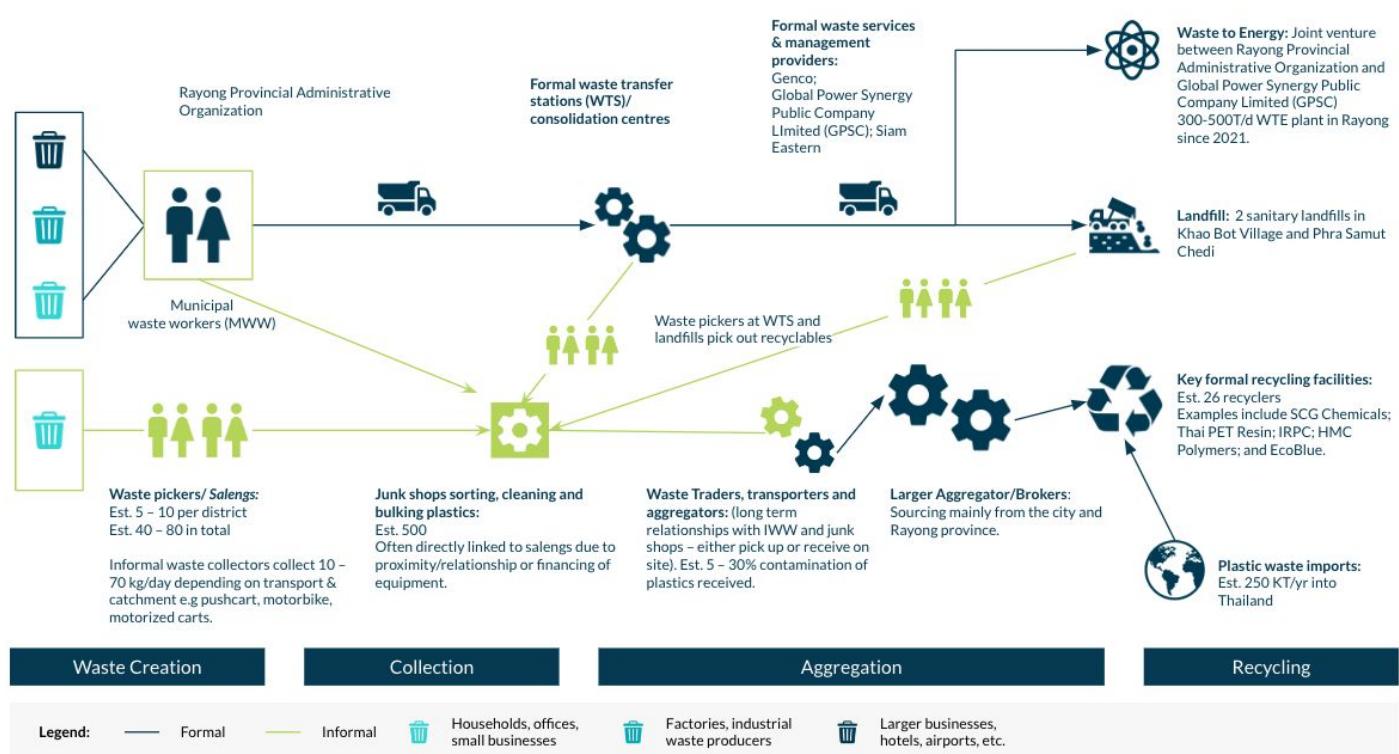
The informal sector underpins the collection and aggregation of plastic waste for recycling in Rayong. The plastic waste collected by the informal waste collectors (*salengs*) goes to the junk shops, which are often directly linked to each other due to proximity or established relationships between the two. The waste then goes to aggregators, which may also have long-term relationships with the informal waste collectors and junk shops, followed by larger aggregators before going to recyclers.

¹⁸ GPSC – Pracharat helps manage waste management in sustainable ways Rayong Province (2018).

Key formal recycling facilities in Rayong include SCG Chemicals, Polyplex Thailand's EcoBlue plant and ALPLA and PTT Global Chemical's ENVICCO facility. SCG's Circular Plas pyrolysis plant was granted the International Sustainability and Carbon Certification (ISCC PLUS) in September 2022, which demonstrates the high-quality post-consumer recycled resins.¹⁹ The EcoBlue plant opened in 2022 and can process 41 KT/yr, including 10 KT/yr of HDPE and PP post-consumer waste and 31 KT/yr of PET, which is being turned into high-grade resin for food packaging and other applications. The ENVICCO facility started operation in 2020 and can produce 30 KT/yr of food-grade rPET and 15 KT/yr of rHDPE.

There are efforts to increase plastic waste that is formally collected for recycling through the 'Rayong model'. The 'Rayong model' promotes source segregation of plastics in households, and offices, via a public-private partnership approach. Following its successful implementation in 2018/19, the model is now being extended to schools, shopping centers, and large supermarkets in Rayong.²⁰ However, the reported amounts of 40-45 tonnes a month (480-540 T/yr) are still very small and have not reached the target of 10% of plastics recycled (or 900 tonnes a month). Therefore, ideally, additional separation needs to take place to extract valuable plastics from mixed waste. Some sorting is done at the WtE plant next to the Integrated Solid Waste Disposal Centre, however, currently films and many other plastics are left in the RDF to achieve the required energy content for the cement industry.

Figure 9: The plastic waste supply chain in Rayong.



¹⁹ SCG News Channel - SCG Chemicals Becomes Thailand's First Company in Petrochemical Industry Certified with ISCC PLUS (2022).

²⁰ Energy News Centre - Tackling plastic waste with the "Rayong Model" (2019).

Analysis of pricing and pricing transparency along the value chain²¹

The amounts and types of plastic waste collected for recycling are dependent on the value of the polymer at different stages of the supply chain (the value chain) and the level of pricing transparency.

Pricing transparency refers to the degree to which pricing information is available to all buyers and sellers in a market. High levels of pricing transparency ensure healthy competition, efficient markets, and better pricing of products and is often considered an indicator of an efficiently operating supply chain, which enables growth.

Data collected through interviews in Thailand highlight the lack of consistency in the price points in some of the polymer markets, which can be 'expected' by collectors selling plastic waste, aggregators buying plastic waste, and recyclers buying feedstock for recycling. The range in data that was identified through this study could be due to the process used, material quality, or regional differences, but is also highly likely to be influenced by the lack of transparency inherent in the market. Overall, there is little transparency across the country; however, companies like Wongpanit are trying to change this by publishing daily price tables for recyclables, as well as making more detailed pricing tables available to their franchisees.²²



²¹ The findings presented in this section of the report are an extract from a pricing and policy interventions analysis on the recycled plastics value chain that was undertaken by The Circulate Initiative in parallel to this study. The results are published separately from this report.

²² Wongpanit website (2022).

Figure 10: Thailand PET pricing information from research and stakeholder interviews.

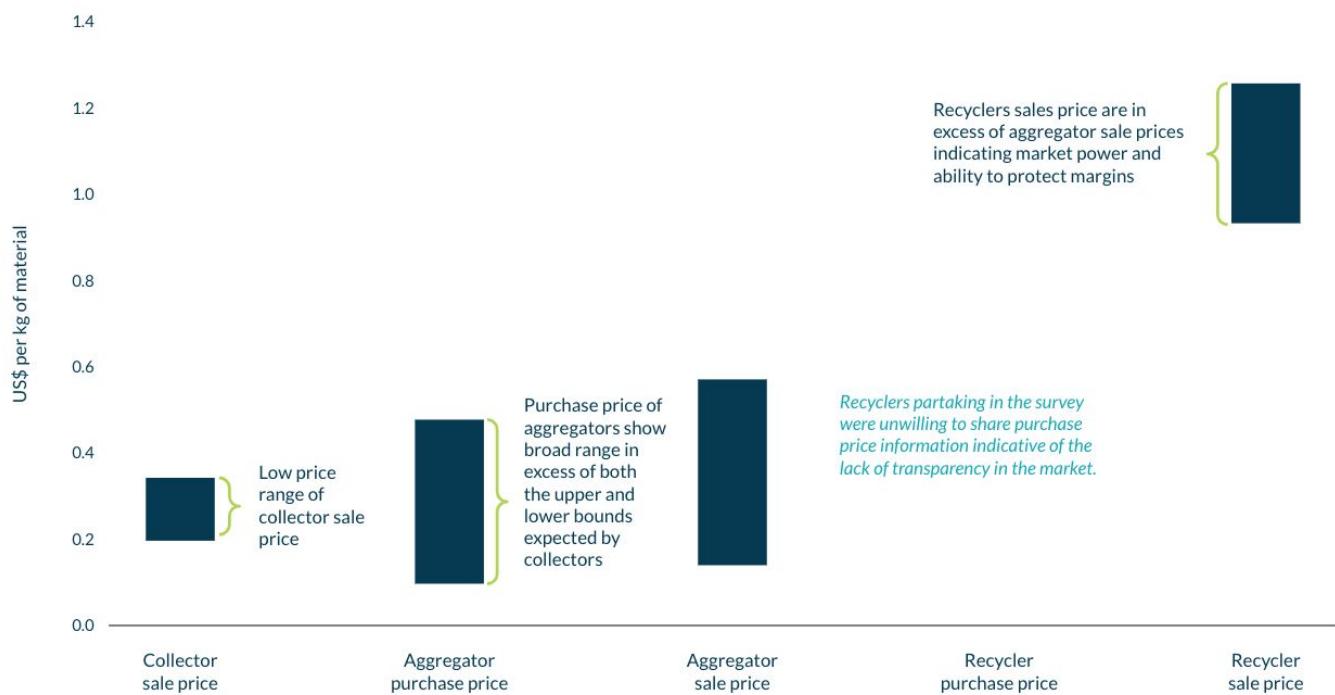


Figure 11: Thailand HDPE pricing information from research and stakeholder interviews.

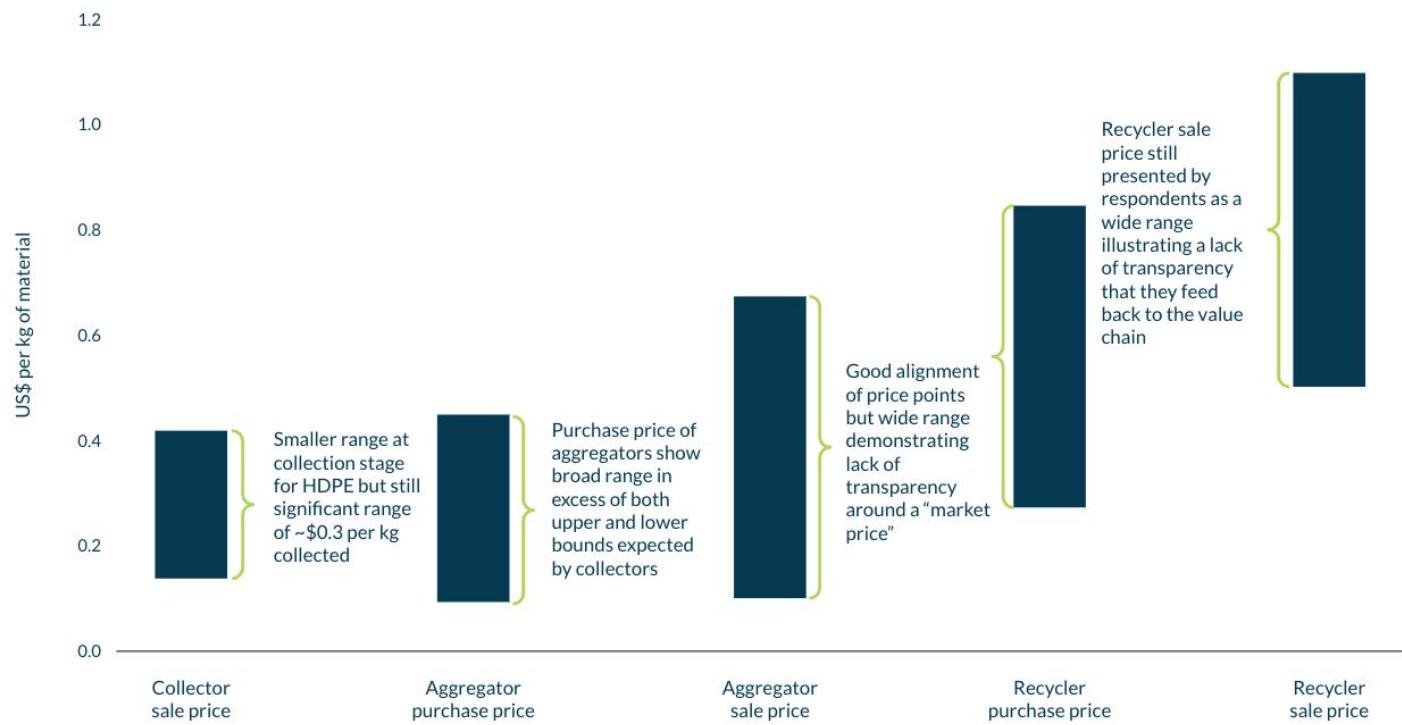
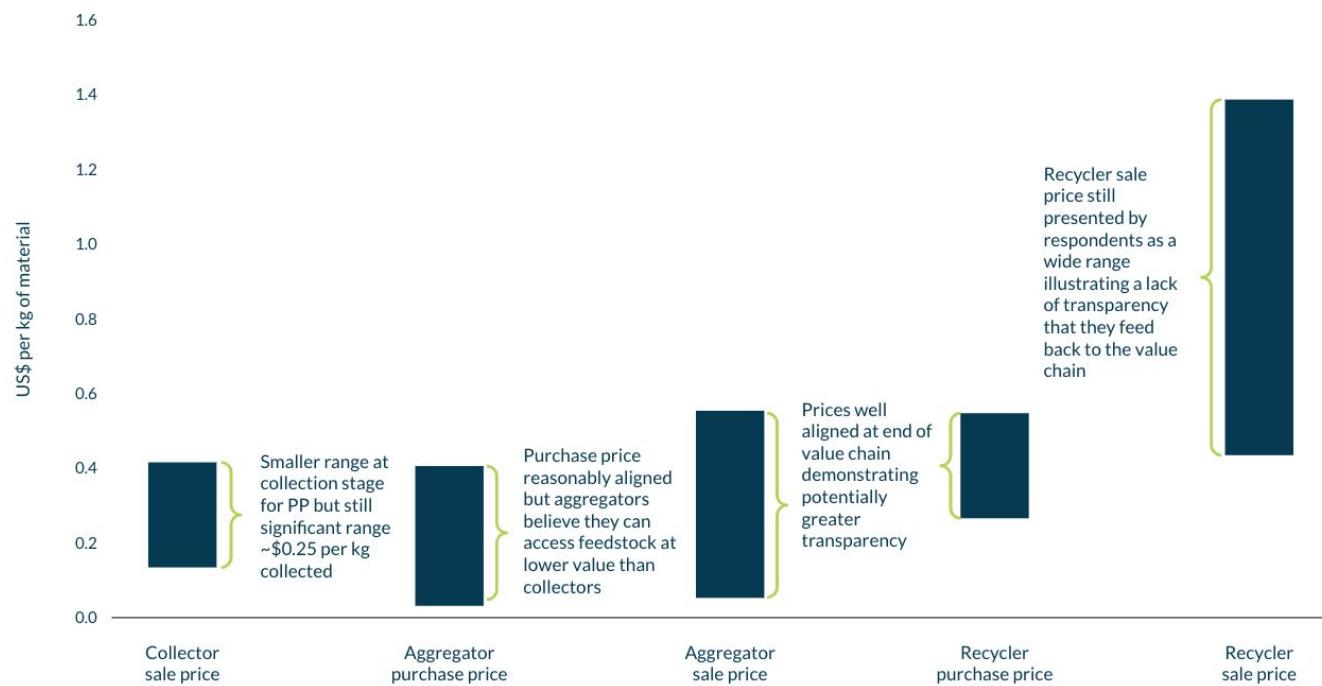


Figure 12: Thailand PP pricing information from research and stakeholder interviews.



In addition, the variation in data collected through interviews in Thailand highlights potential inconsistency in the value chain. This is evident in the early stages of the value chain, with aggregators and collectors not always aligned on a market price for scrap material.

However, it is also evident that there is a large proportion of market power retained by recyclers. Anecdotally, recyclers have been unable/unwilling to share purchase prices of material, adding to the lack of transparency within the value chain.

In addition, the range of price points provided for the sale price results in a lack of understanding of the end value of the material for other actors, which means recyclers can retain market power and set prices.

The plastic waste supply chains in Thailand indicate an imbalance in market power, which is mostly benefitting recyclers in the supply chain and negatively impacting collectors and aggregators. Analysis of supply chain actor profit margins (as a proxy for market power) drawn from the survey data has estimated that 70-80% of the total trade benefits in the value chain are attributable to the recyclers, while the remainder is split between aggregators and collectors. This means that, in practice, any price rises associated with the final output products will not easily flow back to the earlier stages of the value chain e.g., the collectors. This impacts the amounts, formats, and polymers being collected in the plastic waste supply chain.

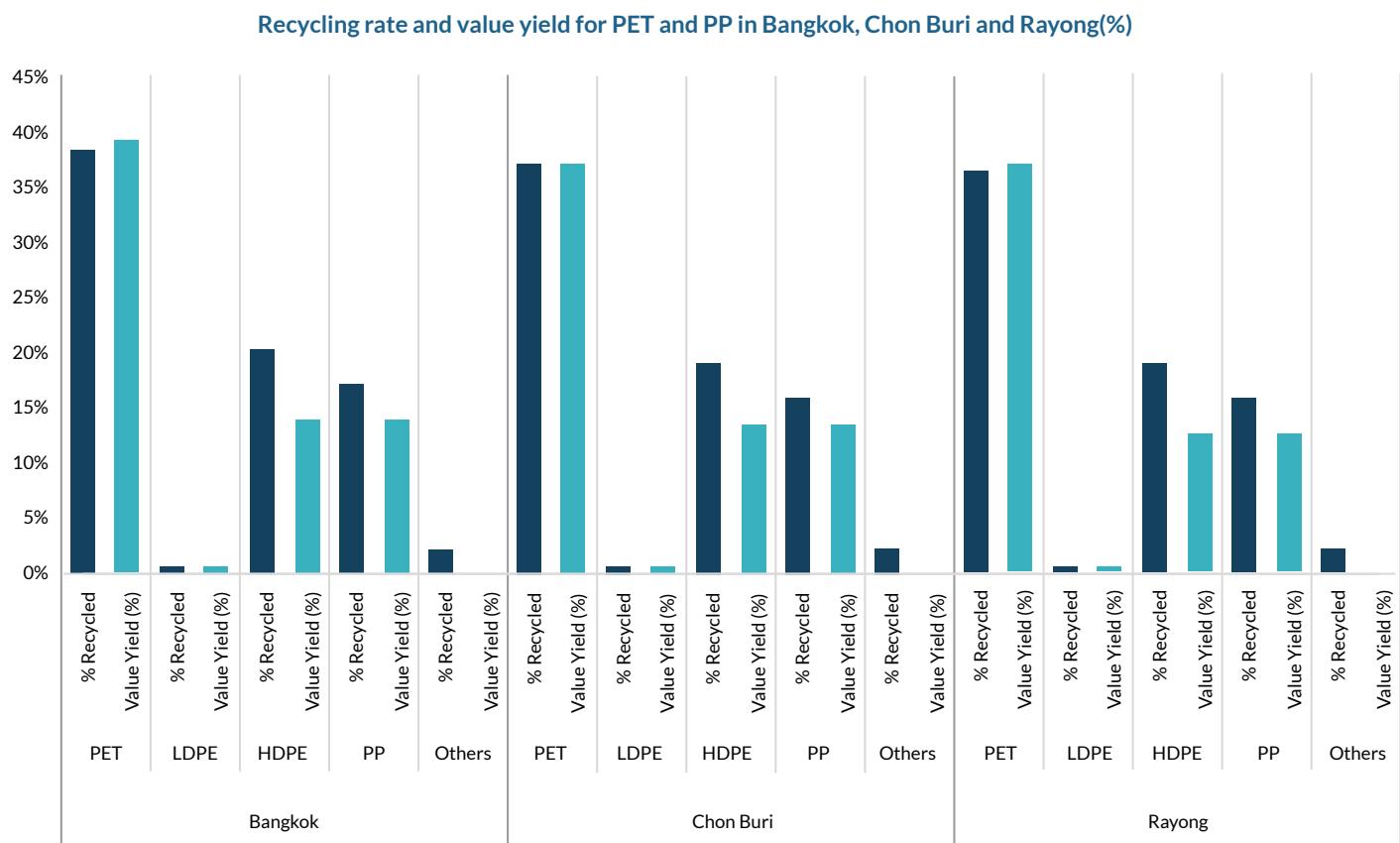
In principle, virgin and recycled PET, HDPE, and PP are commodities that are traded with well understood market values influenced by virgin polymer prices and recyclate quality that should filter back into supply chains. However, the plastic waste supply and value chains in Thailand seem to challenge this, with a more professional and organized recycling sector dominating the markets with their bargaining power. Aggregator interviews confirmed that sales prices to recyclers are mainly influenced by cost of collection, sorting, and aggregation and not so much by virgin pricing, hence the possible disconnect between recycler purchase prices and the actual output value of recycled polymers. The low range of prices paid by recyclers may, however, also be impacted by a more active import market (access to low-cost imports) supplementing local supply.

The comparison between estimated recycling rates and value yields (value of recycled plastics using recyclate pricing vs. value of plastics collected using virgin prices) shows the difference between individual polymers. PET has a significantly higher recycling performance across all wastesheds with 35-40% recycling rates. This indicates the high demand for this material as it is an established market with good feedstock supply and a good network of recyclers. In addition, PET value yields are high, suggesting that rPET prices are higher than virgin prices and good quality materials are provided to the recycling sector.

While both HDPE and PP have similar recycling rates across the wastesheds, the value yield for PP is slightly higher than HDPE relative to the quantity that is recycled as a result of differences between virgin and estimated recyclate pricing. This could be due to a lack of supply of recycled PP, supporting a higher recycling price relative to virgin material; however, this might also be related to the sample PP pricing information collected for this research.



Figure 13: Plastic recycling rates vs. value yields in Thailand.



Sources: Recycled pricing for individual polymers were obtained from research and interviews conducted. Virgin prices are virgin polymer price points from local producers (pre-Covid-19) from Circulate Capital - Safeguarding the Plastic Recycling Value Chain: Insights from Covid-19 impact in South and Southeast Asia (2020).



Evaluation of current supply chains

SUPPLY CHAIN ASSESSMENT

This section provides an overview and comparison of key aspects of the local plastic waste recycling supply chains in each wasteshed and the current barriers to recycling. An evaluation of each wasteshed in terms of different criteria identified to assess a well-functioning supply chain is presented in Table 2.

These indicators include the CFR rate, types of processes and infrastructure available, pricing transparency and regulatory framework. A high (green), moderate (amber), and poor (red) rating is assigned to each indicator depending on the status of the wasteshed, with a fuller description of the indicators provided in Appendix 1.



Table 2: Evaluation of supply chains in Bangkok, Chon Buri and Rayong using a red, amber, green rating approach.

Region	CFR Rate	Market Structure - Collection	Market Structure - Aggregation & Sorting	Market Structure - Recycling
		Main polymers being recycled are rigid HDPE, PP and PET, with nearly 100% of LDPE and flexibles disposed in landfill, WtE or leaked into the environment.	Public waste providers contracts with private waste service providers operating bulking stations, WTE and landfills. Limited recyclables e.g. rigid plastics (PET, HDPE and some PP) are being traded with informal sector. Main recycling is through informal collection from source, transfer stations and landfills.	No sorting and separation takes places at key transfer stations, but are mostly undertaken at junk shops and aggregators. Where LDPE/flexibles are being collected, these are not accepted by traders due to low value and lack of end markets.
Bangkok	15%	Bangkok Metropolitan Administration (BMA) contracted 10+ private waste management companies. Est. 15,000 salengs (IWC)	Est. 250 junk shops plus traders and aggregators - highly competitive market for PET and HDPE. There are also collection/ aggregation points at major malls & shopping centres*	Est. 60+ recycling companies
Chon Buri	14%	Chonburi Provincial Administration contracted ~ 5 private private waste management companies. Est. 50 - 100 salengs (IWC)	Est. 1,100 junk shops plus traders and aggregators	Est. 60+ recycling companies
Rayong	14%	Rayong Provincial Administration contracted private waste management companies. Est. 40 - 80 salengs (IWC)	Est. 500 junk shops plus traders and aggregators Public private partnership through the Rayong model to improve collection and aggregation is expanding.*	Est. 20+ recycling companies

Legend: High Moderate Poor

Note: * Aggregation is judged moderate due to good level of competition between different junk shops and aggregators.

Region	Pricing Transparency	Knowledge Gaps & Data Availability	Value Yield & Quality of Outputs	Regulatory Framework
	Poor to moderate pricing transparency depending on the recycled polymer with many informal collectors and aggregators in a fragmented market.	Limited data availability. Main data sets were derived from a literature search of recent studies and supported by interviews. However, there is good quality data on recyclers.	The low recycling rate for rigid plastic waste and the lack of recycling of flexibles leads to considerable value loss. Plastic value loss has been defined as the value of plastic collected based on virgin pricing against the value of plastics recycled based on recyclates prices for individual polymers.	Strong national framework. Various strategies and policies have been announced, but target dates vary.
Bangkok	Market power or share of the profit margins/trade benefits held by recyclers/large aggregators is ~70% for PET and 80% for HDPE and PP.	0-5 city studies on plastic waste generation, but limited data on waste treatment and polymer level details.	Est. value yields: 39% PET, 14% HDPE and PP, 0% LDPE	No specific policies or regulations relating only to Bangkok.
Chon Buri	Market power or share of the profit margins/trade benefits held by recyclers/large aggregators is ~70% for PET and 80% for HDPE and PP.	0-5 city studies on plastic waste generation, but limited data on waste treatment and polymer level details.	Est. value yields: 37% PET, 13% HDPE and PP, 0% LDPE	No specific policies or regulations relating only to Chonburi.
Rayong	Market power or share of the profit margins/trade benefits held by recyclers/large aggregators is ~70% for PET and 80% for HDPE and PP.	0-5 city studies on plastic waste generation, but limited data on waste treatment and polymer level details.	Est. value yields: 37% PET, 13% HDPE and PP, 0% LDPE	The Rayong model through public-private partnership sets targets to eliminate plastic waste from landfills by 2022 through engaging local administrative organisations and communities. This model is set to be replicated in Bangkok and Chonburi.*

Legend: High Moderate Poor

Note: * Rayong's implementation of source segregation requirements via the public-private partnership for plastics provides a good example for implementation of EPR principles and waste regulations. Therefore it has been marked high as it provides supportive conditions for plastic collection and recycling.

THE NEED FOR INTERVENTION

Recognizing the gaps that are limiting the effectiveness of existing local plastic waste recycling supply chains across the wastesheds, this section outlines the need for intervention in terms of collection and aggregation, plastic recycling and reprocessing, and municipal solid waste treatment.

Collection and Aggregation

Despite good availability of formal recycling infrastructure within each of the wastesheds and the associated demand for plastic waste, this has not led to high levels of collection as it is limited by the size of the informal sector and the lack of segregation of recyclables for formal collection. Without widespread and established separation of recyclable plastic through formal means (e.g., separation at source or by treatment of collected waste), the market growth in terms of amounts and types of plastic collected for recycling is limited. The low amount of domestically collected material is contributing to continued plastic waste imports, which in turn is also influencing pricing across the value chain.

Lack of shared information and a wide range in buying prices by plastic recyclers means that there is a low level of pricing transparency. This particularly affects collectors, who have a high dependency on a limited number of nearby junk shops to sell material. They depend on the prices offered on the day and have very little financial security if prices change.

Though there is potential for future reprocessing capacity for film to be developed, there is no current demand for post-consumer film waste. Implementing collection of new materials will take effort, time, and funding, as well as a firm commitment from recyclers to provide long-term off-take. The limited data availability and informal supply chains for recycling also make it difficult to ensure feedstock security when planning new plastic recycling infrastructure.

Plastic Recycling and Reprocessing

The general feeling from the interviews conducted is that all actors want to do more recycling. However, despite the strong recycling infrastructure, market prices are a key barrier that do not make it feasible for many types of plastics, especially plastic films.

Interviewees also suggested that they would welcome policies to make recycling more feasible (e.g., not using multi-layered plastics for food packaging and colored plastic bottles).

Municipal Solid Waste Treatment

Currently, the majority of municipally-collected material is sent to landfills. Although not ideal, this is currently providing an opportunity for additional plastics to be picked. WtE capabilities are growing in all wastesheds, which could reduce the recovery of plastic unless other steps are taken (e.g., formal pre-treatment).

Recommendations for interventions

This section summarizes interventions that could be considered to improve local plastic waste recycling supply chains in terms of: improving collection rates, increasing sorting and segregation of plastics for recycling, and enabling growth in plastics recycling for a circular economy. The interventions are aimed at governments and industry to improve supporting regulatory and social conditions to create a stable policy framework. They cover financial interventions to improve value creation from plastic waste, as well as technical and digital improvements to increase supply chain efficiency.

The interventions presented in this section are generally similar as most wastesheds in a country encounter common challenges in terms of infrastructure gaps, fragmented supply chains, limited enforcement of regulations, and imbalance of market power between value chain stakeholders. Where appropriate, examples of models or interventions that could be applied in specific wastesheds are highlighted. The implementation pathways for these interventions were not part of the study and are not outlined in detail. Key interventions for consideration are summarized in Table 3 and described in more detail in the following sections.

Table 3: List of potential interventions to improve plastics recycling and increase value creation along the supply chain.

Intervention categories →			
Desired supply chain impacts ↓	1. Improve supporting regulatory and social conditions to create a stable policy framework	2. Financial interventions to improve value creation from plastic waste	3. Technical and digital improvements to increase supply chain efficiency
Improve collection rates of plastics	Implement (harmonized) source segregated collection and EPR systems	Support payment of informal sector (fair & prompt payment) <i>(Improve funding for formal waste collection infrastructure)</i>	Digitalize recyclable collection and material tracing, for example explore 'pay as you throw systems (PAYT)' linked to material quality and level of segregation
	Awareness raising campaigns & behavior change e.g. to sort household waste, stop discharging bottles etc. into sea & oceans	<i>(Market incentive payments for hard to recycle, low value waste formats and polymers)</i>	
Improve sorting of polymers and quality for recycling	Import restriction (bans, import fees) for mixed and low-value plastic waste	Invest in formal segregation and sorting infrastructure (public sector, FMCGs etc.) and integrate informal sector (employ waste pickers)	National or regional virtual marketplaces to improve price transparency and increase access for buyers
		<i>(Plastic collection and sorting credits/incentives (as part of an EPR system))</i>	
		<i>(Subsidize formalization of informal or small scale aggregators (cooperatives, tax payments, permits))</i>	<i>(Digital certification and tracing of sorted plastics waste and polymers)</i>
Increase demand from plastic recyclers	Landfill and WtE disposal limits to encourage recyclables extraction (pre-processing requirements for residual/wet waste)	Quality standards for recycled plastics incentivising circular recycling (plastic credits for hard to recycle plastics, high recycling yields, closed loop recycling) <i>(Lobby for tax relief for recyclate content)</i>	National or regional virtual marketplaces to improve supply chain security

Legend: Primary interventions/(secondary interventions)

IMPROVE COLLECTION RATES OF PLASTICS

- Storage for material:** In city centers, available space to store material at waste shops is limited, particularly in Bangkok. Aggregators could benefit from funding opportunities to enable them to buy balers (or small compaction machinery) and increase the amount of material managed.
- Sorting and segregation:** Improving sorting at source and additional segregation of plastic from mixed waste at WtE and landfill sites is crucial to scale up plastic waste supply chains. The public/private partnership model in Rayong, as well as company and industry schemes as part of the nationwide 'bring-back initiative'²³ at major shopping centers, malls and businesses, have made some progress towards this, but they need to be supplemented by further action. This could include investment in formal sorting and segregation infrastructure to extract plastics from mixed waste after collection (e.g., at key transfer and consolidation centers or before WtE treatment or landfill). To incentivize key players, tax relief could be given for sorting and segregation equipment purchases. It could also be made easier for aggregators to obtain operating permits. Campaigns focused on behavior change and source segregation at waste generator level could also increase the amount of waste being sorted at source. These efforts could be supported by limits on landfill disposal and WtE by implementing pre-treatment requirements for mixed waste or the taxation of untreated waste going to disposal and WtE.
- Financial security for the informal sector:** To encourage financial security in terms of consistent and sufficient payments to informal collectors, a cash fund could help bridge payments from recyclers to collectors or aggregators. The Wongpanit business model serves as a good example. Wongpanit publishes daily price tables for recyclables, and more detailed pricing tables to their franchisees, influencing the price set by smaller aggregators across the country. Through the franchise model and transparent pricing, junk shops are able to have a steadier cash flow to ensure fair and consistent payment is made to the collectors.

IMPROVE SORTING OF POLYMERS AND QUALITY FOR RECYCLING

- Incentivising sorting of hard-to-recycle plastics:** This could include plastic credits for hard-to-recycle plastic waste and more closed-loop recycling. Recycling rates could also be increased by expanding the range of accepted materials to include plastic films and mandating recycled content targets in key applications to increase the amount of material being brought back.
- Policy implementation:** While EPR principles are included in Thailand's Roadmap on Plastic Waste Management 2018-2030 and in the Action Plan on Plastic Waste Management Phase 1 (2020-2022), the regulation and implementation mechanisms have not been signed off. Developing the EPR system could improve both segregation and recycling as producers begin to take responsibility for collection and sorting of waste.
- Improving quality:** Collectors and aggregators have a customary framework categorizing plastic based on visual and physical observation of the material. Although this framework may be practical for the collectors and aggregators, different polymers are often not fully segregated. For example, in the 'clear plastic' category, it was found that a collector mixed clear PP and PS cups with clear PET bottles. There could be an opportunity to improve sorting by collectors and aggregators through information campaigns.

—

²³ Bring Back Recycle - Recycling Drop Off (2021).

²⁴ Examples of the bring-back initiatives include: 1. Thai Beverage Recycle (PET bottles) drop-off points. 2. The WON project set up by the former CFO Won Kamon of TPBI Public Company Ltd, a producer and exporter of packaging in Thailand. Stretch plastics (e.g., T-shirt bags, shopping bags, ice bags, shrink film (cover of bottled water or UHT beverage containers) can be sent to or dropped into containers at 400 locations of the WON project for recycling. For every kilogram received, a 5 Thai baht donation will be made to an environmental foundation. It is understood that TPBI already recycles post-industrial LDPE film, but now also takes post-consumer film from WON. 3. Recycling Market Fairs (Plastics Institute of Thailand).

INCREASE DEMAND FROM PLASTIC RECYCLERS

- Improving pricing transparency:** There is potential for the Thai government to provide pricing subsidies for plastic waste to support collectors, as they did for waste paper during lockdowns and to alleviate the impact of high-waste imports flooding the market; however, this is not a long term solution. A digital intervention could include the creation of a national or regional virtual marketplace to improve supply chain security, through improved pricing transparency and increased access for buyers of the material.
- Policy implementation:** To encourage recycling and make it more feasible, design for recycling standards, and a tax on the use of virgin polymers in packaging materials could also improve recycling rates can be introduced through EPR. Design for recycling standards can include prohibiting coloured plastic bottles.
- Incentivising recycling of hard to recycle plastics:** For hard to recycle plastics, such as plastic films, plastic credits can be explored to encourage collection. These plastic credits need to be complemented with stringent monitoring and quality assurances. Plastic films is rarely collected because the multiple actors in the supply chain are not interested in buying it. While Wongpanit had trialed the collection of films, the lack of off-take led to collection trials being discontinued. One aggregator in Bangkok highlighted that film is difficult to clean, requires storage space to keep it dry, and it takes large quantities of film to reach saleable weights/loads. These additional efforts would need compensation, estimated to be at least THB 8 (USD 0.3) from recyclers. WON/TPBI (formerly known as the Thai Plastic Bags Industries Co Ltd) has a Bring Back Recycle website where drop-off points for recycled items are listed to collect post-consumer stretch film; however, the amounts, quality, and consistency of this collection project is not known.



Conclusion

Thailand is on a good trajectory towards having stronger local plastic waste supply chains in future. It has an established and growing national reprocessing infrastructure operated by local and international players.

While the EPR policy is being developed, a number of initiatives driven by the joint working of public and private sector organizations seems to be the main driving force. These are focused on building alternative supply chains via bring-back initiatives, take-back schemes, and encouraging source segregation of plastic waste at households, schools, businesses, and community centers/enterprises. Together these factors will encourage higher levels of good-quality material in future.

This will need to be supported by a scale-up of sorting and aggregation activities to enable aggregators to increase the amount of plastic waste handled (e.g., PE films) and create a level playing field to support pricing transparency initiatives and incentivize collection of PE films and flexible packaging from post-consumer sources.

In addition, the development of RDF and WtE capabilities is moving waste up the hierarchy from landfills, but this needs to be coupled with centralized sorting equipment to extract plastic waste and other recyclables and ensure that the full environmental benefit of a move away from landfills is realized.

Recyclers in the country hold a large amount of power in relation to pricing transparency. Ideally, steps should be taken to increase visibility of pricing to collectors and aggregators and ensure they have a greater opportunity to be fairly rewarded for their efforts. More competition aligned with a more stable supply of plastics could improve this, as could the implementation of EPR and similar policies.



References

- Bring Back Recycle. (2021). *Recycling Drop Off* [Online]. Available at: <http://www.bringbackrecycle.com/recycle> (Accessed: October 2022).
- Circulate Capital. (2019). *Investing to Reduce Plastic Pollution in South & Southeast Asia: A Handbook for Action* [Online]. Available at: <https://www.thecirculateinitiative.org/projects/Investing-to-reduce-plastic-pollution-in-South-%26-Southeast-Asia-A-Handbook-for-Action> (Accessed: October 2022).
- Energy News Centre. (2019). *Tackling plastic waste with the Rayong model.* [Online] <https://www.energynewscenter.com/tackling-plastic-waste-with-the-rayong-model/> (Accessed: October 2022).
- GPSC. (2018). *Pracharat helps manage waste management in sustainable ways Rayong Province* [Online]. Available at: www.gpscgroup.com/en/investor-relations/newsroom/press-releases/668277/pracharat-helps-manage-waste-management-in-sustainable-ways-rayong-province-rayong-provincial-administration-have-joined-hand-with-gpsc-to-create-comprehensive-waste-management-strategy-with-refuse-derived-fuel-rdf-technology (Accessed: October 2022).
- IUCN and Mar Plastics. (2020). *The legal, policy and institutional frameworks governing marine plastics in Thailand* [Online]. Available at: https://www.iucn.org/sites/default/files/2022-08/thailand_scoping_study_english_marine_plastics_marplasticscs.pdf (Accessed: October 2022).
- National News Bureau of Thailand. (2021). *MEA to construct waste-to-energy plants in Bangkok* [Online]. Available at: https://thainews.prd.go.th/en/news/print_news/TCATG_210323015013068 (Accessed: October 2022).
- OIE. (2019). *Directory* [Online]. Available at: <http://plastic.oie.go.th/Directory.aspx> (Accessed: October 2022).
- Rujivanarom, P. (2021). *Thailand's Plastic Waste Conundrum* [Online]. Available at: <https://th.boell.org/en/2021/10/26/thailands-plastic-waste-conundrum> (Accessed: October 2022).
- SCG News Channel. (2022). *SCG Chemicals Becomes Thailand's First Company in Petrochemical Industry Certified with ISCC PLUS Throughout Whole Supply Chain* [Online]. <https://scgnewschannel.com/en/scg-news/scg-chemicals-becomes-thailands-first-company-in-petrochemical-industry-certified-with-iscc-plus-throughout-whole-supply-chain-accelerating-advancement-of-high-quality-post-consumer-recycled-resins/> (Accessed: October 2022).
- Statista. (2021). *Thailand – Statistics and Facts* [Online]. Available at: <https://www.statista.com/topics/4194/thailand/> (Accessed: October 2022).
- Suez in Asia. (2019). *Chonburi Clean Energy (CCE) inaugurates its waste-to-energy power plant* [Online]. Available at: <https://www.suez-asia.com/en-cn/news/press-releases/chonburi-clean-energy-inaugurates-its-wte-power-plant> (Accessed: October 2022).
- Sukholthaman, P., Shirahada, K., and Sharp, A. (2017). 'Toward effective multi-sector partnership: A case of municipal solid waste management service provision in Bangkok, Thailand.' *Kasetsart Journal of Social Sciences* [Online]. Available at: <https://www.sciencedirect.com/science/article/pii/S2452315117303740> (Accessed: October 2022).
- Thailand Environment Institute (TEI). (2021). *Role of Public Private Partnership for Sustainable Plastic and Waste Management (PPP Plastics) for solving the plastic waste problem in Thailand* [Online]. Available at: https://www.tei.or.th/file/library/2021-Brochure_PPP-Plastics-ENG_60.pdf (Accessed: October 2022).
- Trash Lucky – Coca-Cola Recycle Me 2022 Campaign. (2022). Available at: <https://trashlucky.com/en/recycleme/> (Accessed: October 2022).
- Wongpanit (n.d.). *Suvarnabhumi Recycle Station Co., Ltd.* บริษัท สวนน้ำรีไซเคิล วงศ์พานิชย์สุวรรณภูมิ จำกัด. [Online]. Available at: <http://www.wongpanitsuvarnabhumi.com/> (Accessed: October 2022).
- World Bank. (2021). *Market Study for Thailand: Plastics Circularity Opportunities and Barriers* [Online]. Available at: <https://openknowledge.worldbank.org/handle/10986/35114> (Accessed: October 2022).
- World Bank. (2022). *Plastic Waste Material Flow Analysis for Thailand* [Online]. Available at: <https://www.worldbank.org/en/country/thailand/publication/plastic-waste-material-flow-analysis-for-thailand> (Accessed: October 2022).

Appendices

Appendix 1: Supply chain assessment indicator descriptions and rating scales

Criteria to assess a well-functioning supply chain	Benchmark for good standard
CFR rate for plastic waste:	 >30%  15-30%  < 15%
Plastics collected for recycling (CFR) out of plastics collected in MSW.	
Market structure - Collection:	Majority of plastics collected for recycling via the formal sector with a good level of formalized infrastructure for source segregated collection. % of plastics collected for recycling by the formal sector:
Proportion of plastic collected for recycling via the formal sector.	 >50%  25-50%  < 25%
Market structure - Aggregation & sorting:	Majority of plastics collected for recycling is being aggregated and sorted by the formal sector with a good level of formalized infrastructure for bulking and sorting of plastics for recycling.
Proportion of plastic aggregated/sorted for recycling via the formal sector.	 >50%  25-50%  < 25%
Market structure - Plastic recycling:	Majority of plastics collected is being recycled in permitted, formal sector facilities.
Proportion of formal vs. informal recyclers and 'fair' competition.	 >50%  25-50%  < 25%
Pricing transparency:	High transparency: with a good level of pricing information and similar number of buyers and sellers.
Pricing transparency as an economic concept refers to the degree to which pricing information is available to all buyers and sellers in a market. A high level of pricing transparency ensures healthy competition, efficient markets, and better pricing of products, and is often considered an indicator of an efficiently operating supply chain, which enables growth.	Moderate or poor transparency: with a medium level of pricing information and disproportionate number of buyers and sellers. Ranking based on market power or share of the profit margins/trade benefits held by recyclers/large aggregators:
	 < 50%  50-75%  75%
Knowledge gaps and data availability:	 High: Multiple recent data and information sources available from reputable sources – >10 city studies with detailed, verified waste flow data.  Moderate: Some data is available but it is less recent or is from less reputable sources – 5-10 city studies with some verified waste flow data.  Poor: No/extremely limited data and information sources available; data is not recent or there are considerable discrepancies between different sources – 0-5 city studies with contradictory or unverified data sets.
Value yield and quality of outputs:	 >50%  25-50%  < 25%
Regulatory framework:	 High: Suitable national (or local) legislation in place, which has been implemented and is functioning well in practice.
Waste management policies, permitting systems, funding and fiscal incentives that are driving the collection, segregation, and recycling of plastics. Level of implementation of EPR systems, plastics taxation, and other specifically targeted measures.	 Moderate: Some suitable national (or local) legislation is in place, though it has not been fully implemented in practice.
	 Poor: Suitable national legislation (and local legislation) is not yet established/is in very early stages of development.

Legend:  High  Moderate  Poor

Appendix 2: List of potential interventions

Full list of potential interventions to improve plastics collection rates and increase value creation along the plastic waste supply chain.

Intervention categories →			
Desired supply chain impacts ↓	1. Improve supporting regulatory and social conditions to create a stable policy framework	2. Financial interventions to improve value creation from plastic waste	3. Technical and digital improvements to increase supply chain efficiency
Improve collection rates of plastics	Implement (harmonized) source segregated collection and EPR systems.	Increased waste collection fees/levies charged to households.	Digitize recyclable collection and material tracing; for example, explore 'pay-as-you-throw (PAYT) systems' linked to material quality and level of segregation.
	Improve welfare standards of informal workers (annual health check-ups, PPE, insurance etc.).	Improve funding for formal waste collection infrastructure.	Smart bins, underground containers etc. to reduce collection costs and maximize space and access (linked to registered informal collectors).
	Registrations or permits for informal waste pickers with the incentive to receive tools/equipment, access to loans, PPE etc. to build capacity.	Support payment of the informal sector (fair and prompt payment).	
	Central registry of official collection points for specific plastics/waste formats.	Market incentive payments for hard to recycle, low-value waste formats and polymers.	
	Awareness-raising campaigns and behavior change e.g., to sort household waste, and stop discharging bottles etc. into seas and oceans.	Fund/incentivize take-back schemes via retailers, hospitality and transport sectors.	
		Subsidize formalization of informal pickers (cooperatives, tax payments, permits, share EPR fees).	
Improve sorting of polymers and quality for recycling	Clear administrative pathways for operating permits for sorting and aggregation.	Invest in formal segregation and sorting infrastructure (public sector, FMCGs etc.) and integrate the informal sector (employ waste pickers).	National or regional virtual marketplaces to improve pricing transparency and increase access for buyers.
	Mandate design for recycling standards to improve plastic and polymer separation (part of EPR).	Support payment of the informal sector – financial incentives for good quality recyclables.	R&D funding for innovative plastics/polymer sorting technologies (NIR, AI etc.).
	Introduce sorting and segregation quality standards for key waste streams (as part of an EPR system).	Plastic collection and sorting credits/incentives (as part of an EPR system).	Upgrade existing sorting facilities with automated equipment.

Appendix 2: List of potential interventions (continued)

Intervention categories →			
Desired supply chain impacts ↓	1. Improve supporting regulatory and social conditions to create a stable policy framework	2. Financial interventions to improve value creation from plastic waste	3. Technical and digital improvements to increase supply chain efficiency
Improve sorting of polymers and quality for recycling	Import restrictions (bans, import fees) for mixed and low-value plastic waste.	Improve funding for environmental regulators and protection agencies.	Digital certification and tracing of sorted plastics waste and polymers.
	Comprehensive monitoring and enforcement of environmental regulations/permits.	Tax relief for sorting and segregation equipment and facilities.	Fund paid for private industry to provide grants for small-scale equipment: balers, sorting bays/containers, transport.
	Central registry and master planning of segregation and sorting of plastics and polymers for recycling.	Subsidize formalization of informal or small-scale aggregators (cooperatives, tax payments, permits).	
		Funding of automated/large-scale plastic segregation from mixed MSW prior to WtE/landfill (secondary sorting systems).	
	Mandate recycled content targets in key applications (incl. rigid and flexible packaging).	Invest in medium- to large-scale plastics recycling of mixed and hard to recycle plastics.	National or regional virtual marketplaces to improve supply chain security.
	Clear administrative pathways for operating and building permits for recycling facilities.	Subsidize formalization of informal/small-scale recyclers (cooperatives, tax payments, permits).	R&D funding for innovative plastics recycling technologies.
Increase demand from plastic recyclers	Green/sustainable public procurement policies and funding support for regional plastic recycling projects.	Improve funding for environmental regulators and protection agencies to ensure a level playing field.	
	Export restrictions (bans, fees) for collected and segregated plastic waste.	Tax relief for plastics recycling equipment and facilities.	
	Landfill disposal limits or bans, and limitation on recyclables to WtE (pre-processing requirements for residual/wet waste).	Quality standards for recycled plastics incentivizing circular recycling (plastic credits for hard to recycle plastics, high recycling yields, closed loop recycling).	
		Taxation of virgin content or tax relief for recyclate content.	
		Landfill or incineration taxes.	

Acknowledgements

We would like to extend our sincere appreciation to the following organizations for their contributions to this publication.

LEAD RESEARCH PARTNER & CO-AUTHOR:



LOCAL RESEARCH PARTNERS:



Our gratitude also extends to all interviewees and peer reviewers for their involvement in this study. The following individuals provided support through interviews or critical reviews, and we also acknowledge several other contributors (waste collectors, waste pickers, aggregators, recyclers and other value chain stakeholders) who wish to remain unnamed:

- Aditya Dalmia, Dalmia Polypyro
- Boby Setiawan, PT Sumber Djaja Perkasa
- Chetan Baregar, Recykal
- Circulate Capital
- The Dow Chemical Company
- Dr. Shilpi Kapur Bakshi, Environmental Management Centre Pvt Ltd
- Hien Nguyen, ReForm Plastic
- Hong Tran, BMI Polymer JSC
- Kabir Arora, WIEGO
- Paradorn Chulajata, Prepack Thailand and Plastic Industry Club
- Phonsak Likithatsin, Thai Plastic Recycle Group Co Ltd
- Pimphan Chujam, Global Plasts Center Company Limited
- POPSEA
- Rahul Nainani, ReCircle
- Saharuddin Ridwan, Yayasan Peduli Negeri (YPN)
- Siddharth Hande and Toke Sabroe, Kabadiwalla Connect
- Suneel Pandey, The Energy and Resources Institute (TERI)
- Teerapat Yuanmee, PF Recycling
- Tuyen Pham, ALBA-Singapore
- Wilson Pandhika, Pan Era Group
- Wimonrat Santadvatana, Wongpanit

JANUARY 2023

Mapping Local Plastic Recycling Supply Chains: Insights from Selected Cities in Thailand

