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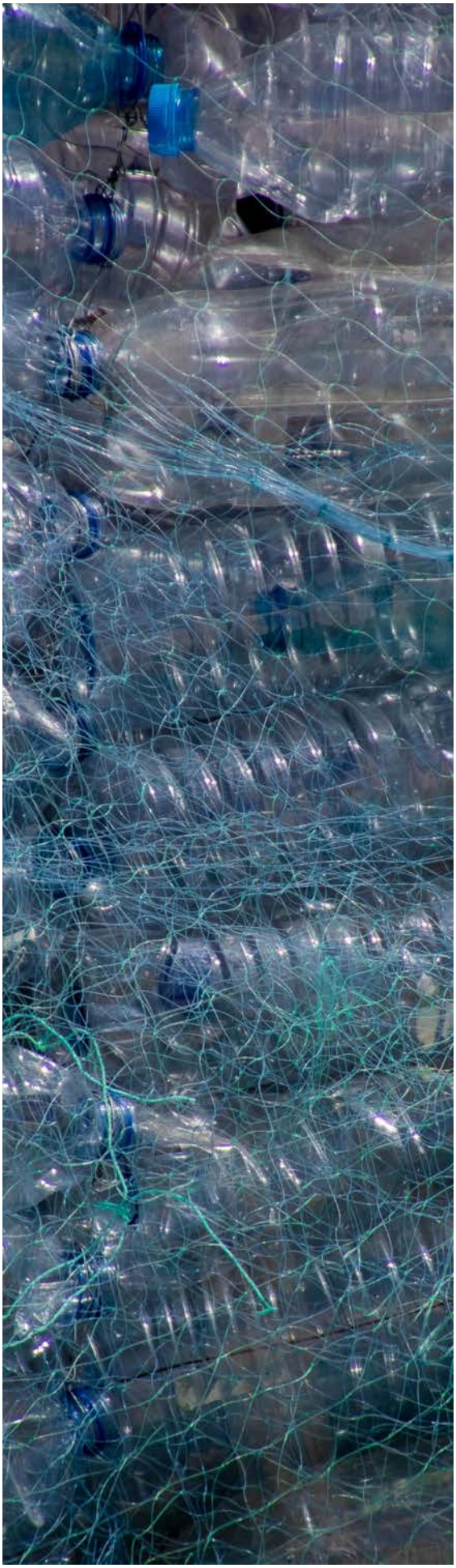
Pricing Transparency in the Recycled Plastics Supply Chain in India, Indonesia, Thailand, and Vietnam

The Circulate Initiative

Contents



Executive Summary

Background to the study

Recycled plastics markets in India and Southeast Asia face multiple demand- and supply-linked bottlenecks along the value chain, including a lack of transparency in the pricing of plastic waste feedstock and recycled plastics. This opacity results in fluctuating demand and supply, poor capacity utilization at recycling facilities, and, ultimately, challenges for brand owners to meet commitments on using recycled content in plastic packaging. Data on prices is critical for strategic planning at all levels. In the absence of pricing data, brands and other buyers of recycled plastics set targets that are out of sync with market realities.

The Circulate Initiative, with its research partner Anthesis Group, has conducted this study to investigate pricing transparency within the recycled plastics supply chains in four countries – India, Indonesia, Thailand, and Vietnam. The study focuses on the core actors in the recycled plastics supply chain – collectors, aggregators, and recyclers. Recycled plastics covered in the study include rPET, rHDPE, rLDPE, and rPP. Data points collected and analyzed include recycled plastic volumes; collector, aggregator, and recycler costs and margins; and recycled plastic prices.

In the first section of this report, we provide insights into the pricing structure of the recycled plastics supply chain. This includes the drivers of the price of recycled plastics and the potential margins for collectors, aggregators, and recyclers. In the second section, we review policy as an instrument to improve pricing transparency. We evaluate the potential impact of various policy interventions on the volume of plastic waste collected and recycled, and the potential distribution of the additional value generated across the supply chain. This Executive Summary spotlights the key takeaways from the report.

A lack of alignment in price points between supply chain actors indicates a lack of pricing transparency, which could distort market indicators on the pricing of material

The analysis reveals a lack of consistency in the price points in some of the polymer markets. There is a misalignment between price points expected by collectors selling plastic waste, aggregators buying plastic waste, and recyclers buying feedstock for recycling. Despite being a commodity-like product, the market value and price is not well defined at each stage of the supply chain. In most cases, the misalignment is more significant at earlier stages of the supply chain but can still be prevalent at the latter stages.

Significant variation of prices among the same actors adds to a complex supply chain for material quality, consistency, and prices

The analysis also reveals significant variation, even at the same stage of the supply chain. For example, collectors provide a wide range of prices, despite undertaking similar activities and providing similar outputs. This could be due to differences in processes, differences in material quality or regional differences. These markets can also be inherently dynamic, with some price points changing daily or monthly, depending on external factors. Another possibility is that the prices are indicative of inconsistent material specifications. In this case, the range of prices could indicate differences in the quality of materials traded. It is also highly likely that the ranges are influenced by lack of transparency; i.e., they are indicative of markets where there are no "market prices" that are well understood by all parties.

An imbalance in the distribution of the total gains from trade among supply chain actors hinders improvements in market efficiency

While the distribution differs from country to country, it follows the same trend, with recyclers having the greatest share. In the recycling value chain, recyclers tend to have the highest fixed and operational costs and take on greater risk among the value chain participants covered in the study. Hence, recyclers need to make sufficient profit to compensate for these costs and risks. However, the share of total profits that flows through the value chain, and to informal waste workers in particular – without which there would be no supply of recycled plastic in many countries – needs to increase if we are to significantly increase plastics recycling, and in turn for brands to meet their recycled content goals.

The market imbalances lead to differing impacts of potential policies. Policies aimed at supporting output prices for recycled content, as well as investment in infrastructure, do not easily flow back to the earlier stages of the supply chain (e.g., collectors). Low transparency also disrupts the link between recyclers and collectors, with collectors having less clarity on the value of final outputs, which could influence the range of price points "expected" by collectors. A more equitable distribution of the total gains from trade can improve efficiencies along the entire value chain. This will also positively impact recycled content volumes and improve the livelihoods of the informal sector.

Supply chains require direct interventions to become more efficient and develop as conventional markets in which all value chain actors can add value and be profitable

The imbalance in market power means that the impact of policies will likely not filter capital to all parts of the supply chain equally. Therefore, additional practical interventions that support sharing of knowledge within the market are required. These could involve digital tracking of plastics, published market price points, and more involvement from industry bodies and regulators in standardizing material specifications.

The benefits of rising market demand and any potential increase in the price of recycled materials need to be

distributed through the value chain to provide the right economic signals to stimulate local investment.

The impact of policy interventions in improving pricing transparency varies by country

Based on the study and modeling results of three policy interventions in each country to raise the volume of plastics recycled, the implementation of a deposit return system (DRS) was observed to be most effective in India, minimum recycled content targets in Indonesia, and the formalization of the collection system in Thailand and Vietnam. Given the importance of informal waste workers to recycling in the four countries, any policy measures undertaken should integrate with existing waste collection systems and prioritize the inclusion of informal waste workers, who play a crucial role in plastic waste management in emerging economies.

Extended Producer Responsibility (EPR) was modeled to have a minimal impact on increasing the collection of material for recycling, the distribution of profits through the value chain, and, resultantly, the overall transparency in pricing. This minimal impact may be a result of the high reliance of the recycling supply chain on the informal sector for material collection in the studied markets. It should, however, be noted that EPR could lead to improvements in other indicators outside the scope of the study. These include a potential reduction in leakage rates, or the collection of unrecyclable plastic, which may not have otherwise been collected.

Finally, taxes on virgin polymers are expected to increase profits for the supply chain actors, but have a negligible impact on recycling output. This negligible impact may be a result of improved profit margins being absorbed by the operators, rather than being reinvested to incentivize and improve the expansion of recycling performance.

Glossary

Term	Description
Formal recyclers	Recycling sites that hold suitable business and environmental permits and licenses for their operations.
Formal sector	Collective term for municipal (or licensed) collectors, aggregators, and recyclers who have obtained the necessary permits and licenses to operate.
Informal recycler	Recycling facilities that operate without full licenses and permits.
Informal sector	Collective term for informal waste workers, smaller-scale aggregators, and recyclers that operate without full licenses and permits.
Informal Waste Workers (IWW)	People who earn an income from managing waste but are not formally employed to do so. Roles performed by IWWs include collection (including picking), sorting, and other pre-processing and recycling activities.
Junk shops	Typically small spaces, often set up in the houses of aggregators. Material may be brought to the site by local collectors, with owners sometimes also undertaking the collection of material themselves. These shops are often operated informally without licenses or permits.
Municipal Solid Waste (MSW)	Municipal solid waste refers to the total amount of household and household-similar waste. It excludes industrial waste and construction waste.
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.
Plastic recycling supply chains	A system, which can consist of formal and/or informal actors, through which discarded plastics can be recycled. Typically includes collection, aggregation, pre-processing, reprocessing, and manufacturing into new goods.
Plastic waste	Plastic products, including plastic packaging that has 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, rHDPE.
Recycling/ reprocessing	The process of transforming plastic waste into a new output product so the material can be used again.
rPET	Recycled polyethylene terephthalate.
rHDPE	Recycled high-density polyethylene.
rLDPE	Recycled low-density polyethylene.
rPP	Recycled polypropylene.
Waste-to-energy (WtE)	Waste-to-energy includes formal, permitted waste-to-energy plants with heat and electricity recovery where known. Also included are incineration plants without energy recovery, depending on the data available.

Introduction

The current state of plastics recovery and recycling in South and Southeast Asia consists of complex, highly fragmented supply chains, involving formal and informal actors. The economics and pricing of plastic recovery and recycling are opaque, making it challenging for those who wish to improve and invest in the system and markets for recycled plastics. This lack of pricing transparency significantly hinders stakeholders' abilities to drive meaningful change to establish equitable supply chains.

The need for pricing transparency in recycled plastic supply chains

Pricing transparency refers to the degree to which information on the prices of plastic waste and the finished products at each point in the recycled plastics supply chain is available to all buyers and sellers in each market. Pricing transparency is important both vertically, where actors have a good view of prices upstream and downstream in their supply chains, as well as horizontally, where actors producing the same output have visibility of comparable pricing for the products.

Transparency in input and output prices helps to ensure that all actors, all the way to the informal waste workers who collect plastic waste, are fairly compensated for their services. Transparency also helps to support investment. It does this by providing greater clarity for investors to assess project and market risks, thereby offering greater assurance on the potential returns on investment.

High levels of pricing transparency can most commonly be found where there is a well-defined supply chain with homogenous product groups that can be traded between many buyers and sellers. Applying this perspective, commodity markets, such as recycled plastics, should be markets that can achieve high pricing transparency. Commodities such as crude oil, virgin plastics, and copper, for example, have market prices actively tracked from source to use, prices along the supply chain disclosed in real-time, and established futures markets. These have resulted in a more efficient and competitive market environment for these commodities. Recycled plastics, in comparison, represent a nascent market where there is a need to improve transparency on prices.

The need of the hour is to bring about systemic change by growing the recycling rate and volume of plastic recycled. Transparency on material prices can be an effective switch to activate this system change. A good understanding of the value of the material, prices, and bargaining power across the supply chain (the market power of different supply chain actors and their ability to influence prices) is also the first crucial step to a more transparent and fair distribution of profits along the supply chain.

Recycled plastics supply chains in India, Indonesia, Thailand, and Vietnam operate with low pricing transparency

The plastics recycling supply chains in India, Indonesia, Thailand, and Vietnam represent a mix of formal and informal actors, where plastic waste and secondary products are traded between the two sectors. This contributes to markets that are complex and highly fragmented, contributing to a lack of transparency on:

- The scale of plastic waste volumes passing through the recycling supply chain
- The quality of material in circulation
- Overhead and input costs of collectors, aggregators, and recyclers
- Pricing information at each point along the supply chain

All these factors have resulting impacts on the performance of the market, which include:

- A market dominated by a few market players who operate as price-setters
- A market where prices are dependent on external factors
- A market that faces supply or demand constraints due to a lack of competition
- A market where actors who lack an understanding of market dynamics are unfairly compensated for their activities

To address these issues, the development of a tool could be beneficial to model the impact of policy interventions on pricing transparency in the recycled plastics supply chains.

Diverse stakeholders can assess the impact of policy interventions through the pricing transparency policy modeling tool

Recycled plastics supply chains involve a diverse set of actors, each with unique interests and needs. Stakeholders such as collectors, aggregators, and recyclers can benefit from using a tool that allows them to assess how policies influence prices and volumes of recycled plastic outputs. By gaining insights into these dynamics, they can engage in more effective planning and goal-setting, thereby optimizing their operations and contributing to sustainability efforts.

For buyers of recycled plastic such as brands and retailers, understanding the impact of policies on the demand and supply of different recycled polymers is crucial in making informed decisions about incorporating recycled materials in their products. Understanding this impact enables them to set realistic targets for procuring recycled content and allocate budgets effectively for purchasing recycled materials, thus aligning their business practices with sustainability goals.

Investors in the recycling sector require tools that allow them to evaluate the financial viability of potential investments within the recycled plastics value chain. The tool enables investors to anticipate how emerging policies may affect their investments. By having access to such insights, they can identify profitable opportunities and make strategic decisions that align with both financial and sustainability objectives.

Lastly, policy makers can leverage this tool to model the impact of their policies on various aspects of the value chain. By assessing how policies influence the volumes, market share, and prices of recycled plastic polymers, policy makers can use a data-driven approach to the implementation of policies.

Data availability and local nuances affect the degree of pricing transparency

This report is a first attempt to examine the degree of pricing transparency in the recycled plastics value chain in each country. The tool allows users to estimate the impact of different policy interventions on the output volumes, market share, and prices of recycled plastic polymers. The tool also indicates the potential impact of policy interventions on the profits of the value chain participants. Additional information on the background of the modeling and details of the assumptions can be found in the accompanying document, "Research Methodology and References". For the purposes of the study, secondary data is supplemented with data collected from interviews conducted at multiple locations and aggregated to present a national picture.

Readers must note that recycling supply chains are complex, especially due to their informality. The functioning and power dynamics among the participants in the supply chain can vary widely in each location. As revealed in the study, "Mapping Local Plastic Recycling Supply Chains: Insights from Selected Cities in India, Indonesia, Thailand, and Vietnam,"[1] where we review 12 local recycling supply chains, there are distinct nuances within both the recycling supply chain and among the various value chain actors. The present report sheds light on the complexities in pricing in the supply chain and the lack of transparency. To gain a more comprehensive understanding and precise market data, similar studies will need to be undertaken in specific locations. It is also important to note that the availability of data varies due to the sensitivities associated with sharing information on prices. This presents a challenge in comprehensively assessing pricing transparency and its implications across the recycling industry.

1 The Circulate Initiative. (2023). Mapping Local Plastic Recycling Supply Chains: Insights from Selected Cities in India, Indonesia, Thailand, and Vietnam [online]. Available from: https://www.thecirculateinitiative.org/mapping-local-plastic-recycling-supply-chains-in-india-indonesia-thailand-vietnam

Research Objectives

The Circulate Initiative, with its research partner Anthesis Group, conducted this study to investigate pricing transparency within the recycled plastic supply chains in India, Indonesia, Thailand, and Vietnam. Through this study, we model the role and impact that various policies can play in improving pricing transparency.

In the first part of the study, we aim to provide insights into the pricing structure of the plastics supply chain, i.e., the market structure of the plastics supply chain, the drivers of the price of recycled plastics, and the potential margins for each player along the supply chain (i.e., collectors, aggregators, and recyclers). It also aims to highlight any price imbalances along the supply chain, which can indicate a lack of pricing transparency or failures in the market. Developing a market where there is clarity in the pricing structure of recycled plastics feedstock and output ensures the effectiveness of the implementation of policies in boosting recycling output volumes. It also incentivizes investments to flow into these countries and the value chains.

In the second part of the study, we assess the potential impact of various policy interventions on the volume of plastic waste collected and recycled, and the potential distribution of that additional generated value across the supply chain. The outcomes of the policy intervention assessment in this report should be seen as example outcomes, as the model provides a flexible tool in which the assumptions around the policy impact can be changed based on best practice and knowledge, leading to different outcomes. The scope of the modeling includes:

Table 1: Pricing transparency modeling scope

Country
India Indonesia Thailand Vietnam
Recycled plastic
rPET rHDPE rLDPE rPP
Data coverage
Recycled plastic volumes (tonnes) Collector, aggregator, recycler cost (US$/kg) Recycled plastic price (US$/kg/tonne)

Research Methodology

We took a four-step approach to our research:

1. Conduct a literature review and stakeholder interviews to better understand data on costs and prices of different polymers in each country
2. Review of data quality and the use of data in the model
3. With input from stakeholders, identify a shortlist of policies
4. Develop the economic model

1 Literature review and stakeholder interviews with a focus on the collation of data on costs and prices for each polymer in each country

Data utilized in the study

Data 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). Data collection was carried out by The Circulate Initiative, Anthesis Group, and our in-country partners. 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. In some instances, some organizations interviewed operated across the region and are therefore considered for multiple countries in Table 2 below.

Table 2: Number of respondents by type of stakeholder and country

	India	Indonesia	Thailand	Vietnam
Collectors	17	30	13	16
Aggregators	17	22	11	11
Recyclers	20	7	3	5

2 Review of data quality and the use of data in the model

It is important to note that responses received were of varying quality and completeness. Considering the sensitivity associated with disclosing information on costs, markups, and prices, not all respondents uniformly provided the data required. This resulted in the following data points used, provided in Table 3 below.

Table 3: Number of respondents in each country by polymer stakeholder and actor

Polymer	Actors	India	Indonesia	Thailand	Vietnam
PET	Collectors	3	17	8	12
	Aggregators	3	10	9	5
	Recyclers	3	5	1	2
HDPE	Collectors	1	14	7	5
	Aggregators	0	9	7	4
	Recyclers	8	2	2	2
LDPE	Collectors	1	6	2	0
	Aggregators	0	6	2	0
	Recyclers	7	2	1	0
PP	Collectors	1	13	8	7
	Aggregators	0	8	6	6
	Recyclers	8	3	1	2

The differences in data availability by stakeholders, polymers and across countries should be considered when interpreting the results of the analysis included in the report. Although due care has been taken with the data provided and results are anticipated to be representative, the limitations of the data should not be overlooked.

Additional interviews were conducted with organizations privy to local recycled plastics supply chains (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.

3 Policy shortlisting for analysis, with inputs from stakeholders through roundtable discussions

As part of the project, we convened an advisory group which comprised brands, NGOs, policy makers, and other stakeholders involved in the recycled plastics supply chain to provide guidance and feedback. These stakeholders provide inputs on material pricing and potential policies, and raise the importance of non-supply-chain stakeholders and voluntary measures to support pricing transparency and improve market performance. The key points from these discussions are outlined below, with stakeholders providing their opinions on the responsibilities of each of these groups:

Policy makers – Stakeholders acknowledge the importance of policy makers and regulators in policy interventions. However, they also acknowledge the limitations and complexities involved in implementing policies in less structured markets with limited data provision and an active informal sector managing large proportions of the recycling collections. The key challenge is that developing policy interventions takes considerable time and requires political buy-in – not just from the government, but also from other supply chain actors lobbying for action. Although this can lead to regulatory-supported interventions, implementation can be challenging. EPR is one such example, where a government regulated EPR system would be an industry-wide and regulated scheme, but implementation will take significant buy-in and time from multiple parties. As such, shorter-term voluntary measures that may be implemented more quickly and effectively are discussed in the later sections of this report.

Regulators – Stakeholders agree that in order to support market development and market transparency, part of the solution needs to be a better regulated market, particularly from waste aggregators to recyclers. This may require greater enforcement of permitting infrastructure, as well as greater efforts to collect and analyze data on waste flows into and out of sites to better understand the scale and form of the marketplaces. Establishing a framework for this data collection and making it accessible to market actors supports market transparency more generally, improving efficiency and providing greater confidence for potential investors in the sector.

Brands and manufacturers – A key takeaway from the advisory group is the important role that can and should be played by brands and manufacturers. As offtakers and purchasers of recycled content, they present a key point of the supply chain where the value of the recycling system and its actors is reflected in the price paid for the recycled polymer. They are also the actors in the extended supply chain that have the longest view on demand and comparisons to virgin polymer prices, and have the potential to provide greater security through longer-term contracting periods. It is also true that they have a need to increase transparency within the supply chain in order to demonstrate that they are contributing to the capture, diversion, and recycling of used polymers from the natural environment. Many of these brands and manufacturers can foresee the long-term local and global need for recycled content, so they are acting to ensure their own supply chains of recycled content are secure via contracting or integrated investment in the recycling sector. In doing so, they have a great deal of power and influence with recyclers, but the challenge remains regarding how to ensure profits trickle back to plastic collectors and aggregators in the supply chain. A suggestion includes long-term offtake agreements, which should support more stable prices and the ability to invest up the value chain to benefit collectors.

NGOs – A final stakeholder group of importance is non-governmental organizations. These are seen as particularly important in regions where there are large and active informal sectors. Typically they offer additional investment or support that can be beneficial to certain actors and even the entire value chain, but at times in a short-term manner that does not create self-sustaining market conditions. The view of stakeholders is that the role of NGOs should be to support data collection initiatives that aid the development of an efficiently operating plastics supply chain. This includes considering how to incorporate informal workers within an increasingly formal recycled plastics sector. This may include supporting the implementation of more systemic approaches, as well as education and training campaigns to support a more educated and skilled workforce and better working conditions.

A final discussion point raised during the engagements with stakeholders was the importance of voluntary measures currently implemented by supply chain actors. These voluntary measures, such as Coca-Cola's Purchase Assistance Fee and Sales Assistance Fee below, are centered around the final stages of the supply chain (see Case Study on Coca-Cola's Purchase Assistance Fee and Sales Assistance Fee). This demonstrates how brands and manufacturers are acting ahead of policy and regulatory frameworks to develop their own secure access to recycled content. In order to do this, they need to support market conditions that are stable and conducive to all parties within the supply chain. One of the key barriers to this is perceived to be the relative price point of recycled content compared to virgin polymers.

Case study

Coca-Cola's Purchase Assistance Fee (PAF) and Sales Assistance Fee (SAF)

There are some voluntary measures that attempt to address the gap between virgin and recycled polymer prices. Two such examples are highlighted by Coca-Cola in how they work with recyclers and their suppliers within developing markets. These relate to offering contracted purchase assistance fee (PAF) and sales assistance fee (SAF) mechanisms. These mechanisms work to contractually support rPET recyclers by providing additional payments or adjustment mechanisms when virgin polymer prices decline, which allows sustained business operations and protects the supply chain from short-term shocks. This support to recyclers in turn also provides a consistent output market for collectors and aggregators, with benefits filtering throughout the supply chain.

4 Economic modeling and review of the supply chain for a consistent, simplified approach

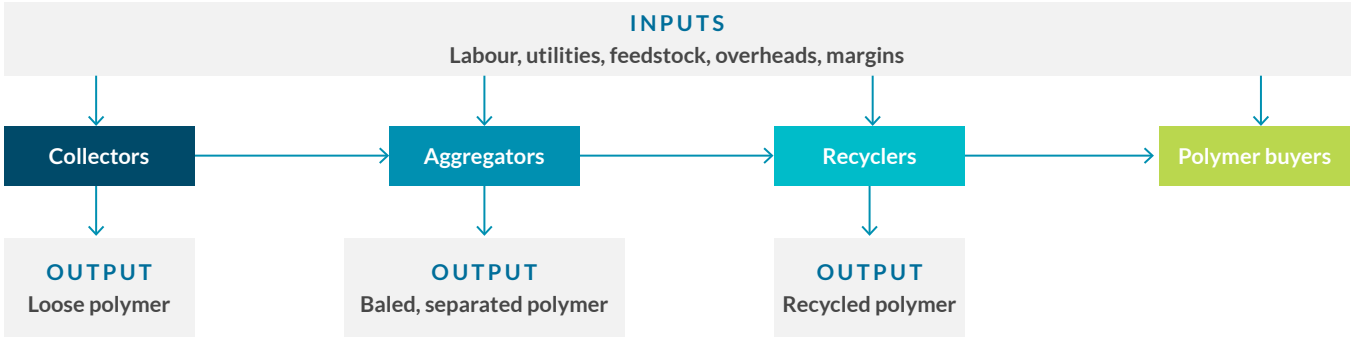
Following the selection of the interventions, the economic model was developed for each country.

The supply chains were simplified to their core actors and their activities so that the economic model developed would accurately and adequately reflect the core activities and parties involved. This supply chain format was utilized consistently across the polymer supply chains and countries as shown in Figure 1 below.

- **Collectors –** first step of the supply chain; those who physically collect the various plastic waste materials. This can include both formal and informal collectors of varying scales.
- **Aggregators –** second step of the supply chain; those who aggregate smaller amounts of recycled materials for onward sale and processing, or are involved in the onward transport of plastics. They may deal with many smaller collectors aggregating small volumes of plastic. Activities may include sorting.
- **Recyclers –** final step of the supply chain; the physical recyclers turning plastic waste into recycled polymers sold in the market.
- **Manufacturers/brands/polymer buyers –** although not part of the supply chain, buyers are included in the model as the offtakers of recycled polymers.

The Recycled Plastics Policy and Pricing Tool, which consolidates the various economic models, allows users to estimate the impact of various policy interventions on the output volumes, market share and prices of recycled plastic polymers. The tool also informs the potential impact of policy interventions on the profits of the value chain participants.

Figure 1: Supply chain overview



Pricing Transparency in the Recycled Plastics Supply Chain

This section of the report presents each country's market summary and the analysis of pricing transparency.

Pricing transparency refers to the direct interpretation of the data gathered and what this means in terms of the supply chain flows and price points. These have been reviewed and analyzed to provide a picture of the potential transparency within each country and specific polymer market.

India

Collection

In India, waste is collected by service providers appointed by local municipalities and also by the informal waste sector. The municipalities of India either collect waste using municipally-operated collection services or through contracts with private waste management companies. This primarily consists of residential collection of mixed waste, where organic and non-organic waste is collected in bags or bins. Under the Solid Waste Management Rules 2016, Urban Local Bodies (ULBs), which are small local bodies that govern a city or a town, charge fixed monthly amounts for mixed (and in many cities, segregated) waste collection from waste generators, such as households or small shops. However, plastic waste collection largely depends on the informal sector.

Aggregation

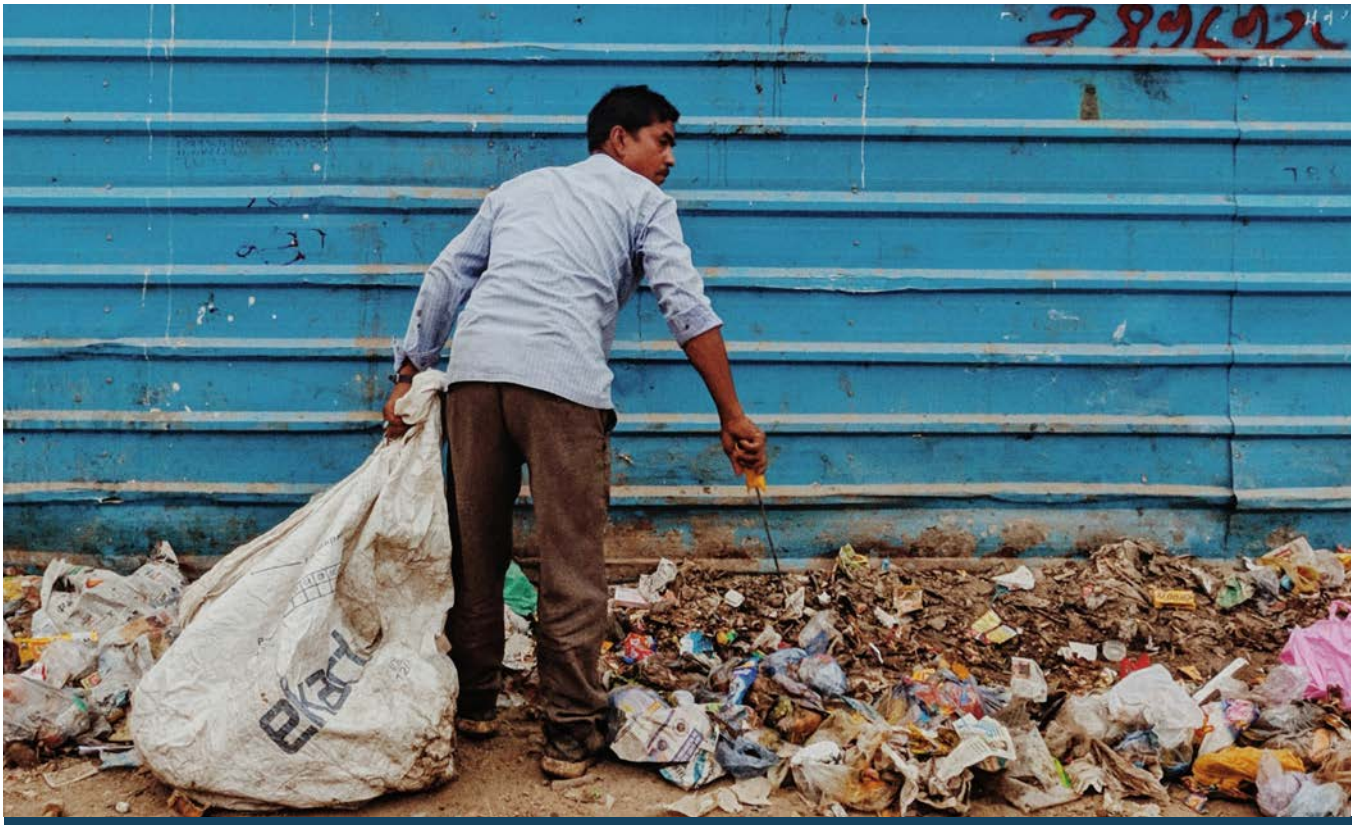
Collectors sell materials to the nearest aggregator, who charges a market price according to local demand and supply. These local aggregators buy different types of materials and typically operate out of small shops where they collect, store, and minimally process waste materials.

Preparation steps during aggregation are usually limited to further sorting and bulking of material, and aggregators sell the material (including plastics) to larger aggregators, intermediate dealers or other agents. These larger aggregators will sometimes shred material as well as undertake further sorting and bulking. This trading is done in a hierarchical and non-transparent supply chain in a market space that is semi-formal or informal, with no clear price estimates for different plastic waste products. In addition, there are traders who source plastic waste on behalf of recyclers – these can be large aggregators or individuals organizing and administering plastic waste supply.

Recycling

India is estimated to have more than 7,500 registered and unregistered recyclers, who collect approximately 60% of the plastic waste generated for recycling.[2] An estimated 70% of material is recycled within formal registered recycling infrastructure, 20% in unregistered informal infrastructure, and the remaining 10% within the smaller-scale informal sector focusing on reuse or repurpose activities.[3]

2 The Energy and Resources Institute (TERI). (2018). Circular Economy for Plastics in India: A Roadmap. New Delhi: The Energy and Resources Institute [online]. Available from: https://www.teriin.org/sites/default/files/2021-12/Circular-Economy-Plastics-India-Roadmap.pdf 3 Shanker, R. et al. (2022). Plastic waste recycling: existing Indian scenario and future opportunities [online]. Available from: https://pubmed.ncbi.nlm.nih.gov/35401771/



Case study

Informal Plastic Waste Collectors in India

There are several types of waste pickers engaged in the collection of plastic waste for recycling in India.

- Waste pickers who collect residential mixed municipal waste within a certain territory. These waste pickers use a tricycle or a similar vehicle to transport the waste and are paid a monthly fee by households.
- Waste pickers who collect and recover recyclable materials from mixed waste at non-residential locations, for example, transport terminals, streets and markets, landfills, and Materials Recovery Facilities (MRFs).
- Itinerant buyers who do not undertake a regular collection service but instead purchase separated, higher-quality materials such as plastic bottles and jars, paper, cardboard, metal, and glass from households. Such households are often middle- and high-income.

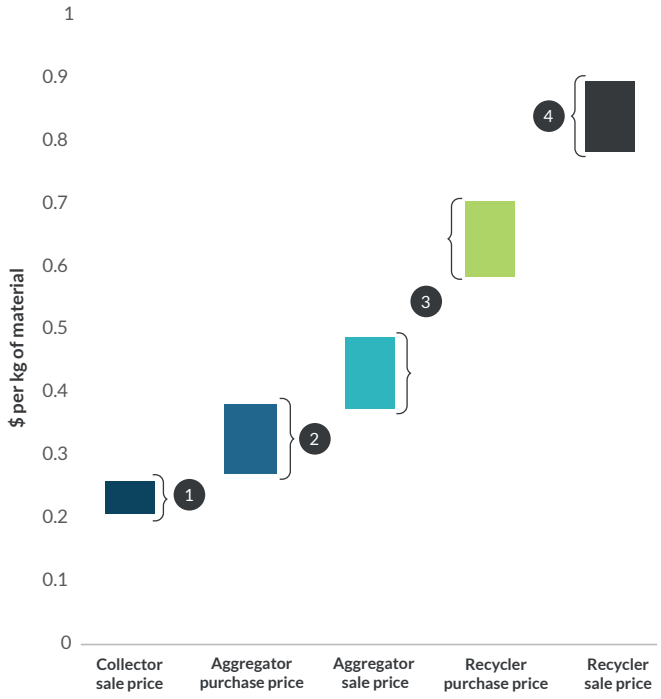
Pricing transparency: Market power retained by recyclers

Data collected through interviews in India is more sparse than that from other countries, demonstrating a more limited ability or level of comfort by respondents in sharing pricing data. This in itself may demonstrate a lack of transparency, or a more competitive market within which pricing is more commercially sensitive.

Analysis of supply chain actor profit margins drawn from the survey data, which is used as a proxy for market power, estimates that 70-80% of the total profits made by collectors, aggregators, and recyclers within the supply chains can be attributed to the recyclers, while the remainder is split between aggregators and collectors. This indicates an imbalance in market power in the plastic waste supply chains in India.

The large proportion of market power in India retained by recyclers, which is comparable to other countries reviewed, means that in practice, any price increases associated with the final output products will not easily flow back to the earlier stages of the supply chain. However, if the value of the end product is more visible to collectors, it may influence the higher end of the range of price points presented by collectors in India. This would impact the amounts, formats, and polymers being collected in the supply chain.

Figure 2: India rPET price ranges as collected through the interviews (in US$)



How to read this chart

Collectors sell rPET for between US$0.21 and US$0.25 per kg, and aggregators buy it for between US$0.24 to US$0.34 per kg. They then sell it on for US$0.37 to US$0.47 per kg to recyclers. Recyclers buy it for between US$0.59 to US$0.70 per kg, and sell it for US$0.81 to US$0.91 per kg.

*Price ranges provided are minimum/maximum prices as reported by stakeholders

India rPET price comparison

1. More defined price point for collector prices in India but based on reduced sample sizes
2. Aggregator purchase price expectations slightly higher than those expected by collectors
3. Aggregator sale price and recycler purchase price misaligned, demonstrating potential lack of transparency
4. Recycler sale price for rPET appears to be aligned with global price points and value-added activities undertaken in value chain

Strong reliance on the informal sector to collect PET for recycling; well-defined and aligned prices at collector and aggregation stages

The rPET market in India is the most well-defined and developed market among the four polymers covered in this study. There is a strong reliance on the informal sector at the stages of collection, aggregation, and sorting, while the PET recycling sector in India is driven by the formal sector.

However, despite these informal operations driving the majority of recycling, the market pricing data at the collection and aggregation stages is well-defined and aligned. Each actor appears to understand their pricing potential, allowing each of them to progressively add value prior to the material being sold to recyclers. This is likely a factor of the dominant material stream traded being that of PET bottles, which have a more commodity-like pricing model and are more easily defined.

From the pricing data gathered through the study, the final sale value of US$850-US$1,000 per tonne, offered by recyclers to buyers, is well-aligned with global pricing expectations of US$900-US$1,500 (rPET price points for Asia between April and September 2022[4]). This allows buyers to access PET feedstock in the domestic market, with data suggesting that recyclers are willing to pay more than the highest sales price offered by aggregators.

The disconnect between the amount that aggregators are receiving and the amount that recyclers say they are paying for feedstock could be due to recyclers not being fully transparent in their responses. It could also suggest a certain lack of pricing transparency within the supply chain. This would indicate an absence of a clear market price, which could benefit some recyclers as they are able to access material at a lower price from certain aggregators.

HDPE the second largest supply chain in terms of volumes of material collected

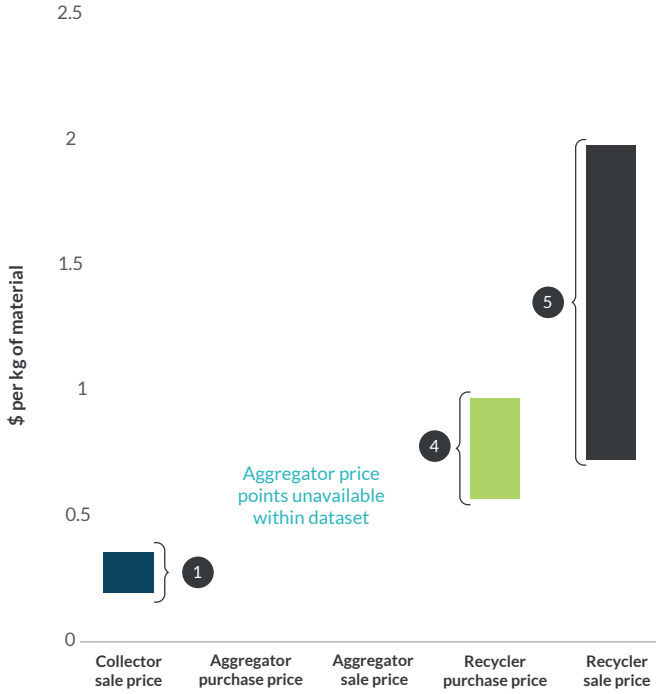
According to a review of wastesheds in India[5], the rHDPE supply chain in India is the second largest in terms of volumes of material collected, but significantly smaller than that for rPET. The rHDPE recycling sector is not as developed as PET recycling, which is reflected in the lack of data provided by actors during the data-gathering process.

The pricing data collated presents a challenge as minimal information was available from collectors and aggregators, and it is unclear if this price point is a reasonable estimate of scrap rHDPE.

Recycled HDPE prices were estimated to be between US$1,000 and US$1,200 per tonne based on pricing points available for the region, which would appear comparable to global traded price points of US$800-US$1350 (rHDPE price points for Asia between April and September 2022[6]). If these price points were to be true of the domestic pricing in India, then this would provide an output market price that would allow value-added activities to be undertaken by both aggregators and recyclers, despite the relatively higher price of collected HDPE scrap of US$400-$500 per tonne reflected by collectors.

4 ICIS data. (2022). 5 The Circulate Initiative. (2023). Mapping Local Plastic Recycling Supply Chains: Insights from Selected Cities in India [online]. Available from: https://www.thecirculateinitiative.org/_files/ugd/77554d_3015af411a8c4e5c98473757e86f1d28.pdf?index=true 6 ICIS data. (2022).

Figure 3: India rPP price ranges as collected through the interviews (in US$)



How to read this chart

Collectors sell rPP for between US$0.25 and US$0.37 per kg. Aggregator's purchase and sale prices are unavailable. Recyclers buy it from aggregators for between US$0.59 to US$0.91 per kg, and sell it for US$0.72 to US$1.95 per kg.

*Price ranges provided are minimum/maximum prices as reported by stakeholders

India rPP price comparison

1. More defined price point for collector prices in India but based on reduced sample size
2. Aggregator price points unavailable within dataset
3. Aggregator price points unavailable within dataset
4. Recycler purchase price appears to be aligned with global market prices, which may suggest limited margins
5. Recycler price for rPP presents a wide range, with upper range high relative to global market prices

Maximum market value significantly higher than global traded price points

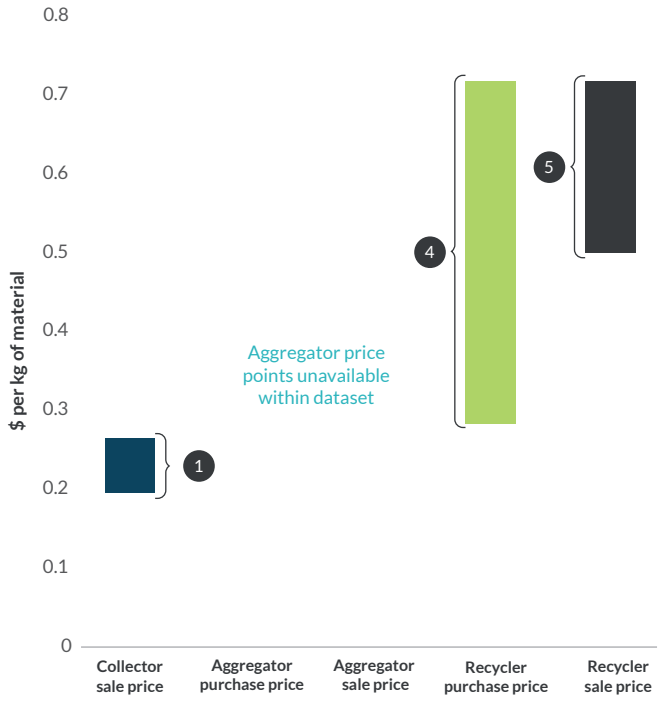
The rPP supply chain for collectors and aggregators presents an incomplete picture, with limited available data from aggregators to validate collectors' and recyclers' expectations.

According to survey data, collection prices for PP are in line with HDPE, which aligns with expectations, given the similar form and perceived polymer value of both materials.

Although the market for rPP is less developed in comparison to rPET, the recyclers surveyed as part of this research project still demonstrated output prices aligned with virgin polymer prices and at a high enough rate to provide revenue to those providing value-added services in turning plastic waste back into a commodity.

In the example of rPP, the maximum market value achieved of US$2,000, of data points from eight recyclers, would appear significantly higher than global traded price points. Similar to other polymers, the challenge is the wide range in price anticipated by recyclers, of US$700-US$$2000. This could potentially be due to less structured markets with a less well-defined market value. The wide range could also be a sign of greater price volatility, with fewer recyclers acting in the market to access PP material for recycling, or unrealistic expectations displayed by recyclers surveyed within the study.

Figure 4: India rLDPE price ranges as collected through the interviews (in US$)



How to read this chart

Collectors sell rLDPE for between US$0.19 and US$0.25 per kg. Aggregator's purchase and sale prices are unavailable. Recyclers buy it from aggregators for between US$0.26 to US$0.72 per kg, and sell it for US$0.52 to US$0.72 per kg.

*Price ranges provided are minimum/maximum prices as reported by stakeholders

India rLDPE price comparison

1. More defined price point for collector prices in India but based on reduced sample size
2. Aggregator price points unavailable within dataset
3. Aggregator price points unavailable within dataset
4. Recycler purchase price would suggest a wide range of price points for aggregated material, potentially as a result of varying qualities
5. Recycler sale price for rLDPE would seem to compare well to global price points

Least developed market, though dedicated recyclers are emerging

The supply chain for rLDPE in India is the least well developed of all polymers, with dedicated recyclers only beginning to emerge to target LDPE films. Although there are large volumes of this material, it is light, contaminated, and of lower value when compared to PET and HDPE, providing less incentive for the informal collection sector to collect the material for recycling.

This is represented by the lack of data points collected in the survey, with very few collectors and aggregators surveyed able to provide separate price points for LDPE material that is collected and managed. Of the data that is available from collectors, pricing expectations would appear low relative to PET, HDPE, and PP.

Recyclers of LDPE are focused on post-industrial films, and it would appear from the data that this material is sold at a lower price of US$500-US$700 per tonne compared to >US$1000 for other polymers. The lower market demand also makes it unclear from the data whether the output prices are at a high enough rate to provide revenue to the supply chain, particularly as recyclers' purchase prices for LDPE scrap are estimated to be between US$300 and US$700 per tonne. Reprocessing would only be feasible and profitable for recyclers to undertake at the lower end of this price range.

Indonesia

Collection

Formal waste collectors working on behalf of the local municipality collect household waste using manual pull carts, tricycles or motorized carts. The mixed waste and recyclables are transported to a small local aggregation facility known as a Temporary Shelter (TPS) or to a TPS 3R (material recovery facility) where available.

Informal waste workers collect waste plastic and other recyclables directly from households, as well as via picking from accessible waste containers and littered waste in public places and industrial zones. They interact with the formal waste collection system at all stages, with informal waste pickers present at transfer stations, material sorting and recovery sites, and landfills to remove valuable recyclables from the residual waste stream. Interviews with informal workers indicate that in many cases, they sort the plastic and prepare it for recycling to improve its value by removing caps and labels from plastic bottles and separating waste into clear and colored plastic before sale to aggregators.

Aggregation

There are different types of facilities that undertake aggregation. In some areas, community-based aggregators known as TPS 3R sites support aggregation and sorting of informally collected waste and recycling. High-value plastic (e.g., HDPE and PET) will typically be extracted at these sites and sold for recycling. While there are a large number of TPS 3R sites, only an estimated 10% are believed to be operational due to a lack of local and regional government funding, objections from residents, availability of land, and operational challenges.[10]

Tempat Pembuangan Sampah Terpadu (TPST), or integrated waste management sites, are regency-level waste transfer and treatment centers in Indonesia that aggregate both household and commercial waste. Some sites also produce refuse-derived fuel (RDF) for cement kilns. Valuable plastic waste is sometimes picked from these sites by informal workers if the sites are accessible to them and permitting arrangements allow it.

Most waste is then transported to a Tempat Pembuangan Akhir (TPA), which is the final (processing) site, typically a major landfill site outside city boundaries. Mixed waste is also dumped illegally and many landfill sites have very little capacity left, resulting in environmental pollution and leakage.[11]

Recycling

There are an estimated 1,300 recycling companies in Indonesia processing plastics. Indonesian Plastic Recyclers (IPR) estimates that there are 120,000 workers at the collector level, 40,000 granulators/grinders, 100,000 plastic factory workers, and 60,000 traders in products and recycled materials. There are also 40,000 people in sectors supporting the plastic industry who are involved in the plastics recycling sector in Indonesia.

There is considerable demand for PET bottles for recycling in Indonesia. Historically, demand has been tied to the polyester yarn industry, although bottle-to-bottle recycling is increasing. While PET and rigid plastic waste are recycled into bottles or fiber for textiles, collected plastic films are made into garbage bags and buckets for construction.

The supply of plastic waste to recycling facilities is hindered by a lack of waste separation, resulting in large amounts of recyclable waste going to landfills.

Case study

The Role of Waste Banks in Indonesia's Plastic Waste Supply Chain[7]

In addition to the recyclable plastic waste collected from households by informal waste workers, households can also sell or deposit recyclables directly at neighborhood waste banks. It is estimated that a waste bank typically caters to a neighborhood of 1,000 residents and that in 2019, an estimated 8,000 waste banks were operational in Indonesia. [8,9]

Households that sell recyclables to a waste bank have an account through which they can save and withdraw money to recognize the value of the recyclables that they have brought to the waste bank as a deposit. Recyclable waste collected at a waste bank is generally sent to a central waste bank (often operated by the local environment agency), larger aggregators or directly to recyclers. A payment is made for the waste deposited, which can then be withdrawn when needed after a contribution of roughly 15% is deducted for the waste bank's operating costs. Many waste banks are supported by the Indonesia Packaging Recovery Organization (IPRO), local community and environmental organizations, and private sector brands.

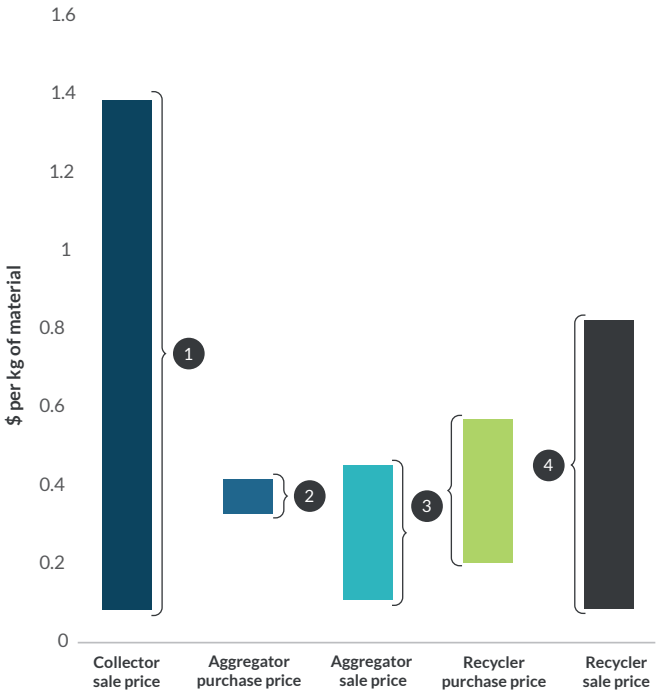
7 The Circulate Initiative. (2023). Mapping Local Plastic Recycling Supply Chains: Insights from Selected Cities in Indonesia [online]. Available from: https://www.thecirculateinitiative.org/_files/ugd/77554d_0ed00073d7ba461190398bb0e3d3f6c1.pdf?index=true **8** Temesi Recycling. (2022). Waste Banks [online]. Available from: http://temesirecycling.com/waste-banks/ **9** Greeners.co. (2019). Waste Bank in West Jakarta Hit Billions Rupiah of Profit [online]. Available from: https://www.greeners.co/english/waste-bank-in-west-jakarta-hit-billions-rupiah-of-profit/ **10** Information provided by in-country research partner Rebel/Waste4Change (2022). **11** AlJazeera Centre for Public Liberties and Human Rights. (2022). Indonesia plastic waste [online]. Available from: https://liberties.aljazeera.com/en/indonesia-plastic-waste/

Pricing transparency: Low transparency in the recycled plastics value chain in Indonesia

Data collected for Indonesia indicates low overall transparency in prices of plastic waste across the country. The role of aggregators in the recycled plastics supply chain is limited, with pricing data suggesting that they operate at low price points and add limited value to the supply chain. The detailed analysis by polymer stream is set out in the following sections.

Polymer in focus: rPET

Figure 5: Indonesia rPET price ranges as collected through the interviews (in US$)



How to read this chart

Collectors sell rPET for between US$0.08 and US$1.36 per kg, and aggregators buy it for between US$0.31 to US$0.41 per kg. They then sell it on for US$0.14 to US$0.51 per kg to recyclers. Recyclers buy it for between US$0.20 to US$0.55 per kg, and sell it for US$0.14 to US$0.77 per kg.

*Price ranges provided are minimum/maximum prices as reported by stakeholders

Indonesia rPET price comparison

1. Wide range of proposed prices for collected material. High end more aligned with rPET global price point
2. Aggregators present but only providing a service at lower price points
3. Price range proposed by aggregators aligned with collectors but does not allow margin relative to recycler price
4. rPET sales price point would appear low relative to supply chain view and not aligned with price proposed by collectors/aggregators

Prevalence of waste banks enables sorting of PET from other recyclables

The rPET market is the most well-defined and developed market in Indonesia, making up 70% of the plastic recycled domestically. There is a strong reliance for collection and aggregation on the informal sector, who sort and prepare the material for recycling, while the PET recycling sector is a formal part of the supply chain in Indonesia. The prevalence of waste banks enables the sorting of PET from other recyclables, which allows for the value of the polymer to be recognized earlier in the supply chain. This partially explains the pricing structure for the polymer in which there is limited value being added progressively (with visible steps in pricing) within the value chain. However, this does not fully explain the variances in pricing data received from the various parts of the supply chain.

There is a high level of variability in the pricing data. There is also a wide range of price points, particularly by collectors and recyclers, which also presents an issue for transparency, indicating different types of business models at each supply chain step, or a lack of consistency in pricing data. This could also be due to the different regions that the supply chains operate in reflecting different prices.

In Indonesia, rPET outputs are priced at roughly US$800 per tonne, which is below the global pricing expectations of US$900-US$1,500. This could suggest that there is a lack of value-add by recyclers, or that there low local demand for the material. The pricing data collected via interviews may therefore not be representative of the actual supply chain for recyclers.

High variability in collector and aggregator sale prices reflects a lack of pricing transparency

The rHDPE supply chain in Indonesia is the second largest in terms of volumes of material collected but significantly smaller than that for rPET.

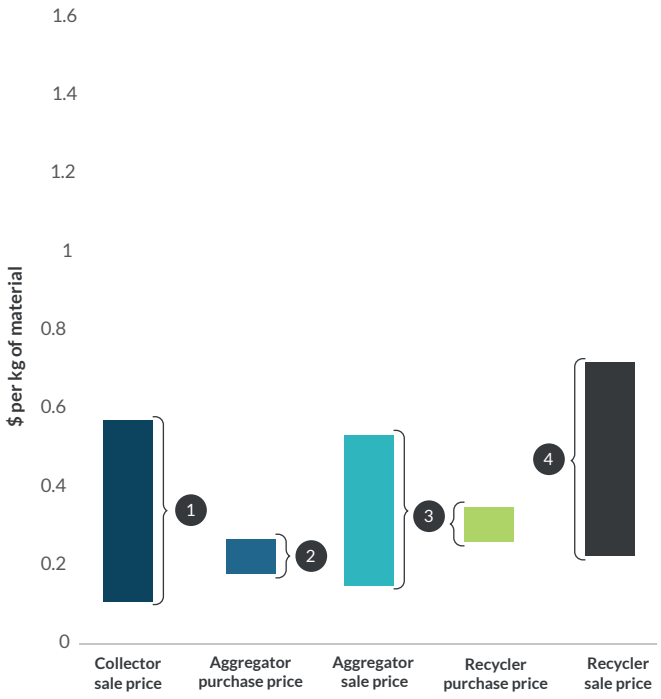
The pricing data collated, however, does mirror that of rPET in structure, suggesting that the same market dynamics are in place, with waste banks playing a key role in influencing the market dynamics of rHDPE. Although aggregator purchase prices seem better defined in comparison to rPET, there is still high variability in collector and aggregator sale prices, which is indicative of an informal marketplace with higher inconsistency in price points.

This also reflects a lack of pricing transparency, with deals struck on a bilateral basis, which may be highly variable depending on market conditions or timing.

The HDPE recycling sector is less well developed, which may be reflected in the below-market prices indicated by recyclers. rHDPE prices are estimated to be between US$200 and US$600 per tonne, which appears low compared to global traded price points. The relatively low prices are a reflection of a supply chain that places less value on rHDPE vis-à-vis rPET and is not connected to trade in global commodity markets. The low price point needed to access feedstock is also indicative of an economy that does not yet demand high volumes at the production stage.

Polymer in focus: rHDPE

Figure 6: Indonesia rHDPE price ranges as collected through the interviews (in US$)



How to read this chart

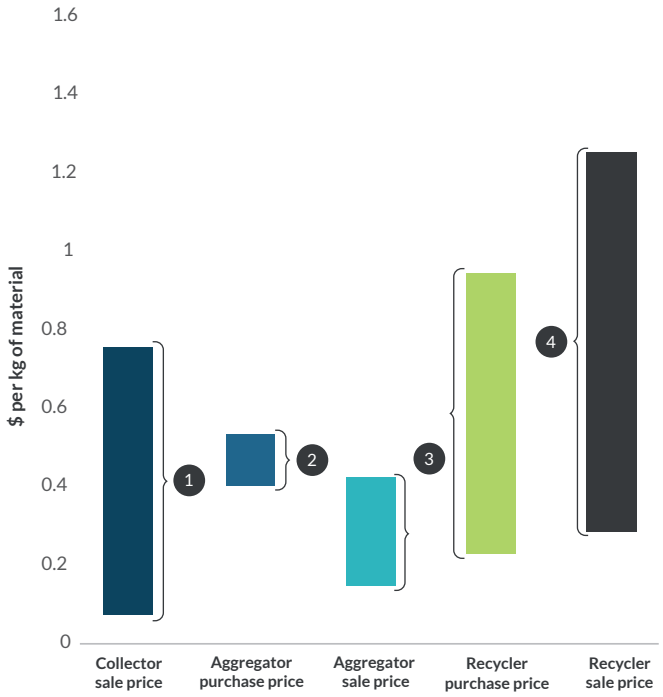
Collectors sell rHDPE for between US$0.10 and US$0.51 per kg, and aggregators buy it for between US$0.17 to US$0.27 per kg. They then sell it on for US$0.14 to US$0.46 per kg to recyclers. Recyclers buy it for between US$0.27 to US$0.34 per kg, and sell it for US$0.24 to US$0.65 per kg.

*Price ranges provided are minimum/maximum prices as reported by stakeholders

Indonesia rHDPE price comparison

1. Wide range at collection stage indicative of low transparency of product value in early stages of value chain
2. Aggregators present but only providing a service at lower price points
3. Aggregators and recyclers reasonably aligned on price point but still a wide range, with upper and lower bounds that do not align with recycler expectations
4. Recycler sale price still presented by respondents as a wide range, illustrating a lack of transparency that they feed back to the value chain

Figure 7: Indonesia rPP price ranges as collected through the interviews (in US$)



How to read this chart

Collectors sell rPP for between US$0.10 and US$0.71 per kg, and aggregators buy it for between US$0.41 to US$0.51 per kg. They then sell it on for US$0.14 to US$0.44 per kg to recyclers. Recyclers buy it for between US$0.29 to US$0.92 per kg, and sell it for US$0.31 to US$1.19 per kg.

*Price ranges provided are minimum/maximum prices as reported by stakeholders

Indonesia rPP price comparison

1. Wide range at collection stage indicative of low transparency of product value or range of material quality/segregation
2. Aggregators present but purchase price does not align with sale price quoted
3. Aggregators and recyclers misaligned on price point and indication of limited added value by aggregators
4. Recycler sale price still presented by respondents as a wide range illustrating a lack of transparency that they feed back to the value chain

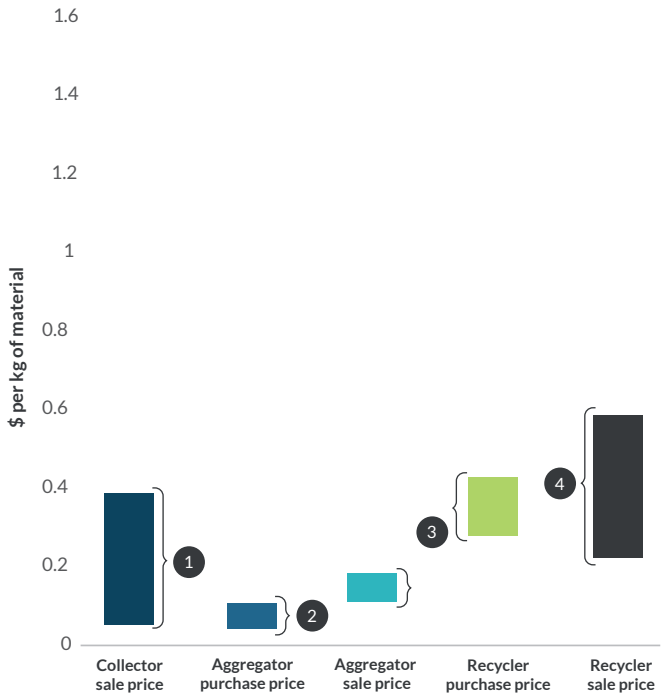
Less structured markets lead to a wide range of input and output prices

The rPP supply chain for collectors and aggregators presents a picture which does not reflect significant added value at either the collection or aggregation phases, and suggests inconsistent demand for rPP. It also mirrors that of rPET and rHDPE, reflecting a similar dynamic of waste banks being key in the separation of material at source and the more limited role of aggregators.

Although the market for rPP is less well developed, the recyclers surveyed as part of this research still demonstrate an end output price of up to US$1,400, which would appear comparable to, if not higher than, globally traded price points. Similar to other polymers, the challenge is that the range in both input and output prices for recyclers is very wide. From Figure 7 above, we can see that the price ranges are in excess of US$600 per tonne, potentially because of less structured markets with a less well-defined market value, or an issue of differing material quality. It could also be a sign of greater price volatility with fewer recyclers acting in the market who access PP material for recycling.

Polymer in focus: rLDPE

Figure 8: Indonesia rLDPE price ranges as collected through the interviews (in US$)



How to read this chart

Collectors sell rLDPE for between US$0.06 and US$0.37 per kg, and aggregators buy it for between US$0.02 to US$0.12 per kg. They then sell it on for US$0.14 to US$0.20 per kg to recyclers. Recyclers buy it for between US$0.26 to US$0.41 per kg, and sell it for US$0.24 to US$0.59 per kg.

*Price ranges provided are minimum/maximum prices as reported by stakeholders

Indonesia rLDPE price comparison

1. Wide range at collection stage indicative of low transparency of product value or range of material quality/segregation
2. Aggregators present but only providing a service at lower price points
3. Aggregators and recyclers misaligned on price point, with recyclers expecting to pay in excess of aggregator sale price
4. Recycler sale price still presented by respondents as a wide range, illustrating a lack of transparency that they feed back to the value chain

Wide range of price points by collectors and recyclers

The variation in data collected through interviews in Indonesia highlights potential inconsistencies across the value chain. This is evident in the early stages of the value chain with aggregators' purchase price points often being far lower than the price points provided by collectors. This could be a result of aggregators' more limited involvement in the value chain, operating only with lower-value material, or it could be that they are accessing waste from more informal collectors on lower wages. The higher-end collector prices are likely to represent more formalized waste collectors and central waste banks with a more direct route to recyclers and a better understanding of the value of their plastic.

The wide range of price points presented particularly by collectors suggests a lack of transparency regarding the value of the material, indicating different types of business models or a lack of consistency in pricing data caused by limited transparency.

Thailand

The polymer recycling market in Thailand is dominated by rigid plastics. The national recycling rate for PET bottles is estimated to be over 80%, with existing drop-off points for bottles at major malls and other locations contributing to this rate.[12] There is increasing demand for rigid PP from domestic recyclers responding to growing demand. Historically, there has 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 capacity for post-industrial PE films is being developed near Bangkok.

Collection

The waste plastics supply chain in Thailand relies on the informal sector for the collection of plastics for recycling. Informal collectors buy recyclable materials, including plastic waste where available, mainly from middle- and high-income households, but also from formal workers operating municipal collections. 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. These activities take place within well-defined catchment areas, with collectors operating within a 5-10km range.

The formal collection system is focused on household waste as a sanitation service, with limited segregation of material provided at source, and bulk materials collected predominantly for disposal at landfill. Formal collectors can play a role, but often via informal routes, with these collectors retrieving recyclables from their waste trucks to sell to nearby aggregators or junk shops to earn an income in addition to their formal salary.

Aggregation

Municipally collected waste is aggregated via transfer stations, which are primarily operated by private waste companies contracted by 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.

The aggregated 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 through this route.

Private aggregators (waste shops or junk shops in Thailand) are mostly formal. They hold permits from the local authorities to conduct business activities on their premises, but most such shops do not have an industrial permit or waste license that allows them to process plastic or handle more general waste. Plastic waste often moves through at least two stages of aggregation, from smaller local aggregators to larger aggregators before reaching recycling facilities. The multiple stages of aggregation add value by reducing contamination and preparing single polymer fractions. Our research indicates that there is clear communication between collectors and aggregators about what is an acceptable price, and this sets the price.

Recycling

Formal reprocessing is much more prevalent in Thailand than it is in 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.[13]

Pricing transparency: Low pricing transparency, but situation expected to evolve and improve

The data collected for Thailand indicates low transparency across the country. However, with companies like Wongpanit beginning to publish daily prices for recyclables and making more detailed pricing tables available to their franchisees, the situation is improving.

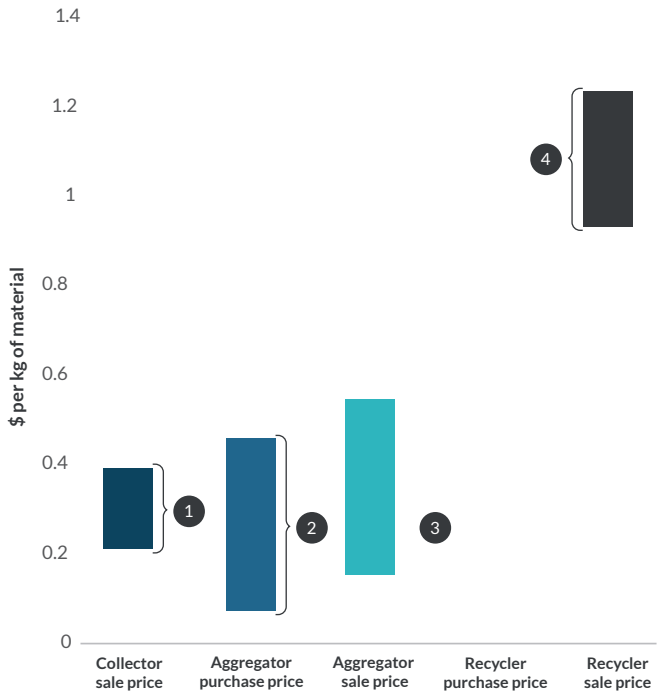
The variation in data collected through interviews in Thailand highlights potential inconsistencies in the perceived value of plastics within the supply chain. This is evident in the initial stages of the supply chain, with aggregators and collectors not always aligned on a market price for the recyclates. However, it is also evident that a large proportion of the market power is retained by recyclers.

The indicated imbalance of market power in Thailand mostly benefits recyclers and negatively impacts collectors and aggregators in the supply chain. Analysis of supply chain actor profit margins drawn from the study, as a proxy for market power, has estimated that 70-80% of the total gains from trade are attributable to the recyclers, while the remainder is split between aggregators and collectors. This means that, in practice, any price increases associated with the final output products will not easily flow back to the earlier stages of the supply chain, e.g., the collectors. This impacts the amounts, formats, and polymers being collected in the supply chain.

12 Bring Back Recycle. (2021). Recycling Drop Off. http://www.bringbackrecycle.com/recycle 13 Data provided by SEI based on information extracted from OIE – Directory (2019).

Polymer in focus: rPET

Figure 9: Thailand rPET price ranges as collected through the interviews (in US$)



How to read this chart

Collectors sell rPET for between US$0.20 and US$0.35 per kg, and aggregators buy it for between US$0.08 to US$0.48 per kg. They then sell it on for US$0.14 to US$0.57 per kg to recyclers. Recycler purchase price is unavailable within this dataset. Recyclers sell rPET for US$0.95 to US$1.26 per kg.

*Price ranges provided are minimum/maximum prices as reported by stakeholders

Thailand rPET price comparison

1. Low price range of collector sale price
2. Purchase price of aggregators shows broad range in excess of both the upper and lower bounds expected by collectors
3. Recyclers partaking in the survey did not share purchase price information — indicative of the lack of transparency in the market
4. Recyclers sales price is in excess of aggregator sales price indicating market power and ability to protect margins

Supply chain gets more disparate at later stages of the supply chain

The rPET market is the most well-defined and developed market in Thailand, with an estimated 80% of PET plastic bottles recycled. There is a strong reliance on the informal sector at the collection and aggregation stage, and additional activities undertaken by private aggregators to improve quality ahead of sale into the formal recycling system. At the recycling stage of the value chain, the rPET recycling sector is a formal and commercially-driven sector within Thailand, with more than 200 recycling plants in operation in the country.

Since the majority of material procured is rigid PET bottles, it is assumed that the price of material would be fairly homogenous, and this can be seen to an extent in the collector sale price, where a reasonably well-defined price point is apparent. At the aggregator stage, the supply chain becomes more disparate, with aggregators purchasing a wider variety of materials of different qualities to add value. This will involve the purchase and aggregation of smaller parcels of separate plastic material, as well as the purchase of mixed material streams and the undertaking of basic sorting to segregate plastics for resale. This may explain the relationship between collector and aggregator prices. In some instances, limited value is added as high-quality material is passed through for sale to recyclers, while in other cases, aggregators are separating PET from mixed and contaminated materials for onward sale.

For the purposes of this study, rPET recyclers were unable or unwilling to share purchase prices of recyclates. In addition, the range of price points provided for the sale price results in a lack of understanding of the end value of the plastic waste for other actors, which means recyclers can retain market power and set prices that flow back into the supply chain.

rHDPE market less well developed than rPET market; varied role of aggregators in adding value in the supply chain

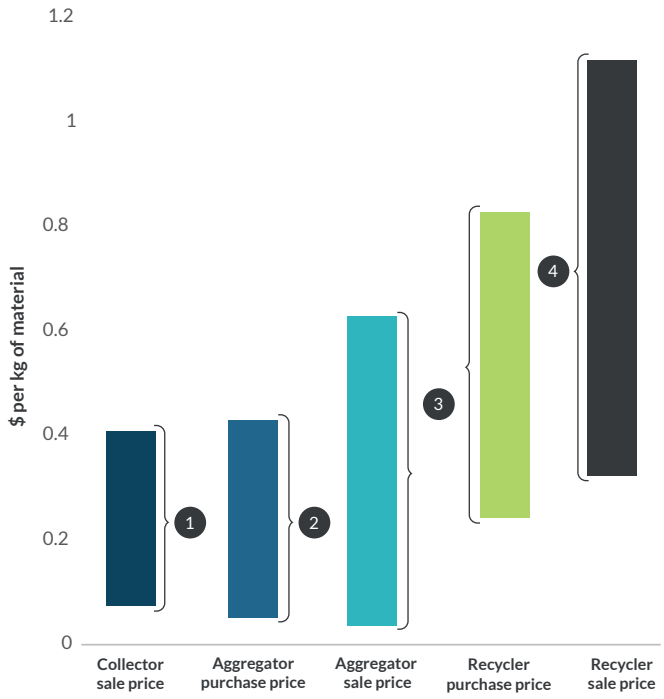
The rHDPE supply chains, despite being less well developed in Thailand, present a similar picture to the rPET supply chain. Although the market for HDPE is less well developed, the recyclers surveyed as part of this study still demonstrate output prices aligned with virgin polymer prices and at a high enough rate to provide revenue to those providing value-added services in turning plastic waste back into a commodity.

For each of the supply chain stages, the pricing appears flatter. There is limited value being added progressively (with visible steps in pricing) within the value chain, demonstrating a potentially varied role of aggregators acting to add value in different ways – aggregating high-value material as well as being the first point of separation for lower-quality or contaminated material. A key difference of these markets compared to the PET market, however, is the relatively wider pricing range for HDPE at the collection stage and aggregation sale point, which may reflect the less well-developed market and understanding of the material value.

In the example of recycled HDPE material where prices go up to $1,200, this would appear comparable to globally traded price points of US$800-US$1,350 (rHDPE price points for Asia between April and September 2022[14]). The challenge is that the ranges for both input and output prices for recyclers are wide, potentially because of a less structured market with a less well-defined market value. It could also be a sign of greater price volatility with fewer recyclers acting in the market who access HDPE for recycling.

Polymer in focus: rHDPE

Figure 10: Thailand rHDPE price ranges as collected through the interviews (in US$)



How to read this chart

Collectors sell rHDPE for between US$0.14 and US$0.42 per kg, and aggregators buy it for between US$0.10 to US$0.45 per kg. They then sell it on for US$0.10 to US$0.67 per kg to recyclers. Recyclers buy it for between US$0.27 to US$0.84 per kg, and sell it for US$0.50 to US$1.09 per kg.

*Price ranges provided are minimum/maximum prices as reported by stakeholders

Thailand rHDPE price comparison

1. Smaller range at collection stage for HDPE but still significant range ~$0.3 per kg collected
2. Purchase price of aggregators shows broad range in excess of both the upper and lower bounds expected by collectors
3. Good alignment of price points but wide range, demonstrating lack of transparency around a "market price"
4. Recycler sale price still presented by respondents as a wide range, illustrating a lack of transparency that they feed back to the value chain

14 ICIS data. (2022).

Wide range in input and output prices for recyclers

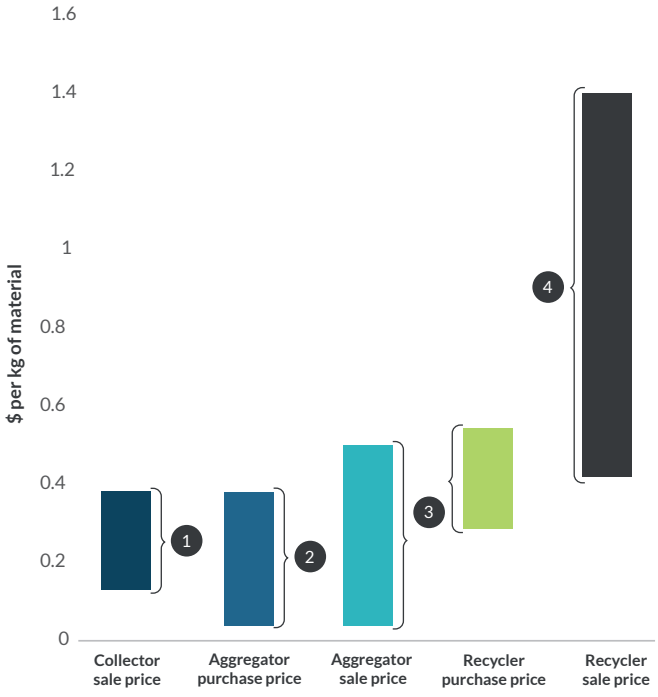
The rPP supply chains, despite being less well developed in Thailand, present a similar picture to the rPET and rHDPE supply chains. Although the market for rPP is less well developed, the recyclers surveyed as part of this research project still demonstrated output prices aligned with virgin polymer prices and at a high enough rate to provide revenue to those providing value-added services in turning plastic waste back into a commodity.

For each supply chain stage, pricing appears flatter (indicating less value added by each actor). This demonstrates a potentially varied role of aggregators acting to add value in different ways; for example, aggregating high-value material as well as being the first point of separation for lower-quality or contaminated material. A key difference between these markets compared to rPET is the relatively wider pricing range at the collection stage and aggregation sale point, which may reflect the less well-developed market and a less well-developed understanding of the material value.

The rPP prices of up to US$1,400 per tonne are also comparable to, if not above, traded prices. The challenge, however, is that the range in both input and output prices for recyclers is wide, potentially because of a less structured market with a less well-defined market value. It could be due to a snapshot in time issue, where market prices were low during the period of data collection, or a sign of greater price volatility, with fewer recyclers acting in the market to access HDPE and PP material for recycling.

Polymer in focus: rPP

Figure 11: Thailand rPP price ranges as collected through the interviews (in US$)



How to read this chart

Collectors sell rPP for between US$0.14 and US$0.42 per kg, and aggregators buy it for between US$0.04 to US$0.42 per kg. They then sell it on for US$0.05 to US$0.56 per kg to recyclers. Recyclers buy it for between US$0.28 to US$0.56 per kg, and sell it for US$0.43 to US$1.40 per kg.

*Price ranges provided are minimum/maximum prices as reported by stakeholders

Thailand rPP price comparison

1. Smaller range at collection stage for PP but still range of $0.25 per kg collected
2. Purchase price reasonably aligned but aggregators believe they can access feedstock at lower value than collectors
3. Prices well aligned at end of value chain, demonstrating potentially greater transparency
4. Recycler sale price still presented by respondents as a wide range, illustrating a lack of transparency in what is being fed back to the value chain

Least developed market, though dedicated recyclers are emerging; well-defined value at recycler stage, with a narrower range of prices reported

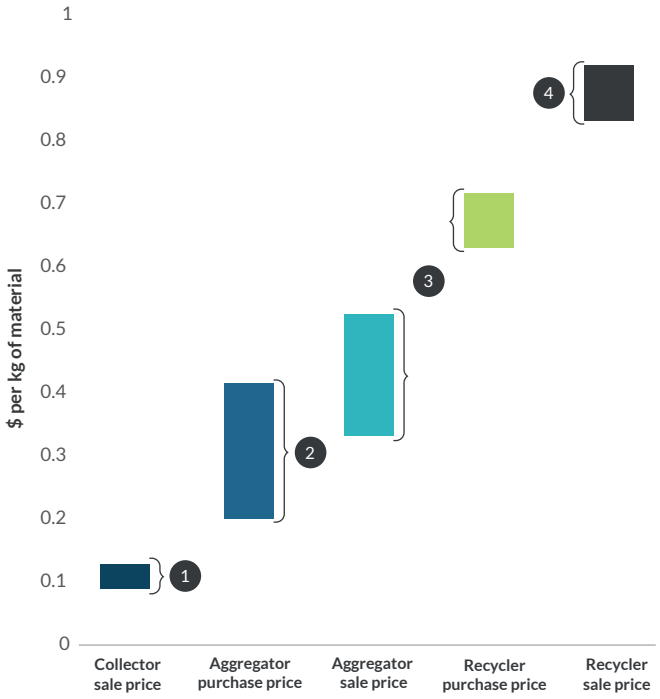
The supply chain for rLDPE in Thailand is the least well developed, with dedicated recyclers only beginning to emerge to target PE films. Although there are large volumes of this material, it is light and often contaminated, making it difficult to collect for the informal collection sector. A significant volume of PE films must be collected to generate the mass required for sale. This is particularly difficult because films are more difficult to sort and grade.

This is demonstrated in the data collected, with LDPE collectors in particular highlighting the lower expected price per kilogram relative to other materials. Beyond the point of collection, the supply chain appears to function more traditionally, with aggregators playing a key role in material upgrading, sorting, and separating films to prepare the material for recycling.

Recyclers of LDPE are focused on films, and it would appear from the data that despite this material being of relatively lower value compared to other recycled plastics (roughly US$1,000 a tonne compared to over US$1,000 for other polymers), prices are more well defined, with stakeholders reporting a narrower range. This narrowing of price points could be due to market conditions or a more limited selection of recyclers being able to provide prices for rLDPE. The whole supply chain for rLDPE, however, appears to function more traditionally, with clear delineations of tasks undertaken at each step, resulting in clear value-added opportunities for each actor. This is true despite the fledgling nature of the market in Thailand.

Polymer in focus: rLDPE

Figure 12: Thailand rLDPE price ranges as collected through the interviews (in US$)



How to read this chart

Collectors sell rLDPE for between US$0.10 and US$0.14 per kg, and aggregators buy it for between US$0.20 to US$0.42 per kg. They then sell it on for US$0.34 to US$0.53 per kg to recyclers. Recyclers buy it for between US$0.63 to US$0.73 per kg, and sell it for US$0.84 to US$0.94 per kg.

*Price ranges provided are minimum/maximum prices as reported by stakeholders

Thailand rLDPE price comparison

1. LDPE represents low value material stream for collectors
2. Purchase price provided by aggregators misaligned with collectors with perceived greater value
3. Prices between aggregators and recyclers aligned but recyclers still paying above aggregator expectations
4. Recycler sale price well aligned with recycled content market prices

Vietnam

The plastics recycling market in Vietnam is dominated by rigid plastics. While demand from recyclers is currently focused on PET and HDPE bottles, there is also increasing demand for rigid PP. 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 informal collection is being undertaken, mainly for post-industrial white and clear films.

Collection

Non-industrial waste generators (such as households, markets, small businesses, and schools) do not separate plastic waste for the formal recycling system, but rather, at their discretion, set aside plastic for sale to informal waste workers. Typically, this will be rigid plastics of value, such as PET and HDPE. The waste is collected by municipal waste operators employed by public waste management organizations linked to the local and national government. Municipal waste collectors typically extract some valuable materials during their collection routes and trade them through the informal sector for additional income. This practice is mostly accepted (but not supported) by waste operators and enables some plastic to be extracted before disposal at landfill.

Aggregation

Municipally-collected waste is transferred from collection carts to compression trucks at temporary transfer stations, which are used to consolidate waste and make onward transport more efficient. These are usually small-scale sites without infrastructure and are not designed for waste sorting to extract plastics for recycling. However, they are often used by informal waste workers to pick out valuable materials before landfill. Larger, more formal municipal aggregation sites are used in some locations to increase efficient transport to landfill. These larger sites typically do not have extraction of tradable waste either and are mainly used to compact and consolidate waste, leaving little opportunity for the informal waste workers to pick valuable materials.

Informal workers usually trade the plastics they collect at small local aggregators (collection centers, junk shops or waste banks). These are small spaces often run as a family business in the owner's house without business licenses or permits. Some aggregators may undertake pre-processing steps to increase the value of material (e.g., sorting and label removal from bottles). Materials are typically traded on to larger aggregators (consolidation centers), which have staff and own collection vehicles. These larger centers will collect from small aggregators and larger waste generators (e.g., large businesses or factories) and typically undertake further preparation steps, which can include sorting, baling, and shredding. They are mostly registered businesses, but often do not hold adequate waste permits. Materials are traded on to recyclers or larger traders (who sometimes export material).

Large amounts of recyclable waste are handled through craft villages. These are villages in which many households are involved in informal waste collection, aggregation, pre-processing, and even some recycling of tradable waste. They also sometimes process imported waste, and larger craft villages may trade directly with formal recyclers.

Recycling

Both formal and informal facilities (mainly craft villages) recycle plastic in Vietnam, with most recyclers located in and around Ho Chi Minh City and Hanoi. In Vietnam, it is estimated that there are 50 to 75 active formal recyclers, with capacities ranging from 4-15 kilotonnes/yr, and about 200 active informal recyclers, who typically process 1-10 kilotonnes/yr.

Informal recyclers are mostly run as family businesses, which sometimes have basic business permits, but rarely waste treatment or recycling permits. These recyclers typically have basic technology (i.e., balers, crushers, washers, dryers) and mostly produce plastic flakes to trade with local compounders or with brokers for export.

Formal recyclers have both business permits and suitable environmental permits and invest in large-scale equipment and machinery. Most formal recyclers using domestic supply are closely linked to the informal sector, who supply raw feedstock or flakes. This reliance on the informal sector impacts the quality, quantity, and pricing of recycled plastics and the potential to scale up plastics recycling infrastructure in Vietnam.

Case study

Craft Villages and their Role in Recycling in Vietnam[15]

"Craft villages" are villages in which many households are involved in informal waste collection, aggregation, pre-processing, and even some recycling of tradable waste. They also sometimes process imported waste and larger craft villages may trade directly with formal recyclers. While the term "craft village" is mainly used in Hanoi, this term has been used to describe informal collection, sorting, and recycling activities throughout Vietnam.

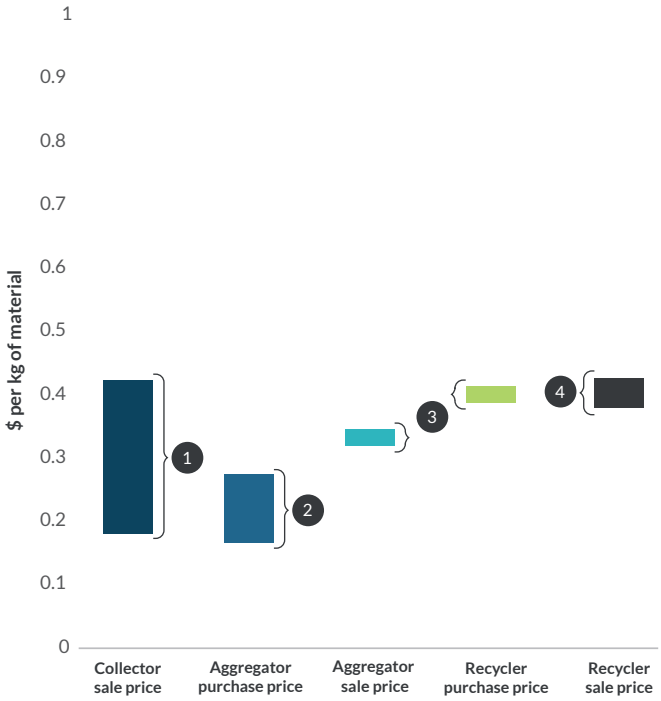
15 The Circulate Initiative. (2023). Mapping Local Plastic Recycling Supply Chains: Insights from Selected Cities in Vietnam. Available from: https://www.thecirculateinitiative.org/_files/ugd/77554d_ad28e8ae2a17401c9a6367737ec473a5.pdf

Pricing transparency: Lack of consistency in price points along the value chain

The data collected through interviews in Vietnam highlights potential inconsistencies in the supply chain. In particular, the relationship between the collector and aggregator provides an interesting dynamic, where collectors need to be paid daily for small amounts of recyclables and can only access local aggregators. The detailed analysis by polymer stream is set out in the following sections.

Polymer in focus: rPET

Figure 13: Vietnam rPET price ranges as collected through the interviews (in US$)



How to read this chart

Collectors sell rPET for between US$0.17 and US$0.47 per kg, and aggregators buy it for between US$0.17 to US$0.30 per kg. They then sell it on for US$0.32 to US$0.34 per kg to recyclers. Recyclers buy it for between US$0.39 to US$0.41 per kg, and sell it for US$0.39 to US$0.44 per kg.

*Price ranges provided are minimum/maximum prices as reported by stakeholders

Vietnam rPET price comparison

1. Wide range at collection stage indicative of low transparency of product value in early stages of value chain
2. Purchase price only aligns with lower range of collector estimated value, signaling market power of aggregator and price setting
3. Alignment of prices better at end of value chain, indicative of greater transparency around final product value
4. Recycler sale price of rPET would appear low relative to global price points

Strong reliance on informal sector for collection and aggregation; pricing of rPET supply chain outputs does not seem to account for value addition by recyclers

The rPET market in Vietnam is the most well defined and developed market, despite the fact that less than 20% of plastics is currently collected for recycling. There is a strong reliance for collection and aggregation on the informal sector, who play the role of material separators and upgraders to prepare the material for recycling. The rPET recycling sector consists of a mixture of formal and informal actors, with craft villages undertaking some of the recycling activities.

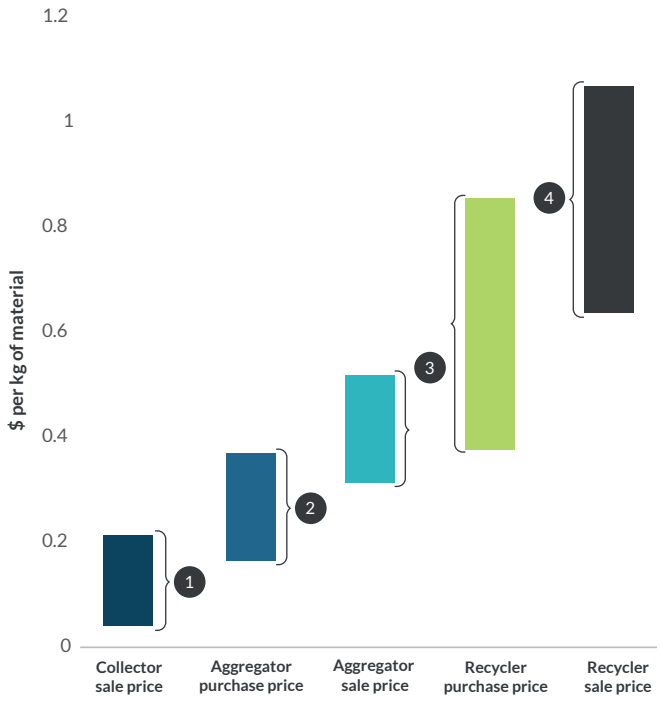
This can be seen in the pricing data, with overlaps in the pricing of material managed and sold by collectors and aggregators.

In some cases, it would appear collectors may be selling directly to recyclers and receiving a higher price, while in other cases, selling to aggregators at lower price points. This overlap in activities could also lead to a lack of transparency in pricing data, or could simply be a reflection of the complex processing sector.

This may be indicated in the pricing structure of the rPET supply chain outputs, which would appear to be producing rPET outputs below market value, at roughly US$500 per tonne, as compared to the global commodity price of US$1,000 per tonne. This would not seem to account for any value being added by recyclers. The pricing data collected via interviews may therefore not be representative of the actual supply chain for recyclers and may reflect operators looking to protect their commercial information.

Polymer in focus: rHDPE

Figure 14: Vietnam rHDPE price ranges as collected through the interviews (in US$)



How to read this chart

Collectors sell rHDPE for between US$0.04 and US$0.22 per kg, and aggregators buy it for between US$0.17 to US$0.37 per kg. They then sell it on for US$0.30 to US$0.52 per kg to recyclers. Recyclers buy it for between US$0.39 to US$0.86 per kg, and sell it for US$0.65 to US$1.08 per kg.

*Price ranges provided are minimum/maximum prices as reported by stakeholders

Vietnam rHDPE price comparison

1. Smaller range at collection stage for HDPE and lower than aggregator purchase price expectations
2. Purchase price only aligns with very upper range of collector estimated value, signaling disparity in market
3. Misalignment in aggregator sale price and recycler purchase price, indicating lack of transparency between parties
4. Recycler sale price for rHDPE appears to be aligned with global price points and value-added activities undertaken in value chain

Market pricing structure aligns with expectations of supply chains; distinct pricing windows at each supply chain stage

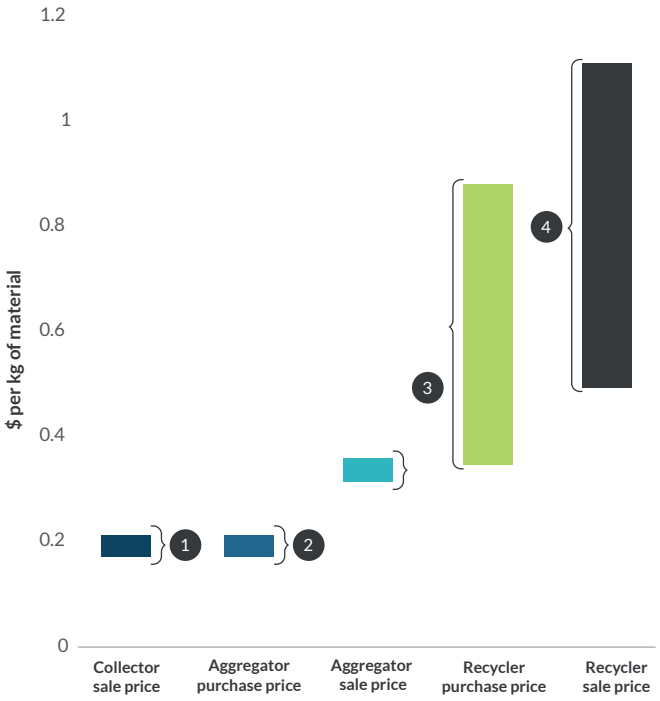
The rHDPE supply chains, despite being less well developed in Vietnam, present a market pricing structure that is expected from a recycling supply chain. Each actor in the collection and aggregation stage has the opportunity to access material at market rates, add value through their aggregation and upgrading activities, and sell onwards for a margin, with recyclers' sale price aligning with the upper end of their purchase prices. Although the market for rHDPE is less well developed, the recyclers surveyed as part of this research still demonstrated output prices aligned with virgin polymer prices and at a high enough rate to provide revenue to those providing value-added services in turning plastic waste back into a commodity.

This is reflected in the distinct pricing windows at each stage of the supply chain, with limited overlap in pricing expectations. The only stage at which the rHDPE supply chain would appear to be unconventional is the relationship between collectors' sale prices and aggregators' purchase prices. The misalignment of these two price points could possibly represent a disconnect or perceived difference in price.

In the example of recycled rHDPE material where prices go up to US$1,100, this would appear comparable to globally traded price points. The challenge is that the range in both input and output prices for recyclers is wide, potentially because of less structured markets with a less well-defined market value.

Polymer in focus: rPP

Figure 15: Vietnam rPP price ranges as collected through the interviews (in US$)



How to read this chart

Collectors sell rPP for between US$0.17 and US$0.22 per kg, and aggregators buy it for between US$0.17 to US$0.22 per kg. They then sell it on for US$0.30 to US$0.34 per kg to recyclers. Recyclers buy it for between US$0.33 to US$0.88 per kg, and sell it for US$0.49 to US$1.12 per kg.

*Price ranges provided are minimum/maximum prices as reported by stakeholders

Vietnam rPP price comparison

1. Range of prices at supply chain stage seems better but based on more limited data
2. Alignment seems artificially good, resulting from limited data points provided
3. Misalignment in aggregator sale price and recycler purchase price indicating lack of transparency between parties
4. Recycler sale price still presented by respondents as a wide range, illustrating a lack of transparency that they feed back to the value chain

No value addition observed and rPP recycling remains limited; gains of trade skewed towards recyclers

The rPP supply chains in Vietnam for collectors and aggregators present a picture that does not seem to reflect significant added value at either the collection or aggregation phases, with collectors reporting a similar range of sale prices as aggregators' purchase prices. Although the market for rPP is less well developed, the recyclers surveyed as part of this research still demonstrated output prices aligned with virgin polymer prices and at a high enough rate to provide revenue to those providing value-added services in turning plastic waste back into a commodity.

For these supply chain stages, the pricing does appear better defined, with actors surveyed in agreement on the range of pricing achieved at the points of collection and post aggregation. What this means, however, is that the rPP supply chain appears to be skewed towards the recyclers, who have the power to access material from aggregators and who add significant value via reprocessing and resale to manufacturers and producers.

In the example of rPP, the market value achieved of up to US$1,200 would appear comparable to, if not higher than, globally traded price points. The range in both input and output prices for recyclers is very wide, with a range in excess of US$600 per tonne, potentially because of less structured markets with a less well-defined market value.

Dedicated recyclers are emerging; lack of pricing transparency reflected through lack of available price points

The supply chain for rLDPE in Vietnam is the least well developed, with recyclers dedicated to PE films only beginning to emerge. Although there are large volumes of this material, it is light and often contaminated, making it difficult for the informal waste sector to collect the material for recycling and to sell it for a profit.

The lack of pricing transparency is represented by the lack of data points collected in the survey, with none of the collectors or aggregators surveyed able to provide separate price points for rLDPE material collected and managed.

Recyclers of LDPE are focused on post-industrial films, and it would appear from the data that this material is perceived to be of relatively lower value overall (roughly US$800 per tonne compared to over US$1,000 for other polymers). It is unclear from the data how sustainable this output price is without understanding the purchase price for rLDPE and the potential value-added activities and margins that recyclers can achieve within the domestic supply chain.

Policies and their Impact on Pricing Transparency

This section of the report assesses the impact of a selected number of policy interventions on the volume of plastic waste collected and recycled, and the potential distribution of the profits across the supply chain, with a specific view towards how this could improve the flow of profits to waste workers.

In discussion with various stakeholders operating in the recycled plastics ecosystem in South and Southeast Asia, and due to budgetary considerations, we selected three policies for each country for further examination. The policies selected were identified to be the most relevant for the respective country. The selected policies were evaluated based on how they could support greater pricing transparency and, if so, how this would influence the supply chains in the form of price points, profits, and the volume of supply of recycled polymers. The list of policies selected for each country is provided in Table 4.

Please note that the outcomes of the policy intervention assessment should be seen as illustrative outcomes, as the model provides a flexible tool in which the assumptions around the policy impact can be changed based on best practice and knowledge, leading to different outcomes. The data gathered during the pricing transparency study is used to underpin the model, with additional assumptions considered for:

- Cost structures for different operators
- Process flows, e.g., collector/recycler yields
- Overall scale of the recycled plastics markets and how the value chain functions

The model is also based on economic principles and thus reflects rational behavior anticipated by market theory rather than real world actors. The implementation of these policies or a combination of them in an ever-changing recycled plastics market landscape may result in differing outcomes. The results are intended to provide directional guidance for users of this report.

Table 4: Shortlist of policies selected for intervention analysis by country

	India	Indonesia	Thailand	Vietnam
1. Extended Producer Responsibility	✓	✓	✓	✓
2. Implementation of a Deposit Return System	✓	✓	–	–
3. Minimum Recycled Content Targets	✓	✓	–	–
4. Formalization of the Collection System	–	–	✓	✓
5. Taxes on Virgin Polymers	–	–	✓	✓

Extended Producer Responsibility (EPR)

How EPR can influence pricing transparency

EPR is a policy approach whereby producers are made responsible financially and/or operationally for the end-of-life management of the products and/or packaging they sell. The twin purposes of EPR are to improve waste recovery and management and increase the supply of materials for recycling. Notably, ensuring a "fair" distribution of profits is not an objective of EPR. EPR fees applied are based on one or more of the unit count, weight, or material type. Eco-modulation, on the other hand, varies the fees applied by promoting more environmentally-friendly packaging materials, formats, and alternatives, and penalizing the less friendly ones.

When EPR is implemented as a mandatory requirement, the calculation of producer fees is based on the costs of collection, aggregation, sorting, and recycling of plastic waste. The implementation of EPR is therefore expected to result in greater transparency around the processing costs and a potential interest in vertical integration. Where implemented, a known proportion of operational costs are expected to be covered by EPR. As EPR fees are publicly disclosed, the fees provide a certain level of transparency to the revenue model of operators within the supply chain. The fees can be modulated to reflect the costs associated with difficult-to-recycle material streams, support the transition towards increased recycling, and, in the process, improve transparency in pricing.

Data availability and input assumptions for modeling

In the modeling, EPR has the impact of lowering the overhead costs for all actors in the supply chain, assumed to be paid for by the policy measure. Hence this is modeled by a reduction in collector input price. Modeled results of the impact of the imposition of EPR as a policy measure are available for the countries and polymers shown in Table 5. We considered a 20% reduction in the collector input price to evaluate the potential impact of EPR. A 20% reduction in the collector input price was used as it was assumed to be a realistic representation of the likely impact of EPR on the reduction in collector input price in developing markets.

Table 5: Data availability for modeling: Extended Producer Responsibility

	rPET	rHDPE	rPP	rLDPE
India	✓	–	–	–
Indonesia	✓	✓	✓	✓
Thailand	✓	✓	✓	✓
Vietnam	✓	✓	✓	–

Limited impact of EPR in improving the volume of plastic waste collected and recycled

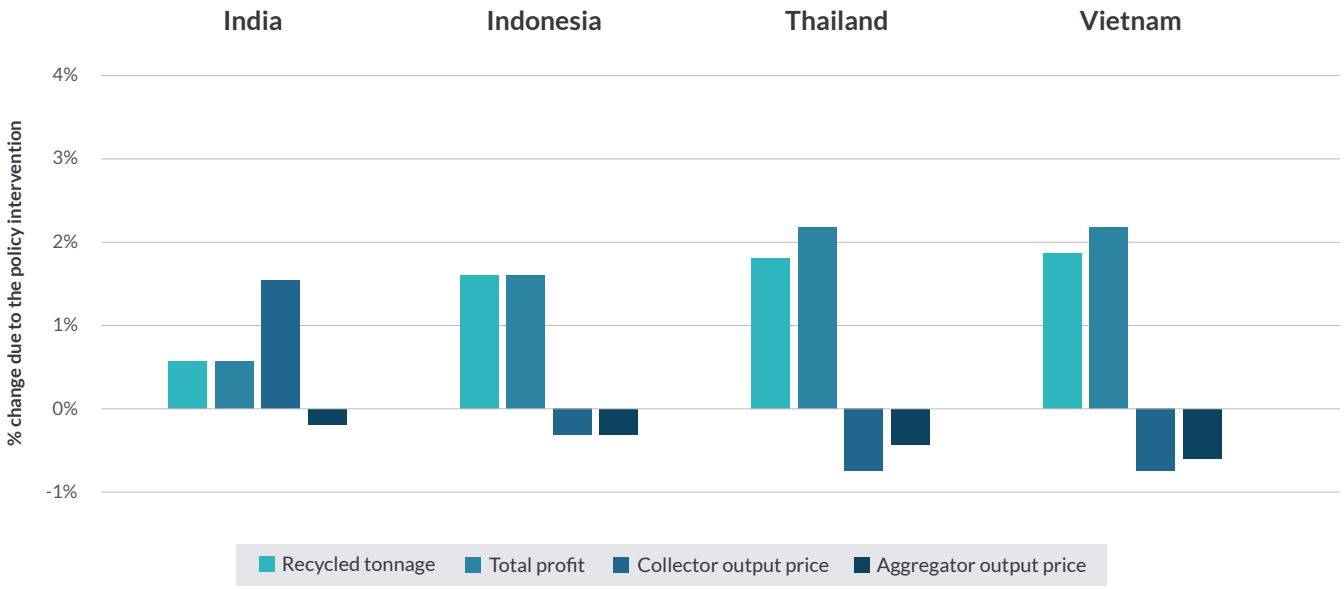
We observed minimal impact on the collection and recycling of materials or the change in profits in the value chain when EPR was imposed with an input parameter of 20% reduction in the collector input price. For most polymers across the four geographies, recycled material output was observed to increase by less than 5% and profits in the value chain increased by a similar percentage. We also observed a minimal reduction in the output price of material across the polymers.

The minimal impact of EPR may be a result of the high reliance of the recycling supply chain on the informal sector for material collection in the studied markets. EPR as a structured, government-backed intervention is more effective in markets where there is better visibility of the value chain actors and the functions they perform as the money collected through EPR can be directed to support parts of the value chain that need to be improved or supported.

Considerations when implementing EPR for driving pricing transparency

Due to the informal nature of the value chain across the four markets, there is limited transparency around market players and materials flows. In such a scenario, various actors lack clarity on how the EPR fees levied against producers are likely to benefit or trickle down to them. Based on the modeling, in the absence of this transparency, EPR is unlikely to be an effective policy instrument in significantly increasing the collection of material for recycling, the distribution of profits through the value chain, and, resultantly, the overall transparency in pricing in the value chain.

Figure 16: Impact of EPR on recycling performance – e.g., rPET in India, Indonesia, Thailand, and Vietnam



Implementation of a Deposit Return System (DRS)

How DRS can influence pricing transparency

A deposit return system or scheme functions through a deposit for a plastic container (e.g., a bottle) paid for upfront by the consumer. This deposit is redeemed when the container is returned for recycling by the consumer who purchased the product or by other actors such as waste collectors. DRS is a supply-side policy instrument that may involve a monetary deposit or token system and is typically implemented to encourage users to return the containers and set a minimum guaranteed price for the collection/return of containers.

A deposit return offers a minimum guaranteed value for the material. Depending on the implementation pathway, this also provides an element of transparency in terms of the cost associated with the purchase of scrap plastic, which will be the value of the material plus the set rate that is redeemed by the collectors. This token rate may either be a pass-through cost to a compliance scheme, or it could be a fixed cost covered within the supply chain. A DRS provides for improved transparency as there is a more "centralized" management system for the collection of material and better control and visibility of the volume of material flows and the prices.

Data availability and input assumptions for modeling

Implementation of DRS will result in an expected reduction of operational costs (lower transport costs and reduced processing, resulting from more segregated material collection). It also increases output prices through better quality material (and "guaranteed" food-grade rPET) and lower sorting/contamination costs. Modeled results of the impact of the imposition of DRS are available for India and Indonesia. However, due to the absence of material price data, results are not available for all types of polymers for India.

To evaluate the potential impact of the imposition of DRS, three input parameters were considered. These include a 10% reduction in the collector input price, a 20% reduction in the overhead costs for aggregators and recyclers, and a 30% increase in the efficiency of the labor collecting plastic waste for recycling. The data points were selected based on estimated potential cost savings from improved quality of materials, mechanization, and reduced sorting requirements.

Table 6: Data availability for modeling: Deposit Return System

	rPET	rHDPE	rPP	rLDPE
India	✓	–	–	–
Indonesia	✓	✓	✓	✓

DRS is an effective policy tool in improving volumes recycled

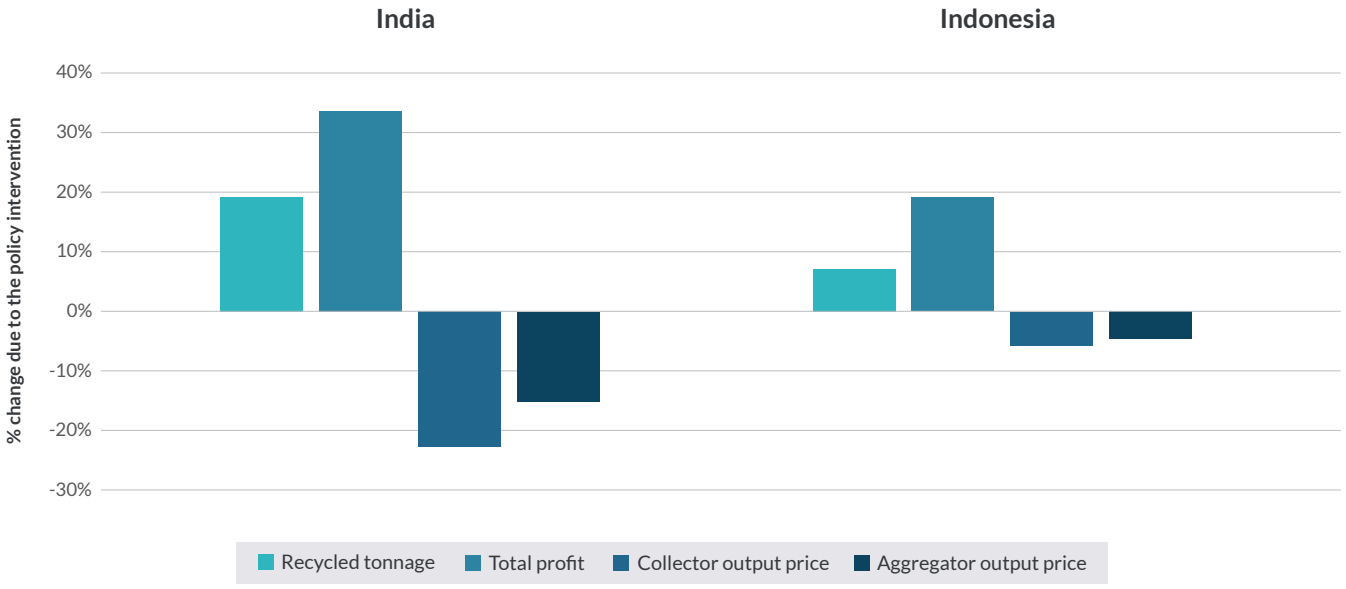
Globally, the implementation of DRS is an effective policy lever to grow the amount of collected material, thereby raising the volume of plastics recycled. A median 76% return rate of single-use drinks containers was observed in more than 40 (mostly developed) geographies where DRS was implemented.[16] This points to the success in the recovery of material for recycling when DRS is implemented.

Based on the input parameters for India and Indonesia, the total volume of PET recycled is expected to increase by 20% in India and 7% in Indonesia if DRS is implemented. For PP and HDPE for Indonesia, the increase was higher than that observed for PET. As current HDPE and PP collection for recycling levels are lower than PET, a collection incentive available through DRS is likely to increase the volume of material returned by consumers or its collection and return by waste pickers. DRS is also expected to improve profits across the value chain as better-quality clean feedstock becomes available and efficiencies improve.

Considerations when implementing DRS for improving pricing transparency

In countries where DRS is considered for implementation, if collection systems are already in place, policy makers should set up a collection system that is integrated with systems that are already available. For example, infrastructure, such as waste banks in Indonesia, which have already been established for the collection of material, can be used as collection points. Further, considering the significant contribution of the informal workforce to the collection and recycling of plastic waste in the four countries, any implementation of DRS has to be inclusive and integrate waste collectors. The implementation of DRS could be supplemented via "new" return points for consumers, but the intervention should not exclude access by waste collectors to the materials or the redemption centers. When DRS is implemented, steps must be taken to ensure that waste collectors are not left out due to the need for registration processes or collection infrastructure.[17]

Figure 17: Impact of DRS on recycling performance – e.g., rPET in India and Indonesia



16 Reloop Platform. (2022). Global Deposit Book 2022: An Overview of Deposit Return Systems for Single-Use Beverage Containers [online]. Available from: https://www.reloopplatform.org/wp-content/uploads/2022/11/RELOOP_Global_Deposit_Book_11I2022_P1.pdf 17 Cass Talbott, T., Chandran, P., Allen, C., Narayan, L. and Boampong, O. (2022). Extended Producer Responsibility (EPR) and Waste Pickers [online]. Available from: https://www.wiego.org/sites/default/files/publications/file/technical-brief-no-15.pdf

Minimum Recycled Content Targets

How a minimum recycled content target can influence pricing transparency

Minimum recycled content targets require producers to use a specified minimum amount of recycled content in their new products or packaging. The establishment of minimum recycled content targets within the supply chain creates a quantified demand for recycled polymers. These mandates specify the products or packaging for which the requirements apply, the type of input materials (post-consumer versus post-industrial content, for example) that can be used, the amount of recycled content required, verification requirements, exemptions, and enforcement of the rules.[18]

As a result of minimum recycled content requirements, the domestic recycling market is expected to become more mature. Manufacturers will need to consider the cost of accessing recycled material from an international market vis-à-vis supporting the development of the domestic supply chain in the market where they operate. International markets will therefore provide an indication of the trade value of recycled polymers and potentially stimulate investment to ensure supply of feedstock from these markets meets minimum recycled content mandates.

Any fines for non-compliance with minimum recycled content targets become a cost to the producer for not using recycled content. Companies' products that do not meet minimum recycled content mandates could also be prohibited from being sold in the market. This cost acts as a clear indicator of the pricing premium that can be expected on the purchase of recycled content; i.e., manufacturers are willing to pay up to a certain premium as long as it is lower than the cost of non-compliance. In this regard, the minimum recycled content target supports the differentiation of recycled polymers from virgin polymers as one that is a "green product" and has a different cost structure.

Data availability and input assumptions for modeling

For India and Indonesia, modeled results of the impact of minimal recycled content targets are available for rPET. However, due to the absence of material price data, results are not available for other types of polymers for India.

Minimum recycled content targets are expected to boost output price security by providing a demand signal to the market to improve recycling performance and output. For modeling purposes, this is assumed to affect the demand for recycled plastic up to the minimum quantity requirement set by the policy. To evaluate the potential impact of the imposition of minimal recycled content targets, a 30% recycled content requirement in new plastic products has been assumed.

Table 7: Data availability for modeling: minimum recycled content targets

	rPET	rHDPE	rPP	rLDPE
India	✓	–	–	–
Indonesia	✓	✓	✓	✓

A significant increase in material volumes is possible if minimum recycled content targets are imposed

Based on the modeling of the data, the implementation of mandatory minimum recycled content targets had a significant impact on the rPET output in India and Indonesia. In India, this is modeled to lead to a significant increase in rPET supply, with an 11% increase in the volumes of PET recycled. In Indonesia, on the other hand, total PET recycled increased by approximately 34%, with a double-digit increase in recycled volumes observed across the other types of polymers. The implementation of minimum recycled content targets provides a clear signal that these materials are of interest for producers. This creates a pricing signal to the market as a whole, incentivizing the increased collection for recycling.

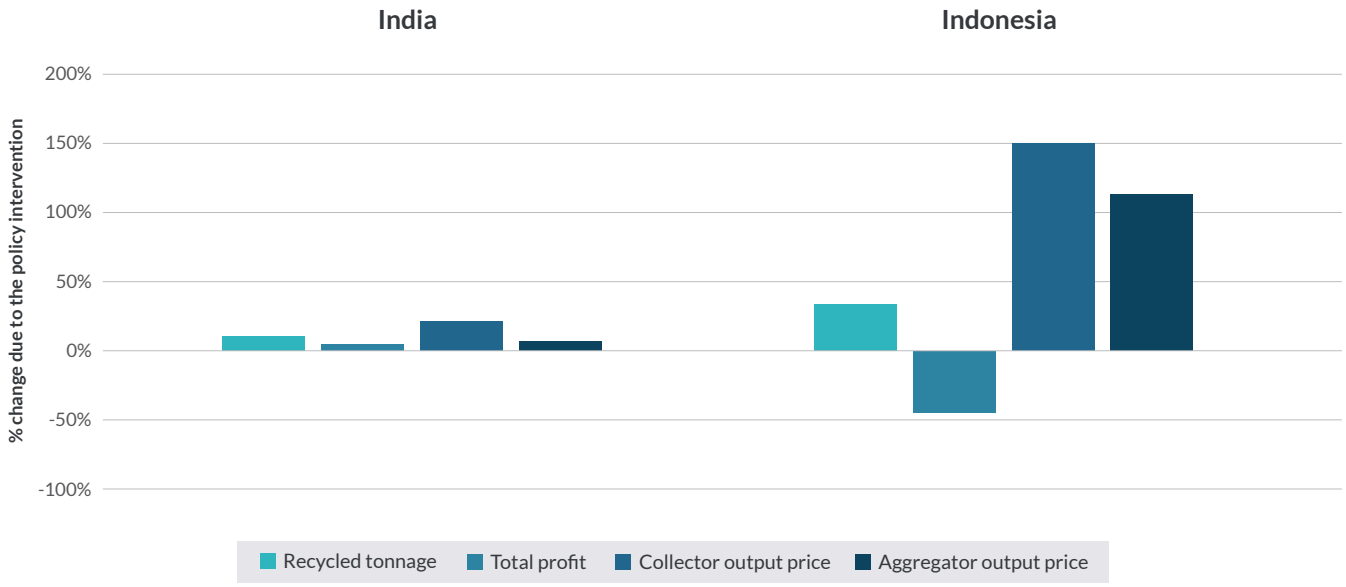
The data and modeling results are less conclusive for profits and output price for Indonesia and warrant further research. For example, a 30% minimum recycled content requirement resulted in profits for aggregators decreasing across all types of polymers, except rPP. For rPP, the profit increased for aggregators. The underlying data for Indonesia suggests that aggregator roles with respect to recycling PP are somewhat unclear, and business models appear unprofitable, even in the baseline scenario at average price levels.

Considerations when implementing minimum recycled content targets for improving pricing transparency

When minimum recycled content targets are implemented in India and Indonesia, the additional demand and profits should be used to encourage and incentivize the informal sector to collect additional material for recycling. This will improve the livelihoods of informal waste workers, while increasing the quantity of plastic waste feedstock for recycling. It is therefore in the interest of recyclers to share some of the pricing benefits with collectors and aggregators in order to maximize the output of recycled polymers and increase revenue generation and profitability. Changes in output price should translate to changes in prices of scrap collected and the incremental income must be passed through the value chain to improve collection.

18 Ocean Conservancy. (2022). Recommendations for Recycled Content: Requirements for Plastic Goods and Packaging [online]. Available from: https://oceanconservancy.org/wp-content/uploads/2022/02/RRS_OceanConReport_Feb2022_Final.pdf

Figure 18: Impact of minimum recycled content targets on recycling performance – e.g., rPET in India and Indonesia



Formalization of the Collection System

How formalization of the collection system can influence pricing transparency

Formalization of the collection system should involve changes in the legal policy landscape to recognize and integrate the informal waste and recovery sector in law and in practice, and, in the process, extend legislative frameworks to cover labor and social protection for informal sector workers.[19] Formalization typically takes place via (1) one or more informal worker organizations, such as cooperatives or associations, (2) employment in waste management systems operated by municipalities or private players, or (3) organization through community-based bodies or micro-, small- and medium enterprises.[20]

In formalized collection systems, the collection costs for scrap plastic are better understood as they are accounted for within contracted terms and values of the material. Contracting of polymer collection often also includes some element of profit sharing on material values. In these instances, the offtake value of plastics is included in the agreements (normally linked to some sort of material price index) so that the increased revenue derived from the material collected can be shared.

In addition to adding to pricing transparency, formalization of collection may also improve the security of polymer prices for collectors as a part of the collection costs are fixed, reducing collectors' exposure to fluctuations in material prices.

Data availability and input assumptions for modeling

Modeled results of the impact of the formalization of the collection system are available for all polymers for Thailand. However, due to the absence of price data, results are not available for rLDPE for Vietnam.

Formalization of the collection system will result in an expected reduction of operational costs (lower transport costs and reduced processing resulting from more segregated material collection). It also increases output prices through increased scale at collection and aggregation, and greater bargaining power by collectors and aggregators. For modeling purposes, it is assumed to increase the efficiency of collectors' labor input and lower the cost per kg of material collected and provided as feedstock for the recycling supply chain. To evaluate the potential impact of the formalization of the collection system, a 20% increase in the efficiency of the labor involved in collecting plastic waste for recycling has been assumed. The data point was selected based on estimated potential cost savings from improved quality of materials, mechanization, and reduced sorting requirements.

Table 8: Data availability for modeling: formalization of the collection system

	rPET	rHDPE	rPP	rLDPE
Thailand	✓	✓	✓	✓
Vietnam	✓	✓	✓	–

19 United Nations Human Settlements Programme. (2022). Leaving no one behind – How a global instrument to end plastic pollution can enable a just transition for the people informally collecting and recovering waste [online]. Available from: https://unhabitat.org/sites/default/files/2022/11/un-habitat_niva_report_leaving_no_one_behind_1.pdf
20 Aparcana, S. (2017). Approaches to formalization of the informal waste sector into municipal solid waste management systems in low- and middle-income countries: Review of barriers and success factors [online]. Available from: https://doi.org/10.1016/j.wasman.2016.12.028

Formalization of collection systems has positive impacts on material collection

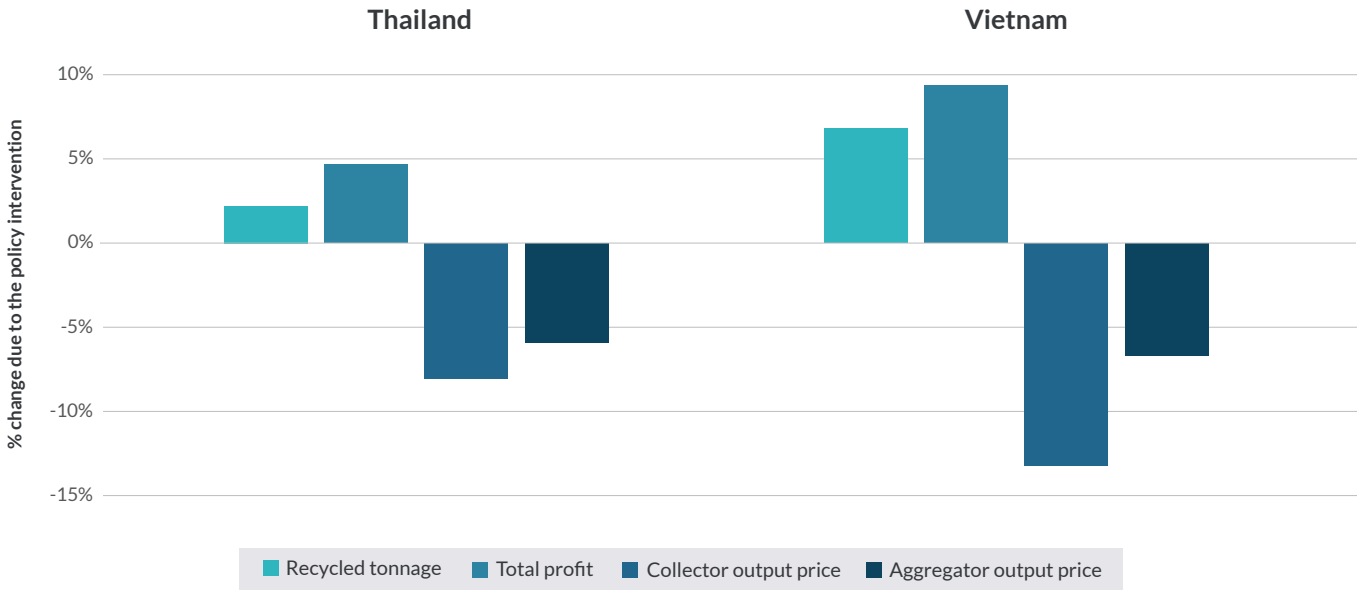
Formalizing the collection system in Thailand and Vietnam can improve the volume of material recycled by 2-7% across the different polymer types. The formalization of the collection system in Vietnam demonstrates the potential to have a larger impact if it is focused on materials such as PP, which sees collection for recycling rates lower than rigid PET or HDPE. A centrally enforced formalization system to collect and segregate PP within contracts would provide a strong market signal that it is a polymer of interest and value and would support the development of a domestic market.

It is observed that between the two countries, in Vietnam, where the informal sector is less organized than in Thailand, the impact of the formalization of collection systems is greater for rPET and rPP output. The collection system in Vietnam is reliant on a fragmented informal sector; therefore, formalization should involve the provision of additional equipment to increase the efficiency of collection by the informal sector. Formalizing collectors working in rural or difficult to access communities and supporting them to aggregate and feed material effectively into the recycling system could be another step to improve recycling output.

Considerations when formalizing the collection system for improving pricing transparency

In highly fragmented, informal collection systems, formalization should be a choice offered to informal waste workers and any formalization measures developed should be carried out with the participation of the workers. Top-down measures can disrupt the positive impact of the informal sector. A formalized market structure should support informal waste workers through greater transparency and data collection on activities undertaken. This transparency should also support them in delivering a better audit trail of the material collected, which will be valued by recyclers and producers seeking recycled content. In value chains with a more formalized structure, investments made to improve contracted collections and processing can be specifically directed to support parts of the supply chain that need to be improved or supported beyond simple market incentives.

Figure 19: Impact of the formalization of the collection system on recycling performance – e.g., rPP in Thailand and Vietnam



Taxes on Virgin Polymers

How taxes on virgin polymers can influence pricing transparency

Modeled results of the impact of taxes on virgin polymers on recycled material are available for rPET, rHDPE, and rPP for Vietnam. Due to the absence of material price data, results are not available for rLDPE for Vietnam.

As a price point reference for recycled material, with a tax on virgin polymers, manufacturers are able to pay a price that is at least the cost of virgin polymer plus the applicable tax. At any point below this, recycled content is more viable for manufacturers to use. Pricing transparency is achieved through defining the competitive price point for recycled polymer.

Data availability and input assumptions for modeling

Modeled results of the impact of taxes on virgin polymers on recycled material are available for all polymers for Thailand. However, due to the absence of material price data, results are not available for LDPE for Vietnam.

Taxes on virgin polymer products are expected to support output prices for recycled content production from the recycling supply chain. This acts as a demand signal to markets. As prices rise and demand increases for recycled content, this filters down to greater willingness to collect plastic material from the market. To evaluate the potential impact of a tax being applied on virgin polymers, a 10% tax on virgin polymers has been assumed.

Table 9: Data availability for modeling: taxes on virgin polymers

	rPET	rHDPE	rPP	rLDPE
Thailand	✓	✓	✓	✓
Vietnam	✓	✓	✓	–

Taxes on virgin polymers increase profits, but do not necessarily increase recycled material outputs

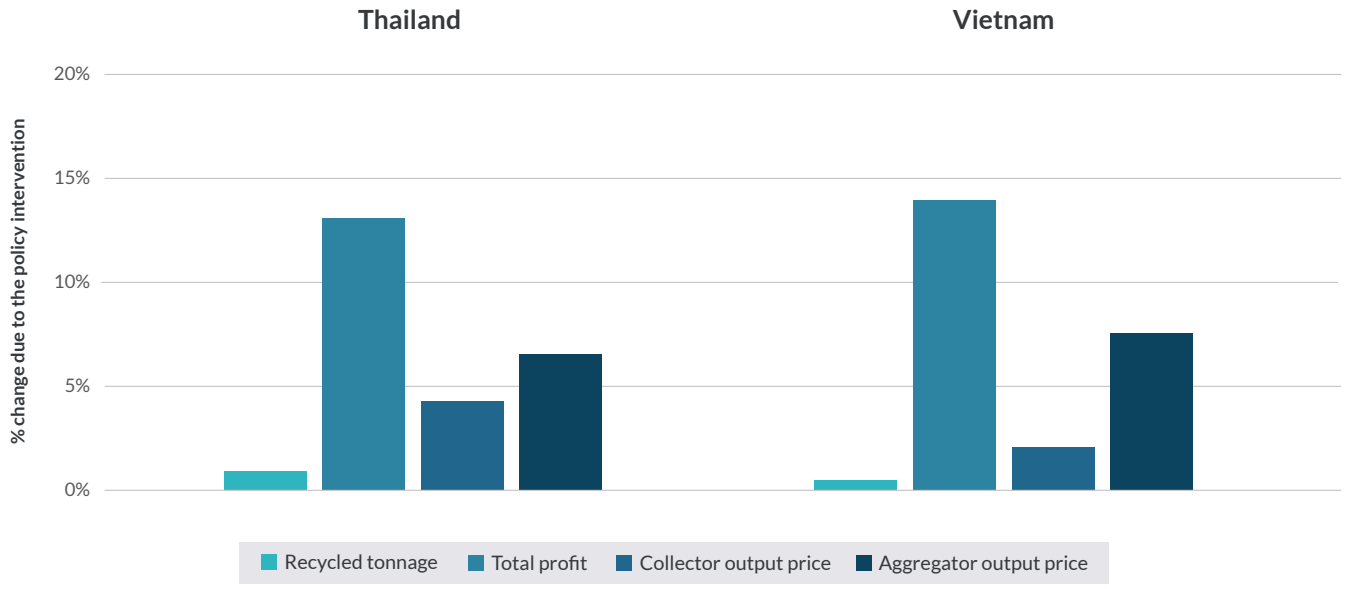
Despite potentially providing a more significant increase in profits for supply chain actors, taxes on virgin polymers do not necessarily result in greater recycling performance. In the studied markets of Thailand and Vietnam, the recycling output increase was negligible (less than 1%), while profit for collectors, aggregators, and recyclers increased between 10% and 14% across polymer types. This could be due to operators retaining the improved profit margins, instead of channeling profits down the supply chain to stimulate the growth of recycling efforts. Although taxes can indirectly create market incentives for using recycled polymers, they may not direct funding to where it is needed most within the supply chain.

Considerations for imposing taxes on virgin polymers for improving pricing transparency

To lead to greater recycling output, taxes on virgin polymers have to be combined with an additional market incentive for collectors and aggregators, which is directly linked to material collection. However, this market incentive is difficult to create in less well-developed supply chains, particularly if there is an existing lack of transparency, or instances where market power is concentrated among a few more commercial actors who control output.

As a purely market-based incentive focused on the final product output, taxes on virgin products improve the overall recycling output in markets with greater transparency. In the absence of market transparency, operators improve their profit margins rather than incentivizing expansion of recycling performance. In particular, this is true if these market incentives are not transparent and cannot provide signals for new operators to enter the market. In this regard, taxes on virgin polymers are not the ideal type of intervention to support collectors and informal workers within the supply chain in emerging economies such as Thailand and Vietnam.

Figure 20: Impact of taxes on virgin polymers on recycling performance – e.g., rHDPE in Thailand and Vietnam



Case study

Improving the collection of LDPE for recycling through policy interventions

Among the four polymers covered in the study, LDPE had one of the lowest recycling rates. Due to the limited quantities being collected for recycling, information on price and cost was limited. Lower output price and difficulties in collection and aggregation of LDPE are barriers to improving the recycling output of LDPE.

While in general the same policy dynamics may be true for LDPE as they are for the other polymers, a disproportionately higher level of intervention may be required to improve the output of LDPE recycled. Comparing the three policy levers that were considered for Thailand, for example, investments in EPR and formalization of collection systems would have to be higher relative to other polymers to support LDPE markets. It is also expected that rather than short-term artificial support to boost collection and recycling as a one-off, investment via EPR and formalization of collection systems will provide long-term benefits to improve the collection and recycling of LDPE.

Key Takeaways and Future Considerations

1 Recycled material pricing in the four countries is complex

This study was undertaken to provide insights into the drivers of the cost of recycled plastics, potential margins for each player along the supply chain, and the pricing structure of the plastics supply chain. It also aims to highlight and show any price imbalances along the supply chain, which can indicate a lack of pricing transparency or failures in the market. In doing so, it identified the complex nature of polymer supply chains in Southeast Asia and India, which makes them operate with low transparency despite being commodity markets feasible to operate most efficiently with high levels of price transparency.

Developing a market where there is clarity over the pricing structure of recycled plastics feedstock and output ensures the effectiveness of the implementation of policies in boosting recycling output volumes. It also incentivizes investments to flow into these countries and the value chains. Towards this goal, this final section of the report provides preliminary ideas on the way forward based on the findings from the study. These ideas are intended to be a starting point only. Further research and more in-depth engagement with stakeholders involved in the value chains are required to develop localized approaches to improving pricing transparency.

2 The concurrent implementation of demand and supply policy levers is required to provide correct market signals

In order to provide the right economic signals to stimulate local investment, the benefits of rising market demand and any potential increase in the price of recycled materials need to be distributed through the value chain. This will allow the plastics supply chains to capitalize on the tailwinds provided by global policy measures, such as minimum recycled content targets and taxes on virgin polymers.

These policies, which are typically adept at providing clear market signals, may not perform the same way in the four countries by improving supply through collection and sorting. This challenge is already being observed with the continued import of plastic scrap material into these economies for reprocessing rather than increased collection and local sourcing. Without tackling issues with market transparency, it is difficult to foresee a market where the policies serve their intended purposes. This challenge is also why policies targeted at the collection end of the supply chain, such as DRS, may be more effective at providing the right market signals. These policies offer more direct signals for investment and require an alternate way of collecting material from the supply chain without the need to respond to a demand or price signal being fed back down the supply chain.

3 Addressing low levels of pricing transparency in the system requires multiple initiatives

As revealed by this study, the recycled plastics supply chains in the four countries operate with limited pricing transparency. Publishing pricing data and allowing stakeholders to interact with the model developed will not only improve transparency, but also provide a framework within which multiple parties can continue to investigate and address the challenges. However, more needs to be done to ensure that the issue of pricing transparency is addressed holistically. Some examples of other initiatives that can improve pricing transparency include:

- The development of regulatory datasets on material flows and permitted operators within each region/country to enable oversight and understanding of market dynamics. These can support better regulation of the markets and also give confidence to investors and support a greater understanding of the market on which pricing data can be overlaid.
- The development of an accessible online database of benchmark material prices from the point of collection to the final recycled product. As an example, this could draw reference from Wongpanit,[21] which publishes material prices on a daily basis at the aggregator level.
- The creation of a futures market for recycled plastics, where buyers and sellers agree to exchange buy and sell contracts at a fixed price, which are delivered on a future date. This facilitates price discovery and stability, lowers risk, and improves efficiencies through better visibility of demand in the supply chain.
- The creation of a new open-access platform, or the convergence of existing recycled plastics trading platforms into a single global market platform to streamline demand and supply signaling.

The above suggestions are not intended to be exhaustive, and additional measures have to be considered at the local, regional, and global level to improve pricing transparency. However, without improved pricing transparency, it is difficult for markets to respond efficiently to demand changes in a way that could stimulate greater efficiency, and it also makes it difficult for policy levers to be implemented and have the desired results.

21 Wongpanit. (n.d.). Wongpanit home page [online]. Available from: https://wongpanit.com/

4 There is an urgent need to recognize the contributions of informal waste workers and reward them better to improve collection and recycling outputs

In the four countries, to increase recycling output, it is critical to improve the supply of plastic waste through collection. To do so, it is necessary to ensure that benefits in the supply chain flow down to more actors in the supply chain, in particular the informal waste workers who contribute to the bulk of the plastic waste that is collected for recycling. The following are some examples of initiatives that may result in a more equitable distribution of the gains from trade:

- Improving informal waste workers' access to information through technology or other means. For example, to improve market knowledge and help informal waste workers make informed decisions, easy to access mobile applications (accessible by workers with mobile phones) or WhatsApp groups can be created. This could include market platforms with information on prices and material volumes demanded, and other applications to track the volume of material supplied and prices paid.
- Formalization measures, such as associations or cooperatives of informal waste workers, can facilitate collective bargaining and improve negotiation power, thereby increasing the returns for informal waste workers. These associations can also help improve market access and links to more profitable parts of the supply chain, reducing middlemen. The membership-based waste worker organization Kagad Kach Patra Kashtakari Panchayat (KKPKP) from Pune, India, provides an exemplary model to consider.[22]
- Undertaking activities which provide incremental value. These could, for example, include supplying bales instead of bags of material to command higher prices, with shared baling machines provided through associations or cooperatives.

The pricing data collated through this study and the supply chain model will be vital tools in beginning the process of improving transparency within the supply chains. Through other measures such as aligning policy levers, creating transparency in market structures, and recognizing the role of informal waste workers in the recycled plastics supply chains, a holistic approach can be employed to address the issue of pricing transparency.

22 SWaCH Cooperative. (2023). SWaCH home page [online]. Available from: https://swachcoop.com/

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