

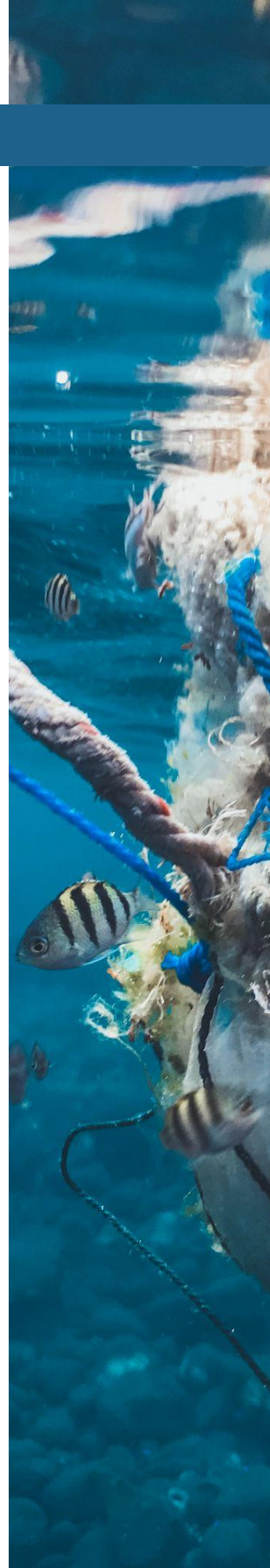
JANUARY 2023

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



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Glossary

Aggregation / consolidation point	Location at which waste materials are consolidated (bulked) into larger amounts for onward transport. Activities vary by site and may allow for consolidation only, or include some pre-processing e.g., sorting or picking of valuable material.
Collected for recycling (CFR)	The CFR rate is calculated using the amount of plastic collected vs. the overall amount of plastic actually recycled. Some plastics that are collected as part of the mixed solid waste are landfilled or sent to WtE. Other plastics collected for recycling may be rejected during sorting or become residues during recycling.
Craft villages/waste villages	Villages in which many households are involved in informal waste management (which can include collection, aggregation, pre-processing, and recycling). While the term 'craft village' is mainly used in Hanoi, this term has been used to describe informal collection, sorting and recycling activities throughout the report.
<i>Dong Nat</i>	Local term used in North Viet Nam for informal workers (street waste pickers); same as <i>Ve Chai</i> used in South Viet Nam.
Extended Producer Responsibility (EPR)	A policy approach under which producers are made responsible (either financially or physically) for the end-of-life management of the products and/or packaging they sell.
Formal recyclers	Typically large recycling sites with large-scale equipment that hold suitable business and waste permits and licenses for their operations.
Formal sector	Collective term for municipal (or licensed collectors) and fully permitted/licensed aggregators and recyclers.
Informal recycler	Typically small recycling facilities that operate without full licenses and permits.
Informal sector	Collective term for informal waste workers and typically smaller-scale aggregators and recyclers that operate without full licenses and permits.
Independent waste collectors	Individuals who are issued with a permit to collect waste (e.g. in Ho Chi Minh City, the government issues collection licenses to individuals).
Informal waste worker (IWW)	People who earn an income from managing waste but are not formally employed to do so. Roles include collection (including picking), sorting, and other pre-processing and recycling.
Infrastructure (e.g., plastic infrastructure, waste infrastructure)	Equipment and facilities used to aggregate, sort, and/or treat waste materials.
Junk shops	Typically small spaces, often in the houses of the owners. Materials may be brought to the site by local collectors, with owners sometimes also undertaking collection themselves. Usually run informally without licenses or permits.
Landfill	Landfill mainly describes permitted landfill disposal facilities and sanitary waste dumps permitted by the authorities. Some data sets might also include illegal dumping and unsanitary landfills.
Municipal solid waste (MSW)	Within this report we use the term 'municipal solid waste' to describe waste generated by smaller sized properties such as households, small businesses, and schools. It generally excludes waste from larger businesses, industrial sites, and from construction.
Municipal waste worker (MWW)	An individual working on behalf of the local government, either employed directly by them or by their (private or semi-private) collection contractor.

Pay-as-you-throw	A policy through which properties are charged based on the amount of waste they present for collection. In some cases, charging for separately presented recyclables is lower than residual waste.
Plastic leakage	Refers to plastic waste that is not kept within managed (formal or informal) systems and 'leaks' into the environment.
Plastic recycling supply chain	A formal or informal system through which discarded plastics can be recycled. Typically includes collection, aggregation, pre-processing, reprocessing, and manufacture into new goods.
Plastic waste	Plastic packaging or products that have been discarded by the user.
Pre-processing	Preparing material for recycling (e.g., can include sorting, label removal, washing, and shredding).
Recyclables	Waste materials collected for recycling.
Recyclate	Material that is recycled e.g., rPET and rHDPE.
Recycling/reprocessing	The process of transforming waste into a new output product so the material can be used again.
Temporary Transfer Stations (TTS)	Term used in Viet Nam to describe municipal aggregation points that are usually used to transfer waste from carts to compression trucks. They are spread throughout cities to help allow for efficient collection and have no equipment or very basic equipment. They are not designed for waste extraction, but are often used by informal waste workers for final extraction before landfill.
<i>Ve Chai</i>	Local term used in South Viet Nam for informal workers (street waste pickers); same as ' <i>Dong Nat</i> ' used in North Viet Nam.
Waste/recycling cooperative	While the arrangements of a cooperative can vary, the broad meaning is an umbrella organization with a legal structure that unites individual waste workers and coordinates the work undertaken. Cooperatives are usually controlled by workers and provide them with shared benefits and profits.
Waste-to-Energy (WtE)	This mainly includes formal, permitted Waste-to-Energy plants with heat and electricity recovery, where known. Data sets might also include some basic incineration plants without energy recovery, depending on the data sets available.
Wasteshed	A geographical region having a common solid waste disposal system or designated by the governing institutions as an appropriate area within which to develop a common recycling program.

General abbreviations

CITENCO	Ho Chi Minh City Urban Environment Company Limited
CFR	Collected for recycling
DURENCO	Da Nang Urban Environment Company Limited
EPR	Extended producer responsibility
KT/yr	Kilo tonnes (or thousand tonnes) per year. Metric tonnes are used.
MRF	Material recovery facility
MSW	Municipal solid waste
MT/yr	Mega tonnes (or million tonnes) per year. Metric tonnes are used.
MWW	Municipal waste worker
T/d	Tonnes per day. Metric tonnes are used.
TTS	Temporary transfer stations
URENCO	Hanoi Urban Environment Company Limited
WtE	Waste-to-Energy

Polymer abbreviations

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



BACKGROUND

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

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

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

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

RESEARCH OBJECTIVES

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

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

The objectives were to:

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

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

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

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

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

SCOPE AND METHODOLOGY

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

The wasteshed areas were selected to include:

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

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

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

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

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

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

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



COUNTRY OVERVIEW³



Population
98 MILLION



Total Municipal Solid Waste (MSW) generation
12.8 MT/YR



Plastic waste generation (in MSW)
2.4 MT/YR



Plastic waste recycled (in MSW)
0.5 MT/YR



Viet Nam has a significant plastics manufacturing industry, producing an estimated 8.3 MT of plastic products in 2018.⁴ 70% of the plastic consumed in the same year was imported, and 80% of the total plastic came from virgin sources. There is a considerable opportunity to reduce reliance on plastic imports and increase recycled content through improving domestic supply chains for secondary plastic derived from waste. Currently, the vast majority of municipal plastic waste that is recycled in Viet Nam is collected and traded through the informal sector. The informal sector supports the livelihoods of thousands of individuals, who play a critical role in delivering the country's recycling efforts.

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

MSW generation: Schneider et al - *Solid Management Solid Waste Management in Ho Chi Minh City, Viet Nam: Moving towards a Circular Economy?* (2017).

Plastic waste generation: Estimate made by Anthesis Group based on municipal waste estimate above and supplementary information from CECR - *Women Empowerment in the Plastic Value Chain* (2019).

Plastic waste recycled: Calculated by Anthesis Group based on plastic waste collected estimate above, in line with Yeoh - *Going Circular: A Roadmap for Plastics Recycling in Viet Nam* (2020), suggesting around 20% of plastic waste is recycled in Viet Nam.

⁴ World Bank Group - *A roadmap for plastics recycling in Viet Nam* (2020).

⁵ ENDA Viet Nam - *Integration of the informal sector in SWM & EPR* (2022).

NATIONAL REGULATION

The central government has been taking action to protect the environment from plastic waste pollution and has adjusted national legislation to improve recycling and recovery of waste. This includes a mandate for source separation of recyclable material, a pay-as-you-throw charging system, and the launch of an Extended Producer Responsibility (EPR) scheme.

Many upcoming regulations are set to affect pricing of goods and services for all actors in the supply chain. Bans on specific plastic packaging materials and products, taxes, and stricter controls on pollution will likely drive the price of plastic waste further up the supply chain. Minimizing the use of certain plastic packaging materials and products may benefit actors as more efforts are made to increase the amount of plastic waste being collected and encourage higher recycling rates. Broader regulations on electricity and labor will indirectly affect actors in the supply chain as higher energy and labor costs will be placed on plastic materials.

The new regulations provide a strong basis for circular resource utilization and reduced environmental pollution. However, the national legislation must be implemented by local government, which is subject to funding and lengthy timelines (e.g., it is expected that a country would take more than five years to fully implement an EPR scheme). Anecdotal feedback indicates that local government needs professional support and funding to help with the implementation (e.g., source separation planning has not started in most areas, mechanisms for the 'pay-as-you-throw' volume-based charging for waste fees has not been established, no waste data tracing systems have been set up, and the actual details of the EPR scheme are still in discussion). Industry sources indicated that significant changes as a result of the new legislation are not expected in the near future, and enforcement of environmental regulations remains weak. There are concerns that the informal sector will require up to two years to be trained in EPR requirements. In addition, the recyclables trading via aggregators and informal recycling at craft villages will need to be formalized in order to integrate the trade flows to enable them to compete against more large-scale, private waste management and recycling firms.⁵

Figure 1: Summary of key national legislation in Viet Nam

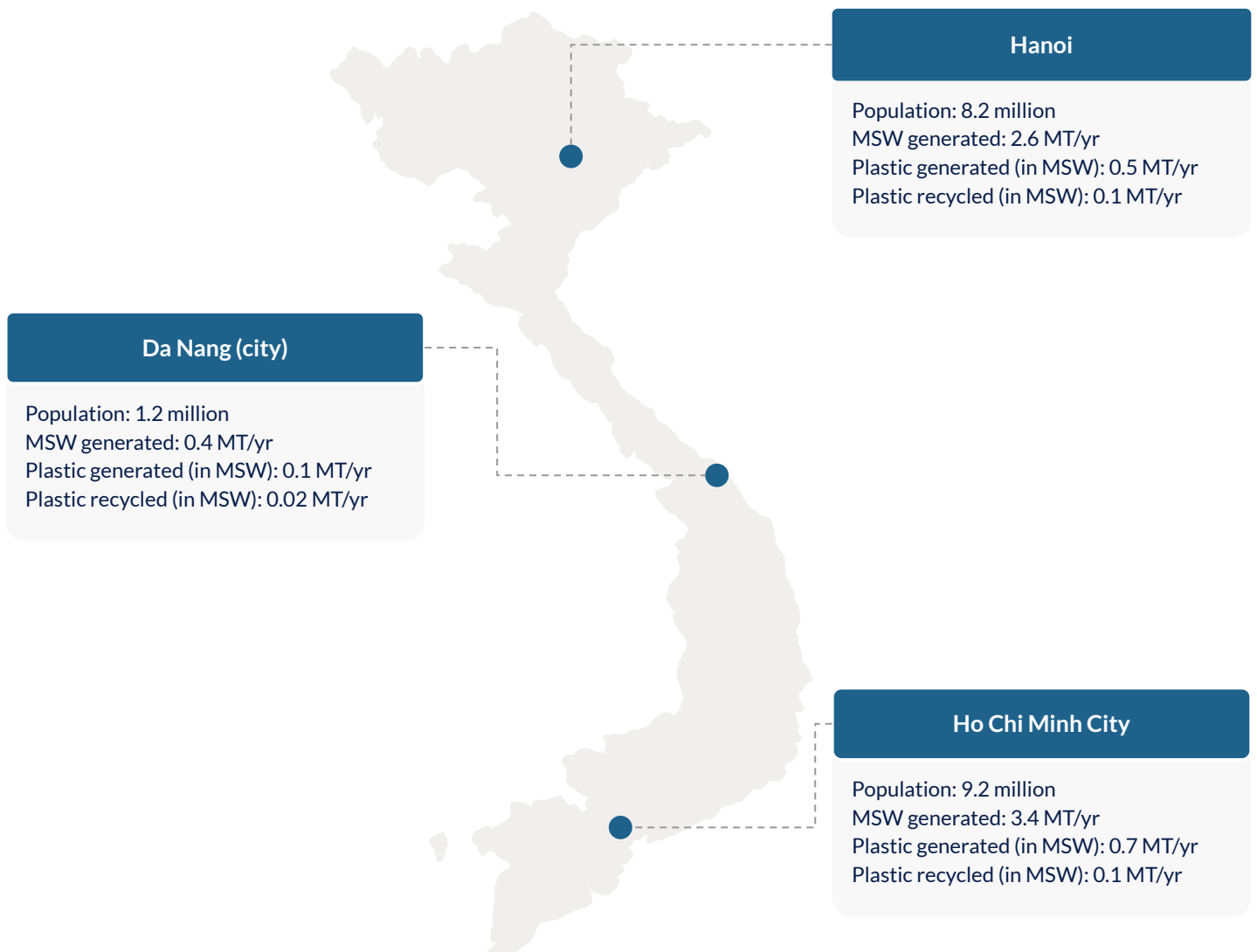


Overview of Selected Wastesheds

The regions selected for plastic waste mapping in Viet Nam are:

- ▶ **Hanoi:** The country's capital and second largest city. Hanoi has a long-established informal waste collection system and local formal recycling facilities.
- ▶ **Ho Chi Minh City:** The largest city in Viet Nam, it surrounds the Saigon River and has an established informal collection system, which the city has taken steps to formalize.
- ▶ **Da Nang (city):** A fast growing city with a port and a high level of tourism. There are no formal recyclers in the area, which contributes to a low rate of collection of plastics.

Figure 2: Key statistics for the areas selected for plastic waste mapping.⁶



⁶ Population data: General Statistics Office, Viet Nam (2020 data).
MSW and plastic waste generated data: Ministry of Construction (2020), UNESCAP (2020); Project office for Sustainability research in Viet Nam (2019).
Plastic waste recycled: Calculated by Anthesis Group.

CURRENT SUPPLY CHAINS

In Viet Nam, the management of plastic waste in the wastesheds has many commonalities due to the dominance of the national and local administration in the country's waste management services, with limited involvement of the private sector. This section describes how local plastic recycling supply chains typically operate within the selected wastesheds before providing a detailed outline of waste flows, key actors and infrastructure in the three wastesheds.

Collection: Stakeholders and processes

Non-industrial waste generators (such as households, markets, small businesses, and schools) do not separate plastic waste into a formal recycling system, but at their discretion set aside plastic for sale to informal waste workers (sometimes locally called *Dong Nat* in North Viet Nam or *Ve Chai* in South Viet Nam). 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 landfills.

Aggregation: Stakeholders and processes

Municipally collected waste is transferred from collection carts to compression trucks at Temporary Transfer Stations (TTS), 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 landfills.

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 collectors to pick valuable materials.

Informal workers usually trade the plastics they collect at small local aggregators (collection centers or junk shops). 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 the material (e.g., sorting and label removal from bottles). Materials are typically traded on to larger aggregators (consolidation centers) that 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.

The capacity and capabilities of individual craft villages and other informal recyclers for processing and preprocessing material vary significantly. A previous study of two craft villages indicated a capacity between 100-200 tonnes and 550-600 tonnes per day,⁷ depending on the types of activities included, e.g., collection and/or sorting and reprocessing.

⁷ Salhofer et al. - *Plastic Recycling Practices in Viet Nam and Related Hazards for Health and the Environment* (2021).

Recycling: Stakeholders and processes

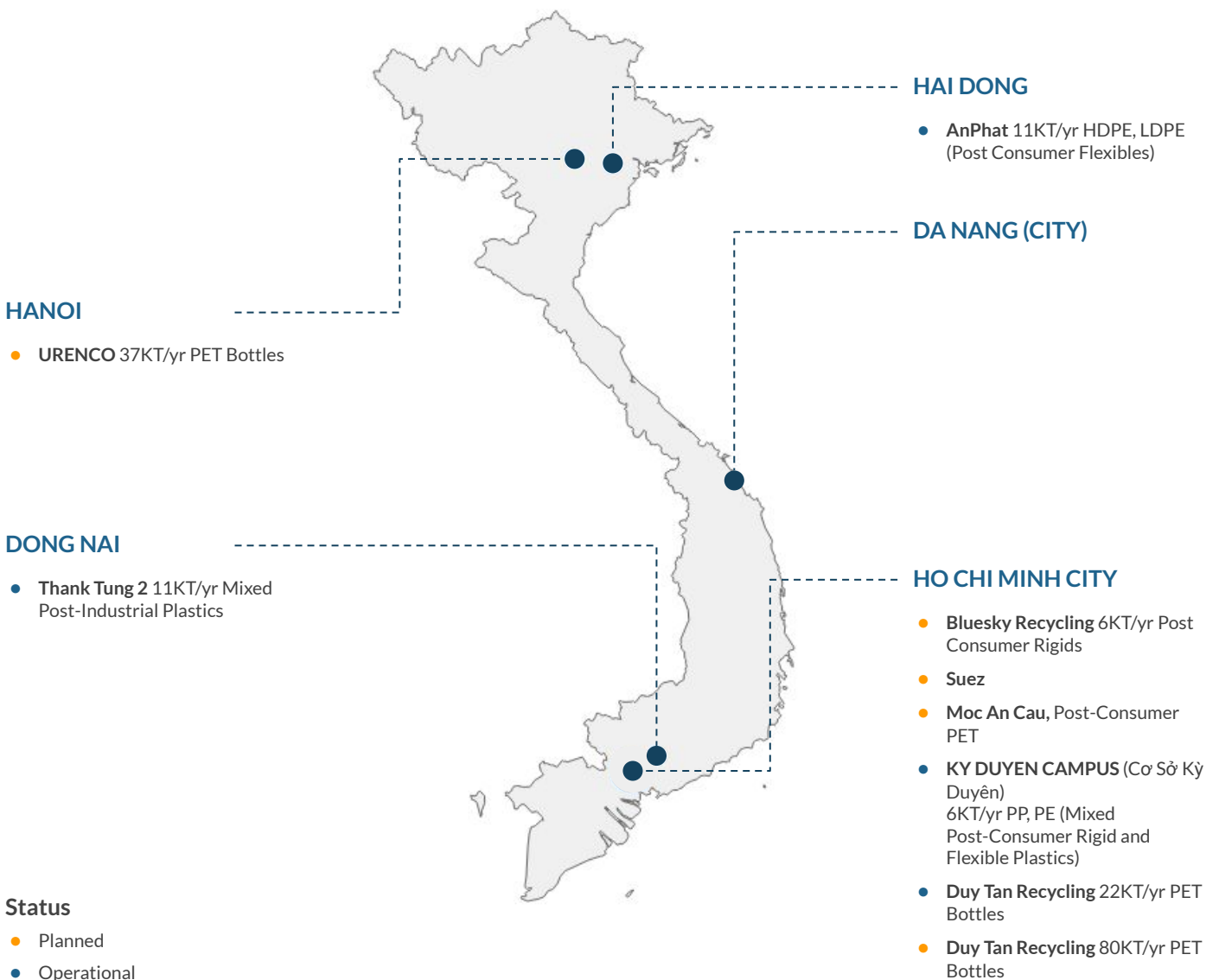
Both formal and informal facilities (mainly craft villages) recycle plastic in Viet Nam, with most recyclers located in and around Ho Chi Minh City and Hanoi. It is estimated there are 50-75 formal recyclers with capacities ranging from 4-15 KT/yr, and about 200 informal recyclers typically processing 1-10 KT/yr actively in Viet Nam.

Informal recyclers are mostly run as a family business, sometimes with basic business permits, but rarely waste treatment or recycling permits. These recyclers typically have basic technology (balers, crushers, washers, dryers) and mostly produce plastic flakes to

trade with local compounders or with brokers for export. They often infringe health, safety, and environmental standards.

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 for supply of 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 Viet Nam.

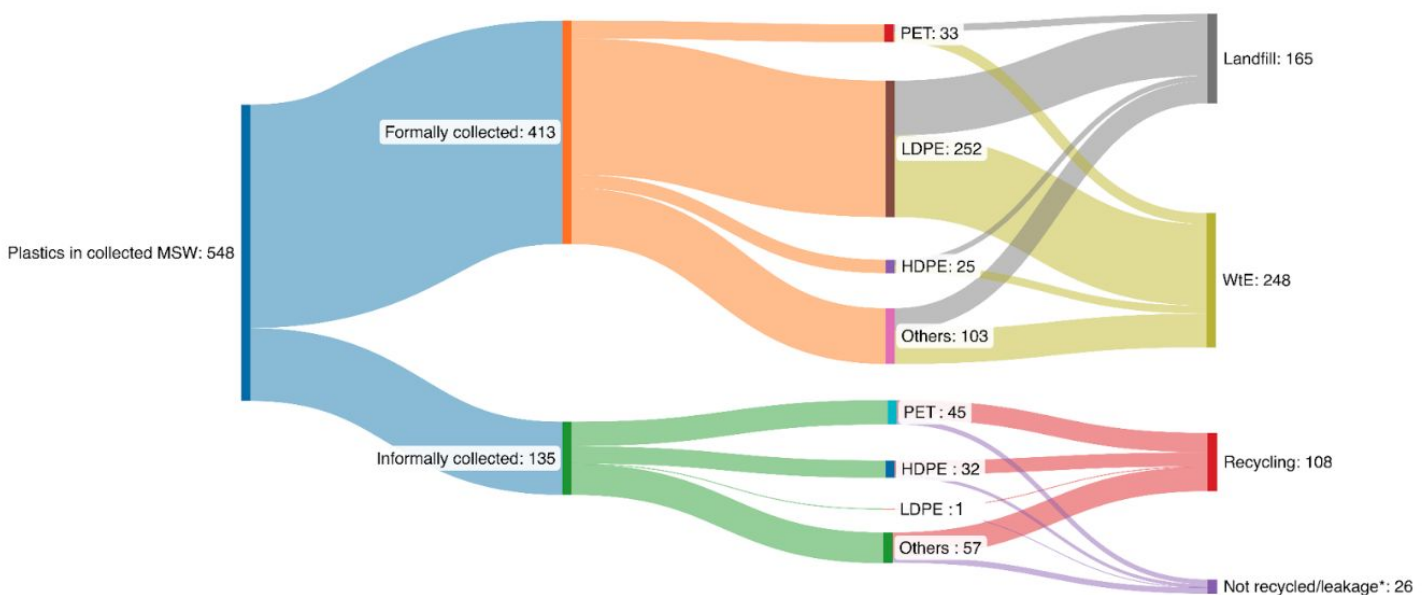
Figure 3: Overview of formal plastic recycling facilities in the vicinity of Hanoi, Ho Chi Minh City and Da Nang that were identified during the mapping research (locations are approximate and capacity has been provided where available).





Though Hanoi has a good level of waste collection with an estimated 90% of MSW being collected and a long-established informal supply chain, it is estimated that only 20% or 108 KT/yr of plastics collected in the region are being recycled. Rigid PET and HDPE waste formats are recycled in significant quantities, while LDPE bags and other flexibles are being sent to WtE plants and landfills without being extracted for recycling. Although the 'Others' polymer category in the waste flow shows the largest tonnage for recycling, this includes a wide range of polymers, including PP, PVC and PS, which individually have lower rates than PET and HDPE.

Figure 4: Flow of plastic within municipal solid waste in Hanoi (thousand tonnes per year). Figures are rounded to the nearest whole number and may not sum because of rounding. The share of plastics collected in Hanoi is calculated based on an 91% MSW collection rate. *'Not recycled/leakage' refers to plastic waste collected, but not recycled due to contamination or the collectors being unable to sell low-value plastics to aggregators.



While some private operators exist in the region, the Hanoi Urban Environment Company Limited (URENCO), the state-owned municipal waste operator, is the dominant waste collector and landfill operator in Hanoi. URENCO has implemented a small-scale program to encourage the public to segregate their recyclables; however, this has not yet been rolled out across the city.⁸

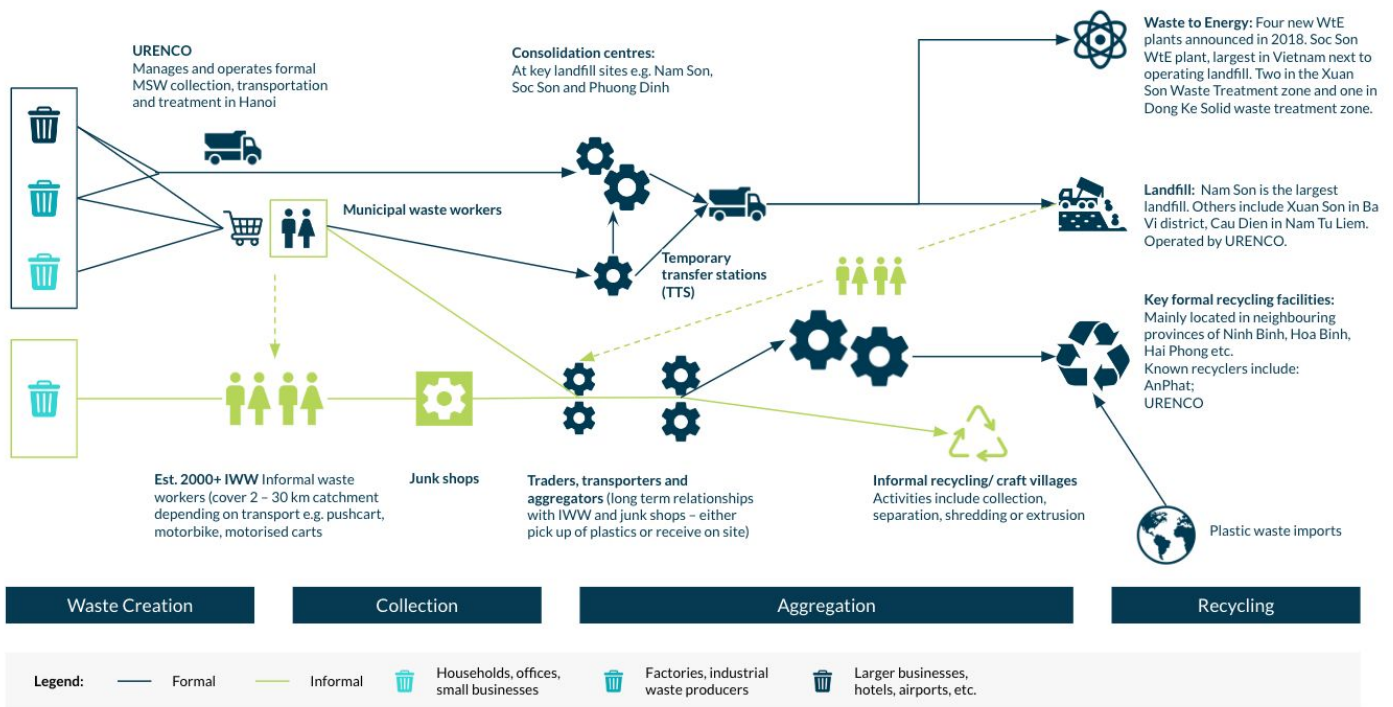
Once the waste is collected by the waste operators, there is no further separation or sorting facilities in the formal supply chain. However, some municipal waste workers may separate recyclables of value and sell these to waste dealers near the transfer station, while there are some waste pickers at the transfer station that sort out recyclables and take these to small and large waste dealers, who sort and clean the material. Small dealers send waste to the larger ones, who then transport the plastic waste to recycling. It was not possible to quantify the material being traded on to the informal sector by municipal waste workers, but the amount is anticipated to be small.

There has been a traditional reliance on landfill; however, four new WtE plants have been announced. This includes the Soc Son plant, which is thought to be the second largest facility of its kind in the world. It will have a daily capacity of 4,000 tonnes, which is expected to cover a large proportion of the current waste production of Hanoi and is due to be fully operational by the end of 2022.⁹

⁸ Viet Nam Economic News - Waste not, want not: Increased eco awareness generates recycling push (2021).

⁹ VN Express International - Viet Nam's largest waste-to-energy plant begins operation (2022).

Figure 5: The plastic waste supply chain in Hanoi.



Most formal and informal recyclers are located outside Hanoi in the neighboring provinces. An Phat, located in Hai Duong outside Hanoi, is a key formal recycler. ABM and BMI Polymer are also preparing to produce recyclates in future; however, no further detail was available. URENCO has proposed the development of a PET recycling facility due to start operations in 2023.¹⁰

While more formal recycling facilities have been announced, the informal recyclers are currently dominating the supply chain in terms of plastics processed and recycled. Craft villages include those located at:

- Trieu Khuc and Trung Van (Nam Tu Liem district).
- Tan Trieu (Thanh Tri district).
- Tien Duoc commune (Soc Son district).
- Minh Khai craft village (Hung Yen province), one of the largest in Viet Nam.
- Tu Chau village, Lien Chau commune (Thanh Oai district).
- Xa Cau village, Quang Phu Cau commune (Ung Hoa district).
- Tien Duoc and Kim Lu communes (Soc Son district).

Hanoi has a functioning ecosystem of formal and informal actors collecting, aggregating, and recycling plastics; however, the current supply chain structure incurs considerable average value losses¹¹ as only small percentages of individual polymers such as rigid PET and HDPE are recycled. LDPE and PP plastic bags and other post-consumer flexibles are not being collected as informal collectors are not experiencing demand from aggregators for them, therefore these are perceived as low- or no-value plastics.

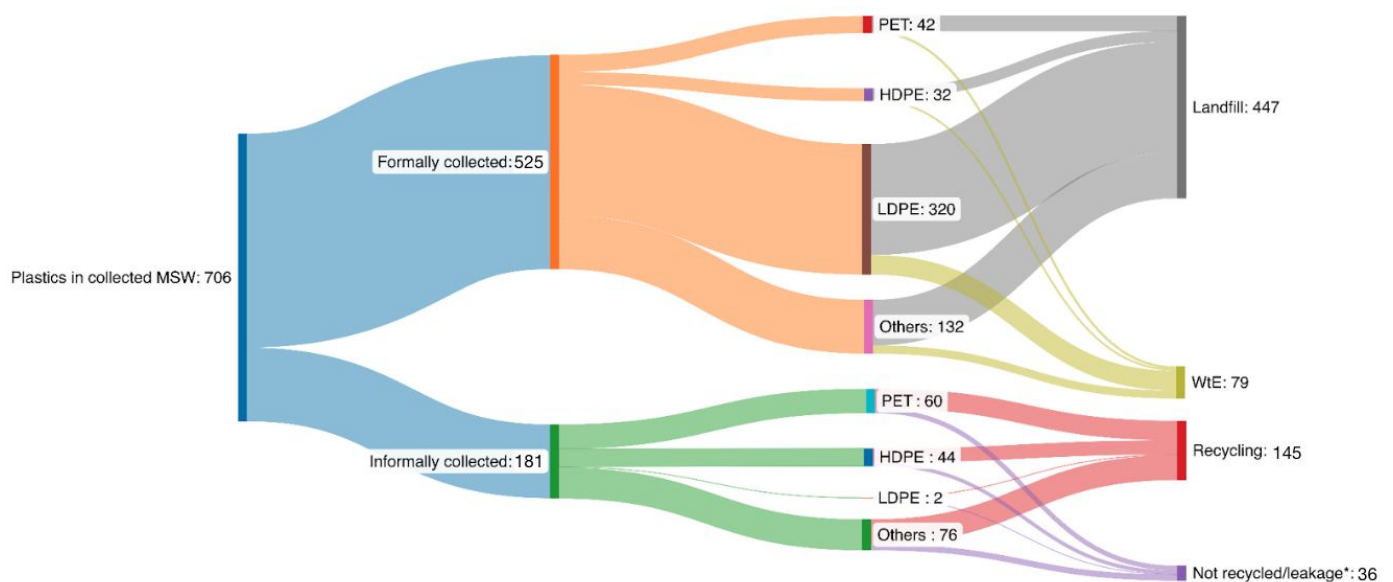
¹⁰ Viet Nam Net Global - URENCO building plastic recycling factory (2022).

¹¹ Plastic value loss has been defined as the value of plastic collected based on virgin pricing against the value of plastics recycled based on recyclates prices for individual polymers.



It is estimated that 21% or 145 KT/yr of plastic waste in collected MSW is recycled in Ho Chi Minh City. This is a slightly higher collection rate than Hanoi and may be partly driven by the permitting of informal waste collection workers to coordinate collection from properties that are hard to access with a vehicle. It is estimated that informal collection workers collect 65-70% of domestic waste from households, which is then either transferred to formal collection points, or the sorted recyclables like plastic are being sold through the informal network.¹² This is specific to Ho Chi Minh City and as the permitted, informal waste collectors are a hybrid between the formal and informal sector, the collection activity has been designated as formal collection, but the sorting and recycling activities are covered by the informal supply chain.

Figure 6: Flow of plastic within municipal solid waste in Ho Chi Minh City (thousand tonnes per year). Figures are rounded to the nearest whole number and may not sum because of rounding. Formal MSW collection figures include the contribution of permitted informal waste collectors, but their contribution to plastic recycling is captured in the informal recycling trade flow. The share of plastics collected in Ho Chi Minh City is calculated based on an 91% MSW collection rate. *'Not recycled/leakage' refers to plastic waste collected, but not recycled due to contamination or the collectors being unable to sell low-value plastics to aggregators.



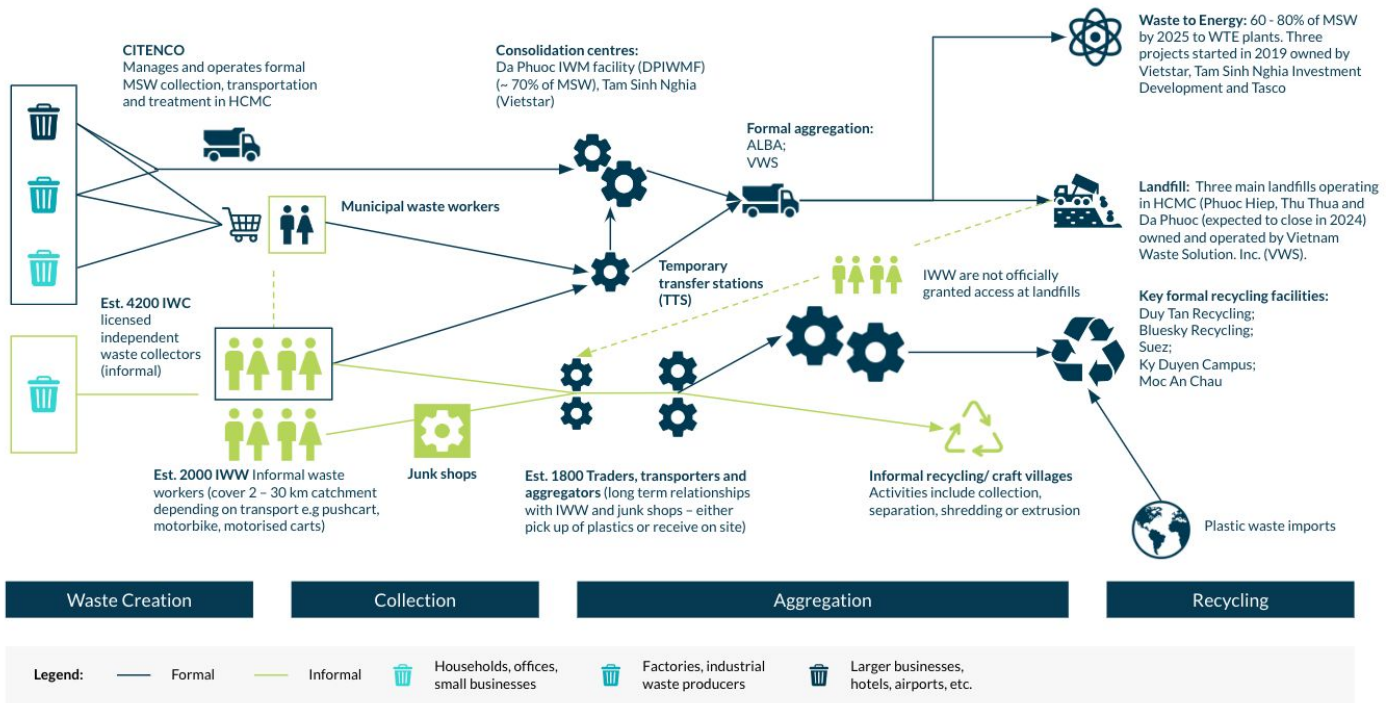
Ho Chi Minh City uses a mix of municipal and private waste operators, with Ho Chi Minh City Urban Environment Company Limited (CITENCO) operating as the semi-privatized but still majority state-owned waste company. Several private waste collectors are contracted for collection in specific areas or the management of landfills. Material is transferred via two large compression transfer stations, which are not designed to allow extraction for recycling. Landfill is the main disposal route currently, though by 2025 it is anticipated that the majority of MSW will be treated by WtE plants.

In the past, the city has explored the use of formalized sorting facilities and has, in principle, agreements with key private waste management companies to deliver single-stream recyclable materials (e.g., paper, cardboard, plastics, metals, and glass) for sorting. However, to date, arrangements have not been implemented to deliver suitable single-stream recyclable material and it is estimated that 98% of mixed waste collected is going to landfills.

One of the biggest landfill operators for Ho Chi Minh City has stated that the waste that arrives at landfills is mostly stripped of valuable material and does not justify the investment cost of formal extraction or the related health and safety risks to informal workers of allowing informal extraction. Further work would be needed to explore this in detail as it is expected that the landfilled waste currently retains a large amount of potentially recyclable material.

¹² Enda Viet Nam - *Integration of the informal sector in SMW & EPR (2022)*.

Figure 7: The plastic waste supply chain in Ho Chi Minh City.



Unique from the other regions covered in the study, Ho Chi Minh City has started formalization of waste collectors through licensing, where independent waste collectors are appointed to collect from households and businesses which are difficult to access with vehicles. The collectors can negotiate a collection fee with households and can generate an income from the sale of recyclables.¹³ Due to the unintended trading of collection permits, resulting in the aggregation of permits by larger operators, the city is changing the model and requesting that informal workers form legal entities (e.g., in the form of cooperatives). This allows them to participate in legal tenders and contracts. It remains the responsibility of the independent workers to purchase their own equipment and care for their own health and safety.

Ongoing efforts to close junk shops in the city and move aggregators to the outskirts are showing some effects, but the informal sector still has a strong presence in the city. It is not clear how the services of the informal sector could be replaced in the short term as recycling is currently not part of the formal sector’s services and segregation at source will take considerable time to become established.

City officials hope that aggregators can develop into companies or social enterprises to operate more professionally. However, with the current capacity and ability of aggregators, it is difficult for them to meet the city’s requirements, in particular in regard to their knowledge, skills, and funding to run a company or social enterprise.¹⁴

There is an area in the wetlands surrounding Ho Chi Minh City, known as Moc An Chau, that is dedicated for the city’s waste management activities. Besides hosting one of the central landfills, this area also hosts a private waste treatment zone, with current and planned activities including hazardous waste handling, hospital waste incineration, recycling, and organic waste treatment.

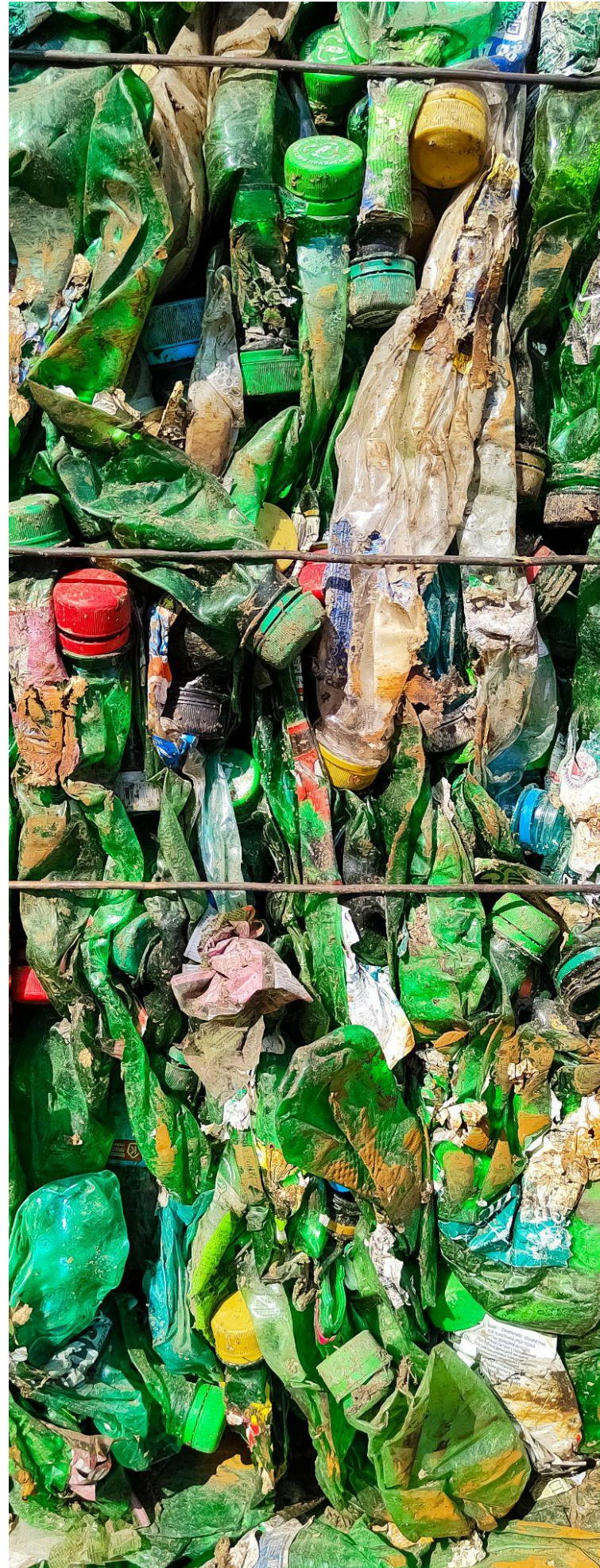
¹³ UNEP – *City-Level Decoupling: Urban Resource Flows and the Governance of Infrastructure Transitions* (2013).

¹⁴ Nguyen – *Constraints, levers and possible recommendation for the integration of not-yet-collected plastic packaging at the aggregator and recycler levels in Ho Chi Minh City* (2022).

Key formal recyclers in Ho Chi Minh include Duy Tan, which is the first bottle-to-bottle plant in the country. It has a current capacity of 22 KT/yr but is expected to increase to 100 KT/yr and is partnering with key brands to supply recycled material.¹⁵

There are an estimated 300 informal recycling facilities in Ho Chi Minh City, mainly in District 11. Around 70 of these are plastic recycling facilities.¹⁶ These are slowly being moved out of the central business district and in future recycling plants are expected to be on the outskirts or in the surrounding areas of Ho Chi Minh City. Existing craft villages include those at Duc Hoa, Long An, and Binh Chanh.

Ho Chi Minh City has a functioning ecosystem of formal and informal actors collecting, aggregating, and recycling plastics; however, the current supply chain structure incurs considerable average value losses¹⁷ as only small percentages of rigid polymers, such as PET and HDPE, are being recycled. LDPE and PP plastic bags and other post-consumer flexibles are not being collected due to a lack of demand from traders and aggregators; therefore, these are perceived as low- or no-value plastics. The city is making efforts to integrate the informal sector and expand the formal sorting, aggregation, and recycling infrastructure; however, progress has been slow and some ventures had to be abandoned due to technical and management constraints impacting the implementation of new treatment facilities.



¹⁵ The Saigon Times - *Duy Tan targets environmentally friendly production by using renewable energy* (2021).

¹⁶ UNDP Accelerator Lab Research and Evergreen Labs - *Mapping Informal Waste Sector in Da Nang* (2020).

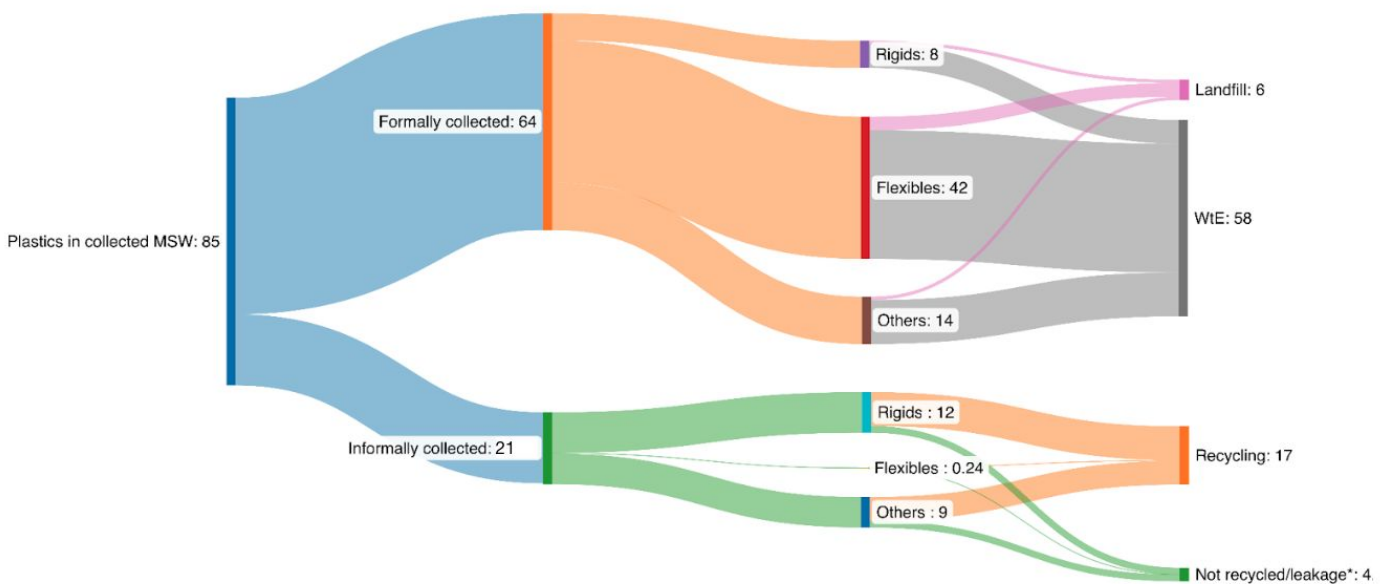
¹⁷ Plastic value loss has been defined as the value of plastic collected based on virgin pricing against the value of plastics recycled based on recyclates prices for individual polymers.

Insights on local plastic recycling supply chains in Da Nang



An estimated 20% or 17 KT/yr of plastic waste in collected MSW is recycled. Da Nang does not have any known permitted plastic recyclers, and recycling either takes place in informal craft villages or material is transported outside, which contributes to a lack of local demand. Observations of landfilled material indicate that significant amounts of tradable recyclable material are being disposed of, which could otherwise be feedstock for recycling.

Figure 8: Flow of plastic within municipal solid waste in Da Nang (thousand tonnes per year). Figures are rounded to the nearest whole number and may not sum because of rounding. The share of plastics collected in Da Nang is calculated based on a 91% MSW collection rate. **Not recycled/leakage* refers to plastic waste collected, but not recycled due to contamination or the collectors being unable to sell low-value plastics to aggregators.

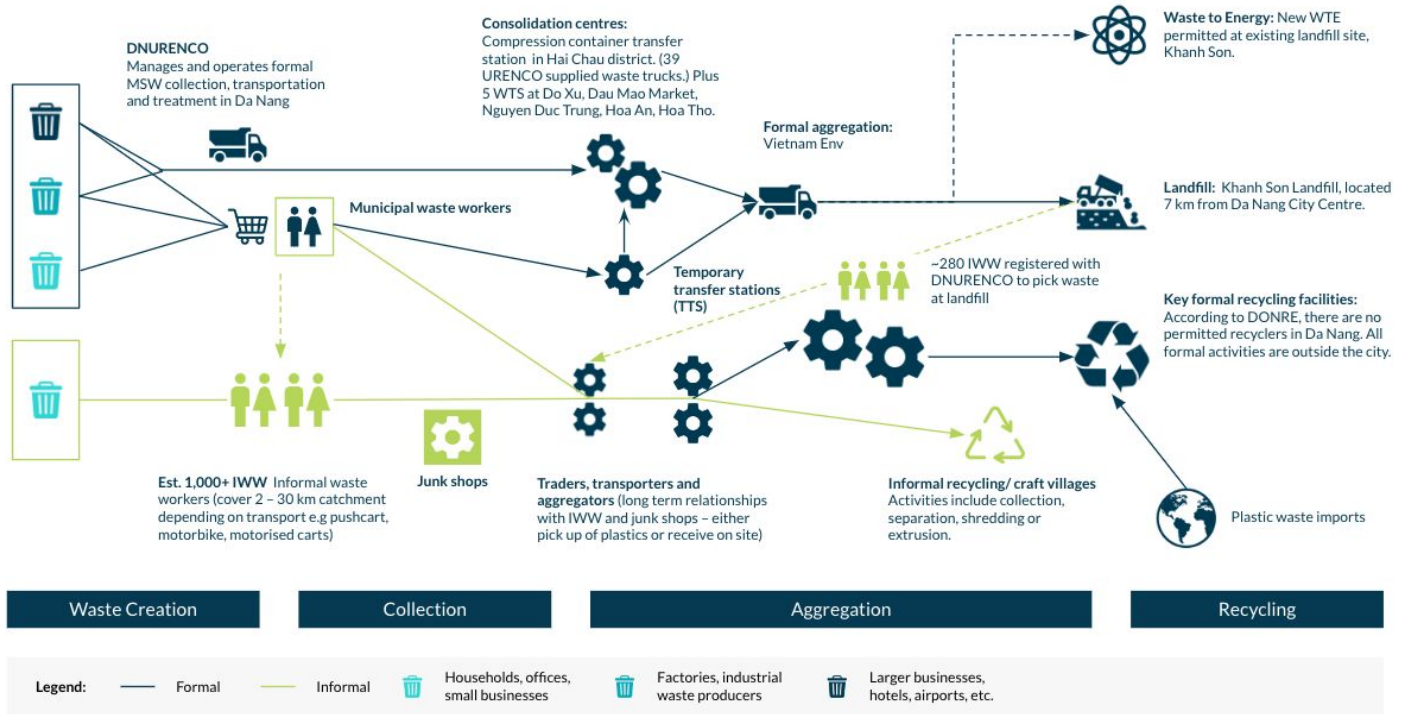


The majority of municipal waste in Da Nang is collected by the Da Nang Urban Environment Company Limited (DNURENCO), a state-owned, semi-privatized waste operator. Collection in some wards is undertaken by URENCO Hanoi. Da Nang recently opened its first compression container transfer stations to help consolidate municipal waste. This site does not have a dedicated process for extraction of recyclables.

Recycling is currently conducted by informal workers; however, the city announced plans to implement a new household recycling scheme and has set a 15% recycling rate target for 2025 (for MSW). While the city does not issue any permits for collection centers, it does not currently actively interfere in the informal collection system and allows, for example, informal picking at landfills.

The life of the central landfill is coming to an end and a new WtE facility is currently under construction with a capacity of 1 KT/d. The city is considering three further similar projects to provide alternatives to landfill disposal.

Figure 9: The plastic waste supply chain in Da Nang.



Da Nang has an ecosystem of formal and informal actors collecting, aggregating, and recycling plastics. The current supply chain structure incurs average value losses¹⁸ as only rigid polymers such as PET and HDPE are being recycled. LDPE and PP plastic bags and other post-consumer flexibles are not being collected as the informal collectors are not able to sell these materials to traders and aggregators. These are therefore perceived as low- or no-value plastics. The city is a growing hub of industrial activity and will need to scale up its plastic waste recycling supply chain to ensure higher levels of segregation and recycling.

¹⁸ Plastic value loss has been defined as the value of plastic collected based on virgin pricing against the value of plastics recycled based on recyclates prices for individual polymers.

Analysis of pricing and pricing transparency along the value chain¹⁹

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

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

Data collected through interviews in Viet Nam highlight the lack of consistency in the price points which can be 'expected' by collectors selling plastic scrap, aggregators buying plastic waste, and recyclers buying feedstock for recycling. The range in data that was identified through this study could be due to the process used, material quality, or regional differences, but is also highly likely to be influenced by the lack of transparency inherent in the market.



¹⁹ The findings presented in this section of the report are an extract from a pricing and policy interventions analysis on the recycled plastics value chain that was undertaken by The Circulate Initiative in parallel to this study. The results are published separately from this report.

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

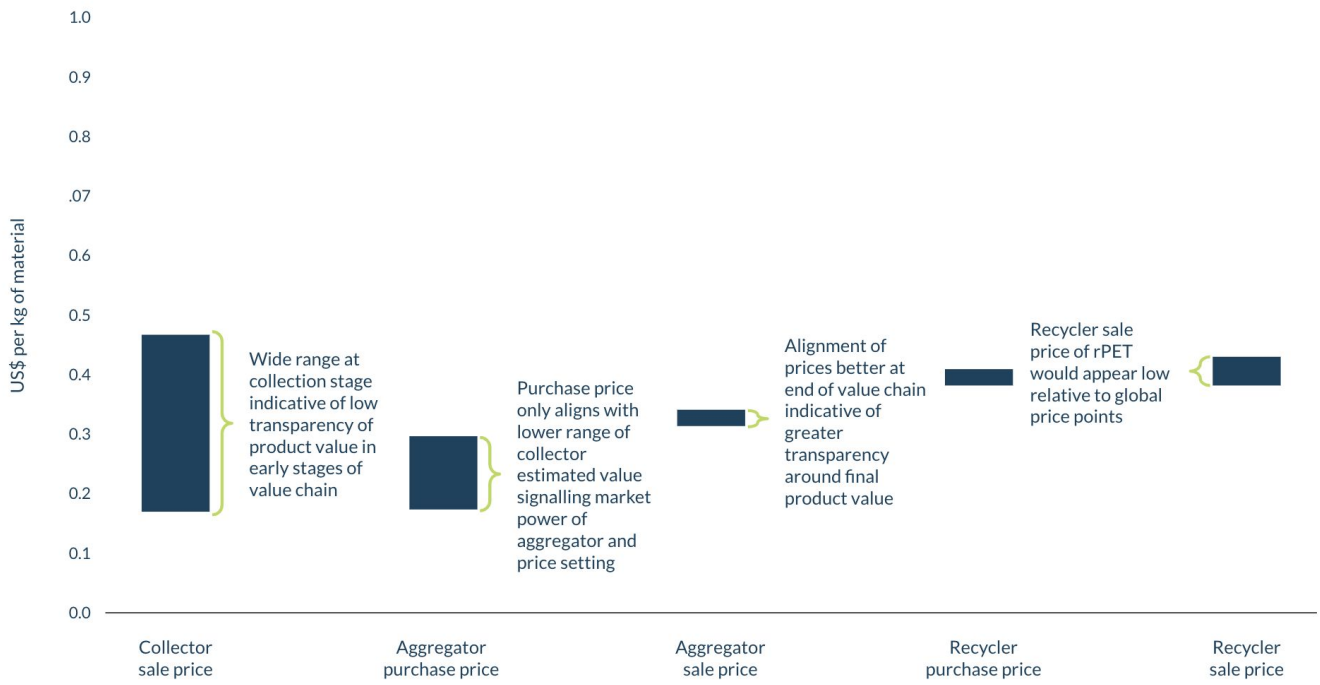


Figure 11: Viet Nam HDPE pricing information from research and stakeholder interviews.

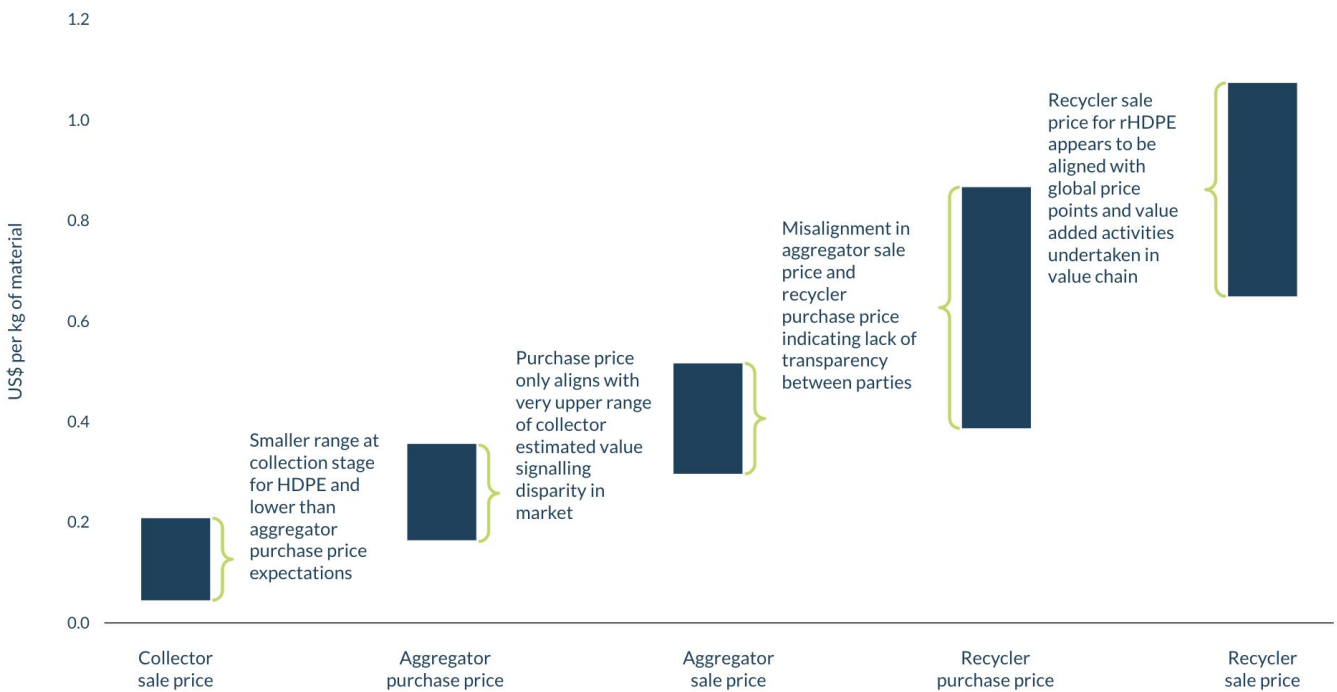
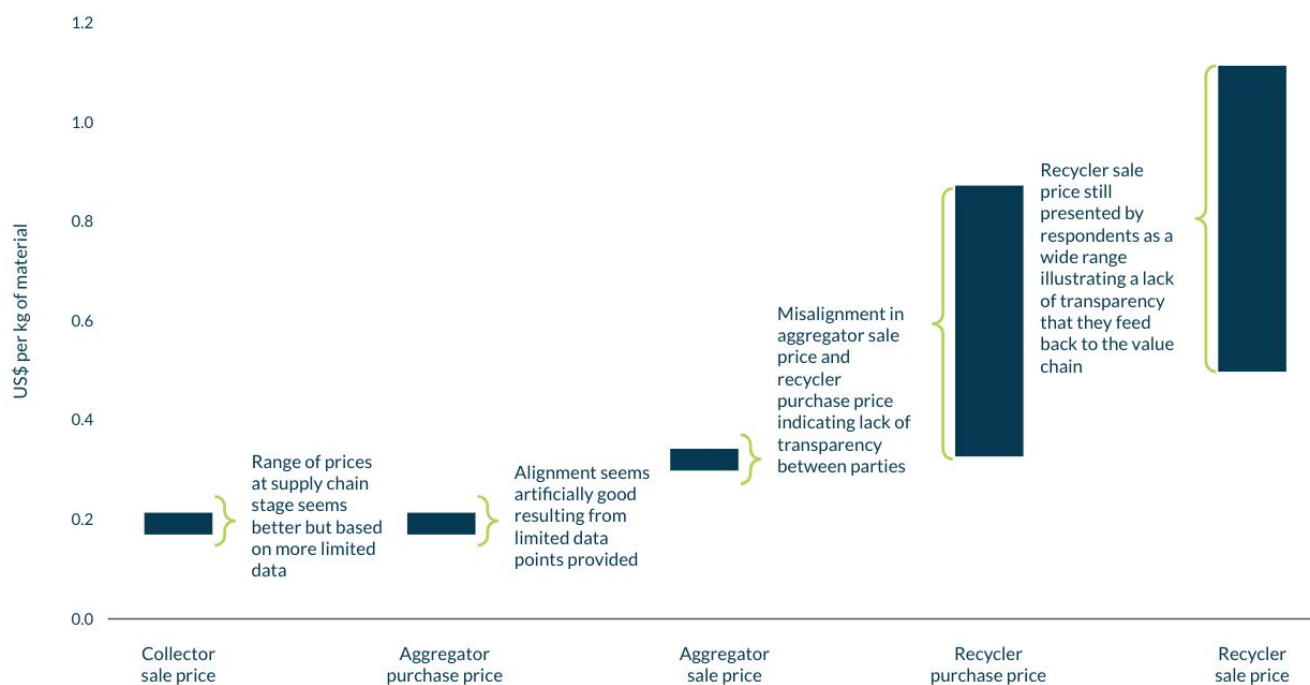


Figure 12: Viet Nam PP pricing information from research and stakeholder interviews.



In addition, the variation in data collected through interviews in Viet Nam highlights potential inconsistencies in the value chain. This is particularly true of the relationship between the collector and aggregator, where collectors need to be paid daily for small amounts of recyclables and can only access local aggregators, which are then selling the recyclates on to other aggregators, adding to their margins (with little or no value add), until it is received by a formal or larger-scale aggregator with the ability to bulk a sufficient amount of material to sell it to the recyclers or plastic processors, depending on the quality and format.

In principle, both virgin and recycled PET and HDPE are commodities that are traded with well-established market values influenced by virgin polymer prices and recyclate quality that should filter back into supply chains.

However, the plastics waste supply and value chains in Viet Nam are complex and highly fragmented, as collection and aggregation for recycling are dominated by the informal sector, with plastics waste being traded bilaterally with little information on local and regional market data (such as plastic waste volumes, and recyclate pricing information) being shared along the value chain. Instead, local markets represent conditions of limited pricing transparency on which buying and selling is being undertaken; as a result, there are challenges around market failure.

The plastic waste supply chains in Viet Nam indicate an imbalance in market power, which is mostly benefitting later stages of the supply chain e.g., recyclers and final aggregators, and negatively impacting the informal collectors, junk shops, and smaller aggregators in craft villages. Analysis of supply chain actor profit margins (as a proxy for market power) drawn from the survey data has estimated that 82% of the total trade benefits in the value chain are attributable to the recyclers, while the remainder is split between aggregators and collectors.

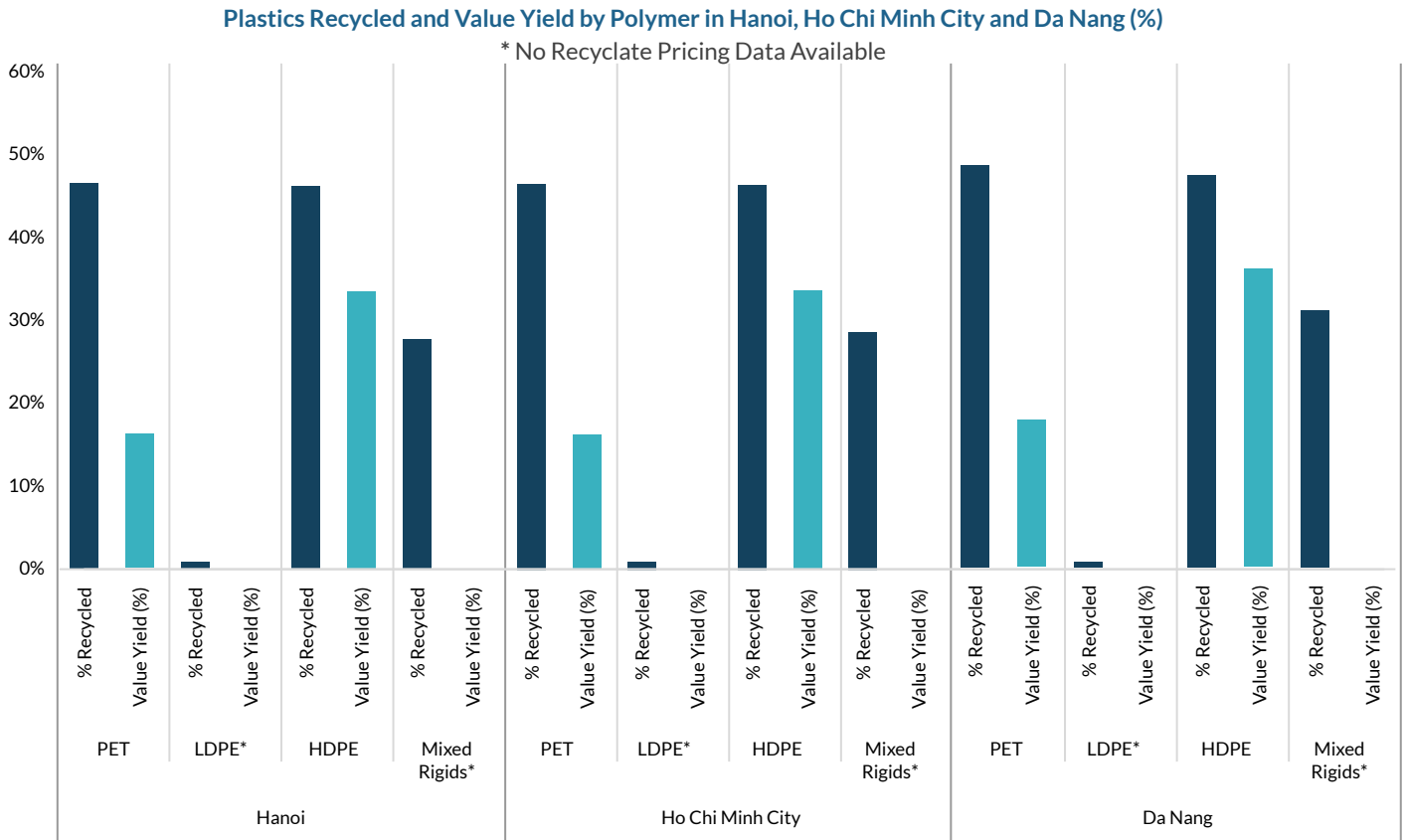
In practice, this means any policies set up to support output material prices and support investment in infrastructure will not easily flow back to the earlier stages of the value chain e.g., the collectors. This impacts the amounts, formats, and polymers being collected by the informal sector, as well as making it difficult for the formal sector to incentivize sorting and separation of recyclable plastics at transfer stations and landfills. It also means the supply chain is likely to require more direct intervention in order to become more efficient and developed, as conventional market economics will not necessarily filter capital to all parts of the supply chain equally.

The comparison between estimated recycling rates and value yields (value of recycled plastics using recycle pricing vs. value of plastics collected using virgin prices) shows the difference between individual polymers. While both PET and HDPE have similar recycling rates across the wastesheds, the value yield for PET is lower than that of HDPE due to the difference between virgin and estimated recycle pricing. This could be due to lack of demand/oversupply as PET bottles are easy to collect and are perceived by the collectors as having a good value, while recyclers are not prepared to pay higher prices due to quality, or the limited application of recycled PET in food-grade products. There is no clear 'chain of custody'²⁰ that only food-grade PET has been collected and processed for recycling.



²⁰ 'Chain of custody' describes the ability to trace waste from waste source to final disposal or recycling.

Figure 13: Plastic recycling rates vs. value yields in Viet Nam.



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



SUPPLY CHAIN ASSESSMENT

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

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



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Table 2: Evaluation of supply chains in Hanoi, Ho Chi Minh City and Da Nang using a red, amber, green rating approach.

Region	CFR Rate	Market Structure - Collection	Market Structure - Aggregation & Sorting	Market Structure - Recycling
	Main polymers being recycled are HDPE & PET with nearly 100% of LDPE and flexibles disposed in landfill, WTE or leaked into the environment. It is not clear if small amounts of PP are recovered as part of the 'mixed rigids' fraction.	Public waste management providers (URENCO, CITENCO and DNURENCO) dominate MSW collection without competition. Only rigid plastics (PET, HDPE and some PP) are being collected informally. Some additional rigid plastics are being retrieved from major landfills.	No sorting and separation takes place at key consolidation centers, but a new waste management segregation park is being developed. Most plastic waste segregation is undertaken by informal traders and at craft villages. Where LDPE/flexibles are being collected, these are not accepted by traders due to low value and lack of end markets.	Limited number of medium to large scale recyclers for PET, HDPE and PP, but there is a lack of capacity for mixed and flexible recycling.
Hanoi	20%	URENCO manages and operates formal MSW collection, transportation and treatment. Est. 2,000 IWW	3 transfer/ consolidation centers at key landfill sites	5-10 formal recyclers in outskirts of Hanoi
Ho Chi Minh City	21%	CITENCO manages and operates formal MSW collection, transportation and treatment. Est. 4,000 IWC (licensed independent waste collectors) and 2,000 IWW	2 transfer/ consolidation centers, Moc An Chau Ind. Park for sorting/ segregation	5-10 formal recyclers in outskirts of HCMC
Da Nang	20%	DNURENCO manages and operates formal MSW collection, transportation and treatment. Est. 1,000 IWW	5 transfer/ consolidation centers	Main fractions transported to HCMC/ Hanoi/ other areas

Legend: ■ High ■ Moderate ■ Poor

Region	Pricing Transparency	Knowledge Gaps & Data Availability	Value Yield & Quality of Outputs	Regulatory Framework
	Low transparency with high number of informal collectors and aggregators. Craft villages are dominating recycling of plastics and limited number of formal recyclers.	Limited data availability. Main data sets were derived from a literature search of recent studies and supported by interviews.	The low recycling rate for rigid plastic waste and the lack of recycling of flexibles leads to considerable value loss. Plastic value loss has been defined as the value of plastic collected based on virgin pricing against the value of plastics recycled based on recyclates prices for individual polymers.	There is a strong national framework. EPR and other national initiatives have been announced but time frames and the EPR mechanism remain outstanding.
Hanoi	Market power or share of the profit margins/trade benefits held by recyclers/large aggregators ~70 for PET and 80% for HDPE and PP.	0-5 city studies on plastic waste generation, but limited data on waste treatment and polymer level details.	Est. value yields: 16% PET, 34% HDPE, 0% LDPE & PP	URENCO has launched a small trial to encourage separation of recyclables, however this is not city-wide and further work is needed to fully implement the key national framework legislation to increase recycling.
Ho Chi Minh City	Market power or share of the profit margins/trade benefits held by recyclers/large aggregators ~70 for PET and 80% for HDPE and PP.	5-10 city studies providing relevant data around plastic waste generation and treatment but limited polymer level details.	Est. value yields: 17% PET, 34% HDPE, 0% LDPE & PP	The city has implemented a policy to start to formalize informal sector collection of materials. However, the key national framework legislation to increase recycling is not yet implemented locally.
Da Nang	Market power or share of the profit margins/trade benefits held by recyclers/large aggregators ~70 for PET and 80% for HDPE and PP.	0-5 city studies on plastic waste generation.	Est. value yields: 18% PET, 36% HDPE, 0% LDPE & PP	Though local recycling targets have been set, the key national framework legislation to increase recycling is not yet implemented locally.

Legend: ■ High ■ Moderate ■ Poor

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Legend: ■ High ■ Moderate ■ Poor

THE NEED FOR INTERVENTION

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

Collection and Aggregation

While the vast majority of households in Hanoi, Ho Chi Minh City and Da Nang are provided with municipal solid waste collection, they are not routinely separating plastic for recycling in a standardized way, nor are plastics recovered at scale during transfer to landfills and WtE facilities.

This severely limits the amount and quality of material available for recycling to only the amounts being collected and picked by informal waste collectors. Local implementation of national legislation to increase source separation of recyclable material should improve this in theory, though in practice the impact and success will depend on the approach taken by the local government, and household behavior to segregate recyclables. There is a risk that without sufficient guidance and funding, the implementation will not be successful. Currently the majority of supply chain actors interviewed in Viet Nam were unaware of the forthcoming changes, or believed it would not have a significant impact on their operations.

The informal sector is currently leading the extraction of plastic waste for recycling, and although this is a relatively effective method in terms of extraction yield for high-value polymers, the practice has considerable environmental and social issues. In addition, the lack of demand and inadequate pricing is limiting recycling of lower value and harder to handle polymers. Plastic film is an example of this. Although recycling of plastic films is taking place (particularly white and clear films from post-industrial sources with larger businesses dealing directly with recyclers), it is negligible.

Recovery of films tends to be more complicated and costly than rigid plastics due to contamination with food and low bulk density, a lower sales price and limited high-quality material available. This means it is often not a key target for collectors.

Comprising thousands of individual workers, the informal sector lacks the capability to efficiently scale the quantity of plastic or range of polymers collected and provide consistent and high-quality feedstock flow to support investment in future plastic infrastructure. Ho Chi Minh City has taken steps to formalize collectors and is encouraging aggregators to develop into companies or social enterprises to operate more professionally. This could bring a more cohesive approach to collection and aggregation, though further work is needed to ensure benefits to workers and opportunities are realized. Informal aggregators have indicated that, as they do not have permits, they are reluctant to invest in larger spaces and many lack the knowledge, skills, and funding to run a company or social enterprise. Larger, formally-operated aggregators are experiencing barriers too, and have commented that they lack the resources and funds to develop larger formalized consolidation points in cities to aggregate recyclable materials for efficient transport.

Plastic Recycling and Reprocessing

Feedback from recyclers indicates that:

1. It is extremely difficult to obtain permits to allow them to operate in full compliance with the law. The process is not clearly defined, which means recyclers do not know how to approach the task, or are given differing advice on permitting requirements from various departments within local government. This increases uncertainty for them and their investors.
2. Reliance on the informal sector is a barrier for recyclers that wish to increase input or enter the local market as they do not have high security of supply. In addition, potential investors are reluctant to provide funding as feedstock security is low, unless alternative feedstock supply is being set up e.g., own collection systems from transport hubs, hotel chains, etc.

Intentionally or unintentionally, formal recyclers are often taking advantage of the lower cost of pre-processing of plastic feedstock in the informal sector, especially when purchasing washed plastic flakes for regranulation. While permitted recyclers are monitored to ensure compliance with environmental and health and safety regulations (especially wastewater discharge standards), informal pre-processors and recyclers typically do not invest in wastewater treatment systems and health and safety equipment. This means they do not carry the same cost and enables formal recyclers to shift some of the cost of plastic feedstock cleaning to the informal sector at the expense of the environment. Similarly, public waste management costs are being moved to the informal sector as households are not paying for waste segregation and sorting. Waste collections are funded by either households or businesses paying for waste collection and disposal, or the final recyclers are paying for waste services when paying for recycled plastics.

Reprocessing activity is currently focused around Ho Chi Minh City and Hanoi, which results in long transport distances and the associated costs of material from other areas. While transport costs are relatively low in Viet Nam, the recent increase in fuel prices appears to be a growing concern for aggregators and recyclers.

Municipal solid waste treatment

Alternative solutions for waste treatment to reduce landfill disposal are advancing in Viet Nam. The study has shown that significant WtE infrastructure is being developed in all three cities and compression transfer stations are being introduced to increase aggregation and transport efficiency at existing waste sites.

WtE plants are expected to reduce access for waste collectors, who would normally pick waste from landfills, and therefore reduce collection for recycling. However, they can also provide opportunities for additional investment to efficiently remove recyclables using larger-scale and automated segregation equipment combined with manual picking, which could also provide employment for waste workers.

To date, a number of modern treatment facilities proposed and planned for Viet Nam have been severely delayed or failed to be properly utilized as material supply arrangements have not supported their operation.



Recommendations for interventions

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

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

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

Desired supply chain impacts ↓	Intervention categories →		
	Improve supporting regulatory and social conditions to create a stable policy framework	Financial interventions to improve value creation from plastic waste	Technical and digital improvements to increase supply chain efficiency
Improve collection rates of plastics	Implement (harmonized) source segregated collection and EPR systems	Market incentive payments for hard to recycle, low-value waste formats and polymers	<i>(Digitalize recyclable collection and material tracing, e.g., explore 'pay-as-you-throw' systems (PAYT) linked to material quality and level of segregation)</i>
	Improve welfare standards of informal workers (annual health check-ups, PPE, insurance, etc.)	<i>(Subsidize formalization of informal pickers e.g., cooperatives, tax payments, permits, EPR fees)</i>	
	Registration or permits for informal waste pickers with the incentive to receive tools/ equipment, access to loans, PPE etc. to build capacity		
	<i>(Awareness raising campaigns and behavior change e.g., to sort household waste, stop disposal of bottles etc. into oceans)</i>		
Improve sorting of polymers and quality for recycling	Clear administrative pathways for operating, sorting, and aggregation permits	Funding of automated/large-scale plastic segregation from mixed MSW prior to WtE/landfill (secondary sorting systems)	<i>(Private industry to provide grants for small-scale equipment: balers, sorting bays/containers, transport)</i>
	Mandate design for recycling standards to improve plastic and polymer separation (part of EPR)	<i>(Plastic collection and sorting credits/incentives as part of an EPR system)</i>	
	<i>(Import restrictions e.g., bans and import fees for mixed and low-value plastic waste)</i>		
Increase demand from plastic recyclers	Mandate recycled content targets in key applications (incl. rigid and flexible packaging)	Invest in medium- to large-scale plastics recycling of mixed and hard to recycle plastics	<i>(National or regional virtual marketplaces to improve supply chain security)</i>
	Clear administrative pathways for operating and building permits for recycling facilities	<i>Improve funding for environmental regulator and protection agencies to ensure level playing field</i>	
		<i>(Subsidize formalization of informal/small recyclers e.g., cooperatives, tax, permits)</i>	

Legend: Primary interventions/(secondary interventions)

IMPROVE COLLECTION RATES OF PLASTICS

- Policy implementation:** A national legal framework for improving recycling is in place (including EPR and source segregated collections), and there have been some moves towards delivering this (e.g., small-scale trials by URENCO in Hanoi). However, guidance, funding, and monitoring may be needed to ensure effective implementation by local governments. As system change is implemented, it is important to consider how public awareness-raising campaigns can support new arrangements to maximize diversion of plastic to recycling and reduce environmental damage from leakage. Digital solutions (e.g., for waste tracking and consumer engagement) could also help to maximize the benefits by increasing price transparency for supply chain actors and ensuring efficient delivery.
- Formalization of supply chain:** Ho Chi Minh City has started to formalize collectors, though further intervention may be needed to ensure the benefits are maximized, particularly regarding the welfare of workers. Formalization, carried out with care to protect the livelihoods and welfare of workers, could also be considered in Da Nang and Hanoi. Delivered well, this could improve supply chain cohesion, allowing scaling of collection and aggregation activities, and providing greater supply security to recyclers and investors. This will require additional funding for the formal waste management system.

IMPROVE SORTING OF POLYMERS AND QUALITY FOR RECYCLING

- Infrastructure planning and automated recovery:** Significant WtE capacity is in development in Hanoi, Ho Chi Minh City, and Da Nang. Ideally, the introduction of WtE would be coupled with systems to ensure that plastics and other recyclables are extracted.

However, the development of any large-scale facilities to do this would need to be approached with care, particularly since a number of high-technology sorting facilities developed and planned in Viet Nam have failed to operate as originally intended. In addition, observations of landfilled material in Hanoi and Ho Chi Minh City indicate a lot of high-value material is already extracted from waste (though it remains in Da Nang), which is likely to weaken the case for investment.

The implementation of national legislation to segregate recycling at the household level could also impact the suitability of the waste for pre-treatment and the level of plastics recovery that could be achieved. Ideally, a centrally mandated needs assessment will be undertaken for each region to develop a master plan on the infrastructure that needs to be established and the interventions required to support it, such as the master plan being drawn up in Ho Chi Minh City.²¹ Once approved by the municipalities, projects could be tendered under predefined conditions. This could help increase the number of providers that are willing to invest in Viet Nam's infrastructure requirements.

- Industry grants:** A number of aggregators in Viet Nam commented that they could scale their operations to some extent if they had additional equipment e.g., balers could help them to handle film if there was demand. Small grants could help them to develop the capabilities of their sites. This could be an opportunity for private industry to get more involved in the waste treatment sector in Viet Nam.

—
²¹ Viet Nam News - HCM City draws up master plan on solid waste (2020).

INCREASE DEMAND FROM PLASTIC RECYCLERS

- **Permits for recyclers:** The process of receiving the necessary permits is currently a major barrier for recyclers and their investors. Ideally, the process could be simplified and clarified, with responsibilities within local government being well defined and communicated externally. Similarly, permits could provide an opportunity to formalize the activities of informal waste workers, improve their working conditions, and provide access to equipment and transport.
- **Invest in reprocessing:** There is currently no formal reprocessing infrastructure within close proximity to Da Nang. The lower local demand for plastic from re-processors contributes to a much lower collection rate than in the other two cities included in this study. Further exploration could be undertaken to identify the feasibility of encouraging the development of formal reprocessing infrastructure in the area. However, as this needs secure supply chains, fiscal support might be necessary to ensure feedstock supply before the EPR system is implemented.
- **Support domestic supply:** After a surge in 2018, the importing of plastic waste has been reduced due to the import restrictions imposed. However, good quality plastic from abroad is still available and seems preferred to domestic waste supply as the quality is considered more consistent, and supply is based on formal contractual arrangements with waste companies or brokers in Europe, Asia, or the USA. This suggests that further work may be needed to make domestic materials comparably more favorable. As well as supply chain improvements, virtual marketplaces for domestic material could help to increase demand by improving availability and making transactions easier.



Conclusion

Viet Nam has a strong and growing plastics manufacturing industry reliant on polymer imports, but is experiencing the impacts of considerable environmental pollution from plastic waste.

While the reduction of single-use items and plastic waste is the key goal, improved plastic waste collection for recycling and additional separation of plastics for recycling could also support efforts to reduce pollution and recover value from waste.

A more sustainable approach will be to improve general conditions for informal waste workers, as well as raise funds for the integration of the informal sector into a formalized working environment at permitted and monitored waste treatment sites. Scale-up of plastic recycling and the implementation of EPR and similar policies are only feasible when waste can be tracked and monitored to develop a chain of custody.



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Appendices

Appendix 1: Supply chain assessment indicator descriptions and rating scales

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

Legend: ■ High ■ Moderate ■ Poor

Appendix 2: List of potential interventions

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

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

Appendix 2: List of potential interventions (continued)

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

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