INDIA PLASTICS PACT

Insights report

Landscape assessment of plastic recycling in India

Managed by

CII Confederation of Indian Industry

CII-ITC Centre of Excellence for Sustainable Development

Supported by

wrap

Funded by

UKRI UK Research and Innovation

Authors: Shourjomay Chattopadhyay, Abhishek Pawar and Dr Nandini Kumar, Confederation of Indian Industry, with contributions by Megg Humphrey and Peter Skelton, WRAP

Consultations: This report is a product of primary and secondary research, based on interactions with stakeholders across the plastics value chain. The India Plastics Pact is grateful to individual experts and specialists for valuable inputs and insights during the preparation of this report. The support of India Plastics Pact Member and Supporter organisations is appreciated and acknowledged.

Funder: UKRI

Date of publication: September, 2023

Table of contents

List of abbreviations

ABS	-	acrylonitrile-butadiene-styrene
AI	-	artificial intelligence
BIS	-	Bureau of Indian Standards
CIPET	-	Central Institute of Petrochemicals Engineering and Technology
CPCB	-	Central Pollution Control Board
EEE	-	electrical and electronic equipment
EOL	-	end-of-life
EPR	-	extended producer responsibility
FMCG	-	fast moving consumer goods
GeM	-	government e-marketplace
HDPE	-	high-density polyethylene
IIP	-	Indian Institute of Packaging
IPP	-	India Plastics Pact
LDPE	-	low-density polyethylene
MRF	-	material recovery facility
MSW	-	municipal solid waste
NGO	-	non-governmental organisation
PC	-	polycarbonate
PCC	-	Pollution Control Committee
PET	-	polyethylene terephthalate
PIBO	-	producer, importer, brand owner
PP	-	polypropylene
PS	-	polystyrene
PVC	-	polyvinyl chloride
PWM	-	plastic waste management
RIC	-	resin identification code
rPE	-	recycled polyethylene
rPET	-	recycled polyethylene terephthalate
SPCB	-	State Pollution Control Board
tpa	-	tonnes per annum
ULB	-	urban local body
UT	-	Union Territory

List of tables

List of figures

Executive summary

Plastics recycling[1] is set to grow in India on the back of an ambitious Extended Producer Responsibility regulation with targets for collection, recycling and incorporation of recycled content back into packaging. These and voluntary commitments made by businesses in the India Plastics Pact, for example, must be matched by a recycling industry operating efficiently and at the scale needed. However, India's readiness to meet these targets in terms of estimates of current recycling capacity, and estimates of the capacity needed, by resin, and location, are not easy to come by.

A survey of mechanical recycling units[2] that recycle plastic waste was carried out between August 2022 and February 2023, using government records (CPCB, SPCB/PCB, EPR portal) as base. A sample of 819 recycling units were visited, with 208 in the north, 160 in the south, 44 in the east, 328 in the west and 79 in the central regions of India. It is estimated that the sample represented 20% of India's installed capacity for recycling. Out of the 819 recycling units visited, 600 led to positive responses: survey responses for these were extrapolated to estimate trends and draw up a recycling landscape for the country as it exists halfway through 2023.

About 2,309 recycling units with an installed capacity of 47,77,639 tonnes per annum (tpa) operate at country level. Recycling units processing polyolefins (PP, PE, HDPE and LDPE) make up the largest proportion, among the resins considered (PET, polyolefins, PS, PVC and 'others'), in terms of installed capacity at 21,80,818 tpa. This was followed by units recycling PET, at 17,79,013 tpa. There was a small number of recycling units, 527 out of 2,309, processing resins such as PVC, PS, ABS, polycarbonate and nylon.

Most recycling units visited in the field assessment, irrespective of their installed capacity, are equipped with at least shredders and extruders; some recycling units, especially those handling PET, have washing lines. A robust end market is crucial for the recycling industry as it creates the demand for recyclate and pulls the flow of plastic material through from waste generator to recycler and on to new products/packaging. Current end markets include a wide range of industrial sectors such as packaging, automobile, construction, agriculture, fibre and household. However, it is evident that packaging is currently not a primary end-market for recyclate.

A few recyclers currently produce high-end rPET and rPET recyclate suitable for use back into rigid and flexible packaging applications. At the time of writing, it was estimated that there is at least 36,500 tpa of capacity for closed-loop PET recycling, while 73,000 tpa capacity was available for high-quality polyolefins. However, meeting the EPR targets for incorporation of recycled content will mean that by 2025-26, more than one-third (34%) of recycling, up from 5% at present, will need to be of a high quality (closed-loop).

The main findings are:

- polyolefin recycling units make up two-thirds of recycling units (by number) in India
- less than 5% of installed capacity is for closed-loop recycling
- recycling units are unevenly distributed over the country; few recycling units are located in the eastern and central regions
- a large proportion of recyclate is used for low-value applications

[1] recycling means the process of transforming segregated plastic waste into a new product or raw material for producing new products
[2] recycling units are entities who are engaged in the process of recycling of plastic waste

- installed capacity appears to be under-utilized at most locations.

Extrapolated data suggest that most recycling units (45%) procure feedstock from both industrial post-consumer waste and municipal solid waste (MSW), while 36% of units get their input feedstock from MSW only, and 19% of units procure input feedstock only from industries.

At first glance, the landscape assessment suggests that the overall recycling capacity available will be enough to meet the demand generated when the EPR recycling targets begin to kick in, in 2024-25. However, installed capacity of the high-quality type of recycling which will be needed for closed-loop recycling (addition of recycled content back into packaging) is not sufficient.

The following challenges are identified by recyclers:

- availability of clean, segregated waste;
- high variability in composition of plastic packaging;
- volatility of demand;
- absence of specific technology (for deodorization, de-inking, for example);
- underutilized capacity for reasons such as labour shortage;
- insufficient capacity for high-quality recycling;
- availability of workers, skilled or otherwise, and,
- uneven distribution of recycling units over the country.

To drive a circular economy for plastic packaging, the flow of clean waste plastic packaging from source to recycling facilities should be maximized, and market demand for recyclate along with a robust recycling sector should be in place.

Based on the challenges identified above, four groups of recommendations are provided; those relating to:

1. input feedstock,
2. the recycling facility itself,
3. end-markets, and,
4. cross-cutting aspects.

The following overarching enabling factors also emerge:

- availability of clean, segregated waste;
- significant investments to upgrade existing equipment and addition of capacity for high-quality (closed-loop)[3] recycling all over the country;
- standardization of packaging design and composition to increase recyclability;
- enforcement of Extended Producer Responsibility principles to create robust end-markets for recyclate;
- developing waste management into a full-fledged sector of the economy of which recycling is a major part;
- developing and running capacity-building and awareness programmes to upskill workers and create jobs.

Only mechanical recycling units were surveyed for this landscape assessment; chemical recycling is still in its infancy in India and elsewhere. From the India Plastics Pact's perspective, chemical recycling holds huge opportunities and should be explored for the management of certain kinds of plastic waste.

[3] Closed-loop recycling refers to the recycling of plastics into same or similar quality applications. Ellen MacArthur Foundation (2016). The New Plastics Economy Rethinking the Future of Plastics. https://ellenmacarthurfoundation.org/the-new-plastics-economy-rethinking-the-future-of-plastics

Chapter 1: Introduction

Plastic products and packaging have become an integral and essential part of the global economy due to their low cost, versatility, durability, and high strength-to-weight ratio. Global plastic production has risen from two million tonnes in 1950 to 390 million tonnes in 2021.[4] Out of this, the use of plastic for packaging alone accounts for 44%.[5] The very properties of plastics which render them invaluable in many applications, have also led to their persistence in all kinds of ecosystems, urban and rural areas across the world.

Inefficient waste management practices, make plastic pollution much more visible in developing countries, especially those in Asia and Africa. Mismanaged plastics cause choked drains which can lead to flooding in urban areas[6,7] and provide the ideal breeding ground for mosquitoes, and diseases such as dengue, malaria, and chikungunya.[8] Uncollected plastic waste can lead to leaching of hazardous chemicals into soil and water bodies. Unmanaged waste is routinely burnt releasing toxic chemicals into the air enabling formation of particulate matter.[9,10,11]

Data on the quantum of plastic waste generated in India vary with source, with numbers varying from three million tonnes per annum to 10 million tonnes per annum.[12,14] Based on estimates for average municipal solid waste (MSW) generation, share of plastic waste in MSW and population, it is estimated 10 million tonnes of plastic waste was generated in 2022. 94% of plastic waste is thermoplastics and 6% is thermosets.[9] The largest quantity of this waste was generated in Maharashtra (12%), Tamil Nadu (12%), Gujarat (12%), West Bengal (9%) and Karnataka (9%).[13]

To address the challenge of plastic waste management, the Government of India notified the Plastic Waste Management (PWM) Rules in 2016, with the latest amendment in 2022 strengthening the Extended Producer Responsibility (EPR) regulation.[14] The EPR regulation sets out quantitative targets for collecting, reusing, recycling packaging waste and incorporating recycled content into packaging. These targets will drive the recycling of plastic packaging waste helping plastic circulate through the economy.

[4] Heinrich Boell Stiftung Hong Kong Office, Break Free From Plastic Asia Pacific and Institute for Global Environmental Strategies. (2021). Plastic Atlas 2021: Facts and figures about the world of synthetic polymers. Hong Kong. Retrived from https://hk.boell.org/sites/default/files/2021-04/042921-Plastic%20Atlas%20Asia%202021%20-%20web.pdf
[5] Plastic Soup Foundation. (2021). Plastic Facts & Figures. Retrieved from www.plasticsoupfoundation.org:https://www.plasticsoupfoundation.org/en/plastic-facts-and-figures/
[6] Hindustan Times. (2019, October 14). Plastic waste flowing into sea major problem in Mumbai. Retrieved from www.hindustantimes.com: https://www.hindustantimes.com/india-news/plastic-waste-flowing-into-sea-major-problem-in-mumbai/story-X7Kd5TrL46iRzIVQSreYbJ.html
[7] Sohail, S., & Jain, A. (n.d.). Plastic Waste: Will the new rules clear up the clogged mess? Retrieved from www.cseindia.org/: https://www.cseindia.org/plastic-waste-will-the-new-rules-clear-up-the-clogged-mess-3705
[8] Foolmaun, R., & Ramjeeawon, T. (2012). Disposal of post-consumer polyethylene terephthalate (PET) bottles: comparison of five disposal alternatives in the small island state of Mauritius using a life cycle assessment tool. Environmental Technology, 563-572. Retrived from https://www.researchgate.net/publication/225061267_Disposal_of_post-consumer_polyethylene_terephthalate_PET_bottles_Comparison_of_five_disposal_alternatives_in_the_small_island_state_of_Mauritius_using_a_life_cycle_assessment_tool
[9] Gunthe et al., 2021, available at https://www.nature.com/articles/s41561-020-00677-x
[10] Chakraborty et al., 2019, available at https://doi.org/10.1016/j.envpol.2018.11.010
[11] Charaborty et al., 2018, available at https://doi.org/10.1016/j.scitotenv.2017.11.083
[12] Plastic Waste Management – Issues, Solutions and Case Studies : Ministry of Housing & Urban Affairs http://swachhbharaturban.gov.in/writereaddata/SBM%20Plastic%20Waste%20Book.pdf
[13] Central Pollution Control Board. (n.d.). Annual Report 2019-20 on Implementation of Plastic Waste Management Rules, 2016. Delhi. Retrived from https://cpcb.nic.in/uploads/plasticwaste/Annual_Report_2019-20_PWM.pdf
[14] Ministry of Environment, Forest and Climate Change, Government of India (2022). Guidelines on Extended Producer Responsibility for Plastic Packaging. G.S.R. 133(E). https://egazette.nic.in/WriteReadData/2022/233568.pdf

Waste management is needed on a massive scale in India. At present, collection, segregation, aggregation, and recycling are carried out by both informally and formally organized workers, municipal corporations and private enterprises, with varying degrees of involvement. However, credible information/data about the relative contribution of these channels is not available; this hinders both, estimation of the scale of recycling, investment, and infrastructure available at present, and estimation of resources that might be required for effective recycling in the context of India's EPR regulation. Gathering such data is complex given the complicated post-consumer value chain and involvement of waste pickers and "kabadiwalas"[15] in informal recycling. Reported plastic waste recycling rates therefore vary greatly, with ranges between 12% and 60% often quoted.[16,17]

This report aims to understand how plastic waste flows through both the formal and informal channels of collection, segregation, aggregation, and recycling in India. Using primary and secondary research, it will document data about recycling units including number of formal and informal plastic recycling units; their location, the type and quantity of plastic waste collected and recycled, destination of the recyclate and associated end markets. This information will help achieve the following objectives:

- assess the overall landscape of plastic waste recycling in India (recycling rate of both formal and informal recyclers, recycling rate by region, end-market for the recycled plastic, for example, agriculture, packaging, automobile),
- assess gaps in the current plastic waste recycling landscape with respect to policy, infrastructure, and investments/finance, and,
- recommend possible pathways to meet both the EPR targets and achievement of Target 3 (50% of plastic packaging to be effectively recycled) of the India Plastics Pact (IPP) by 2030.

[15] kabadiwala: a person involved in running a small facility or business to collect, sort and sell the sorted dry waste to generate income
[16] World Environment Day: 68% of India's plastic waste unaccounted for. (2022, June 5). Retrieved from www.thefederal.com: https://thefederal.com/news/plastic-waste-world-environment-day-june-5/
[17] Annual Report 2018-19 for implementation of Plastic Waste Management by CPCB https://cpcb.nic.in/uploads/plasticwaste/Annual_Report_2018-19_PWM.pdf

Chapter 2: Methodology

Approach and sampling

Sampling was needed at two points in the plastic waste value chain:

- **City-level:** to understand the flow of collected, segregated, and aggregated plastic waste through formal and informal channels that forms the input stream into recycling, and,
- **Recyclers:** to set out the current landscape of plastic waste recycling in India.

To gather information about the flow of plastic waste from cities, an end-to-end assessment from collection to recyclers, through both formal and informal channels, was carried out in 25 cities by a core team of four people assisted by a team of 20 field staff/assessors. Face-to-face interactions with stakeholders operating along both pathways, formal and informal (waste workers including waste pickers and aggregators)[18], also helped understand the flow of waste plastic. A purposive sample of 25 cities was selected (five in each region[19]) based on size and demographic diversity.

Table 1: List of 25 cities identified for surveys

North	South	East	West	Central
Delhi	Bangalore	Kolkata	Ahmedabad	Bhopal
Chandigarh	Kollam	Guwahati	Mumbai	Indore
Meerut	Pondicherry	Bhubaneswar	Pune	Raipur
Dharamshala	Hyderabad	Patna	Panaji	Nagpur
Rishikesh	Tirupati	Ranchi	Jaipur	Gwalior

[18] To understand the flow of waste plastic in the city, meetings were scheduled with the concerned officials at municipal corporations/ULBs; interactive group discussions were done with informal waste sector workers and communities; one-on-one discussions were held with aggregators/scrap dealers.

[19] North: Jammu and Kashmir, Delhi, Chandigarh, Haryana, Punjab, Uttar Pradesh, Himachal Pradesh, Uttarakhand, Ladakh; South: Karnataka, Kerala, Tamil Nadu, Puducherry, Telangana, Andhra Pradesh; Andaman and Nicobar Islands, Lakshadweep East: West Bengal, Odisha, Bihar, Jharkhand, Assam, Manipur, Arunachal Pradesh, Tripura, Mizoram, Sikkim, Meghalaya, Nagaland; West: Gujarat, Maharashtra, Goa, Rajasthan, Daman and Diu, Dadra and Nagar Haveli; Central: Madhya Pradesh, Chhattisgarh.

Existing information and data on recycling units was collated to create a repository using secondary desk research. Information/data was drawn from the portals of Central Pollution Control Board (CPCB), State Pollution Control Boards (SPCBs), Pollution Control Committees (PCCs), and websites of different ministries of the Government of India such as NITI Aayog and Ministry of Housing and Urban Affairs (MoHUA).

Information about aspects such as installed capacity, type of resin recycled, packaging format recycled and end market of recyclate, was required for the report but was not available at these sources. A field assessment team visited selected sites to gather this data firsthand using a questionnaire: it also used this opportunity to validate data about recycling units in the repository (address and registration status, for example).

Field assessments were carried out using a questionnaire (Annex 1) and schedule provided to the assessment team. The questionnaire was used to carry out the assessment of sample recycling units via questions about infrastructure, supply chain (whether waste came from post-consumer or post-industrial sources; collection and storage; recycling capacity by resin), type of recycling (mechanical or chemical), and end market for recyclate. A schedule was used to collect information about collection, segregation, and aggregation of plastic waste, by both formal and informal channels, in the sample cities.

Given the tight timeline and India's large area, five regions (north, south, east, west and central) were identified and a sample of 30% of recycling units targeted for study in each. The repository mentioned earlier, consisted of 1,924 recycling units, with 30% of that number translating into a target of 577 recycling units covering the country.

This was thought to be a sufficient sample for a landscape assessment also considering that similar studies are not available at this time. Location/city data were available for all 1,924 units in the repository.

Selection of recycling units to be covered during field visits could not be based on installed capacity, type of resin, packaging format recycled, etc., because information about these aspects was not available on the CPCB/SPCB/PCC portals from which the initial repository of recycling units was created. Thus, the selection of recycling units to visit was largely based on their proximity to the 25 sample cities (Table 1); this was necessitated by the limited time available. Proximity also made it convenient to revisit recycling units during the field visits, which was often required to build trust with facility owners, or to verify the operating status of a facility.

As the study progressed a new source of information about recycling units became available in the form of the EPR portal set up by the Central Pollution Control Board. As mandatory registrations began, new business names became available; by the time data collection was closed for this study, an additional 917 recycling units had been entered on the portal. The field assessment also revealed the presence of recycling units (formal and informal) not recorded on either portal, bringing the estimated count of plastic recycling units to 3,098.

A combination of quantitative and qualitative methods was used to collect data from the selected plastic recycling units. A questionnaire covered topics related to infrastructure, supply chain, technology used, and end markets for the recycled plastic. In addition to the questionnaire, open-ended responses to questions about challenges and possible solutions from recycler's point of view were recorded.

Sample size

The field assessment team visited a total of 819 recycling units across India and encountered one or other of the following situations at each:

- the recycler responded to the assessment team's questions
- the owner had changed their business,
- there was no recycling unit at the address visited (as mentioned in government records),
- the unit had permanently shut down,
- the owner was not available,
- incomplete information (follow-up visit needed), and,
- the owner refused to be interviewed/respond to the questionnaire.

Out of 819 visits, the field assessment team was able to successfully ascertain that 600 were operating as recycling units. These visits led to one of the following outcomes

- a response to the questionnaire,
- information that the owner was not available,
- follow-ups for response to the questionnaire, but no response in the project period, and
- owners of the recycling units who declined to respond to the questionnaire

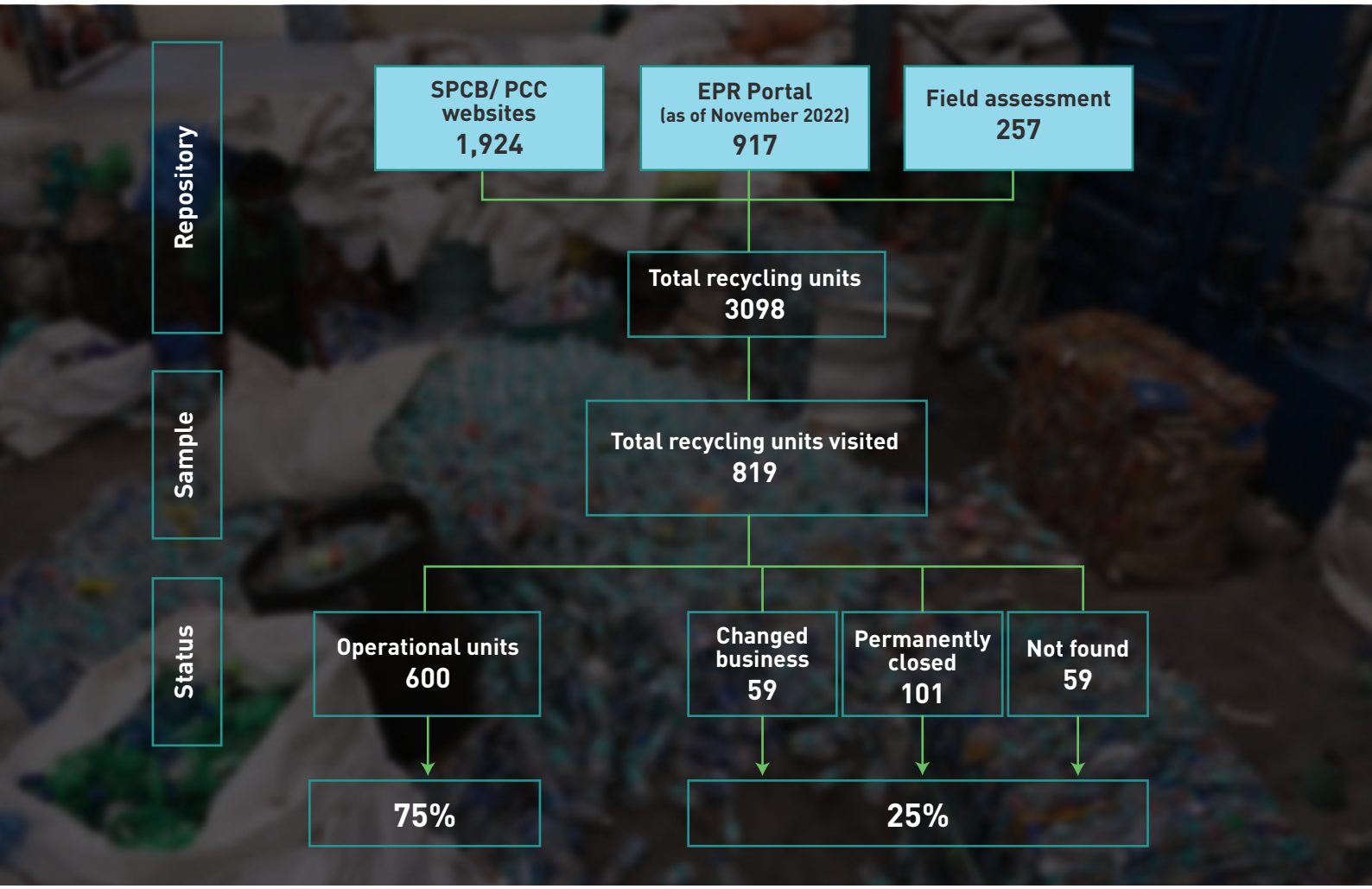


Figure 1: Sample selection

The spatial distribution of recycling units was plotted on a map (Figure 6) and thematic analysis used to analyze open-ended qualitative responses.

Data extrapolation

Some extrapolations were made to estimate trends for the entire country with respect to recycling landscape of the entire country. The formula used for extrapolation is,

$$E_{x,y}=A_{x,y} \times n$$

where,

$E_{x,y}$: extrapolated data for parameter x for resin y

$A_{x,y}$: average data for parameter x from sample for resin y

n: number of recycling units

However, the total number of recycling units (n) for this computation could not be taken as equal to that in the repository (3,098). This was because all visits did not lead to useful outcomes (as described in Sample size, above). Since only 600 of the 819 field visits were classified as successful interviews, the factor (600/819) was multiplied by the total number of recycling units in the repository (3,098) to arrive at the total number of operating recycling units (2,309). This matches, approximately, the number of recycling units registered on the EPR portal set up by the Central Pollution Control Board (CPCB).[20]

Limitations

The limitations of this study were:

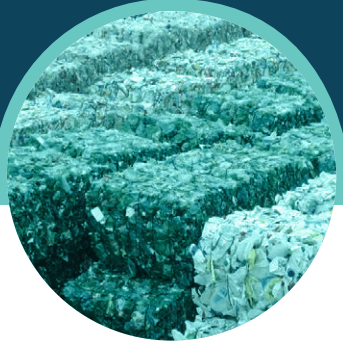
- time available for study (six months)
- limited publicly available information about the location of recycling units, their recycling capacity, and resin recycled
- lack of quantifiable information on end-markets, technology and finance as recycling units were hesitant to share this information
- predominance of informal recycling units throughout the country

Organization of report

The report is organized as follows:

- the next chapter summarises information collected from the surveys, both at city level, and, at recycling units
- Chapter 4, Landscape, draws on the data collected from surveys to describe the recycling landscape in India; extrapolations have been used to estimate trends for the country as a whole for installed capacity, sourcing practices. Qualitative information on equipment, technology and end-markets has been compiled from the responses
- a summary of challenges emerging from the landscape assessment is presented in Chapter 5 followed by recommendations in Chapter 6.

[20] https://eprplastic.cpcb.gov.in/#/plastic/home/main_dashboard



Chapter 3: Field assessment findings

This chapter details out information gathered from the field surveys: it is been presented in two sub-sections. The first focuses on details related to collection, segregation and aggregation of plastic waste collected using city-level surveys. The second focuses on aspects related to recycling, collected by a survey of recyclers.

Collection, segregation and aggregation

Collection and segregation, both have a large impact on the quality of recyclate produced by a recycling unit, and the end markets accessed. Input feedstock for recycling units comes largely from waste plastic collected via both formal and informal channels, but the relative significance of each (formal or informal), may vary with location across the country.

The goal of the field assessments in 25 sample cities was to follow the flow of material to identify and understand variations and practices. Results of the field assessment indicated a city-to-city variation in the practice of segregating waste at household level. Of the 25 sample cities, it was observed that segregation into two categories (dry and wet) was carried out to some extent in ten cities. In the others there was no, or very limited practice of, segregation at source.

Formal

Door-to-door waste collection in the formal sector[21] is typically carried out by *safai mitras*[22] (formal waste pickers). In Tier 1 cities within the sample, such as Delhi, Mumbai, Pune, Bangalore and Kolkata, the collected municipal solid waste is transported to local transfer stations/ aggregation points. Dry waste is usually collected, transported, and aggregated together, not as separate material streams. From here, it is moved to material recovery facilities (MRFs) for secondary segregation. Dry waste is further segregated into multiple categories, one of which is plastic. In most cases, high-value plastic waste is channelized to recyclers. Low-value plastic waste is sent for end-of-life (EOL) disposal (incineration or waste-to-energy) or to landfills, because these are convenient ways to manage waste.

[21] formal sector refers to entities, not limited to private limited firms, NGOs, agencies registered with the urban local body (ULB), Pollution Control Board (PCB) or Pollution Control Committee (PCC). All other entities are considered part of the informal sector.

[22] *Safai mitras*: formal waste collectors who are associated directly with urban local bodies or their engaging agencies.

In some instances, low value plastics (such as MLPs) often remain at MRFs for long durations, because viable end markets (including EOL disposal) are not available. Many waste pickers and aggregators in Kolkata, Patna, and Raipur spoke of the lack of initiatives promoting the collection of low-value, multi-layered plastic. The field assessment team came across many instances of such plastics being burnt, dumped, and leaking into water bodies, especially in these (eastern) regions. The typical flow of post-consumer plastic waste is shown in Figure 2.

A combination of the following collection patterns prevailed in the sampled cities:

- ULBs themselves collect waste and transport to material recovery facilities, where employees on the their payroll, segregate it into two categories (wet and dry). This was found in Ahmedabad, Patna and Kolkata.
- ULBs outsource collection, aggregation, and segregation by engaging NGOs, or companies through tenders/contracts. Indore, Pune, and Mumbai follow this practice.
- a mix of the above two methods, for example, as observed in Raipur and Bangalore.

ULBs generally do not sell plastic waste directly to recyclers, these are channelised through larger aggregators who might specialise in specific types of resins/packaging formats. Many ULBs have yearly contracts/agreements with cement kilns and waste-to-energy plants and dispose municipal solid waste there, including plastics. This is a convenient arrangement for ULBs, but may result in recyclable plastics not finding their way into a recycling unit.

There are exceptions, for instance, the Municipal Corporation of Chandigarh auctions plastic waste directly to recyclers via the Government e-Marketplace (GeM) portal, and the Patna Municipal Corporation has its own plastic recycling facility.

Informal

All over the country, informal pathways for collection, segregation and aggregation dominate over formal ones. The scale of operation and therefore quantity of plastic waste material collected by the informal sector is significantly

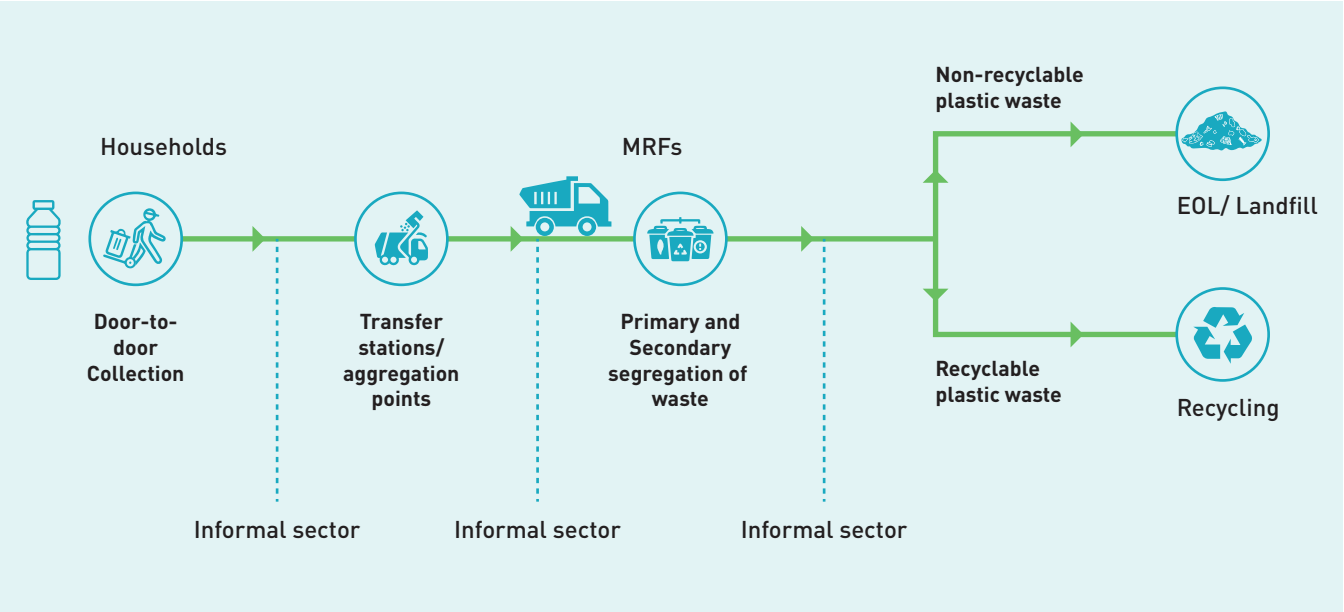


Figure 2: Plastic waste flow through the formal channel

[23] Nallathambi M, Prasad G, Samuel, S. (2018). Life cycle inventories of plastic recycling-India. Retrieved from https://www.ecoinvent.org/files/sectorial_report_sri_plastics_report.pdf

[24] Informal waste collectors: informal actors who collect plastic waste from households, marketplaces, etc., and may be associated with a waste management organization or agency.

higher than that collected by the formal sector but reliable data on quantities collected by both, and what is sent for recycling are lacking.[23]

In addition to the formal channel's door-to-door collection of waste, informal waste collectors[24] also collect plastic waste from households, streets, dump yards/landfills and markets, segregate it and sell it to aggregators. The hierarchy of aggregators varies with location and depends on the quantity of waste generated. Aggregators may segregate waste again by resin or packaging format and then sell it on to recyclers, either formal or informal.

During the field assessment, voluntary organisations were found to be playing an important role as aggregators, in some cities, receiving plastic waste from waste pickers and segregating it for sending on to recyclers; Waste Warriors and Clean Himalayas, for example, were found to be actively working in Dharamshala (Himachal Pradesh) and Haridwar (Uttarakhand), respectively.

In a typical scenario, waste pickers sell plastic waste to aggregators at different prices for different resins. However, in some cities, such as Patna, Gwalior, and Nagpur, aggregators buy plastic waste of all resins at the same price from waste pickers but sell it ahead at resin-wise prices to recyclers. Field interactions suggested that there was a lack of awareness among the waste pickers about the types and prices of different resins.

[further detail on the informal waste sector and its role in plastic waste management is available in a separate body of work reported by the India Plastics Pact]

Recycling

A description of the data collected during the field assessment is presented here with more detail in Chapter 4 (Figure 1). The largest number of recycling units (43%) was found in the western region, followed by the southern (25%) and northern (22%) regions. By state, the largest number of recycling units was in Gujarat (876), followed by Delhi (386) and Tamil Nadu (292): about half of the recycling units in India are located in these three states.

Many of these units lie in or close to four important industrial belts of the country: Gurgaon-Delhi-Meerut in the north; the Ahmedabad-Mumbai-Pune belt in the west, and Bangalore-Coimbatore, and Kollam-Thiruvananthapuram in the south-west. These belts are also situated in the country's top plastic waste generating states, and are close to large urban areas, ensuring an uninterrupted feedstock of waste plastic.

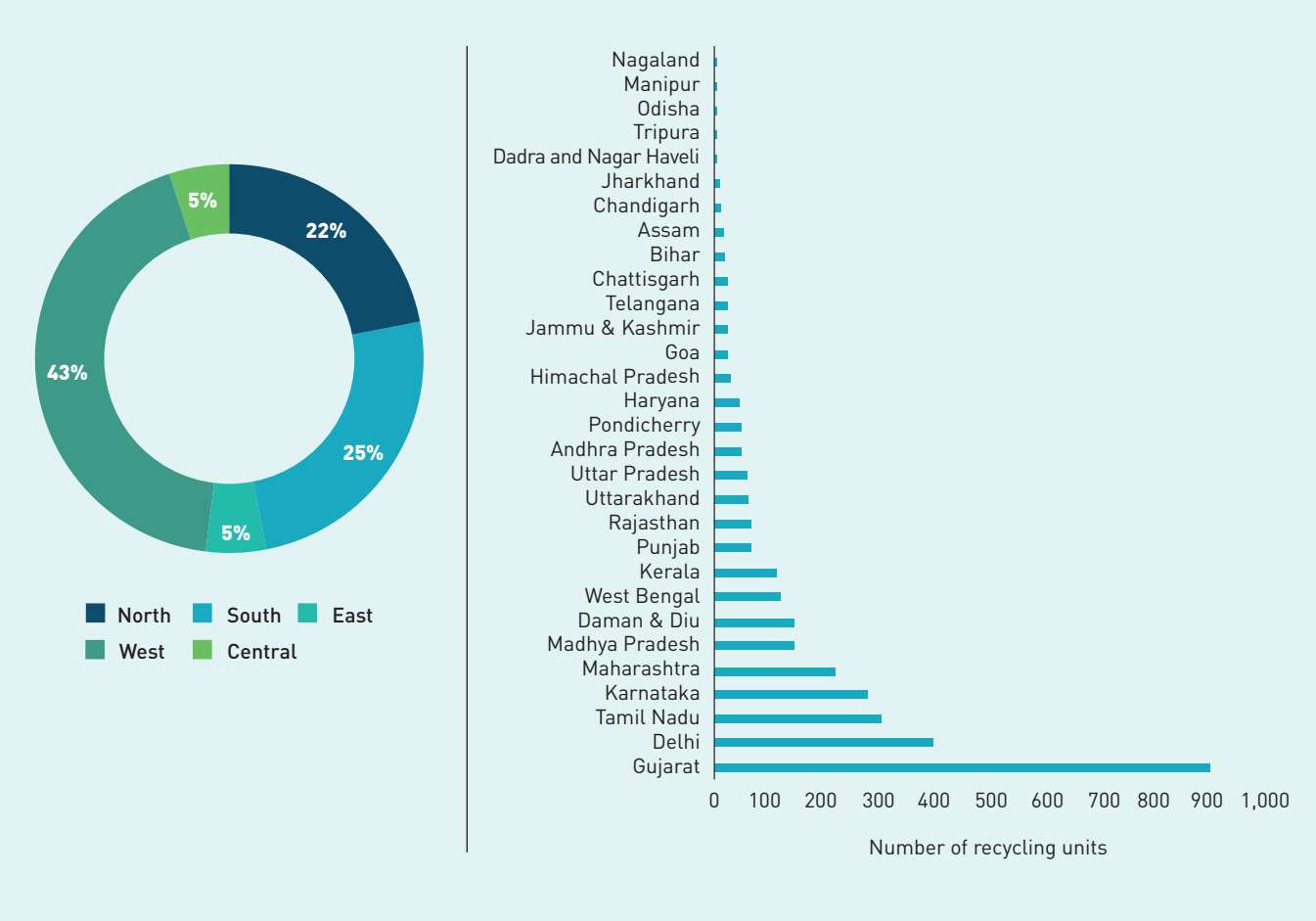


Figure 3: Distribution of plastic recycling units in India, by region (on left) and by state (on right)

Typically, recycling units are located:

- inside cities,
- on the periphery of cities, or
- in designated industrial estates[25] generally outside cities.

As is true for activities in other parts of the plastics value chain, recycling activities are carried out formally and informally. For this study, formal plastic recycling units are defined as those registered with the State or Central Pollution Control Boards/Pollution Control Committees or those appearing on the EPR portal. Such units have a consentto Operate certificate from the concerned SPCB/PCC. These consents indicate that the units meet all environmental protocols with regard to emissions, water disposal and waste disposal.

Informal recycling units are those not registered with the above government agencies and may be of two types:

- **Type 1:** those which have equipment (such as shredders, extruders and washing lines) for recycling but choose not to register as recycling units (to avoid inspection and monitoring). Information about quantities of recyclate and equipment used for processing was only obtained if the owners cooperated.
- **Type 2:** small-scale backyard recycling units which are owned individually or by communities. These can be located near landfills or anywhere in a city with all operations, including processing, carried out in small rooms/backyards. It was not possible to identify resins recycled, equipment used, if any, and quantities collected/processed because owners did not give out information to outsiders.

[25] These are areas developed into industrial plots by government agencies, which can be bought or leased by someone wanting to set up a factory/industrial unit.

Figure 4: A typical Type 1 informal recycling unit

Figure 5: A Type 2 recycling unit manufacturing recycled blocks from mixed plastics

Informal recycling units of both types are located in areas such as Kolabagan, Kolkata (West Bengal); Dhoraji, Rajkot (Gujarat); in the Gujarat Industrial Development Corporation located at Vatva; Ahmedabad (Gujarat); Narela-Bawana, Delhi; and Bachupally, Hyderabad (Telangana). Discussions with recyclers suggests there are 15,000 such units across 70 clusters in the country.

During the field assessment, responses were received from 479 recycling unit owners, out of which 24% were informal, and belonged to Type 1, as described above. The remaining (76%) were formal recycling units. The degree of certainty of assessment is higher for formal recycling units, but low for the informal recyclers (Type 1 and Type 2) because of the reluctance of Type 2 informal recyclers to reveal information.

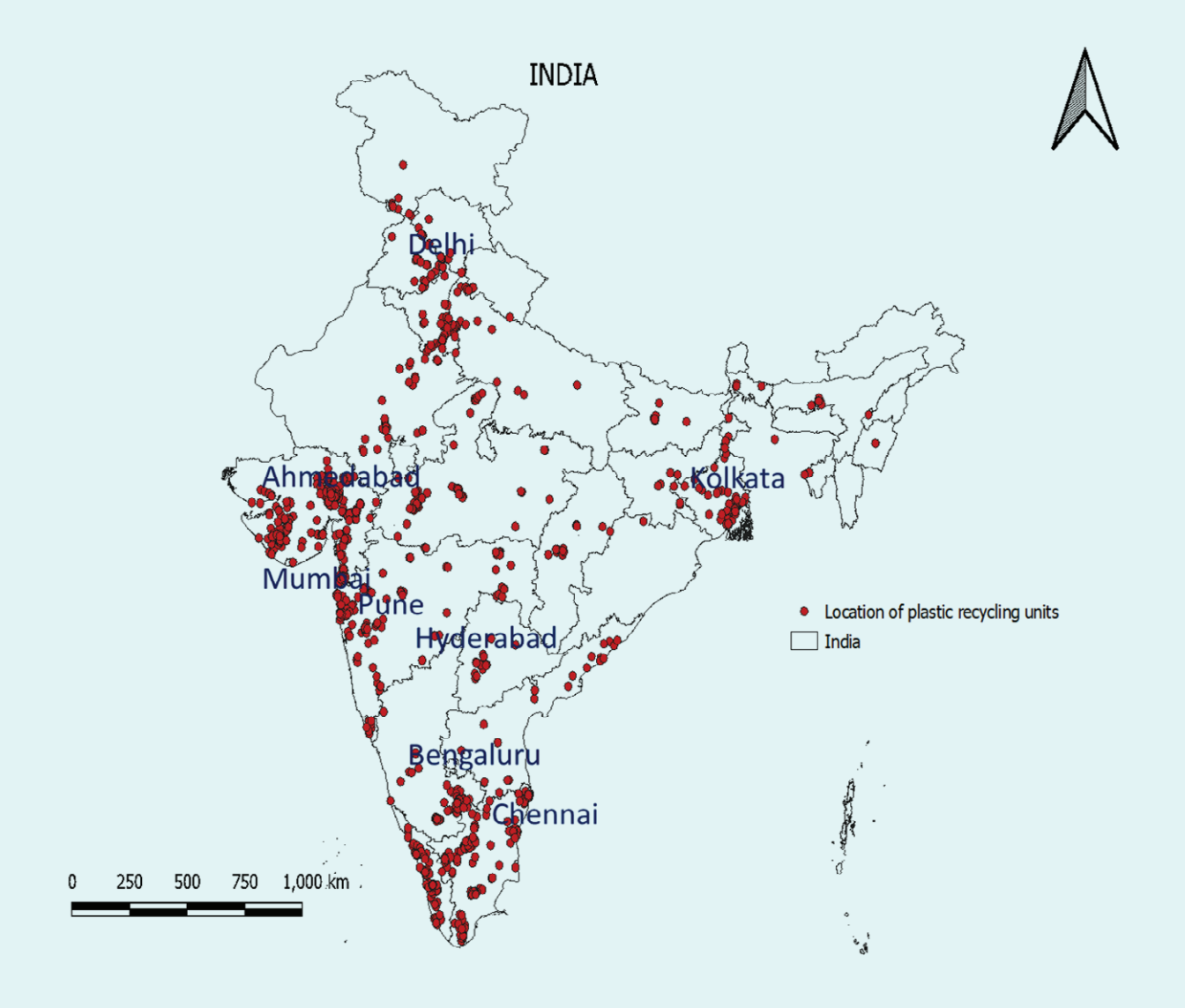


Figure 6: Plastic recycling hotspots in India (2,309 recycling units)

Figure 7 below shows the operating status of the 800 recycling units visited during the survey: the recycling units broadly fell into four categories:

- those that were operational
- those not present at the addresses provided in government records
- those which had shut down permanently
- those which had changed their business.

Overall, 73% of the recycling units visited were operating. The largest number of operational recycling units was in the south (nearly 90%), followed by in the north, east, west and central. The number of units not found at the recorded address was highest in the central region, followed by west, east and north. In the southern region all the recycling units were at the address entered in government records.

Overall, 12% of the recycling units visited were found to be permanently closed, with a significant share of such units in the west, owing to reasons such as labour shortage, high operating costs and low demand for end-product: these will be discussed later in the report.

Many recycling units had also changed their business (7% of recycling units sampled). These units and their owners were found at the given address but had stopped recycling operations and had started to manufacture an entirely different product or plastic products (such as buckets and toys). The share of such recyclers in the sample ranged between negligible in the south to 18% in the central region.

A significant portion (71%) of recycling units interviewed were polyolefin (LDPE, HDPE and PP) recyclers. About 18% of recycling units interviewed were categorised as 'Others' and were recycling plastics such as ABS, nylon, polycarbonates and EVA. Units recycling mostly PET and PVC made up 6% and 5%, respectively, of the total sample.

It is interesting to note that at the time of sampling, half of the recycling units were registered both on the EPR portal and had a Consent to Operate from the CPCB/PCBs; registration on the EPR portal by recycling units makes them eligible to generate credits which can be purchased by brands to meet their EPR obligations.

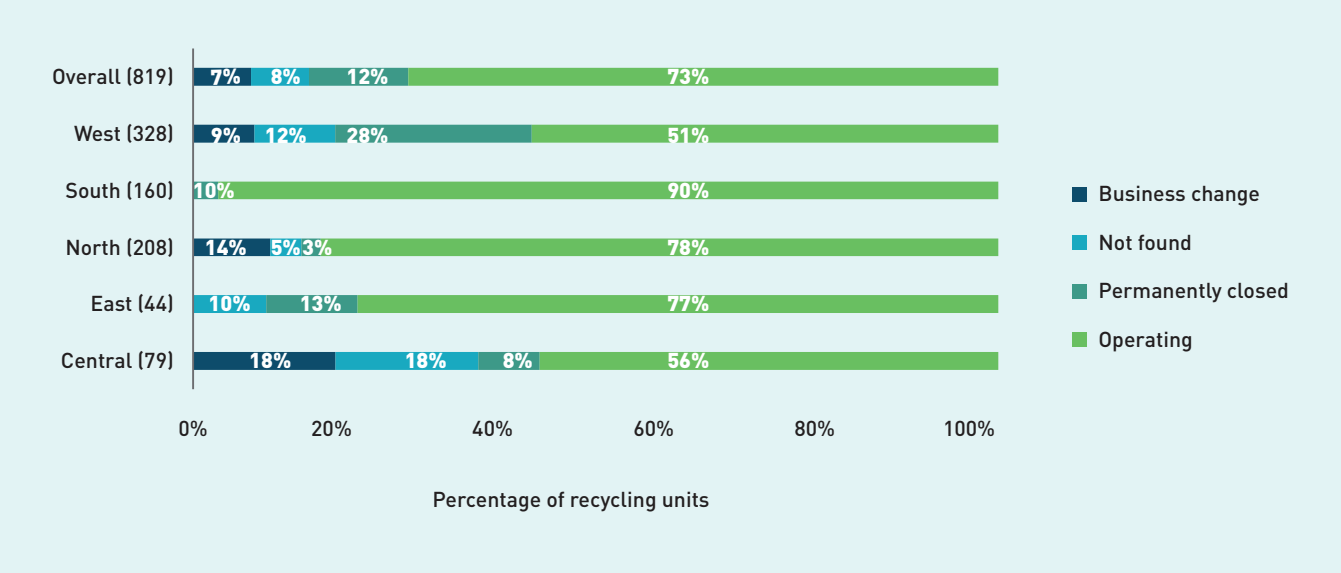


Figure 7: Functional/operating status of recycling units sampled, by region (number of recycling units visited mentioned in brackets)

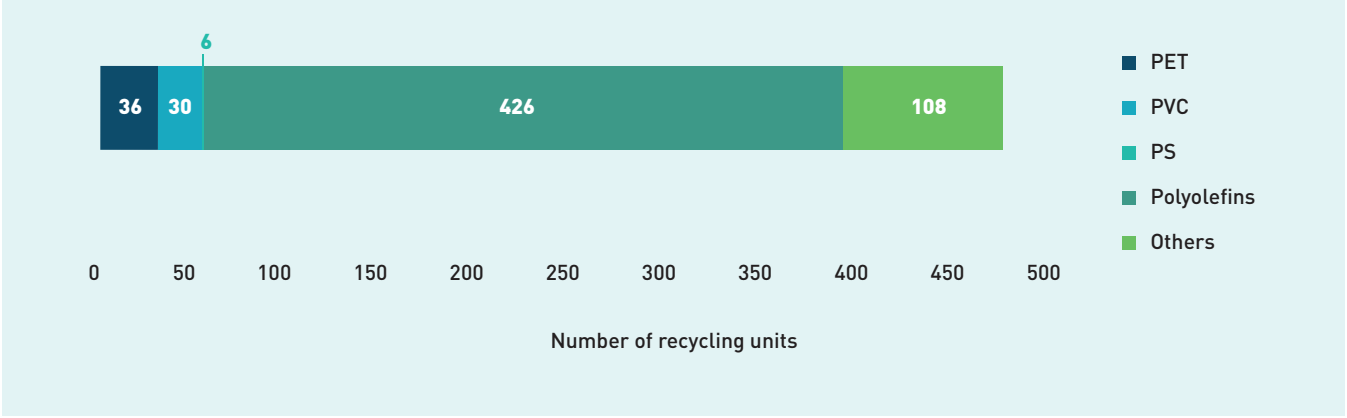


Figure 8: Number of recycling units sampled, by resin

Chapter 4: Landscape

In this chapter, a landscape of plastics recycling in India is drawn up based on inferences from the surveys in the previous chapter. Using a questionnaire (quantitative and qualitative), 479 plastic waste recycling units were interviewed on the following aspects: infrastructure, supply chain, technology, and end-market. The analysis included objective responses on parameters such as storage capacity, recycling capacity, resin recycled. Interviews also captured subjective responses to support the data. These parameters will help analyse the current situation of plastic waste recycling units in India, assess the gaps, and recommend possible pathways to meet the EPR targets and Target 3 of the India Plastics Pact by 2030.

In this section, the graphs/charts are expressed in percentage or total count (extrapolated numbers) which will help draw up the landscape with respect to plastic recycling for the entire country.

Installed capacity

The total number of operating recycling units in India is estimated to be 2,309 with a cumulative installed capacity of 47,77,639 tpa (Figure 9); of these 71% process polyolefins, 6% process PET, while 18% of recycling units process resins in the 'Others' (that is, resins other than PET, polyolefins, PS, PVC) category. A significant portion of the installed capacity is for low-quality recycling which will not help achieve the EPR targets for incorporation of recycled content in packaging, but which prevents plastic from reaching the environment.

While the number of PET recycling units makes up a small percentage of the total number of operating recycling units, their share in the overall installed capacity for all plastic resins in the country is more than one-third (37%). PET recycling units are usually larger than those processing other resins.

The average installed capacity of polyolefin recycling units was estimated to be 1,334 tpa for each unit which is much lower than that of PET recycling units (12,045 tpa); however, the absolute number of polyolefin recycling units is larger so their share in the overall installed capacity is 46%.

Recycling polyolefins is cheaper than recycling PET because the equipment required is cheaper, locally manufactured, and does not take up much space. Recycling units classified in the 'Others' category contribute to 12% of the installed capacity; as mentioned earlier, such units focus on recycling plastics such as EVA, polycarbonates, nylon and ABS.

About 5% of installed capacity corresponds to PVC recycling with under 1% corresponding to PS recycling.

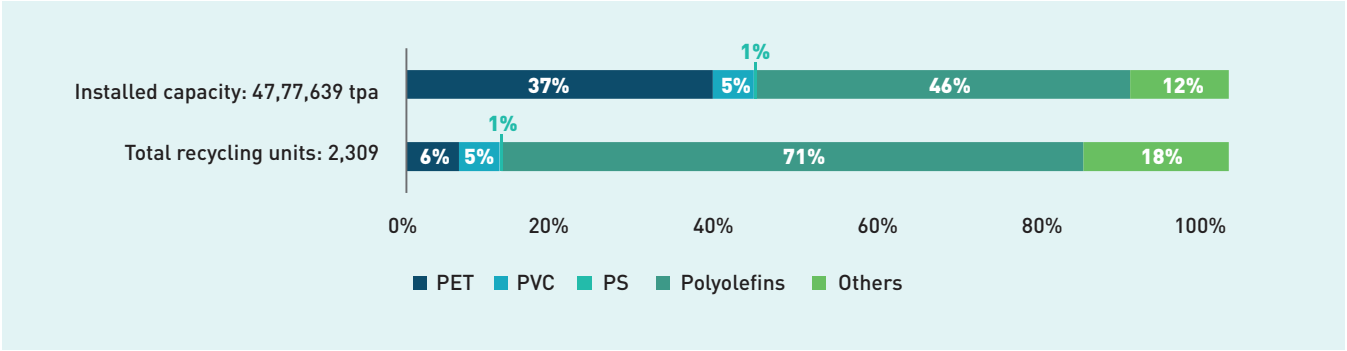


Figure 9: Relative share of number of recyclers and installed capacity, by resin

In terms of recycling unit area, PET recycling units are, on average, about 30 times larger than those of units for other resins (average area of a PET recycling unit is about 14,000 m2). PET recycling involves more steps. As a result, the requirement of space is also higher compared to other resins as more equipment is required. For all other resins, the plot area ranges between 250 and 650 m^2.

Most recycling units store two to three days of input material to buffer against market volatility, transportation delays, raw material prices and availability. During the field assessment, a few recyclers mentioned that they would also stock recyclate (output material) if they do not get the desired price for it.

The distribution of plastic recycling units as shown in Figure 3 (previous chapter) shows that the number of units in the eastern and central regions are far lower than in other parts of the country (10% in both regions, east and central, combined, versus 90% in all other regions combined).

A lack of industrial hubs, of infrastructure, roads and a reliable electricity source are some of the reasons cited for this. This large disparity in availability of installed capacity has an impact on the management of plastic waste in those regions, which was corroborated by the field assessment team, and some media reports.[26] Most aggregators in this region transport high-value plastic waste to other states, especially Delhi and Gujarat. Low-value plastic waste is collected only in a few pockets, primarily driven by EPR requirements. Most of the collected low-value plastic waste is channelled to cement kilns or waste-to-energy plants, or then dumped/burnt in the open.

This is also true in the mountainous regions of north India (Himachal Pradesh, Uttarakhand, Ladakh, and, Jammu and Kashmir).

Source of input feedstock to recycler

'Source' here refers to the point of generation of plastic waste such as households or industries from where the recyclers procure their input feedstock. The feedstock may be collected directly by recyclers from the source or indirectly via scrap dealers and aggregators. The type of sourcing (direct or indirect) affects the quality of feedstock and recyclate. The waste generated at source is usually a mix of plastic and other materials. This is why the availability of infrastructure for collecting and segregating waste is important to ensure a consistent flow of good quality feedstock to recyclers. Absence of an efficient system for collecting segregated dry waste results in contaminated/mixed plastic reaching recyclers which affects quality of recyclate. The urgent need to practice waste segregation at scale was corroborated during interviews.

Understanding the supply chain is important for assessing the recycling landscape. Questions related to the input feedstock (municipal post-consumer, industrial post-consumer, or both), quantity of plastic waste reaching recycling

[26] Need for Waste Management in Northeast India: 30 December 2022 https://www.sentinelassam.com/north-east-india-news/need-for-waste-management-in-northeast-india-518677#:~:text=Nearly%2085%25%20of%20waste%20in,near%20water%20bodies%20or%20forests

units, type of resin and packaging format recycled, and sourcing method (direct or indirect) were asked during the field assessment.

Plastic waste generated by factories/plants/warehouses is termed industrial post-consumer waste while the plastic waste discarded by individual consumers is termed municipal post-consumer waste. Responses to a question on the source of feedstock indicated that that just under half of recycling units (45%) obtained it from a mix of municipal post-consumer and industrial post-consumer sources (Figure 10). It is well-recognized that industrial sources of waste are less contaminated than post-consumer waste and recycling units often add post-industrial waste to improve yield.[27] It is estimated that 36% of recycling capacity fed by municipal post-consumer waste.

Input feedstock for recycling units commonly comes via two channels:

- Direct sourcing: this refers to the procurement of plastic waste by recycling units directly via arrangements with waste generators, such as residential communities and industries.
- Indirect sourcing: this refers to the procurement of plastic waste by recycling units through aggregators and scrap dealers.

Many recycling units procure feedstock from both sources.

Almost half (47%) of recyclers use both sources (direct and indirect) of input material. Recycling units either source directly from industries or bulk waste generation sources like residential or commercial places or source from indirect pathways such as scrap-dealers or aggregators. Recycling units which source indirectly have internal quality control procedures to manage input quality, while others carry out secondary segregation, raising costs.

For the following sections, Equipment and technology, and End-markets, it was not possible to quantify information from the surveys because of the reluctance of owners of recycling units to share information. However, qualitative inputs, corroborated via conversations with recyclers and other stakeholders in the value chain, are presented below.

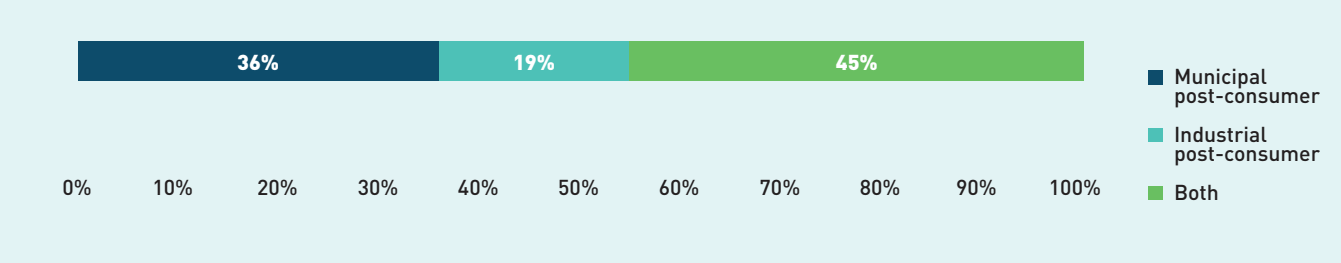


Figure 10: Source of input feedstock to recycling unit, (municipal, industrial or both) by region

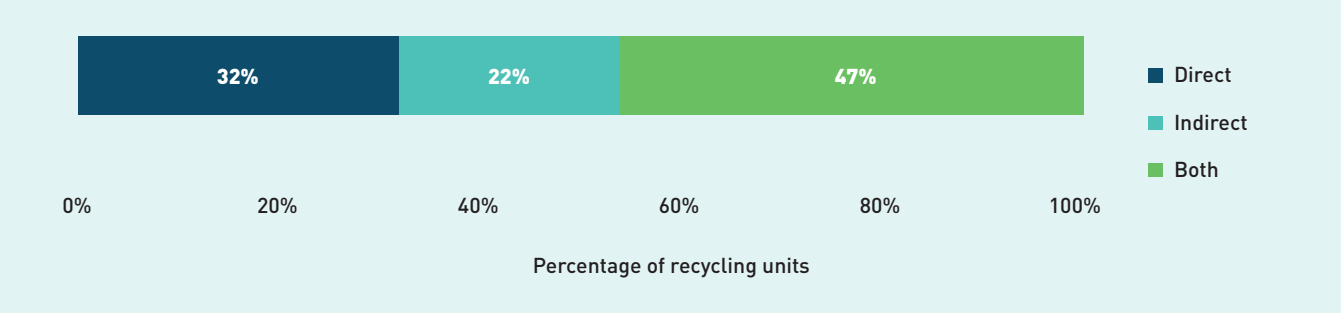


Figure 11: Sourcing of plastic waste (direct, indirect or both)

[27] This was corroborated by interviews with recyclers

Equipment and technology

Availability of equipment such as conveyer belts, balers, and forklifts in MRFs improves the efficiency and quality of segregation; however, the field assessment indicated that well below 10% of MRFs had such equipment. This affects the quality of input feedstock and is a widespread challenge in the recycling industry. Although waste is generated in large quantities, the recyclable component is usually mixed with wet waste, reducing its intrinsic value and the quality of recyclate.

When waste enters a recycling facility it may be sorted manually or by a combination of manual and automated processing depending on the level of investment made by the owner. Primary sorting includes removal of contaminants such as soiled plastics and non-compatible plastics (for example, PVC and PE from a PET stream): this is generally manual. Automated sorting includes use of near-infrared sensors which enables optical sorting by resin. This technology is not widely used because it is expensive to install. For many owners of units processing polyolefins, investments in technology are a challenge because they produce recyclate for low-value applications, with narrow profit margins (<10%).

Almost all polyolefin recycling units, irrespective of their installed capacity, are equipped with locally made shredders and extruders; although washing is a primary process in recycling, many polyolefin recyclers do not have washing lines while all PET recycling units do.

Recycling of PET is both, capital-intensive and must meet higher end-market specifications (as compared to polyolefins). Some estimates of the cost of setting these up can be found in Annex 2. Given the emphasis on closed-loop recycling articulated in the EPR Guidelines, many large PET recyclers are investing in solid state polycondensation (SSP) technology. Apart from the technology and cost of equipment, the space required for operation and storage also have implications on the cost of setting up a recycling unit. PET recyclers typically make larger investments than most polyolefin recyclers; however, government regulation supporting closed-loop recycling will encourage recyclers to invest in newer technologies.

End markets

A reliable and stable end market (the sector of the economy where these new products, such as granules, pellets, fibre, are made into new products) is crucial for the recycling industry as it determines the demand for recyclate and therefore, the financial sustainability of a recycling unit.

Several steps are needed during recycling to turn discarded plastic waste into recyclate which can be used to make new products. High quality recyclers mostly work on long-term contracts while low quality recyclers sell by weight and specification according to demand.

Field observations and interactions with plastic recycling units indicated that polyolefin recyclers sell recyclate (mostly as granules) to manufacturers of pipes and other injection-moulded consumer items such as buckets, barrels, toys and flower pots. Polyolefin recyclates are also used in construction, electrical and electronic equipment manufacturing sectors. The construction industry uses polyolefin recyclates for pipes, flooring, and roofing sheets. Some high-quality polyolefin recyclate is sent to the automobile industry to manufacture interior parts (door panels, dashboard components), exterior parts (bumpers, fenders, body panels), underbody parts (skid plates, engine covers) and battery casing for electric vehicles. For PET recyclers, textiles are the most common end market. rPET flakes are mostly recycled to polyester staple fibre, and to sheets and straps. Currently, packaging is not a large end-market for recyclate, with just a few recyclers manufacturing high-end rPET and rPE to be used back in rigid packaging applications. Recycled content in flexible packaging is used to make garbage bags (low-quality polyolefins) and carry bags.

A very small number of recyclers made high quality recyclate to be put back into flexibles, mostly used to make tertiary packaging (overwraps).

The current low rate of recycled content incorporated back in packaging was corroborated by data in the India Plastics Pact Year One report indicating that less than 1% recycled content was used by signatories to the Pact. The changing regulatory framework is likely to increase the demand and use of recycled content in packaging.

Most recyclers felt that the regulations to allow using recycled plastics for food-contact primary packaging along with the new EPR regime would favour packaging as an end market for recyclate but this would need to be supported by investments to upgrade machinery for washing and decontamination.

Installed capacity and EPR targets

The new EPR Guidelines were introduced by Government of India in 2022, with quantitative targets for collection, recycling, and the use of recycled content in packaging. At the time of sampling, Producers, Importers and Brand Owners (PIBOs) were mandated to meet a collection target of 70% in FY 2022-23, going up to 100% in FY 2023-24.

Recycling targets of 30% to 50% (by category, Table 2) are effective from FY 2024-25. Targets for incorporation of recycled content range from 5% to 30% (by category, Table 2) are to be met from FY 2025-26 (Table 2).[14]

Recycling plants are built specific to resins, and any additional plant capacity requirement at national level should also be determined resin-wise. This determination is a challenge because, EPR targets are not set by resin, and so, data collected by the Central Pollution Control Board are not broken down by resin.

As evident in Table 2, EPR targets are specified in terms of packaging format, that is, rigid and flexible (including MLP and compostable films), which does not allow for meaningful projections of additional capacity required.

Recycling capacity may appear to be sufficient at first glance, but meeting EPR targets will require only high-quality (closed-loop) recycling. This capacity is low (about 36,500 tpa for PET and 73,000 tpa for polyolefins). Augmenting it will require investments (expanded in Annex 2), but also stepping up collection, segregation and transport of plastic waste to recyclers.

An estimate of the recycling capacity required in the backdrop of the EPR Guidelines and targets therein (Table 2) is presented here. Calculations use data reported in previous chapters for installed capacity and quantities of plastic packaging placed on market by PIBOs on the Central Pollution Control Board's portal (link here).

It is estimated that in 2025-26, over 7,00,000 tpa of high-quality recycling will be required. In 2028-29, the additional requirement will increase to over 20,00,000 tpa, the bulk (63%) of which will be for Category I (Rigids).

Table 2: EPR targets for brand owners for recycling and incorporation of recycled content back into packaging

Plastic packaging category	Target for	2024-25	2025-26	2026-27	2024-25	2027-28
Category I: rigids	Recycling	50%	60%	70%	80%	80%
	Incorporation of recycled content	-	30%	40%	50%	60%
Category II: flexibles	Recycling	30%	40%	50%	60%	60%
	Incorporation of recycled content	-	10%	10%	20%	20%
Category III: multi-material flexibles	Recycling	30%	40%	50%	60%	60%
	Incorporation of recycled content	-	5%	5%	10%	10%

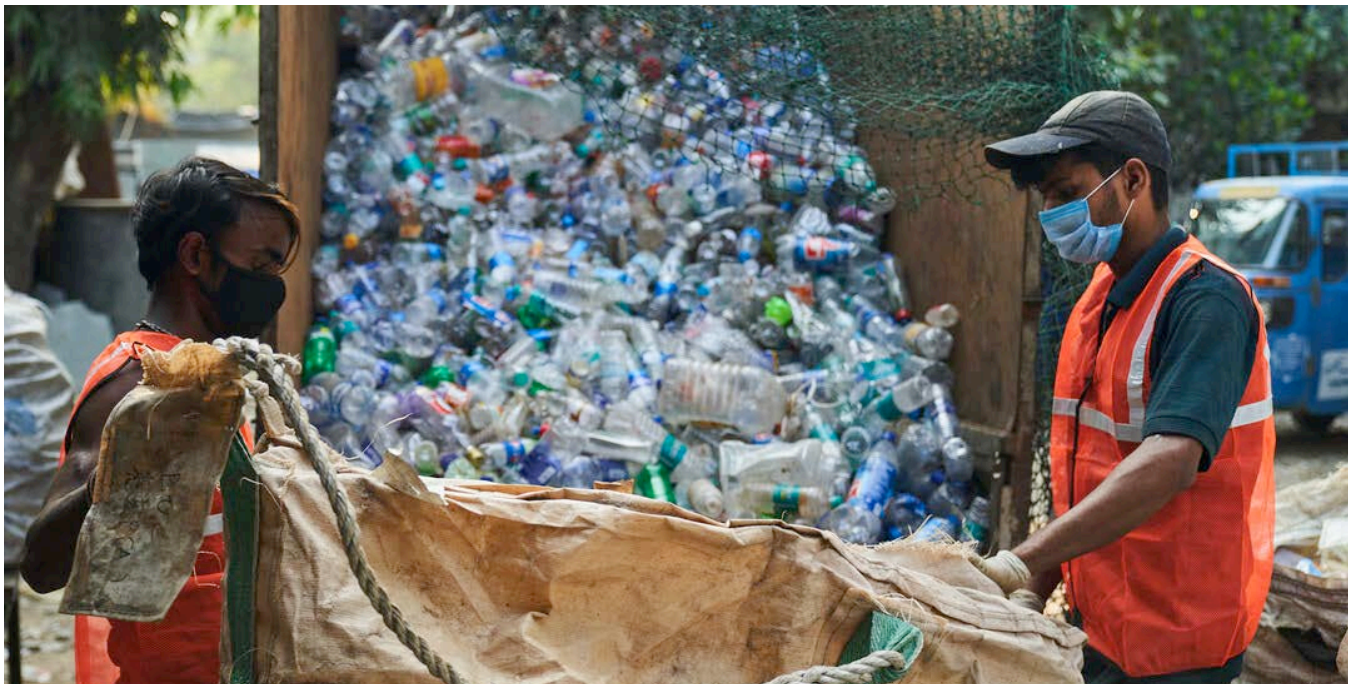
Chapter 5: Challenges

The challenges faced by the recycling industry have been drawn from responses to the questionnaires, and from observations during the field assessments and visits. It is convenient to divide the challenges broadly into those relevant to the quality of input feedstock, those encountered in the recycling unit, and those pertaining to output, or recyclate. Some cross-cutting challenges are mentioned at the end.

- **Input: this refers to feedstock entering recycling units.**
  - **Inadequate collection of municipal waste (with plastic waste a subset):** the frequency and coverage of collection of waste from all generators does not meet the requirement, leading to leakages.
  - **Absence of direct linkage between recyclers and ULBs:** (never previously part of the waste flow from ULBs). This prevents a smooth flow of feedstock to recycling units.
  - **Poor quality of waste reaching recycling units:** segregation of waste at source is not practiced consistently or at scale, which results in contaminated waste feedstock for recycling. This adds to the cost of processing (washing, for example), for a recycler, and may also limit end-markets.
  - **Insufficient space to store and segregate collected waste:** insufficient material recovery facilities slow down sorting and hamper segregation, lowering the quality of waste reaching recyclers.
  - **Lack of basic infrastructure,** such as roofs, at aggregators leading to contamination by dust, as aggregators typically store the collected material openly.
  - **Loss of material value:** a tendency to send collected waste to end-of-life fates such as landfill, incineration, cement kilns and waste-to-energy, rather than to recyclers, since these are convenient and cost-effective ways but prevent the value of waste plastic from being realised.
  - **Variability in supply of input waste material:** seasonal variations affect patterns of consumption of packaging such as beverage bottles.
- **At recycling facility**
  - **High dependence on manual sorting of input feedstock:** partly a consequence of poor segregation at source, manpower costs rise with the requirement for an additional round of segregation in the recycling facility.
  - **Use of poor-quality equipment:** cheap equipment (such as shredders and extruders) which is easily available but often breaks down, affects the quality and rate of production.
  - **Absence of specific technology:** equipment for metal separation, deodorizing, de-inking, for example, which can greatly improve recyclate quality is not available or is expensive for recyclers in the absence of economies of scale; qualified technicians will be required to operate these machines.

- **Unreliable supply of electricity and water at some locations:** interruptions in electricity and water supply, especially in the case of PET, can hamper recycling operations in some parts of the country.
- **Underutilized installed capacity:** many small and medium-scale recycling units simply do not operate to capacity for several reasons, including labour shortages. The available capacity can be put to good use, particularly in the new EPR regime.

- **End markets**
  - **Absence of capacity for high quality recycling:** while a large unused installed capacity exists, facilities for high quality (closed-loop) recycling able to meet present demands are insufficient.
  - **Volatility in crude oil prices:** demand from end markets for recyclate can be significantly affected by fluctuating prices of crude oil; fluctuations also affect the price recyclers pay to procure waste material.
- **Cross-cutting**
  - **Lack of investment in recycling:** many investors and recyclers have been in the 'wait-and-watch' mode in absence of clear policy direction; this is expected to change with the new EPR Guidelines mandating recycling targets and incorporation of recycled content into packaging.
  - **Availability of skilled and unskilled workers:** as workers move higher up in the labour market, fewer workers are available for recycling work (may not be perceived as desirable); recycling itself is not a highly profitable business.
  - **Unstandardized packaging composition:** there is an increasing number of relatively small, direct-to-customer businesses which often use packaging compositions different from those in the mainstream/conventionally used. Small, local brands also use different packaging types with cost driving the choice of material in both cases, rather than ease of recyclability. These material choices hinder recycling.
  - **Uneven distribution of recycling units across India:** with units located largely in industrial estates or close to large urban areas, there are several regions underserved by recycling facilities. Waste is transported to recycling hubs which is expensive and carries a large carbon footprint.



Chapter 6: Recommendations

The report sets out a landscape of plastics recycling in India and identified challenges in achieving mandatory EPR targets and voluntary targets on plastics recycling. The India Plastics Pact through its targets and commitments from Pact members will play an instrumental role in supporting the advancement of closed-loop recycling. Mentioned below are some of the overarching recommendations aligned with the Pact which can improve the current state of recycling in India.

- **Input: this refers to feedstock entering recycling units.**
  - Ensure traceability of feedstock with the help of digital technology
  - Create large-scale awareness and behaviour change through campaigns with a clear and consistent message to segregate at source.
  - Encourage collection of segregated, clean post-consumer waste through different schemes and channel to a recycler
  - ULBs to focus attention urgently on
    - › maximising collection of MSW;
    - › segregation of waste at source (at least into dry and wet)
    - › building their capacity and awareness on importance of recycling as a means of waste management
    - › establishing end-to-end linkages to enable waste to be channelized to recyclers
    - › setting up infrastructure for storage and sorting (many successful models are operating across the country).
- **Recycling units**
  - Inject capital to upgrade existing equipment for sorting, washing, and extruding.
  - Inject capital to augment installed capacity of high-quality (closed-loop) recycling, especially for polyolefins and PET. This could be done via external investments or easing financing options through banks (lower interest/higher repayment tenure)
  - Provide access to testing equipment to assess the quality of feedstock and recyclate
  - Increase awareness, capacity-building, and skilling programs for machine operators and technicians at training institutes such as the Industrial Training Institutes (ITI) located across India. Promote knowledge and technology transfer to introduce and rapidly scale newer technologies in Indian recycling ecosystem.
  - Set up plastic recycling parks across the country to scale the capacity of closed-loop recycling

- **End markets**
  - Strictly enforce of EPR to encourage packaging as an end-market
  - Encourage use of recycled content in plastic products and packaging
  - Develop methods to determine percentage of recycled content in packaging
- **Cross-cutting**
  - Standardize packaging compositions and labelling for adoption across industry
  - Develop standards for both, recyclates as well as products incorporating recycled content
  - Create widespread awareness and outreach on India Plastics Pact's technical guidance to increase chances of adoption into business practices
  - Develop plastic recycling into a formal sector of the economy to attract priority lending from banks and other financial institutions
  - Set up recycling facilities within a radius of 100 km to 150 km of urban centres/sources of MSW

Chapter 7: Conclusion

The work in this report provides an overview of the current landscape of plastics recycling in India with respect to installed capacity, feedstock, equipment, technology and end-markets. This was arrived at through primary surveys of 819 recycling units.

It is important to set out the landscape because a large installed capacity for high-quality, closed-loop recycling is necessary for (i) achieving the India Plastics Pact's targets, and, (ii) meeting the targets stated in the Government of India's EPR Guidelines.

India's recycling landscape for polyolefins is dominated by micro, medium and small-scale enterprises (MSMEs). About 2,300 recycling units with an installed capacity of 47,77,639 tonnes per annum (tpa) operate at country level and are located in four main industrial clusters, concentrated in the West, South and North; very few units (percentage of number sampled) are to be found in the East and central regions of the country which leads to large quantities of waste being mismanaged.

Overall, utilization rates are low for many reasons, including unavailability of quality feedstock and trained/skilled labour.

The largest number of units, about 65%, recycle polyolefins and most have shredders and extruders, at minimum. Somewhat larger units (these are mostly PET processing units) have washing lines in addition. A consistently observed trend was the use of recyclate in low-value applications, that is, is not of the closed-loop type; however, there is a large demand for the products made of recyclate - furniture, toys, carry bags, for example.

Less than 5% of current installed capacity is fit for closed-loop recycling which highlights the need for capacity expansion of high-quality recycling to meet EPR targets. Meeting the EPR targets for incorporation of recycled content will mean that by 2025-26, more than one-third (34%) of recycling operations in the country will need to be of a high quality (closed-loop).

For the Indian recycling sector to make the required transition in capacity and quality of output, significant investment will be required in mechanical recycling. These will need to be complemented by large scale chemical or non-mechanical recycling technologies. To facilitate such a transformation will require concerted action by policy makers, businesses and investors.

Annex 1

Questionnaire

1. **Name of the Recycler:**
2. **Registered with:**
   A. CPCB
   B. SPCB
   C. Not Registered
3. **Under what category is the recycling unit registered as per the EPR guidelines/PWM Rules?**
   A. Processing Unit
   B. PRO
   C. Manufacturing Unit - Yes
   D. Others

If others, please specify

4. **Address of the recycling unit(s):**
5. **Contact Number:**
6. **Full name & Designation of the Point of Contact (POC):**
7. **E-Mail ID:**
8. **Has the recycler received any kind of investment/grant?**
   A. Yes
   B. No

(Any kind of investment/grant highlights the potential of the recycler. In addition to that, it'll help to correlate the investment/grant status of the recycler to various parameters such as the overall capacity of the recycling unit, supply chain, technology and end market challenges etc. Here the recycler doesn't have to provide details regarding the investment/grant)

9. **What is the plot area? (Unit: m2)**
10. **What is the built-up area of the facility? (Unit: m2)**
11. **What is the storage capacity?**

(It refers to the in-house storage capacity. If the recycler has any external warehouse(s), please mention the number of warehouses and their respective storage capacities)

Please note that Q12 to Q14 should be answered in Tons Per Day (TPD) unit.

12. **What is the installed recycling capacity?**

(If different resins are being recycled, installed capacity for each resin should be mentioned separately)

13. **How much plastic waste enters the facility?**

(If different resins enters the facility, quantity of each resin should be specified separately. For example: 2 TPD PET and 1 TPD HDPE)

14. **Quantity of final recycled product?**

(If the recycling unit is producing more than one category (flake, pellet, final products such as bottle, mug or other plastic item) of recycled product, please mention category-wise quantity of the recycled product)

15. **Source of raw material/plastic waste**
    A. Direct source
    B. Indirect source
    C. Both

(Direct source refers to the sourcing method where the procurement of raw materials is done by the recycling unit itself. Ex: If the recycler is collecting the plastic waste directly from the source like residential areas, bulk waste generators etc)

Indirect source refers to the sourcing method where the recycler is not directly involved in the collection of waste. Ex: The recycling unit procure the raw materials through external parties like MRF, aggregators, etc.)

16. **Types of Plastic (As per Plastic Waste Management Rules, 2022)**
    A. Category I: Rigid
    B. Category II: Flexible
    C. Category III: Multi-layered plastic (MLP)
    D. Category IV: Compostable plastic

17. **Polymer type**
    A. PET
    B. HDPE
    C. PVC
    D. LDPE
    E. PP
    F. PS
    G. Others

[Regarding Q16-Q17, if the recycling unit answers that it recycle Rigid PET, the field assessment specialist will mention 16(A) and 17(A)]

18. What are the type of challenges in supply chain?

A. Quality of raw material
B. Challenges with vendor management
C. Transportation issues
D. Availability (quantity) of raw material
E. Fluctuation of market rates
F. Others

If others, please specify

19. Possible solutions:

(Solutions suggested by recyclers to overcome the above challenges)

20. Type of Recycling:

A. Mechanical Recycling
B. Chemical Recycling
   I. Pyrolysis
   II. Hydrogenation
   III. Gasification
   IV. Others

21. Challenges with respect to recycling technology:

A. Knowledge/Technical know-how
B. Financial feasibility
C. Input/Feed limitations
D. Others.

If others, please specify

22. How can the recycling units scale up their production with the existing technology?

23. What technological improvements can enhance the production of recycling unit?

24. What is the final recycled product?

(If the recycling unit is producing more than one category of product, please mention each product separately)

25. What is the selling price/rate of recycled product?

(If the recycler is producing more than one category of recycled product, please mention the cost for different product. For example: If a recycler is producing plastic granules and plastic yarn, the cost can be mentioned as Rs 100 for a ton of plastic granules and Rs 120 of a ton of plastic yarn)

26. What is the end market for the recycled product?

A. Packaging Industry
B. Agricultural Industry
C. Construction
D. Automobile Manufacturing
E. Electrical and Electronic (EEE) Manufacturing
F. Waste-to-energy
G. Other

27. What are the challenges with respect to the end market?

A. Demand of the product
B. Fluctuation in market rates
C. Transportation
D. Certification and testing facilities
E. Others

If others, please specify

Annex 2

Investment needed for setting up PET and polyolefin recycling units

Upon conversations with the sample recyclers, it was revealed that setting up a recycling unit roughly incurred the following costs. (These exclude operational and maintenance costs)

For PET Recycling

Particulars	Cost of setting up recycling unit (PET Washing) (10TPD)		
	Cost (INR)	Cost (USD)	Assumptions
Land (leased)	40,00,000	49,000	50,000 sq. ft.
Shed	1,25,00,000	153,000	15,000 sq. ft.
Machinery	2,00,00,000	245,000	Indian make
Electricity	30,00,000	37,000	Lease line (Private transformer)
Effluent Treatment Plant	25,00,000	31,000	20 kl

*basic infrastructure required for fibre grade PET flakes for local markets

*additional INR 2,50,00,000 (USD 310,000) required for bottle-to-bottle grade

*a PET-PSF plant may cost anywhere between INR 80,00,00,000 (USD 10 Million) to 100,00,00,000 (USD 12 Million) for 60 TPD capacity

*land cost may vary according to region and location within the region

For Polyolefin Recycling

Particulars	Cost of setting up recycling unit (Polyolefins) (10TPD)		
	Cost (INR)	Cost (USD)	Assumptions
Land (leased)	10,00,000	12,000	10,000 sq. ft.
Shed	30,00,000	37,000	10,000 sq. ft.
Machinery	70,00,000	85,000	Indian make
Electricity	2,00,000	2400	Private transformer
ETP	1,00,000	1200	Direct line to CETP

*the cost used to set-up a recycling plant for low value application of recyclate

*plant for recycling polyolefins for high quality application/closed-loop recycling may range above INR 15,00,00,000 (USD 2 Million) and above

About the India Plastics Pact

The India Plastics Pact, launched in 2021, unites businesses, governments, NGOs and citizens to create a circular plastics economy in India. It was developed by Confederation of Indian Industry (CII) and WWF India. The CII-ITC Centre of Excellence for Sustainable Development (CESD) anchors the India Plastics Pact, within CII. The initiative is supported by WRAP, a global NGO based in the UK.

It is the first Plastics Pact in Asia. As of June 2023, there are 14 Plastics Pacts spread across the globe. As of September 2023, 51 organizations are currently part of the India Plastics Pact. The Pact works on all plastic resins at all stages of the plastics value chain.

Confederation of Indian Industry

About Confederation of Indian Industry

The Confederation of Indian Industry (CII) works to create and sustain an environment conducive to the development of India, partnering Industry, Government and civil society, through advisory and consultative processes.

For more than 125 years, CII has been engaged in shaping India's development journey and works proactively on transforming Indian Industry's engagement in national development. With its extensive network across the country and the world, CII serves as a reference point for Indian industry and the international business community.

As India strategizes for the next 25 years to India@100, Indian industry must scale the competitiveness ladder to drive growth. CII, with the Theme for 2023-24 as 'Towards a Competitive and Sustainable India@100: Growth, Inclusiveness, Globalisation, Building Trust' has prioritized 6 action themes that will catalyze the journey of the country towards the vision of India@100.

With 65 offices, including 10 Centres of Excellence, in India, and 8 overseas offices in Australia, Egypt, Germany, Indonesia, Singapore, UAE, UK, and USA, as well as institutional partnerships with 350 counterpart organizations in 133 countries, CII serves as a reference point for Indian industry and the international business community.

About WRAP

WRAP is a UK based international resources and climate action NGO working around the globe to tackle the causes of the climate crisis and give the planet a sustainable future. WRAP is working with businesses across the plastics value chain globally through the Plastics Pact network, transforming how we make, use, collect, sort, reuse and recycle plastics to create a circular economy.

WRAP set up, and manages, the UK Plastics Pact. Established in 2018, in partnership with The Ellen MacArthur Foundation, it has catalyzed 14 further Plastics Pacts to be developed including South Africa, US, Chile, Kenya and Colombia. WRAP was instrumental in establishing the India Plastics Pact with CII and WWF-India. The Plastics Pact network encompasses over 1,000 leading plastics businesses in their membership. WRAP provides operational and technical support to the India Plastics Pact and other Pacts. WRAP also runs a knowledge sharing platform between the various circular plastics initiatives internationally.

UKRI

UK Research and Innovation (UKRI) was launched in April 2018. It is a non-departmental public body sponsored by the Department for Business, Energy and Industrial Strategy (BEIS). It brings together the seven disciplinary research councils, Research England, which is responsible for supporting research and knowledge exchange at higher education institutions in England, and the UK's innovation agency, Innovate UK. UKRI's nine councils work together in innovative ways to deliver an ambitious agenda, drawing on our great depth and breadth of expertise and the enormous diversity of our portfolio. Through our councils, we maintain and champion the creativity and vibrancy of disciplines and sector specific priorities and communities. Our councils shape and deliver both sectoral and domain-specific support. Whether through research council grants, quality related block grants from Research England, or grants and wider support for innovative businesses from Innovate UK, we work with our stakeholders to understand the opportunities and requirements of all the different parts of the research and innovation landscape, maintaining the health, breadth, and depth of the system.

INDIA PLASTICS PACT

Managed by

Confederation of Indian Industry

CII-ITC Centre of Excellence for Sustainable Development

Supported by

wrap

This report is funded by

UK Research and Innovation