CLIMAKE

ASPEN NETWORK OF DEVELOPMENT ENTREPRENEURS
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INVESTING IN THE WASTE AND CIRCULARITY SECTOR IN INDIA

Plastic Waste and Circularity Guide

ABOUT ANDE

The Aspen Network of Development Entrepreneurs (ANDE) is a global network of organizations that propel entrepreneurship in developing economies. ANDE members provide critical financial, educational, and business support services to small and growing businesses (SGBs) based on the conviction that SGBs create jobs, stimulate long-term economic growth, and produce environmental and social benefits.

As the leading global voice of the SGB sector, ANDE believes that SGBs are a powerful, yet underleveraged, tool in addressing social and environmental challenges. Since 2009, ANDE has grown into a trusted network of over 250 collaborative members that operate in nearly every developing economy. ANDE grows the body of knowledge, mobilizes resources, undertakes ecosystem support projects, and connects the institutions that support the small business entrepreneurs who build inclusive prosperity in the developing world. ANDE is part of the Aspen Institute, a global non-profit organization committed to realizing a free, just, and equitable society.

ABOUT CLIMAKE

Climake was founded in 2020 as a platform to make climate finance more accessible. Climake focuses on improving access to equity and non-dilutive capital, for startups, and to support investors to improve funding flows to the climate action, especially into emerging sectors. Climake's work focuses on 4 core areas: investment advisory for high-potential climate startups, development and adoption of innovative financing structures to mainstream climate innovations, research and knowledge sharing on climate finance trends, and advocacy with investors to focus on climate action.

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IKEA Foundation

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ABBREVIATIONS

ADB:	Asian Development Bank
AEPW:	Alliance to End Plastic Waste
B2B:	Business-to-business
B2C:	Business-to-consumer
CAGR:	Compound annual growth rate
DEG:	German Investment Corporation
DFI:	Development finance institution
EBITDA:	Earnings before interest, taxes, depreciation and amortisation
EPR:	Extended producer responsibility
FDA:	Food & Drug Administration
FLDG:	First-loss default guarantee
FMCG:	Fast-moving consumer goods
FY:	Financial year
GHG:	Greenhouse gas
HDPE:	High-density polyethylene
IFU:	Investment Fund for Developing Countries
LDPE:	Low-density polyethylene
MRF:	Material recovery facility
NBFC:	Non-banking finance company
PE:	Polyethylene
PE:	Private equity
PET:	Polyethylene terephthalate
PP:	Polypropylene
PS:	Polystyrene
PVC:	Polyvinyl chloride
R&D:	Research and development
rPET:	Recycled polyethylene terephthalate
SGB:	Small and growing business
TReDS:	Trade receivables electronic discounting system
USDFC:	United States Development Finance Corporation

CHAPTER 1: THE OPPORTUNITY IN PLASTIC CIRCULARITY

India grapples with a substantial plastic waste challenge. In 2021, according to government data, the country generated nearly 26,000 tonnes of plastic waste daily, amounting to approximately 4.1 million tonnes over the year.[1] However, other estimates state that the actual figures are more than double, with an estimate from a recent Nature paper, stating that India generated 9.3 million tonnes of plastic waste in 2023.[2] A significant portion of that waste, approximately 75%, consists of three primary polymers: polypropylene (PP), polyethylene (PE) and polyvinyl chloride (PVC), with the remainder coming from other polymers such as polystyrene (PS), high-density polyethylene (HDPE), low-density polyethylene (LDPE), and polyethylene terephthalate (PET).

Plastic waste generation in India will only continue to rise as consumption increases; based on current trajectories, India is expected to witness an increase in plastic consumption from 24.1 million tonnes in 2019 to 70.5 million tonnes in 2035. As a result, India could be generating up to 46 million tonnes of plastic waste every year by 2035.[3]

Despite the daunting scale of the plastic waste issue, India's plastic recycling industry is experiencing remarkable growth. Estimated at US$ 2.3 billion in 2023,[4] the industry is poised for a meteoric rise, with a projected compound annual growth rate (CAGR) of 24%, it is forecasted to soar to US$ 10.2 billion by 2030. This surge is being driven by a growing awareness of the detrimental environmental impacts of plastic waste, which has spurred heightened demand for plastic recycling solutions.

The last comprehensive study of India's plastic recycling rate, undertaken in 2020–21, found that only 13% of India's plastics are recycled,[5] although the recycling rates of specific plastics, such as PET, can range up to 90%. With this significant recycling gap, India is at an early stage in its plastic circularity journey, meaning both demand and opportunity will be extensive. Throughout this guide, we refer to the segments of plastic waste management, plastic recycling, plastic alternatives and circular solutions as "plastic circularity".

THE OPPORTUNITY

The key opportunities for plastic circularity in India are emerging around enabling higher-quality recycled outputs, packaging solutions and circularity in traditionally hard-to-recycle segments, such as flexible and multilayer plastics. These cascade into specific opportunity areas across the value chain, which are summarised below (and detailed further later in this guide):

1. Central Pollution Control Board, 2021, Annual Report 2020-21 on Implementation of Plastic Waste Management Rules, 2016. Retrieved from: https://cpcb.nic.in/uploads/plasticwaste/Annual_Report_2020-21_PWM.pdf
2. Cottom J.W., Cook E., Velis C.A., 2024, A local-to-global emissions inventory of macroplastic pollution. Nature 633, 101–108. Retrieved from: https://doi.org/10.1038/s41586-024-07758-6
3. Dhodapkar R., Bhattacharjya S., Niazi Z., Porter N.B., Retamal M., Sahajwalla V., Schandl H., CSIRO, Australia, 2023, National Circular Economy Roadmap for Reducing Plastic Waste in India. Retrieved from: https://www.csiro.au/-/media/Environment/Circular-Economy-Roadmap-India/23-00249_ENV_REPORT_IACPRoadmap_WEB-230714.pdf
4. Avendus, 2023, Circular Economy: Recycling waste to wealth. Retrieved from: https://www.avendus.com/india/reports/61
5. Central Pollution Control Board, 2021, Annual Report 2020-21 on Implementation of Plastic Waste Management Rules, 2016. Retrieved from: https://cpcb.nic.in/uploads/plasticwaste/Annual_Report_2020-21_PWM.pdf

- High-quality mechanical recycling of hard plastics like PET bottles that can create food-grade and medical-grade recycled plastics.
- Emerging chemical recycling solutions that enable circularity for flexible, multilayer and other low-quality plastics, which are currently often improperly disposed of because of a lack of recycling options.
- Low-carbon plastic alternatives, such as biodegradable and natural materials like bamboo, which are primarily generating demand as flexible packaging applications.

The above opportunities are reliant on a strengthened and effective plastic circularity value chain, which is also providing opportunities for small and growing businesses (SGBs) that strengthen collection and sorting systems.

THE OPPORTUNITY DRIVERS

Plastic circularity is presently the most investable of all the waste and circularity segments. There are four main reasons for the growth of the plastic circularity industry in India, which is driving investment opportunities in the areas outlined above:

Figure 1: The four main drivers for plastic circularity (Climake analysis)

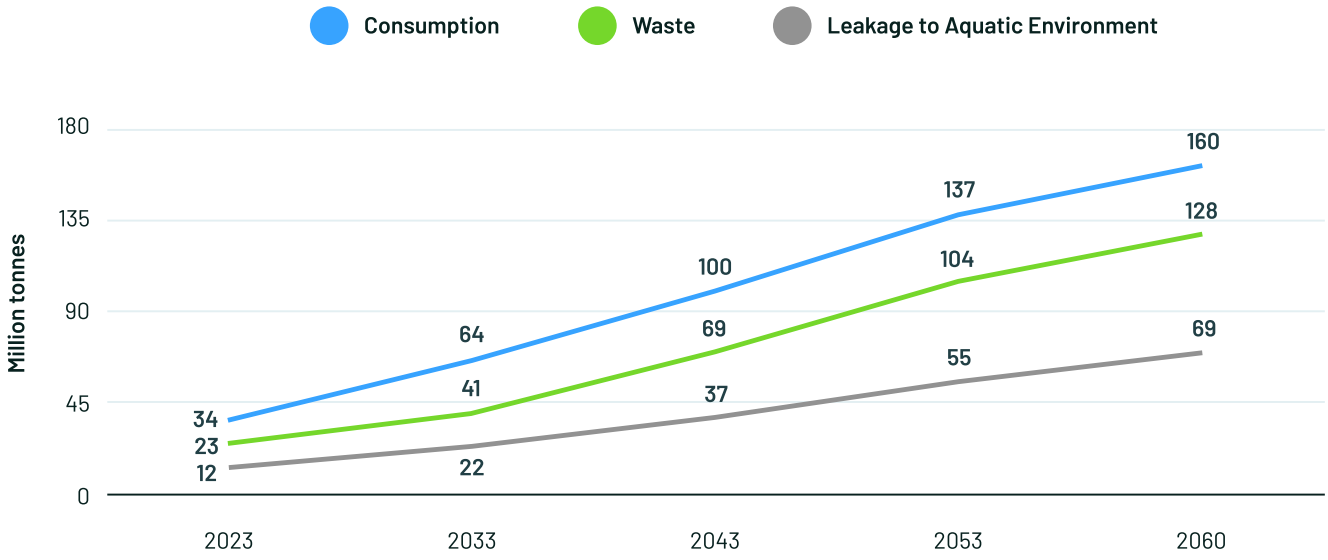
1 Plastic consumption (and the supply of materials for recycling) continues to increase

Despite the consumer sentiment against plastic usage and the policy push to reduce plastic consumption, the demand for plastics continues to rise. As of 2019, India's annual plastic consumption was 24.1 million tonnes.[6] Projections paint a stark picture of escalating plastic consumption in India, with estimates indicating a surge to at least 70.5 million tonnes annually by 2035. This exponential growth trajectory underscores the urgent need for comprehensive strategies to manage plastic waste and mitigate its adverse environmental and public health impacts.

Packaging reigns supreme in India's plastic consumption landscape, commanding a staggering 59% share, followed by building and construction at 13% and agriculture at 9%. Notably, there has been a discernible uptick in the adoption of lightweight hard plastics, particularly in sectors such as automotive manufacturing, machinery and equipment production. This trend is driven by a concerted effort to reduce the weight of vehicles and machinery, with electric vehicle (EV) manufacturers increasingly incorporating higher proportions of plastics to offset the weight of batteries and enhance overall efficiency.

The increasing availability of input raw materials is the driving force for multiple plastic circularity businesses setting up in India and/or significantly increasing their recycling capacities over the next five years.

Figure 2: Plastic consumption and waste generation trends until 2060 (Source: OECD[7])



6. Dhodapkar R., Bhattacharjya S., Niazi Z., Porter N.B., Retamal M., Sahajwalla V., Schandl H., CSIRO, Australia, 2023, National Circular Economy Roadmap for Reducing Plastic Waste in India. Retrieved from: https://www.csiro.au/-/media/Environment/Circular-Economy-Roadmap-India/23-00249_ENV_REPORT_IACPRoadmap_WEB-230714.pdf

7. OECD, 2022, Global Plastics Outlook: Policy Scenarios to 2060. Retrieved from: https://www.oecd-ilibrary.org/sites/aa1edf33-en/1/3/2/2/index.html?itemId=/content/publication/aa1edf33-en&_csp_=ca738cf5d4f327be3b6fec4af9ce5d12&itemIGO=oecd&itemContentType=book

2 Policy is creating a positive momentum for the sector

The implementation of extended producer responsibility (EPR) targets, facilitated by the Plastic Waste Management Rules of 2016 and subsequent amendments,[8] has emerged as a pivotal driver shaping the demand landscape for plastic production, waste management and recycling in India. The establishment of EPR targets underscores the imperative for transparency throughout the plastic lifecycle, from production to recycling. To facilitate compliance, India has introduced an EPR Portal dedicated to plastic packaging,[9] mandating producers, importers, brand owners and recyclers of packaging plastic to report their activities on this platform.

Table 1: Policies and legislation related to plastic circularity (Climake analysis)

Type of policy / legislation	Regulations for proper waste management	Policies encouraging circular products / solutions	Material recovery mandates	Recycled content / circular material use mandates	Subsidies for high-quality recycling / circular outputs
Name of policy / legislation	Plastic Waste Management Rules	• Plastic Waste Management Rules (The Single-Use Plastics Ban) • IS 14534: Guidelines for Recycling of Plastics • IS 17899: Assessment of Biodegradability of Plastics	EPR Guidelines for Plastic Wastes	EPR Guidelines for Plastic Wastes	State-specific rules and guidelines
Impact on plastic circularity	Create demand for plastic waste management and collection solutions	Incentivise demand for recycling solutions and alternatives to plastic solutions	Incentivise demand for recycling solutions, especially ones that create higher-quality recycled materials	Incentivise demand for recycling solutions, especially ones that create higher-quality recycled materials and products	Incentivise the setup of high-quality recycling facilities

The imperative to meet EPR compliance and recycled content targets for plastic products is reshaping the norms governing plastic waste management. This paradigm shift incentivises high-quality extraction from plastic waste, fostering a transition away from low-value recycling or downcycling practices. Moreover, it serves to disincentivise the utilisation of virgin feedstock, despite its abundant availability and reasonable pricing. The 2021 edition of the Plastic Waste Management Rules also outlined a ban on certain single-use plastic materials to encourage the adoption of circular alternatives.

8. Central Pollution Control Board, 2022, Plastic Waste Management Rules. Retrieved from: https://cpcb.nic.in/rules-4/
9. Ministry of Environment, Forest and Climate Change, Government of India, 2024, EPR Portal for Plastic Packaging. Retrieved from: https://eprplastic.cpcb.gov.in/

Additionally, the Bureau of Indian Standards has established the Indian Standard 14534:1998 Guidelines for Recycling of Plastics[10] and will issue an upcoming standard on biodegradable plastics – IS 17899 Assessment of Biodegradability of Plastics.[11] The guidelines for plastic waste incentivise collection and recycling through EPR for companies. This is most viable for PET and hard plastics, but there is a growing focus on different types of packaging plastics.

Table 2: Extended producer responsibility (EPR) targets for plastic packaging (Plastic Waste Management Rules[12])

Minimum level of recycling (excluding end-of-life disposal) of plastic packaging waste				
Plastic Packaging Category	**2024–25**	**2025–26**	**2026–27**	**2027–28 ++**
Category I (Rigid plastic packaging)	50%	60%	70%	80%
Category II (Flexible plastic packaging of single layer or multilayer)	30%	40%	50%	60%
Category III (Multilayered plastic packaging)	30%	40%	50%	60%
Category IV (Plastic sheet used for packaging and compostable carry bags)	50%	60%	70%	80%
Mandatory Composition of Recycled Plastics in Plastic Packaging				
Plastic Packaging Category	**2024–25**	**2025–26**	**2026–27**	**2027–28 ++**
Category I (Rigid plastic packaging)	30%	40%	50%	60%
Category II (Flexible plastic packaging of single layer or multilayer)	10%	10%	20%	20%
Category III (Multi-layered plastic packaging)	5%	5%	10%	10%

10. Bureau of Indian Standards, 1998, Indian Standard Guidelines for Recycling Of Plastics. Retrieved from: https://law.resource.org/pub/in/bis/S11/is.14534.1998.pdf
11. Bureau of Indian Standards, 2022, IS 17899 T : 2022: Assessment of Biodegradability of Plastics in Varied Conditions (Tentative Indian Standard). Retrieved from: https://archive.org/details/gov.in.is.17899.t.2022
12. Government of India, 2022, Plastic Waste Management Rules. Retrieved from: https://eprplastic.cpcb.gov.in/plastic/downloads/4th%20Amendment%20(EPR%20guidelines)%20Feb%202022.pdf

Mandatory Requirement for Reuse of Packaging				
Plastic Packaging Category	**2024–25**	**2025–26**	**2026–27**	**2027–28 ++**
Category I (Rigid plastic packaging) – volume or weight equal to or more than 0.9 litres or kg but less than 4.9 litres or kg	10%	15%	20%	25%
Category I (Rigid plastic packaging) – volume or weight more than 4.9 litres or kg	70%	75%	80%	85%

3 Consumer demand for circular plastic and plastic alternatives is growing, regardless of policy

Plastic waste, once subjected to pre-processing, serves as a raw material for generating recycled plastic products across a spectrum of quality standards. High-quality plastic waste, characterised by hardness, effective segregation and minimal contamination, yields premium recycled outputs suitable for diverse applications, ranging from food packaging to industrial uses. Demand for these recycled outputs is gaining momentum driven by the net-zero goals of large global corporations, many of whom believe packaging to be a low-hanging fruit when seeking to reduce the emissions generated by their supply chains.

Additionally, the emergence of bio-based plastic alternatives, which are biodegradable and/or compostable, presents a promising avenue for corporations addressing specific plastic applications while reducing their reliance on virgin polymer-based plastics and alleviating the burden on recycling infrastructure. This dual approach of curtailing plastic waste generation at source via alternatives and using recycled materials as part of input materials is being pursued by most fast-moving consumer goods (FMCG) companies for packaging. Demand is also increasing from users of high-quality plastics in electronics and technology manufacturing.

4 The technology to recycle plastic is well developed

The overall rate of plastic recycling in India is poorly documented, with the last government study placing it at 13% but with estimates ranging between 30% and 50%.[13] Hard plastics and PET are plastic recycling's success stories, with recycling rates up to 64%.[14] Mechanical recycling, the current technology of choice, is well established, with multiple plants operational at scale over the last decade. In areas like chemical recycling, sustainable alternatives, and high-quality circular outputs from hard-to-recycle flexible and multi-layered plastics, technologies are emerging and being deployed in pilots and commercially at small scales. The constraints, however, are in how these technologies can be scaled, given that many are first-of-a-kind (FOAK) solutions which may not be attractive to more conservative investors, who will continue to favour the available investment opportunities in scalable, mature technologies, such as mechanical recycling.

13. Dhodapkar R., Bhattacharjya S., Niazi Z., Porter N.B., Retamal M., Sahajwalla V., Schandl H., CSIRO, Australia, 2023, National Circular Economy Roadmap for Reducing Plastic Waste in India, 2023. Retrieved from: https://www.csiro.au/-/media/Environment/Circular-Economy-Roadmap-India/23-00249_ENV_REPORT_IACPRoadmap_WEB-230714.pdf

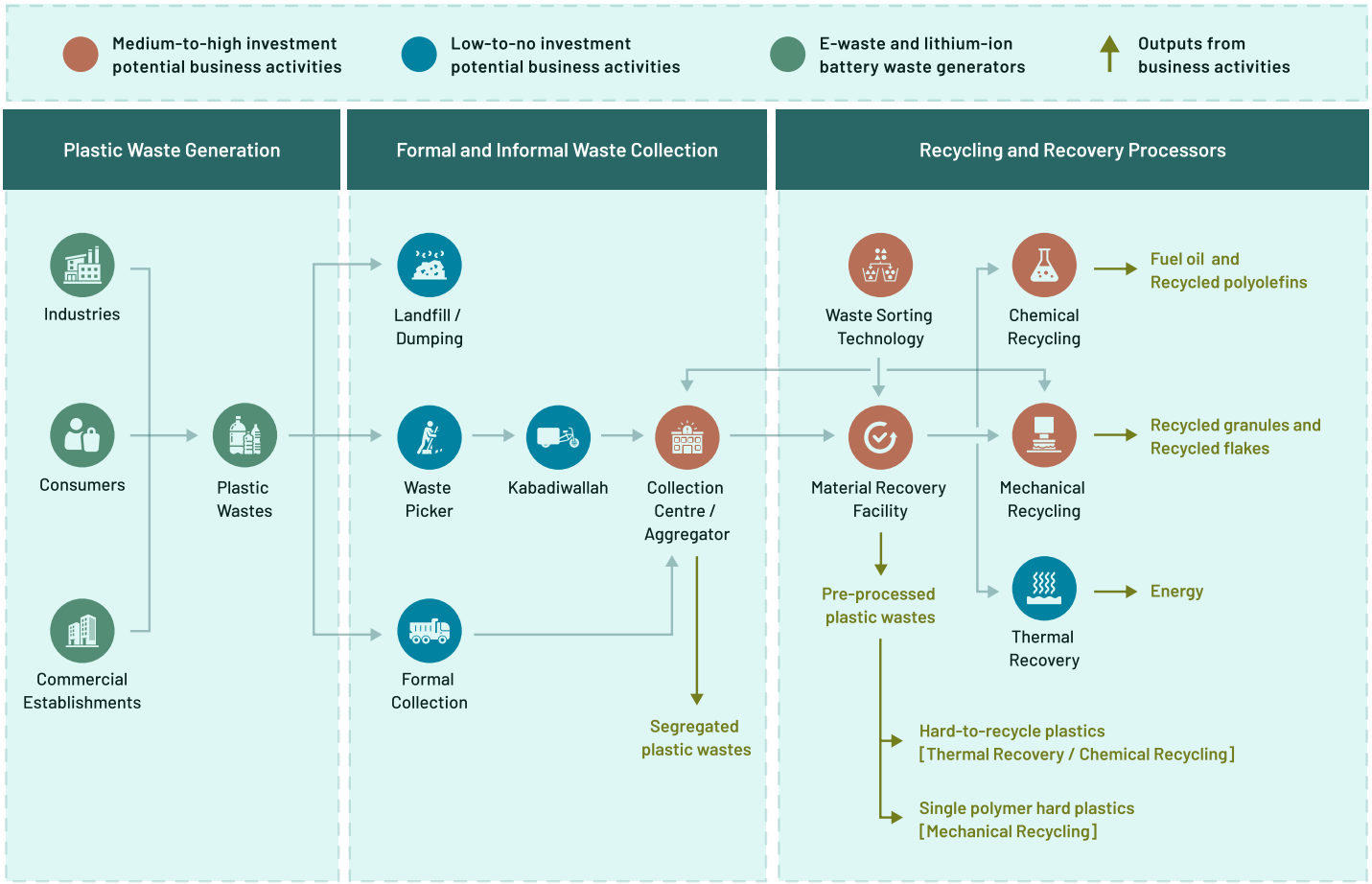
14. Confederation of Indian Industry, 2022, Material Flow of PET Used in Packaging Applications in India for the year 2021-22, India Plastics Pact. Retrieved from: https://www.indiaplasticspact.org/uploads/1703753076document.pdf

CHAPTER 2: THE CASE FOR INNOVATION IN PLASTIC CIRCULARITY

The Plastic Waste Management Value Chain

In response to the positive market and demand forces outlined above, innovative startups and forward-thinking packaging companies are spearheading initiatives across the entire plastic recycling value chain, from collection and segregation to separation and recycling. These efforts are instrumental in harnessing the potential of plastic waste as a valuable resource, thus mitigating its adverse environmental effects. Additionally, startups are building low-carbon and circular alternatives to plastics, reducing or eliminating the use of plastics in certain applications. The plastic waste value chain is shown below alongside the key business models and outputs generated at each stage of that chain.

Figure 3: Plastic waste recycling and circularity value chain (Climake analysis)



The main business models that form part of the plastic waste management and circularity value chain are described below:

Collection Centres

Collection centres play a critical role in the plastic circularity value chain by aggregating and collecting plastic waste from households, commercial establishments and other waste generators. These centres supply larger waste aggregators and material recovery facilities (MRFs), forming the initial stage of the plastic recycling process. In India, this segment is primarily operated by the informal sector.[15] Low margins and inconsistent practices are challenges for formal enterprises to address, particularly those seeking entry as standalone operators.

Despite barriers to entry, specialised collection centres have emerged and are in place and have begun to emerge (collection and processing constitutes the largest number of formal enterprises identified among the business models in the plastic waste value chain as shown in Chapter 3, using opportunities for value addition – like enhanced waste segregation or converting waste plastics into intermediate flakes. These value-added processes offer transparency, reliability, and compliance with extended producer responsibility (EPR) regulations, enabling higher-margin sales for such value-added businesses. As a result, specialised collection centres are gaining traction, supporting formalisation within the industry and improving the economics of plastic waste management.

Collection centres directly influence the pricing of plastic waste received by MRFs and recyclers. Unpredictable supply patterns from informal collection centres drive pricing volatility, which impacts the margins of recycling operators. In response, formalised and specialised collection centres are positioning themselves as stable suppliers, providing more consistent pricing and supply flows for downstream recyclers and end-users of recycled plastics. This shift towards formalised operations is an evolution in India's plastic waste management landscape, balancing the demands for scalability, transparency and improved supply chain resilience.

Waste Sorting Technologies

India's waste sorting industry relies on manual labour and conveyor-based physical sorting processes. That labour-intensive approach is well established, but it also carries inherent inefficiencies and safety risks because of the direct human interaction with waste. Waste sorting technologies have emerged to integrate automation that streamlines the process of identifying and segregating recyclable materials from mixed waste.

15. Dhodapkar R, Bhattacharjya S, Niazi Z, Porter NB, Retamal M, Sahajwalla V and Schandl H, National Circular Economy Roadmap for Reducing, Plastic Waste in India. CSIRO, Australia. Retrevied from: https://www.csiro.au/-/media/Environment/Circular-Economy-Roadmap-India/23-00249_ENV_REPORT_IACPRoadmap_WEB-230714.pdf

These systems, including conveyor belts, optical sorters and AI-driven robots, are a significant technological leap for material recovery facilities (MRFs) and recycling facilities. However, the effectiveness of these solutions is highly reliant on partnerships with MRFs and recycling operators, given their dependency on such allied businesses for operation and deployment. Technology-enabled waste sorting solutions offer varying degrees of automation – from partial to full automation of the sorting process – transforming the speed, accuracy and safety of waste management.

A key driver of this shift is the rising demand for recycled plastics.[16] This demand has made optical sorters and AI-powered systems increasingly economically viable. These solutions not only offer operational efficiency but also collect and analyse data, providing valuable insights that enable smarter decision-making. As industry leaders evaluate the potential for scaling up such technology in India, they face critical decisions regarding adoption strategies like: investment in automation, and its impact on labour dynamics and cost structures in the recycling industry.

Mechanical Recycling Facilities

Mechanical recycling facilities are central to India's plastic recycling efforts, employing a process of sorting, cleaning, shredding and melting to convert plastic waste into reusable granules or flakes. These facilities typically focus on hard plastics, prioritising meticulous sorting by removal of contaminants to enhance the quality of the recycled material. This straightforward method of recycling plastic into flakes or extruded granules has made mechanical recycling the most prevalent approach in India's plastic waste management industry.[17]

The quality of recycled outputs from mechanical recycling is relatively low, limiting their use for low-value products. Driven by both market demand and regulatory pressures, recyclers are now investing in advanced technologies within mechanical recycling to produce higher-quality outputs. This shift includes a focus on creating food-grade and other high-value recycled plastics – a trend that reflects an industry-wide push towards high-value applications.

Despite these trends, mechanical recycling has inherent limitations. It is unable to process hard-to-recycle plastics, such as contaminated, flexible, or multilayered materials, which remain under-recycled and contribute to persistent plastic pollution. As the sector evolves, mechanical recyclers face the challenge of improving output quality while recognising the need for complementary recycling solutions to address India's range of plastic waste.

16. Avendus, Circular Economy: Recycling waste to wealth, 2023. Retrieved from: https://www.avendus.com/india/reports/61
17. Centre for Science and Environment, 2021, Plastic recycling decoded. Retrieved from https://www.cseindia.org/plastic-recycling-decoded-10885

Chemical Recycling Facilities

Chemical recycling has emerged as a promising solution to address the challenge of hard-to-recycle plastics. Employing advanced processes such as pyrolysis and depolymerisation, chemical recycling facilities decompose plastic waste into fundamental molecular components. These molecular building blocks are then used to manufacture new plastics or other valuable chemicals, creating a closed-loop solution for recycling contaminated, flexible and multilayer plastics – materials that are particularly difficult to process through conventional mechanical recycling. In India, while pyrolysis plants that convert plastic waste into fuel are in operation, facilities focused on chemical recycling for polyolefin production are only now starting to gain traction.[18]

By producing polyolefins, the foundational material for new plastics, chemical recycling offers the potential to create high-quality recycled plastics, including food-grade, medical-grade and automotive-grade products. This level of quality is challenging to achieve with mechanical recycling, which relies on clean, contaminant-free inputs to produce comparable high-grade outputs. The demand for chemical recycling is accelerated by extended producer responsibility (EPR) mandates and an increasing emphasis on reducing the environmental impact of hard-to-recycle plastics.

Although still a nascent industry in India[19] chemical recycling represents a potential transformation in waste management and plastic circularity. It has growing interest from both policymakers and industry stakeholders. As the sector matures, the technology faces questions around scalability, economic viability and regulatory alignment, which will determine its role in India's plastic recycling ecosystem.

Bio-based Plastic Alternative Producers

Bio-based plastic alternatives are an emerging solution aimed at reducing dependence on traditional petroleum-based plastics – by developing materials from renewable biomass sources, such as plant-based feedstocks. These alternatives not only seek to address environmental concerns but also aim to create biodegradable or compostable plastics. While bio-based plastics have gained traction in specific sectors, their mass-market adoption has been limited due to competitive pricing from traditional plastics.

18. R. Shanker, D. Khan, R. Hossain, Md. T. Islam, K. Locock, A. Ghose, V. Sahajwalla, H. Schandl, R. Dhodapkar (2022), Plastic waste recycling: existing Indian scenario and future opportunities, International Journal of Environmental Science and Technology 20:5895–5912. Retrieved from: https://pmc.ncbi.nlm.nih.gov/articles/PMC8976220/

19. Centre for Science and Environment, 2021, Plastic recycling decoded. Retrieved from https://www.cseindia.org/plastic-recycling-decoded-10885

In India, bio-based alternatives have the potential to be viable in packaging applications, aligning with India's focus on reducing plastic use through EPR mandates. While the high cost of bio-based alternatives is a barrier, certain sectors – such as cosmetics, speciality foods, and consumer electronics – are finding bio-based packaging increasingly viable,[20] as the cost of this packaging represents a small fraction of the overall product cost in these categories.

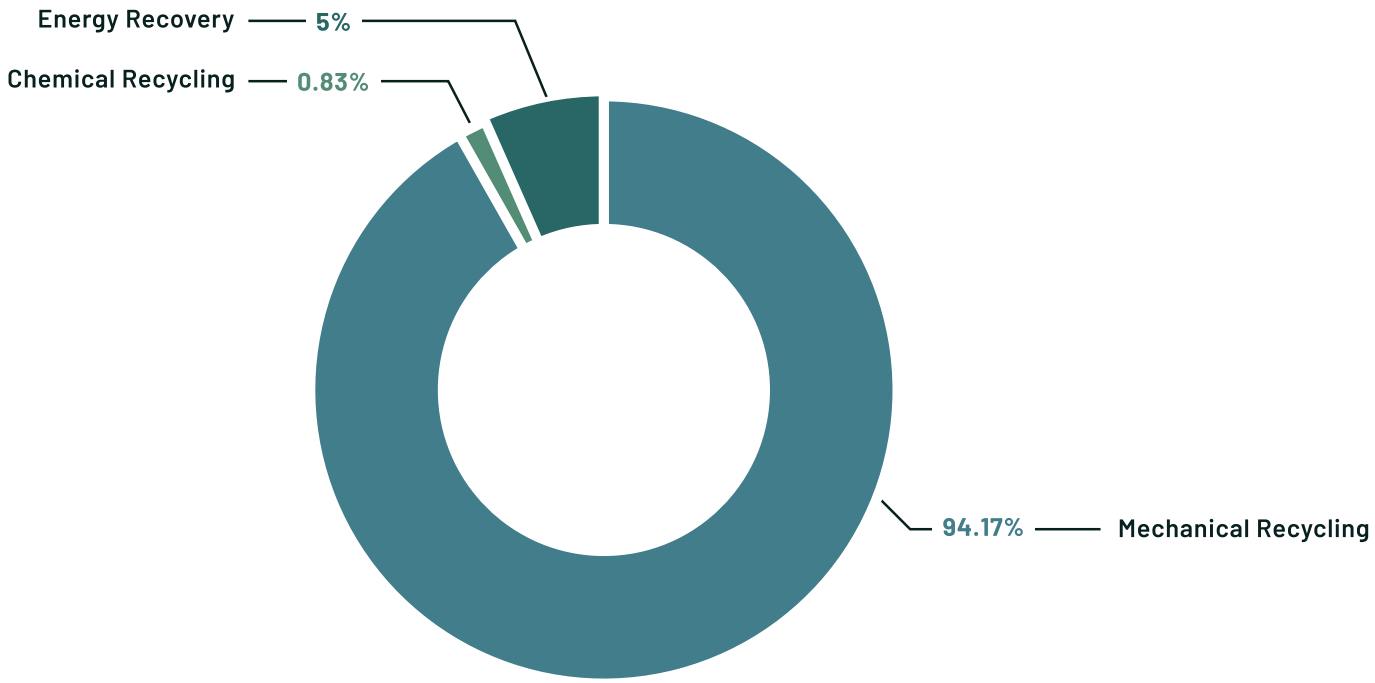
However, achieving widespread scale is a significant challenge for bio-based plastic producers. Success will depend on achieving price parity with conventional plastic packaging, regulatory measures that limit or ban traditional plastics, and the extent to which bio-based plastic manufacturers offer enhanced material properties like improved water resistance or durability.

20. EY India, How policy and fiscal benefits can boost India's bioplastics industry, 2024. Retrieved from: https://www.ey.com/content/dam/ey-unified-site/ey-com/en-in/insights/tax/2024/10/ey-incentivising-bioplastics-a-biopolymer-a-move-towards-a-circular-and-sustainable-economy.pdf

The Current State of Plastic Recycling in India

India's legacy plastic recycling industry is quite mature, with multiple businesses operating at scale and profitably for the past three decades. However, until about five years ago, the entire plastic circularity industry was dominated by informal players, primarily producing low-value and low-quality outputs. Mechanical recycling, particularly of rigid plastic into downcycled materials has dominated the market thus far. The largest of these businesses convert shredded PET bottles (or PET flakes) into synthetic fibre. Others convert multiple forms of high-quality plastic into low-value buckets, mugs and park benches.

Figure 4: Share of recycling approaches as of 2021 (Source: Centre for Science and Environment[21])



However, increased consumer demand for turning recycled materials into equivalent-use products (for example, using recycled PET granules in new food-grade bottles) and the EPR norms requiring the use of recycled materials are leading to a change in trends as innovative startups create businesses centred around maintaining the value of the plastic being recycled. Advanced processes with higher efficiency that lead to higher-quality recycled outputs (for more circular products) are entering the market. Biodegradable plastic alternatives are starting to make a dent as well.

21. Centre for Science and Environment, 2021, Plastic recycling decoded. Retrieved from https://www.cseindia.org/plastic-recycling-decoded-10885

Investable Business Models for SGBs

The following four emerging areas in the plastic circularity ecosystem could offer the potential for innovative SGBs to build scalable businesses and attract significant investment in the next decade.

1 EFFICIENT COLLECTION, SORTING AND PRE-PROCESSING

Context and opportunity

Plastic waste in India is collected from two key sources: it forms part of the municipal waste collection that is then transported to material recovery facilities (MRFs) that sort and segregate different types of plastic for further processing. However, much of the high-value rigid plastic waste does not enter this system because a network of ragpickers, waste collectors and aggregators pick the waste at its source. This informal sector plays a significant role in plastic waste aggregation and recycling in India,[22] complemented by formal municipal initiatives. However, recycling processes conducted by the informal sector without proper cleaning and segregation often yield lower-quality outputs suitable only for low-value applications.

There are two opportunities to disrupt this ecosystem:

- Organising the informal value chains to create better processes for collection and sorting. By ensuring that the plastics are categorised correctly, higher value extraction is possible when this waste is sold to the recyclers.
- Establishing pre-processing facilities that combine collection, sorting and categorisation with the removal of contaminants. This ensures that diverse feedstock types and qualities are available for recycling, enhancing the efficiency of the recovery and recycling process.

Both these models also allow for effective integration with EPR reporting and with voluntary net-zero initiatives like plastic credits, increasing profit margins compared to the limited profitability offered by collections alone.

EXAMPLES OF STARTUPS IN THIS BUSINESS MODEL

Growth Stage	ReCircle (Recover. Recycle. Rethink), Plastics for Change
Mature Stage	recykal

22. Dhodapkar R., Bhattacharjya S., Niazi Z., Porter N.B., Retamal M., Sahajwalla V., Schandl H., CSIRO, Australia, 2023, National Circular Economy Roadmap for Reducing Plastic Waste in India. Retrieved from: https://www.csiro.au/-/media/Environment/Circular-Economy-Roadmap-India/23-00249_ENV_REPORT_IACPRoadmap_WEB-230714.pdf

RECIRCLE - CASE STUDY

ORGANISATION SUMMARY

Year of foundation: 2016
Number of employees: 87
Overall processing: 73,000 tonnes of plastic waste in FY2023–24 (own and partner collection)
Current own processing capacity: 4,000 tonnes of plastic waste per annum

ReCircle has developed a unique approach to formalising India's informal plastic waste sector, working directly with waste collectors and aggregators to create a fully traceable supply chain for plastic waste. Through a technology-driven platform, ReCircle connects waste collectors with recycling companies while ensuring traceability back to the material source. This traceable infrastructure enables recycling plants to receive high-quality materials with visibility into sourcing quantities, increasing operational efficiency and recovery rates. For brand partners, ReCircle's platform facilitates extended producer responsibility (EPR) compliance and supports accurate claims on greenhouse gas emissions reductions, aligning with their net-zero objectives. Additionally, the platform provides training for waste collectors, promoting safer practices and eliminating child labour from the process.

ReCircle's journey began in 2016 with a B2C model under the brand RaddiConnect, which aimed to link households, offices and institutions with informal sector waste collectors (known in India as raddiwalahs or kabadiwallahs) in an "Uber for scrap" model; an approach that sought to bring standardisation to plastic waste recycling rates and measurements to move the fragmented market towards formalisation. However, the organisation soon recognised that scaling in the formal waste sector would require mobilising larger volumes, which a consumer-facing model was unable to achieve. In response, ReCircle pivoted to a B2B model in 2019, aligning with regulatory shifts and a growing emphasis on EPR, which reshaped the ecosystem and incentivised bulk waste management.

Today, ReCircle operates a partner-centric, inclusive business model focused on empowering rather than displacing the informal sector. By acting as a linkage between waste collectors, aggregators, processors and recyclers, ReCircle has built a reverse supply chain for plastic waste that is transparent from the collector to the recycler. While the current focus is on plastic waste, the company has plans to scale its platform to cover other waste streams, further solidifying its role in India's circular economy transformation.

SCALE

- **Existing revenue (FY23–24): US$ 3 million**
- **Break-even year: 2018**
- **25% gross margins**
- **Profitable**

IMPACT

Improved livelihood and income of 3,000+ waste collectors

170,000 tonnes of plastic waste removed and avoided from improper disposal

170,000 tonnes of material recovered

AWARDS AND RECOGNITION

- TSS Social Enterprise of the Year, 2021
- BW Young Entrepreneur of the Year, 2021
- Best Social Impact Startup, Entrepreneur Magazine, 2022
- Top 30 – Swachhata Startup Challenge, 2022
- Social Impact Leader in Recycling, BusinessWorld, 2022

FUNDING RAISED

Type of Funding	Year	Purpose	Funders / Investors
Grants	2020	Product development	Philanthropists/government
Equity	2023, 2024	Growth capital	Acumen, 3i Partners, Venture Catalyst, Mumbai Angels
Debt	2024	Working capital	NBFCs, banks

INVESTMENT OPPORTUNITY

Total funding raised to date	Equity: US$ 1 million

As ReCircle prepares for its next phase of expansion, equity capital will be essential to support its growth objectives. The company intends to channel this funding into forward integration, demonstrating a proof-of-concept for high-quality recycling to meet customer demand for superior, traceable recycled materials. Additionally, ReCircle plans to invest in further developing its technology stack, enhancing platform capabilities to support scalable operations and maintain a competitive advantage.

ReCircle's profitability presents a significant advantage, enabling the company to access debt financing from Indian banks to address its working capital needs as it scales. This balanced approach to financing positions ReCircle to pursue aggressive growth while maintaining operational flexibility, with equity funding driving long-term strategic projects and debt financing supporting immediate scaling needs.

SUCCESS FACTORS

ReCircle has positioned itself as a pivotal player creating value for both waste collectors and recyclers. Through its platform, ReCircle delivers high-quality, sorted and reliable material supply, with end-to-end traceability – an increasingly critical feature as extended producer responsibility (EPR) norms tighten. ReCircle's traceability system offers brands and recyclers the assurance of ethically sourced materials, which has become essential for companies seeking sustainable, compliant supply chains for packaging. With a fully developed technology stack and an established model, ReCircle is poised for rapid expansion, anticipating growth of over 100% CAGR in the next five years.

ReCircle's advantage lies in its experience of standardising a fragmented and informal value chain and its robust traceability infrastructure, both of which meet the requirements of the plastic EPR policy. Brands and recyclers highly value this traceability, making ReCircle's approach integral to their compliance strategies. ReCircle's business model, centred on traceability and formalisation, also holds potential for scale beyond plastic. The fragmented nature of other waste streams in India suggests that ReCircle's model could be successfully replicated in these sectors, presenting significant expansion opportunities for the company as it seeks to transform waste management across multiple materials in India's circular economy.

2 HIGH-VALUE EXTRACTION VIA MECHANICAL RECYCLING

Context and opportunity

Mechanical recycling is a three-decade-old industry in India, which employs a well-established technology for plastic recycling. The process involves washing collected and sorted plastic waste to remove impurities and then shredding this cleaned waste into flakes that retain the properties and chemical structure of the original material. These flakes are then transformed into synthetic fibre or extruded as plastic products (such as buckets and bench stools). However, most of this mechanical recycling leads to downcycled products which have lower value than the original materials.

However, that trend is now changing. Due to net-zero goals and EPR norms globally moving towards requirements to use recycled materials in packaging and new plastic products, there is an increased demand for high-quality granules/pellets that can help to create equivalent-quality products. That requires a much higher level of processing: after the flakes are created with the shredder, they are deodorised and undergo processes to remove impurities like paper labels. This material is then melted and extruded into granules or pellets, which are then used to manufacture other products.

Economics of high-value mechanical extraction

High-value recovery via mechanical recycling requires almost 2.5x the initial capital investment compared to a flakes plant due to the requirement of additional machines to remove impurities, deodorise and make granules. The facilities that make these granules also seek higher-quality input material, typically PET or HDPE, which can be used to create food-grade PET bottles or food/FMCG packaging. That additional cost is, however, recovered via the high margins that these products generate. While earnings before interest, taxes, depreciation and amortisation (EBITDA) margins for low-quality flakes are in the 5–8% range, food-grade pellets can generate EBITDA margins over 20% on a sustainable basis.

EXAMPLES OF SCALED-UP BUSINESSES IN THIS SEGMENT

PET bottles	Srichakra Polyplast; Dalmia Polypro Industries Private Limited
HDPE/LDPE	Banyan Nation
Flexible packaging	Lucro Plast-E-Cycle Private Limited

SRICHAKRA POLYPLAST - CASE STUDY

ORGANISATION SUMMARY

Year of foundation: 2010
Number of employees: 169
Current production capacity: 42,000 tonnes per year of recycled PET (rPET) flakes

Srichakra stands as India's foremost PET recycling company, converting used PET bottles into high-quality, food-grade granules that are reintegrated into new PET bottles. Leveraging proprietary, in-house technology, Srichakra achieves a level of quality and consistency that matches virgin plastic in chemical structure and strength. This innovation has earned the company critical approvals for use in food-grade applications, setting it apart in a competitive industry.

Among Srichakra's clients are global beverage giants such as Coca-Cola, PepsiCo and Niagara Water. While current sales are primarily driven by these companies' voluntary net-zero commitments, demand is expected to surge over the next five years as EPR regulations in India and other markets mandate the use of recycled materials.

Founded in 2010, Srichakra initially focused on recycling various types of non-biodegradable post-consumer plastics. However, recognising the market potential and the technological requirements for high-quality outputs, the company strategically pivoted to PET recycling. This shift allowed Srichakra to capitalise on the scalability of PET recycling and the demand for bottle-grade recyclates. Today, Srichakra's ability to continually innovate has positioned it as India's only food-grade-certified, bottle-to-bottle recycler of PET waste plastic.

SCALE

- **Existing revenue (FY23–24):** US$ 12 million
- **Break-even year:** 2023
- **10%** EBIDTA
- **3x growth in the past two years**

IMPACT

36,000 tonnes of material processed

176,000 tonnes of CO2 emissions saved

AWARDS AND RECOGNITION

- First food contact rPET resin recycling plant in India
- First Indian recycling company to receive a positive assessment from the European Food Safety Authority

FUNDING RAISED

Type of Funding	Year	Purpose	Funders / Investors
Equity	2020, 2022	Growth capital	Circulate Capital
Debt	2022	Working capital	NBFCs, banks
Debt	2023	Project finance	Commercial banks, DFIs

INVESTMENT OPPORTUNITY

Total funding raised to date	**Equity: US$ 9.3 million** **Debt: US$ 15 million**

Srichakra has announced plans to triple its installed capacity over the next two years. Already scaled and profitable, Srichakra is well positioned to partially finance this expansion through debt. However, equity infusion will be crucial to optimise leverage and secure additional funding. A successful equity raise would enable Srichakra to access further debt, financing its targeted capacity increase and unlocking projected revenue growth.

This growth strategy is supported by Srichakra's leadership position and technological edge in PET recycling. As the only bottle-to-bottle recycler in India with FDA-approved, food-grade capabilities, Srichakra's competitive advantage at scale provides a compelling justification for expansion, aligning with market demand and the company's potential for sustained profitability.

SUCCESS FACTORS

Srichakra operates in a rapidly expanding market, fuelled by global demand for circular packaging solutions as companies pursue net-zero targets. The regulatory landscape in India further bolsters Srichakra's growth prospects, with the country's EPR regulations mandating 60% recycled plastic content in packaging by 2029. This regulatory push not only creates demand but also reinforces the business case for high-quality recycled plastic, positioning Srichakra at the forefront of the industry.

Srichakra has established a strong competitive moat, underpinned by FDA approvals that certify its recycled plastic products as food grade – an essential credential that elevates it above many competitors. The company has already secured major customers, providing it with a first-mover advantage and an estimated three-year lead over potential entrants. This early market leadership, combined with regulatory alignment and product quality, strategically positions Srichakra to capture long-term growth in the sector.

3 CHEMICAL RECYCLING

Context and opportunity

In India, mechanical recycling predominates,[23] accounting for over 90% of plastic waste recycling, followed by energy recovery and chemical recycling. However, mechanical recycling, while common, fails to address the additives and contaminants in plastic waste. Additionally, repeated mechanical recycling cycles degrade the material, yielding lower-value products.

Chemical recycling offers promise in overcoming the limitations of mechanical recycling, albeit at greater resource intensiveness in terms of energy and cost. While chemical recycling technology is nascent today, its promise of using a variable mix of input materials that require far less sorting than mechanical recycling and the potential it offers for a fully circular solution, resulting in input materials that do not degrade over multiple recycling cycles, make it an attractive investment opportunity. Ongoing research and pilot initiatives aim to refine chemical recycling processes and expand their application beyond fuel oil production, potentially enabling the recycling of low-value, flexible plastics.

EXAMPLES OF STARTUPS IN THIS BUSINESS MODEL

Early Stage	POLYCYCL Circular Economy for Plastics	APChemi We recycle plastics, transparently.
Mature Stage	revalyu Revalyu Recycling (India) Limited.	resGen

23. Avendus, 2023, Circular Economy: Recycling waste to wealth. Retrieved from: https://www.avendus.com/india/reports/61

POLYCYCL – CASE STUDY

ORGANISATION SUMMARY

Year of foundation: 2016
Number of employees: 12
Current production output: Pilot scale
Projected output: 1.1 million tonnes of pyrolysis oils per annum over the next ten years

Polycycl's patented chemical recycling process offers a transformative approach to addressing mixed plastic waste by converting it back into refined hydrocarbon oils, suitable for chemicals and refinery feedstock. This technology enables the recycling of challenging plastics, yielding outputs equivalent in quality to virgin plastic. For plastic manufacturers, this represents a fully circular solution to material sourcing.

In contrast to traditional mechanical recycling, Polycycl's chemical recycling process integrates seamlessly into the plastic manufacturing value chain. The process produces recycled materials that are devoid of residual inclusions and contaminants, rendering them suitable for high-demand applications, including food-grade and medical uses. Additionally, the premium quality of Polycycl's recycled products supports a value proposition that allows the company to command higher pricing. Given the nascent stage of the chemical recycling industry in India, Polycycl and its competitors are positioned early in their lifecycle and funding trajectories.

Polycycl has secured eight patents for its innovative technology, with a pilot plant already operational and a proof-of-concept validated specifically for Indian plastic waste. This capability is attributed to the founders' strategic use of resources from partner companies, which has allowed for sustained R&D investments. The company's next challenge is to scale up to industrial production. Through iterative technological advancements, Polycycl has effectively mitigated the technological risks associated with its processes, positioning itself ahead of other emerging players in India's chemical recycling sector.

SCALE

- **Existing revenue (FY23–24):** US$ 25,000 (currently at pilot scale)
- **Break-even year:** Not realised yet

IMPACT

Projected to remove 1.6 million tonnes of plastic waste per annum from improper disposal and landfills

Projected to recycle 1.6 million metric tonnes of plastic waste per annum

AWARDS AND RECOGNITIONS

- 1st Prize: National Award for Single-Use Plastics Challenge, Government of India
- Top 25 Recycling Startups in the World, HolonIQ
- 5th National Prize, Department of Science & Technology, India Innovation Initiative

FUNDING RAISED

Type of Funding	Year	Purpose	Funders / Investors
Equity	2022	Seed capital	Angels

INVESTMENT OPPORTUNITY

Total funding raised to date	Equity: US$ 1 million

Polycycl is preparing to raise equity capital to fund the construction of its first commercial plant, aiming to scale its operations from the current successful pilot stage, which has a capacity of 100 tonnes per day. The company has addressed the technological risks associated with producing high-value recycled polyolefins and has secured its value chain by partnering with India's largest solid waste management company, RE Sustainability, to strengthen the operational and supply chain for its first-of-a-kind facility.

SUCCESS FACTORS

Polycycl has established a robust technology moat, having successfully demonstrated proof-of-concept in a nascent yet high-potential market. With strong backing and strategic partnerships –including its collaboration with RE Sustainability – the company is now poised to scale its operations.

Polycycl's product, while characterised by high initial investment and operating costs, can command a significant premium in the market, fetching two to three times the price of conventional materials. This pricing advantage positions the company to achieve high profitability and attractive returns, provided it can scale its operations efficiently. The combination of strong customer interest from large global players and strategic alliances places Polycycl in a favourable position to capitalise on emerging opportunities in the recycling and sustainable materials sector.

4 LOW-CARBON PLASTIC ALTERNATIVES

Context and opportunity

As efforts to reduce plastic usage intensify, alternatives and replacements are gaining traction, particularly in applications where direct plastic substitution is feasible. Biodegradable plastics offer one such alternative, undergoing degradation via biological processes without leaving behind microplastics or toxic residue, distinct from compostable plastics.[24] These biodegradable alternatives to single-use plastics are made from a range of materials, including agricultural residue, starch, bamboo and seaweed.

After the ban on single-use plastics in India in 2022, a large number of plastic alternative startups have been established. Of these, many have struggled to offer the product with the same properties and price point as plastic. Those who have succeeded have either built unique products that offer identifiable advantages over plastics or provide a measurable and significant GHG emission reduction impact compared to plastics.

While the alternatives are clearly a better option to recycling, since they do not create plastics or plastics waste in the first place, mass adoption beyond single-use retail packaging is still lagging. Paper, when made sustainably using source materials like bamboo, is emerging as a scalable solution with comparable price points to plastic and is finding acceptance among e-commerce players for shipping applications.

EXAMPLES OF STARTUPS IN THIS BUSINESS MODEL

Early/Growth Stage	zerocircle, altM
Mature Stage	BAMBREW

24. Ministry Of Environment, Forest and Climate Change, 2022, Plastics Waste Management Rules, 2016. Retrieved from: https://cpcb.nic.in/rules-4/

BAMBREW - CASE STUDY

ORGANISATION SUMMARY

Year of foundation: 2018
Number of employees: 38
Sustainable packaging products supplied: 60,000 tonnes
Production capacity: 200 tonnes per day

Bambrew produces sustainable packaging solutions made from bamboo, offering an eco-friendly alternative to plastic packaging. Its products, used by major brands like Amazon, provide a durable, chemical-free and biodegradable solution that meets the functional demands of traditional plastic packaging. Bambrew's pricing strategy, which aligns its prices with those of plastic packaging, is crucial in the Indian market, where customers seeking sustainable options often resist paying a premium. As India's leading sustainable packaging company by revenue and growth, Bambrew has successfully garnered significant customer traction, serving diverse applications across e-commerce packaging, FMCG food and beverage brands and the pharmaceutical sector.

Initially focused on manufacturing bamboo-fibre-based straws, Bambrew has expanded its product line to include a variety of packaging materials derived from natural plant fibres, including bamboo, sugarcane and seaweed. That diversification has allowed it to develop comprehensive eco-friendly packaging solutions that can replace not only plastic straws but a wide range of single-use plastic items. Bambrew's growth has been further accelerated by India's nationwide ban on certain single-use plastics, implemented in July 2022. That regulatory shift has driven many businesses to seek sustainable alternatives, solidifying Bambrew's market leadership in eco-friendly packaging solutions.

SCALE

- **Existing revenue (FY22–23):** US$ 5.5 million
- **Break-even year:** 2023
- **EBIDTA:** Positive
- **Expected to be profitable in** FY2024–25

IMPACT

60,000 tonnes of single-use plastics avoided in FY23–24

125,000 tonnes of CO2 emissions reduced in FY23–24

Logging of 3 million trees prevented in FY23–24

AWARDS AND RECOGNITIONS

- Winner of the India-Australia Hackathon 2020
- Top 10 Global Company awarded by MISK Global Forum, Saudi Arabia
- Most Promising Startup in Sustainability by Coca-Cola India, 2018
- Cleantech Startup of the Year, Entrepreneur Magazine, 2023
- Winner of Zomato Packathon Challenge, 2024
- Advisor to Bamboo Sector Development, Government of India

FUNDING RAISED

Type of Funding	Year	Purpose	Funders / Investors
Grant	2020	Product development	Philanthropists, challenge awards
Equity	2021, 2023, 2024	Multiple: initial scale-up and growth capital	Blume Ventures, Blue Ashva Capital, family offices, angels
Debt	2022	Working capital	Caspian

INVESTMENT OPPORTUNITY

Total funding raised to date	Equity: US$ 11.8 million

Bambrew is preparing to expand its production capacity substantially to meet the growing demand from its customers. To sustain its growth trajectory, Bambrew will also need to increase its investment in R&D, enabling the development of new applications for its products and fostering demand across new customer segments and industries.

To support these ambitions, Bambrew will require a diversified capital structure. The company plans to seek grant or concessional capital to fund its R&D efforts, equity financing to drive business growth, and debt to support project funding and manage working capital needs. Given Bambrew's established track record, the strong growth potential of its market and the increasing demand driven by supportive policies, the company is well-positioned to secure the necessary investment.

SUCCESS FACTORS

Bambrew offers a sustainable alternative to traditional packaging, addressing a large and rapidly growing global market as companies with net-zero goals increasingly seek circular packaging solutions. Natural substitutes for plastic packaging are becoming the preferred choice among brands committed to sustainability. Historically, this segment has faced challenges in achieving the quality, volume and price competitiveness offered by conventional plastic packaging. Bambrew effectively addresses these critical issues, which have often limited the scalability of companies within this sector.

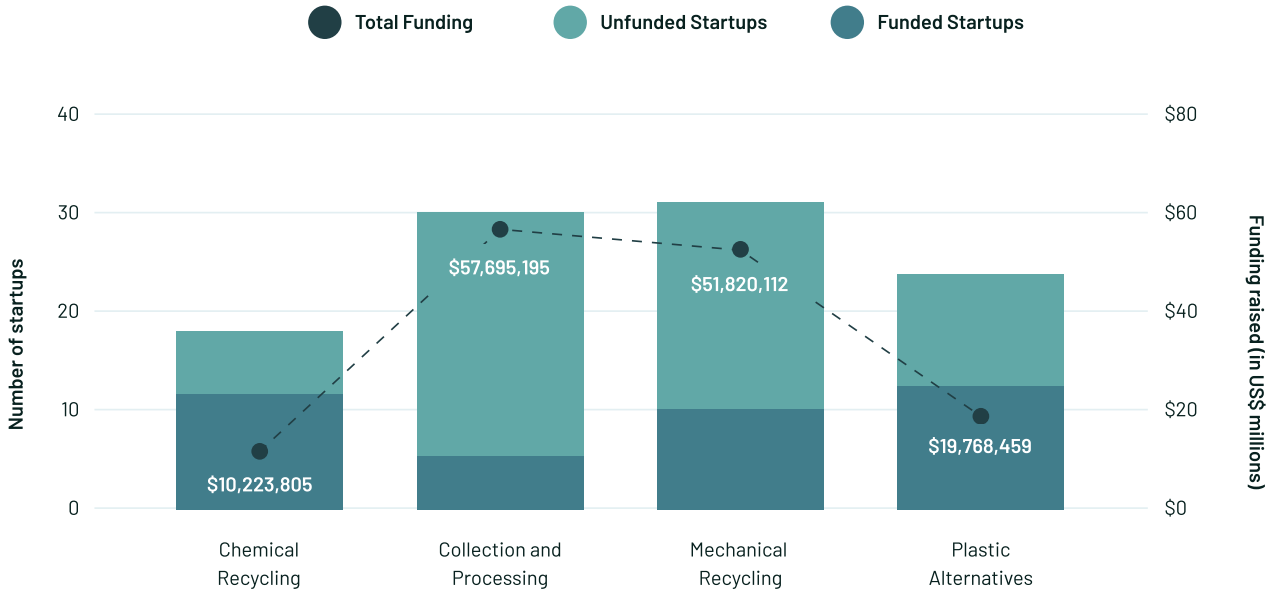
As the only Indian company operating at scale in its segment, Bambrew has built a substantial market position. Through continuous R&D and innovation, the company has developed plastic-free packaging alternatives that replicate the quality characteristics of multi-layer plastics, even for traditionally challenging applications like food packaging. Leveraging natural materials, Bambrew's products serve a wide range of industries. The company's success in securing contracts with high-profile customers has fortified its competitive moat, reinforcing its position as a leader in sustainable packaging solutions.

CHAPTER 3: INVESTMENT LANDSCAPE

Equity Investment Trends in Plastic Circularity

Identified Companies	Funded Startups	Total Equity Funding Raised (US$)
102	38	139.5 million

Figure 5: Startups across the four main business models in the plastic recycling and circularity value chain (Climake analysis)



The **102 startups** identified in Figure 5 are formal entities that operate across the plastic waste value chain in fields ranging from collection systems to chemical and mechanical recycling. The highest number of startups are involved in mechanical recycling and collection systems (with the business models of most in the latter category driven by EPR revenues). The funding for collection systems startups is skewed by one company – Recykal – which accounts for around 85% of that business model's total funding.

Collection and processing activities are often not seen as investable solutions without a significant value addition that can increase an enterprise's revenue margin; therefore, only 17% of the startups identified in that business segment were able to access funding. Equity funding opportunities are usually dependent on the utilisation of technology advantages to access higher volumes of waste, but more recently this is being superseded by the need for collection startups to create higher-value outputs. The likely future investment trajectory of these startups will be dependent on demonstrating the strength of their collection systems and their abilities to generate higher-value outputs by adopting recycling technology practices.

Mechanical recycling has high participation due to the relative ease of recycling rigid single-polymer plastics into plastic flakes or granule outputs. Most mechanical recycling of plastic waste has led to low-quality outputs, but the funded entities all focus on higher-quality outputs, from bottle-to-bottle recycling to creating high-value accessories from multilayer packaging. The investment future of mechanical recycling will be defined by delivering higher-quality outputs. Low-value recycled plastic products, such as bins and boards, will continue to have a market but are not likely to be an investment opportunity due to the plethora of competing companies and the low levels of differentiation for outputs.

Most chemical recycling startups are engaged in making low-value fuel oil rather than higher-quality recycled polyolefins for new plastics. The research for this guide identified only three such startups, all either pilots or in the early stages of commercialisation. However, one chemical recycling company, Revalyu, is a subsidiary of a large multinational conglomerate, which offers it better opportunities to access capital for growth, relative to stand-alone enterprises. This business segment is the least commercially mature segment, due to the need for large-scale facilities to deliver growth and offtake contracts with plastic producers and manufacturers, a capital-intensive process.

Plastic alternative startups are the youngest entities identified, but they also have among the highest funding percentages, which is indicative of the bullishness of investors in this sector, even though it is at an early stage. Plastic alternatives have primarily been used in packaging to reduce the impact of single-use plastics. Such alternatives, however, struggle to remain competitive and deliver scale for a low-margin business case, leading to startups developing plastic alternatives in higher-revenue-generating use cases, such as medical devices and chemical applications.

Figure 6: Stage of investments of startups across the four business models in the plastic recycling and circularity value chain, by funding raised (Source: Climake analysis)

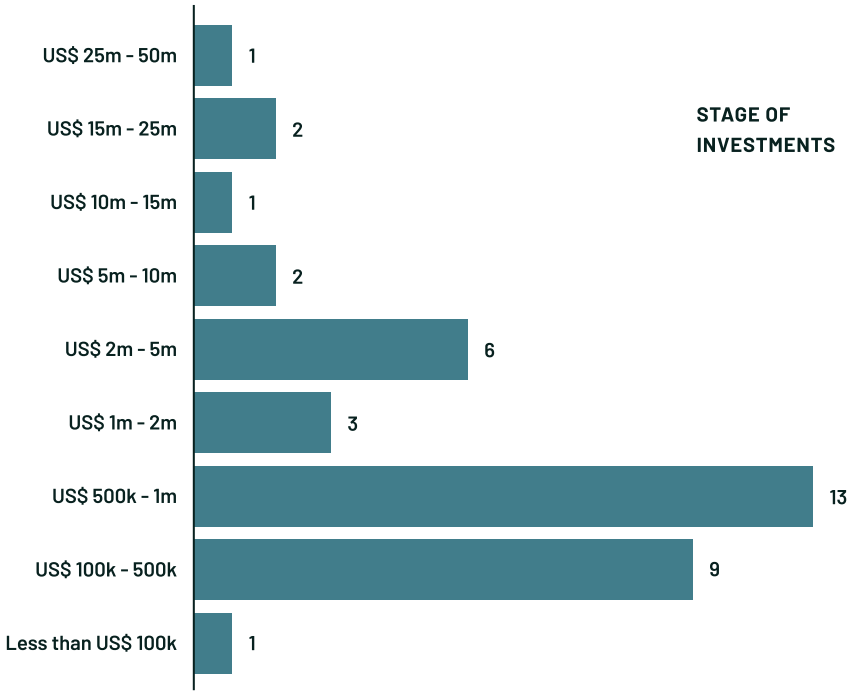
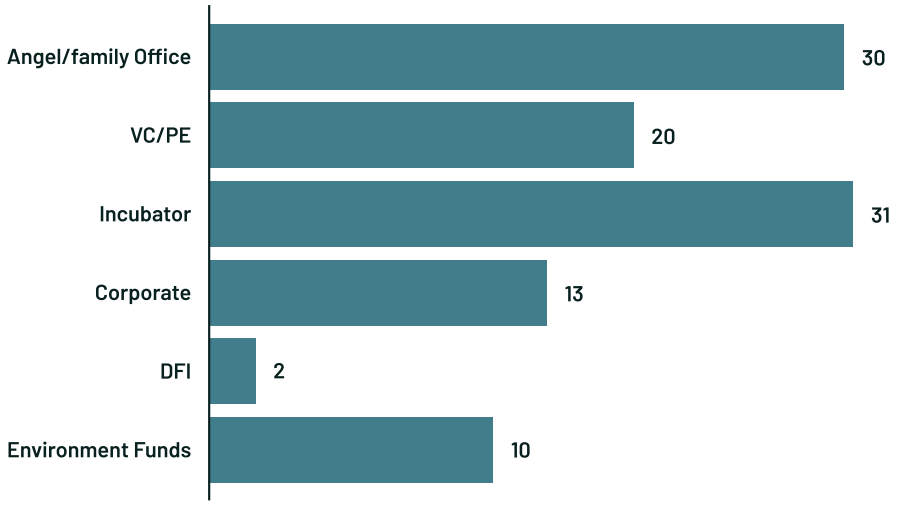


Figure 6 outlines the funding raised by plastic waste and circularity startups in India. 60% of the latest funding was below US$ 1 million – a range that spans from the pilot development of technologies to early traction. Plastic circularity will steadily see more growth funding deals compared to other sectors, due to the relative maturity of its solutions and demand for increasing levels of recycling and recycled outputs. These trends are consistent across the four business models studied; however, the maturity of mechanical recycling is more evident as it accounts for 60% of the deals above US$ 4 million. Plastic alternatives make up most of the early-stage, sub-US$-500,000 funding raised, reflective of its emerging, nascent stage. However, only one entity in the segment has reached the growth stage.

Investor and Funding Landscape

Figure 7: Number of investors who have funded waste management and circularity startups by type (Source: Climake analysis)



The equity universe for plastic circularity is extensive – 23% of all waste and circularity investors have invested in plastic circularity – indicating that it is the most mainstream circularity sector today. Six main types of investors operate in this space; the range and participation of these investor types highlight that plastic circularity is currently a nascent sector, but one that is starting to grow with mainstream, growth-stage investor participation. We expect this universe to grow as more climate-focused funds, development finance institutions (DFIs), and mainstream venture capital (VC) and private equity (PE) funds explore investment opportunities in the sector.

The roles played by each investor in supporting enterprises are summarised below:

- Incubators are often the first backers of plastic circularity startups, helping to fund product creation and proofs-of-concepts. In India, the majority of incubators are tied to academic institutions, but the presence of private platforms is growing and promising to provide more context-specific support.
- Angel funds and family offices often come in as the first institutional investors for early-stage proofs-of-concepts to enable them to transition to initial go-to-market. Environmental-focused family offices are emerging to mainstream sustainability in corporate settings.
- VC and PE funds operate in a wide space from funding initial go-to-market and seed-stage investments up to growth-stage investments, based on the nature of focus of such funds. However, these funds often lack a clear thesis on asset-heavy investments which is needed in climate action and circularity. VC funds, in particular, operate in the current biggest funding gap in plastic circularity: providing Series A/B ticket sizes for enterprises to fund go-to-market and initial growth.

- That gap is starting to be tackled by environment-focused funds, which come in with a clear thesis aligned to the needs of plastic circularity enterprises and are potentially better equipped to fund and back these high-potential, often technologically complex bets. However, such funds are limited and few, with only ten identified that have at least one investment in plastic circularity.
- DFIs fund growth, but the scale of the capital they can deploy means that they can influence the direction and bets of earlier-stage funds, driving them to align their priorities with those of the DFIs. DFIs also play a catalytic role, bringing more private finance to the sector. They often do that by offering debt or equity on concessional terms to an enterprise, which allows it to grow to a level at which it can meet the expectations of more commercial investors. However, given the nascence of the waste and circularity sector, there is a need, currently, for DFIs to operate at lower ticket sizes (around US$ 10 million) compared to the scale of traditional DFI investments (above US$ 30 million).

Figure 8: Active equity investors in plastic circularity (Source: Climake analysis)

Plastic Circularity Businesses Also Have Significant Debt Potential

Plastic circularity businesses in India, particularly those in the growth stage, have demonstrated an ability to fund part of their capital needs with debt. These companies are raising three kinds of debt:

Project Finance

Both plastic recycling (mechanical as well as chemical) and the manufacturing of plastic alternatives require the setting up of capital-intensive, asset-heavy plants. For companies that have raised equity and built a profitable business model, such debt financing is widely available from banks in India.

Banks, however, require companies to provide three years of profitable track record and to offer collateral security beyond the project's assets. For companies that do not meet such criteria, specialised lenders like Tata Cleantech Capital and DFIs have stepped in. Recent examples of such funding include the expansion capital provided to Banyan Nation by the United States Development Finance Corporation (USDFC) and to Revalyu by the German Investment Corporation (DEG) and the Investment Fund for Developing Countries (IFU).

Working Capital

As with project finance, profitable companies that can offer collateral security and personal guarantees from their founders are able to raise credit lines from local banks to meet their working capital needs. There are several other options for those who do not qualify for bank loans:

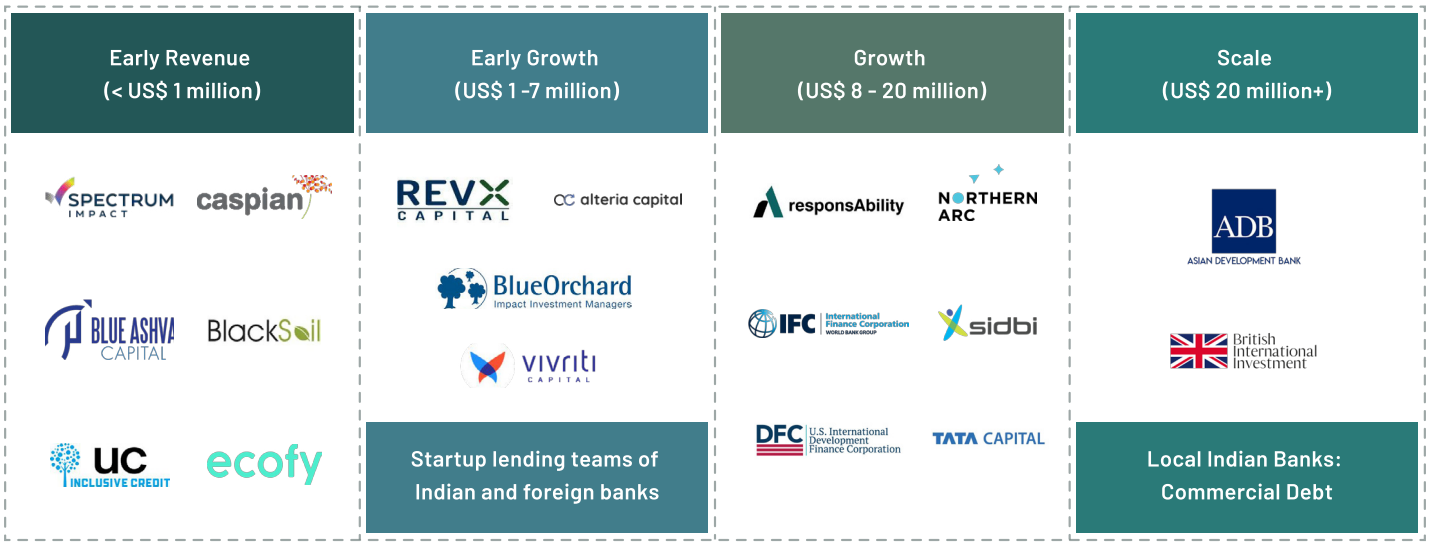
- Non-banking finance companies (NBFCs) offering unsecured business loans to meet the working capital requirements of young startups.
- Invoice discounting offered by banks, NBFCs and multiple trade receivables electronic discounting system (TReDS) platforms.
- Financing linked to orders that provides working capital to purchase raw materials and pay vendors with repayments linked to the revenue received from such orders.
- Revenue-based financing for companies that have fixed monthly revenue or standard offtake contracts.

Venture debt

While more popular with technology startups, venture debt is increasingly gaining traction in the environment and circularity sectors as well. Venture debt providers are able to complement the equity raised with a small debt component, thus increasing the runway for early-stage startups and providing an option for lower dilution in early rounds of fundraising.

The universe of active debt investors in the plastic circularity segment is shown below.

Figure 9: Active debt lenders in plastic circularity (Source: Climake analysis)



Blended Finance Options for Plastic Circularity

Startups in plastic circularity have accessed blended and concessional capital in their early product development and pilot stages. While parts of the plastic circularity sector are now becoming mature and no longer need concessional capital, there is still a need for innovation in areas like chemical recycling. Further, startups that work on creating awareness and establishing a formal workforce in a highly disorganised collection sector also benefit from technical assistance and grants. Blended capital, in the form of first-loss guarantees, is also being used by organisations that are not able to lend to early-stage plastic circularity startups without such support.

One example of catalytic concessional capital for plastic circularity is the support offered by the Alliance to End Plastic Waste (AEPW). This institute raises capital from companies that contribute to plastic waste and deploys it to fund recycling initiatives through a variety of concessional finance options, thus supporting the adoption of solutions for pilot demonstration and commercial validation. Grants are also provided for technical assistance, awareness programmes and supporting the development of recycling technologies. AEPW also provides loans primarily to scale up proven plastic waste management and recycling approaches as project finance. Additionally, AEPW also co-funds, primarily with DFIs, large-scale project implementations, such as working with municipalities to adopt recycling technologies.

CHAPTER 4: CONCLUSION

India generates around 4.1 million tonnes of plastic waste annually – a figure that, based on current trends, could reach up to 46 million by 2035.[25] The country's overall plastic recycling rate is around 13%, although some types of plastic have substantially higher rates, such as PET at 90%. The demand and need for plastic circularity in India is extensive. Plastic circularity is presently the most investable of waste and circularity segments in India, driven by four prevailing trends that incentivise the adoption of plastic circularity solutions and enterprises:

- Plastic consumption (and the supply of materials for recycling) continues to increase
- Government policies and legislation are creating a positive momentum for circularity and high-quality recycling.
- Consumer demand for circular plastics and plastic alternatives is growing, regardless of policy.
- Technologies for recycling plastics are well developed and reaching commercial scales of adoption.

This study has identified 102 formal enterprises operating across four main business models in plastic circularity: collection and processing (31% of all plastic circularity enterprises), mechanical recycling (31%), chemical recycling (17%) and plastic alternatives (21%). Each segment offers differing levels of investment opportunity and potential based on the nature of the business and the operating context. Only 9% of collection and processing enterprises were able to access equity funding, in contrast to 55% of the plastic alternative startups and 61% of chemical recycling startups. Businesses that are able to deliver and demonstrate high-quality plastic circularity outputs are being recognised as investment opportunities.

Over 60% of the equity investments have been early-stage, sub-US$-1-million investments, which accounts for why incubators and angel funds have dominated the investor landscape in backing high-potential plastic circularity technologies towards initial traction and validation. This sets the stage for larger investments to flow into the sector as these early-stage businesses start to grow and mature. There is an equally active community of equity investors backing the sector, though such activity is largely concentrated at the two ends: seed investors and large PE funds / DFIs looking to invest in mature businesses.

The gap in growth-stage equity is being partly met by the evolution of debt investors who are showing an active interest in funding the intensive capital expenditure required to set up plastic recycling and plastic alternative production facilities and the working capital needed to access plastic waste supplies. Blended finance and grant-based concessional financing structures are emerging together with commercial equity and debt to cater to the expectations of startups across different stages of their lifecycle.

25. Dhodapkar R., Bhattacharjya S., Niazi Z., Porter N.B., Retamal M., Sahajwalla V., Schandl H., CSIRO, Australia, 2023, National Circular Economy Roadmap for Reducing Plastic Waste in India. Retrieved from: https://www.csiro.au/-/media/Environment/Circular-Economy-Roadmap-India/23-00249_ENV_REPORT_IACPRoadmap_WEB-230714.pdf

RESEARCH METHODOLOGY

The insights and conclusions of this guide were informed by data gathered from primary and secondary sources. The insights also leveraged the extensive work that Climake has already undertaken in the waste management and circularity sector.

DATA COLLECTION

1 Secondary Public Source Analysis

The first phase involved a thorough review of publicly available secondary sources: academic literature, industry publications and reports, government reports and statistics, news articles and press releases, and open-access databases and repositories.

2 Access to Proprietary Databases

We also accessed proprietary databases containing specialised and detailed information relating to start-ups, funding and investors. The main database leveraged for this was Tracxn. Access to these databases allowed us to obtain up-to-date market data and gather detailed company and investor-specific information.

3 Primary Research

To gather sector-specific feedback, we engaged in primary research with key stakeholders: start-up founders, investors and experts in waste management and circularity. This primary research was undertaken as part of targeted and ongoing engagements with stakeholders. A total of six interviews were conducted with the following:

- Four founders of funded entities in each of the identified core business models:
  - Collection systems and processing
  - Mechanical recycling
  - Chemical recycling
  - Plastic alternatives
- Two funds with a defined thesis in plastic circularity.

DATA ANALYSIS AND SYNTHESIS

The data collected from all sources were systematically analysed and synthesised. This process involved:

- Conducting content analysis to identify insights, conclusions, trends and forecasts
- Using data visualisation approaches to represent quantitative findings
- Validating assumptions and identifying discrepancies by cross-referencing information from different sources.

LIMITATIONS

While efforts were made to ensure comprehensive and accurate data collection, some limitations should be noted:

- Accurate data on key metrics such as waste quantities and recycling rates are poorly documented in India and vary significantly across waste streams. Our research aimed to validate all data points identified by identifying multiple sources, if available, validating with primary interviewees and leveraging our extant knowledge of the sector.

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