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Circular Business Models

Policy Enablers for Plastic Packaging Alternatives in India

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Abstract

In recent years, global production of plastics has surged and is expected to increase further over the following years, with over a quarter being attributed to plastic packaging. Plastic packaging poses environmental risks due to the fossil fuels consumed in its production and the impact on eco-systems due to its inappropriate disposal. A large share of mismanaged plastic waste can be attributed to a few developing and emerging countries (DECs) in Asia. Their expected income and population growth, as well as associated increase in consumption and urbanisation, is expected to further strain inadequate waste management systems. In response, young ventures offering circular business models in packaging have emerged to tackle plastic packaging pollution. These ventures are embedded in an entrepreneurial ecosystem in which policies are, among others, determining enablers, and policy-makers have a key role in setting optimal framework conditions for circular business models in packaging to succeed. At the same time, policy agendas that address resource efficiency and the circular economy are on the rise in multiple DECs. For this reason, this paper addresses the question of the extent to which existing policies are supporting and enabling circular business models.

This paper first discusses opportunities, risks, and challenges of existing circular business models in packaging in terms of waste hierarchy levels – reducing and dematerialising, reusing and refilling, replacing, and recycling – before examining the entrepreneurial ecosystems in which they operate. With a focus on policy as an enabler for circular business models in packaging, a holistic overview of possible policies in the circular packaging context is provided. Against this conceptual background, India is examined as a case-study. In recent years, multiple Indian start-ups have emerged, offering reusable packaging solutions or bio-based packaging alternatives, while other ventures seek to improve waste management and recycling. India's previously introduced policies, including the Plastic Waste Management Rules, Swacch Bharat Mission, extended producer responsibility and a ban on single-use plastic, are the first stepping stones towards an enabling ecosystem for circular business models in packaging.

However, this paper points out further opportunities – so far, India's key policies have been addressing the downstream on the macro level. This study showed that macro-level policies need further enforcement and should be complemented by upstream policies. Meanwhile, meso-level and micro-level policies have been rather neglected. Policy-makers and development cooperation are encouraged to take action now, given the limited window of opportunity to establish a supporting framework for circular economies in development policy.

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Abbreviations

B2B	business to business
B2C	business to consumer
CE	circular economy
DEC	developing and emerging country
EPR	extended producer responsibility
EU	European Union
FMCGs	fast-moving consumer goods
GDP	gross domestic product
GHG	greenhouse gas
Mt	megatonne (million tonnes)
OECD	Organisation for Economic Co-operation and Development
PBAT	polybutylene adipate terephthalate
PE	polyethylene
PET	polyethylene terephthalate
PWMRs	Plastic Waste Management Rules
PHA	polyhydroxyalkanoate
PLA	polylactic acid
PRO	producer responsibility organisation
PU	polyurethane
PVC	polyvinyl chloride
R&D	research and development
SBM	Swacch Bharat Mission
SDGs	Sustainable Development Goals
SUP	single-use plastic

1 Introduction

The transition to a circular economy (CE) away from the current linear economic rationale of "take-make-dispose" is a major pillar in achieving the 2030 Agenda for Sustainable Development Goals (SDGs) and the 2015 Paris Climate Agreement (Schröder, 2020). Implemented globally by businesses, cities and nations, a circular economy can reduce resource extraction and use by 28 per cent, thereby cutting greenhouse gas (GHG) emissions by 39 per cent to reach the 1.5-degree goal (Circle Economy, 2022). Similarly, the Ellen MacArthur Foundation (2021) argues that the adoption of circular strategies in four key sectors – steel, cement, plastics and aluminium – could decrease global emissions from key industry materials by 40 per cent by 2050. However, previous nationally determined contributions (NDCs) and GHG reduction plans of the COP26 reveal that the focus for carbon reduction is the energy transition and exchanging fossil fuels for clean energy: only one third of nations made any mention of the circular economy in their pledges.

Circle Economy (2022) argues that energy transition alone is not enough to stem climate breakdown; a more holistic approach is needed. In this context, a "circularity gap" is being debated. In 2018, a circularity gap of over 90 per cent was reported, which worsened slightly from 9.1 per cent circularity in 2018 to 8.6 per cent in 2020. The negative shift can be explained by several underlying trends. To serve the needs of a growing population, urbanisation and rising consumption levels, materials for consumption, housing, infrastructure and heavy machinery continue to be extracted (Circle Economy, 2022; Never et al., 2020; Portevin, 2018). At the same time, the growth rate of resource extraction outpaces improvements in efficiency and end-of-use recovery by a factor of two to three. Consequently, the quantity of secondary materials available for use is falling short (Circle Economy, 2022).

Aside from achieving climate targets, the circular economy and its related natural resource management are expected to benefit developing and emerging economies (DECs) in terms of at least 12 of the 17 Sustainable Development Goals (SDGs), while meeting the needs of a growing and urbanising population (Ekins & Hughes, 2017; Gower & Schröder, 2016; Preston & Lehne, 2017). For example, the circular economy can be a gateway for more resilient economic growth (SDG 8). It decreases dependence on raw materials and finite resources, as waste from one industrial process is a valuable input for another. As a consequence, it increases the resilience of supply chains by shielding them from upward trends in resource prices and increased price volatility and therefore also mitigating risks of resource-related conflicts (Gower & Schröder, 2016). Diverse opportunities for value creation, skills development and employment may arise from the circular economy, as remanufacturing and repairing products tends to require more labour than manufacturing them from raw materials, deconstruction is typically more labour-intensive than demolition, and secondary products are often linked to service-oriented jobs and opportunities in reverse logistics. While specific data on employment opportunities refer to Europe (Vaughan & Smith, 2018), case studies have highlighted job opportunities in DECs in organic waste, reverse logistics, repair, remanufacture and reuse. Traditional cultures of repair and reuse, as well as the large base of informal workers in DECs, can be a competitive advantage if their working conditions can be adequately accounted for (Gower & Schröder, 2016; Preston, Lehne, & Wellesley, 2019).

The neglect of the social dimension in the transition to a circular economy is anticipated by the Just Transition framework, which

> can identify opportunities that reduce waste and stimulate product innovation, while at the same time contributing positively to sustainable human development. More specifically, it is important that the CE transition delivers on social objectives – poverty eradication, improved livelihoods and well-being, decent work, and reduced inequalities (Schröder, 2020, p. 4).

For the implementation of a circular economy, authors are pointing to a limited window of opportunity in which international development organisations can support leapfrogging to a circular economy as a new framework for development policy alongside the SDGs and the Paris Climate Agreement (Preston & Lehne, 2017). In striving for a circular economy, each country must tailor the roadmap of circular solutions to suit its context and population. If solutions are not tailored to different countries and eco-social considerations are not part of the transition, there is a risk that the mistakes of the linear economy will be repeated (Circle Economy, 2022).

This study builds on this need and explores context-specific policies for the implementation of a circular economy in the contect of DECs, thereby focusing on circular business models in packaging and how to support them as one solution in the transition to a circular economy that minimises plastic packaging pollution. Chapter 2 provides conceptual background knowledge on the concept of a circular economy, and highlights the major issues related to plastic packaging waste encountered by DECs. Following this, circular business models in packaging are described that could present key solutions and new opportunities for preventing future plastics pollution with innovative new materials or by closing resource loops along plastic packaging value chains. To gain a better understanding of the environment businesses are operating in, a brief introduction to the entrepreneurial ecosystem is provided. Existing policy enablers for development cooperation are introduced that support the transition to circular business models in packaging. Chapter 3 introduces India as a case study for implementing enabling policies for CBMPs. India, with a dedicated mission to develop a circular economy and resource efficiency is an essential partner of German development cooperation (BMZ, 2023). Following a brief introduction to India's plastics sector, enterprises that were interviewed by the non-profit organization Saahas are discussed (see Annex for a list of participating entities). Following this, tailored policies are highlighted and summarised for development cooperation to promote circular business models in packaging in India's country-specific conditions.

2 Conceptual background

2.1 Definition of the circular economy and emergence in development policy

The circular economy is often described as one important element of the broader umbrella concept of the green economy (D'Amato et al., 2017), which is defined as

> one that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities. In its simplest expression, a green economy can be thought of as one which is low carbon, resource efficient and socially inclusive (UNECE [United Nations Economic Commission for Europe]/FAO [Food and Agricultural Organization], 2018, p. 6).

The circular economy (CE) has most recently been defined as:

> A systems solution framework that tackles global challenges like climate change, biodiversity loss, waste, and pollution. It is based on three principles, driven by design: eliminate waste and pollution, circulate products and materials (at their highest value), and regenerate nature. It is underpinned by a transition to renewable energy and materials. Transitioning to a circular economy entails the decoupling of economic activity from the consumption of finite resources. This represents a systemic shift that builds long-term resilience, generates business and economic opportunities, and provides environmental and societal benefits" (Ellen MacArthur Foundation, 2022).

Aside from this definition, many varying definitions of the concept of CE are circulating in research and practice. Kirchherr, Reike, & Hekkert (2017) analysed 114 definitions from 2012

to 2017. In their sample, between 35 and 40 per cent referred to the 3R-framework – reduce, reuse and recycle. Recycling was the most common component mentioned (79 per cent), followed by reuse (74–75 per cent) and reduce (54–55 per cent). The authors remark that only 30 per cent of those definitions include a waste hierarchy that prioritises "reducing" against the other Rs. The waste hierarchy occurs less frequently in practitioner definitions compared to peer-reviewed ones, assuming practitioners have little interest in reducing consumption and curbing economic growth (Kirchherr et al., 2017). After 2012, the 3R framework is found less frequently in definitions, whereas the mention of the systems perspective increased compared to pre-2012 from 29 to 47 per cent. The definitions also vary in their emphasis on the three sustainability dimensions: only 13 per cent of all definitions refer to all three sustainability areas. Economic prosperity was highlighted most frequently (46 per cent), followed by environmental quality (37–38 per cent), whereas the social equity dimension is neglected (18–20 per cent). A more recent framework for the circular economy (Schröder, 2020) addresses the neglect of the social dimension with a just transition framework – a term more commonly used in sustainability policy debates and research:

> The just transition ensures environmental sustainability, decent work, social inclusion, and poverty eradication. (…) A just transition is needed to reduce inequalities within and between countries, and to ensure that the commitment of the UN Sustainable Development Goals to leave no one behind is fulfilled (Schröder, 2020, p. 2).

According to Schröder (2020), social justice considerations and the adoption of a just transition approach are critical to establishing an alternative economic model and ensuring active participation and public acceptance of policies and regulatory reforms. Following this, Schröder (2020) has further embedded the just transition framework into the circular economy context, as highlighted in the introduction.

According to Kirchherr et al. (2017), many definitions of a circular economy fail to highlight business models and consumers as enablers of it. Circular business models help eliminate waste streams and close resource loops (Dijkstra, van Beukering, & Brouwer, 2020), yet only 11 per cent of definitions mention business models (Kirchherr et al., 2017). If the private sector is expected to lead the transition to a circular economy, definitions thereof should not neglect the importance of business models. The consumer perspective cannot be neglected either, since circular business models risk being unviable, with a lack of consumer demand and willingness to pay for associated products and services (Kirchherr et al., 2017).

The concept of a circular economy has already been reflected in multiple global policies, but calls for "building back better" have increasingly been linked to the concept since the Covid-19 pandemic (Circle Economy, 2022; OECD [Organisation for Economic Co-operation and Development], 2020). The most prominent international example of a policy on circular economies is the European Circular Economy Action Plan, first introduced in 2015 (European Commission, 2020). The literature discourse on the topic has long focused on industrialised countries, with little attention given to the concept in developing countries. A circular economy could enable developing countries to "leapfrog" to a more sustainable development path and avoid them being locked into resource-intensive practices, especially since many sectors are already undergoing profound disruption (Halog & Anieke, 2021; Preston & Lehne, 2017). Increasingly, the literature discourse is shifting to DECs, as *regional* circular economy initiatives are gaining momentum outside industrialised countries. The Regional 3R and Circular Economy Forum in Asia and the Pacific, launched in 2009, is addressing reducing, reusing, and recycling, and added "Circular Economy" to the conference title in 2020. The African Circular Economy Alliance was launched in 2016 during the World Economic Forum and is government-led by Benin, Burkina Faso, Cote d'Ivoire, Ghana, Nigeria, Rwanda, South Africa and Sudan. It aims to support the transition to a circular economy through policy development, leadership and advocacy, and by scaling up businesses that contribute to it (ACEA [African Circular Economy Initiative], 2022). Similar continental initiatives include the Circular Economy Coalition for Latin

America and the Caribbean (Circular Economy Coalition Latin America and the Caribbean, 2021). Examples of *national* initiatives that include the CE concept are the Chinese Five-Year Plan (2021–2025) (UNDP [United Nations Development Programme], 2021) and the Indian National Resource Efficiency Policy (MoEFCC [Ministry of Environment, Forest and Climate Change], 2019). In addition, national CE initiatives are also gaining traction in smaller DECs, as visually depicted in a world map by Chatham House (2022). In addition, development cooperation increasingly includes CE approaches. For example, the European Union (EU) has launched several CE initiatives in the EU–Africa cooperation context including transnational EU financing and cooperation on research, innovation and circular business models (Rademaekers et al., 2021). Other EU-funded examples include the Switch-Asia or Switch2Green initiatives (Switch2Green, 2023; Switch-Asia, 2023).

2.2 Plastic packaging waste and the circular economy in developing countries

Globally, the production of plastics has surged 230-fold since the mid-20th century – from 2 million tonnes (Mt) in 1950 to 460 Mt in 2019 – and is expected to rise to 1,231 Mt in 2060 (OECD, 2022b). The volume of synthetic polymers used has been increasing constantly and faster than that of other commodities, including steel, aluminium and cement. Globally, 26 per cent of the total volume of plastics used goes into plastic packaging. Plastic packaging solutions are popular as they can increase the shelf-life of food, reduce food waste, and reduce the consumption of fuel during transportation because of their low weight (World Economic Forum et al., 2016).

However, the production of fossil-fuel-based plastic is associated with a significant carbon impact that could peak with increasing consumption: 90 per cent of all plastics (not only packaging) are based on virgin fossil fuels, which amounts to 6 per cent of global oil consumption. Following estimates of plastic consumption growth, total oil consumption for plastics could increase to 20 per cent by 2050 (World Economic Forum, Ellen MacArthur Foundation, & McKinsey & Company, 2016). In addition, fossil fuel companies are looking into the plastics sector as a growth market while their fossil-based energy operations are declining in the energy transition. In this pursuit, developing and emerging countries in Asia and Africa are considered focal markets (Brigham, 2022).

Aside from issues related to the sourcing of raw materials for the production of plastics, the short average lifespan of plastic packaging is causing global problems – it is responsible for an extraordinarily high proportion of waste. In 2019, 42 per cent of the 353 million tonnes of plastic waste generated constituted packaging waste. Overall, about 15 countries contribute about 80 per cent of total global plastic waste, which amounts to 270 Mt each year (Gao, Hundertmark, Pais, Ryba, & Wallach, 2022). Almost half of the plastic waste is generated by members of the Organisation for Economic Co-operation and Development (OECD). Outside the OECD, China accounts for 19 per cent of global plastic waste, India 5 per cent, and the rest of the world 27 per cent (OECD, 2022a). While industrialised countries have larger shares of global plastic waste, DECs and non-OECD countries have higher leakage to the environment than OECD countries. In particular, countries with large ocean-bound rivers, long coastlines and weak collection infrastructure have increased risk of plastic leakage (Eurasia Group, 2021). The main cause for leakage is mismanaged plastic waste from municipal and non-municipal sources and littering of end-of-life-plastic products (OECD, 2022a). In low-income countries with poor waste-management infrastructure, waste generation can outpace improvements in collection and disposal capacity, leading to higher volumes of mismanaged waste – waste that is either not collected, or collected but disposed of in dumpsites, or collected for disposal in the environment (OECD, 2022a). Globally, around 32 per cent of plastics and plastic packaging are leaking from collection systems (World Economic Forum et al., 2016), with plastic packaging particularly prone to leakage due to its small size, high rate of dispersion and low residual value. The World

Economic Forum et al. (2016) assumes that even if plastic packaging leakage was globally reduced from 32 per cent to 1 per cent, about 1 million tonnes would still escape collection systems and accumulate in natural systems each year. Every year around 8 million tonnes of plastic leaks into the oceans, but forests, waterways and urban infrastructure can also be affected. The cost of negative externalities is estimated at USD 13 billion (World Economic Forum et al., 2016) as there are also impacts on human livelihoods, health, food chains and societal systems.

Asian countries, in particular, are among the largest sources of ocean plastic leakage. China, India, Indonesia, Thailand and Vietnam account for about 85 per cent of mismanaged plastic waste globally (Gao et al., 2022). Expected income and population growth in South and Southeast Asia could significantly increase plastic consumption, further straining inadequate waste-management systems. In addition, the growing middle class in DECs such as the Philippines have pointed to resource and carbon-intensive consumption patterns that are levelling up to consumption patterns in developed countries and could result in a surge in the use of plastic packaging (Kharas, 2017; Never et al., 2020). Moreover, urbanisation could put further pressure on municipal waste systems. Currently, 20 of the world's 33 megacities are located in Asia and the Pacific, and it is predicted that this number will rise to 27 by 2030 (Hondo & Arthur, 2022). In South Asia and Africa, the fast-moving consumer goods (FMCG) sector is a major source of plastic packaging pollution, as single-use plastics (SUPs) such as water bottles and sachets are strongly implicated in coastal and marine pollution (UNCTAD [United Nations Conference on Trade and Development], 2022). In addition, many Asian countries are often destinations for large volumes of plastic packaging waste from industrialised countries, including the EU. While not discussed in depth in this study, To (2022) provides further discussion on this subject.

Implementation of circular business models in packaging could prevent or minimise environmental impacts of leakage by slowing down the lifecycle of plastic packaging, utilising existing materials and minimising material consumption (Hondo, 2022), especially in regions that struggle with resource efficiency and waste management. By 2050, waste generation per capita is projected to increase by 40 per cent in DECs, compared to industrialised countries, which are expected to see an increase of 19 per cent (Hondo, 2022). Economic sectors that could benefit from circular packaging solutions reach beyond the plastics value chain and could include tourism, fishing and shipping – all areas sensitive to the effects of poor waste management. This is of particular concern for many developing Asian countries that rely on tourism for economic growth. For example, pre-pandemic, tourism accounted for 22 per cent of GDP in Thailand and 13 per cent in Malaysia (Eurasia Group, 2021). Moreover, circular business models in packaging hold opportunities along the entire packaging value chain.

Approaches to finding alternatives to the use and consistency of plastic packaging have a potentially large impact in DECs with economies based on the use of plastic sachets (multilayer laminates packaging for small servings of foods, medicine and hygiene goods). Such sachets are not usually recyclable, so informal waste collectors have little incentive to collect and segregate them. They are widely used in low-income countries as they enable people to purchase products in smaller quantities at a lower cost. Some DECs have the potential to source alternative materials for packaging, such as jute.

Reuse models also hold increasing potential, especially in urban areas, and those experiencing the growth of e-commerce. Recycling offers additional income opportunities for informal workers and marginalised groups. For example, an analysis of Indonesia found that economy-wide circular economy initiatives would create a net gain of 4.4 million jobs, with over 100,000 of those jobs tracing back to improved plastics management and 85 per cent of those jobs going to women (Eurasia Group, 2021).

Not all circular business models in packaging are suitable for DECs, however. Implementation challenges and risks are present along the packaging value chain, alongside opportunities.

Dematerialisation in the sense of making packaging more lightweight could decrease its material value, which could make recycling less attractive to informal workers. As for bio-based materials, there can be risks and challenges concerning their compostability in a given environment. Reuse models have been successful in industrialised country markets but could be challenged in DECs by the complexity of reverse logistics. Recycling of plastic packaging in DECs could be limited by operational challenges, lack of access to quality plastic feedstock and its recyclability. Due to this ambiguity, the following section introduces circular business models in packaging and discusses associated opportunities, risks and challenges in more depth.

2.3 Circular business models in packaging

Core to most circular business models in packaging are solutions in which plastics

> never become waste; rather, they re-enter the economy as valuable technical or biological nutrients. Its ambition is to deliver better system-wide economic and environmental outcomes by creating an effective after-use plastics economy, drastically reducing the leakage of plastics into natural systems (in particular the ocean) and other negative externalities; and decoupling from fossil feedstocks.

This approach has been framed as the New Plastics Economy by the World Economic Forum et al. (2016, p. 8).

Dijkstra et al. (2020) have conducted a systematic literature review on circular business models in packaging. The researchers identified 44 unique business models and assigned them to waste hierarchy levels as defined by the EU Waste Framework Directive (European Commission, 2018). The highest-ranked option according to the waste hierarchy logic is prevention and reuse, followed by recycling (including composting), with disposal as a last resort. This typology is also reflected in the classification by Retamal, Panandiker, Talwar, Sah, & King (2021). However, in his review, the category “substituting”, here referred to as replacing, was added as a business model specific to the plastic packaging context. Consequently, circular business models in packaging can be classified into five categories.

- **Preventing** includes reconsidering the necessity for packaging altogether and, following that, rethinking packaging design to reduce plastic material use.
- **Reusing** refers to business models that rely on reusable and/or refillable packaging and extend the lifecycle of a packaging solution.
- **Recycling** relates to upcycling and downcycling, where the product is transformed into a similar or new product or material of higher or lower quality. Before considering up- and downcycling, business models are also looking into incorporating design requirements that facilitate recycling.
- **Replacing** involves the substitution of fossil-fuel-based plastics with alternatives. This is a common business strategy to prevent negative impacts related to producing and discarding fossil-fuel-based plastics and/or non-compostables.
- **Disposal** is the final option for plastic waste and can include landfilling, dumping or burning (Dijkstra et al., 2020). While not mentioned by Dijkstra et al. (2020), a related stream of business model could be classified as “capture and removal”, which focuses on removing plastic from the environment that has leaked from traditional waste disposal streams. For example, this includes ocean-clean-up companies such as Seven Clean Seas (Seven Clean Seas, 2023) and The Ocean Cleanup (Ocean Cleanup, 2022). However, this will not be further discussed in this paper.

In contrast to the waste hierarchy prioritisation, most business models analysed by Dijkstra et al. (2020) were focused on recycling (55 per cent), followed by prevention (11 per cent), and reusing plastic materials (9 per cent), whereas replacement models were not analysed in their study. The next section, however, provides a discussion of circular business models in packaging in reducing, reusing and refilling, replacing and recycling.

2.3.1 Reducing and dematerialisation

Dematerialisation is a business model that minimises the use of materials. The simplest approach is direct elimination, which involves considering whether the packaging is needed at all. Supermarkets in Germany, for example, have been phasing out plastic films from products such as multi-buy tins and vegetables (Rewe, 2023). More innovative elimination approaches aim to achieve the benefits of packaging by different methods, such as laser-etching fresh fruits and vegetables to replace plastic labels and packaging (EcoMark, 2023), or edible coatings directly applied to fruits and vegetables to keep produce fresh (Nature India, 2022). Alternatively, companies are working on redesigning their packaging to reduce the volume of plastic packaging. For example, Unilever (2022) offers concentrated home and personal care products, such as toothpaste tablets, that use less packaging, and Mars (2022), who is redesigning and eliminating packaging from its products. Over the past 40 years, many companies have achieved significant material savings by making their plastic packaging lighter in weight (World Economic Forum et al., 2016): The MuCell Technology inserts gas bubbles into materials to reduce the density of the material and therefore the amount used (Yeung, 2022). Reuse and refill formats are a related way of preventing plastic packaging and are further discussed in the “reuse” section.

Opportunities. Dematerialisation is the most favoured option, according to the waste hierarchy, and could also be most appropriate for DECs to avoid the problem of packaging pollution upstream, causing pollution downstream. If approached using innovative redesigns, investment would primarily be needed in R&D, while materials costs are minimal. Several major multinational FMCG companies have implemented actions to eliminate packaging: Mars has removed 17 per cent of polyvinyl chloride (PVC) in plastic windows in rice boxes, while L’Oréal has started to phase out multilayer materials in some products (PRI [Principles for Responsible Investment], 2021). The biggest impact opportunity for dematerialisation lies in developing Asian countries which are often dominated by a sachet economy. For example, in Manila in the Philippines it was estimated that sachets made up 50 per cent of residential plastic waste (Eurasia Group, 2021).

Risks and challenges. For DECs, “light-weighting” may not be a suitable business model as the material value of plastic packaging could be lowered, increasing the risk of leakage, and disincentivising circular after-use paths (World Economic Forum et al., 2016). Light-weighted materials could also be less valuable for collection by informal workers in DECs. Due to the lack of waste-management infrastructures and the high risk of leakage in DECs, incentives for after-use paths should, rather, be increased. Instead, redesigning to reduce packaging should be a favoured approach for DECs as its implementation does not require highly technological advancements. To ensure consumer acceptance, consumer perceptions, behaviours, habits and willingness to pay should be considered in the intended packaging improvement (Gustavo Pereira, Bond, Viegas, & Borchardt, 2018). This is especially the case in DECs where consumers favour the sachet economy.

2.3.2 Reusing and refilling

Historically, reusable packaging used to be the standard format for milk, wine and other beverages, e.g., with returnable glass bottles. Over time, reusable packaging has disappeared from the business-to-customer (B2C) sphere because of longer supply chains, increased distance between the point of supply and point of use, decreasing costs for single-use packaging

(World Economic Forum et al., 2016) and the needs for brands to use packaging differentiation. However, reuse packaging business models have been experiencing a slow comeback in industrialised countries. Driven by consumer awareness and the regulatory environment, multiple solutions have emerged whereby consumers are encouraged to return or refill reusable containers in their homes or stores. According to surveys across 24 countries between 2019 and 2021, consumers in industrialised countries are already altering shopping habits and are actively avoiding plastic packaging (Murphy, 2022), indicating that shoppers are receptive to packaging innovation. On the regulatory side, the legislation for reusable packaging in the food and drink sector (Bundesregierung, 2023) could be a trailblazer for success models, including that of Recup, a provider of reusable to-go beverage cups and bowls (Recup, 2023).

Feber et al. (2022) are also observing a significant increase in the number of start-ups developing reusable packaging, typically in food and food service end-use areas, but also in new segments such as beauty and personal care (Feber et al., 2022). The most common segments for reusable packaging are beverages, food service, packaged food, home care, e-commerce packaging and retail secondary packaging/transport packaging. Within these segments, reusable packaging can be implemented through the multiple solutions outlined by Feber et al., 2022:

- *Refill at home*. Consumers refill their reusable containers at home. Examples include shampoo pouches to bottles at home.
- *Refill on the go*. Consumers refill their reusable containers in a shop or at the point of supply. Examples include “zero-waste” shops where consumers bring their containers and use self-service weighing machines to buy fresh and dried grocery products.
- *Return from home*. A pickup service collects packaging from a consumer’s home.
- *Return on the go*. Consumers return the packaging to a shop or drop-off point. Examples include deposit-return machines or mailboxes.

Opportunities. Given increasing resource and carbon-intensive consumption patterns in DECs, reusable packaging has the potential to decrease the amount of packaging leaking into the environment by reducing the number of packaging out on the market and by increasing the circularity of materials (that is, using raw materials as many times and as long as possible). Due to the reuse of materials, fewer GHG emissions are created in comparison to single-use plastics, while the overall sustainability of packaging is dependent on how it is used by the consumer. For DECs, reusable packaging would also alleviate pressure on waste-management systems. The World Economic Forum et al. (2016) forecasts that emerging trends will further encourage reusable packaging. This includes the growth of e-commerce, with online grocery markets on the rise (Rai, 2022), as well as urbanisation that forces a greater disaggregation of product into current logistics systems, leading to congestion challenges in urban environments.

While multiple reuse solutions exist, traditional reuse business models with glass and aluminium are most frequently mentioned in the DEC context. In their analysis, UNCTAD (2022) considers glass and aluminium as potential feedstock to substitute plastics in single-use plastics, especially in bottles for water and other beverages in Bangladesh, Kenya and Nigeria. Business models with glass bottles for beverages have also been tested in other regions, such as in the tourism sector in Thailand (Glassic, 2022). As the materials are widely known, consumer acceptance is already high.

Risks and challenges. Varying by region and end use, the market for reusable packaging is forecast to reach only 5 per cent penetration or less by 2030 in the EU and North America (Feber et al., 2022). This forecast is related to multiple risks faced by reusable packaging solutions in logistics, cost, hygiene, food safety and quality, as well as consumer and producer acceptance (Feber et al., 2022). In terms of logistics, many reuse business models rely on reverse logistics

where consumers bring the packaging to the supplier for the refill (for example, beverage glass bottles). While deposit systems for glass bottles exist in both industrialised and developing countries, reverse logistics are complex, food and beverage containers are bulky to transport, and long-distance transportation increases greenhouse gas emissions. In addition, reusable packaging is typically more costly to producers/retailers than single-use plastic since space and labour are needed for collecting and washing packaging. Low labour costs and manpower in DECs could help lower those costs. However, to maintain hygiene and food safety, reusable packaging needs to be food-grade, especially if recycled materials are used in the packaging. Food residues at collection points can be an issue and the packaging solutions need to be of sufficiently high quality and durability to maintain consumer trust. From a consumer convenience perspective, there is a trend for smaller portions due to smaller and single households. Consumers' willingness to return packaging may also be limited by reasons of convenience and product preferences: refilling products requires time and effort – for example, bringing a container to a shop for a refill – and is limited to certain product categories. From a brand/producer point of view, standardised packaging can conflict with their desire for packaging variety and brand differentiation. In addition, producers would have to commit to a complex reverse supply chain and producers may lack the incentive to commit. Aside from market factors, policies are another success factor for reuse business models and their consumer acceptance, as discussed in Section 2.4.

2.3.3 Replacing

Businesses involved in creating circular packaging models have been working on alternative materials to replace plastic in packaging and, with this, address two major concerns. On the one hand, they are seeking alternative *feedstock* options to decouple the production of packaging from fossil fuels – addressed in the first two sections of this subchapter. On the other hand, businesses are opting for *compostable* packaging to mitigate the environmental impacts of end-of-life plastic packaging leaking into the environment – addressed in the last section.

As for alternative feedstocks, two options are discussed: bio-based or GHG-based feedstocks. I explicitly refer to *bio-based* materials (wholly or partly derived from biomass) as opposed to the term *bio-plastic* because the latter does not have a distinct definition and has therefore, in the past, loosely referred to bio-based, compostable materials or both (World Economic Forum et al., 2016). However, it is important to note that the feedstock used for a packaging material is independent of its ability to be composted, meaning that bio-based and GHG-based materials are not necessarily compostable: While some bio-based plastics are industrially compostable (e.g., polyactic acid (PLA)), others are only recyclable (bio-polyethylene terephthalate (PET)), whereas others are recyclable and industrially compostable (polyhydroxyalkanoate (PHA)). Likewise, compostable materials do not always have to be bio-based plastics. Aside from GHG-based materials, some fossil-based plastics are industrially compostable, e.g., Ecoflex®, a polybutylene adipate terephthalate (PBAT) by BASF (2023). Nevertheless, they only represent a minor segment of the market (World Economic Forum et al., 2016).

Bio-based materials. Circular business models in packaging increasingly focus on materials with feedstock sourced from biomass. Based on the biomass source, it is categorised into different generations by the World Economic Forum et al. (2016):

- *first generation* – biomass from food or animal feed plants (e.g. sugar cane, corn, and wheat).
- *second generation* – biomass from plants *not* suitable for food crops or animal feed production (e.g., non-food crops like cellulose, or waste materials of first-generation feedstocks such as vegetable oil or bagasse).
- *third generation* – biomass with a higher growth yield than first- and second-generation biomass (e.g. algae) was assigned its own category.

Bio-based plastics can indirectly help capture carbon dioxide from the atmosphere: as plants grow, carbon is harnessed in the polymer. Considering the entire carbon footprint, bio-based polyethene (PE) is -2.2 CO_2e per kg compared to 1.8 kg CO_2e per kg for fossil-based PE (World Economic Forum et al., 2016).

GHG-based materials. These refer to materials that are produced from carbon feedstock derived from captured GHG (methane or carbon dioxide), also referred to as "fourth generation feedstock", and hence have potential as carbon sinks. The technology for GHG-based plastics is being scaled up by some companies, including Bayer Material Science (Laird, 2014). Methane can be used to produce PHA, which, for example, can be applied to cutlery, cups, films, bottles and surgical tools and could replace fossil-based plastics such as PE or PET (Newlight, 2022). Carbon dioxide can be used to produce polyurethane (PU) which is used in foams. The feedstock for GHG-based plastic is available from multiple sources. Methane can be recovered from landfill gas, anaerobic digesters (from biogas), or coal mines (coal mine methane), whereas carbon dioxide can be recovered as a by-product of industrial and chemical processes and is sourced from the cement industry, the production of iron, steel, petrochemicals, and oil and gas processing. Business models for producing GHG-based plastics are in their research phase for carbon dioxide (Fraunhofer, 2021; Rosane, 2022) and the start-up phase for methane (Krymowski, 2021). Costs and viability still need to be researched for scaled production, but some companies claim GHG-based materials also to be cost-competitive with fossil-based plastics (e.g., PE, PP, PCV) at the pilot level (World Economic Forum et al., 2016). Assuming that methane and carbon dioxide are only recovered as a by-product of ongoing production, it offers potential for carbon capture and does not have the side-effects of bio-based materials such as impact on land use or biodiversity (World Economic Forum et al., 2016). Little is yet known about research and start-ups in DECs on GHG-based plastics. For this reason, it will not be considered in the opportunity/ risk analysis below. However, it would be worthwhile in seeing in what direction this innovation goes in a few years.

Compostable materials. Businesses involved in circular models of packaging are turning to compostable packaging solutions in which materials are suitable for the after-use pathway of industrial composting or home composting. The World Economic Forum et al. (2016) suggests using the term "compostable" instead of "biodegradable" packaging, since the latter is very broad and not clearly defined. The definition for industrially compostable materials is more distinct: for Europe, it is defined in norm EN13432, and in the US in ASTM D6400 (Fraunhofer UMSICHT, 2023; World Economic Forum et al., 2016). In essence, a material is industrially compostable if it contains at least 50 per cent organic matter, biodegrades by at least 90 per cent within six months under controlled conditions (temperature of 58 +/- 2°C), disintegrates into pieces smaller than 2 mm in controlled condition within 12 weeks, and its compost is not ecotoxic, i.e. does not cause any negative effects. In contrast, home compostable materials can be treated at ambient temperatures but need longer for biodegradation and disintegration than industrially compostable materials. Home compostable materials are also industrially compostable but not vice versa. Since industrially compostable plastics are only compostable under certain conditions, materials require clear labelling. In the EU, several organisations offer testing and certification services (World Economic Forum et al., 2016).

Opportunities. Due to the major contributions of DECs to the global waste stream from single-use plastics and the prevalence of pollution by single-use plastics in coastal regions (Ocean Conservancy, 2020), the priority for many DECs is on identifying bio-based feedstocks that are available, compostable and have the potential to fully or partially substitute for major SUP products. Moreover, the focus should be on bio-based feedstocks that do not require specialised industrial composting facilities to decompose as they are not available in most DECs.

UNCTAD (2022) has analysed potential materials for Bangladesh, Nigeria and Kenya, has made a life-cycle assessment, looked at trade considerations (export performance, established export markets or potential for new regional and global markets) and techno-economic aspects

(domestic resource availability, feedstock pricing, competitiveness relative to plastic feedstocks and products, manufacturing facilities and technology, established markets, and potential for domestic employment generation and rural development).

For example, identified alternative feedstocks for Bangladesh include paper, jute and cotton. Paper is likely to achieve scalability and price parity as an alternative to single-use plastics for specific uses, and paper recycling is a mature industry, so collection and recycling are also possible. Bangladesh has been a world leader in the jute industry, and jute presents an available option to replace existing plastic options, including grocery bags for dry products. While jute and cotton have been unpopular due to high prices and scarcity in the local market; the rise of scrap fabric from the ready-made garment industry offers a thin and lightweight raw material for affordable bags with potential for mass use. Moreover, banana is cultivated all over Bangladesh, and the banana pseudo-stem is mostly disposed of as waste. Banana leaves are already used for traditional foods, and now it is a question of stopping their replacement by single-use plastic. The potential to mainstream the use of pseudostem as an industry to make low-cost products to replace SUP bags and food boxes in Bangladesh is relatively high. Other materials introduced include murta for reusable bags, areca leaves for food packaging, and bamboo for straws (UNCTAD, 2022). UNCTAD (2022) suggests that investments in manufacturing capacity and technology would help expand production in DECs at scale to compete with SUPs. An effective regulatory environment that ensures the proper enforcement of SUP bans could also accelerate compostable and renewable alternatives.

Other substitute materials for plastic include glass and aluminium (e.g. for beverages). However, these materials provide more opportunities in the reusing and refilling context than in the single-use context, as the following discussion shows.

Risks and challenges. The suggested substitute materials may come with some challenges. First, bio-based materials, glass and aluminium may not always be the more sustainable option compared to single-use plastics, and especially to reusable plastics. Assuming that material recovery at end-of-life is ensured, life-course assessment meta-studies show that single-use plastics and reusable plastics can be superior to non-plastic options when it comes to environmental performance (including water and land use, acidification, eutrophication, and GHG emissions in production). However, if the impact of littering and microplastics is accounted for, SUPs fare much worse than other options (UNCTAD, 2022). Environmental performance is further strongly impacted by reuse: if reuse is applied in practice, reusable plastics present a lower environmental impact than single-use alternatives. Bio-based products (or glass and aluminium) can be associated with high GHG emissions in production and only provide better environmental performance if properly composted or (recollected), while improperly managed degradation could result in considerable amounts of GHG emissions, eutrophication and acidification. Due to this controversy on bio-based feedstock, UNCTAD (2022) suggests exploring agricultural by-products and post-harvest waste, which could lower the associated environmental impacts of bio-based plastics from cultivation due to apportioning. Through this, crop waste disposal could be avoided, and it could serve as an alternative source of income for small farmers if the main crops fail due to climate reasons or pests. For example, wheat straws and banana leaves could be feedstock sources for single-use straws, food containers and plates. As for glass and aluminium, these materials should preferably be introduced in businesses that operate a circular business model, reusing and refilling packaging, so emissions from initial production are dispensed throughout the longest possible product lifecycle.

Second, the problem of interference of potentially compostable materials, such as paper being rendered uncompostable by a plastic coating, is already a common issue in industrialised countries and may equally be problematic for DECs (World Economic Forum et al., 2016), where industrial composting sites hardly exist, as highlighted by UNCTAD (2022). Contamination between compostable and recyclable packaging could be even more problematic for municipal waste composting plants, adding to general recycling issues discussed in the next section.

Another risk concerns “home compostable” packaging, which can contaminate compost and lower its quality. Research suggests that packaging declared as “home compostable” has failed to disintegrate in the expected time period, or products are mislabelled or not labelled at all – thus licensing procedures for new materials to ensure compostability are crucial (EEA [European Environment Agency], 2023). Another challenge for both industrial and home compostables relates to the consumers’ side: consumers find it difficult to separate packaging appropriately, or do not have the compost facilities, time or motivation to do so. Plastic packaging may be favoured by consumers due to convenience and price considerations, as consumer awareness still needs to be raised (Purkiss et al., 2022).

2.3.4 Recycling

This section discusses two aspects of a recycling business model. First, the recycling process itself is considered, including the collection, sorting, processing and eventually upcycling or downcycling of packaging into a similar or new material of higher or lower quality. A key principle of the circular economy is that products and materials are circulated at their highest value whenever possible. The second aspect is the trade of recycled plastics as a feedstock. The potential of secondary plastics does not yet seem to be exhausted: global production of recycled plastics has quadrupled in the last decades but still only accounts for 6 per cent of total feedstock (OECD, 2022a). Hereby, DECs are currently only playing a minor role in supplying global secondary markets with recycled materials.

Opportunities. Recycling enables resource inputs from waste streams and thus is an opportunity for material and cost savings (Dijkstra et al., 2020). A functioning waste and recycling management system and related investments in roads, landfills, waste-to-energy facilities, trucks, trash points and recycling are also enhancing economic development by enabling transportation and commerce, and supporting quality of life, hygiene and health (Gao et al., 2022). Moreover, recycling can create 50 times more jobs per unit of waste compared to waste destined for landfills or incineration, even when highly mechanised recycling processes are accounted for (Eurasia Group, 2021). In this context, DECs might have potential competitive advantages due to existing informal workers (Preston & Lehne, 2017) who are already on the frontline of the plastic crisis. Expanding the circular economy in the plastic value chain could increase income opportunities for the informal sector, which often consists of groups with limited education and little access to work, healthcare and housing (Ocean Conservancy, 2021). For example, it was estimated for Indonesia that eliminating plastic pollution by 2040 would create 150,000 direct net new jobs in the plastic waste and collection sector. On a city level, it is estimated that achieving a waste recovery rate of 80 per cent would create over 15,000 recycling jobs in Ho Chi Minh City and over 5,000 recycling jobs in Dhaka (Eurasia Group, 2021).

An additional income opportunity could result from trading recycled plastics. In Europe, prices for recycled PET (rPET) are increasing, which could be linked to mandatory recycled content targets for PET and other beverage bottles as part of the legislation associated with the European Union Circular Economy Action Plan (EU-CEAP). Hence, additional opportunities could be linked to supplying the European market (To, 2022).

Risks and challenges. DECs face multiple barriers in scaling recycling processes. Many countries lack comprehensive waste-management systems that require significant government, intergovernmental and private-sector funding (Gao et al., 2022). In addition, Gao et al. (2022) list operational challenges in emerging economies, such as ambiguous land-use rights, the need for significant coordination with different government layers, the diversion of funds, and challenges to foreign investment. As a result, large-scale infrastructure projects and programme rollouts are often delayed and require longer execution timelines (Gao et al., 2022). The waste sector in DECs is moreover characterised by informal workers who work in complex structures and are difficult to reach (Gao et al., 2022). Moreover, informal workers often do not receive

appropriate recognition and there is a lack of financing that could improve their working conditions while strengthening plastic value chains and providing incentives to collect more low-value plastic (Ocean Conservancy, 2021).

Another barrier is the lack of access to sorted plastic-waste feedstock for recycling (Gao et al., 2022) as a large percentage of the waste is not collected at all and is dumped or burned. This could be related to several factors. One is the absence of (or too low) landfill fees. In Nairobi, the fees are USD 2 per truck compared to USD 100 or more per truck in industrialised countries. On the contrary, collection contractors are paid a fee per tonne for landfill, while no comparable fee is offered for delivering materials to recycling facilities. This discourages formally collected waste from being diverted to recycling, given that it is much cheaper to dump than to recycle. Due to low capacity, enforcement systems often cannot stop this from happening, even where it is illegal (Gao et al., 2022). Moreover, while formalised waste collection could increase plastic-waste feedstock, it could be challenged by a lack of consumer acceptance and willingness to pay for private waste collection where government or municipal waste management is absent (Gao et al., 2022).

Yet another barrier concerns the recyclability and quality of plastic packaging materials. Material types such as PET and high-density polyethylene have high recycling rates that reach between 80 and 90 per cent in certain markets (World Economic Forum et al., 2016). High-grade materials are characterised by high-purity after-use streams, competitive prices and significant volumes, and are easy to recognise by citizens for separation. In contrast, other low-value packaging types are not recycled at scale yet (Brooks, 2021). Materials that are more challenging for recycling are multi-layer packaging, polyvinyl chloride (PVC), polystyrene, and packaging with labels, as often found in single-use plastic items and small sachets (World Economic Forum et al., 2016). Even for high-quality grade plastics, there are recycling challenges related to contamination with additives, colours or lower-grade plastics (To, 2022) and the recycling process itself is associated with air pollutants and toxins harming the environment and health of workers (Human Rights Watch, 2022). DECs are particularly challenged by low-quality materials that partly come from domestic plastic packaging consumption, while another large share originates from exports, as discussed in more depth in To (2022) in relation to EU exports. Material recovery facilities or recyclers faced with unsorted or challenging materials have to set up their collection and sorting system at a high cost (as opposed to the situation in many industrialised countries where the waste producer must pay for the recycling) (Gao et al., 2022), which discourages the scaling of recycling in general but also the recycling of more challenging materials. At the same time, facilities may put lower efforts into health and safety measures to protect workers from toxins.

Some initiatives in DECs are trying to prevent low-grade plastic materials from incineration, using mixed low-grade plastic for the production of furniture or other products, sometimes mistakenly referred to as *upcycling* (Reform, 2023). While these business models extend the material lifecycle for the moment, it is essentially a type of material *downcycling* that is a departure from the closed-loop circularity concept, since the mixed materials cannot be separated and recycled – eventually, products need to be incinerated at the end-of-life (Krosofsky, 2021). Consequently, designing for recyclability is a prerequisite for effective and economically attractive collection, sorting and recycling infrastructure. It can have significant positive impacts – even in countries without formal waste collection systems – by making it more likely that packaging will be collected by waste pickers, and by lowering the cost of developing formal collection systems (PRI, 2021). Due to the mentioned high shares of export of plastic waste to DECs, this principle needs to be implemented in both exporting, industrialised countries and in plastic-packaging-producing DECs.

As for the trading of recycling plastics, DECs only represent 5 per cent of suppliers, according to Cirplus, an online marketplace for recycled plastics (Cirplus, personal communication, 2021). A well-functioning secondary market for recycled materials is crucial for both industrialised and

developing countries to accelerate their transition to a New Plastics Economy (World Economic Forum et al., 2016). The involvement of DECs in the recycled plastic markets could open export markets and result in employment opportunities and technology spillovers for local recycling (To, 2022). However, recycled plastics from DECs are not viable for foreign markets yet due to quality issues that are linked to contamination levels, inability to compete with advanced food-grade plastics suppliers from Europe, a lack of standards to verify the quality of recycled plastics and supply chain compliance, and low volumes of recycled plastics (To, 2022). Nevertheless, recycled materials are used for local production in small-scale units. Section 2.4 discusses (existing and needed) policies to enhance secondary markets.

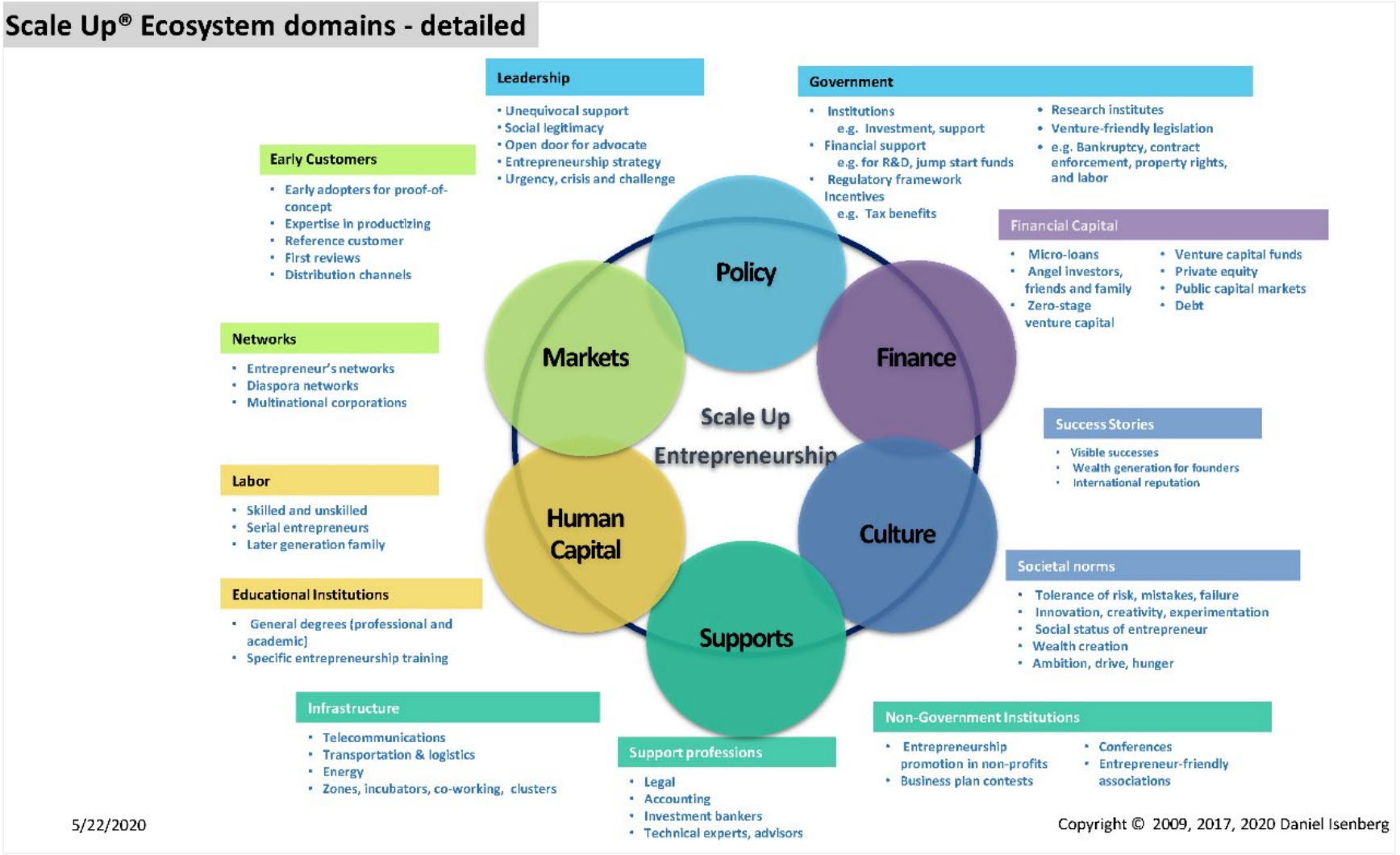
2.4 Framework for enabling circular business models

The previous discussion of opportunities and barriers for business models has neglected the fact that a business does not act on its own but is embedded in a broader setting. Mapping the business ecosystem helps to identify gaps and constraints in an entrepreneurial environment. As a result, more effective interventions can be designed to stimulate entrepreneurship, such as within private-sector development programmes. The mapping goes beyond common GIZ country analysis, conducted as part of project planning, which may be insufficient on its own to identify activities to support entrepreneurship (GIZ [Deutsche Gesellschaft für Internationale Zusammenarbeit], 2018).

The entrepreneurial ecosystem is further described by Daniel Isenberg, who lists six domains: policy (support for R&D, regulatory incentives, such as tax benefits, venture-friendly legislation), finance (micro-loans, venture capital, private equity), markets (early customers), human capital (skilled and unskilled workers, education), support (logistical/telecommunication/energy infrastructure, support professionals including legal/accounting/investment bankers), and culture (societal norms) (GIZ, 2018; Isenberg, 2011).

To simplify, GIZ (2018) summarises the domains into three elements: the investment and business environment, interacting actors, and entrepreneurial culture and attitude. The investment and business climate form the regulatory framework for the actors, while culture and attitude resonate with the business environment and the actors' interaction. The investment climate broadly defines a country's competitiveness, defined by labour markets, political situation, infrastructure, economic predictability, human resources and skills, legal rights, and financial markets. As a subset of the investment climate, the business environment is the interplay of policy, legal, institutional and regulatory conditions that govern business activity and includes institutional arrangements, administration and enforcement mechanisms to enforce the policy. For example, this includes tax policies, labour laws and business registration procedures. Within development cooperation, GIZ (2018) recommends focusing on the business environment as it is the area that can more likely be addressed in a private-sector development programme. As for the investment climate, the components most relevant to a private sector development programme are economic predictability, political situation and labour market. Interacting actors in the entrepreneurial ecosystem include individuals (founders and investors), organisations as in a unit of people (companies, universities, banks) and institutions as in longstanding patterns of behaviour (value, family, religion) (GIZ, 2018). Development cooperation is also recognising culture and attitude alongside social protection schemes as determinants of entrepreneurial action in a country. Whether entrepreneurship is desirable in a society depends on the promotion of entrepreneurship (as a career) in media, the status of entrepreneurs, and behavioural patterns for entrepreneurship.

Figure 1: Domains of the entrepreneurship ecosystem



Source: Isenberg (2011)

Adding to this European Environment Agency (EEA) (2021) has drafted a framework for enabling circular business models in Europe which can be also applied to the DEC context. Adding to Isenberg's ecosystem domains, the framework acknowledges the importance of education and consumer behaviour to enable business model innovation (Gillabel, Manshoven, & Grossi, 2021). Consumer behaviour and education are crucial enablers, as consumer choices can support or hamper the adoption and upscaling of circular business models in packaging. Consumers need to be knowledgeable, able and willing to move towards circular products and services.

2.5 Policy enablers for cicular economy business models in packaging

The active engagement of government and the legislative environment present major enablers of circular supply chains and business models. Policies can support and enable circular business model innovation by providing adequate regulations, financial support, economic incentives, information, and behaviour change tools. The key to a successful transition to a circular economy will be the coordination of different actors on various levels and the harmonisation and implementation of strategies across these levels. For many sectors, circular economy business models largely revolve around closing and slowing resource loops and supporting circular value chains, including repair and remanufacturing. As highlighted in Section 2.3, activities and potential in plastic packaging mostly occur in reducing, reusing, replacing and recycling. The discussion of development cooperation policy instruments will therefore focus on these value chain areas.

Table 1 gives an overview of policy instruments to support circular business development in the plastics sector, structured according to the multi-level and multi-actor approach of development cooperation. The macro level refers to policies that can be mostly enabled by ministries and apply to various levels of the circular economy plastics value chain: reducing, replacing, reusing and recycling. Other policies in the table refer to reusing and recycling only. The policy types discussed include economic incentives, regulation, standardisation, informational instruments and government procurement. The meso-level actions are targeted at the industry to initiate and lead in circular business model innovations and build related infrastructure but also to address educational institutions to teach the circular economy concept to future generations. The micro-level highlights policies directed at individuals in the plastics value chain, including (informal) recyclers, employees and consumers, and aims to increase knowledge and awareness about the entire plastics value chain.

Table 1: Policy enablers for circular business models in packaging

Instrument	Instrument type	Actors
Macro level: instruments for reducing, replacing, reusing, recycling		
Funding and set-up of a **strategy body for CE** vision development and harmonisation of processes, setting clear goals (composed of government, industry, and civil society)	Economic, norms/ standards, information	Various ministries (e.g. economics, science, environment, industry and commerce, labour)
Environmental fiscal reform (higher taxes on resource use/emissions; virgin material and equivalent lowering of labour taxes)	Economic	Various ministries (e.g. finance, environment, economics, labour)
Tax incentives for circular companies (tax rebates, decreasing VAT for products with recycled plastics content)	Economic	Ministry of finance, tax collection agencies
Eco-design regulation	Regulation, information	Government, industry, and consumer associations
Packaging regulation (reducing packaging/material quotas, incentivising alternative material use, guide-lines for types of plastics; material standardisation)	Regulation, economic	Ministry of environment, economy
Waste management directive specification (define plastic as waste or for recovery; fees and/or bans for landfilling or incineration of reusable plastics; quotas for collection and reuse)	Regulation	Ministry of environment
Extended Producer Responsibility: development, implementation and monitoring of a circular system	Norms, standards, information, prospectively regulation	Businesses, informal recyclers, ministries, possibly new public agency
Import regulation of single-use and other plastics (bans, quotas, types allowed)	Regulation	Ministry of finance, foreign trade
Stimulation of the **adoption of distributed ledger technologies by industry** (e.g.**,** blockchain) via norms and standards to allow traceability of products and materials along the whole material cycle (global value chain impact)	Information, norms, standards	Industry, lead firms in value chains (e.g. in the EU); ministry of electronics and information technology
Public procurement of reusable, reused, recycled, and alternative plastic products	Economic	Ministries, and govern-ment agencies at all levels
Macro-level: instruments for reusing, recycling		
Development and harmonisation **of standards for reused/recycled plastics** (ideally regionally to manage cross-border flow, e.g.**,** across ASEAN countries)	Norms, standards	Industry associations, national standards agencies, ministry of environment
Regulation of recycling share in products via **quotas**	Norms, standards	Industry associations, national standard agencies, the ministry of environment
Support **development and improvement of inter-nationally existing recycling standards and certifycation systems** (e.g.**,** RAL per cent, cradle to cradle)	Norms, standards	Industry associations, national standards agencies, ministry of environment

Instrument	Instrument type	Actors
Meso-level: instruments for reducing, replacing, reusing, recycling		
Investments in **business innovations for reusable and alternative** plastics Example: service-based models and circular leasing contracts (drinking water in refillable bottles); stimulation of demand for such services and removal of local barriers.	Economic, information	Industry, public–private partnerships
Business training (actors in the plastics value chain, e.g., how to adjust to circularity demands), **capacity building** on waste collection and segregation for municipalities and districts	Information	Ministry of education, business associations, business development service providers
Dialogues for the development of plastic alternatives and matchmaking of industry waste and waste reuse firms (B2B facilitation), e.g. UK National Industrial Symbiosis programme	Information	Industry
Investments in physical recycling infrastructure and waste-to-energy plants	Economic	Industry, public–private partnerships
Set-up up circular economy education at all levels, e.g. schools, training and study options at universities, apprenticeships, including financing of teachers and professorships	Economic, information	Ministry of education
Support of voluntary commitments in the industry; aim for mandatory commitments over time	Information, norms/ standards	Industry associations, ministry of economy/trade and environment
Micro-level: instruments for reducing, replacing, reusing, recycling		
Integration of informal recyclers (e.g. in EPR collection systems; via recycling demonstration projects)	Economic, norms, information	Informal recycler associations, civil society, industry/national body for CE (if newly set up)
Labels and information on reused/recycled plastic content in packaging	Information	Industry/business associations, civil society, government
Behaviour change strategies for consumers (households, employees) to foster plastic reducing, replacing, reusing, and recycling	Information, norms/ standards	

Source: Based on acatech et al. (2021); Wilts & Fink (2016)

Selected instruments and their importance for circular business models in packaging are discussed in more detail, highlighting policies most commonly discussed in the DEC context.

On the macro-level, good waste-management practices and functioning waste-collection systems are important preconditions for a shift to a circular economy so that material recovery facilities for circular business models in packaging are not confronted with dirty and contaminated waste. Hence, funding in waste management needs to be extended, as sorting capacities in DECs are limited. Public funding could focus on investing in waste management infrastructure for collection and segregation, such as landfill and collection vehicles, while

private capital could be invested in the collection and recycling of materials that are not profitable for informal workers, such as multilayer and single-use plastics.

Public–private partnerships could also provide a platform for more creative collaboration models as well as additional sources of funding (for example, output-focused contracts for municipal solid-waste collection) (Gao et al., 2022). Moreover, with some minor incentives (such as tax exemptions or higher refuse-site fees), material recovery facilities could become profitable (Gao et al., 2022). According to a McKinsey analysis, it takes more than ten years for a material recovery facility in Kenya to reach cash-flow positivity and with no to little landfill fees, recycling appears unattractive in comparison to landfill.

Another key environmental policy for effective waste management and realising the circular economy is extended producer responsibility (EPR). The concept is based on the "polluter pays principle", whereby the cost of environmental externalities is internalised by making producers responsible for (paying) the management of the end-of-life of products. In systems without EPR, the responsibility of managing household waste lies with municipalities that conform with their own operations or by outsourcing to a third party through public–private partnerships. Over 400 different EPR schemes have been identified, mostly in OECD countries, and implementation efforts are ongoing for electronic waste and batteries. Countries such as Indonesia and India have also introduced EPR schemes (Sachdeva & Srivastava, 2022). EPR can play an important role for DECs in moving towards a circular economy, since evidence points to a significant contribution of EPR to increasing recycling rates. In addition, EPR reduces the funding gap for waste management by shifting the burden of managing waste from taxpayers to producers. Producers can dispense their responsibility by outsourcing collection services, or can fulfil their responsibility in a "collective producer responsibility" through a producer responsibility organisation (PRO), which can be private or state-led. Producers pay a fee to the PRO, based on the quantity and weight of packaging put on the market by them. The PRO implements EPR on behalf of the producers and collects, sorts and recycles end-of-life packaging in partnership with waste-management operators (Sachdeva & Srivastava, 2022; Wilts, Von Gries, & Bahn-Walkowiak, 2016).

Within EPR systems, uniform adoption and enforcement among all stakeholders need to be monitored continuously, and free-riding by producers needs to be reported. Free-riding adds to the financial burden on producers participating in the EPR scheme, as participating producers are indirectly paying for the waste-management costs of the free-riding producers. This leads to inefficiencies and low collection rates. An increase in free-riding has been reported with the growth in e-commerce, as online sellers might not be registered for EPR (Hogg et al., 2020). For an EPR system to succeed, adequate monitoring and enforcement mechanisms such as online platforms, data reporting and auditing should be established (Sachdeva & Srivastava, 2022) which would also increase the legitimacy of recycling activities. Other challenges of EPR systems in the past included resistance by informal recyclers due to pricing and profit issues (e.g. trial in Ghana on e-waste EPR) due to illicit trade flows, confusion or low producer effort in terms of concrete responsibilities (in shared collection systems at sectoral level) and consumer confusion over who is a formal EPR collector and who is an informal collector (Compagnoni, 2022).

Some of these challenges can be met by individual producer responsibility, which makes producers more directly responsible by establishing a supply chain specifically for their own products (Sachdeva & Srivastava, 2022; Wilts et al., 2016). This individual producer responsibility creates a direct feedback loop between the design of brand-specific products and their end-of-life management and provides incentives for producers to adapt the product design to easier repair, reuse and end-of-life treatment. Companies systematically considering these aspects in the products' design would benefit from lower end-of-life costs (Wilts et al., 2016). Nevertheless, the feedback loop would be limited to domestic producers of plastic waste and

would not impact waste importers. The challenges related to waste imports specifically are further discussed by To (2022).

Another strategy to mitigate free-riding and implementation inefficiencies could be to systematically include all major stakeholders in the planning and implementation of the EPR system. For example, the Indian Bureau of Energy Efficiency successfully followed such an approach in its energy efficiency standards and labelling programme (Kemp & Never, 2017). Transferring this approach to EPR, a central agency could be established for a mandatory EPR system that provides an implementation timeline and clear enforcement/control steps such as non-compliance fees. The agency would then agree with the major plastic producers on how to concretely set up a take-back system for packaging and ascribe individual responsibilities, fees and collection quota. Smaller shops and informal recyclers would need to be integrated into the process, for example for collection from rural areas or towns without supermarkets. Once the system by the major producers and chains is running successfully and has reached a previously negotiated market threshold, it would become mandatory for all producers, thus ensuring stakeholder buy-in and a staggering market transformation.

In all cases, EPR schemes need to be flanked by a range of other measures on various levels. The transition to circular business models in packaging cannot rely on one channel alone. In parallel, a systematic consumer awareness and behavioural change campaign would have to start via various channels.

3 Circular business models in India: plastics

3.1 Introduction to India's plastic sector: consumption and pollution

India is the second largest producer of plastic polymers in the world, responsible for creating 14.17 million tonnes (Mt) a year (Hossain et al., 2022), and its consumption and production of plastics is increasing at a rapid pace. From 2018 to 2019, consumption in India was at 913 kilotonnes (kt), which increased by 5.5 per cent yearly to 964 kt from 2019 to 2020 (Hossain et al., 2022). It is estimated that gross domestic product (GDP) and urbanisation will be the main drivers for increased plastics consumption in future. With an annual economic growth of 7.5 per cent, India is one of the most rapidly growing G20 economies; its GDP and growth rate are the highest among the BRICS countries (Brazil, Russia, India, China and South Africa). Globally, India's urbanisation is among the most rapid (Hossain et al., 2022). Plastics consumption in India is mainly driven by the following sectors: packaging, agriculture, infrastructure, home and office furnishings, personal care products, surface coats, transport, electrical and electronics, industrial machinery, biomedical applications, food and beverages, and textiles (Hossain et al., 2022). The packaging industry represents the largest sector for plastics use in India, accounting for 59 per cent. The major drivers for plastics in the packaging industry are fast-moving consumer goods; processed, packaged food/beverages and the fast-food industry; single-use packs; fibres and toys (Hossain et al., 2022). In the past years, food delivery services in India have boomed (Schmall, Singh, & Loke, 2023) and are becoming a new source of plastic waste generation in the country. Online businesses such as Swiggy and Zomato are among the major generators of plastic waste and are estimated to generate 22,000 tonnes of plastic waste monthly (Analysis, 2020). Plastic waste represents 8 per cent of the total waste generated in India (Hossain et al., 2022). It is estimated that plastic waste generation could amount to 15,342 tonnes daily, with around 40 per cent of it remaining uncollected and hence ending up on streets, roads and beaches (Aryan, Yadav, & Samadder, 2019). In addition, another major challenge is the import of plastic waste. Its role for DECs has been discussed in depth in To (2022).

A major issue related to waste plastics is aquatic pollution and microplastics. It is estimated that 0.6 million of the 8.8 million tonnes of waste plastics produced globally enter the ocean every year from India (Aryan et al., 2019). The major source of marine pollution is land-based coastal pollution that is within 50 kilometres of a coastline – it contributes more than 80 per cent of marine pollution, 90 per cent of which is plastic waste, and mostly single-use plastics (Hossain et al., 2022). Discharge from rivers is one of the most crucial sources of plastics pollution into oceans, due to the unidirectional flow of rivers (Hossain et al., 2022). In addition, the tourism, industrialisation, population and economic growth in the coastline of India, which extends to 7,500 km, is assumed to further contribute to plastic in the oceans. Marine pollution is affecting almost all ocean basins, freshwater, and terrestrial environments (Hossain et al., 2022). Moreover, waste plastics and single-use plastics were identified as the main reason for drainage channel clogging, increasing the risk of flooding and damage in residential areas (Times of India, 2017).

3.2 Circular business models in packaging In India

The losses in India's plastic packaging sector due to inefficient design, handling and disposal are estimated at USD 133 billion (Accenture & FICCI, 2020). A circular economy offers the opportunity to limit the extraction of raw materials and slow down the use of materials and products throughout the waste hierarchy. For this reason, this section introduces existing business models that provide solutions for the plastic packaging sector. In their review and research of literature, business publications, industry fora, reports and company websites, (Retamal et al., 2021) identified 55 Indian circular business model for packaging overall, which they categorised into the typology described in Section 2.3. In alignment with previous research by (Dijkstra et al., 2020) on global circular business models for packaging, those in India most commonly relate to recycling (27 out of 55) and replacing fossil-derived plastics (15/55) (Retamal et al., 2021). Other sources such as the SUP-Challenge-Goa, an international acceleration programme to address the demand for, and waste of single-use plastics in the food and beverage industry (Climate Collective, 2022), as well as one-on-one interviews by Saahas, point to circular business models in reuse and refill of plastics (Saahas, personal communication, 2022a).

Reusing. An established and more traditional circular business model in food delivery is the Mumbai Tiffin Box and the associated Dabbawala, which is a lunchbox (Dabba) delivery service. Lunch meals are delivered in reusable metal boxes and are delivered from customers' homes or commercial kitchens to their workplaces. The lunch boxes are returned the same day. The service is known for its reliability and resilience, offering on-time deliveries at a low cost, despite monsoons, floods, riots and terror attacks. The service is based on a simple coding system that enables workers (the majority of whom are semi-literate and come from a low-income background) to quickly sort lunchboxes and deliver them to their destinations correctly. Their operations involve almost no paperwork and use public transport (railways) and bicycles. Some providers connect with charities and trusts to pick up leftover food and deliver it to the needy, thereby reducing food waste. Customers are charged a monthly service fee that may range from INR 800 to INR 1500 (USD 10 to USD 20), depending on the distance and the time taken. A "Digital Dabbawala" initiative to expand service offerings from lunchboxes to other products in partnership with various government e-initiatives and other doorstep services is being developed (Retamal et al., 2021). Since Dabbawala is a 130-year-old tradition from Mumbai and relies on its specific infrastructure (geography and railway network), it may not be relevant to other locations. Aside from this traditional model, start-ups have been looking into the food delivery sector. Infinity Box and Ecovia are providing reusable food containers that restaurant partners can offer to their customers on food delivery apps. They build a reverse supply chain to collect used boxes, wash and clean them and deliver them back to the restaurants (Ecovia, 2023; InfinityBox, 2023; Saahas, personal communication, 2022a). Since the food and grocery

delivery industry in India is snowballing (Rai, 2022; Srivats, 2021), these initiatives have the potential to prevent plastic pollution in the sector.

Other ventures provide metal bottles for water and dairy, the hospitality, pharma, and FMCG sectors (Amplepac). Others rent out dish sets for events (Crockery Bank), and one interviewed venture focuses on refill stations (Irefill) (Amplepac, 2021; Irefill, 2021; Saahas, personal communication, 2022a; Walia, 2019).

Replacing. Aside from reusables, the replacement of fossil-based single-use plastics with bio-based alternatives was identified as another major circular business model. Interviewed start-ups are mostly in their early stages (Saahas, personal communication, 2022a). Bio-based materials used for this product category include rice straw, sugarcane and bagasse (Banc, 2022; Ecoware, 2022); discarded coconut shells (Kasoi, 2022); areca nut (Ecotopia, 2019); bamboo (Biomize, 2019); seaweed (Zerocircle, 2020); edible cereals (Edible Pro, 2018); corn starch and cellulose for biodegradable bags and coatings (Bioreform, 2022) (Sprout, 2022); cellulose for bottles (Kagzi Water Bottle, 2021). One venture also looked into GHG-based materials, i.e. methane (Terra Bioware, 2022). The food delivery sector has communicated interest in bio-based alternatives. Food platforms such as Zomato and Swiggy have announced or already started an online marketplace that enables a restaurant to procure alternative packaging materials (Dash, 2019).

Recycling. Circular business models in the Indian recycling context are linked to several technology platforms that facilitate the networking of waste-management actors and EPR schemes, while others focus on reverse logistics and collection systems.

Digital business models include Kabadiwalla Connect and Recykal. Kabadiwalla Connect is based on information and communications technology (ICT) and platforms based on the Internet of Things, which facilitate the exchange between actors in the informal recycling system (Retamal et al., 2021). This involves informal workers who segregate and sell recyclable waste to local kabadiwallas (“waste aggregator-entrepreneur” in the local dialect) who then sell waste to larger waste aggregators and processors. Kabadiwalla Connect’s business model hence integrates informal actors into formal waste-management systems. In addition, Kabadiwalla Connect collaborates with designers to make upcycled products out of waste material sourced from kabadiwalla shops and sells them on its platform. Other offered service solutions include geospatial mapping of informal and formal waste infrastructure in cities; digitisation to ensure transaction-based material tracking and traceability across formal/informal waste supply chains; sourcing of secondary raw materials for guaranteed supply to waste recyclers and processors; and postconsumer municipal waste collection through hyperlocal reverse-logistics solutions backed by a network of kabadiwallas and their waste pickers (Veolia, 2018). Kabadiwalla Connect helps public and private stakeholders recover post-consumer waste cheaply, efficiently and safely, diverting waste away from landfill and improving the livelihoods of informal workers (Sugumar, 2019; Retamal et al., 2021). Retamal et al. (2021) see a business model with social, economic, and environmental benefits with the potential for replication in developing countries where informal actors are indispensable for the waste value chain. Similarly, Recykal provides an online end-to-end waste management marketplace that facilitates transactions across all stakeholders in waste management and allows real-time visibility of material flows. Recykal’s revenue is based on e-marketplace commissions on each transaction between waste generators and recyclers and a product fee for its Software as a Service (SaaS) from its enterprise customers. In partnership with manufacturers and brand owners, the company also executes plastic take-back and engagement programmes to comply with the EPR rules mandated by the government. The digital solutions help organise the highly informal waste management sector, bringing efficiencies and cost-effectiveness to improve collection and disposal, reducing landfill and enabling sustainability practices (Recykal, 2022a; Retamal et al., 2021).

Aside from digital solutions, other circular business models in packaging, such as Saahas Zero Waste (SZW), offer services relevant to EPR and reverse logistics by establishing waste collection systems in tech parks, malls and residential premises, aggregation of electronic waste items from households and commercial sites, information dissemination, consumer education and the adoption of technology to strengthen recycling infrastructure for a range of material types. SZW has been helping national and multinational brands in managing their EPR in 20 locations across 12 states of India. The company has an extensive collection network that includes consumers and the informal sector. SZW has also formally collaborated with authorised recyclers and end destinations (Retamal et al., 2021; Saahas Zero Waste, 2022).

Lastly, start-ups such as Banyan Nation focus on the technical aspect of recycling by providing a plastics-cleaning technology, removing inks, coatings and contaminants. As a result, collected plastic waste can be converted into high-quality recycled pellets that are comparable to virgin plastic in quality and performance. Banyan Nation has been working with automotive and cosmetics companies (Banyan Nation, 2023).

3.3 Policies in India for circular business models. Focus: plastic alternatives

This section discusses existing or lacking policy measures in India on multiple policy levels (macro, meso, and micro) that have the potential to enable and support discussed circular business models in packaging.

3.3.1 Macro level

3.3.1.1 Plastic Waste Management Rules

As mentioned in Section 2.5, good waste management practices are essential for material recovery facilities and providing adequately sorted waste. In India, the Plastic Waste Management Rules (PWMRs) were the first formal rules addressing the surged in plastic waste in municipal waste streams. The precursor was introduced in 2011 and replaced by another version in 2016, with further amendments in 2018, 2021 and 2022 (Indian Pollution Control Association, 2022; Talwar et al., 2021). The rules cover end-of-life management aimed at minimising plastic packaging waste and plastic packaging waste handling, including collection, segregation, transportation, processing and disposal, as well as recycling and material recovery. The PWMRs include guidelines for standard operating procedures for segregation, collection, and disposal (Talwar, Thanduparakkal, Arora, Niaza, & Retamal, 2021). In 2016, the extended producer responsibility (EPR) (see Section 3.3.1.3 below) also established standards for sustainable plastic-waste management (Talwar et al., 2021), while in 2021, the PWMRs were amended with SUP definitions (section 3.3.2).

In theory, the PWMRs have set favourable framework conditions for businesses with a circular model focused on packaging. However, in practice, the conditions may not have a positive effect yet due to the challenges of implementation. Previously, the guidelines were considered self-regulatory since no enforcement mechanism or penalties for non-compliance existed (Talwar et al., 2021). However, in their latest amendment in 2022, environmental compensations are mentioned (Central Pollution Control Board Delhi, 2022). In its current layout, the PWMRs strongly focus on the downstream, while the upstream remains unaddressed. Consequently, it fails to reduce plastic packaging consumption and does not encourage plastic manufacturers to offer alternatives. Another aspect that could limit the efficacy of the regulations is the practical integration of the informal sector (Talwar et al., 2021). For countries with the presence of an informal sector, the EPR fee should also cover the costs of the integration of the informal sector into the EPR scheme (Sachdeva & Srivastava, 2022). The integration of the informal sector

presents a conundrum: how to achieve full traceability of the plastic waste lifecycle (as desired by EPR) while the informal sector relies on undocumented cash transactions that limit accountability. In an ideal scenario, the informal sector would move towards a formalisation that offers them better income and working conditions.

3.3.1.2 Swachh Bharat Mission

In the context of policies on plastic-waste management, the Swacch Bharat Mission (SBM) is also commonly mentioned. It is a nationwide campaign initiated in 2014 to target issues related to sanitation and municipal solid waste management, including plastic waste. The SBM provides education and training on cleanliness and sanitation, and raises awareness about segregation and hygiene practices (Talwar et al., 2021). While the SBM has a focus on the collection and transport aspects of waste management, the related Swacch Bharat Mission Urban 2.0 (SBM U 2.0) focuses on processing and disposal. According to SBM U 2.0, funding is provided to states and union territories for setting up processing facilities and undertaking refuse site/legacy waste remediation. Plastic-waste management has been made a priority, and public–private partnerships are encouraged to implement private capital and efficiencies from the private sector in the urban infrastructure (Ministry of Housing and Urban Affairs, 2021).

The SBM in theory could increase awareness and consumer acceptance, but its positive impact on circular business models in packaging is limited in practice. First, while the SBM is deemed successful in generating community awareness and behavioural change in solid-waste management (Debnath et al., 2022; Talwar et al., 2021), it does not address awareness and consumer acceptance of alternatives to plastic packaging. Second, the funding of waste-management practices in India at the municipal level comes with a lot of challenges, such as the percolation of funds, vested interests and corruption. While the profitability of material recovery is a general concern in DECs, the government of India allocated funds to the SBM meant for municipalities to implement collection, transport, segregation and treatment projects. However, there are discussions that large sums of money are unutilised or held up in administrative loops. Thus, EPR in India is looked upon as the means for funding waste-management activities which otherwise could not get funded by the municipalities.

3.3.1.3 Extended producer responsibility

Extended producer responsibility (EPR) is a major tool in India for enhancing plastic waste management and recycling. First introduced to tackle e-waste in 2012, EPR was later extended to plastic packaging waste under the PWMRs in 2016, and its amendment in 2018 (Talwar et al., 2021). Under EPR, plastic packaging producers, importers, and brand owners are responsible for taking back and processing the plastic packaging waste generated from their products (Talwar et al., 2021).

However, several sources are hinting at a poor implementation of the EPR due to a lack of clarity regarding, roles, responsibilities, and guidelines for those involved. Moreover, there is a lack of monitoring and mapping of the producers, importers and brand owners (Hossain et al., 2022; Talwar et al., 2021). For example, only a fraction of them has registered to a portal that allows the tracking of plastic collection and recycling targets that are based on self-declarations by those responsibile. Additionally, the option to buy credits if companies fail to meet their targets might increase lax implementation (Deshpande, 2022). Moreover, EPR in India is mandated for brands that have an annual turnover of more than INR 500 million (EUR 5.7 million). All brands below this threshold are currently exempted from the EPR scheme, resulting in a free-rider problem.

3.3.1.4 Single-use plastic ban

With around 43 per cent of plastic waste being attributed to single-use plastic (SUP) (Recykal, 2022b), the PWMRs 2021 amendment bans the manufacturing, importing, stocking, distributing, selling and use of 21 SUP items by 2022, including items such as plates, cups, cutlery, straws, packaging films and cigarette packets. SUP is defined as “plastic commodities intended to be used once for the same purpose before being disposed of or recycled” (MoEFCC, 2021). Since the announcement of the ban, 26 states have imposed a complete ban on SUP bags and commodities, while other states introduced partial bans (Talwar et al., 2021).

Literature indicates a failure of SUP bans due to issues related to the lack of enforcement authorities and penalties, support for suppliers, plastic alternatives, and behaviour change programmes. Despite the ban, numerous banned items are still widely available in Indian markets (Zaffar, 2022) related to the lack of effective implementation strategies and weak and insufficient enforcement authorities, especially in rural and remote areas (Krishnan, 2022; Zaffar, 2022). Consequently, alternatives to plastics may have difficulty in gaining market shares. This perception was further confirmed by interviewed start-ups. Most start-ups offering bio-based alternatives, and reusable packaging solutions have been founded post-2016, at the time when many countries introduced SUP bans (Saahas, personal communication, 2022a). However, all interviewees agree that implementation of the ban is limited and consequently provides uncertain prospects of the demand market (Saahas, personal communication, 2022a). None of the entities reported any significant change in their sales volumes since the SUP-ban in India. Many companies experience additional seasonal demand fluctuations. There are higher sales for reusable beverage cups as well as for straws in summer months, and higher demand for tableware during festive seasons, religious events and national holidays (Saahas, personal communication, 2022a). If fully implemented, major job losses are expected at small and medium suppliers of SUPs, the most vulnerable to the ban (Krishnan, 2022). Yet, affected producers do not obtain adequate technological and financial support to transition to more circular alternatives (Talwar et al., 2021).

3.3.2 Meso level

The previous section discussed existing policy conditions on the macro-level for circular business models in packaging. The literature review and interviews, however, revealed a gap in measures on the meso-level that could also support such models.

3.3.2.1 Investments in R&D and manufacturing

NITI Aayog (2022) have identified gaps in research and development (R&D) on plastic alternatives in several sectors, including packaging, agriculture, healthcare, electronics and automotive. Research gaps concern material functionality, such as stability and biodegradability of materials, flexibility in cold environments, food safety, testing and analysis; and waste management of plastic alternatives (NITI Aayog, 2022).

Despite this need for further research, Indian start-ups working on plastic alternatives report not having received support for R&D from the government. Financial support is required for product development, machinery and import of some product elements (e.g. bioadhesives or raw materials) that are not available in the local market yet. Start-ups have hence started collaborating with established brands for product development. For example, Bamboo India assigned Oral B for the bristling of its toothbrushes, while the costs need to be borne by Bamboo India (Saahas, personal communication, 2022a). In addition to a lack of government funds, start-ups also reported a lack of access to formal financial instruments: 17 out of 22 interviewed entities were bootstrapped, i.e. were solely financed based on personal finances or operating revenue (Saahas, personal communication, 2022a). Two start-ups of a previous interview relied on the support of an external academic institution (Saahas, personal communication, 2022b).

The few with funding are still at the pre-seed or first round of investment. All interviewees reported difficulties in getting bank loans and that primarily tech-focused start-ups benefit from funding schemes (Saahas, personal communication, 2022a).

NITI Aayog (2022) suggest supporting R&D through programmes such as the EU Research and Innovation Programme and public–private partnerships. Indian plastic manufacturers could collaborate with leading research institutions (for example, Indian Institutes of Technology, IITS or Council of Scientific & Industrial Research, CSIR) to develop indigenous technology for plastic alternatives. Moreover, the interviewed start-ups favoured taxation schemes in favour of circular business models in packaging, R&D tax incentives, and import subsidies on required raw materials, machinery and transport costs. Alongside this, higher duties on imported (finished) plastic alternative products to encourage home production are needed, since the availability of other cheaper alternatives and low-quality duplicates from China is a huge risk for young companies (Saahas, personal communication, 2022b, personal communication, 2022a) (NITI Aayog, 2022). As for formal financing instruments, start-ups could be supported, with better access to finance in the shape of low-interest and mortgage-free loans and grants.

Interviewed start-ups also mentioned difficulties in finding suitable manufacturers and suppliers. Raw materials to produce plastic alternatives require specific precautions. Some require temperature control. For example, polylactic acid products can melt, while products of sal, palash and sali leaves can degrade in their transport to production facilities. Consequently, the start-ups require support in providing capacity building, training and sensitisation on inventory management of all partners in their value chain, especially when materials need to be imported. In addition, financial support may be needed, as precautionary measures for transportation and storage are costly. Moreover, the low shelf life and seasonality of products increase potential waste of raw materials and hence lead to supply risks (Saahas, personal communication, 2022a). Start-ups are confronted with an additional financial burden when acquiring licenses. This concerns the government licence for the manufacturing of compostable products. The process can take up to a year, which leads to rising risks and costs for businesses as production downtime increases. Since licence applications are only possible after setting up the facility, licensing time should be reduced, or a provisional certificate should be issued to minimise waiting periods (Saahas, personal communication, 2022a). Additional support is required for the product certification. To prevent the aforementioned risks of contamination and environmental harm, compostable products should be certified adequately to ensure products fulfil criteria from industrial and/or home composting and can be easily identified by consumers.

3.3.2.2 Investments in physical infrastructure, labelling and guidelines

As highlighted in Section 2.3.4, industrial composting sites currently hardly exist in DECs. However, if investments into R&D for plastic alternatives take place, there must be equal emphasis on expanding the appropriate physical infrastructure and industrial composting facilities (Saahas, personal communication, 2022a).

Alongside investment in facilities, additional effort is needed to prevent the contamination of materials, i.e. the interference of non-recyclables with recyclables and compostables at recycling facilities. Consequently, proper labelling (after testing and certification, as mentioned before) of home compostable and industrially recyclable materials are crucial aspects of plastic substitutes to ensure adequate recovery. Moreover, a standardised definition of industrial composting should be added to EPR guidelines and PWMRs, and standard operating procedures should be developed accordingly (NITI Aayog, 2022). As for home compostables, research has shown low consumer and household participation in home recycling, which can be addressed with micro-level policy instruments (Loan et al., 2019).

3.3.3 Micro level

3.3.3.1 Consumer awareness and acceptance scaling up

Many home compostable products such as bagasse tableware or wheat straws are backyard compostable and do not leave any traces of microplastics (Saahas, personal communication, 2022a). However, consumer studies in DECs indicate that consumers and households lack the motivation to engage in home recycling and composting practices (Loan et al., 2019). While this reluctance may be related to space constraints in the home, the absence of consumer education on the negative impacts of plastics may be an additional reason. The lack of awareness is not only reflected in the reluctance towards composting practices but also in the low consumer acceptance of plastic substitutes. The customers of such solutions are mostly educated, eco-conscious consumers in urban areas. In addition, providers of refillable home-care products have found that their typical customers are women aged between 25 and 45. All start-up interviewees consider the expansion of product and service acceptance among Indian consumers as a major challenge (Saahas, personal communication, 2022a).

Aside from consumer education, a key limitation to the widespread adoption of alternative products is the price difference between the plastic and their substitutes – this holds in both B2B and B2C scenarios (Saahas, personal communication, 2022a). Although competitiveness of alternative materials has improved overall in the last few years, products made from alternative materials are often not readily available at scale yet and hence cost more. Alternatives are still priced between 20 and 100 per cent higher compared to their plastic counterparts (Saahas, personal communication, 2022a; Zaffar, 2022). For refill solutions, prices vary. As for the start-up Refillable, which has set up kiosks with refill products in residential and retail properties, the cost per refill is lower than equivalent single-use plastic products, whereas reusable drinking cup options like Cupable are 70 per cent more expensive than single-use plastic options (Recube, 2023). For reusable e-commerce packaging Ecovia, reverse logistics create an additional cost burden (Ecovia, 2023; Saahas, personal communication, 2022a).

As for the introduction of consumer education campaigns, NITI Aayog (2022) and Talwar et al. (2021) point to a valuable waiting period in which alternative plastic materials are being tested and certified. This period can be utilised to sensitise the public to environmental and health benefits of plastic alternatives as well as their recycling and composting, which could increase consumer acceptance in time for product launches. Awareness and behaviour change measures on the consumer level in DECs have already been discussed literature (Dowarah et al., 2022; Loan et al., 2019; Pegels et al., 2022). Meanwhile, governmental or corporate sustainability initiatives could help advocate for alternative materials and more shelf space at retailers. If shelf-space limitations cannot be overcome in the short term, B2C groups can be best targeted via e-commerce and social media (Saahas, personal communication, 2022a). Nevertheless, while general eco-consciousness may be able to increase willingness to pay to a certain extent, some consumer segments may simply be limited by low incomes. Hence, policy measures introduced on the meso-level for R&D and manufacturing are indispensable for lowering the prices of packaging alternatives and making them affordable by a larger consumer base.

4 Fostering a New Plastics Economy in India

This study introduced circular business models in packaging as a key component for transitioning to a circular economy in the plastic packaging sector, also referred to as a New Plastics Economy. Circular business models in packaging address the global plastic waste crisis on various levels throughout the value chain, including reducing, reusing, replacing and recycling. Interviews with young ventures from India highlighted aspiring initiatives in reusing, replacing and recycling. In the reuse sphere, India looks back on traditional reuse systems for food delivery, but young entrepreneurs have been developing additional solutions with a lot of potential impacts given the country's boom in food deliveries – if obstacles in reverse logistics and consumer acceptance can be overcome. Other enterprises focused on alternatives to plastics made from bio-based materials that can offer a viable alternative to single-use plastic (SUP) – as long as the material meets the criteria of compostability and is composted adequately. Ventures in the recycling sphere have been working on strengthening the physical waste collection, the segregation and cleaning processes, and on facilitating exchanges between formal and informal recyclers.

These circular business models do not operate as isolated entities but are embedded in an ecosystem where policies, among other factors, are key to their success. Thus, such enabling policies were discussed.

On the macro level, India has introduced measures that are fundamental in building a New Plastics Economy. This includes waste-management regulations such as the Plastic Waste Management Rules (PWMRs) that provide formal guidance on the end-of-life plastics cycle, the Swacch Bahat Mission (SBM) that targets solid-waste management, and an extended producer responsibility (EPR) scheme that expands responsibility for waste management from municipalities to producers. However, interviews with Indian packaging start-ups reveal that the framework conditions are limited in supporting them. Until 2022, there were no punishments for non-compliance with the PWMRs, funding allocated to municipalities within the SBM was challenged by percolation. In addition, the EPR lacks a monitoring system, and its participants do not have clarity on their roles while some producers were not included in the system. With the ban on single-use plastics, India also introduced a packaging regulation that encouraged many entrepreneurs to introduce alternatives to plastic packaging. However, due to inconsistencies in the enforcement of the ban, products packaged in single-use plastics are still widely available and used, particularly by small businesses and the informal economy, leaving start-ups subject to uncertain market demands. Aside from fixing listed flaws, policy-makers should also address the upstream gap that the previously mentioned regulations left unaddressed. While proper enforcement and monitoring of waste-management regulations are still to be implemented, it is equally important to enact regulations for the upstream, including efforts to reduce the production and use of virgin plastics through redesign, a (phase-wise) increase in mandatory recycled content and alternative materials in new product design. As discussed in To (2022), upstream regulations equally apply to producers from countries that import plastic packaging waste to DECs. To build a reliable demand stream for circular business models in packaging, purchasing regulations in favour of plastic alternatives could be implemented in public procurement.

On the meso-level, a surge of R&D investment is strongly needed, as nearly all interviewed start-ups rely on personal financing, with no access to government funds or traditional financial instruments. Large-scale funding is required to foster and incentivise the transition to more sustainable packaging solutions. This could include fostering research partnerships with international research facilities to tap into international funds and capacities (e.g. the EU), governmental taxes for R&D, and import subsidies on required materials and transport. Meanwhile, access to financial instruments such as low-interest loans and grants needs to be improved. Aside from R&D, support for manufacturing is needed. Start-ups require support in

setting up capacity-building activities for their manufacturers and suppliers on material-specific requirements of raw materials in transport, storage, and handling. Additionally, start-ups require financial funds for the costs of obtaining product and operating licences – these are crucial to ensure that compostable products have the desired environmental benefits and meet health and safety criteria. At the same time, investment in recycling facilities and framework conditions needs to keep pace with investment in innovative materials and their manufacturing, as many alternative materials require industrial recycling or composting. To prevent contamination between recyclables and non-recyclables, adequate labelling that allows consumers and recycling facilities to distinguish between (home) compostables and industrially recyclable packaging is needed. EPR schemes should add standardised definitions of materials to their guidelines. Finally, the success of investment in alternative plastic solutions is contingent on the consistent enforcement of policies on the macro-level (plastic-waste management, EPR, single-use-plastic ban). Without a preceding implementation in these areas, investment in innovative solutions is at risk of failure.

Likewise, meso-level policies have implications for the micro-level. Investment in R&D and manufacturing not only encourages suppliers and start-ups but can also ultimately help lower the price for consumers, making alternative solutions more affordable to a broader customer segment – both B2B and B2C enterprises consider the price as a major barrier for switching to plastic alternatives. Finally, measures to educate consumers on the negative environmental and health impacts of plastics can empower consumers to demand more representation of alternatives on shelves and to push for stricter macro-level policy regulations.

To conclude, India has set the first fundamental stepping stones for its path to a New Plastics Economy. So far, India's key policies have been addressing the downstream on the macro level. This study shows that macro-level policies need further enforcement and should be complemented by upstream policies. Meanwhile, meso-level and micro-level policies have been rather neglected – yet successful policy engagements towards a circular economy cannot be limited to one sphere but need a coherent strategic implementation on all policy enabler levels.

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Annex

Annex 1: Entities interviewed by Saahas

Name of the entity	Product offering	Point of contact	Website
Arni Eco Steps	Refillable services	Ms Gauri Gupta	https://aranieco.com /
Bamboo India	Bamboo products	Mr Yogesh Shinde	https://bambooindia. com/
Bioreform	Biodegradable bags	Mr Azhar Mohiuddin	https://bioreform.in/
Capable	Reusable cups	Mr Rahul Batra	https://www.recube. co.in/cupable
Compact Innovations	Recycled paper	Mr Cherish Thota	
Crockey Bank for Everyone	Crockery bank	Ms Sameera Satija	https://www.faceboo k.com/crockerybank foreveryone/
Dharaksha	Mycelium products for packing	Mr Anand Bodh	https://www.dharaks ha.com/
Ecolastic Products Pvt. Ltd	Bio-compostable bags, films and bags made of starch and vegetable oil derivatives	Mr Jitendra Nimmagadda	https://ecolastic.in/
Ecovia	Reusable e-commerce packaging	Mr Rahul Batra	https://www.ecoviar enewables.com/
Empowera Technorganics Pvt Ltd	Adhesive and coatings	Mr Nikhil Mahajan	https://www.empow era.net/
Epione Groware	Wheat stem straws	Mr Pajwal Patel	https://www.epionei ndustries.com/
Instagood	Cloth bag vending technology	MrVijayaragavan Viswamithran	
M/S Ecopak	PLA products	Mr Mitanshu Choudhary	
Pritvimitra	Rental cutlery bank	Ms Lakshmi	https://prithvimitra.c om/
Qudrat	Disposable tableware from rice husk and straws	Mr Rishab Suri	https://qudrat.co.in/
Refillable	Packaging free refill service for homecare liquids	Mr Rahul Batra	https://www.recube. co.in/cupable
Stone soup	Shampoo bars	Ms Malini	https://stonesoup.in/
Sunbird Straws	Coconut straws and pens	Mr Saji Varghese	https://sunbirdstraw s.com/
Terrabiomaterial	Compostable films and laminates	Mr Amit	
Udaan Bio Packs	Corn-based bio-compostable bags	Mr Harshit Agarwal	http://www.udaanbio packs.com/
Vistaraku	Leaf-based plates, bowls, and take-away boxes	Mr Venugopal Vippulancha	https://www.vistarak u.co.in/
Yash Pakka Limited	Bagasse-based cutlery (sugarcane fibre)	Mr Gautam Ghosh	https://www.yashpak ka.com/