PRI Principles for Responsible Investment

THE PLASTICS LANDSCAPE:

RISKS AND OPPORTUNITIES ALONG THE VALUE CHAIN

UNEP FINANCE INITIATIVE | United Nations Global Compact

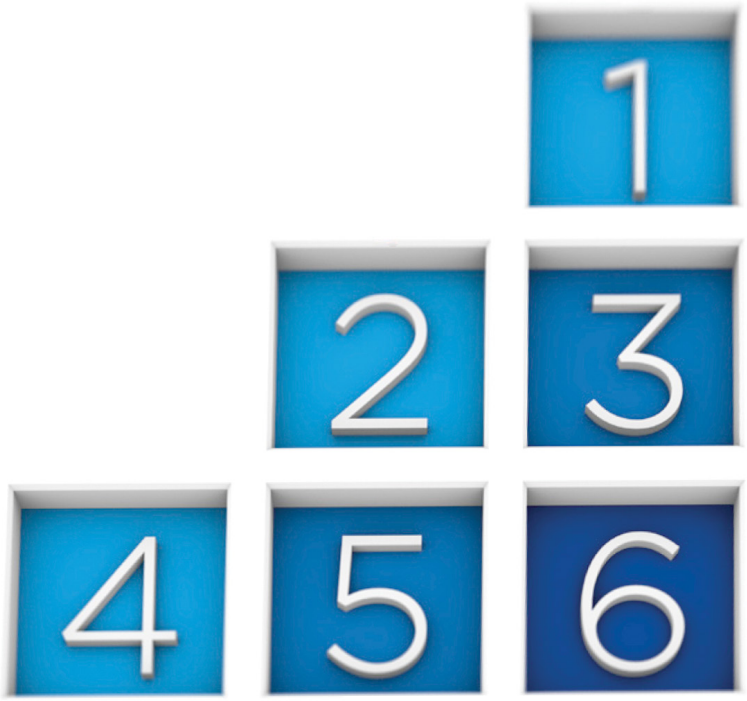
An investor initiative in partnership with UNEP Finance Initiative and UN Global Compact

THE SIX PRINCIPLES

PREAMBLE TO THE PRINCIPLES

As institutional investors, we have a duty to act in the best long-term interests of our beneficiaries. In this fiduciary role, we believe that environmental, social, and governance (ESG) issues can affect the performance of investment portfolios (to varying degrees across companies, sectors, regions, asset classes and through time). We also recognise that applying these Principles may better align investors with broader objectives of society. Therefore, where consistent with our fiduciary responsibilities, we commit to the following:

1. We will incorporate ESG issues into investment analysis and decision-making processes.
2. We will be active owners and incorporate ESG issues into our ownership policies and practices.
3. We will seek appropriate disclosure on ESG issues by the entities in which we invest.
4. We will promote acceptance and implementation of the Principles within the investment industry.
5. We will work together to enhance our effectiveness in implementing the Principles.
6. We will each report on our activities and progress towards implementing the Principles.



PRI's MISSION

We believe that an economically efficient, sustainable global financial system is a necessity for long-term value creation. Such a system will reward long-term, responsible investment and benefit the environment and society as a whole.

The PRI will work to achieve this sustainable global financial system by encouraging adoption of the Principles and collaboration on their implementation; by fostering good governance, integrity and accountability; and by addressing obstacles to a sustainable financial system that lie within market practices, structures and regulation.

CONTENTS

ACKNOWLEDGEMENTS

The PRI would like to thank members of the PRI Plastic Investor Working Group for their contributions throughout the research process.

KEY FINDINGS

- Different sectors will experience near and long-term risks across the plastic value chain (see figure 2), driven by shifting demands for plastic, regulation, changes in supply of raw materials and alternative materials, and access to recycled materials. Starting with raw material production, the oil and gas sector is responsible for fossil-based production. Investors should consider the long-term risks (stranded assets) facing the sector in the future due to potential disruptions in demand for plastic packaging and the supply of alternative materials. On the production of bio-based feedstock, the agricultural products sector will find itself under closer scrutiny amid competing demands for food security and responsible sourcing requirements.
- Related to bio-based feedstock is the topic of bioplastics. There are many misconceptions about bioplastics as investors consider alternatives to conventional oil-based plastic. It is important to note that bio-based materials may or may not be biodegradable, and biodegradable materials that are used as alternatives to plastics may or may not be bio-based. A major challenge is that recycling is only suitable for non-biodegradable (fossil or bio-based) plastics, which is not always clearly signed.
- Global fossil fuel-based plastics production (see interactive tool on global plastic production) is dominated by large petrochemical companies, including some major oil and gas producers. However, some of these companies are becoming more integrated players in plastic production, providing waste processing solutions and supplying raw materials.
- The containers and packaging sector, as well as related sectors such as food and beverage and consumer goods, face reputational and regulatory pressures to use alternative materials and recycled content at scale. This is creating opportunities for companies to collaborate and find solutions with different players across the value chain.
- While waste management is part of the problem, it is also part of the solution (see interactive tool on global waste management of plastic waste and figures 5,6,7 and 8). Less than 20 percent of plastic waste is currently recycled globally and demand for recycled content is outstripping supply. This will be amplified by regulatory disruption in the secondary commodities market (see interactive tool on global plastic waste legislation).

ABOUT THE PLASTICS LANDSCAPE SERIES

This is the second report in a series aimed at equipping investors with the information they need to understand plastic as a systemic issue, providing a technical overview of plastic and the plastic market, and exploring common concepts.

The series will help investors to identify where and how their portfolios might be exposed to plastic, enabling them to analyse relevant sectors and engage at the corporate and policy levels accordingly.

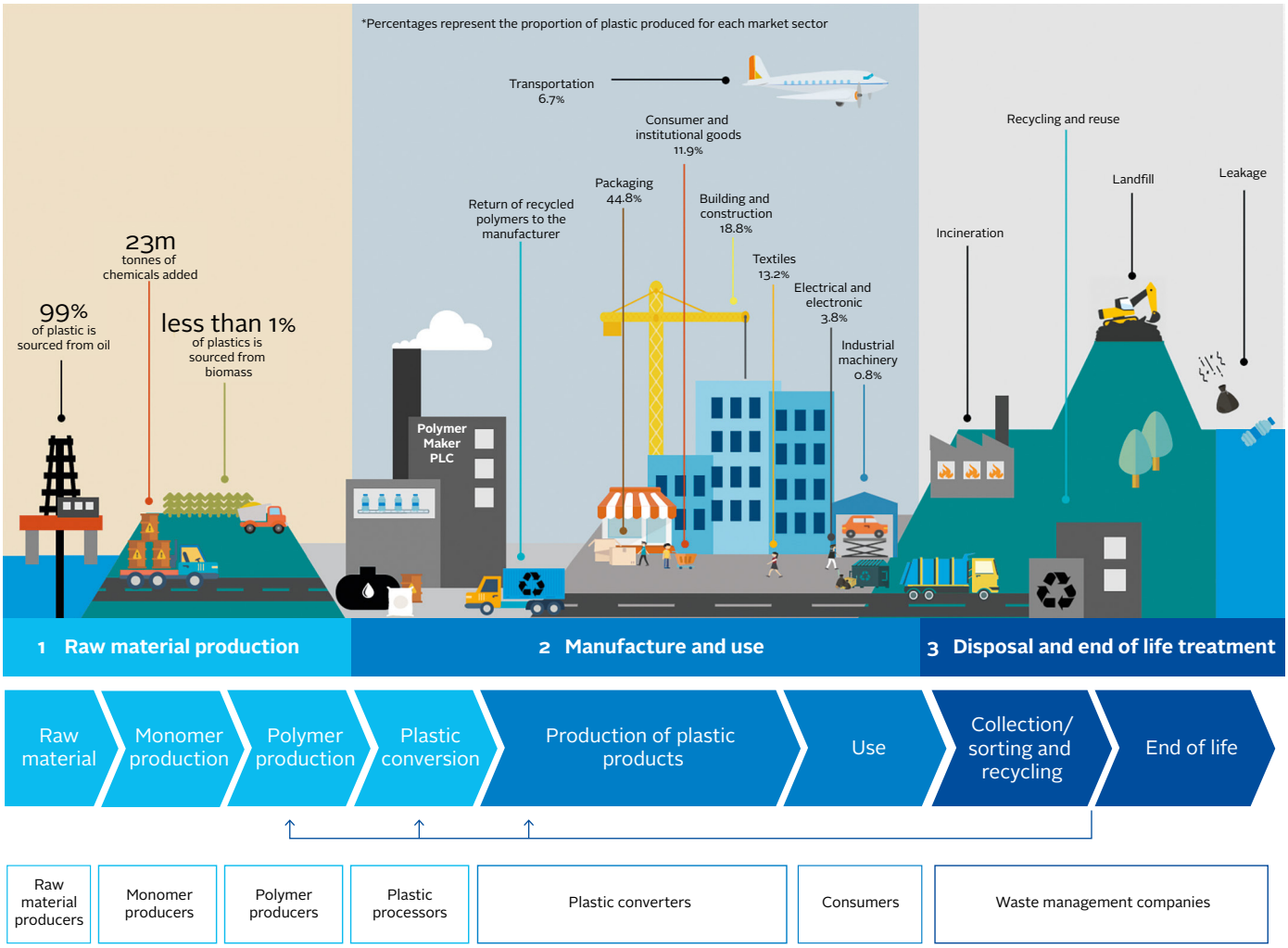
The first report looked at the challenges and solutions for the plastics system, and the third will identify regulations, policies and influencers of change in how plastic is managed.

OVERVIEW OF THE VALUE CHAIN AND RISKS

The level of global interest in plastic production, consumption and waste has soared in recent years. While much of this focus has been on the risks and impacts, it is important to recognise that the flexibility and resilience of plastic mean that products made from the material perform many crucial functions in society and across sectors.

The plastic value chain is complex, touching most (if not all) businesses sectors globally. Therefore, investor portfolios are exposed to an array of risks and opportunities associated with plastic.

Figure 1: Overview of the plastic value chain[1]. Source: Anthesis



Although demand for plastics is not expected to slow in the short term, certain sectors and plastic products will be exposed to six main risks across the plastic value chain (see figure 2).[2] While these risks are low for some sectors now, they could materialise in the future. Where applicable, analysis considered the risks in the short (immediate), medium and long term.

1 Note on consumers: these can be business-to-business customers e.g. packer fillers to retailers (e.g. Unilever, Nestle, Coca-Cola and Johnson & Johnson selling to grocery retailers) and suppliers to consumers.

2 All parts of the value chain are subject to other sustainability-related business risks, which have not been considered in detail in this assessment. This assessment only considers plastic-related risk.

Figure 2: Plastic-related risk assessment across the value chain

STAGE OF VALUE CHAIN	SECTOR	REPUTATIONAL	REGULATORY	USE OF ALTERNATIVES	ACCESSING FEEDSTOCK	ACCESSING RECYCLED CONTENT PLASTIC	EMERGING MARKET
Raw materials production	Oil and gas	Short term	Low	Long term	Low	N/A	N/A
	Agricultural products (corn and sugarcane)	Short term	Low	N/A	Medium term	N/A	N/A
Primary plastics production	Chemicals (oil-based)	Medium term	Long term	Long term	Low	N/A	Low
	Chemicals (bio-based)	Short-medium term	Medium term	N/A	Medium term	N/A	Short term
Secondary plastics production	Waste management (recycled content plastic)	Low	Medium term	Medium term	Short term	N/A	Medium term
Manufacture and use	Containers and packaging	Short term	Short term	Short term	N/A	Short term	Low
	Engineering and construction services and home builders	Low	Low	Low	N/A	Short term	Low
	Consumer goods	Short term (for specific products) Low for other products	Short term (for specific products) Low for other products	Short term (for specific products) Low for other products	N/A	Short term	Low
	Industrial machinery and goods	Low	Low	Low	N/A	Short term	Low
	Transportation	Low	Low	Low	N/A	Short term	Low
	Apparel and textiles	Medium term	Low	Medium term	N/A	Short term	Low
Disposal	Collection/export	Short term	Medium term	Medium term	N/A	N/A	Low
	Plastic recycling	Low	Low	Medium term	Short term	N/A	Short term (for specific products) Low for other products

- **Reputational:** Increased public and civil society scrutiny demanding a shift away from plastic production and use
- **Regulatory:** Bans, taxes, levies or regulation of plastic production, use and disposal
- **Impact of using alternative materials:** Increased availability of plastic alternatives at equivalent or lower costs
- **Access to feedstock:** Accessing raw materials in the supply chain to produce recycled plastics
- **Access to recycled content:** Accessing recycled plastics to meet voluntary commitments and company pledges or new regulations
- **Emerging market risks:** Scalability of new business models and market acceptance of new products and technologies

Each stage of the value chain in figure 2 is assessed in the following sections,[3] with opportunities or solutions also identified. However, possible solutions should consider:

- The real-world context – this includes existing systems or processes that may affect operations
- Potential unintended consequences – fundamental ESG principles (e.g. traceability of supply chain) should be applied to the project or company assessment
- Scalability – this will depend on the market and context of operation

Collaboration across the value chain is required to develop impactful solutions.

3 The sectors used are aligned with the Sustainability Accounting Standards Board (SASB) Sustainable Industry Classification.

STAGES OF THE VALUE CHAIN

RAW MATERIAL PRODUCTION

SECTOR: OIL AND GAS

Most plastic is derived from fossil fuels. At current levels of production, plastic accounts for 6 percent of global oil and gas consumption.[4] The way plastics are produced from each type of fossil fuel feedstock varies slightly. After extraction, there is a separating process which involves converting chemical components into olefins – the basis of most plastic.[5]

As plastic demand continues to grow, oil and gas companies continue to forecast growth in demand for petrochemicals, even if at a slower rate due to anticipated regulation affecting the production, use and disposal of plastic. It is predicted that plastics will account for nearly half of the growth in demand for oil through 2050.[6] However, fossil fuel feedstock must be phased out to successfully transition to a circular economy. Oil and gas giant BP's scenario analysis based on a global single-use plastic ban from 2040 concluded that "a substantial tightening in the regulation of plastics could significantly reduce the growth of oil demand."[7] Focus is also intensifying on how the oil and gas sector is contributing to climate change, with investors increasingly concerned about the risk of stranded assets in the future.[8]

SECTOR: AGRICULTURAL PRODUCTS

Bio-based means that the feedstock to make bioplastic comes from plants, not fossil fuels. This type of feedstock can be:[9]

- First generation: Traditional agricultural crops
- Second generation: Cellulosic crops as well as residue and waste products
- Third generation: Non-traditional organisms such as algae

Renewable feedstock for bio-based plastics typically comes from corn and sugarcane. Brazil and India are the largest producers of sugarcane[10] and the US, China and Brazil are the largest producers of corn.[11] It is estimated that 0.81 million hectares of land in 2018 was used to grow renewable feedstock to produce bioplastics, accounting for less than 0.02 percent of the global agricultural area of 4.9 billion hectares.[12] Concerns regarding the diversion of land from food production – and required fertilizers and water – exist despite it being possible for waste from crops (such as waste sugarcane) to be used as feedstock. The impact of producing renewable feedstock depends on the context of where the crop is grown, the types of crop or waste product used, and the manufacturing location and process. In some cases, bio-based plastics may result in lower greenhouse gases than oil-based plastics, but a responsible sourcing approach must be taken.

PRIMARY PLASTICS PRODUCTION

SECTOR: CHEMICALS

Production from fossil fuel feedstock

Nearly all (97-99 percent) plastics come from petrochemicals sourced from fossil fuels constitutes,[13] with the remaining 1-3 percent[14] produced from bio (plant)-based plastic (see interactive tool on global plastic production).

Global fossil fuel-based plastics production is dominated by large petrochemical companies, including major oil and gas producers: Dow Chemical Company; LyondellBasell; Exxon Mobil; SABIC; INEOS; BASF; ENI; LG Chem; Chevron Phillips Chemical; and Lanxess.[15]

These companies produce monomers for in-house conversion to plastic and/or to sell to companies that polymerise them to create plastic at a smaller scale. The largest companies within this sector generally provide a wide range of products to numerous markets across sectors and geographies. Smaller players are more likely to be specialised, producing a limited range of products and/or operating in fewer markets.

4 Ellen MacArthur Foundation, 2016. The New Plastics Economy: Rethinking the future of plastics.
5 See CIEL, 2019. Plastic & Climate: The Hidden Costs of a Plastic Planet for more information.
6 International Energy Agency, 2018. The Future of Petrochemicals Towards more sustainable plastics and fertilisers.
7 BP, 2019. BP Energy Outlook: 2019 Edition.
8 Carbon Tracker Initiative, 2019. 2 degrees of separation – Transition risk for oil and gas in a low carbon world.
9 Bioplastic Feedstock Alliance, 2019. The Bioeconomy: Sustainability, the Bioeconomy and the Circular Economy.
10 International Sugar Organization, 2019. New Information from the Institute of Food Science and Technology provides technical analysis on dietary sugars.
11 Statista, 2019. World corn production by country 2018/19 (in 1,000 metric tons).
12 European Bioplastics, 2019a. Bioplastics market data.
13 CIEL, 2017. Fueling Plastics: Fossils, Plastics, & Petrochemical Feedstocks.
14 European Bioplastics, 2019b. Bioplastic market data 2016.
15 OECD, 2018. Improving Markets for Recycled Plastics: Trends, Prospects and Policy Responses. Policy Perspectives: OECD Environment Policy Paper No.12.

Over 30 types of primary plastics are commonly used globally, with different properties and applications across a range of sectors. When used in combination and with different additives or barrier properties, polymers represent thousands of material types. However, five primary plastic types account for almost three-quarters of plastic used:

1. **Polyethylene terephthalate (PET)** can be rigid or flexible, is resistant and is a good water and gas barrier. Common uses include drinks packaging, cooking oil bottles, packaging trays and fleece clothing.
2. **High-density polyethylene (HDPE)** is strong, high density and can withstand high temperatures and chemicals. Common uses include cleaning products and personal hygiene bottles, shopping bags, pipes, insulation, bottle caps, protective helmets and street furniture.
3. **Polyvinyl chloride (PVC**) is easy to mould. Common uses include clothing, pipes, flooring, vinyl records and cables.
4. **Low-density polyethylene (LDPE)** is not as strong as HDPE but is more resilient. Common uses include plastic bags, trays and lids, computer hardware and playgrounds.
5. **Polypropylene (PP)** is strong and flexible, with common uses including bottles and caps, food containers and straws.

All five can be recycled mechanically (see section on disposal and end of life).

THERMOPLASTIC AND THERMOSET

Polymers can also fall under one of two categories – thermoplastic and thermoset – which differ widely in their characteristics and recyclability.

- **Thermoplastic** materials become soft when they are heated and solid when cooled to room temperature. They are typically strong, shrink-resistant and flexible.
- **Thermoset** materials cannot be re-heated and softened again. Once they are formed, they cannot be reformed. They strengthen a material's mechanical properties, providing enhanced chemical resistance, heat resistance and structural integrity.

As companies adopt circular business models, there is potential for plastics production to become more integrated, providing waste processing solutions and supplying raw materials. Some larger companies involved in producing primary plastics are already focusing on opportunities and innovations associated with increased plastic recycling and the recycled content in plastic. These include:

- integrating recycling company production/businesses models, rather than the traditional approach of outsourcing this activity to third parties;[16]
- adapting primary plastics production processes to include recycled content in products;
- producing primary plastics that are easier to recycle using current recycling infrastructure;
- developing chemical recycling technologies that are commercially scalable by investing in research and development and/or collaborating with technology providers.

CASE STUDY: BASF'S CHEMCYCLING PROJECT

Aim: To develop a commercially-viable process in which plastic waste is used to produce a raw material using thermochemical (pyrolysis) technology. The raw material is then included in BASF's production processes to create new chemical products.

Focus: The project is targeting several types of plastic: plastic with adhering residues (e.g. food residues on packaging) and plastic which cannot (economically) be sorted for recycling as feedstock.

Achievements: Pilot products including packaging, refrigerator components and insulation panels that meet quality and hygiene standards.

Next steps: Make the first products from the ChemCycling project available commercially.

Chemical recycling challenges:

- Existing technologies must be adapted to deliver reliable, high-quality outputs.
- Regulation may determine whether the technology will be adopted by the waste industry (e.g. by including chemical recycling in recycling definitions).

Sources: www.basf.com[17, 18]

16 McKinsey & Company, 2018. How plastics waste recycling could transform the chemical industry.

17 BASF, 2018. BASF for the first time makes products with chemically recycled plastics. BASF business and financial news, 13 December 2018.

18 BASF, 2019. Chemical recycling of plastic waste.

Production from plant feedstock

Bioplastic is a broad term for a substance derived wholly or in part from plant-based material, or is biodegradable. Concerns associated with oil-based plastics have prompted a rise in demand for alternatives to plastic in the form of natural raw materials and as biodegradable or compostable materials. It is possible to mix raw material sources to combine bio-based and oil-based materials when producing polymers and products.

With rising demand for alternatives to fossil fuel-based plastic, some petrochemical companies have boosted their research and development in bio-based and recycled plastic feedstocks, as well as chemical recycling. However, while demand has increased, production levels of bio-based plastic by these petrochemical companies currently remains low. It also remains the focus of small and medium-sized companies, and technology providers (see interactive tool on bio-based production).

The production of bio-based plastic is seen as an emerging market, with no companies or technologies dominating this part of the value chain to date. Collaboration is currently underway among multinationals (including Dow, Neste and BASF) and smaller technology providers to invest in research and product development as the market develops.

It is commonly assumed that bio-based plastics are biodegradable, but this is not the case:

- **Bio-based:** The feedstock to make bioplastic comes from plants, not fossil fuels.
- **Biodegradable:** Biological action will completely degrade material into carbon dioxide, methane and water. It does so to a defined time frame and in a defined environment.

Bio-based materials may or may not be biodegradable. Biodegradable materials that are used as alternatives to plastics may or may not be bio-based.

A bio-based plastic can be recycled in the same polymer stream as its fossil fuel-based alternative (e.g. a PET bottle made from plant-based materials can be recycled alongside a fossil fuel-based PET bottle). However, biodegradable plastic is not commonly recyclable and can contaminate other materials if placed in non-biodegradable recycling streams (see section on disposal and end of life).

PRIMARY PLASTICS PRODUCTION FROM RECYCLED MATERIALS: CHALLENGES AND OPPORTUNITIES

Demand for recycled content plastic as a feedstock is growing, driven by targets for recycled content set by business and regulation.[19] However, volumes of secondary plastic production are low, raising questions about whether the supply of recycled content can meet increasing demand.

Recycled content experiences unique challenges, such as conflict with other regulations. For example, there are limitations with food contact packaging due to food standards regulations. Other factors impacting the flow of recycled content plastic into the secondary commodities markets are summarised in figure 3.

Figure 3: Barriers to the secondary commodities market for plastic

ECONOMIC BARRIERS	Costs of collecting, sorting and processing waste plastics are high
	Demand for recycled plastics compared to virgin plastics
	Poor data on the structure and performance of the sector
TECHNICAL BARRIERS	Waste plastics are typically contaminated and mixed with other materials
	Inability to differentiate between food and non-food packaging
	Problematic additives and pigmentation
	Biodegradable plastics mixing with other plastics
	Limited collection schemes and treatment technologies for thermosets
ENVIRONMENTAL BARRIERS	Hazardous additives in non-food plastics such as waste electric and electronic plastics
	Potential competition between recycling and incineration
	Concerns over environmental standards for recycling in emerging markets
REGULATORY BARRIERS	Regulatory burden of materials classified as waste
	Illegal trafficking of waste plastics

PET has the largest share in the recycled plastic market and is expected to grow further.[20] Availability of recycled PET (rPET) is high due to the high recycling rates of PET and lower cost relative to other recycled plastics. Recycled HDPE (rHDPE) has the second-largest market share, accounting for a third of the total recycled plastic market.

There are lower volumes of other types of plastic in the recycled waste stream. An increase in demand for recycled content could result in supply challenges for companies that want to boost the amount of recycled content in the plastics they produce.

While ocean plastic can also contribute to recycled content, demand for it is currently low despite recent success in integrating marine plastics into manufacturing. For example, sportswear company Adidas worked with clean-up network Parley to develop a clothing range made from plastic litter found on beaches and coastal communities.[21] However, current business models for integrating ocean plastics into supply chains are economically unviable due to a lack of demand for the feedstock, as well as unsustainable purchase prices.[22] Successful uses of ocean plastics have been initiated by larger corporates that have the necessary structure and partnerships in place. Unlike domestic waste recycling systems on land, which are more established (though not necessarily effective), these formal collection and supply systems are not yet in place for ocean plastics.

19 For example, packaged goods, retailers, hospitality and food service and packaging producer signatories of the Ellen MacArthur Foundation's (2016) New plastic economy global commitment have committed to set an ambitious 2025 recycled content target across all plastic packaging used.

20 Persistent Market Research, 2017. Global market study on recycled plastic: LDPE resin type projected to be a comparatively high growth segment through 2025.

21 Adidas, 2019. The oceans: death by plastic. Adidas blog, June 2019.

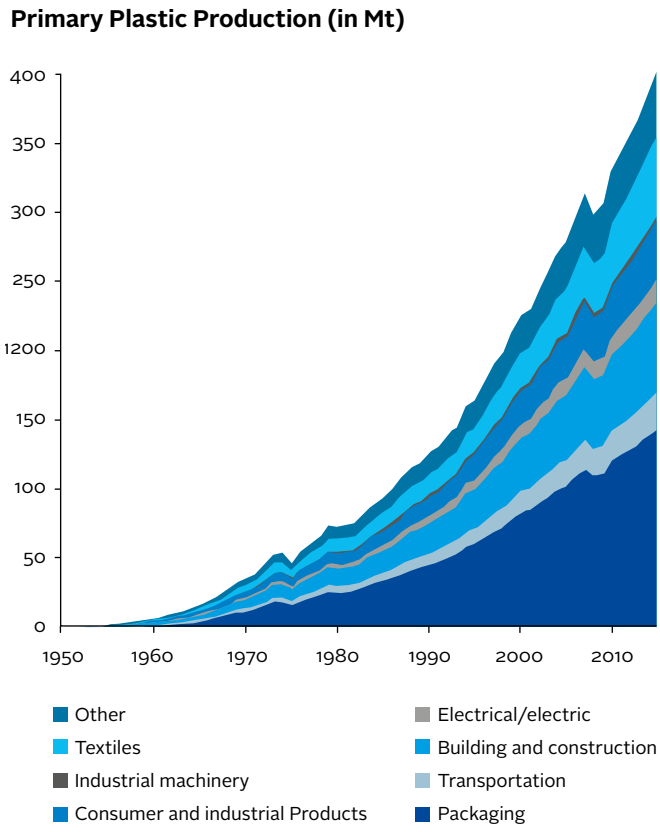
22 Resource Recycling Inc., 2019. Lack of demand could sink ocean plastics recycling program. Plastics Recycling Update, 9 January 2019.

MANUFACTURING AND USE OF PLASTIC PRODUCTS

Four sectors account for three-quarters of plastic used in the world today: containers and packaging, infrastructure (construction), automobiles and electrical and electronic equipment. These sectors are a source of employment for a wide range of skill sets[23] and develop products for different purposes in society.

Industry sectors use various combinations of polymers (see interactive tool on plastic use per sector). Polyethylene (PE), including LLPE, LLDPE and HDPE, accounts for 36 percent of all non-fibre polymers, the largest market share of any plastic.[24]

Figure 4: Global plastic production levels by industry (in 2015). Source: Adapted from Geyer et al, 2017[25]



SECTOR: CONTAINERS AND PACKAGING (CONSUMER GOODS AND FOOD AND BEVERAGE)

Packaging accounted for 45 percent of all plastic produced in 2015[26] and is most exposed to the risks associated with the factors outlined in figure 2. Production levels have soared in the past 50 years, fuelled by a global shift away from reusable containers to single-use containers, and driven in part by an increase in on-the-go consumption and convenience purchasing. Fast-moving consumer goods (FMCG) and retail products also use single-use packaging and will be exposed to some of the same risks experienced by the packaging sector.

Plastic plays a major role in packaging because:

- it helps to prevent food waste;
- it keeps food fresher for longer, enabling a wider variety of food availability;
- it protects goods during transport and distribution.

To preserve these benefits, the packaging sector – FMCG and retailers with food packaging in particular – will need to address several challenges. Without wider changes to food distribution systems, eliminating all plastic packaging could *increase* food waste. For example, in the EU there are regulations to maintain food safety standards in relation to packaging.[27] While the circular economy concept intends to increase the use of recycled content, food packaging must be of a certain quality. For some recycled content, there is a tendency for downgrading to occur (where quality diminishes due to shorter polymer chains)[28] and it may not be appropriate for food products. However, the Waste and Resources Action Programme (WRAP) notes that rPET does not compromise the physical properties[29] (see *Primary plastics production from recycled materials: Challenges and opportunities*). Chemical recycling could also play a role in recycling content without losing quality.

23 BPF, 2019. Jobs and careers in the plastics industry.
24 Geyer, R., Jambeck, J.R. & Law K. L., 2017. Production, use, and fate of all plastics ever made. Science Advances, 3(7), e1700782.f
25 Geyer, R., Jambeck, J.R. & Law K. L., 2017. Production, use, and fate of all plastics ever made. Science Advances, 3(7), e1700782.
26 Geyer, R., Jambeck, J.R. & Law K. L., 2017. Production, use, and fate of all plastics ever made. Science Advances, 3(7), e1700782.
27 European Commission, 2014. Union Guidelines on Regulation (EU) No 10/2011 on plastic materials and articles intended to come into contact with food.
28 National Geographic Society, 2018. 7 things you didn't know about plastic (and recycling). National Geographic, 4 April 2018.
29 WRAP UK, N.D. Case study: Using recycled content in plastic packaging: the benefits.

The packaging sector and businesses that handle packaging in their own operations are exposed to various risks, including reputational ones. Packaging – because much of it is single use – has been the target and focus of campaigns against plastic. Brand values can be severely impacted[30] by images of packaging found on beaches by association. For example, Nestlé was one of the three most frequent brands to be identified in global clean-ups in 2018[31] and was subsequently a target of Greenpeace's Plastic Monster campaign.[32]

Governments are also intensifying their focus on plastic, with many regulations coming into force aimed at packaging. This raises questions about whether companies are prepared for these changes. For example, the UK government announced that from April 2022 it would introduce a tax on the production and import of plastic packaging with less than 30 percent recycled content, subject to consultation.[33] Companies will need to assess their supply chains and accessibility of the recycled feedstock, as well as be able to understand how to measure recycled content.

Some types of plastic are more at risk than others when it comes to packaging. Businesses that produce plastics that are difficult to recycle, such as PVC, face risks as customers and sectors phase out their use of such products (see table 1).

Table 1: Risk of plastic being phased out of packaging

PLASTIC	RISK OF PHASING OUT
PET	Low
HDPE	Low
PVC	High
LDPE	Medium
PP	Low
PS	Medium
EPS	High
Black plastic	High
Coloured plastic	Medium

Sectors that use high levels of packaging will need to find ways to reduce the volume of plastic used, as well as improve reusability, recyclability and compostability. This will be driven by companies' own commitments, those of their customers and regulation in certain jurisdictions.

Companies committed to using recycled content, or those required to respond to regulations requiring recycled content in packaging, are also subject to risks associated with accessing materials. For example, it could be difficult to secure recycled PET if there is a significant increase in demand for it. There is currently insufficient global supply of appropriately priced, high quality and consistent (in terms of quality and availability) secondary materials. Unless there is a substantial increase in plastic waste collection for recycling to generate feedstock that meet the standards required, accessing recycled materials will remain a major challenge.

30 Client Earth, 2018. Risk unwrapped: plastic pollution as a material business risk.

31 #breakfreefromplastic, 2018. Coca-Cola, PepsiCo, and Nestlé found to be worst plastic polluters worldwide in global cleanups and brand audits. #breakfreefromplastic, 9 October 2018.

32 Greenpeace, 2019. Plastic monsters from around the world return home to Nestlé. Greenpeace, 24 April 2019.

33 H.M. Government, 2019. Consultation outcome: Plastic packaging tax. gov.uk, 18 February 2019.

Table 2: Opportunities for sectors that are major users of packaging (in order of desirability)

OPPORTUNITY	EXAMPLE
Develop product distribution models to reduce or eliminate materials used (e.g. refill models).	Loop: An online retail business that uses a waste-free delivery system.
Develop packaging based on alternative materials (e.g. paper, card, metal or glass) for single-use products (e.g. using paper in cotton bud stems). In these circumstances, there is a requirement to ensure sustainable sourcing and disposal, and understand the associated environmental footprint.	Hydrophil: A producer of sustainable hygiene products such as bamboo cotton buds.
Increase the recyclability of packaging through polymers standardisation and removing plastics that are difficult to recycle by: ■ working with technology suppliers, waste management companies and government bodies/regional initiatives to develop recycling solutions for their products; ■ working with recyclers and re-processors to develop more suitable track and trace mechanisms for packaging so that the full value of the material can be realised.	Marks & Spencer: The UK retailer reduced the number of polymers in its plastic packaging from 11 in 2007 to four in 2018. It aims to assess feasibility of using just one polymer for all M&S plastic packaging to simplify recycling by 2022.
Develop packaging using recycled content in collaboration with others in the value chain to ensure that innovations are compatible with recycling systems, and do not result in further consumer confusion on how to dispose of the packaging.	Method: An eco-cleaning brand has developed bottles made from 100 percent recycled plastic, designed to be recycled in the US.

FMCG brands are also exploring the bioplastic market, including **Coca-Cola**, which introduced PlantBottle, made from up to 30 percent plant-based materials. The plant-based component is the ethylene glycol monomer derived from ethanol from cane sugar. Meanwhile, food products company **Danone** has partnered with the Bioplastic Feedstock Alliance,[34] co-created with the WWF, to develop plant-based plastic. **Danone and Nestlé Waters** also launched a research consortium, NaturALL Bottle Alliance, to develop 100 percent bio-based PET bottles.[35]

While single-use packaging has been in the spotlight, plastic products are found in an array of consumer goods, most of which are unregulated. However, certain products are the focus of bans and/or regulation in several jurisdictions and are therefore considered high risk. These plastic products (such as household and personal care products such as cotton buds) tend to be single-use items and (in countries in Asia in particular) contribute to marine plastic litter. Companies that are part of these product supply chains are exposed to risk depending on the jurisdictions the company operates in.

SECTOR: INFRASTRUCTURE (ENGINEERING AND CONSTRUCTION SERVICES, AND HOME BUILDERS)

The building and construction sector is the second-largest user of plastic, accounting for nearly a fifth (19 percent) of all plastic produced in 2015.[36] The construction sector uses plastic for building components and is also exposed through packaging for building materials. The typical lifespan of plastic products used as building components in the construction industry ranges from 20 to 30 years.[37]

Plastic packaging protects building materials which can be expensive to replace and bulky to transport. For building components, plastics are used due to their strong, durable and lightweight characteristics. They can be used in roofing, insulation, wall coverings, windows, piping, decks, fencing and railings. As well as their long lifespan, plastics can reduce the need for other resources in the long term such as water and energy, through reduced leakages and insulation.[38]

34 Bioplastic Feedstock Alliance, 2019. What we do.

35 Nestle USA, 2017. Danone and Nestlé Waters launch NaturALL Bottle Alliance with California startup to develop 100% bio-based bottles. Nestle USA, 2 March 2017.

36 Geyer, R., Jambeck, J.R. & Law K. L., 2017. Production, use, and fate of all plastics ever made. Science Advances, 3(7), e1700782.

37 British Plastics Federation, 2019. Construction.

38 European Plastics Converters, 2019. Building and construction.

Governments and civil society have paid less attention to the construction sector's use of plastic, resulting in less risk from a reputational perspective. However, on the packaging side, many of the challenges related to the packaging sector apply. Packaging for the construction sector is still regarded as single use, and the sector uses a large amount of it. In the UK, about a quarter of construction packaging waste by weight is plastic.[39] Construction firm Mace launched a campaign to reduce disposable plastic use, while for Willmott Dixon reducing plastic waste is part of an existing longer-term waste strategy spanning all materials.[40] Although the construction sector does not currently appear to face the same reputational risks as other sectors, these examples illustrate how the sector may respond to societal concerns around plastic.

Like other sectors, construction companies send plastic waste through the standard routes of incineration, landfill and recycling. Plastic waste from the construction sector could also be part of the solution to providing plastic waste as feedstock for recycled content. However, the sector could also create demand for recycled content if it is able to secure access (particularly as there are fewer limitations compared to food quality standards).[41]

SECTOR: CONSUMER GOODS (APPAREL, ACCESSORIES AND FOOTWEAR)

Textiles account for about 14 percent of plastic used globally. Plastic is used to create synthetic fibres for different materials such as polyester and Lycra. In 2016, global synthetic fibre production was estimated at 64.8 million tonnes (65 percent of all fibres produced annually) – a figure expected to increase to 134.5 million tonnes by 2025.[42] Clothing is often under-used and not recycled, resulting in the loss in value of US$500 billion annually.[43] Plastic is seen as an alternative to cotton, which has its own environmental challenges (or it can be blended with cotton).

Plastic has enabled advances in safety clothing including heat and water-resistant safety wear. It also meets the demands of athletes because of its weight, resilience and moisture-related properties.[44]

However, microfibres – created when synthetic fibres used to make clothing or material break – can leak into waterways and end up in oceans when clothes are washed, entering water supplies and food production systems (see report 1 on the challenges and possible solutions facing the plastics landscape). While it is not the only source of microfibre pollution (with 35 percent of microplastics in the ocean coming from plastic), public awareness of the issue has risen sharply.[45]

The textiles industry will likely face increased public pressure (from consumers and NGOs, and, potentially, regulatory interventions in some regions) to use more renewable feedstock materials, such as cotton and wool, as well as more recycled content. Companies that continue to use synthetic materials will need to prevent the leaching of microfibres into the environment. Solutions to this challenge are likely to be found by collaborating within the sector, and with other sectors, to develop new materials and technologies. For example, washing machines could be fitted with filters to catch microfibres.

Some companies have started sourcing recycled content or ocean plastics as feedstock to use in certain products and collections.[46] However, this requires a stable and secure supply of the feedstock. To avoid supply chain risks for recycled content such as rPET, companies will have to invest in plastic collection and/or fibre-to-fibre recycling facilities to secure supply. The sector may also lobby governments to invest in this area of the value chain to increase supply of rPET.

The end-of-life stage for textiles is also a challenge. Current mechanical recycling methods are limited and cannot separate dyes, contaminants and blended polyester and cotton. However, there are long-term opportunities to commercialise fibre-to-fibre recycling facilities such as Worn Again[47] and DEMETO. Recycling facilities are being developed in Europe and the US, helping to provide solutions for end-of-life garments, and incorporate recycled fibres into the supply chain (see H&M case study).

39 Considerate Constructors Scheme, 2019. Spotlight on ... plastics and packaging.

40 Building, 2019. Plastic waste in construction - is the sector doing enough? Building.co.uk, 1 March 2019.

41 WRAP UK, N.D. Using recycled plastic products in construction.

42 Common Objective, 2016. Synthetics & sustainable synthetics: global production.

43 Ellen Macarthur Foundation, 2017. A new textiles economy: redesigning fashion's future.

44 Plastics Europe, 2019. Plastics in sport and leisure applications.

45 Environment Journal, 2018. 35% of microplastics in oceans come from clothing, research reveals. Environment Journal, 5 October 2018.

46 For example: Patagonia and Adidas

47 Worn Again Technologies, 2019. Worn Again

CASE STUDY: H&M GROUP

H&M Group has a target to use 100 percent recycled and other sustainably-sourced materials by 2030. In 2018, 57 percent of its materials came from these sources.[48]

H&M group is the sixth-biggest user of recycled polyester.[49] The group is a member of DEMETO,[50] a project on polyester recycling which aims to build a pilot plant to treat 500 tonnes of such waste a year. The project is funded by the EU and its partners.

In 2018, the H&M Foundation and the Hong Kong Research Institute of Textiles and Apparel (HKRITA) opened a recycling facility in Hong Kong. The facility uses a technology developed by HKRITA that recycles cotton and polyester blends into new fibres.

Source: www.hm.com

TRANSPORTATION, ELECTRONICS AND HEALTHCARE SECTORS

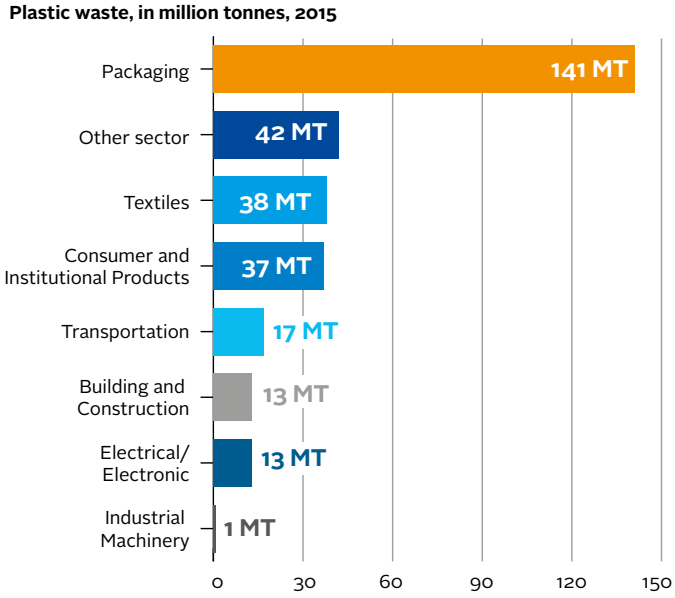
Sectors that use plastic with a longer lifespan are less scrutinised for how they use and manage the material. Most plastic packaging products are used within one to two years, whereas the majority of those used in the transportation, electronics and healthcare sectors outlined below have longer lifespans in the region of five to 20 years. Benefits include:

- Transportation: Plastic's lightweight property means that using it in vehicles reduces fuel consumption compared to heavier alternative materials. Sectors related to transportation such as catering services for airlines and railways face the same challenges as those associated with packaging.
- Electrical and electronic equipment: All electronic devices and wiring use plastic for electrical insulation. The non-conductive properties of plastic, combined with its light weight, durability and ability to be moulded, has enabled the production of affordable electronic devices like mobile phones, laptops and tablets.
- Healthcare: Materials such as metal, glass and ceramics, traditionally used for prosthetics, glasses and medical implants have been replaced by plastic due to its lightweight properties, better biocompatibility and cost-effectiveness. In addition, single-use plastic medical devices (e.g. syringes, surgical gloves, IV tubes and catheters) can reduce the spread of infectious diseases as the need to sterilise and reuse products is eliminated.

DISPOSAL AND END OF LIFE

Poor management of global plastic waste at end of life adds to the challenges facing the plastics landscape. Plastic packaging accounts for over 141 million tonnes of annual global plastic waste (see interactive tool on global plastic waste generation). With plastic packaging having the largest share of the plastic market and the shortest average life span per product, more plastic packaging becomes waste each year than any other plastic product. Figure 5 shows total global plastic waste production by sector in 2015 (also see interactive tool on plastic waste generation by sector).

Figure 5: Plastic waste generated by industrial sector, 2015. Source: Adapted from Geyer et al



48 H&M 2018 Group Sustainability Report

49 Textile Exchange, 2018. The textile exchange's preferred fibre and materials market report.

50 Demeto, 2019. Welcome to DEMETO.

Globally, waste management infrastructure (formal collection systems and management disposal or treatment facilities) varies significantly. A major barrier for implementation is financing, particularly in low and middle-income countries where formal systems for some or all materials are absent or development is underway[51] (see interactive tool on global waste management of plastic waste).

There are three main routes for plastic disposal: recycling, incineration or landfills. Achieving a circular economy will require eliminating incineration and landfill streams – the current managed plastic waste routes. However, illegal and open dumping, as well as plastic that is leaked into the environment, contribute to unmanaged plastic waste. In figure 6 and table 3, landfill and unmanaged plastic waste are collectively considered as discarded.

Figure 6: Global plastic waste by disposal route. Source: Adapted from Our World in Data

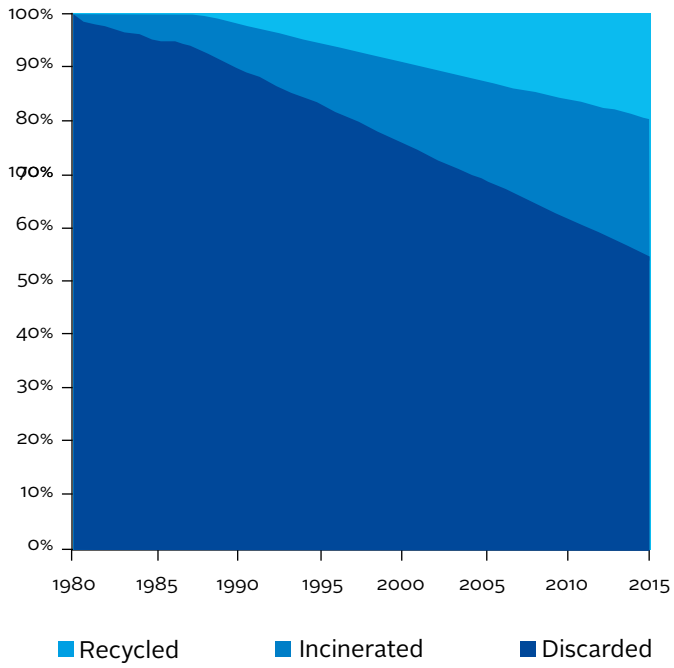


Table 3: End of life management of plastic

	YEAR	RECYCLING RATES	INCINERATION RATES	DISCARD RATES
Global	2015	14 percent[52] to 19.5 percent[53]	25.5 percent	55 percent

SECTOR: RECYCLING INFRASTRUCTURE (WASTE MANAGEMENT)

This section covers the differences in recycling structures globally and the different types of recycling processes. It also highlights changes in the recycled waste market.

Plastic recycling differs across regions and involves a range of players and supply chain structures. There is no readily available data on the structure of the plastic recycling industry across different regions and countries. However, the observations presented in table 4 outline broad differences in the main parts of plastic waste supply chains (collection, sorting and reprocessing) across low, middle and high-income areas.[54]

51 Cision PR Newswire, 2018. Circulate Capital announces US$90 million in expected funding to combat ocean plastic Circulate Capital, 25 October 2018.

52 Ellen MacArthur Foundation, 2017. Industry endorses plan to recycle 70% of plastic packaging globally. Ellen MacArthur Foundation News, 16 January 2017.

53 Geyer, R., Jambeck, J.R. & Law K. L., 2017. Production, use, and fate of all plastics ever made. Science Advances, 3(7), e1700782.

54 OECD, 2018. Improving Markets for Recycled Plastics: Trends, Prospects and Policy Responses. Policy Perspectives: OECD Environment Policy Paper No.12.

Table 4: The plastic waste supply chain, a global picture. Source: OECD, Review of Secondary Plastic Market

STAGE	LOW INCOME	MIDDLE INCOME	HIGH INCOME
Collection	■ Informal sector plays a key role ■ Mechanisation of collection limited to wealthy urban areas ■ Recycling likely to be informal or SME-led. Few municipal-led plastics recycling schemes in this context	■ Some municipal-led recycling schemes, particularly in urban areas ■ Some mechanisation of collection, particularly in urban areas ■ Informal sector often plays a key role	■ Municipal-led plastics recycling schemes are common ■ Collection systems are highly mechanised
Primary recycling	■ Manual sorting is common ■ Mechanical sorting is usually limited to balers for compaction	■ Some mechanisation ■ Where informal sector is active, manual separation is likely	■ Highly mechanised and capital intensive to maximise recovery of valuable plastics
Recycling	■ Waste plastics typically exported, although there may be some simple recycling processes used for plastics (e.g. manufacturing paving slabs from waste plastic bags)	■ Waste plastics typically exported for recycling but there may be some local recycling industry in some contexts	■ Waste plastics exported but local capacity in some countries for high-value plastics

Materials collected post-consumer are usually sent for sorting before being treated at Material Recycling Facilities (MFRs). Specialist plastics sorting facilities (which typically receive part-sorted plastics, and of which there are fewer) are called Plastic Recycling Facilities (PRFs). After sorting, two technologies are used when plastic waste is recycled: mechanical recycling and chemical recycling.

Chemical recycling, which includes gasification and pyrolysis, is also an option for materials that are unattractive to mechanical recyclers. As gasification (to produce synthetic gas) requires little oxygen, it does not produce dioxins – but this process is economically inefficient compared to the price of natural gas.[55] Pyrolysis melts shredded plastics at lower temperatures, and with less oxygen, back into oil or diesel. Scalability of this technology has been limited, though, due to technical and financial constraints. The regulatory position on chemical recycling may also impact the long-term uptake of the technology. The current definition of recycling in Extended Producer Responsibility (EPR) regulations only includes mechanical plastic recycling technologies, and excludes chemical recycling. In countries with EPR schemes, businesses may then favour mechanical recycling options for their packaging. This factor could limit the expansion of chemical recycling.

It is important to note that while all plastics are technically recyclable, it is not practical to recycle all plastic. The five most common polymer types are generally accepted for recycling, but there are fewer facilities for the other types of polymers. Polymer types generally need to be recycled as separate streams. There are also challenges associated with the consumer stage of identifying and segregating the right plastic waste streams. Recycling is only suitable for non-biodegradable plastics (either fossil or bio-based). Biodegradable and compostable plastics need to be treated in appropriate composting facilities. Plastics sent to the wrong treatment facilities are classified as contaminates, as they disrupt the recycling processes and impact the quality of the product.

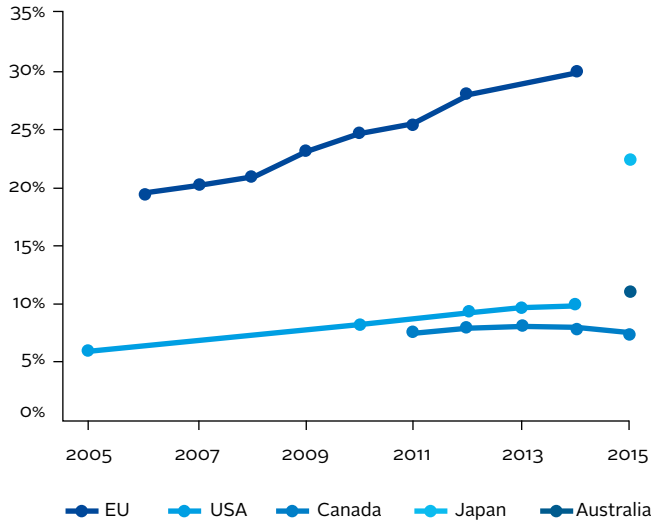
55 National Geographic Society, 2019. Is burning plastic waste a good idea? National Geographic, 11 March 2019.

Despite marked geographic differences, less than 20 percent of plastic waste is recycled globally. The limited data available on recycling rates at a regional level indicate that the highest recycling rates are seen across EU member states. It is difficult to compare official recycling rates due to differences in the types of waste included in the calculations (e.g. household only, household and commercial) and the varying definitions of recycling across countries. Countries that report official plastic recycling rates are more likely to be those that have legislation in place aimed at increasing targets, such as EPR legislation in EU Packaging Waste Regulations.

Less than 20 percent of plastic waste is recycled globally

The global recycling rate of 20 percent is an estimate due to the informal nature of collection and recycling systems, particularly in the urban regions of lower-income countries. According to the Wold Bank,[56] about 1 percent of the urban population (at least 15 million people) survive by salvaging recyclables from waste.

Figure 7: Plastic recycling in the EU, US, Canada, Australia and Japan (2005-15). Source: Anthesis (adapted from Plastics Europe, OECD member questionnaires and US EPA)



Recyclable plastic waste is traded on the global secondary commodities market, valued at US$35.4 billion in 2018 and predicted to exceed $50 billion by 2024.[57] The market consists of small and large companies, including Veolia and Suez. Countries and regions that operate plastic waste collection systems rely on domestic and export markets.

In 2016, 70 percent[58] of plastic waste was imported by countries in East Asia and the Pacific – primarily China. However, in 2018, China introduced its National Sword import criteria, which included high-quality standards on imported waste plastic sent for recycling. This has disrupted the global market and resulted in neighbouring countries (including Malaysia, Vietnam and Thailand) increasing their imports of plastic waste. These countries are now also banning imports of low-quality plastic waste (materials that are unrecyclable) by setting higher quality standards due to the recognition of the environmental costs relative to the income generated from importing waste.[59] There is now a smaller market for the materials that were once accepted by China, and major waste exporters (e.g. the US, Japan and European countries) will need to think of alternative strategies to manage their waste.

The plastic recyclers in Europe and North America will continue to compete for plastic waste feedstock with the import markets in South East Asia. As these markets tighten controls on the quality of plastic waste imported, this could boost the global quality of plastic waste sent for recycling. It also puts pressure on the companies that rely on these markets to improve the quality of plastic waste collected for recycling.

56 World Bank Group, 2019. What a waste 2.0: a global snapshot of solid waste management to 2050. Open knowledge repository.

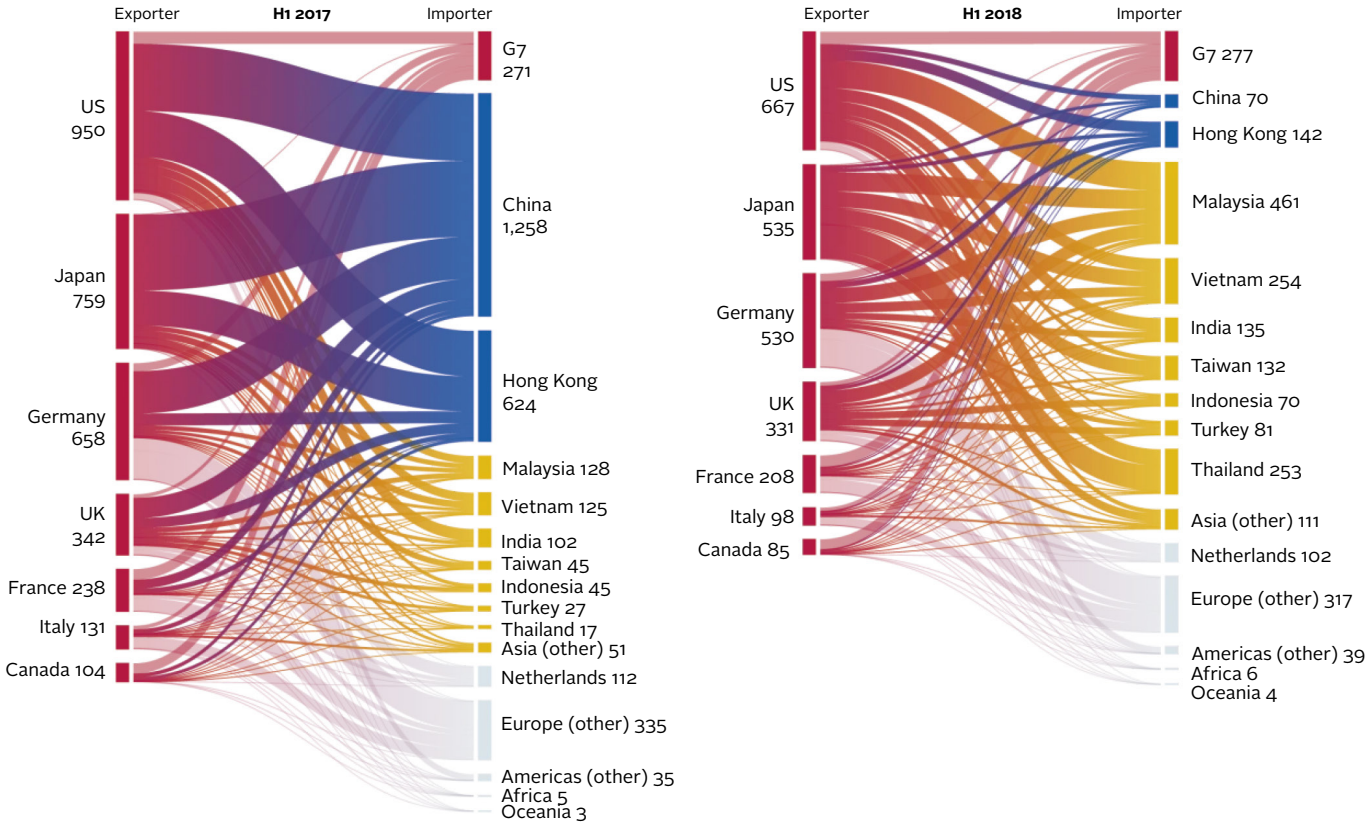
57 Research and Markets, 2018. Recycled plastics market: global industry trends, share, size, growth, opportunity and forecast 2019-2024.

58 Brooks, A.L., Wang, S. & Jambeck, J.R., 2018. The Chinese import ban and its impact on global plastic waste trade. Science Advances, 4(6), eaat0131.

59 Time, 2019. Southeast Asia doesn't want to be the world's dumping ground. Here's how some countries are pushing back. Time online, 3 June 2019.

Figure 8: Global flows of plastic waste and the impact of China's restrictions on plastic imports in 2018. Source: FT

Exports of plastic waste, parings and scrap from G7 countries ('000 tonnes)



China and Hong Kong received nearly 60 per cent of plastic waste exports from G7 countries in the first half of 2017.

Following the Chinese crackdown on imports of plastic waste, which came into effect at the beginning of 2018, exports from G7 fell by more than 20 per cent overall. The share of the remaining exports that went to China and Hong Kong fell below 10 per cent, with other Asian countries – particularly Malaysia – making up much of the shortfall.

Table 5: Plastic reprocessing capacity. Source: OECD, Review of Secondary Plastic Market

COUNTRY	NUMBER OF PLASTIC WASTE RECYCLERS	AMOUNT OF PLASTICS PROCESSED (TPA)	MEAN PROCESSED PER COMPANY (TPA)
China	25,000	24,500,000	980
Poland	324	1,315,841	4,061
Austria	35	330,000	9,429
USA (HDPE bottle processors only)	28	466,929	16,676
UK (includes dedicated sorters)	40	1,300,000	32,500

The heightened demand for high-quality plastic waste as a feedstock to produce recycled content plastic is expected to continue in the long term. However, without significant investment in collection and sorting infrastructure globally, this demand will be difficult to meet. The investment in, and implementation of, collection and treatment infrastructure in developing countries is also seen as one of the key solutions to prevent plastics polluting the marine environment.

New players are likely to emerge in the sector, including companies that would traditionally have been found in other parts of the value chain (e.g. petrochemical companies looking at chemical recycling and FMCG companies looking to secure plastic waste feedstock). Nestlé is partnering with Veolia to collect, sort and recycle plastic material in 11 priority countries in Asia, Africa, Latin America and Europe. The company will also explore technologies and identify recycling models in different countries.[60] While other sectors will penetrate the recycling stage, there are opportunities in certain regions to develop new recycling infrastructure for collection and/or plastic waste reprocessing. The development is not limited to emerging markets (e.g. Africa and South America); markets like the US could also access more material if current facilities are improved, and collection behaviours are addressed. Countries in Eastern Europe have also started to establish themselves as plastic recycling centres.

CASE STUDY: IKEA'S INVESTMENT IN PLASTICS RECYCLING

As part of its commitment to phase out oil-based plastics, Ikea has pledged to make 100 percent of the material in its plastic products from renewable and/or recycled sources.[61]

The homeware company has adopted a strategy to provide some control across its supply chain to help it achieve this commitment. In 2016, it pledged to invest €1 billion (£850 million) in recycling companies and forests.[62] The company has since invested in a plastics recycling plant, Morssinkhof Rymoplas, in the Netherlands[63] as well as Austrian recycling specialist Next Generation Recycling Group.[64]

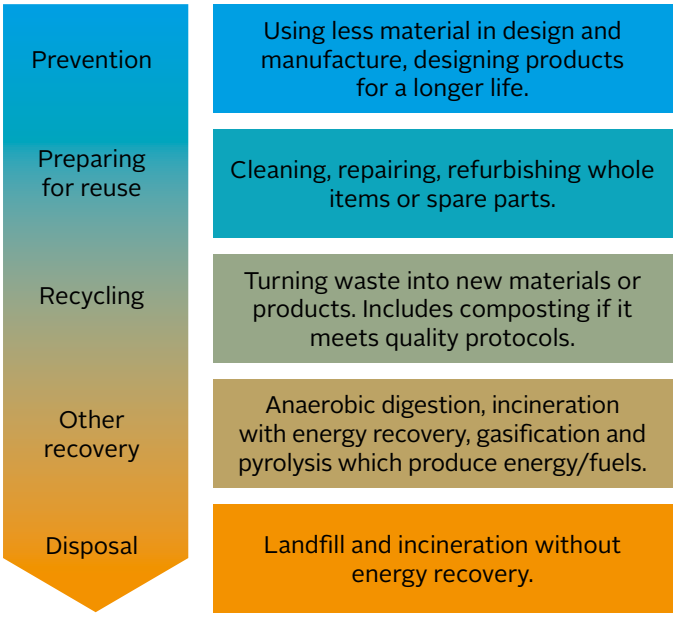
SECTOR: INCINERATION INFRASTRUCTURE (WASTE MANAGEMENT)

Clearly, incineration is an undesirable outcome for plastics at end of life. As society aims to transition to a circular economy, incineration creates an *outflow* from the circular model. However, if production and consumption of plastic continues to grow, incineration is likely to increase to handle the plastic waste generated. According to the Center for International Environmental Law, plastic packaging incineration accounted for 16 million metric tons of CO2e in 2015.[65] This statistic does not include the 32 percent of plastic packaging waste that is unmanaged, burned illegally or incinerated without any energy recovery.

The main challenges with incineration, with or without energy recovery, is that it produces greenhouse gas emissions and dioxins. In regions like Europe, emission standards require harmful substances to be treated (adding to costs).

The efficiency of waste-to-energy for electricity or heat depends on the size and type of plant. A 2015 study found that: *"In the case of only electricity production, the achievable values are strongly dependent on the plant size: for large plant size, where advanced technical solutions can be applied and sustained from an economic point of view, net electric efficiency may reach values up to 30–31%. In small-medium plants, net electric efficiency is constrained by scale effect and remains at values around 20–24%."*[66]

Figure 9: The waste hierarchy. Source: Anthesis



60 Nestle, 2019. Nestlé and Veolia join forces to tackle plastics leakage into the environment and develop recycling schemes. Nestle Press Releases, 18 March 2019.

61 IKEA, 2016. Sustainability Report FY 2016.

62 Guardian, 2016. Ikea Group plans €1bn investment in recycling companies and forests. Guardian online, 7 December 2016.

63 Guardian, 2017. Ikea's solution to peak stuff? Invest in plastics recycling plant. Guardian online, 15 May 2017.

64 Plastic News Europe, 2018. IKEA parent group invests in Austrian recycling specialist NGR. Plastic News Europe, 28 November 2018.

65 CIEL, 2019. Plastic & Climate: The hidden costs of a plastic planet.

66 Lombardi, L., Carnevale, E. & Corti, A., 2015. A review of technologies and performances of thermal treatment systems for energy recovery from waste. Waste Management, 37, pp. 26-44.

SECTOR: LANDFILL INFRASTRUCTURE (WASTE MANAGEMENT)

Landfill, along with incineration, is the least desirable destination for plastic as per the waste hierarchy. Landfills or open dumping are used when there is a lack of material recovery infrastructure in place. Plastics may stay in landfill for thousands of years without decomposing. However, biodegradable plastic can generate methane in landfill conditions, further contributing to climate change.

While the climate impacts from sending plastic to landfill are lower than incineration, toxins and chemicals may be leached into the soil and waterways, including groundwater.[67] There is also the issue of running out of space for landfills, causing waste management companies to turn to alternative means such as waste-to-energy recovery.[68]

67 CIEL, 2019. Plastic & Climate: The hidden costs of a plastic planet.

68 Financial Time, 2018. Suez group backs UK energy-from-waste power as landfill space shrinks. Financial Times online, 17 September 2018.

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