UN environment programme

# Turning off the Tap

## How the world can end plastic pollution and create a circular economy

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# Acronyms

**BAU** - Business-as-usual

**BPA** - Bisphenol A

**Capex** - Capital expenditure

**CEN** - European Committee of Standardisation

**DEHP** - Di(2-ethylhexyl) phthalate

**EIA** - Environmental Investigation Agency

**EMF** - Ellen MacArthur Foundation

**EOL** - End-of-Life

**EPR** - Extended Producer Responsibility

**EPS** - Expanded polystyrene

**ESM** - Environmentally sound management

**EU** - European Union

**G20** - The Group of Twenty (the premier forum for international economic cooperation)

**GDP** - Gross domestic product

**GESAMP** - Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection

**GHG** - Greenhouse gas

**GIZ** - German Agency for International Cooperation

**HDPE** - High-density polyethylene

**HI** - High-income economies

**ICAO** - International Civil Aviation Organization

**IFC** - International Finance Corporation

**ILO** - International Labour Organization

**IMO** - International Maritime Organization

**INC** - Intergovernmental Negotiation Committee

**IRP** - International Resource Panel

**ISO** - International Organization for Standardization

**ISWA** - International Solid Waste Association

**IUCN** - International Union for Conservation of Nature

**LCA** - Life Cycle Assessment

**LDPE** - Low-density polyethylene

**LI** - Low-income economies

**LiFE** - Lifestyles for Environment

**LLDPE** - Linear low-density polyethylene

**MMt** – Million metric tons

**NIVA** - Norwegian Institute for Water Research

**NPV** - Net Present Value

**OECD** - Organisation for Economic Co-operation and Development

**Opex** - Operational expenditure

**P2F** - Plastic-to-fuel

**P2P** - Plastic-to-plastic

**PBDE** - Polybrominated diphenyl ethers

**PCDD/F** - poly-chlorinated dibenzo-p-dioxins and dibenzofurans (dioxins and furans)

**PCR** - Post-consumer recycled content

**PE** - Polyethylene

**PET** - Polyethylene terephthalate

**PFASs** - Polyfluoroalkyl substances

**POPs** - Persistent organic pollutants

**PP** - Polypropylene

**PPA** - Power purchase agreements

**PS** - Polystyrene

**PVC** - Polyvinyl chloride

**R&D** - Research and Development

**RDF** - Refuse-derived fuel

**RPET** - Recycled PET

**SAPEA** - Science Advice for Policy by European Academies

**SC scenario** - Systems change scenario

**SDG** - Sustainable Development Goals

**UMI** - Upper middle-income economies

**UNEP** - United Nations Environment Programme

**UNIDO** - United Nations Industrial Development Organization

**WEEE** - Waste from Electrical and Electronic Equipment

**WEF** - World Economic Forum

**WWF** - World Wide Fund for Nature

# Glossary

**Additives** - plastic is usually made from polymer mixed with a complex blend of chemicals known as additives. These additives, which include flame retardants, plasticizers, pigments, fillers and stabilisers are used to improve the different properties of the plastic or to reduce its cost (The Pew Charitable Trusts and Systemiq 2020).

**Business-as-usual (BAU)** - see definition under 'Scenarios'.

**Bio-based plastic** - plastic derived fully or partially from plant materials, such as cellulose, potato or corn starch, sugar cane, maize and soy, instead of petroleum or natural gas. Bio-based plastic can be engineered to be biodegradable or compostable, but they can be designed to be structurally identical to petroleum-based plastics, in which case they can last in the environment for the same period of time (UNEP Law and Environment Assistance Platform n.d.)

**Bio-benign (materials)** - a material harmless to natural systems in case it unintentionally escapes collection and recovery systems.

**Biodegradable (materials)** - a material that can, with the help of microorganisms, break down into natural components (e.g. water, carbon dioxide or biomass) under certain conditions (The Pew Charitable Trusts and Systemiq 2020).

**Capex (capital expenditures)** - funds used by an organisation to acquire or upgrade assets such as property, buildings, technology, or equipment.

**Chemical conversion** - process that breaks down polymers into individual monomers or other hydrocarbon products that can then serve as building blocks or feedstock to produce polymers again (The Pew Charitable Trusts and Systemiq 2020).

**Circular economy** - one of the current sustainable economic models, in which products and materials are designed in such a way that they can be reused, remanufactured, recycled or recovered and thus maintained in the economy for as long as possible, along with the resources of which they are made, and the generation of waste, especially hazardous waste, is avoided or minimized, and greenhouse gas emissions are prevented or reduced, can contribute significantly to sustainable consumption and production (UNEP/EA.4/Res.1).

**Circular infrastructure** - for the purposes of this report, circular infrastructure is understood as that which contributes to circularity, e.g. collection and reverse logistics schemes, washing systems for reuse schemes, recycling infrastructure, etc. Infrastructure for end disposal (e.g. landfills and incineration with or without energy recovery) are excluded from this working definition.

**Circular plastic products** - are designed to be reused safely many times, and their material recycled or composted at the end of use, in practice and at scale, minimizing their adverse environmental impacts and respecting the rights, health and safety of all people involved across their life cycle (UNEP/PP/INC.1/7), including product users (adapted from UNEP/PP/INC.1/7 to include health considerations).

**Closed-loop recycling** - is the recycling of plastic into any new application that will eventually be found in municipal solid waste, essentially replacing virgin feedstock (i.e. plastic bottle, pen etc.) (See 'Recycling') (The Pew Charitable Trusts and Systemiq 2020).

**Compostable (materials)** - materials, including compostable plastic and non-plastic materials, that are approved to meet local compostability standards (for example, industrial composting standard EN 13432, where industrial-equivalent composting is available) (The Pew Charitable Trusts and Systemiq 2020).

**Design for recycling** - the process by which companies design their products and packaging to be recyclable. (See 'Recycling').

**Downcycling** – recycling processes where the recovered material is of lower quality or functionality than the original material, due to e.g. structural strength, composition/impurities, colour or other properties.

**Downstream activities** – involve end-of-life management – including segregation, collection, sorting, recycling and disposal. Recycling is a process that starts downstream and 'closes the loop' by connecting with upstream (i.e. starting a new life cycle for new plastic products with old materials). Similarly, repair/refurbish processes provide another way to close the loop by bringing products back into the midstream (UNEP/PP/INC.1/7).

**Dumpsites** - places where collected waste has been deposited in a central location and where the waste is not controlled through daily, intermediate or final cover, thus leaving the top layer free to escape into the natural environment through wind and surface water (The Pew Charitable Trusts and Systemiq 2020).

**Durable plastics** - plastic materials often selected for applications requiring resistance. Refers to the plastics with average use cycles above three years. These plastics are frequently used for industrial and construction applications (Geyer, Jambeck and Law 2017).

**End-of-Life (EOL)** – a generalised term to describe the part of the life cycle following the use phase.

**Essential (plastic products) use** – uses that are considered necessary for health, safety or other important purposes for which alternatives are not yet established (Garnett and Van Calster 2021).

**Extended Producer Responsibility (EPR)** – is an environmental policy approach in which a producer's responsibility for a product is extended to the waste stage of that product's life cycle. In practice, EPR involves producers taking responsibility for the management of products after they become waste, including: collection; pre-treatment, e.g. sorting, dismantling or depollution; (preparation for) reuse; recovery (including recycling and energy recovery) or final disposal. EPR systems can allow producers to exercise their responsibility by providing the financial resources required and/or by taking over the operational aspects of the process from municipalities. They assume the responsibility voluntarily or mandatorily; EPR systems can be implemented individually or collectively (UNEP/PP/INC.1/6).

**Feedstock** – any bulk raw material that is the principal input for an industrial production process.

**Flexible monomaterial plastics** - see definition under 'Plastic categories'.

**Geographic archetype** - parts of the world with similar characteristics when it comes to plastic waste. The archetypes are divided into groups depending on country income, according to World Bank definitions: high-income economies; upper and lower middle-income economies; and low-income economies. The rural and urban settings for each of the four income groups are also analysed separately to create eight geographic archetypes (The Pew Charitable Trusts and Systemiq 2020).

**Incineration** - destruction and transformation of material to energy by combustion.

**Informal waste sector** – where workers and economic units are involved in solid waste collection, recovery and recycling activities which are – in law or in practice – not covered or insufficiently covered by formal arrangements.

**Leakage** – materials that do not follow an intended pathway and 'escape' or are otherwise lost to the system. Litter is an example of system leakage (The Pew Charitable Trusts and Systemiq 2020).

**Legacy (plastic)** - plastics that cannot be reused or recycled, including plastics that are already in the environment as existing pollution, or are stocked or will enter in the economy e.g. in short-lived or durable products designed without considering their circularity or long-term use in the economy.

**Managed landfill** - a place where collected waste has been deposited in a central location and where the waste is controlled through daily, intermediate and final cover, thus preventing the top layer from escaping into the natural environment through wind and surface water (The Pew Charitable Trusts and Systemiq 2020).

**Maritime sources** - all plastics that enter the environment from seagoing vessels (including from fishing activities) (The Pew Charitable Trusts and Systemiq 2020).

**Mechanical recycling** - processing of plastics waste into secondary raw material or products without significantly changing the chemical structure of the material (ISO:472:2013).

**Microfibres** - microsize fragments (<5mm) released via textiles shedding to air, water or wastewater during production or use.

**Microplastics** – refers to plastic particles less than five millimetres diameter, including nano-sized particles (UNEP/EA.2/Res.11).

**Midstream activities** – involve the design, manufacture, packaging, distribution, use (and reuse) and maintenance of plastic products and services. Keeping plastic products at midstream as long as possible is ideal for circularity, because this is where plastic products have their highest value (UNEP/PP/INC.1/7).

**Mismanaged waste** - collected waste that has been released or deposited in a place from where it can move into the natural environment (intentionally or otherwise). This includes dumpsites and unmanaged landfills. Uncollected waste is categorised as unmanaged (The Pew Charitable Trusts and Systemiq 2020).

**Monomaterials** - see definition under 'Plastic categories'.

**Multimaterials** - see definition under 'Plastic categories'.

**Multilayer plastics** - see definition under 'Plastic categories'.

**Municipal Solid Waste (MSW)** - includes all residential and commercial waste but excludes industrial waste.

**New delivery models** - services and businesses providing utility previously furnished by single-use plastics in new ways, with reduced material demand (The Pew Charitable Trusts and Systemiq 2020).

**Nurdles** - see 'Pellets'.

**Open burning** - waste that is combusted without emissions cleaning.

**Open-loop recycling** - process by which polymers are kept intact, but the degraded quality and/or material properties of the recycled material is used in applications that might otherwise not be using plastic (i.e. benches and asphalt) (The Pew Charitable Trusts and Systemiq 2020).

**Opex (operating expenses)** - operating expenses incurred during the course of regular business, such as general and administrative costs, sales and marketing, or research and development.

**Oxo-degradable** - products containing a pro-oxidant that induces breakdown of the plastic product into smaller pieces under favourable conditions (e.g. heat, UV-light and mechanical stress).

**Pathway** - a course of action that combines system interventions across geographic archetypes to achieve a desired system outcome (The Pew Charitable Trusts and Systemiq 2020).

**Pellets** - microsize (≤ 5mm) granules usually with a shape of cylinder or a disk, produced as a raw material (also from plastic recycling) and used in the manufacture of plastic products (The Pew Charitable Trusts and Systemiq 2020).

**Plastic categories** - modelled as flowing separately through the system: rigid monomaterial plastics, flexible mono material plastics, multilayer plastics and multi materials (The Pew Charitable Trusts and Systemiq 2020).

- **Rigid monomaterial plastics** - An item made from a single plastic polymer that holds its shape, such as a bottle or tub
- **Flexible monomaterial plastics** - An item made from a single plastic polymer that is thin, such as plastic wraps and bags
- **Multilayer plastics** - An item, usually packaging, made of multiple plastic polymers that cannot be easily and mechanically separated
- **Multi materials** - An item, usually packaging, made of plastic and non-plastic materials (such as thin metal foils or cardboard layers) that cannot be easily and mechanically separated.

**Plastic pollution** - defined broadly as the negative effects and emissions resulting from the production and consumption of plastic materials and products across their entire life cycle. This definition includes plastic waste that is mismanaged (e.g. open-burned and dumped in uncontrolled dumpsites) and leakage and accumulation of plastic objects and particles that can adversely affect humans and the living and non-living environment (UNEP/PP/INC.1/7).

**Plastic-to-Fuel (P2F)** - process by which the output material of chemical conversion plants is refined into alternative fuels such as diesel (The Pew Charitable Trusts and Systemiq 2020).

**Plastic-to-Plastic (P2P)** - several chemical conversion technologies are being developed that can produce petrochemical feedstock that can be reintroduced into the petrochemical process to produce virgin-like plastic (The Pew Charitable Trusts and Systemiq 2020).

**Plastic utility** - the valuable services (including protection, food preservation etc.) that are provided by plastic under a Business-as-usual scenario. In alternative scenarios, services of equivalent value could be provided in other ways with less plastic (The Pew Charitable Trusts and Systemiq 2020).

**Polymers:**

- PET - Polyethylene terephthalate
- HDPE - High-density polyethylene
- LDPE - Low-density polyethylene
- LLDPE - Linear low-density polyethylene
- PP - Polypropylene
- PVC - Polyvinyl chloride
- EPS - Expanded polystyrene
- PS - Polystyrene
- PA6 - Polyamide 6 (Nylon)

**Recyclable** - for something to be deemed recyclable, the system must be in place for it to be collected, sorted, reprocessed, and manufactured back into a new product or packaging—at scale and economically. Recyclable is used here as a short-hand for 'mechanically recyclable'. See 'mechanical recycling' definition (The Pew Charitable Trusts and Systemiq 2020).

**Recycling** - means processing of waste materials for the original purpose or for other purposes, excluding energy recovery (ISO:472:2013).

**Resin** - a natural or synthetic solid or viscous organic polymer used as the basis of plastic, adhesives, varnishes or other products.

**Reusable** - products and packaging, including plastic bags, that are conceived and designed to accomplish within their life cycle a minimum number of uses for the same purpose for which they were conceived (adapted from the LEAP UNEP Plastic Glossary). In terms of 'minimum number of uses', the PR3 Standards suggest that reusable (containers) should be designed to withstand at least 10 reuse cycles.

**Reuse** - means use of a product more than once in its original form (ISO:472:2013).

**Reverse logistics** - activities engaged to recapture the value of products, parts, and materials once they have reached end-of-use or end-of-life. All Value Retention Processes (such as reuse) may be considered to be part of a reverse-logistics system, and in addition activities including collection, transportation, and secondary markets provide essential mechanisms for facilitating reverse-logistics (IRP 2018)

**Rigid plastics** - see definition under 'Plastic categories'.

**Rural vs. Urban** - see definition under 'Urban vs. Rural'.

**Safe disposal** - ensuring that any waste that reaches its end-of-life is disposed in a way that does not cause leakage of plastic waste or chemicals into the environment, does not pose hazardous risks to human health and, in the case of landfills, is contained securely for the long-term (The Pew Charitable Trusts and Systemiq 2020).

**Secondary microplastics** - small particle pieces that have resulted from the fragmentation and weathering of larger plastic items (UNEP Plastic Glossary: https://leap.unep.org/knowledge/toolkits/plastic/glossary).

**Scenarios** - for the purpose of this report, we define the scenarios as:

- **Business-as-usual (BAU) scenario:** Defined as 'no intervention' scenario; in other words, assumes that the current policy framework, market dynamics, cultural norms, and consumer behaviours do not change.

- **Systems change scenario:** Assumes all system outcomes are actioned concurrently, ambitiously and immediately.

**Short-lived plastic product** - plastics within packaging and consumer products. These are the two categories of plastic products with shortest average use cycles – 0.5 and 3 years respectively (Geyer, Jambeck and Law 2017). Note that the categorisation is based on average life span, therefore some products in this category will in practice have longer life spans than three years.

**Single-use plastic products** - often referred to as disposable plastics, are commonly used plastic items intended to be used only once before they are thrown away or recycled, e.g. grocery bags, food packaging, bottles, straws, containers, cups, cutlery etc. (UNEP Plastic Glossary: https://leap.unep.org/knowledge/toolkits/plastic/glossary).

**Systems change** - captures the idea of addressing the causes, rather than the symptoms of a societal issue by taking a holistic (or 'systemic') view. Systemic change is generally understood to require adjustments or transformations in policies, practices, power dynamics, social norms or mindsets. It often involves a diverse set of players and can take place on a local, national or global level (Ashoka Deutschland gGmbH and McKinsey & Company Inc. 2021); systems change requires modifications in many of the system structures, such as the mindset or the paradigm that creates the system or the system's goals or rules (Meadows 1999).

**Systems change scenario** - see definition under 'Scenarios'.

**Tyre dust** - consists of micro size particles with a spectrum from airborne (>10μm) to coarse fraction (>1mm) released through mechanical abrasion of tyres, with chemical composition depending on rubber type (The Pew Charitable Trusts and Systemiq 2020).

**Upstream activities** - include obtaining the raw materials from crude oil, natural gas or recycled and renewable feedstock (e.g. biomass) and polymerization. Plastic leakage into the environment (e.g. pellets and flakes) already happens at this stage (UNEP/PP/INC.1/7).

**Urban vs. Rural** - the classification of urban versus rural is in alignment with the United Nations Statistics Division, which allows countries to use their own approaches for distinguishing urban and rural areas according to their individual circumstances (The Pew Charitable Trusts and Systemiq 2020).

# Table of Contents

# List of tables



# List of figures

# Turning off the Tap

## Foreword

### Plastics, in many ways, contribute positively to society. There is, however, a dark side: the way we produce, use and dispose of plastics is polluting ecosystems, creating risks for human and animal health and destabilizing the climate.

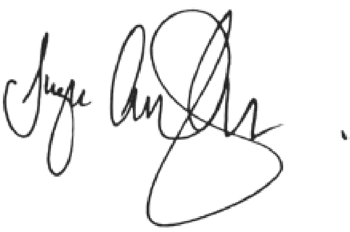
For these reasons, the international community is negotiating a deal to end plastic pollution, which is due by 2024. This report, *Turning off the Tap: How the world can end plastic pollution and create a circular economy*, is designed to inform negotiations and help end this pervasive and growing threat.

The report shows that only an integrated, systemic shift from a linear to a circular economy can keep plastics out of our ecosystems and bodies, and in the economy. The report lays out key elements of the required market transformation – rethinking and redesigning products; reusing, recycling, reorienting and diversifying markets; and addressing demand for durable plastics. The reports also looks at how to manage the legacy of plastic pollution already in the environment, and it defines the policy and legislative changes that can drive the transformation.

Crucially, the report demonstrates that the transformation would provide economic and social wins. Governments and the private sector would save money and hundreds of thousands of new jobs would be created, contributing to poverty alleviation and a just transition for workers.

Everybody has a role to play. Governments can create the regulatory environment to incentivize the shift to a circular economy – and the political will to do so is there, backed by broad social support. The petrochemical industry, municipalities, informal waste pickers, plastic converters and key users – such as packaging, textile, transport, fisheries and agricultural – can accelerate reuse and recycling and ensure the sustainability of alternatives introduced in the market. The finance industry can play a central role by aligning capital flows with a circular plastics economy.

UNEP, as host of the Intergovernmental Negotiating Committee and a long-term actor on plastics, is fully committed to working with all relevant parties to end plastic pollution. This report provides clear guidance as we undertake this necessary journey to a healthier and more prosperous destination. We must all follow this guidance to start turning off the tap on plastic pollution.



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# Executive Summary

In a historic decision at the fifth United Nations Environment Assembly in March 2022, all 193 UN Member States decided to end plastic pollution. With negotiations on a binding legal agreement by 2024 now underway, the question is how to realise that goal.

While many technical solutions for a circular plastics economy are known, the economic, fiscal and business models to address the associated impacts while also safeguarding livelihoods are less clear.

This report examines these issues and proposes a systems change scenario - addressing the causes of plastic pollution, rather than just the symptoms. Such a systems change will enable countries to turn off the tap and end plastic pollution while at the same time transitioning towards safer and more stable jobs for those currently working in the informal sector, and create business and job opportunities.

The report analyses the opportunities and impacts of a systems change scenario. The scenario combines reducing the most problematic and unnecessary plastic uses with a market transformation towards circularity in plastics by accelerating three key shifts - Reuse, Recycle, and Reorient and Diversify – and actions to deal with the plastic pollution legacy (Figure ES 1).

# Ending Plastic Pollution

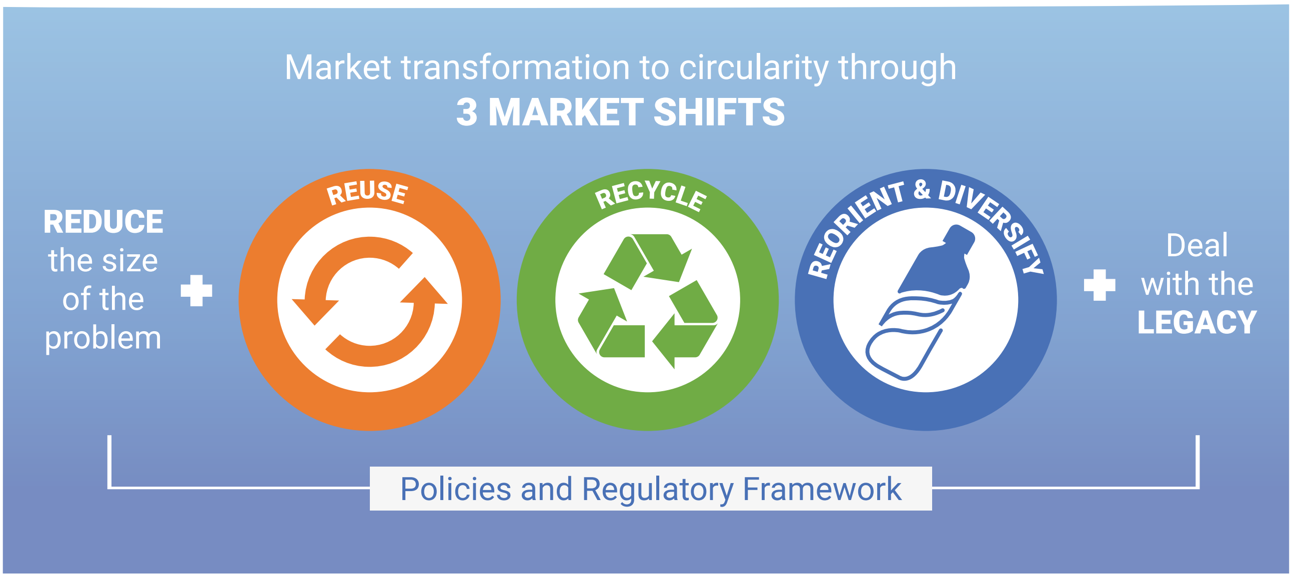


Figure ES 1: **The systems change towards a new circular plastics economy.**

## Shift 1: Reuse

Accelerating the market for reusable products, to transform the throwaway economy to a reuse society, by creating the enabling environment to ensure the reuse market has a stronger business case than the single-use plastics market. Studies show that reuse systems provide the highest opportunity to reduce plastic pollution (a reduction of 30 per cent by 2040) by replacing some of the most problematic and unnecessary products (The Pew Charitable Trusts and Systemiq 2020).

## Shift 2: Recycle

Accelerating the market for plastics recycling by ensuring recycling becomes a more stable and profitable venture could reduce the amount of plastic pollution by an additional 20 per cent by 2040 (The Pew Charitable Trusts and Systemiq 2020). This will require an adequate availability of feedstock that can be recycled and that recycled materials can compete on a level playing field with virgin materials.

## Shift 3: Reorient and Diversify

Shaping the market for plastic alternatives to enable sustainable substitutions, thus avoiding replacing plastic products with alternatives that displace rather than reduce impacts. Sustainable alternatives could reduce pollution by 17 per cent by 2040 (The Pew Charitable Trusts and Systemiq 2020), but struggle to compete in markets with products made of virgin fossil fuel-based polymers owing to a number of challenges: cost of product, consumer demand and lack of appropriate regulations.

Even with the market transformation approach, a significant volume of plastics cannot be made circular in the next 10 to 20 years and will require disposal solutions to prevent pollution. This refers to collecting and responsibly disposing of plastics that cannot be reused or recycled, including plastics that are already in the environment as existing pollution, or are stocked or will enter in the economy e.g. in short-lived or durable products designed without considering their circularity or long-term use in the economy. It also refers to new ways of financing collection and disposal of legacy plastics and preventing microplastics from entering the economy and the environment.

Global plastic production and use has grown exponentially since the 1950s, with around nine million people employed globally in polymer production and plastic processing industries (United Nations Industrial Development Organization (UNIDO) Data Portal - ISIC codes 2013 and 2220). Light, strong and seemingly inexpensive plastics have permeated our lives, our societies and our economies – but at a pace that has escalated into significant costs to the environment, human health and the economy. Currently, the world produces 430 million metric tons of plastics each year (Organisation for Economic Co-operation and Development [OECD] 2022), of which over two-thirds are short-lived products which soon become waste, and a growing amount (139 million metric tons in 2021 [Minderoo 2021]) after one single use. Plastic production is set to triple by 2060 if 'business-as-usual' continues (OECD 2022).

A growing number of researchers are quantifying the social, economic and environmental costs of plastic pollution. Scientific literature is linking chemicals in plastic and damage to human health at every stage of the plastic life cycle including workers and 'fence-line' communities that live next door to plastic production and waste disposal sites (Landrigan *et al.* 2023; Merkl and Charles 2022; UNEP 2021c). As well as the potential for ecosystem impacts, microplastics have been found in the deepest recesses of the ocean, in pristine mountain glaciers, in breast milk and human bodies (Braun *et al.* 2021; Ragusa *et al.* 2021; Jenner *et al.* 2022; Horvatits *et al.* 2022). Research also shows that under a business-as-usual scenario, plastic could emit 19 per cent of global greenhouse gas GHG emissions allowed under a 1.5°C scenario by 2040, essentially making the goal out of reach (The Pew Charitable Trusts and Systemiq 2020). Significantly, the costs and impacts are borne by all but fall disproportionally on people in some of the world's poorest nations.

This report indicates a heavy toll arising from the current linear plastics economy with preliminary estimates of the annual social and environmental costs linked to plastic pollution ranging between USD 300-600 billion per year, with some estimates above USD 1.5 trillion per year (Landrigan *et al.* 2023). Data shows potential litigation stemming from plastic pollution is estimated to exceed USD 20 billion in corporate liabilities in one country alone in the period 2022 to 2030 (Merkl and Charles 2022). These lawsuits express the tension between different parts of society based on the profits received by the plastic industry and the costs borne by society at large but particularly by the most vulnerable, particularly within the framework of a universally recognized human right to a clean, healthy and sustainable environment (UN General Assembly Resolution 76/300 of 28 July 2022).

An economically viable solution for all stakeholders does exist to achieve an end to plastic pollution. The transition to a new plastics economy is the most cost-effective way to ensure plastic pollution is substantially reduced by 2040, with solutions at hand that require vigilance, determination and creativity.

While significant, the investment costs of the systems change are less than the current investment trajectory, around USD 65 billion per year through 2040 as opposed to USD 113 billion per year. But time is of the essence: A 5-year delay could lead to an increase of 80 million metric tons of plastic pollution (The Pew Charitable Trusts and Systemiq 2020).

A transformed plastics economy will introduce new economic benefits by bringing new business opportunities particularly for those who adapt faster. By 2040, it is estimated a new plastics economy could:

- Create opportunities for jobs, income and innovation: 700,000 additional jobs; improved livelihoods for millions of workers in informal settings; close to USD 1.3 trillion (10.3 per cent) savings in direct public and private costs between 2021 and 2040.
- Reduce damage to human health and the environment by reducing exposure through an 80 per cent reduction of plastic pollution; 0.5 Gt CO2-eq GHG emissions prevented annually; avoiding USD 3.3 trillion of environmental and social costs between 2021 and 2040 (32.5 per cent cost savings).
- Reduce liabilities, risks and litigation associated with damage from plastics pollution.
- When the direct, environmental and social cost savings are added up, more than USD 4.5 trillion are saved, or 20.3 per cent reduction in costs overall.

The systems change cannot be done in isolation due to the cross-border flows of plastics, liabilities and risks: it requires harmonised international action. Aligned and coordinated measures and obligations between nations and across value chains will build synergies and create a major shift in the plastics policy landscape. A harmonised knowledge base, driven by strong national reporting requirements, from which to take informed action, measure progress and refine regulatory interventions, depends on a globally coherent approach to monitoring and reporting. However, it is recognised that countries will start from different places to implement market transformations and the specific policy mix appropriate to a particular country will need to consider the trade-offs built into policy choices and options.

# What will this future look like?

The analysis in this report examines the potential impacts of the systems change noted above. Figure ES 2, shows the plastic flows in the economy in 2040 in a business-as-usual linear economy (top) versus that projected in the systems change scenario (bottom). Under the systems change scenario, the inflow of new (virgin) material into the economy of short-lived plastics is more than halved while the utility is unchanged, by increasing the flows of materials that are reused or recycled into the economy to 27 per cent of the total. As a result, the outflow of mismanaged plastic waste ending in the environment decreases by over 80 per cent.

Turning off the tap of plastic pollution is within reach. This compass points to an integrated package of policy measures, clear pathways and new business models that are available to enable countries individually and collectively, to achieve that ambition.

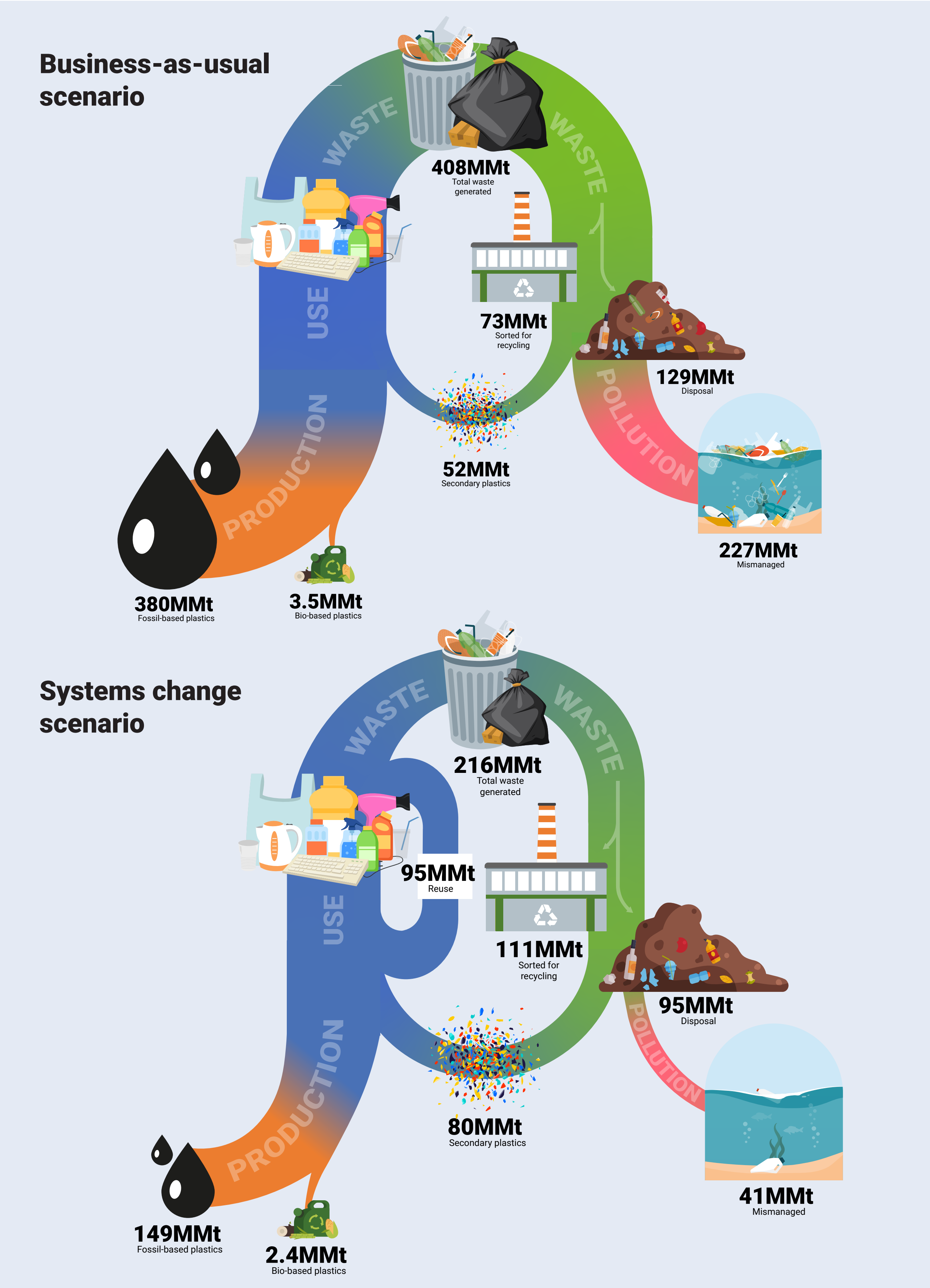


Figure ES 2: **Possible plastic futures.** Top: modelled plastic flows of short-lived plastics in 2040 under a business-as-usual scenario; Bottom: modelled plastic flows of short-lived plastics in 2040 under a systems change scenario.

*Source: UNEP modelling building on The Pew Charitable Trusts and Systemiq (2020) and OECD (2022).*

# The need for a compass to end plastic pollution

Photo: Getty Images

# 1.1 Purpose of this report

This report is designed to inform decision-makers and stakeholders across the whole value chain of plastics about the necessary actions - including market shifts and the associated policies - that could be taken to achieve their stated ambition to turn off the tap and end plastic pollution. Grounded in science and economic analysis, the report aims to strengthen an understanding of the magnitude and nature of the change required in the plastics economy to achieve this goal. Ultimately this report provides stakeholders a compass to implement change.

Building on previous analyses (Ellen MacArthur Foundation [EMF] *et al.* 2016; The Pew Charitable Trusts and Systemiq 2020; United Nations Environment Programme [UNEP] 2021c; International Resource Panel [IRP] 2021; Organization for Economic Cooperation and Development [OECD] 2022; World Bank Group [WBG] 2022a; UNEP 2022a; Economist Impact 2023), as well as consultations with leading international experts, the problems with the current plastics economy are identified (Box 1) and what is needed to transition to a circular plastics economy globally is outlined (Box 2). An analysis is provided of this systemic change and how it can be implemented: the regulatory and fiscal policy changes, the incentives to drive new more comprehensive business models and the practical approaches to manage the job transition, among others.

Crucially, the economic analysis used in this report shows that delivering the systems change scenario – addressing the causes of plastic pollution, rather than just the symptoms - could save 10.3 per cent of the direct costs of the plastics life cycle, a value that increases to 20.3 per cent when including indirect costs as well as addressing the benefit to the environment and health.

The report is complemented by topic sheets on a range of issues including design guidelines, chemical recycling, extended producer responsibility, material and products substitutes, reuse, ensuring an inclusive transition to a circular economy and implementation in local settings.

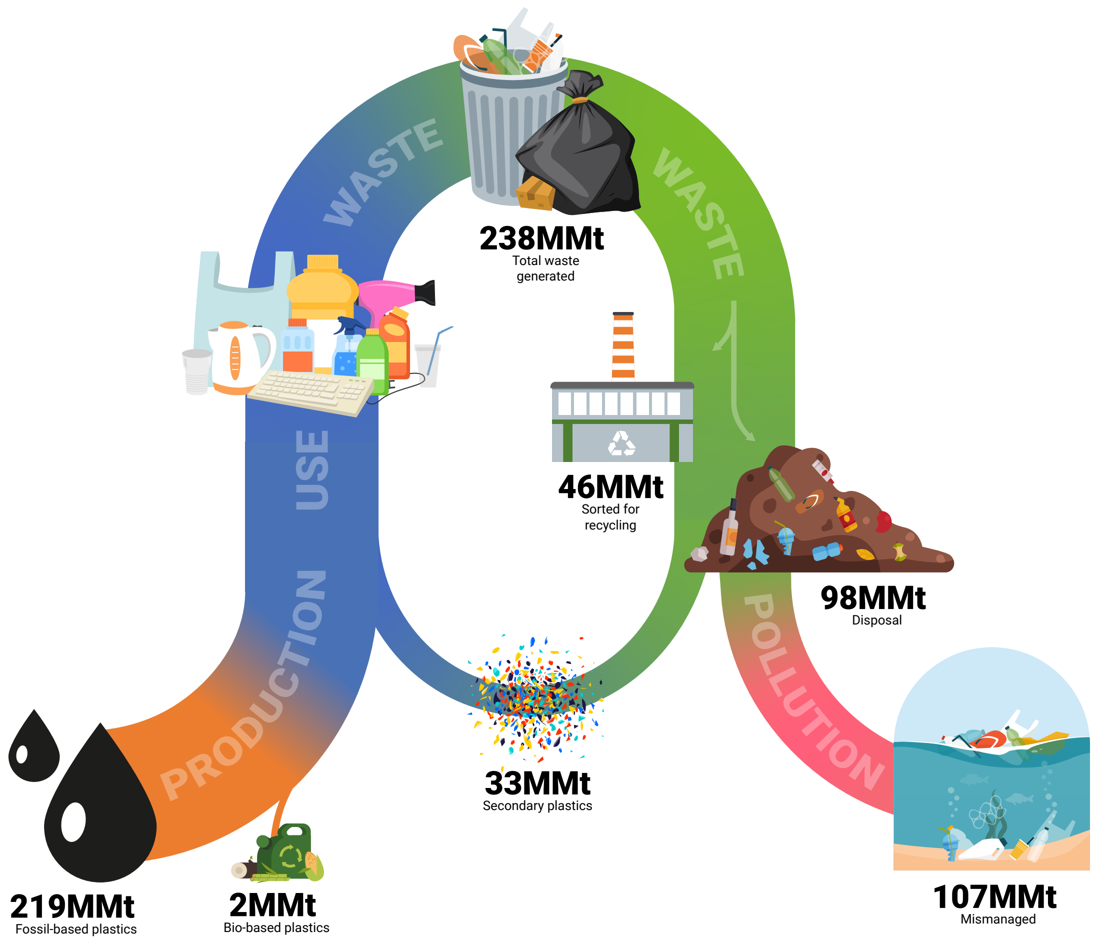


Figure 1: **Short-lived plastic flows in 2020.**

*Source: UNEP modelling building on The Pew Charitable Trusts and Systemiq (2020) and OECD (2022).*

## Box 1: **Characteristics of the current global plastics economy**

The current use of plastic is a linear economy because material is extracted, produced and used only once before being disposed or ending in the environment; a very small circular flow of plastic is cycled back into new uses (Figure 1). Problems with the current plastics economy include:

- **structural flaws:** For example, 95 per cent[1] of the aggregate value of plastic packaging is lost to the economy after a single use cycle. In addition, many plastic products are placed in markets that lack the capacity to collect and safely dispose of them. A systemic approach can lead to a fundamental transformation of the global plastics economy.
- **weak waste management systems:** Capacities for the control of transboundary movements, environmentally sound management of plastic waste, including the necessary infrastructure, are often lacking and have not kept pace with the sharp rise in plastic consumption, particularly in low- and middle-income countries (UNEP and International Solid Waste Association [ISWA] 2015). Collection of waste is chronically underfunded and, despite often being the single highest item in the budgets of municipalities, formal collection coverage remains patchy (UNEP and ISWA 2015). A significant share of plastic waste collection is carried out by the informal recycling sector, involving exposure to undignified labour conditions and significant health risks (UN-Habitat and Norwegian Institute for Water Research [NIVA] 2022). Scaling this as plastic consumption grows is difficult as the informal sector typically only collects high-value plastics. Even when collection is effective (e.g. in many high-income countries) the rate of plastic waste being recycled back into the economy is very low (approximately 15 per cent for plastics in short-lived products or 10 per cent for all plastics [UNEP 2021c]). Gender-related aspects of waste management within value chains also needs to be addressed because when jobs become formalised they are often taken up by men thus leaving local women without a source of income (UNEP 2015a; International Environmental Technology Centre [IETC] 2015).
- **a lack of incentives to encourage the adoption of new solutions:** Today's markets are structured around the ubiquitous use of plastic products, particularly in packaging. New business models that meet overall needs with less environmental impacts have proven effective (UNEP 2021a) but have not reached the scale of impact needed. There are currently few policy incentives for new business models or to promote the adoption of safe and sustainable alternative materials, or new delivery models such as reusable or refillable packaging (Potočnik and Teixeira 2022).
- **design and packaging choices that do not account for local infrastructure:** Many plastic products are designed for a global market, with marketing and sales as primary drivers of product design. Globalised supply chains of consumer goods fail to account for the realities of the local waste management infrastructure available to deal with them, which can vary greatly from one municipality to another. Fast innovation cycles in product design outpace slower innovation downstream (waste infrastructure), which exacerbates the problem further (The Pew Charitable Trusts and Systemiq 2020).
- **insufficient data and reporting:** Consistent definitions and standards for plastic data and metrics are lacking, and there is insufficient transparency regarding the plastic being placed on the global market, including its composition (polymers, chemicals and additives), demand and what drives it, trade flows, waste production, consumption, post-use patterns and impacts on human health and marine life. This lack of data and transparency currently limits effective and safe management of plastics throughout their life cycle. In addition, there is a lack of field data measuring plastic stocks and flows throughout the value chain, and many parameters have high uncertainty (The Pew Charitable Trusts and Systemiq 2020).

[1] Share of actual closed loop recycling for plastic in short-lived products is ~5 per cent

# 1.2 Scope and methodology

This report covers all plastics: short-lived products (including both household and commercial waste), main sources of microplastics (tyre abrasion, textile microfibres, personal care products, pellets and paints[2]) and durable plastics (including the use of plastics in automotive, construction, textiles, electronics, agriculture and fishing). Modelling is focused on plastic flows and related interventions on short-lived plastic products and microplastics, as these categories have the highest likelihood to end up as plastic pollution. These plastic products represent approximately 67 per cent of the total volume of plastics waste generation in the economy (Figure 2).

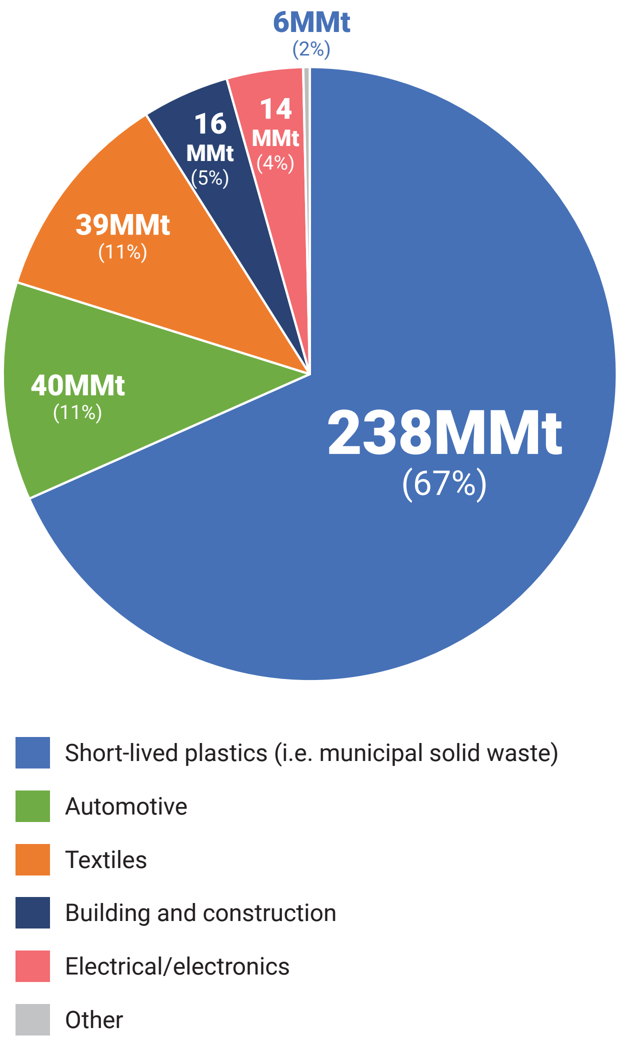


Figure 2: **Total plastic waste in 2019 by category, million metric tons (MMt).**

*Source: OECD 2022b[3].*

The report builds on the model of the systems change scenario (Box 2) described in the report 'Breaking the Plastic Wave' (The Pew Charitable Trusts and Systemiq 2020), and delivers the economic analysis and narrative on how such a scenario can be achieved in practice while strengthening its ambition. The systems change scenario combines actions to reduce the size of the plastic pollution problem with a market transformation toward circularity in plastics through three key shifts - Reuse, Recycle, and Reorient and Diversify - and actions to deal with the plastic pollution legacy. This scenario assumes no change in utility delivered by plastics, although some of this utility may be delivered with less material (e.g. eliminating unnecessary use or through reusable products). Hence, the solutions do not include changing current demand, through behaviour change, which could bring additional opportunities to reduce plastic production.

Further details of the methodology used and the underlying model are provided in Annex 1.1.

[2] Microplastics from paints are addressed primarily in qualitative form, constrained by gaps in data.

[3] Data are derived from OECD Global Plastics Outlook 2022, which estimates 353MMt total waste, with the following adaptations: the estimated total of 238 MMt of short-lived plastic products in 2019 is extracted from the Breaking the Plastic Wave model, and represents annual municipal solid waste. The OECD categories of Packaging, Consumer and Institutional Products, Personal Care Products, and a portion of the 'other' category were all allocated into these 238MMt. OECD sub-categories for textiles (clothing vs other) and automotive (transportation - tyres vs. transportation - other) were combined, and OECD categories with <0.5% of total waste were combined with 'other'.

# 1.3 The economic case for circularity in plastics

Producing plastics is immensely profitable, as its exponential growth over time demonstrates, and creates utility and social welfare in its many uses throughout the economy. However, it is profitable primarily because the external costs it generates have been shifted to others and into the future. While the primary plastics sector of polymers and additives accounts for around USD 600-700 billion per year in revenues[4], it also inflicts a heavy burden on human health and environmental degradation, with the poorest in society facing the highest impacts whilst contributing the least to plastic over-consumption and waste (UNEP 2018).

It is key to factor in gender equality and socio-economic issues in plastic solutions to ensure a 'just transition'.

A number of studies have sought to quantify the economic value of social and environmental costs of plastics over their life cycle (Grandjean and Bellanger 2017; Merkl and Charles 2022; Landrigan *et al.* 2023). This literature details the likely burden of health effects from exposure to chemicals used along the life cycle of plastics production and use, with associated impacts on human development, endocrine and immune systems and the risk of cancers, among others (Figure 3).

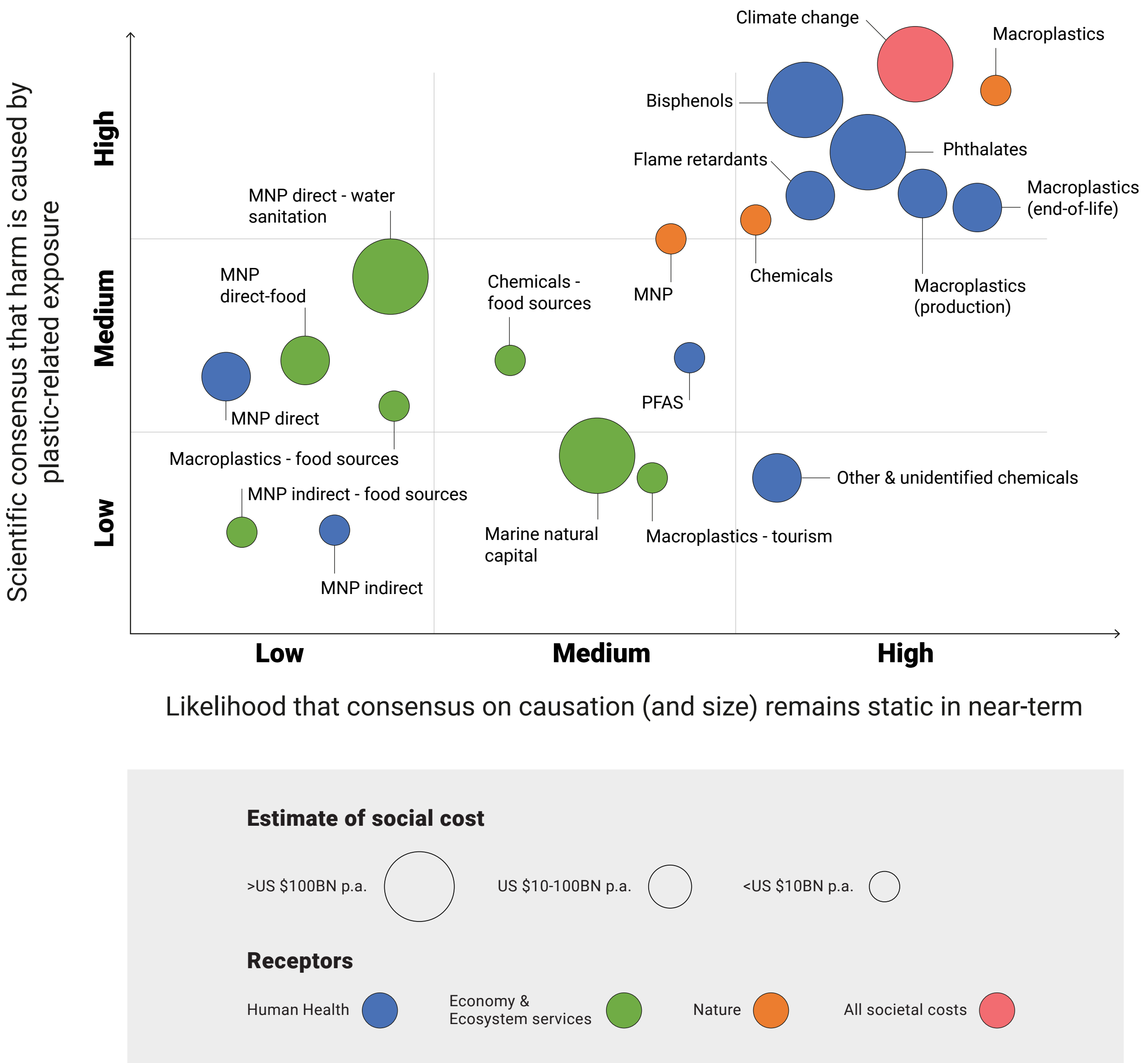


Figure 3: **Relative value of social costs and likelihood of consensus on plastic pollution related externalities.**
*Source: Merkl and Charles 2022.*

[4] According to Precedence Research, the global polymers market size was valued at USD 713.9 billion in 2021. However, according to a report from Grand View Research the global plastic market size was valued at USD 593 billion in 2021.

Table 1 presents estimates for selected externalities available in the literature, comparing the results of studies that make use of different methodologies for valuing the social costs of plastic pollution. This report uses estimates that cover both local and global impacts of plastics value chain dynamics, based on the flow of plastic waste. Other studies (Merkl and Charles 2022; Landrigan *et al.* 2023) use estimates of health impacts resulting from plastics pollution, and estimated costs based on welfare economics (e.g. using Disability-Adjusted Life Years as opposed to using coefficients on the cost of treating health damage or avoiding the emergence of health impacts).

While the estimates vary, due to either the use of different underlying flows of plastic waste or the different methods and cost coefficients, it is worth noting that the social and environmental costs associated with plastic pollution converge around the range of USD 300–600 billion per year. As the data on ecological and health effects across the life cycle are further refined and validated, the accuracy of the estimates will increase. For now, this report adopts a conservative approach and uses the lower bound estimates of costs associated with harms to human health and the environment.

Table 1: **Damage estimates of plastic pollution across the life cycle of plastics (in billion USD per year)**

| | **This study*** | | **Grandjean and Bellanger (2017)** | **Landrigan *et al.* (2023)** | **Merkl and Charles (2022)** |
|---|---|---|---|---|---|
| | **Business-as-usual** Lower Bound | **Business-as-usual** Upper Bound | | | |
| **Carbon dioxide** | 60.5 | 121.1 | | 341.0 | 180 |
| **Air pollution** | 31.3 | 62.5 | | 211.8 | 54 |
| **Ocean cleanup** | 0.7 | 1.4 | | | |
| **Marine ecosystem services** | 70.2 | 143.7 | | | > 100 |
| **Exposure to hazardous chemicals** | 130.8 | 130.8 | | 920.6 (USA only, related to use of three chemicals only: PBDE, BPA and DEHP) | Bisphenols, Phthalates and Flame Retardants each more than 100<br>Micro- and Nano-Plastics and bodily injury 10 to 100 |
| **Total Externalities** in billion USD per year | **$293.5** | **$459.5** | **$4,500** (covers exposure to all chemicals) | **$552.8** (If global occupational health costs are included, the figure is over USD 1.5 trillion/yr) | **> $500** (Upper bound of range could reach USD 800 bn/yr) |

* Note: Sources and methodology provided in Section 1.4.1 (Table 2) and Annex 1.2.

# Box 2: **What is a circular plastics economy?**

The vision of a circular, zero-pollution plastics economy is one that eliminates unnecessary production and consumption, avoids negative impacts on ecosystems and human health, keeps products and materials in the economy and safely collects and disposes waste that cannot be economically processed. This results in permanently increasing material circularity, reducing greenhouse gas emissions and stopping plastic pollution. Achieving this vision requires a fundamental shift to ensure that people responsibly consume, produce and manage plastic globally. This can be achieved with a systems change.

Systems change "captures the idea of addressing the causes, rather than the symptoms, of a societal issue by taking a holistic (or 'systemic') view. Systemic change is generally understood to require adjustments or transformations in policies, practices, power dynamics, social norms or mindsets. It often involves a diverse set of players and can take place on a local, national or global level; systems change requires modifications in many of the system structures, such as the mindset or paradigm that creates the system or the system's goals or rules" (UNEP/PP/INC.1/7).

**A systems change involves:**

1. simultaneous action across the life cycle to trigger the change. For instance, investment in increased recycling capacity (downstream) is coupled with incentives to use recycled plastic in new products (upstream) and the manufacture of products (midstream) that are economically recyclable.
2. international action to create a flourishing circular plastics economy globally that benefits all countries. For instance, eliminating the manufacture of a problematic product in one country is less effective if that product can still be exported to a neighbouring country.

**The systems change scenario is a feasible solution**

The Pew Charitable Trusts and Systemiq (2020) identified a science-based roadmap to significantly reduce the amount of annual plastic pollution in the environment by 80 per cent versus a business-as-usual scenario; while accounting for a range of technical, economic, social and environmental constraints that impact the scale and speed of change in the global plastics economy (see also Lau *et al.* 2020). The systems change scenario is technically feasible within existing technologies, is economically and socially viable (human rights for all and gender equality) and creates co-benefits for climate, health, jobs and the economy. To achieve it, upstream, midstream and downstream solutions are deployed together through ambitious, immediate and global action, as shown in Figure 4 and Table 3.

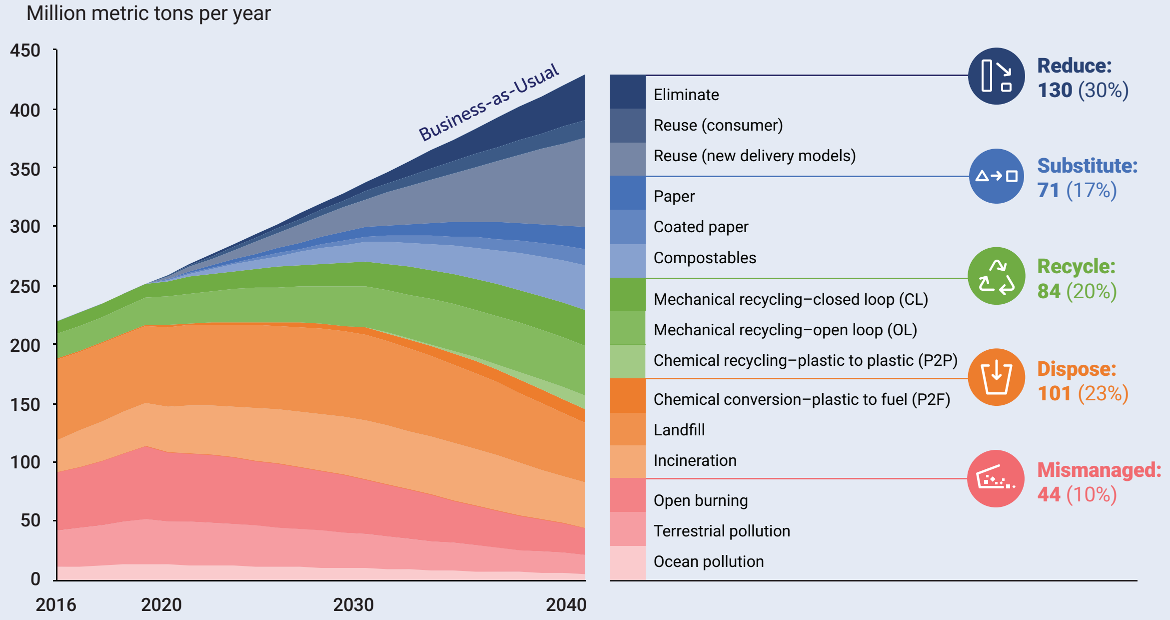


Figure 4: **Wedges showing share of treatment options for plastics from short-lived products entering the system under a systems change scenario from 2016 to 2040.**
*Source: The Pew Charitable Trusts and Systemiq (2020).*

# 1.4 The systems change scenario: An economic opportunity

To understand better the full economic implications of the systems change scenario, an assessment of the plastic waste and pollution flows was undertaken. This section provides an overview of the methodology used to (i) estimate the capital, operations and management costs, as well as the revenues generated in the plastics value chain via recycling processes; (ii) evaluate the most significant health and environment externalities; (iii) assess the extent to which this scenario impacts costs, revenues and the value of externalities. The estimation of costs and revenues is based on the detailed estimation of plastic flows along the value chain, with consideration of specific capital and operation and management costs for each stage considered. This analysis builds on data from the model of these flows and costs described in The Pew Charitable Trusts and Systemiq (2020) and Lau *et al*. (2020) and is further detailed in Annex 1.2.

The economic valuation of externalities quantified the cost of $CO_2$, air pollution, ocean clean-up, marine ecosystem services and exposure to hazardous chemicals. This economic valuation has been performed by using estimated coefficients from the literature (See Table 2 below and further detail is provided in Annex 1.2) and multiplying by the relevant waste flow (e.g. annual amount of waste reaching the ocean, multiplied by the estimated economic damage caused by the impact of plastic pollution on marine ecosystem services). The results of these calculations are presented in Figure 5 and Figure 6.

Table 2: **Summary of the coefficients used in the study.**
The numerical values are expressed in constant terms (inflation adjusted), so that all values are presented in US Dollars (with 2020 base year) per metric ton.

| Indicator | Lower bound (USD/ton) | Upper Bound (USD/ton) | Reference |
|---|---|---|---|
| **Carbon dioxide** | 50 | 100 | Bond *et al.* 2020 |
| **Air pollution** | 250 | 500 | Bond *et al.* 2020 |
| **Ocean clean-up** (per ton disposed in water) | 1,838 | 3,676 | UNEP 2014 |
| **Ecosystem service costs** | 5,749 | 11,771 | WWF 2021 |
| **Exposure to hazardous chemicals from incineration** | 0.05 | 0.95 | Nzihou *et al.* (2012); Cheng and Hu (2010) |
| **Exposure to hazardous chemicals from open burning** | 487 | | Martínez-Sánchez *et al.* 2017; Zhang *et al.* 2017; Smeaton 2021; Atabay *et al.* 2022 |
| **Exposure to hazardous chemicals from dumpsite** | 180 | | Martínez-Sánchez *et al.* 2017; UNEP (2012) |
| **Exposure to hazardous chemicals from microplastics** | 16,500 | | Atabay *et al.* 2022 |

Note: The cost of air pollution focuses on (macro)plastic waste and considers air pollutants from production. The cost of $CO_2$ emissions linked to plastic production is used as a proxy for health impacts from plastic (Bond *et al.* 2020). The cost of exposure to hazardous chemicals focuses on the impact of microplastics and, in addition, to the end-of-life damage emerging from macroplastics (specifically from open burning and fires in dumpsites). Full methodology described in Annex 1.2.

## 1.4.1 **Estimating the benefits from the systems change scenario by 2040**

The results indicate that the systems change scenario is economically viable and creates immediate annual savings as compared to that of a business-as-usual (BAU) scenario. When considering the timeframe, the avoided costs are significant, reaching between USD 130 billion and USD 200 billion per year by 2040. This magnitude of savings and avoided cost is a large part of the 'size of the prize'.

By 2040 the systems change scenario results in a net cost reduction of 10 per cent when considering the direct costs of reduced investment (capex), operation and management costs (opex) and increased revenues (e.g. from recycled materials) (Figure 5). These savings result from reduced plastic production and processing and reduced demand on capacities required to produce them; as well as increased revenues from recycled materials. Note that while operating costs increase somewhat over the projected timeframe, these increases are more than offset by savings in the capital costs.

An additional saving of 33 per cent in avoided costs is possible over the period 2021–2040. The savings in externalized (indirect) costs are considerable: the total cost of the plastics life cycle is estimated at USD 22.3 trillion between 2021 and 2040 in the BAU scenario, and 45 per cent of that value is represented by externalities. The percentage related to externalities declines to 38 per cent in the systems change scenario, which carries total cumulative costs of USD 17.8 trillion by 2040 (all values are presented in constant 2020 USD). Taken together, the costs avoided in the systems change scenario represent an overall savings of 20 per cent of the total.

Overall, the systems change scenario results in USD 1.3 trillion in savings considering investment, operations and management costs and recycling revenues. A further USD 3.3 trillion is saved from avoided externalities.

These results point to a considerable societal value emerging from increasing the sustainability of the plastics economy: for each dollar of conventional (direct) cost saved a further two dollars of societal damage (indirect cost) are also avoided.

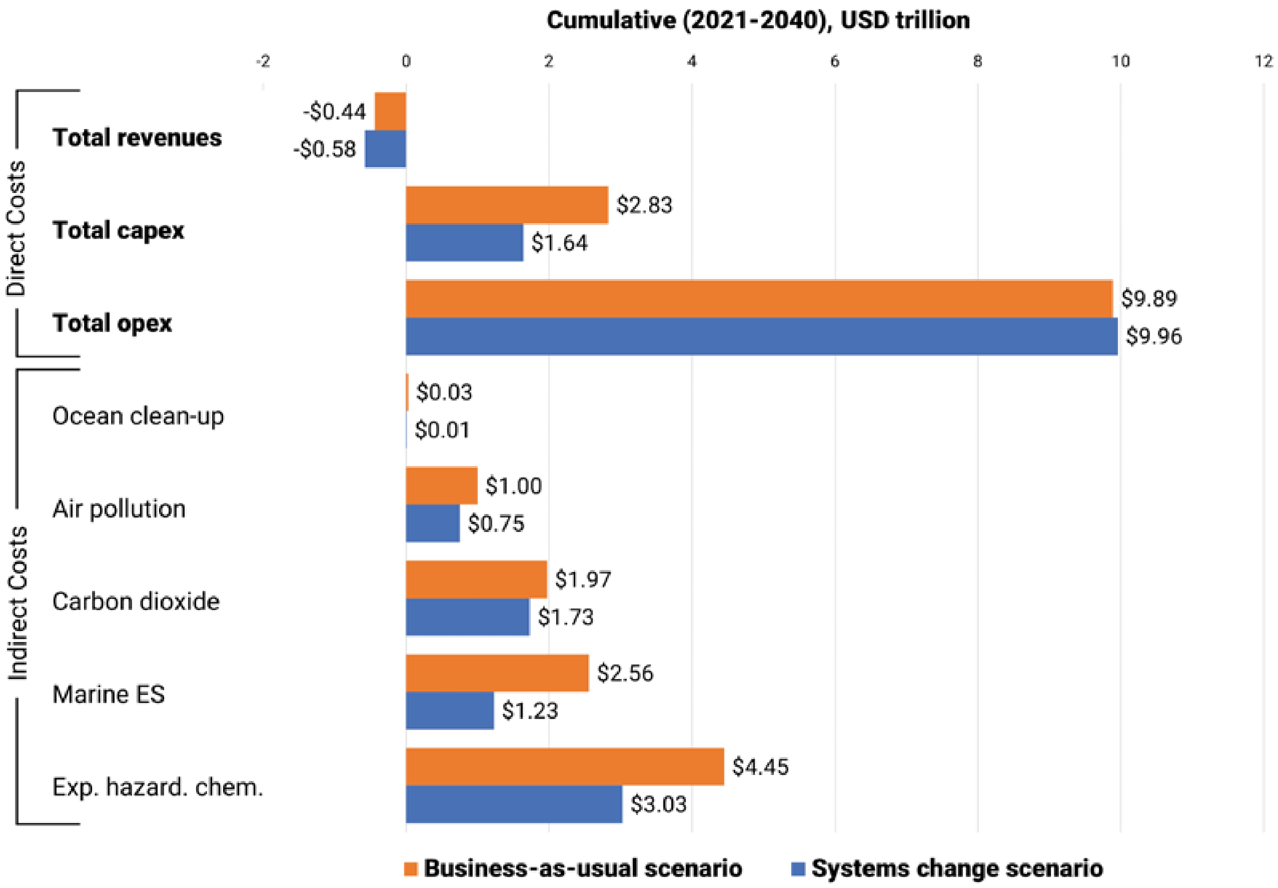


Figure 5: **Total system costs for short-lived plastics for the business-as-usual and systems change scenarios (2021–2040).**

Note: Marine ES = Marine ecosystem services; Exp. hazard. chem. = Exposure to hazardous chemicals.

The forecast evolution of the plastics value chain over time, especially under the systems change scenario, offers valuable insights (Figure 6). Even when using lower bound estimates, the savings are substantial, and externalities in particular decrease with a systems change. The potential savings in terms of avoided costs and damages are illustrated over time in Figure 6 along with reduced investment costs. The avoided cost of pollution represent the largest cost savings in the plastics value chain under the systems change scenario, where continued progress to increase circularity results in annual avoided costs of plastics pollution in the range of USD 412 billion per year by 2040 using the lower bound coefficients (this grows to more than USD 602 billion per year when using the upper bound cost coefficients).

To put these numbers into context, USD 100 billion per year is roughly equal to the amount committed by the World Bank Group in 2022 for all development lending (WBG 2022b).

Of note, both private sector and government/municipal operators in the value chain can realize savings in capital costs as a result of more effective management of waste and reduced waste flows. Operating and maintenance costs may increase in the short term, with collection, sorting and managing waste to increase recycling and reuse – but this increase is smaller than the cost saving realized on capital cost. Further, opex is forecast to decline from 2030, because of reduced waste flows entering the economy.

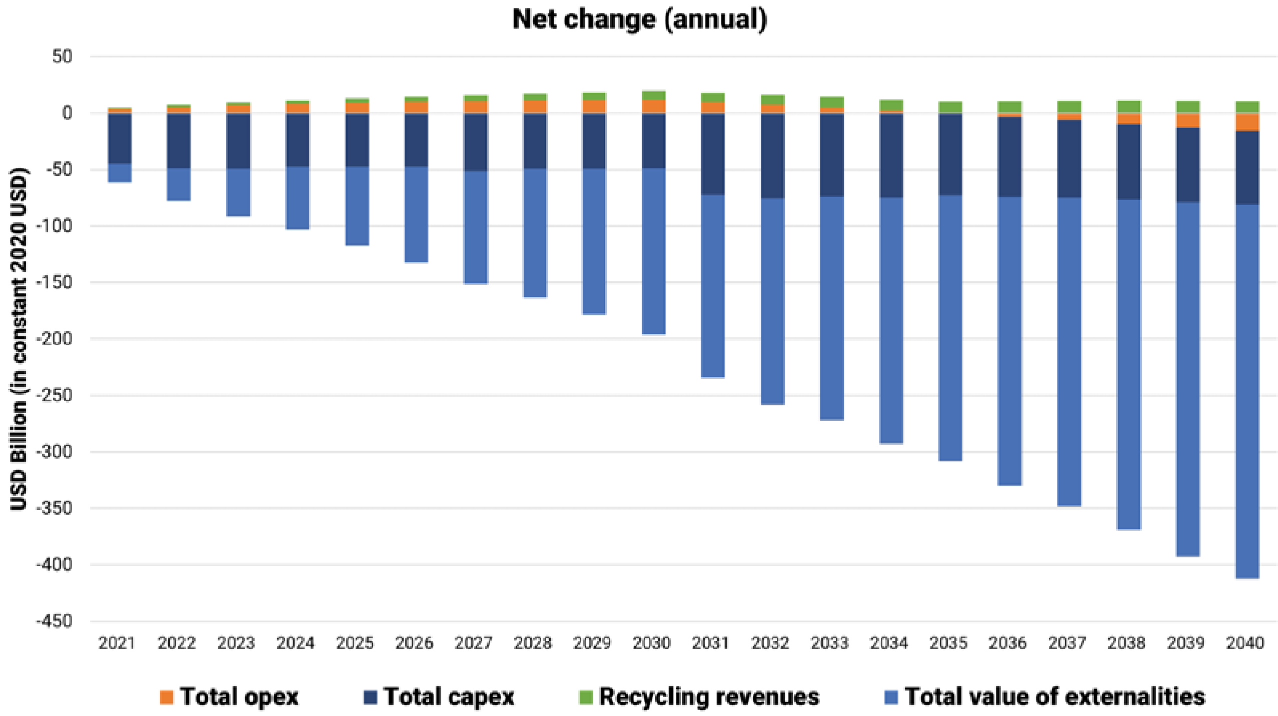


Figure 6: **Net change in annual costs between the business-as-usual and systems change scenarios (SC-BAU), 2021-2040 (in constant 2020 USD billion).**

In interpreting these results, it is important to highlight the difference between direct and indirect avoided costs. The former are costs that translate in cash flows (e.g. avoided investment, made redundant by the reduction in the generation and use of plastics). The latter refer instead to impacts that do not necessarily carry a market price, and are hence not directly converted into cash flow even though they pose real costs (e.g. loss of marine ecosystem services). Yet even if they do not impose direct costs, externalities can be valued economically by considering indirect and induced impacts (e.g. the loss in tourism revenue emerging from the reduction of marine ecosystem services).

Finally, it should be mentioned that several additional externalities, as well as co-benefits, could and should be included in the analysis. An example is represented by employment and income, where a portion of the income created (estimated using country or region-specific income multipliers for upstream and downstream activities), for instance discretionary impact (e.g. 30 per cent of the total salary) could be considered a societal benefit. Section 1.4.3 further explains the job implications of the systems change scenario.

## 1.4.2 Bridging the finance gap of systems change through public and private financial flows

Maintaining the status quo is far from what is economically or socially optimal, and support is required to transition to a more sustainable path in the plastics value chain.

First, support may be provided to generate behavioural and systems change. A trigger is required, for instance to reduce plastics use upstream by accelerating reuse, so that savings can be accrued downstream, on the waste management side. The recent push by the G20 Presidency of India to focus on lifestyles for environment ('LiFE' for short) is an indicator that behavioural change and personal choice decisions are on the agenda for many countries. Actions that promote positive behavioural change are impactful when they consider gender roles, consumption and waste generation preferences; this also helps designing gender-responsive initiatives thus accelerating progress towards sustainable plastic management (OECD 2020).

Second, certain investments may require a considerable amount of upfront capital. Challenges may include the high cost of financing, a lack of collateral to qualify for financing for the private sector or a stretched fiscal balance for the public sector.

Third, the investor may not necessarily be the main beneficiary of improved sustainability in the context of the plastics value chain. For instance, if a tax is charged on plastics consumption, most of the indirect savings will be accrued by the government (or by the organisations and institutions managing plastic waste), and only indirectly by all citizens (e.g. via the reduction of $CO_2$ emissions, air pollution, marine ecosystem degradation and exposure to hazardous chemicals). Such taxes may also have significant impacts on the poorest in society, and further amplify impoverishment.

While the systems change scenario generates positive outcomes systems-wide, only a careful design of the interventions ensures that the transition is economically and financially viable for all actors involved: producers, consumers, citizens and the government.

Consider the case of a virgin plastic tax or levy in the systems change scenario: if 500 USD/metric ton was charged on virgin plastic produced for short-lived products[5], an additional cumulative revenue of USD 1.1 trillion would be generated from 2025 until 2040, higher than the total capex in the same period and circa 16 per cent of the cost of externalities between 2021 and 2040. If, for instance, such levy was to be invested into an international circularity fund, to leverage private financing, it could thus finance the capital expenditure as well as part of the operations expenditure required for the systems change scenario and greatly accelerate the transition. This funding could also be used as an incentive (e.g. a 4:1 type of incentive, where the government provides a 20 per cent contribution and the private sector brings in the remaining 80 per cent), which would deliver five times as many resources (i.e. USD 5.5 trillion more of investment available). Higher taxes of 1,000 and 2,000 USD/metric ton (as suggested in OECD 2022c) would 'recover' 33 per cent and 66 per cent of the externality costs incurred between 2021-2040. Initial analyses suggest that a tax at USD 500/metric ton would be financially viable for the industry.

Additionally, Figure 5 clearly shows that the highest costs in both scenarios are related to operational expenditure. Well-designed Extended Producer Responsibility (EPR) schemes can cover the full costs of ensuring the system's circularity, as shown in successful examples around the world (see topic sheet on '**Extended Producer Responsibility**'). In the European Union,for example, EPR schemes place the responsibility on producers for the financing of collection, recycling and responsible end-of-life disposal of packaging, waste from electrical and electronic equipment, batteries. In France, the fees collected through the EPR schemes for packaging reduce the waste management burden of municipalities by over 50 per cent (UN-Habitat Urban Agenda Platform 2022). Belgium is also often cited as having one of the most successful EPR schemes with rates of over 80 per cent recycling for packaging (EXPRA 2023).

Overall, the emerging literature suggests that a combination of policies are required to shift demand and 'bend the consumption curve' (OECD 2022c; Economist Impact 2023). Price instruments such as levies and even EPR schemes can be helpful, but due to the low-price elasticity of demand will do more to raise revenues than dampen demand; and must therefore be combined with bans on single use plastic products and additives and polymers that are particularly hazardous for human health and the environment.

[5] i.e. similar to the tax already in place in a few frontrunner countries and lower than what OECD (2022c) proposes.

## 1.4.3 **The job implications of systems change**

As shown in Figure 7, a detailed analysis of direct employment and livelihood impacts shows that the systems change scenario is good for the jobs market. By 2040, relative to the BAU scenario, the systems change scenario would result in 700,000 more jobs directly associated with short-lived plastics; there is a net growth of 970,000 jobs in developing countries and a net loss of 270,000 jobs in developed countries (but still a net growth of 150,000 jobs in the Global North relative to today). Further details of the job implications of systems change are shown in Annex 1.1.

This growth is due to the systems change scenario expanding collection and sorting across developing countries, which would support more livelihoods. Additionally, the circular economy is typically more labour intensive than the linear economy because it shifts much of the production activity (which relies mainly on machines) to services which require humans (recycling, reverse logistics and reuse). The considerations of gender equality in job creation is crucial to ensure a just transition, more so in developing countries (International Labour Organization [ILO] 2022).

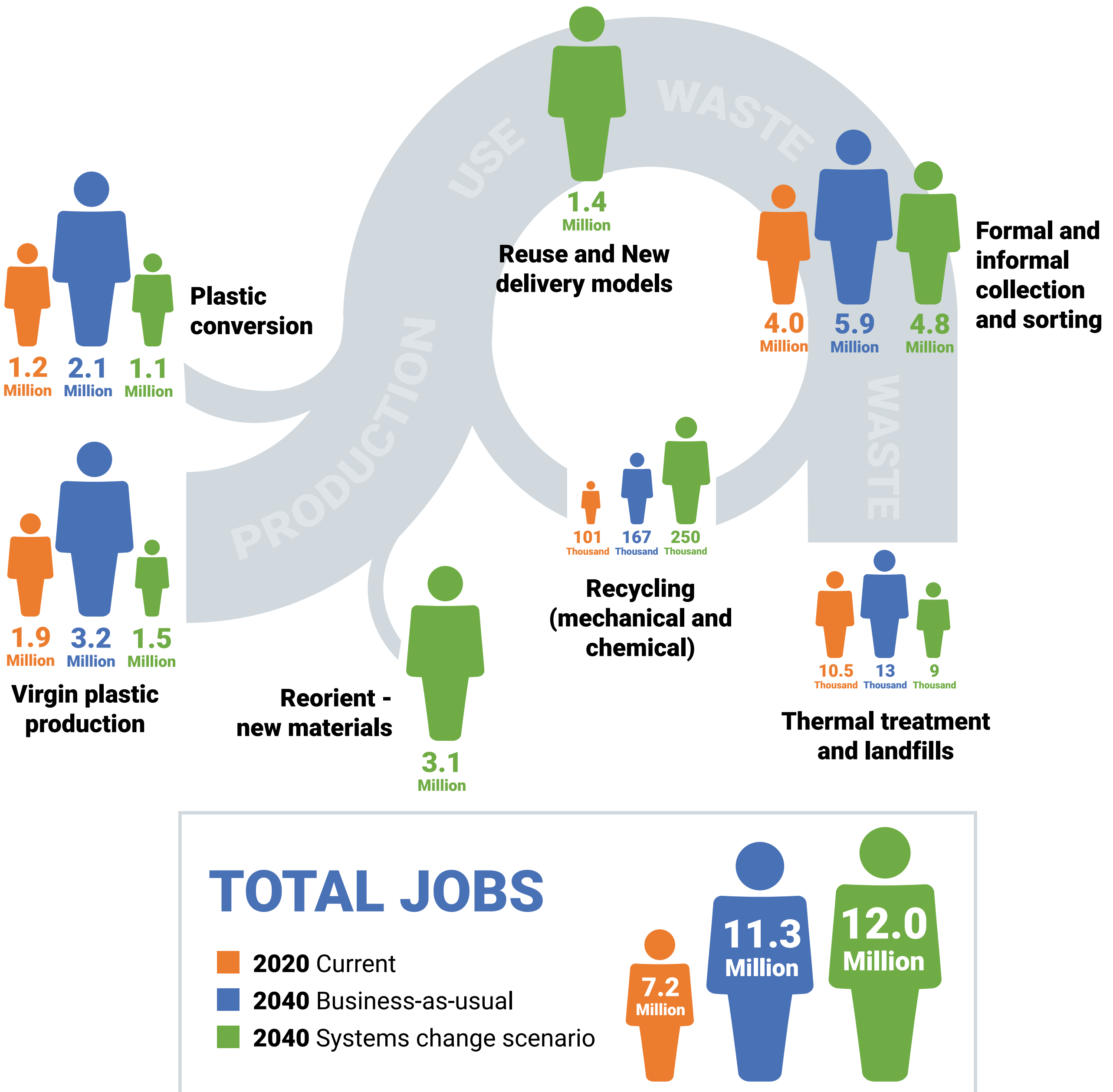


Figure 7: **Total jobs in different parts of the short-lived plastics value chain in the current market, and under business-as-usual and systems change scenarios.**

*Source: The Pew Charitable Trusts and Systemiq 2020*

Photo: Getty Images

Many of the manual jobs required by the circular economy (collection, sorting, recycling, washing of reusables etc.) also have a direct contribution to poverty alleviation because these typically require lower skillsets. While the BAU scenario also has many jobs in these categories, they are mostly in high-income countries as low-income countries still suffer from insufficient waste management infrastructure.

And while areas such as production of virgin plastic and conversion of plastic products decrease in this scenario (all of them are in the high-income countries), these are typically high skilled labour that operate machinery and work in factories, so this labour can likely be directed towards other industrial activities. At the same time, new circular industries like reuse, new delivery models and new materials development and production have the potential to create millions of new jobs in the circular economy[6].

As with any transition, job creation and displacement require careful attention and forward planning, not least to ensure that adequate skills and retraining opportunities exist, as new jobs are created and new opportunities open. The International Labour Organization (ILO) has outlined measures that can underpin a 'just transition' to an economy which is greener and more inclusive for both women and men and other minority groups who are often marginalised (ILO 2015). Even if the systems change scenario results in net increase in jobs, safeguards and just transition should be in place to care for informal workers who may not qualify for formal labour and yet still wish to participate in the system.

[6] Including jobs in the other plastic categories not in the scope of this analysis (automotive, construction, electronics, textiles, fishing gear etc.), could increase the growth in net jobs given that these sectors may experience a smaller relative reduction in volume compared to packaging and single-use plastic.

# 1.5 A better plastics future

For decades the three R's framework (Reduce-Reuse-Recycle) has been the focus of plastic waste management. While these elements all remain core to tackling plastic pollution, to move to a new plastics economy by 2040 requires an expansion of this framework.

Integrated actions are required across the life cycle (UNEP/PP/INC.1/7) under three main categories:

## 1.5.1 Reduce the size of the problem

Eliminating the use of unnecessary or problematic plastics and hazardous chemicals can be achieved by prioritising high-value durable uses such as reusable and refillable products, or removing plastic that is not delivering a necessary function (e.g. excessive headspace). In some cases, such unnecessary plastics can also be substituted by safe and sustainable materials.

## 1.5.2 Transform the market from linear to circular through three market shifts

**Shift 1:**
Accelerate the market for reusable products

**Shift 2:**
Accelerate the market for plastics recycling

**Shift 3:**
Reorient and diversify the market for sustainable and safe plastic alternatives

The reuse market shift, together with elimination of unnecessary and problematic plastic products, can reduce demand for new plastics in 2040 by approximately 30 per cent, while accelerating the recycling market shift can further manage 20 per cent of the plastics volume. Reorient and diversify sustainable alternatives to plastic products, particularly those that are short-lived, can reduce approximately 17 per cent of plastics that risk ending up as pollution. Some cross-cutting policy and fiscal measures, such as a levy on virgin plastic production, could drive market transformation and support the success of all three shifts. Chapter 2 outlines actions to accelerate the three market shifts.

## 1.5.3 Deal with the plastic pollution legacy

Despite the systems change scenario resulting in an 80 per cent decrease in the outflows of mismanaged plastic waste ending in the environment (Figure 9), action will still be required to manage 100 million metric tons of plastics from short-lived products not yet reduced, substituted or brought into circularity by 2040.

These system-level actions are interdependent and rely on their successful implementation at scale, in parallel and with ambition, to shift towards a new circular plastics economy. For example, collection and sorting is required to expand recycling, and design for recycling improves the economic viability and scalability of mechanical recycling systems. These system-level actions must also be supported by cross-cutting measures, such as reporting and monitoring, which will provide transparency and a data base to support effective management through the value chain and drive further transformation. The three key market shifts (reuse, recycling, reorient and diversify) highlight economic opportunities, are supported by actions that reduce the size of the problem and complemented by actions to deal with the legacy; overall they are accelerated by policy and legislative change. Taken together, these form the compass to end plastic pollution through a new circular plastics economy.

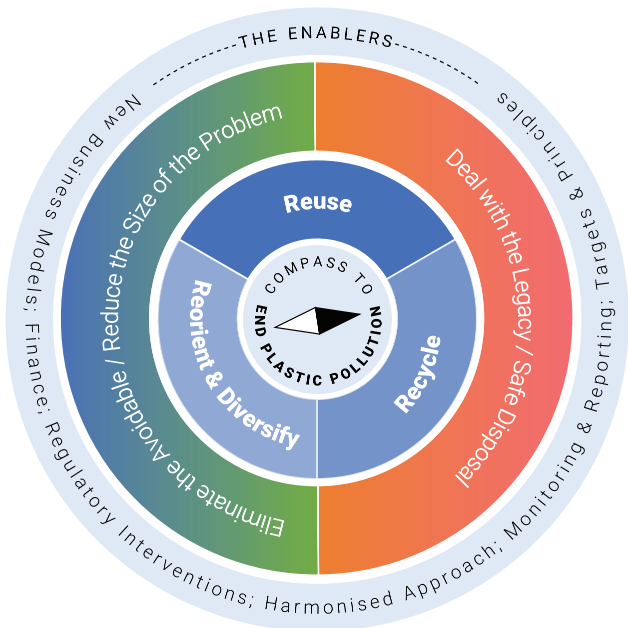


Figure 8: **The compass to end plastic pollution**

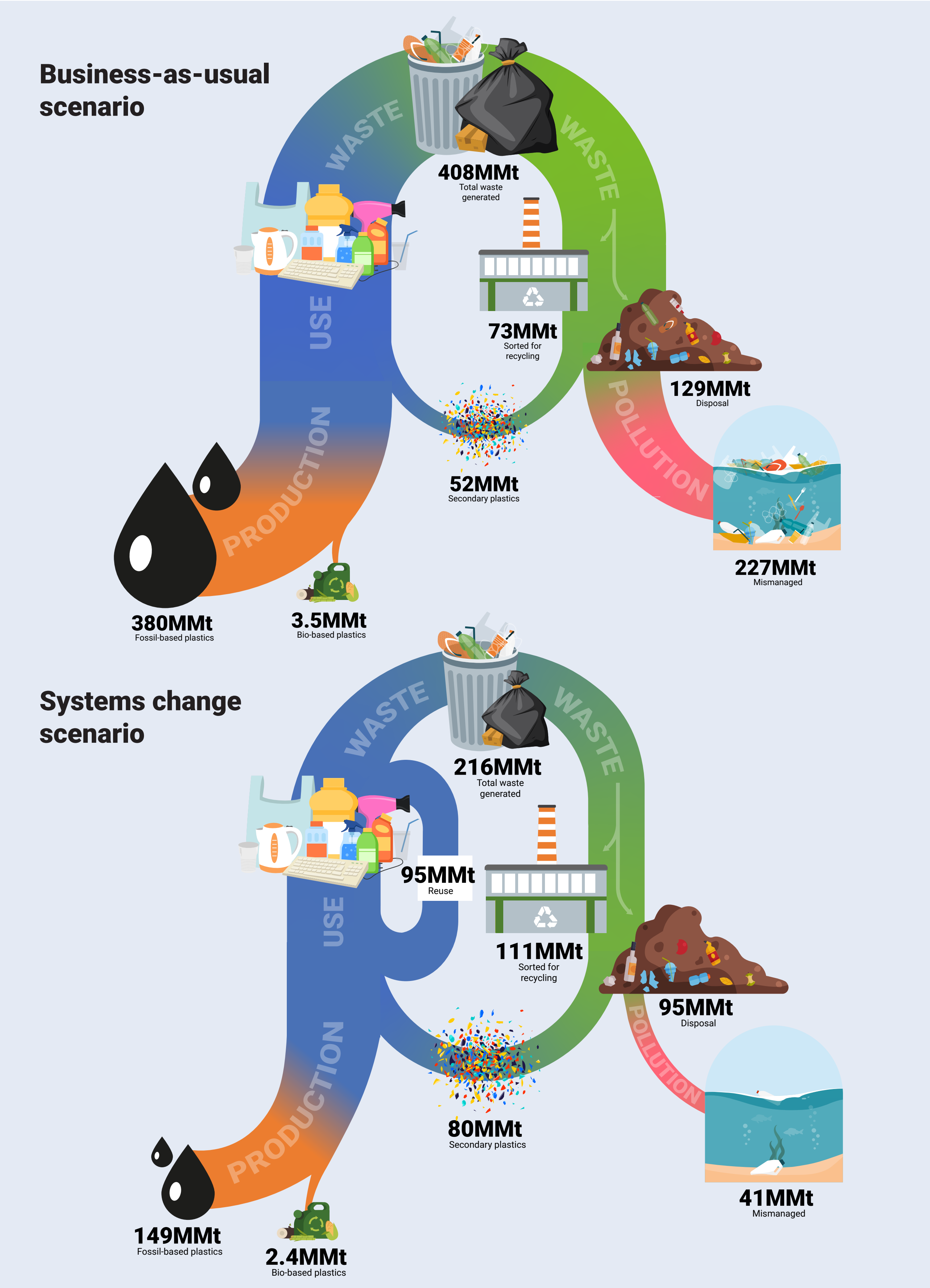


Figure 9: **Top: Modelled short-lived plastic flows in 2040 under a business-as-usual scenario. Bottom: Modelled short-lived plastic flows in 2040 under a systems change scenario to deliver the necessary market transformation.**

*Source: UNEP modelling building on The Pew Charitable Trusts and Systemiq (2020) and OECD (2022b).*

## 1.5.4 **Wasting time will lead to more pollution**

The next three to five years present a critical window for action to set the world on the path towards implementing the systems change scenario by 2040. If it takes longer to apply these same solutions, the model used indicates that an additional 80 million metric tons of plastic pollution will be entering the environment (The Pew Charitable Trusts and Systemiq 2020).

To deliver the targets set out in Table 3, and ultimately a better plastics future, it is crucial to align all financial flows with the goals of the market transformation by 2040 (all values are in net present value [NPV]).

This includes:

- Reducing by USD 2.2 trillion all financial flows towards virgin plastic production
- Mobilising at least USD 600 billion from all sources to reuse and new delivery models
- Increasing by USD 230 billion financial flows to formal collection and formal sorting in middle income and low-income countries, and by USD 70 billion financial flows to improve recycling technologies and increase recycling capacity
- Mobilising at least USD 1.7 trillion from all sources to production of sustainable substitute materials and end of life management facilities and technologies

Table 3: **The systems change scenario outcomes and scale of change in the next 5 years and by 2040.**
MMt = million metric tons.

| | **Required scale of change in the next five years** | **Required outcomes and scale of change by 2040[7]** |
|---|---|---|
| **Reduce the size of the problem and Accelerate reuse** | Reduce 10% (25 MMt) of short-lived plastics versus BAU including at least 20% via reuse and new delivery models for all bottled products and beverage cups | Reduce growth in short-lived plastic consumption to avoid ~30% of 2040 projected plastic waste generation via elimination, reuse and new delivery models, including at least 50% via reuse and new delivery models for bottled products and beverage cups |
| **Accelerate recycling** | Re-designing 25% of multi material and multi-layer globally into mono material formats (13 MMt) | Design products to expand the share of economically recyclable plastics, e.g. switching 100% of multi-material flexibles to mono-material |
| | Increase the amount of post-consumer recycled content in all new products from circa 6% in 2020 to 14% globally (i.e. 69 MMt) | Increase the amount of post-consumer recycled content in new products to 35% of new short-lived plastic products (i.e. 80 MMt) and 6% of durable plastic products (i.e. 19 MMt) |
| | Achieving 70% collection rates (vs. 50% in 2016) in low-income urban areas, while supporting livelihoods of informal waste pickers | Expand waste collection rates in middle and low-income countries to 90% in urban areas and 50% in rural, supporting the informal collection sector |
| | Increasing the global mechanical recycling capacity by 50% versus 2016, from ~43 MMt to ~65 MMt (equivalent to growing mechanical recycling rate of short-lived plastics from 14% in 2016 to 20% in 2028) | DOUBLE annual mechanical recycling capacity globally from 43 MMt to 86 MMt (equivalent to growing mechanical recycling rate of short-lived plastics to 35% globally). Enhanced ambition could TRIPLE mechanical recycling capacity to 129 MMt* |
| | | Develop sustainable plastic-to-plastic conversion, potentially to a global capacity of 13 MMt per year |

[7] Building from Breaking the Plastic Wave - The Pew Charitable Trusts and Systemiq 2020.
* It is important to note that while feasible financially (the necessary investment could pay for itself as the economics of recycling are favourable and would be more favourable with the integrated actions), this recycling target can only be achieved and can only make sense with very ambitious design for recycling, collection and sorting requirements ensuring that virtually all plastic otherwise going to landfill will be recyclable and recycled.

| | | |
|---|---|---|
| **Reorient & diversify** | Substitute ~7% (i.e. 22 MMt) of short-lived plastics for alternatives when these are more sustainable | Substitute short-lived plastic with alternative materials when these are more sustainable, switching ~17% of projected 2040 plastic waste generation |
| **Deal with the legacy** | | Roll-out solutions to prevent ~5.7 MMt of annual microplastic pollution by 2040 (~50% reduction microplastic versus total by 2040) |
| | Adding 6 MMt in annual capacity for controlled waste disposal in low- and middle-income countries | Build facilities with an annual capacity of ~42 MMt to dispose of necessary but unrecyclable plastics until we have a better solution |
| | Reduce leakage of 3.5 MMt of plastic to the environment | Reduce leakage of 7 MMt of plastic to the environment |
| | Reduce mismanaged waste globally from 40% in 2016 to 27% in 2028 | Reduce mismanaged waste globally to 10% in 2040 |
| | Reduce plastic waste exports to countries with low collection and high leakage rates by 50% compared to 2020 plastic waste trade | Completely eliminate plastic waste exports to countries with low collection and high leakage rates |

### 1.5.5 **Considering further ambition is possible**

Two additional considerations in modelling the systems change scenario to 2040 are as follows:

- Assuming no new incineration capacity is built after 2020 (and instead take what would have been incinerated in new capacity to engineered landfill), one would save USD 7.1 billion NPV from 2021 to 2040 in capex and opex, as well as 240 million metric tons (MMt) CO2e for the entire period. This would divert an additional 172 MMt of plastic waste from incineration to engineered landfill, predominantly in High- and Upper Middle-Income countries which is where the new incineration capacity is being built. The impact on jobs of this assumption would be negligible.
- Adding extra recycling capacity up to 129 MMt annual capacity by 2040 (instead of letting waste go to landfill) would cost an incremental capex of approximately USD 33 billion NPV from 2021 to 2040 and opex of approximately USD 140 billion NPV from 2021 to 2040 for the recycling infrastructure (accounting for savings from not building landfill capacity) plus incremental capex of USD 43 billion NPV from 2021 to 2040 and opex USD 130 billion for sorting. In addition, this would save costs for virgin plastic production and plastic conversion as follows: capex USD 185 billion NPV from 2021 to 2040 and opex USD 290 billion NPV from 2021 to 2040. In other words, tripling recycling capacity (from the capacity in 2016) instead of 'only' doubling it would create a net cost saving overall. The critical condition for this to work is ensuring that this extra amount of plastic waste, that would otherwise go to landfill, can be designed to be safely mechanically recycled and that the economics of sorting and mechanical recycling are attractive enough to justify these investments. An ambitious legally binding instrument agreed by the end of 2024 could set the enabling conditions and economic incentives to make this possible, including transparency and controls on or criteria for plastics composition.

The above examples show possible directions of additional impacts the market transformation to a circular plastics economy could have if the right ambition and economic incentives are put in place. This modelling can support policymakers with a full picture of the economic, social and environmental impacts of their policy choices.

# Market transformations:
## Creating the marketplace for the new circular plastics economy

Photo: Getty Images

Analysis shows that circularity in plastics requires the simultaneous acceleration of three market shifts: reuse, recycling, and reorienting and diversifying of plastic to more sustainable alternatives.

The following section defines each of the shifts, how they can be delivered, the level of ambition that can be achieved, the barriers that may be encountered and the potential to improve the economics.

In parallel to the market transformation to circularity, the size of the problem needs to be reduced by turning off the tap, i.e.: eliminating problematic and unnecessary uses of plastic in the economy (see Box 3). This entails removing from the economy those plastics which have least value for recycling precisely because they are the least recyclable and are neither designed to be reused. This also includes reducing the production of unnecessary plastics by redesigning overpackaging and reducing headspace, developing packaging-free products, increasing utility per package and extending life of durable goods such as through reuse and repair.

## Box 3: **What are 'unnecessary and problematic' plastics and plastic products?**

Unnecessary plastics are those with low or no utility (e.g. over-packaging) that can be eliminated while providing the same utility, those designed for a short use period when reuse or new delivery models could provide the same utility, and those that can be substituted for alternative materials with a more sustainable footprint (as validated by Life Cycle Assessment studies). Additional criteria to identify problematic plastics is whether they contain hazardous chemicals that pose a significant risk to human health or the environment (applying the precautionary principle), hinder or disrupt the recyclability or compostability of other items and/or have a high likelihood of being littered or ending up in the natural environment.

Criteria to help identify problematic or unnecessary plastic uses (EMF 2020):

1. It is not reusable, recyclable or compostable in practice and at scale (as per Global Commitment definitions).
2. It contains hazardous chemicals that pose a significant risk to human health or the environment (applying the precautionary principle).
3. It can be avoided (or replaced by a reuse model) while maintaining utility.
4. It hinders or disrupts the recyclability or compostability of other items.
5. It has a high likelihood of being littered or ending up in the natural environment.

Photo: Getty Images

# 2.1 **Market shift one: Accelerate reuse**

| 2X | 30% | ~70% |
| --- | --- | --- |
| Plastic consumption expected to double by 2040 globally under BAU versus 2016 | of plastics from short-lived products are avoidable and can be reduced | of plastic reduction could come from reuse, refill and new delivery models |

Plastic reuse and new delivery models, together with elimination of problematic and unnecessary plastics, are highly effective interventions because they can reduce waste at source. Reuse schemes (also referred to as reuse systems or models), refers broadly to new delivery models in which a single product (e.g. a package) achieves multiple trips, rotations or uses for the same purpose for which it was originally used (International Organization for Standardization [ISO] 2013). This can range from simple bulk dispensers in-store to more complex schemes with deposits and packaging take-back, washing and repair. These include the shift to reusable water bottles, food containers and bags, new delivery models such as refill from dispensers and bulk systems in retail, low-packaging subscription services, concentrated product capsules, and take-back services with reverse vending machines, deposit refund schemes and washing pooling systems (EMF 2019; Environmental Investigation Agency [EIA] 2022).

These solutions also decrease risk of exposure to hazardous chemicals in plastics and our dependence on fossil fuel-based plastics, vital in the face of oil and gas price volatility, geopolitical risks, and the urgent need to tackle climate change. Reusable alternatives are environmentally preferable according to Life Cycle Assessment (LCA) meta-studies (UNEP 2021a). See topic sheet on '**Reuse schemes**' for further details.

This market shift can be unlocked by improving the economics of reuse (which is in turn supported by aligning design and sharing of reuse elements to enable economies of scale); as well as aligning regulation of chemicals, material and waste flows to reuse.

### 2.1.1 **Improve the economics of reuse**

Once established, reuse schemes keep resources at a higher value in the economy and thus avoid losing the economic value of the manufactured goods after a single use. Reuse and new delivery models are the most economic schemes to put in place, after plastic elimination, and are estimated to generate net savings to the system (USD 1,289 per ton of plastic for reuse schemes and USD 516 per ton of plastic for new delivery models) (Annex 1.1; The Pew Charitable Trusts and Systemiq 2020).

However, the costs of shifting to reuse schemes should not be underestimated: private costs of reuse models (reuse and new delivery models) are estimated at circa USD 609 billion between 2021 and 2040 (The Pew Charitable Trusts and Systemiq 2020). Sharing elements of the reuse system (such as return systems and containers in the case of reusable packaging) can enable economies of scale thus improving the economics of reuse. The topic sheet on '**Design guidelines for circularity**' provides more details on what can be achieved.

Circular systems tend to be more labour intensive than linear systems, which are resource intensive; therefore, shifting the fiscal burden from labour to resources improves the economics of reuse (and other circular solutions such as recycling). Several studies (OECD 2022c; World Bank Group 2022a; Economist Impact 2023) have suggested the introduction of a virgin plastic tax to reduce or reverse the price gap between virgin single-use products and those that reduce the amount of virgin plastic demand (such as reuse systems and also recycled products).

Reuse systems require services and infrastructure, which were eliminated a few decades ago when disposability became the norm. Fiscal incentives could support the transition until reuse becomes commonplace again, acknowledging that reuse will also deliver favourable outcomes in terms of jobs, economic benefits and reduced environmental impacts.

Targets embedded in legislation (such as in France's Anti-Waste Law: Government of France 2021) provide assurance in the market by de-risking the investments needed from the private sector to shift from the current single-use models to reuse e.g. through a fund for change within the EPR such as 5 per cent of the global EPR fee, eco-modulation with specific one shot bonus to help brand owners to shift from single use to reusable products and standards to scale up the reuse and refill systems. Policies, which also encourage consumers' behaviour change and increase the demand for reuse, are a key driver of increased investment in reuse models since 2015.

Funds raised for reuse schemes between 2015 and 2021 are estimated over USD 1 billion, mostly in the United States of America, Canada and Europe (where the 2019 directive on single use plastic products has created the ground for the development of new reuse models). Policies and incentives will be crucial to unlock financing in emerging countries and for novel reuse models (World Economic Forum [WEF] 2022).

When only a few front-running countries/value chains incentivise reuse, economies of scale are not achieved, and businesses may have to multiply their delivery systems to accommodate reuse and disposable systems. In the extreme this may even result in systems being incompatible at two ends of the same business, such as with the aviation industry, confronted with reuse systems being favoured in one end of the journey and illegal at the other end (International Civil Aviation Organization [ICAO] 2022). Specifically, reuse systems require the following elements to run effectively: collection points, return incentives (to ensure high enough return rates), reverse logistics (including washing and sanitation), labelling and communication, consumer awareness, among others. Like with all transitions, it is crucial to assess and address any potential negative trade-offs from the market shift to reuse e.g. on vulnerable groups (such as waste pickers currently living off streams of single-use plastic products) or gender impacts e.g. because women are often central in managing plastic in terms of domestic purchasing decisions, recycling and disposing (UNEP 2021a).

Overall, improving the economics of reuse requires addressing the tensions between the economic actors that may perceive themselves as 'winning' or 'losing' with the transition (Table 4).

Table 4: **Implications of the reuse shift for different actors across the value chain**

| Actor | Considerations for the Reuse Shift |
| --- | --- |
| Polymer and chemical producers | • Overall plastic production may plateau / not grow as much as forecast<br>• Polymer production for short-lived plastics would decrease<br>• Stopping the expansion of new production plants now will avoid the risk of stranded assets<br>• Help diversify possible shift in polymer types / chemicals produced<br>• Early adopters/innovators of 'reuse-ready chemicals' stand to win significantly |
| Plastic converters | • Smaller volume of production, though higher value products<br>• May consider shifting business model to 'polymer leasing' |
| Brands / manufacturers | • Significant re-design effort for safe containers and delivery systems<br>• Likely increase in brand loyalty<br>• Strengthened social license to operate as 'branded litter' diminishes<br>• Delivering on corporate targets (e.g. New Plastics Economy Global Commitment) |
| Reuse service providers sector | • Significant boom expected in this sector<br>• Major growth in revenues and jobs anticipated |
| Retailers | • Increased costs as need to devote a share of retail space to reverse logistics / return systems<br>• Strengthened social license to operate<br>• Delivering on corporate targets (e.g. New Plastics Economy Global Commitment) |
| Governments | • Delivery on waste targets and avoiding growth in greenhouse gas and toxic emissions linked to plastic production<br>• Significant job growth particularly in less skilled jobs that may support poverty alleviation and the economic empowerment of women from lower socio-economic status (International Labour Organization 2022)<br>• Reduced health impacts on the population and costs to health services |
| Consumers | • Need to forego convenience of disposable and get used to products looking less shiny<br>• Opportunity to shape the future of consumption as reuse systems are co-designed with the user in mind<br>• Important to consider the gender dimension in the transition to avoid disproportionate impact on women |
| Waste pickers | • Reduced volume of single-use plastic items waste, with potential impact on their revenues<br>• Opportunity to become integral part of the reuse service providing sector with safer and better paid jobs if conditions for a just transition are observed, e.g. by formalising the informal sector and including waste pickers in new reuse businesses such as reverse logistics[8] and washing services |
| Waste management companies | • Reduced volume of waste to be managed vs. BAU, although the sector will still grow compared to today to increase the population covered by waste collection and management<br>• Reduced costs of investment into costly disposal infrastructure.<br>• Opportunity to diversify into reverse logistics and washing systems for reuse |
| Recycling companies | • Need to adapt machinery and processes to more durable products (i.e. reusable products, after at least ten cycles of use) |

[8] Reverse logistics refers to activities engaged to recapture the value of products, parts and materials once they have reached end-of-use or end-of-life. All value retention processes (such as reuse) may be considered to be part of a reverse-logistics system, and in addition activities including collection, transportation and secondary markets provide essential mechanisms for facilitating reverse-logistics (IRP 2018).

## 2.1.2 **Align regulation of chemicals, material and waste flows to reuse**

Chemicals are an integral part of plastics as they confer them with specific desirable functionalities; however, they can be released into the air, water and soil at all stages of the plastic life cycle and have a significant social and environmental cost (Grandjean and Bellanger 2017). Over 13,000 chemical substances have been identified as associated with plastics as monomers, additives and processing aids. After analysing a fraction of these chemicals (>7,000), 3,200 chemicals have been catalogued as of concern due to their potential adverse impacts on human health and the environment in UNEP's (2023) '**Chemicals in Plastics: A Technical Report**'. These include chemicals that can mimic, block or alter the actions of hormones, reduce fertility and damage the nervous system. See topic sheet on '**Criteria for chemicals in plastics**', which builds on UNEP's (2023) 'Chemicals in Plastics: A Technical Report'.

While there is already legislation in place to regulate the safety of plastics, it is often designed to ensure safety of materials used in the economy from a linear perspective, i.e. assuming they will only go through the economy once. For example, the Stockholm Convention does control various persistent organic pollutants (POPs) that have been used in plastics as additives, flame retardants, plasticizers or in the manufacture of fluoropolymers.

The perspective of products having to be used and reused in the economy several times, and their materials cycled back into new products at the end of life, rather than disposed, may require alignment of safety-related regulation. In addition, the economic benefits of allowing new chemicals entering the market quickly will likely need to be balanced with the overall society benefits of those same chemicals and their properties. Improved transparency and traceability on product contents (including chemicals used) must be ensured to allow safer management along the life cycle, for multiple cycles of products and materials in the economy.

Because circularity (through reuse and recycling) will increase the time that these chemicals are circulating in the economy, the reduction of a wide range of hazardous chemicals will minimise potential impacts on human health and biota at all stages of the life cycle. This is particularly important for chemicals that are persistent, bio accumulative and toxic either at very low levels (e.g. carcinogens, mutagens, reproductive toxicants and endocrine disrupting chemicals) or at cumulative exposure. Higher exposure to chemicals happens during production, waste management and recycling phases (mostly in low-income countries). Consumers' exposure to chemical additives in plastics is most significant at the use stage of plastic products (Fantke *et al.* 2016), including plastic based food packaging, building materials, electronics, toys, textiles or household products.

Beyond the regulation of chemicals, waste management generation has been regulated considering waste as a nuisance capable of generating impacts from which humans and the environment need to be protected. While this has ensured a good level of protection, in the context of circularity it may impede the most efficient use of resources. E.g. in reuse schemes empty containers are transported in reverse logistics schemes, for them to be washed and reused again. If these empty containers are classified as waste at the end of each useful cycle, this would generate high management costs and require the intervention of accredited waste handling companies making the shift to reuse economically unfeasible. In the context of aviation, international catering waste often needs to be incinerated to avoid spreading animal diseases, even though research indicates that the risk is negligible (ICAO 2022).

In summary, safety regulations established in the past may need to be revisited with a risk management perspective to ensure losses in efficiency are not disproportionate compared to gains in safety.

## 2.1.3 **What level of ambition can be achieved through reuse?**

Per capita use of plastics in 2040 can be kept at roughly today's levels, by eliminating unnecessary plastics (9 per cent reduction by mass) and switching to reuse and new delivery models (22 per cent reduction, Figure 10). Elimination and reuse offer the biggest reduction in plastic pollution, often represent net savings, and provide the highest greenhouse gas (GHG) emissions mitigation (The Pew Charitable Trusts and Systemiq 2020; UNEP 2021a).

In practice, an ambitious shift to reuse will see significant scale up of product volumes being sold in reusable/refill models, starting with those product categories where change may be easiest or impact highest. Examples of these categories are bottled products, products in sachets, hospitality, retail and catering (including fast food and food delivery). Other sectors have the potential for big impacts (e.g. personal care products such as diapers and menstrual products), but may require further support.

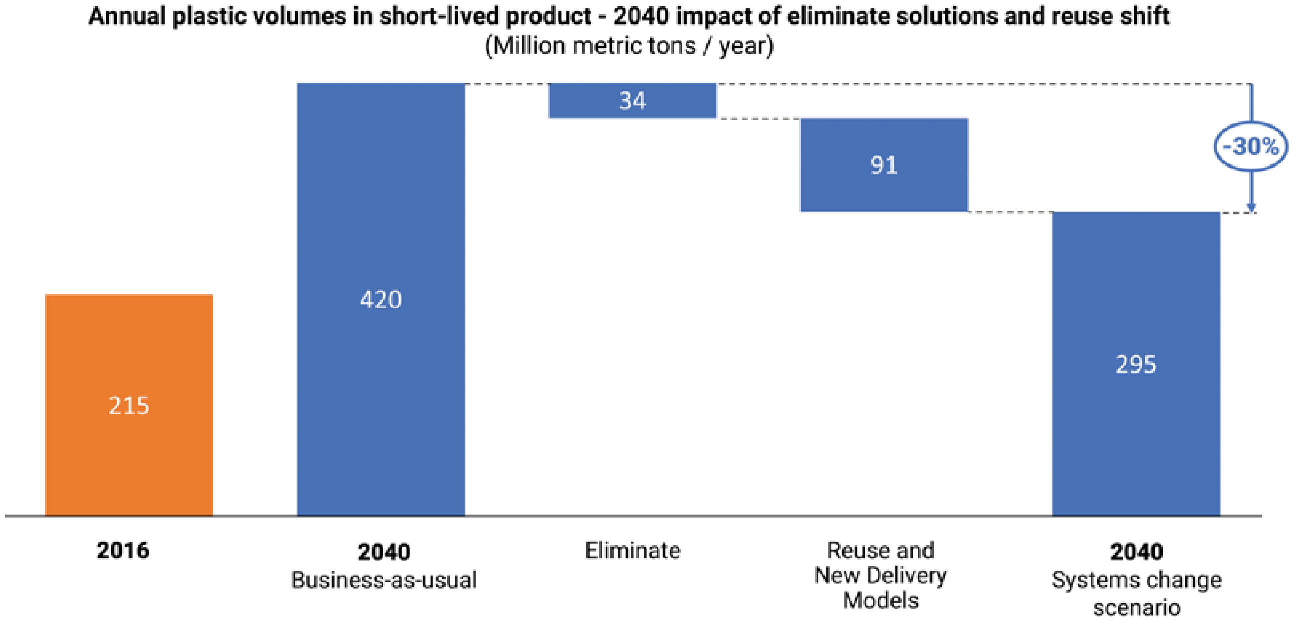


Figure 10: **Utility demand in 2016 and 2040, and how it is met by eliminate solutions and the reuse shift in the systems change scenario.**

*Source: The Pew Charitable Trusts and Systemiq 2020.*

## 2.1.4 **How will implementation differ by context?**

Under the systems change scenario, decreased plastic consumption must happen across all regions, and per capita plastic consumption will decrease dramatically in high-income countries. Despite per capita and total plastic consumption in low- and middle-income countries increasing somewhat compared to today's levels (before switching any plastics to single-use substitutes, which are discussed in section 2.3), a rapid decrease of the current rapid growth trajectory is achieved under systems change. This can bring significant benefits, if countries 'leapfrog' to a modern economy based on material-efficient, innovative reuse solutions that avoid exacerbating their already overburdened waste infrastructure. Design for reuse and refurbishment can bring more benefits in terms of jobs and income in low- and middle-income countries where labour costs are lower.

## 2.1.5 **What are the potential barriers and opportunities for reuse over the next five years?**

Reuse solutions for short-lived plastics are already technologically available today, with many having already been used in the past, and several offer cost savings. However, investment is required to support the transition to an economy that maintains products at their highest possible value. Well-designed EPR schemes provide effective economic incentives to shift supply chains and consumer behaviour and help overcome transition costs e.g. by removing any fees from reuse schemes. Many solutions are also at an early stage of availability and require financial investment to scale, from public and private source, with an essential role of governments to develop progressive policies and incentives to attract private capital, especially for business-to-consumer models which are less mature than business-to-business models such as reusable shipping and logistics (WEF 2022).

However, the shift could ultimately bring strong cost savings and opportunities at-scale: for example, the Ellen MacArthur Foundation estimates the economic opportunity of switching to reuse models at USD 10 billion (EMF 2019). Innovation in this area is on the rise: registered trademarks rose by 23 per cent annually for plastics reuse between 1995 and 2017 (OECD 2022b). Companies are increasingly publicly reporting on plastic footprints and many have set measurable, absolute reduction and reuse targets, such as through the New Plastics Economy Global Commitment (launched by EMF and UNEP in 2018).

It is critical to ensure that shifting to reuse models does not increase GHG or create other unacceptable trade-offs. While UNEP (2021a) shows how LCA studies usually confirm the environmental preference of reuse systems over single-use, it also points at key parameters to be considered to ensure their preference, such as a minimum number of reuse cycles, efficient reverse logistics or washing.

# 2.2 **Market shift two: Accelerate recycling**

| **6%** | **25-47%** | **80-120Bn** |
|---|---|---|
| of plastics is of recycled origin today (OECD 2022b) | material loss rates in today's recycling processes | USD lost to the economy annually (95% of the material value in plastic packaging) (EMF, WEF and McKinsey & Co. 2016) |

For many years, the mantra has been to increase public support for recycling and move away from single-use plastics. However, plastic products need to be designed and made of materials that enable recycling. Close to 80 per cent of the plastic in short-lived plastic products is not economically recyclable due to design decisions such as additives (e.g. dyes), material combinations or even size. A tiny proportion of plastic products can be reused safely. Establishing design rules e.g. to reduce the number of different polymers altogether, favour the design formats that are easier to reuse or recycle, or standardize formats for reuse so they can be shared by multiple companies, can go a long way in improving the profitability of reuse and recycling schemes. By agreeing to establish common design rules and standards in problematic sectors such as packaging, governments could unlock multiple benefits such as significantly increasing reuse rates, expanding the share of economically recyclable plastics (both contributing to a reduction in total plastic use with no change in utility) and unlocking the GHG savings potential of this sector. GHG emissions can be reduced by approximately 48 per cent when comparing recycling versus landfilling plastic waste (see Annex 1.1).

However, re-designing plastic products to enable recycling is not enough; collection systems need to be in place to facilitate recycling. It is estimated that today there are about two billion people not connected to waste collection systems (UNEP and ISWA 2015), and the challenge will only increase as populations grow. Ensuring inclusivity in the informal collection sector will enable expansion of collection and sorting efforts. Aligning the collection and sorting processes with the recycling system can ensure recycled plastic matches the quality, consistency and grade requirements of virgin plastic.

Once the product reaches the recycling plant, the two possible technologies are mechanical recycling or chemical conversion. Mechanical recycling is based on proven technologies, the economics are clearer and it emits approximately 50 per cent less GHG emissions per metric ton of plastic product than chemical plastic-to-plastic conversion (The Pew Charitable Trusts and Systemiq 2020). Chemical plastic-to-plastic conversion is at its early stages of development but can become a synergetic solution to mechanical recycling - if and when its sustainability is demonstrated through LCA studies - for products that mechanical recycling cannot manage, including mixed polymers, low-value and/or contaminated plastic. It creates virgin-like quality which can be used for food-grade plastics and can accept a wider range of materials as feedstock. Hence, while this technology is controversial due to a high environmental footprint, it has the potential to play a role among the solutions to address plastic pollution if these challenges can be addressed. Currently, analyses estimate losses in recycling processes around 25 per cent; improved technologies could significantly reduce the losses (The Pew Charitable Trusts and Systemiq 2020).

Recycling can be accelerated by improving its economics; aligning the incentives in design with the recycling economy and ensuring safe and fair recycling in practice and at scale (i.e. enabling investment in infrastructure). As with reuse, the presence of specific chemicals of concern in plastics reduces their potential for circularity, and thus makes recycling less economically favourable. The considerations for reuse described in section 2.1.2 also apply to recycling. Trading plastic waste from areas where there is no recycling infrastructure to places with surplus recycling capacity can enhance circularity through economies of scale and ensuring access to feedstock. By establishing a legally binding framework for the trade in plastic waste, the Basel Convention plastic waste amendments creates the conditions for more transparent global trade in plastic waste. Increased transparency, traceability and sharing of information will make enforcement more effective, curbing the illegal dumping of plastic waste in countries not wishing to receive such waste or lacking the capabilities for environmentally sound management. The amendments also provide a powerful incentive for the private sector, governments and other stakeholders to create enabling environments and technologies for recycling as well as for reducing the generation of plastic waste.

Photo: Getty Images

## 2.2.1 **Improve the economics of recycling**

Recycling markets cannot take off while virgin plastic has a lower price than secondary plastic. Recycled materials are often sold at higher prices than virgin plastic (10 to 47 per cent lower in Europe, except for recycled polyethylene terephthalate (PET), according to a recent study by the European Commission's Joint Research Center) (García-Gutiérrez *et al.* 2023). Various subsidies for fossil fuels can in some countries lower the costs of producing virgin plastic, making it more difficult for systems that deliver the same function with less / no virgin plastic to appear economically attractive.

Hence most recycling technologies are not economically viable and require support through subsidies or change is needed to the availability or price of feedstock and the market for the recycled output. Even though the economic viability of recycling technologies will evolve over time – average costs for chemical conversion are estimated to decrease by 37.5 per cent between 2019 and 2040, while virgin plastic cost will increase with fossil fuel price rise – breakeven will be reached as far as in 2040 for certain technologies (gasification) (García-Gutiérrez *et al.* 2023).

Considering the indirect costs of the linear plastics economy as demonstrated earlier in this report, governments may consider bringing in these external costs e.g. in the form of a virgin plastic tax or levy as already operational in a few countries (e.g. Spain and the United Kingdom of Great Britain & Northern Ireland). EPR schemes could also modulate their fees to ensure that easier-to-recycle products (and products that incorporate recycled content) pay less than harder-to-recycle ones.

Finally, governments and businesses can incentivise and de-risk investments into recycling infrastructure e.g. through inclusion of minimum recycled content criteria in public procurement or long-term offtake contracts to guarantee demand for recycled polymers, similar to power purchase agreements in the energy sector.

Table 5: **Implications of the recycling shift for different actors across the value chain.**

| Actor | Considerations for the recycling shift |
|---|---|
| Polymer and chemical producers | • Overall plastic production may plateau / not grow so much as forecast<br>• Polymer production for short-lived plastics would decrease<br>• Stopping the expansion of new production plants now will avoid the risk of stranded assets.<br>• Investing in recycling, particularly chemical recycling technologies that may be closer to current business models / technology |
| Plastic converters | • Adapt machinery and design to incorporate growing rates of post-consumer recycled content<br>• Adapt processes to deliver different grades of secondary material (e.g. food grade vs. non-food grade) |
| Brands / manufacturers | • Design products suitable for recycling: simplification of polymer types, removal of dyes etc.<br>• Engage consumers to buy more recyclable products<br>• Strengthen social license to operate as recycled content and recyclability are well understood as part of the solution.<br>• Delivery of corporate targets (e.g. New Plastics Economy Global Commitment) Higher contributions to the costs of running the system as EPR schemes expand, but strong incentives to reduce the fees paid through better and easier to recycle designs |
| Retailers | • May incur increased costs if deposit-return systems are built into retail space, but opportunity to play a clear part of the solution<br>• Strengthened social license to operate<br>• Choice editing to favour most recycled / recyclable items<br>• Delivering of corporate targets (e.g. New Plastic Economy Global Commitment) |
| Governments | • Delivery on waste targets and avoiding growth in greenhouse gas and toxic emissions linked to plastic production.<br>• Significant job growth particularly in less skilled jobs that may support poverty alleviation and gender equality.<br>• Local governments may need to mobilise significant resources to ensure collection, sorting and recycling infrastructure is in place, and possible facilitate permitting processes for these facilities<br>• Reduced health impacts on the population and costs to health services |
| Consumers | • Important role in contributing to close the loop<br>• locally-adapted nudging will help in assuring consumer participation in recycling. Consumer information required to ensure understanding of how product is handled at the end of use<br>• Important to consider the gender dimension in the transition to avoid disproportionate impact on women |
| Waste pickers | • Value of plastic waste will increase as its technical and economic recyclability increases, increasing their revenues<br>• Risk of excluding informal waste pickers as business of recycling becomes more profitable<br>• Opportunity to become formal part of the recycling sector with safer and better paid jobs if conditions for a just transition are observed |
| Waste management companies | • Reduced volume of higher value waste to be managed vs. BAU, but the share of volume being recycled will grow two-three-fold by 2040, also following growth in waste collection globally |
| Recycling companies | • Significant opportunity to grow business as collection of a more valuable plastic waste expands, and demand for Post-Consumer Recycled content increases boosted by legal targets |

## 2.2.2 **Align design incentives with the recycling economy: designing for recycling**

| 2X | ONLY 21% | 25% |
| --- | --- | --- |
| Recyclability and recycling profitability can be doubled via design | of plastic today is economically recyclable | of chemicals linked to plastics bring concerns to health and our environment (Wiesinger, Wang and Hellweg 2021) |

Today, many plastic items are designed in ways that make reuse or recycling difficult and uneconomical. To accelerate recycling, focus needs to first be on the design phase of plastic products because it creates the condition for product recyclability from a technical and economic perspective, facilitates collection and sorting and ensures products do not hinder or disrupt the recyclability of other items in the same waste streams. This will entail designing away from flexible, multilayer and multi-material plastic products (which account for 80 per cent of pollution – Figure 11 – and are harder to collect, sort and less economically viable to recycle) towards rigid and mono-materials, as well as eliminating any additives or pigments that hinder recyclability. Better design standards will contribute to reducing losses in sorting, currently around 20 per cent (The Pew Charitable Trusts and Systemiq 2020). Also critical in the design phase is addressing issues of associated chemicals of concern to avoid adverse impacts on human health and the environment. Design for recyclability can improve recycling profitability from USD 120 per metric ton to USD 240 per metric ton and increase the share of plastics that are economically recyclable mechanically from 21 per cent today to over 50 per cent in 2040.

### Box 4: **What can be called recyclable?**

According to the EMF (2020) a packaging or a packaging component is recyclable if post-consumer collection, sorting and recycling is proven to work in practice and at scale. A package can be considered recyclable if its main packaging components, together representing more than 95 per cent of the entire packaging weight, meet this requirement, and if the remaining minor components are compatible with the recycling process and do not hinder the recyclability of the main components.

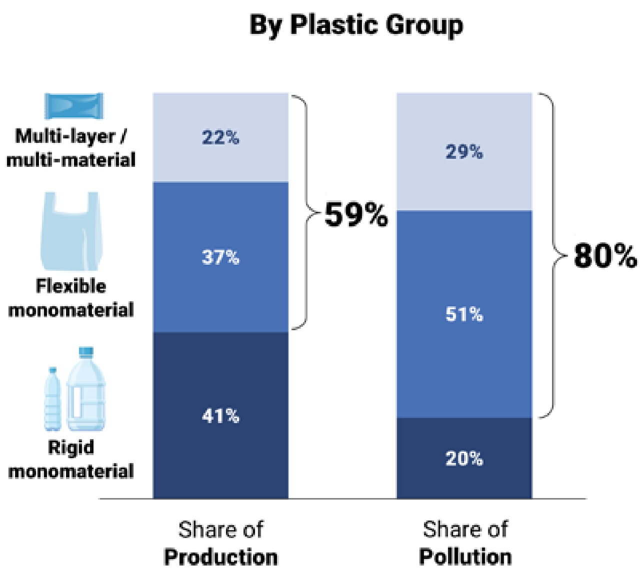


Figure 11: **Pollution vs. production by plastic type.**
*Source: The Pew Charitable Trusts and Systemiq 2020.*

Under the systems change scenario, product design would:

- switch 50 per cent of global multi material flexibles to mono material or recyclable combinations by 2030 and 100 per cent by 2040
- remove all dyes, pigments and additives that interfere with recycling economics
- increase homogeneity of plastic types and formats, designing-out and/or banning hard-to-recycle and problematic polymers (e.g. polyvinyl chloride, polystyrene and expanded polystyrene in packaging)
- improve and standardise labelling to help customers sort waste better
- increase the amount of post-consumer recycled content (PCR) into all new products (e.g. to 35 per cent in short-lived products by 2040, see Table 3)
- eliminate hazardous chemicals, promote and develop safe and sustainable alternatives and build on existing efforts such as UNEP's work on green and sustainable chemistry (UNEP 2022b)

The European Investment Bank (EIB) (2023) also recommends most of the design incentives above. In the case of durable plastic goods, the design can focus on design for disassembly and recycling, extending durability, life spans, refurbishment and reuse. Some industry specific actions include enhancing the use of mono material, recyclable textiles, and ensuring electronic products can be refurbished and reused, including by making replacement parts available and banning 'planned obsolescence'.

## 2.2.3 **Ensure scale-up of safe and fair collection, sorting and recycling of plastic products**

To accelerate recycling both the demand for and the supply of recycled (secondary) plastics needs to be scaled up. Demand signals such as legal targets help in securing long-term demand and help de-risk investments to improve the supply-side of recycling. This section considers the latter and focuses on increasing collection, sorting and recycling capacity.

### Increase collection and sorting

**22%**

of plastic from short-lived products is not collected today

**2 Bn**

people lack access to collection services today (UNEP and ISWA 2015)

**>11 Mn**

informal waste pickers in the world (The Pew Charitable Trusts and Systemiq 2020)

Collection is a critical stage in plastic waste management because uncollected waste not only becomes pollution but also represents lost revenue as resources are not reused. Globally, over 22 per cent of plastic from short-lived products is not collected, and this is predicted to increase to 34 per cent by 2040 (The Pew Charitable Trusts and Systemiq 2020). Uncollected plastic waste leads to open burning, which contributes to the release of toxins and GHG emissions, and blockage of drains which is responsible for floods and spread of diseases.

High-income countries already show most of their waste is collected, even in most rural areas. Rates are lower in low- and middle-income countries, but with significant financial investment and improvements in governance it is possible to reach urban collection rates above 90 per cent and rural collection rates above 50 per cent, which are needed to achieve systems change (Figure 12). Public and private capital are expected to respond to the investments needs, estimated to USD 54 billion for formal collection and sorting between 2021 and 2040. The systems change scenario assumes economic limitations, especially in rural areas, prevent complete collection rates.

| | | 2016 | | 2040 |
|---|---|---|---|---|
| Middle-Income Countries | Urban | 80% | ⇨ | 95% |
| | Rural | 45% | ⇨ | 50% |
| Low-Income Countries | Urban | 67% | ⇨ | 90% |
| | Rural | 30% | ⇨ | 50% |

Figure 12: **Collection rates required to achieve systems change.**

*Source: The Pew Charitable Trusts and Systemiq 2020.*

Higher efficiency in waste management systems can be achieved by improving sorting rules and infrastructure to enhance recycling, including sorting waste at source/home and separation technologies at recycling plants. To ensure the transition to a systems change scenario the share of waste sorted at source needs to be over 50 per cent in high-income countries (currently it is approximately 25 per cent) and between 20 and 30 per cent in low- and middle-income countries (currently it is minimal).

The remainder of non-recyclable plastics must also be managed as part of expanding overall municipal waste collection services including organic waste, which will have added health and climate benefits.

Such an expansion is a costly endeavour, and current waste collection is already a major cost for municipalities (10–20 per cent of council budgets in low- and middle-income countries (Kaza *et al.* 2018)). Investing in collection rate expansion will increase municipality budgets in ranges from USD 80–110 million per million metric tons of plastic waste collected in middle-income countries and USD 40–80 million in low-income countries (The Pew Charitable Trusts and Systemiq 2020).

Local taxation is unlikely to cover the investment level required, even with support from central governments, therefore additional sources of funding, for example extending responsibility to producers, will be necessary.

Parallel to increased funding, stronger regulations and enforcement can accelerate the shift to the systems change scenario. For example, cost-effective solutions to keep track of collection vehicles can help prevent direct dumping of collected waste, a practice common in some countries to avoid landfill costs and/or long drives to landfills.

It is imperative that actions and regulations consider the role of the informal sector and build systems where informal sector workers can access safe, healthy and fairly paid livelihoods. Close to 800,000 new jobs relative to today will be required in formal and informal waste collection by 2040 under the systems change scenario (Figure 7), which provides a clear opportunity for improved livelihoods directly alleviating poverty mainly in the Global South.

## Improve recycling capacity

Mechanical recycling is among the most important solutions to eliminate plastics pollution because it is already proven and managed profitably for some plastic types/products and in certain geographies. Scaling this up will reduce pressure on landfills, reduce the dependence on virgin fossil fuels and potentially lower costs of materials. In addition, the plastics economy can decouple economic development from a dependency on virgin fossil fuels in an environment of volatility and high prices.

With ambitious but realistic assumptions, the systems change scenario presented in this study estimates global mechanical recycling capacity can scale up to address 86 MMt per year of plastic waste by 2040; i.e. doubling the capacity available today and more than doubling the related jobs. Capacity could even be tripled to 129 MMt per year, but this would require even more aggressive progress in accelerating design for recycling as well as collection and sorting. See Annex 1.1 for further details.

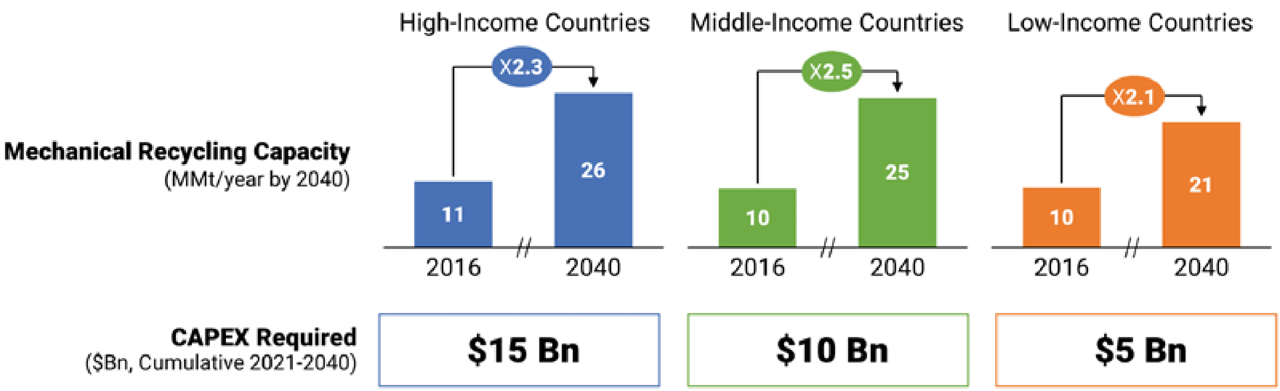


Figure 13: **Mechanical recycling capacity (MMt/year).**
*Source: The Pew Charitable Trusts and Systemiq 2020.*

When reduction, substitution, design and collection are implemented in parallel, mechanical recycling can cover approximately 35 per cent of the total plastics volumes in short-lived products (versus 15 per cent currently) (The Pew Charitable Trusts and Systemiq 2020). Mechanical recycling can bring economic savings into the global plastics economy; it has the potential to reduce the total system cost (e.g. closed loop including collection and sorting costs) by USD 80 to USD 300 per metric ton, depending on the region and in comparison to non-circular life cycles. Mechanical recycling emits approximately 60 per cent less emissions than controlled incineration on a per ton basis. Only the elimination of plastic in the design or reuse schemes are more beneficial than mechanical recycling when it comes to GHG emissions.

Chemical conversion promises certain advantages which can complement mechanical recycling and increase retention of plastic in the economy once its sustainability credentials are assured. The output of chemical conversion can be used in food-grade quality and has more tolerance to different materials and conditions for feedstock. Furthermore, chemical conversion can facilitate many more recycling loops than most mechanical recycling processes. Chemical conversion can therefore be used in synergy with mechanical recycling to address specific plastic types, such as films, multi materials and contaminated plastic, but this will require building chemical conversion capacity as it is currently very low. However, this technology has some important shortcomings and should be scaled with careful consideration (García-Gutiérrez *et al.* 2023) - including high energy requirements, unproven yields and economics for certain applications in some geographies.

## Box 5: **What is chemical conversion?**

Chemical conversion refers to a number of technologies (pyrolysis, depolymerization, gasification and dissolution) that use chemical agents or processes to break down plastic into basic chemical building blocks, either to make new plastic or other materials. Several technologies are being developed that can turn plastic waste back into chemical compounds to be reintroduced as plastic feedstock with the same properties as virgin plastic, usually referred to as plastic-to-plastic (P2P) technologies. Similar technologies are used widely for plastic-to-fuel (P2F) conversion. In P2F, the output material of chemical conversion plants is refined into alternative fuels such as diesel and therefore this is not considered recycling. This chapter about chemical conversion focuses on plastic-to-plastic conversion only.

Using existing investment in chemical plastic-to-plastic conversion as reference, and accounting for feedstock availability and the time to build infrastructure, plastic-to-plastic chemical conversion could reach an annual capacity of 13 MMt per year by 2040, with an investment requirement estimated at USD 30 billion (Figure 14).

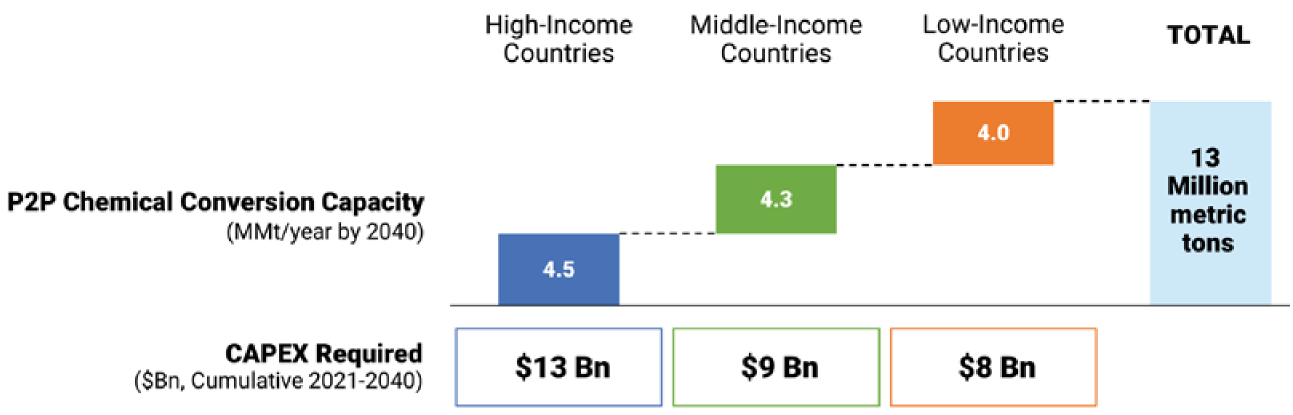


Figure 14: **Chemical conversion capacity in 2040 (MMt/year) by region.**

*Source: The Pew Charitable Trusts and Systemiq 2020.*

Chemical conversion would provide a solution for about 5 per cent of the plastics volume in short-lived products by 2040. While this may seem relatively small, this volume cannot be recycled mechanically and has no better solution. Further development of technologies for chemical conversion would need to address its current high GHG emissions. The GHG emissions generated when producing one metric ton of plastic through P2P (including collection and sorting) is 19 per cent lower than the emissions of producing one metric ton of virgin plastic that is later collected, sorted and incinerated (The Pew Charitable Trusts and Systemiq 2020: Figure 20, page 44). However P2P emissions are 10 per cent higher when compared to producing one metric ton of virgin plastic that is later collected, sorted and landfilled (see Annex 1.1).

## 2.2.4 **How will implementation differ by context?**

Recyclability depends on local sorting and recycling infrastructure. Therefore, companies should select their business models, materials and designs considering the market where the products will be sold. This is especially important for multinational corporations who typically design products and packaging in a central hub for many markets. Harmonised international standards and definitions for design for recycling can make it easier for companies to design products that are recyclable across markets, as well as streamlining the use of polymers, additives, dyes and pigments. Certain polymers - such as PET and High-density polyethylene (HDPE) - are typically easier to recycle from a technical and economical perspective, and have more widespread recycling infrastructure.

Collection may be a challenge in low- and middle-income countries, where inefficient systems, increase in per capita plastic consumption and rapid population growth exacerbate the challenge. Rural regions in these countries need particular attention as they have the lowest collection rates and, in some cases, also generate a disproportionate share of plastic pollution.

Municipalities are typically the main players to improve collection systems, as they are responsible for allocating financial resources, creating the appropriate regulations, encouraging waste management expansions and ensuring that the livelihoods of people in the informal sector are improved. Central governments may also contribute by ensuring national regulations and governance structures make effective collection possible.

The expansion of mechanical recycling capacity can benefit all geographies (Figure 13), and the largest opportunities are in the rural regions in low- and middle-income countries.

Given that chemical conversion requires a certain amount of waste density to be economically attractive, it is typically more applicable in urban areas that have higher feedstock density and more consistent access to plastic waste. The 13 MMt per year of P2P capacity required by 2040 in the systems change scenario could likely be developed across geographies, with analysis indicating that by 2040 it is feasible to develop an annual capacity of nearly 5 MMt in high-income countries, over 4 MMt in middle-income countries, and 4 MMt in low-income countries (The Pew Charitable Trusts and Systemiq 2020).

## 2.2.5 **What are the barriers and opportunities over the next five years?**

Opportunities exist to expand ongoing voluntary initiatives. For example, over 1,000 organisations have aligned behind the Ellen MacArthur Foundation's New Plastics Economy vision, and pledged that their products will be completely reusable, recyclable or compostable by 2025 (EMF 2023).

Additional opportunities can emerge from creating environments that incentivise investment. Policy and industry groups can be encouraged to increase research and development funding and blended capital to finance capacity expansion, and de-risk investments in infrastructure. Mexico is an example of a country where the enabling environment successfully incentivised investment in recycling. Waste management legislation requiring large waste producers to develop plans to reduce and value waste facilitated the expansion of a recycled PET (rPET) entity created by large beverage companies to increase recycling in the country. Initially funded by the International Finance Corporation, the private sector arm of the World Bank, the rPET entity contributed to the creation of the first bottle-to bottle recycling facility in Latin America and increased investment in domestic recycling infrastructure. Resulting in the increase of the recycling rate in Mexico from 8.8 per cent in 2002 to 56 per cent in 2018. This also contributed to the development of new capital market solutions in Mexico through the issuance of the first green bond with a sustainability criteria related to the increased use of recycled PET content (WEF 2022).

Learnings from one country in Southeast Asia indicate there are three root causes to low waste handling levels:

1. Waste systems are dependent on local leadership exposure to political pressures/cycles.
2. In rural areas, a local community often has responsibility for waste management, yet does not have the financial resources, institutional capacity or technical knowledge to do so. Often women undertake this unpaid and unacknowledged role as part of their gender roles (IETC and GRID-Arendal 2019).
3. There is no enforced mandate for governments to provide universal waste services and no incentives for households to responsibly manage their waste.

To address these issues and significantly improve waste governance, these actions have proven beneficial:

- Avoid delegating waste management to local leadership, and rather institutionalise waste management with law and regulation
- Assign the government (e.g regency/city government or municipality) the full responsibility for waste management, instead of local community led approaches. The government in partnership with community-based or private waste operators owns the responsibility to ensure success
- Create incentives against dumping and open burning of waste and in favour of households managing waste responsibly

Table 6: **Innovation opportunities to unlock greater impact from recycling.**

| | |
|---|---|
| **Design for recycling** | • Enhanced barrier properties for mono-materials including paper and compostables<br>• Design additional recycling solutions for replacing multi-materials<br>• Household goods made from recyclable mono-materials, or modular products designed for disassembly and recycling |
| **Collection** | • Reduced collection costs in low-income areas (especially rural, remote and other low-density areas)<br>• Improve profitability, productivity, and working conditions for the informal sector through technology, tools and aggregation markets |
| **Sorting and mechanical recycling** | • New models for sorting and aggregation of waste, including automated sorting<br>• Scaling and simplification of source separation in collection systems through regulation, education, incentives and improved standards<br>• Improved technology to reduce sorting losses, handle food contamination, or create higher-quality output affordably, particularly for food-grade outputs<br>• Investment in innovation in sorting and recycling technology is identified as a priority by EIB (2023) |
| **Chemical conversion** | • Technology, business or financing solutions to reach widespread collection of low-value plastics in remote and low-income countries<br>• Improve process efficiency to increase naphtha fractions and reduce emissions<br>• Technology to allow variety in feedstock composition and quality |

# 2.3 **Market shift three: Reorient and diversify the market for sustainable and safe plastic alternatives**

| 2X | 17% | ~25% |
|---|---|---|
| Plastic consumption is expected to double by 2040 globally under BAU versus 2016 | of plastics in short-lived products can be replaced with sustainable substitutes | average GHG emissions reduction when switching flexible plastic to sustainably sourced paper[9] |

Exploring alternative materials to replace virgin plastics is a critical upstream outcome in the systems change scenario to achieve a decrease in overall virgin plastic production and enable circular end-of-life management. Some plastics from short-lived products cannot be eliminated or switched to reuse models but remain problematic because they are non-recyclable or have high littering rates. In these cases, switching from traditional plastics to sustainable substitute materials may be considered if there is LCA-based evidence demonstrating their sustainability. This section therefore focuses on plastics from short-lived products, such as plastic wrappers, sachets and takeaway items.

The careful replacement of specific problematic plastic products with short-lived products made from alternative materials, such as paper and compostable materials, can deliver a 17 per cent decrease in plastic pollution. The substitutions need to be made in an environmentally and socially sound manner, considering unintended consequences of substitutes or prioritising substitutes that are themselves recycled materials: recycled (secondary) plastic can also be used as a suitable substitute material.

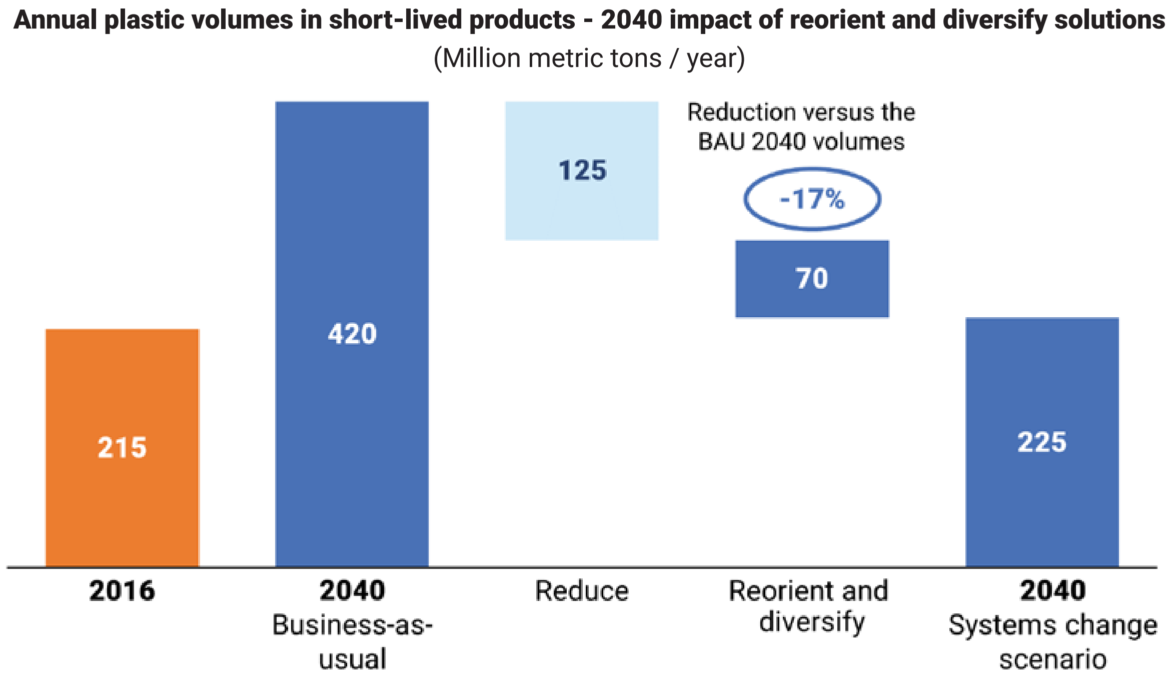


Figure 15: **The role of reorienting and diversifying in a systems change scenario compared to BAU 2040.**
*Source: The Pew Charitable Trusts and Systemiq 2020.*

[9] Average reduction compared to plastic which is mechanically recycled, landfilled or incinerated (See annex - assumes substituting to paper involves using 1.5 tons of paper for every 1 ton of plastic replaced).

Photo: Getty Images

The following enablers will help in enhancing the sustainability and accelerating the pace of reorienting: Ensure sustainability criteria for plastic alternatives are agreed and demonstrable; Improve the economics of reorient and diversify; Align regulation of alternatives to a safe and fair circular economy.

## 2.3.1 **Ensure sustainability criteria for plastic alternatives are agreed and demonstrable**

Material switches, especially from plastic to renewable and/or biodegradable materials, are often the most immediate alternatives that come to mind when considering ways to end plastic pollution. However, comprehensive assessments including environmental and socio-economic indicators often demonstrate that not all alternatives to plastic lead to better outcomes. Usually, the better alternatives are reusable products, regardless of their material (UNEP 2021a).

To identify suitable and more sustainable alternative materials, a mechanism is needed to assess their potential to replace plastic and to avoid unintended consequences of plastic substitution (including costs, land use change, increases in GHG emissions and nutrient effluents, contamination within the waste streams and impacts on human health) (IRP 2021). This should be assured by an objective case-by-case product-level life cycle assessment with appropriate testing to ensure the products comply with sustainability and national health standards (UNEP 2020a; UNEP 2020b; UNEP 2021a).

UNEP's 10 factors to consider when informing substitutions of single-use plastic products with Life Cycle Assessment (UNEP 2021a) and 10 Objectives and Guiding Considerations for Green and Sustainable Chemistry (UNEP 2021b) can be used to inform effective substitution. Due consideration should be given to the societal distribution of costs and benefits of substitution, human rights and gender. For packaging specific analysis, the World Business Council for Sustainable Development (WBCSD) developed a SPHERE packaging sustainability assessment framework (WBCSD 2022). The World Bank has sought to simplify the choice of alternatives by creating the Plastic Substitution Trade-off Estimator to provide a holistic comparison of the costs and benefits of plastics and their alternatives (WBG 2022a).

The topic sheet on '**Materials and products substitutions**' provides more details on the criteria to consider when assessing replacements.

## 2.3.2 **Improve the economics of alternatives under reorient and diversify**

Substitution with more sustainable alternative materials has higher production costs on average (one and a half to two times the cost of plastics), but in some cases substitutes can improve sustainability (e.g. sustainably sourced, recyclable paper). A virgin plastic tax would contribute to improving the economics of alternative materials by increasing the price of plastic products made from virgin plastics. The alternative materials may also save GHG emissions compared to short-lived plastics if key impact considerations, such as avoiding waste, packaging weight changes, sustainable sourcing, and matching substitute materials to available end-of-life treatment options, are well-managed. The systems change scenario estimates the industry for paper and compostables can create around three million jobs globally by 2040 just from plastic substitutes (Figure 7).

Tensions are anticipated between economic actors that may perceive themselves as 'winning' or 'losing' with the reorient and diversify market shift (Table 7).

Table 7: **Implications of the reorient and diversify shift for different actors across the value chain.**

| Actor | Consideration for the Reorient and Diversify Shift |
|---|---|
| Polymer and chemical producers | • Consider investing into renewable / bio-based plastics or alternative materials. Otherwise, this market shift reduces the market share of polymer producers. |
| Producers of sustainable alternative materials | • Investing in assuring the sustainability of materials produced will lead to significant benefits.<br>• Need to assure necessary infrastructure (e.g. segregate collection for compostable plastics and composting plants), and prioritise assessment of safety and sustainability of alternatives. Including producers of bio-based feedstock |
| Plastic converters | As above |
| Brands / manufacturers | • Significant cost implications in shifting to alternative sustainable materials, though in specific markets this may have good consumer buy-in as it is perceived as part of the solution.<br>• Strengthened social license to operate.<br>• Delivery of corporate targets around compostability (e.g. New Plastics Economy Global Commitment). |
| Governments | • Significant job growth linked to alternative materials, which more than compensates reduced job growth in polymer production sector<br>• A shift to compostable products needs significant investments in necessary composting infrastructure and segregate collection |
| Consumers | • Need for awareness and to understand information conveyed on new materials<br>• Harmonised labelling requirements will help guide on how to handle the material at the end of its use |
| Waste pickers | • Unclear value of new materials, potentially impacting on their revenues<br>• Opportunity to create new revenue streams through composting if conditions for a just transition are observed |
| Waste management companies | • Need for significant investments in composting facilities<br>• Segregating organic matter and compostable materials from other recyclables (such as plastics) will increase the value of waste management globally |
| Recycling companies | • Potential diversification opportunity into composting |

### 2.3.3 **Align regulation of alternatives to a safe and fair circular economy**

In contrast with the durability of plastics, biodegradable and compostable materials are often presented as a positive alternative to plastic products. The terms 'compostable' and 'biodegradable' are widely used but at present are inconsistently understood and defined, creating confusion among consumers, companies, regulators and investors. The extent to which compostable and biodegradable plastics can be considered suitable substitutes is highly dependent on their application and end-of-life processing.

This is exacerbated by the intentional misuse of these terms to falsely signal that a plastic product has elevated environmental standards (i.e. 'greenwashing'). Therefore, it is valuable to harmonise the use of terms and create internationally accepted and adopted definitions and standards for 'compostable' and 'biodegradable' materials urgently. This can be accelerated through the International Organization for Standardization (ISO) work programme on the development of standards related to plastics.

#### Box 6: **Key considerations in the development of standards for compostable and biodegradable plastics (adapted from the European Environment Agency) include:**

1. If and how fast a plastic item biodegrades depends on 1) if it is designed for biodegradation or composting, and 2) the conditions and duration it is exposed to after use. There must be alignment with the plastics used and the biodegradation or composting facilities and conditions available.
2. The conditions in home composters and in the open environment are very different compared to industrial composting plants and this affects the rate and extent of breakdown, which again asserts the importance of alignment between plastics and treatment.
3. Biodegradable, compostable and bio-based plastics need clearer labelling and repeated awareness-raising campaigns targeting users to ensure their correct disposal and treatment.
4. A certification scheme is needed to ensure the integrity of compostable and biodegradable claims.

Definitions for compostable and biodegradable (as well as bio-based) are provided in the Glossary.

Science Advice for Policy by European Academies published an evidence-based report (2020) on the biodegradability of plastics in the open environment, which is a guide on applications where biodegradables might bring advantages versus those where they are not advocated. Using the most up to date evidence to inform definitions and standards is essential, and they should be designed with the ability to be updated as more evidence becomes available. Other types of material should not be overlooked. For example, there is a strong case for the development of definitions and standards for sustainable fibre-based materials, or bio-based materials more generally. An additional attribute that received some attention is oxo-degradable. Such products contain a pro-oxidant that induces degradation under favourable conditions, although complete breakdown of the polymers and their subsequent biodegradation have not been proven (UNEP 2015b). The European Commission (COM 2018a) concludes that fragmented plastics will not fully biodegrade and present a subsequent risk of accumulation of microplastics in the environment, and consequently Directive 2019/904 of 5 June 2019 bans the placing on the market of products made from oxo-degradable plastic.

Photo: Getty Images

## 2.3.4 **What are the potential barriers and opportunities over the next five years?**

Deployment of alternatives to plastics should always be backed by LCA studies providing evidence that the alternatives are superior to the plastics they replace (UNEP 2021a). The trade-offs of different material types vary by geography. Sustainable sourcing of wood is a critical concern especially in the Global South, where certification schemes are less developed and paper demand can drive deforestation (Gaveau *et al.* 2018). Under the systems change scenario, low- and middle-income countries therefore roll out less fibre-based substitutes, only 6 per cent of 2040 plastics compared to 12 per cent in high-income countries. Substitute material choices are matched to the local end-of-life waste management infrastructure available, such as paper recycling value chains. The availability of effective end-of-life composting infrastructure enables the roll out of compostable materials in specific geographies. Plastic products most suitable for substitution are problematic or non-recyclable plastic formats, including on-the-go takeaway items and multi-material flexibles. When using recycled (secondary) plastic to substitute virgin plastic, jobs and economic opportunities in both the formal and informal waste sectors are likely to grow as the recycled content targets increase.

Advancing and scaling substitute materials provides an opportunity for innovation and economic development. Importantly, deployment at scale of composting infrastructure for compostable products, as well as segregate collection, would be crucial in any circumstance where these products replace plastic items. Innovation on new materials that are bio-benign, ephemeral, lower-cost and/or are coupled to available waste infrastructure for zero leakage can unlock greater impact from reorient and diversify to near-zero pollution in the coming years. However, the best alternatives are usually linked to the way products are used, rather than the materials they are made of (UNEP 2021a).

# 2.4 **Addressing demand for durable plastic products**

Solutions for durable plastics are addressed from a qualitative perspective structured by industry sector, as each has different use cases, tends to not end up in municipal waste management systems and requires dedicated end-of-life solutions.

Over 30 per cent of plastic waste generation is estimated to come from durable products (OECD 2022b), and a high proportion of this occurs in high-income countries. To date, evidence of significant pollution from durable plastic products in the environment is lacking.

Durables may contribute less to plastic pollution because waste from these products is usually not disposed by consumers (e.g. construction waste) and tends to be better managed, heavier and more expensive. However, it is important to also address pollution from durable plastic products to ensure greater efficiencies in plastic use and reuse; also, durable plastic products produced today for sectors such as transport, textiles and construction will impact the amount of waste arising for decades to come.

## Box 7: **What are durable plastic products?**

Durable plastic products are those that require resistance and with average use cycles above three years. These plastics are frequently used for industrial and construction applications (Geyer, Jambeck and Law 2017). Examples of durable plastics include piping and cabling, insulation, flooring and framing in buildings and construction; structural elements in vehicles; household and industrial machinery; membranes and casings in batteries; office equipment and furniture.

Upstream reduction measures for durable plastic products present unique challenges and opportunities:

- Transport and construction plastics play important roles. Plastics in the transport sector improves vehicle safety and mileage due to their lightweight nature, flexibility and strength. Plastics in buildings support energy and temperature efficiency. Banning, removing or replacing durable plastics in these sectors could have knock-on consequences.
- The industrial sectors involved are fragmented. Each sector - automotive, construction, electronics, textiles and agriculture - involves different companies and policy players, making global governance challenging.
- A change in mindset can offer additional opportunities for reduction of durable plastics. New forms of elimination would include rethinking how societal needs are met with fewer resources through reuse and repair, new delivery models, product lifetime extension and lifestyle changes.
- Durable products offer high potential for use of recycled plastic content. While overall consumption of plastic in durable products may be harder to curb, it can be satisfied with a larger proportion of recycled content, i.e. not involving consumption of solely virgin polymers.

Sensibly reducing plastic demand and waste from durable plastic products over time can be facilitated by industry-specific actions including (Systemiq 2022):

- The use of safe and known chemicals, additives and plastics in construction, automotive and other durable plastics. Durable construction and automotive plastics often contain chemicals of concern potentially risking human and environmental exposure if they leak into nature, enter the recycling value chain or become food packaging or children's toys (Aurisano *et al.* 2021).
- The reduction in automotive material usage through decreasing overall need for vehicles (e.g. promoting shared and public transport), and the refurbishment and reuse of plastic components.
- The reduction or reuse of construction plastics, via a shift towards the renovation and refurbishment of buildings, selective demolition and the use of recycled plastic material
- Decreasing demand for electrical goods and textiles through sharing, reuse, right to repair and increasing the durability and length of use of goods.

An estimated 12.5 MMt of plastic products are used annually in plant and animal production, and plastic use in greenhouses, mulching etc. is projected to increase 50 per cent by 2030 (FAO 2021). For both agricultural and fishing plastics, upstream measures spanning plastic reduction, waste collection, recycling and pollution prevention are likely to be more impactful, and require less labour and capital investment, than remedial clean-up measures. Industry-specific actions for source-reduction of fishing related and agricultural plastic waste include (UNEP 2021d; EIA 2022a):

- Education and economic incentives (such as Extended Producer Responsibility) supporting fishers to maintain, repair and prevent loss of nets and gear (International Union for the Conservation of Nature [IUCN] 2022).
- Design standards and innovation for fishing gear with lower loss rates.
- Standards and best practice frameworks for managing fishing gear (Global Ghost Gear Initiative 2021), and the removal of regulatory barriers.
- Elimination of the most polluting plastic products in agriculture, including plastic films, polymer coated fertilisers, seeds and pesticides (FAO 2021; Center for International Environmental Law [CIEL] 2022), putting in place incentives for reusable plastics and transition towards a regenerative agri-food system with fewer material inputs.
- International voluntary code of conduct for agricultural plastics.
- Collection and recycling of the remaining plastics.


Photo: Getty Images

# Dealing with the legacy

Photo: Getty Images

Even with the market transformation approach described in the previous sections, a significant volume of plastics cannot be made circular in the coming 10 to 20 years and will require disposal solutions to prevent pollution. This will be particularly important in those countries that do not yet have environmentally sound waste management infrastructure at sufficient scale.

Options considered in this section include the elimination of microplastics at source, using plastic waste as fuel in existing facilities, engineered landfilling, plastic-to-fuel (P2F) chemical conversion and incineration with energy recovery. The practice of exporting plastic waste is also addressed, as well as options to deal with existing pollution. It should also be noted that entrepreneurs across the world are coming up with ways to recover some value out of non-recyclable plastics by recovering them as material of lower quality or functionality, what is commonly known as 'downcycling' (e.g. plastics mixed with sand to produce bricks). Although this report does not go into details of this option, it is crucial to ensure that the resulting products do not shed fragments of the disintegrated plastic material to avoid generating new sources of microplastic leakage.

## 3.1 Prevent microplastics at their source

**>6%**

of annual global plastic pollution is from microplastics

**89%**

of microplastic releases end up as environmental pollution

**~50%**

of microplastic pollution can be reduced by 2040 with known solutions

Microplastics can be primary or secondary, depending on the source. Primary microplastics are those originally produced or directly released into the environment as microsize particles (<5mm size). Secondary microplastics are microsize fragments originating from the degradation of large plastic waste into smaller plastic fragments once exposed to the environment. Microplastics bring risks to ecosystems and human health (Bouwmeester *et al.* 2015). Given these particles become dispersed and are hard to collect, the most effective policies focus on prevention. Four key sources of microplastics (non-exhaustive) - tyre dust, plastic pellets, textiles and personal care products - contribute six per cent of the annual plastic pollution entering the environment (The Pew Charitable Trusts and Systemiq 2020). The actual contribution is higher if the abrasion of paints and road markings, or the application of sewage sludge, which contains microplastics, onto fields is included.

Tackling the largest source of microplastics, tyre abrasion, requires reducing automotive mileage, redesigning tyres and behavioural change. For textiles, the design and production phases are critical so that losses from garments are minimised, and losses that do occur during washing could be prevented from becoming pollution at-source by introducing filters on washing machines. Reducing pollution from plastic pellets requires improvements in their production and value chains and facilitating safe transport to prevent spillage including during maritime transport. Banning the use of intentionally added microplastics is key for controlling pollution from personal care products (Figure 16).

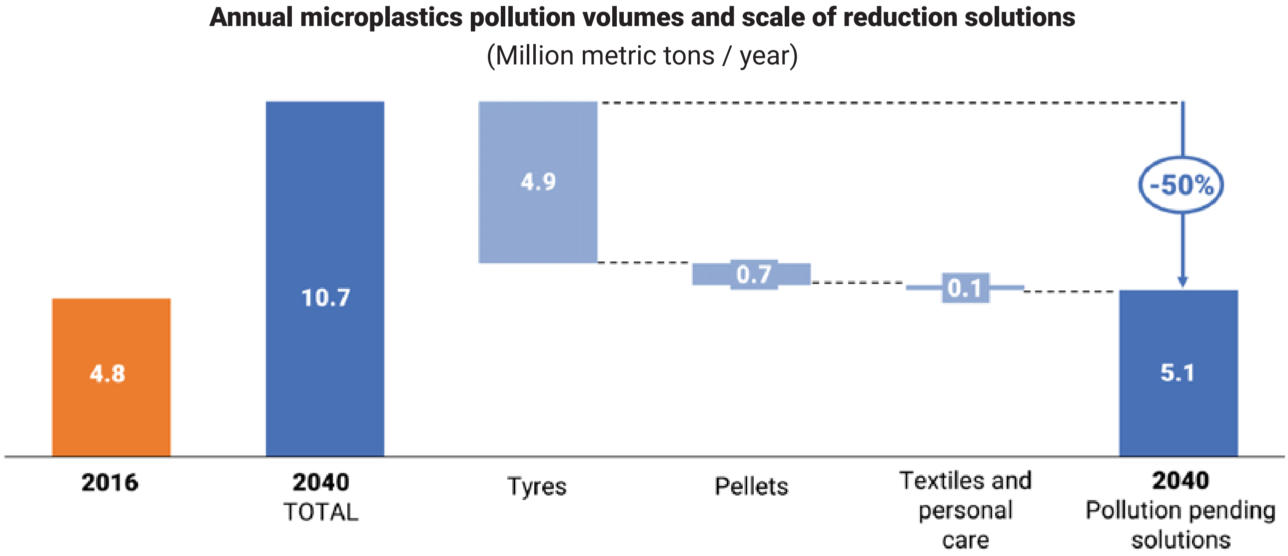


Figure 16: **Microplastic pollution under BAU and reduction from four sources under the systems change scenario in 2040.**
*Source: The Pew Charitable Trusts and Systemiq 2020.*

The largest efforts are needed in high-income countries, which contribute three times more microplastic pollution per capita than low- and middle-income countries. Tackling high tyre abrasion rates from transportation is particularly crucial in high-income countries due to high mileage per capita. Many low- and middle- income countries could more effectively focus on other solutions, for example as the bulk of textile production factories are located in those countries, they could be assisted to reduce and capture microfibres at source, or they could focus on tackling higher plastic pellet losses in industrial production and transport by concentrating on workforce training and enforcement.

## 3.1.1 What are the barriers and opportunities over the next five years?

Globally coordinated efforts that are supported by policy, including through trade on reduction, design standards, substitution and as a second priority downstream capture, can mobilize action on microplastics. Barriers to overcome and opportunities to embrace include:

- Some important challenges in microplastic pollution currently lack robust and scalable solutions, especially tyre abrasion capture and treatment.
- Challenges in funding and accelerating the roll-out of wastewater treatment services to collect and capture microplastics remain after implementing upstream reduction measures. These services offer large co-benefits to human and environmental health, but come with great costs.
- Barriers to trade and investment in sustainable and safe plastic alternatives as well as environmentally sound goods and services for waste management and recycling.
- Large textile industry groups jointly signed an agreement on textile microfibres and carried out a fibre fragmentation trial, hoping to create harmonised CEN (European Committee for Standardisation) and ISO standards.
- Plastics producers globally have voluntarily signed up to Operation Clean Sweep® to implement education and capture technologies for pellet losses during production and transportation, which could be classified as a hazardous material to further avoid leakage during transportation.
- Many sources of microplastics require further analysis, including microplastic releases directly to agricultural soils from fertilisers, plastic mulch and plastic covers, as well as from paints.

# 3.2 **Identify or build safe waste disposal facilities**

**23%**

of collected plastic from short-lived products ends in dumpsites

**>100**

million metric tons of plastic from short-lived products need a disposal solution by 2040

The systems change scenario accepts that sub-optimal solutions will need to be applied to prevent those plastics that we cannot eliminate or recycle from becoming pollution. These avoid plastic pollution but require further assessment of unintended trade-offs such as increased GHG or toxic emissions.

## 3.2.1 **What does this entail?**

Governments should assess whether existing facilities may be available and safe (e.g. cement kilns) or whether new disposal capacity is required, favouring lowest investment needs and reducing risk of technological lock-in. Safe and responsible collection and disposal of non-circular plastics and plastic pollution recovered from the environment will avoid the impacts of this plastic pollution in ecosystems e.g. GHG emissions and air pollution from open burning.

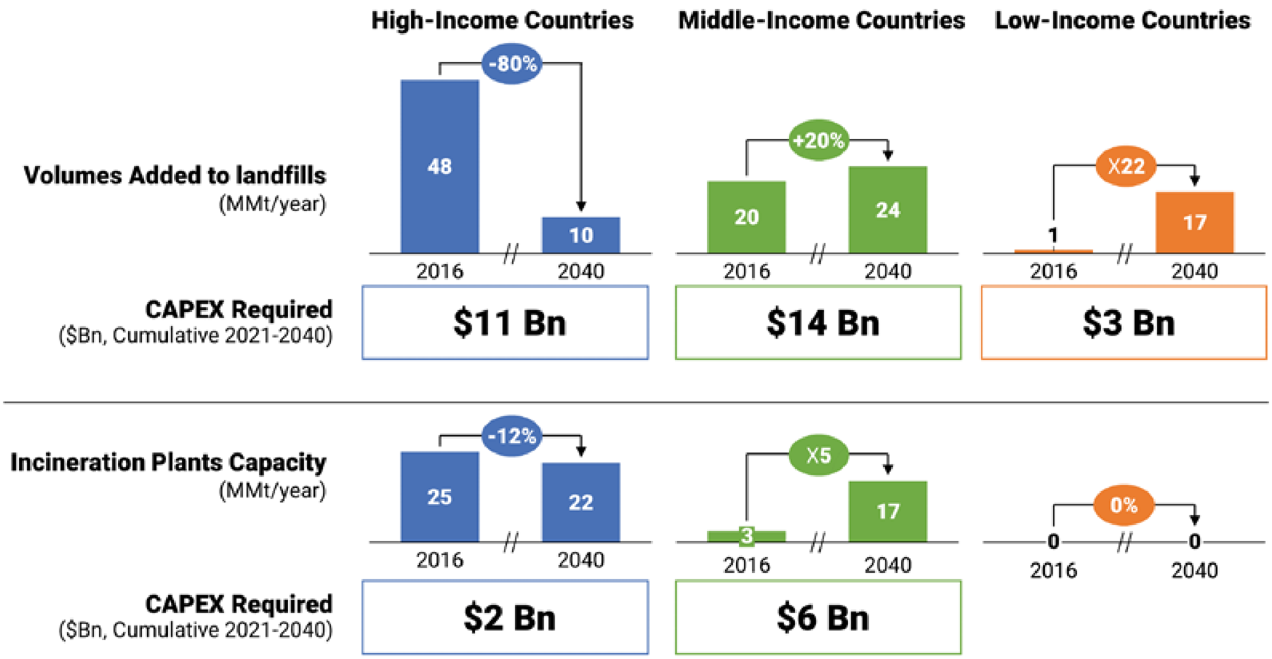


Figure 17: **Volumes (MMt) to be safely disposed by region.**

*Source: The Pew Charitable Trusts and Systemiq 2020.*

Most countries have cement kiln production capacities and the key advantages of using them is the reduced investment requirements and the capacity to deal with plastic waste at an industrial scale from plastic hotspots or mining efforts from landfills and dumpsites (Sharma *et al*. 2019). With this approach, the energy content in non-recyclable plastic waste can be harnessed to produce clinker while reducing the reliance on fossil fuels. While the GHG emissions balance is slightly positive for plastic when compared to coal, there are concerns of potential toxic emissions such as furans and dioxins when the conditions in the kilns are not optimal and close monitoring and quality control are essential. The GIZ-Holcim guidelines for waste co-processing (GIZ-LafargeHolcim 2020) provide a guide for the use of waste as alternative fuels in cement kilns.

While using existing infrastructure requires smaller investments than building new one, the cement kiln process does not come without costs. Collecting waste plastic from landfills, dumpsites and the environment followed by processing the waste into a suitable alternative fuel requires investments and operational cost. The quality assurance aspects also require laboratory testing facilities. This ties in with the health and safety aspects that should be considered to mitigate a range of risks in all steps of the process. Some of the costs related to using plastic waste as an alternative fuel in the cement kiln process could be tied to plastic credits associated with non-recyclable plastics from clean-up activities.

After the use of existing infrastructure, engineered landfills are the most cost-effective waste disposal method and they do not require high capex investments like incinerators. They differ from problematic open landfills in terms of cover and management practices to prevent leakages to the environment or the emission of pollutants from open burning. However, engineered landfills do have important downsides, for example microplastics can percolate into the environment even in the most sanitary landfills. In addition, plastics contaminated with organic matter become a source of GHG emissions as the organic matter rots and turns into methane.

And like with all final disposal options, the costs undergone in their production are lost to the economy when plastics are landfilled. They also take significant space, often near urban centres. Engineered landfills remain a solution for the transition because of low capital needs and the ease of downsizing as better solutions arise (i.e. no locked-in effect), although further research into the chemicals released from plastics in landfills and their impacts on human health is needed.

Incineration plants incinerate waste including plastics and can recover energy in the process. These plants must be managed to a highest standard as otherwise they can bring serious drawbacks for the environment, by releasing GHG emissions, and for human health, for example by emitting pollutants. The disadvantage of investing in incinerators is it locks a municipality into needing a long-term, stable flow of plastic feedstock to recuperate the hundreds of millions of dollars in capital costs. Stable waste incineration requires waste with a minimum average calorific value of 7 megajoules per kilogram (MJ/kg), and should never fall below 6 MJ/kg for combustion without auxiliary fuel. This energy comes largely from plastics, cardboard, paper and textiles. Since these are the materials that are most likely to be collected by waste pickers for recycling, destroying them via thermal treatment threatens waste picker livelihoods (UNEP 2019c), and removes the incentive to invest in recycling the resources back in the economy. Reversely, the overall trend to advance towards enhanced circularity that the three market shifts in Chapter 2 highlight, will surely reduce the amount of plastic waste that will be available for incineration in the future, and hence increase the risk of investments in incineration. UNEP (2019c) provides additional questions that governments should consider before investing in incineration plants; for most developing countries the preconditions to build and operate waste incineration plants are not given.

Chemical conversion of plastic-to-fuel (P2F) has similar consequences as incineration and creates the same locked-in risks and concerns for the environment. Plastic-to-fuel is strongly discouraged.

### 3.2.2 **What will it achieve?**

Given the limits to growing better solutions faster, disposal will still be required in 2040 to prevent approximately 100 MMt of plastic waste pollution in the environment. Disposal solutions will emit more GHG than recycling solutions. For example, a ton of plastic waste ending in an incineration plant emits from 50–150 per cent more GHG than if it's mechanically recycled (see Annex 1.1).

However, disposal solutions remain a better option when compared to open burning - a ton of plastic waste ending in an incineration plant emits around 20 per cent less GHG than if the same ton is burnt in the open (See Annex 1.1).

Also, plastic ending up in the environment has been found to continue emitting hydrocarbons including methane, particularly when exposed to sunlight (Royer *et al.* 2018); while a full quantification of these emissions for plastic pollution globally is lacking, it is likely that controlled disposal would reduce such emissions.

## 3.2.3 **How will implementation differ by context?**

The need for expanding disposal capacities mainly relates to low- and middle-income countries, particularly as population and consumption per capita increases and municipalities improve their collection rates. High-income countries may downsize their infrastructure and capacity to dispose of plastic waste as the different actions to reduce and recycle make an impact.

Some middle-income countries have already announced aggressive plans for expanding waste-to-energy incineration plants. For example China has set a target of disposing of nearly a third of the country's garbage with waste-to-energy plants by 2030 (Guo *et al.* 2021).

Low-income countries require a significant increase of annual capacity to dispose over 20 MMt of plastic waste by 2040, starting from minimal capacities in 2016 (1 MMt per year). Given the high need for capital and lack of margins in incineration plants, the systems change scenario includes existing cement kilns and engineered landfills as the preferential option to meet this need instead of incinerators. A more aggressive uptake of design for recycling and subsequent collection for recycling or, ideally, faster shift to reuse models, would be even better options from socio-economic and environmental points of view.

## 3.2.4 **What are the opportunities and challenges over the next five years?**

One of the challenges is exiting landfilling and incineration efficiently as circularity expands in high-income countries and the flows of waste into incinerators and landfills decreases.

Another challenge is strengthening governance and/or creating economic incentives for proper management of plants. Poor administrative capacity and accountability is likely to be an ongoing barrier to implementing more formal national regulatory frameworks. Both access-controlled landfills and incinerators have attracted criticism because they block the informal recycling sector from accessing materials that people rely on for income.

Under the European Union Landfill Directive (EU 1999), member states will be banned from sending more than 10 per cent of their total municipal solid waste to landfills after 2035, also restricting any waste that is suitable for recycling. This could have unintended consequences, motivating countries to pivot from landfilling to incineration with energy recovery, which would increase system-level GHG emissions from plastic. The EU Landfill Directive requires operational best practices to be implemented.

Photo: UNEP

# 3.3 **Eliminate plastic waste exports except in specific situations**

Plastic waste predominantly flows from regions that are well-prepared to manage waste but with high recycling costs to countries facing higher rates of waste mismanagement and inadequate enforcement capacities (Barnes 2019; Wang *et al.* 2020). Data is limited for the amounts of plastic waste exported for recycling, but best estimates indicate approximately 4 MMt of plastic waste per year is exported from high-income countries to low- and middle-income countries[10]. Strong arguments to stop this practice include:

- **Evidence suggests mismanagement:** There is a lack of adequate transparency or monitoring of plastic waste trade flows (March *et al.* 2022). Anecdotal evidence suggests that mismanaged or lost volumes are often not accounted for, falsely boosting the recycling performance metrics of high-income countries (Law *et al.* 2020; Walker 2023).

- **Governments are walking away from this business:** After China's import ban on plastic waste, other countries, including India, Indonesia, Malaysia, Thailand, Türkiye and Viet Nam, started to capture the plastics waste import business. However, some of these alternative destinations have now also implemented restrictions, temporary freezes or bans on material imports over fears that their waste management systems may become overwhelmed by the volumes entering the country. They are also increasingly returning containers of 'illegal' plastic waste that does not meet standards.

- **The Basel convention and its amendments:** A reduction in the plastic waste trade may already be underway. The fourteenth meeting of the Conference of the Parties to the Basel Convention adopted amendments to Annexes II, VIII and IX to the Convention. The amendments aim to enhance the control of transboundary movements of plastic waste and clarify the scope of the Basel Convention as it applies to such waste. They do not specifically ban the import, transit or export of plastic waste, but rather clarify when and how the Convention applies to such waste. The amendments imply that all plastic waste and mixtures of plastic waste generated by parties to the Convention, and which are to be moved to another Party, are subject to the prior informed consent procedure unless they are non-hazardous and destined for recycling in an environmentally sound manner and almost free from contamination and other types of waste. This will increase transparency and enable easier monitoring of plastic waste trade.

- **The systems change scenario indicates that it is feasible to reduce exports by around 90 per cent by 2040** (see Figure 18) if the right policies are implemented and if infrastructure is built to deal with this plastic waste locally or regionally. Exceptions to this reduction will be small nations, like the Pacific Small Island States, which may have to prioritise reduction and collection and leverage scaled recycling in other countries.

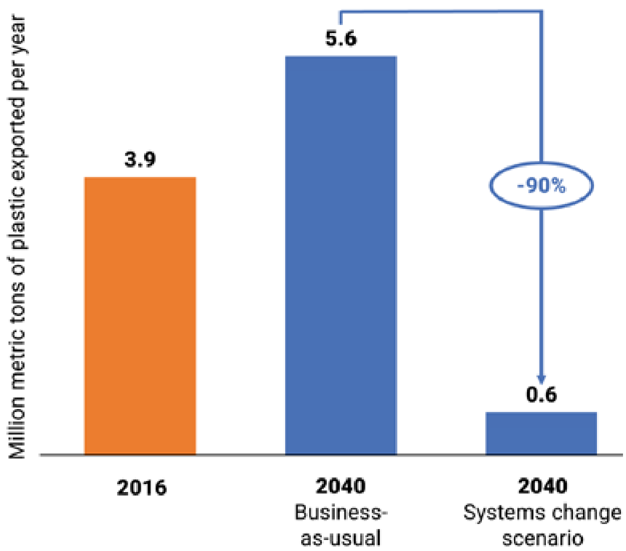


Figure 18: **Volumes (MMt) exported in systems change scenario vs. business-as-usual.**

*Source: The Pew Charitable Trusts and Systemiq 2020.*

While disposal of waste in the country where waste is generated is preferred, exports of plastic waste between neighbouring countries that is non-mixed and non-contaminated is not discouraged if the Prior Informed Consent procedure is followed: sometimes this may be the most efficient way to deal with waste. The challenges described above refer mainly to non-recyclable plastic waste exports.

[10] UN Comtrade data - commodity volumes under Heading 3915 - Waste, parings and scrap, of plastics

# 3.4 **Deal with the existing pollution**

| **22%** | **4,900 MMt** |
|---|---|
| of plastic waste is mismanaged: ending in dumpsites, open-burnt or in the environment | of plastic are estimated to have accumulated in landfills and the environment since 1950[11] |

According to OECD (2022b) 22 per cent of plastic waste evades waste management systems and goes into uncontrolled dumpsites, is burned in open pits or ends up in terrestrial or aquatic environments, especially in low- and middle-income economies. The impacts of this pollution are felt by everyone, but more so by those from a lower socio-economic status, the majority of whom are often women and reside closest to the most polluted environments (UN Women and UN Habitat 2020). Achieving plastic circularity will take time and commitment from producers, regulators and consumers alike. As waste leakage to the environment continues to accumulate, it needs to be cleaned up and dealt with.

Financing instruments are urgently needed to improve local waste management systems as well as livelihoods within the informal sector. To address the challenge of legacy plastics already in the environment, at the First session of Intergovernmental Negotiating Committee Ghana brought up the need to establish a legacy fund to which industrial leaders in the plastics sector could contribute to allocate resources to remove plastics that have already entered the environment.

A market-based solution that has emerged is the plastic credit system. Modelled after carbon credits, businesses can buy plastic credits from project developers who engage with the informal waste collectors. Some plastic credits systems operate as diversion credits; that is, they pay out when it has been proven that the collected materials have been prevented from entering nature or a disposal facility and have been delivered to and accepted by a recycling or manufacturing system. Other plastic credits systems provide a premium or bonus payment above the market price for the plastics sold to the recycling industry. A price support is only paid on top of or in association with actual purchase by the recycling or refurbishment industry. On a lesser scale, some plastic credits operate as a traceability mechanism and subsidy for safe end-of-life management, and the payment goes to supporting the costs of this safe end-of-life management.

## 3.4.1 **What are the opportunities and risks of plastic credits over the next five years?**

According to the World Wide Fund for Nature (WWF 2021), plastic credit systems pose risks if not developed and implemented appropriately. A major issue related to all plastic credits schemes is the current lack of a globally agreed-upon definition for a measurable, verifiable and transferable unit of plastic credit representing a specific quantity of recyclables that have been collected from the environment and recycled.

Another issue related to the plastic credit systems is their dependence on the informal sector to whom the plastics credit system brings opportunities but also poses risks. Informal waste collectors often are at the mercy of fluctuating prices for recyclables and the intermediate waste aggregators they sell their collected recyclables to. Since concerns persist concerning the beneficiaries of these schemes, related to the lack of transparency and standardised definitions making it difficult to assess projects' credibility, and the potential for social and environmental greenwashing, it is key that environmental and social safeguard systems are in place to ensure that the rights of the informal waste collectors are protected (UN-Habitat and NIVA 2022)

It is expected that increased dependence on the informal waste collectors will lead to better care on safety and hygiene aspects and the gradual professionalization for those supporting the waste value chain. However, it is crucial to ensure that women are duly absorbed into formalized systems and are compensated similarly to men. It is expected also that with more transparency required from buyers of credits, the informal sector could gain a stronger voice and strength to negotiate better (UN-Habitat and NIVA 2022).

[11] This estimate represents 60 per cent of all plastic ever produced Geyer *et al.* (2017).

Regarding the risks for the informal sector, a central challenge is that buyers of credits may be only temporary sources of funds, with little or no long-term income security. The volume-based compensation approach instead of work time-based income also means that variability of supply or sources of waste can cause variability of income for waste collectors. Furthermore, as buyers look for the cheapest credits, projects can be going to countries offering cheapest costs.

This can lead to a race to the bottom where the informal sector can be affected and see their income source reduced. Meanwhile, new digital tools applied by some project developers alienate waste collectors who are not able to own and/or use a smartphone, marginalizing certain groups of collectors. Substantial learnings generated from experience with carbon credits should be leveraged to ensure a robust plastic credit system.

### 3.4.2 **Targeting hotspots of plastic pollution**

In the oceans most of the leaked plastic resides in the deep-water column, like a plastic cloud, where cost-effective removal is unachievable without harming the environment (Harris *et al.* 2023). Given that rivers are likely the single biggest carrier of plastic pollution to the ocean (Jambeck *et al.* 2015; Meijer *et al.*, 2022), it makes sense to try and capture plastic in rivers before it reaches the sea. Recent research suggests that most plastic pollution that reaches rivers (over 90 per cent) is retained in them and does not reach the sea (van Emmerik *et al.* 2022). Nyberg *et al.* (2023) provide a mapping of which types of rivers store and spit out waste under different scenarios, informing what could be the most effective action to reduce inputs and clean up accumulations.

### 3.4.3 **The special case of 'ghost gear'**

Abandoned, lost and discarded fishing gear (ALDFG) or 'ghost gear' remains largely overlooked in plastic pollution action around the world. Fishing activities are estimated to cause at least one per cent of total plastic pollution (OECD 2022b). Early estimates based on limited data indicate that an average of 20-30 per cent of plastic litter in the environment comes from sea-based sources, including fishing nets, lines, ropes and abandoned vessels (Li *et al.* 2016). WWF (2020) calls fishing waste the deadliest form of marine plastic, threatening 66 per cent of marine animals, including all sea turtle species and 50 per cent of seabirds, with entanglement or entrapment. World Animal Protection (2014) estimates that abandoned nets kill at least 136,000 seals, sea lions and whales annually, and injure or kill thousands of birds, turtles, fish and other species.

While the threat from ghost gear differs from that of land-based plastics, the types of solutions are similar and require a coordinated effort across stakeholders, namely, to stop pollution at its source while improving waste management and recovery in the environment (see section 2.4). The hard wearing and durable materials fishing gear is made of (predominantly nylon, high-density polyethylene and polystyrene) are recyclable and can be processed into valuable and high-quality recycled pellets for new products (Hennøen 2016). However, recovering and cleaning nets and separating materials such as lead weights is challenging and time consuming and impurities impact quality and structural integrity of recyclables.

Action is needed across the board to prevent leakage into the environment and sustainably manage ghost gear:

- **At community and artisanal fisheries level:** economic incentives; training on cleaning, identifying, separating, and storing nets using simple low-cost infrastructure; and awareness raising are required, to collect and clean nets for recycling (Environmental Justice Foundation 2021).
- **At local and national government level:** multi-stakeholder processes; evidence-based policy frameworks, enforcement of gear marking and addressing illegal, unreported and unregulated fishing; and creating incentive schemes for closed-loop economy of fishing gear are key to encourage collection, sorting, recycling, reuse and repair.
- **At the manufacturing stage:** solutions being discussed include fishing gear that is completely biodegradable, encouraging innovative designs to make it easier to separate and recycle plastics used by the fishing industry and incentives and facilities to return gear at the end of its life, including EPR schemes.
- **At regional and international level:** coordination is needed to harmonize regulatory standards, define common methodologies to assess the scope, sources and impacts of ghost gear; to share knowledge, good practices and guidelines on responsible recovery, management and prevention of ghost gear; to harmonize gear marking and promote enforcement of existing laws and regulations; and invest in cleaning and recycling technologies and scaling good practices. Governments can leverage existing partnerships and mechanisms such as the Regional Seas to share knowledge, data and good practices, build capacity on ghost gear and harmonize gear marking.

# Policy and legislative changes required

Photo: Getty Images

# 4.1 **Regulatory interventions**

A tailored package of policy and legislative instruments specific to the goals and commitments of the jurisdiction can be brought about to address market failures and drive different behaviours that will help enable the shift to a new plastics economy.

For the purposes of this report, a policy is understood to be a plan, guideline, strategy or set of principles to guide actions to achieve a goal. Legislation is understood to mean any law or laws passed by a legislative body (e.g. parliament, congress or assembly) as well as any regulatory instruments or secondary legislation (e.g. regulations, by-laws or statutory instruments) enacted or issued by an authority empowered by law to do so. Plastics governance norms can also exist outside of these formal or contemporary legislative frameworks and structures. Other legal norms can exist, such as religious and customary laws on issues such as property rights and dispute resolution. In many countries, customary law norms are pervasive, and should therefore be considered in the design and implementation of the regulatory mix needed to shift plastics from a linear to a circular economy.

Regulatory instruments should also be viewed on a continuum vis-à-vis the degree of coercion used by a government to achieve the shift to a circular economy for plastics. At one end, governments may employ regulatory interventions that are non-binding but seek to persuade actors to change behaviour. For example, this may include voluntary agreements or codes of conduct with or for plastics industry participants, or a policy to implement a plastic use public behaviour change communication campaign. At the other end, governments may employ binding and enforceable regulatory instruments that have 'teeth', such as virgin-plastic taxation legislation or a legislative ban on single-use plastic products. Combinations of such approaches are often used. In most cases, legislation 'gives life' to non-binding instruments and policies by codifying them; i.e. a policy or other instrument has more chance of succeeding if it is implemented and supported by legislation that is clear, coherent, flexible and enforceable. Similarly, a government's policies will be materially facilitated if they are mandated by legislation.

That said, the choice and design of the optimal package of regulatory instruments must be informed by the specific context and commitments of the jurisdiction in question. The legal norms and traditions, political feasibility and social context of a country will have a material impact on what regulatory package should be pursued. For example, it might be desirable to have a voluntary code of conduct regarding extended producer responsibility put in place quickly, while in parallel consulting on and shaping a regulatory proposal on binding rules on such a scheme and backed by legislation. Similarly, a policy adopting and financing a behaviour change campaign does not necessarily warrant legislative force. A combination of national, subnational and city-based approaches may also be appropriate to ensure that local policies complement national legislation (UNEP 2020b). In all cases, there are cross-cutting issues that will need to be considered the design and implementation of the mix of regulatory instruments. This includes issues around a human rights-based approach and the need for a just transition to a circular plastics economy.

UNEP (2020b) provides guidance on the key considerations and practical recommendations on developing regulatory instruments to prevent plastic pollution, with a specific focus on single-use plastic products. Building from that report, the following four elements need to be considered by governments when developing regulatory instruments to tackle plastic pollution:

1. **Establishing a knowledge baseline**: it is important that governments consider the knowledge base of plastic pollution in their jurisdiction, e.g. through a baseline assessment of plastic import, manufacture, use, disposal and pollution (see the topic sheet '**Think Global – Act Local, NOW**'). Baseline assessments help obtain a comprehensive understanding of the problem to be addressed. In the assessment, governments should identify the sources of plastics and the reasons that they are problematic and identify their social, economic and environmental contexts and impacts (UNEP 2020a). Assessments should also seek to determine the perceptions of consumers, industry and other stakeholders regarding plastic pollution and their willingness to accept regulatory interventions. This is important for anticipating potential implementation challenges or public backlash. Establishment of a baseline will also facilitate the monitoring of results, which is essential for measuring the effectiveness of a policy intervention in combating plastic waste and pollution. Baseline assessments can ensure that the legislation targets the most problematic plastic products and determine what alternatives are already known and available (UNEP 2020b).

2. **Considering objectives and policymaking principles:** The goals defined in the market transformation (Chapter 2), together with the eventual goal(s) of an international legally binding instrument on

plastic pollution, as well as other international treaty obligations, will inform the selection and drafting of regulatory instruments, including promotion of gender equality and human rights. Other principles and concepts to bear in mind include the waste management hierarchy, precautionary principle or approach, polluter pays principle, a just transition and the right to a healthy environment. Beyond their international commitments, policymakers should decide what they wish to accomplish through the regulatory interventions towards achieving a circular plastics economy. This will vary depending on domestic factors such as local policy priorities, environmental and pollution concerns, consumer habits, industry and business concerns, national and local government goals and the political situation (UNEP 2020b).

3. **Selecting appropriate regulatory approaches:** plastic pollution cannot be resolved with individual policies ('silver bullets'). Integrated policies and laws reinforce each other towards the goal of transforming the economy. UNEP/PP/INC.1/INF/8 provides useful reflections on priorities for different types of countries. While the choice of specific instruments is jurisdiction specific, Table 8 provides an overview of what high ambition might look like. It details the types of intervention – including those with 'teeth' – that would be helpful to deliver the ambition described in this report (e.g. in the targets proposed in Table 3). The ultimate selection of which individual or package of policies and legislation to purse in any jurisdiction will necessarily be informed by the specific context and commitments of each country, including under existing multilateral environmental agreements and any new international legally binding instrument on plastic pollution. Whatever regulatory mix of interventions is chosen, effective implementation, compliance and enforcement of the regulatory instruments will be critical to their success.

4. **Participation, information and access to justice:** In line with Principle 10 of the Rio Declaration and other relevant commitments, governments and lawmakers should actively explore and ensure opportunities for facilitating effective access to information, access to public participation and access to justice, as key pillars of sound environmental governance of plastics. Active engagement with stakeholders would include, but would not be limited to, civil society, academia, consumers organizations, industry and private sector in general and any individuals or interest groups and communities whose lives and activities may be affected by the government decision-making.

In addition to regulatory interventions, countries will have to consider the impact of such measures on trade and their relationship with their trade partners (import/export). In an interconnected global economy, supported by a number of bilateral and multilateral trade and investment treaties, countries will need to review the extent to which domestic measures, relating to importation, manufacturing specifications or labelling, that initially aim to address plastic pollution may compromise their ability to honour their obligations under those trade treaties.

Mindful of that dimension of possible non-compliance with their obligations under the World Trade Organization (WTO) treaty regime, a group of WTO members have instigated an informal dialogue within the WTO forum on how the organization could contribute to efforts to reduce plastics pollution and promote the transition to more sustainable trade in plastics. With the WTO system well-known for its 'teeth' due to its effective dispute settlement mechanism, initiating the dialogue among states on how to avoid disagreement and sanctions and move towards harmonized domestic measures is key for international action to deal with plastic pollution.

Some of the policies and legislative options listed in Table 8 are to a certain degree also being addressed through existing instruments and/or agreements. For example, the technical guidelines for the identification and environmentally sound management of plastic wastes and for their disposal, adopted in 2002 by the Conference of the Parties to the Basel Convention, are currently being updated. To ensure that no plastic waste is exported to countries with insufficient waste management capacity, the Basel Convention and its plastic waste amendments create the conditions for the global trade in plastic waste to become more transparent and better regulated.

Table 8: **Policy and legislative options to support the market transformation.**

| | Regulatory Instrument | What high ambition might look like | Degree of coercion<br>Possibility to adopt instruments with 'teeth' | Market shifts |
|---|---|---|---|---|
| UPSTREAM | **U1.** An incremental rising tax/fee on the purchase of virgin plastic feedstock by manufacturers of plastic packaging and plastic-containing products | An incremental rising virgin plastic tax/fee is in place by 2025; rising from 15% (2025) to 50% (2040) of the externality cost | **High**<br>taxation legislation | REUSE, RECYCLE, REORIENT & DIVERSIFY<br>by bringing price of virgin plastic closer to its real cost |
| UPSTREAM | **U2.** A prohibition of products containing problematic or unnecessary plastic | No new unnecessary polymers or products containing problematic or unnecessary plastics are made, distributed or sold after 2025 | **High**<br>legislative ban | RECYCLE<br>by simplifying recycling processes |
| UPSTREAM | **U3.** Control measures on chemicals of concern | Control measures to prevent chemicals of concern put on the market after 2025 and their use in plastic products | **High**<br>legislative controls | REUSE, RECYCLE |
| UPSTREAM | **U4.** Obligation to replace plastics if safe and more sustainable alternatives exist | Substitution rate of 100% where more sustainable alternatives exist by 2030 | **High**<br>legislative requirement | REORIENT & DIVERSIFY |
| UPSTREAM | **U5.** Fiscal policy incentives for companies shifting their operations to circular plastics | Definition of criteria for sustainable circular plastic operations by 2025 to see acceleration of investments by 2030 | **Medium**<br>fiscal policy | REUSE, RECYCLE |
| MIDSTREAM | **M1.** Mandate the implementation of Extended Producer Responsibility schemes | EPR schemes are applied to 100% of new plastic products and packaging by 2030 | **High**<br>legislative requirement | REUSE, RECYCLE<br>better design + financing opex/capex of circular processes |
| MIDSTREAM | **M2.** Binding common design standards for reuse and recycling | Common design rules and standards for reuse and recycling in place by 2030 | **High**<br>legislative requirement | REUSE, RECYCLE |

| | | | | |
|---|---|---|---|---|
| **MIDSTREAM** | **M3.** A single, standardised, global plastics labelling scheme | A single, standardised global plastics labelling scheme is agreed upon and applied to all new plastic products by 2025 | **High** legislative requirement | REUSE RECYCLE REORIENT & DIVERSIFY<br>facilitating efficiency with end of use/end of life |
| | **M4.** A legal requirement for plastic products to contain increasing minimum recycled content for plastics | All single-use plastic products to contain >70% recycled material by 2040, and 50% for all other plastic products (where appropriate). To be defined per sector/use | **High** legislative requirement | RECYCLE<br>boosting demand for secondary plastics/de-risking investment in recycling capacity |
| | **M5.** Mandate establishing large-scale packaging reuse schemes in the fast-moving consumer goods sector | At least 50% of single use plastic items and single use plastic packaging has been replaced by reusable delivery systems by 2030 | **High** legislative requirement | REUSE<br>de-risking investment in reuse schemes |
| | **M6.** Trade mechanisms to reduce trade of problematic plastics | Internationally agreed criteria to identify good and bad plastics are adopted and in use by 2025 | **High** legislative requirement | RECYCLE REORIENT & DIVERSIFY |
| | **M7.** International standard and definitions for compostable and biodegradable materials. If standards and definitions are not in place, then the terms should be banned. | An internationally agreed standard and definitions are adopted and in use by 2025, or if not defined then the use of the terms is banned | **High** legislative requirement | REORIENT & DIVERSIFY |
| | **M8.** International standards and controls of chemicals of concern | Full criteria of international legal safe standards for the production, use and disposal of chemicals by 2030 | **High** legislative requirement | REUSE RECYCLE REORIENT & DIVERSIFY |
| | **M9.** Establish deposit return schemes for all suitable products | 100% of suitable products operative within a deposit return scheme by 2028 | **High** legislative requirement | REUSE RECYCLE REORIENT & DIVERSIFY<br>ensuring safe and fair circularity in practice and at scale |
| | **M10.** Incorporation of reuse and recycled content criteria in public procurement | Clear criteria for the support of reuse and recycling agreed by 2025. Governments set targets in line with ambition proposed in Table 3 by 2027 | **High** legislative requirement | REUSE RECYCLE<br>strengthening the demand |

| | | | | |
|---|---|---|---|---|
| MIDSTREAM | **M11.** Fiscal policy incentives for companies that implement reuse models | Criteria to demonstrate effective reuse agreed by 2025. Governments set targets in line with ambition proposed in Table 3 by 2027 | **Medium** fiscal policy | improving the economics of reuse and de-risking investment into reuse |
| DOWNSTREAM | **D1.** Increase mechanical recycling capacity through financial and fiscal policy incentives | 50% of all plastics are recycled by 2030; mechanical recycling on course to double (or triple, in the higher ambition) globally by 2040 | **Medium** fiscal policy | ensuring safe and fair recycling in practice and at scale |
| | **D2.** Increase chemical conversion capacity through financial incentives for plastic materials that cannot be recycled mechanically (with global standard ensuring the safety and sustainability of chemical recycling processes) | Support the proportional expansion of plastic-to-plastic chemical conversion capacity with full assessment of human and environmental risks and impacts, including by financial incentives and the incorporation of chemical conversion P2P in national targets by 2025 | **Medium** fiscal policy | ensuring safe and fair recycling in practice and at scale |
| | **D3.** Public investment in plastic waste collection | 100% collection of plastic waste by 2030 | **Medium** fiscal policy | ensuring safe and fair recycling in practice and at scale |
| | **D4.** Mandate to strengthen the alignment between the informal and formal plastics waste sector | 100% plastic collection by the informal waste sector is aligned with mainstream solid waste management | **High** legislative requirement | ensuring safe and fair recycling in practice and at scale |
| | **D5.** Establish ambitious recycling targets per material / application | Over 50% of plastics are recycled by 2035 | **High** legislative requirement | boosting demand for secondary plastics / de-risking investment in recycling capacity |

| | | | | |
|---|---|---|---|---|
| **CROSS-CUTTING** | **C1.** Adopting effective social and behaviour change communication strategies to end plastic pollution (Box 8) | | **Low** policy | REUSE, RECYCLE, REORIENT & DIVERSIFY |
| **DEALING WITH LEGACY** | **L1.** A prohibition of all intentionally added microplastics | No intentionally added microplastics included in any products by 2025 | **High** legislative ban | |
| | **L2.** Design standards and EPR for products with high microplastic shedding rates | EPR schemes and design standards in place for the tyre, paint, textile and other microplastic shedding industries by 2030 | **High** legislative requirement | |
| | **L3.** Global standards for landfill, incineration and waste-to-energy facilities | 100% safe disposal of end-of-life plastics by 2030 | **High** legislative requirement building from globally agreed standards/ instrument | |
| | **L4.** Taxes to disincentivize plastic disposal in landfills and incinerators | Established tax on engineered landfill, incineration and waste to energy | **High** taxation legislation | |
| | **L5.** Standards for downcycled plastic products to avoid shedding of microplastics | Standard agreed by 2026; 100% new downcycled plastic products aligned with standard by 2030 | **High** legislative requirement | |
| | **L6.** Global standard and verification system for plastic credits | Standard agreed by 2025; 100% plastic credits aligned with standard by 2030 | **High** legislative requirement | |
| | **L7.** No plastic waste exported to nations with insufficient waste management capacity | International ban on the export of waste plastic to nations with insufficient safe disposal capacity by 2025 | **High** legislative requirement | |
| | **L8**. EPR schemes for fishing gear | Guidance for effective EPR for fishing gear available in 2025 | **High** legislative requirement | |

## Box 8: **Effective social and behaviour change: Adopting communication strategies to reduce plastic pollution**

Tailored social and behaviour change campaigns and initiatives, focusing on sustainable consumption and safe disposal, are essential as they strengthen support for and compliance with plastic reduction policies (Martinho *et al.* 2017). Along with other initiatives such as educational programming, communication and advocacy campaigns are effective tools in generating public support and engagement around plastic pollution and creating a sense of environmental responsibility, which are prerequisites for action (Willis *et al.* 2018).

Yet, despite the heightened awareness and motivation from individuals to eliminate plastic pollution and move towards a circular economy, few campaigns have demonstrated success in bringing broader transformative and societal change to sustainable consumption choices. Tailored campaigns and communication initiatives that showcase the existence of plausible alternatives and provide opportunities on how to access them are more likely to turn awareness and concern for plastic pollution into action, unlocking new patterns of social and behaviour change. Social norms need to be understood and addressed. Focusing on gender roles and behavioural preferences is key to behavioural change (OECD 2020).

To be effective, citizen change campaigns should:

- **Be customizable:** Segment messaging based on aims and goals, regional and political context, and by target audience such as demographic (e.g. gender, age, education levels) and psychographic (e.g. values, political identity etc.).
- **Use positive norms and language:** 'Normalise' plastic reduction, safe disposal of plastics, and illustrate that individual choices matter. Consumers are more likely to engage in sustainable practices if they believe a behaviour is a positive social norm practised widely by others (Borg *et al.* 2020).
- **Convey Benefits:** Encourage social and behaviour change by conveying both individual benefits and change can lead to collective action which provides improved livelihoods on a global scale. Well-designed campaigns can create sustained impact on individual and societal consumption behaviour. By illustrating real life examples of how redirecting purchasing behaviour and shaping reuse behaviour can inspire society to move faster towards sustainable consumption and production practices.
- **Specify action:** Provide clear achievable tasks to drive action forward. Some key behaviours to promote include:
    a. Saying no to avoidable, harmful and unnecessary plastic products, particularly single-use plastic products that cannot be recycled or have excess or unnecessary plastic packaging
    b. Shifting from disposable to reusable products
    c. Actively sorting waste and disposing into correctly labelled containers
    d. Ensuring plastic packaging is reused, recycled and composted
    e. Purchase packaging-free foods
    f. Transitioning from liquid to solid products that require no packaging
- **Catalyse commitments:** For areas where legislation on plastic pollution has not been advanced, citizen behaviour campaigns serve as effective advocacy tools to inspire individuals to use their voices to pressure governments and businesses to legislate or offer plastic free options. Citizens may not have access to reusable options where they live: it is the responsibility of governments and businesses to meet their citizen's needs and create accessible and attraction 'default' options.

# 4.2 A harmonised approach to measures and obligations

While many of the interventions to tackle plastic pollution can be taken at the national scale, the market shifts described in this report will not realise their full economic potential if applied in a fragmented way; unlocking a systemic shift to end plastic pollution will require harmonised international action. A harmonised approach is composed of legally binding rules, standards or laws where coherence and a level playing field are required at the global scale to unlock the benefits available from the economic transformation. These could include global harmonisation of action to support national efforts to address plastic pollution, as presented in Table 9.

Table 9: **A harmonised approach to measures and obligations.**

| | **Global harmonisation required**<br>(linked to specific policies described in this report – Table 8) |
|---|---|
| **Reduce the size of the problem** | • Identification of problematic or unnecessary chemicals (polymers, additives and dyes) and products that should be prohibited (U2; U3).<br>• Common approach to the application of a tax on virgin plastics, including the rate of taxation and the conditions triggering increases in the rate of the tax (U1). |
| **Accelerate reuse** | • Rules that define the desirable necessary minimum operating standards of EPR schemes (M1; topic sheet '**Extended Producer Responsibility**').<br>• Standards and safety considerations for reusable design, including packaging, modular refill systems and materials (M2; M5; topic sheet '**Design guidelines for circularity**'). |
| **Accelerate recycling** | • Design and safety standards requiring all plastic products to be reusable and recyclable (M2; topic sheet '**Design guidelines for circularity**').<br>• Common plastics labelling scheme (M3).<br>• International standards and controls for chemicals of concern (M8).<br>• Common approach to setting minimum recycled content targets (M4).<br>• Common rules on the alignment of the informal waste sector with municipal solid waste management, including protecting human rights for informal waste workers (D4; topic sheet '**Just transition**').<br>• Common minimum standards for deposit return schemes (M9).<br>• Common approach, definition and indicators to setting minimum effective recycling rate targets (D5). Common definition and rules governing conditions under which chemical conversion is considered appropriate (D2; topic sheet '**Chemical recycling**'). |
| **Reorient and diversify** | • Common assessment method to identify which plastics can be substituted and acceptable alternatives (U4; topic sheet '**Materials and products substitutions**').<br>• A global standard for compostable and biodegradable plastics (M7). |
| **Deal with the legacy** | • Common definition and standards governing the safe disposal of end-of-life plastic waste (L3).<br>• Design and safety standards and EPR for products shedding microplastics (L1, L2) |

# 4.3 **Establish a global monitoring and reporting system**

At present, there are no consistent plastics reporting or monitoring requirements at a national or global scale, resulting in limited information about flows of plastic into the economy, plastic use and flows out of the economy, including the distribution and extent of pollution, or trade and finance flows. These inhibit understanding of the distribution, causes and effects of plastic pollution, although enough information exists to select impactful policies and actions and how they can be refined in an evidence-based way in the future.

These concerns could be addressed with a harmonised suite of metrics to inform national action and to report and measure progress towards global goals and targets to tackle plastic pollution. Ideally, these would be simple to understand, offer a direct relationship to policy goals, and reflect the full plastics life cycle. The link between different plastics, their degraded states and the gender- and age-differentiated risks to human health are required to inform interdisciplinary research and ensure that future health consequences can be better managed.

The Environmental Investigation Agency suggests that national reporting includes, inter alia, the following information (EIA 2022a):

- Virgin pellet and resin production and consumption including production, imports and exports.
- Recycled plastic production and consumption also including imports and exports.
- Plastic production, trade and use by market segment, e.g. packaging, building and construction, transport, electrical and electronic, household and leisure, agriculture, appliances and medical.
- Plastic waste management particularly collection, recycling and disposal.
- Plastic waste trade including plastic waste shipments and treatment (in coordination with reporting obligations under the Basel Convention).
- Sea-based sources of plastic pollution from fishing vessels, shipping, offshore industries and tourism (in coordination with reporting obligations under the IMO).
- Primary microplastics including from wear and tear of tyres, road markings, textiles, artificial turf, paint, from accidental spills and from microplastics intentionally added to products.
- Chemicals used in plastics at any point in the supply chain.

To the extent possible, plastics reporting would be harmonised with existing data collection and reporting obligations. However, existing metrics alone cannot be used to monitor national and global progress towards ending plastic pollution, as they do not capture the above basic elements of the plastics economy.

Clear reporting metrics may be combined with full transparency and disclosure by public and private sector actors to achieve a full picture across the entire plastics economy. Transparency and disclosure can be built into all plastics policies together with time-bound and quantitative goals to provide accountability. They will offer potential to unlock investment, particularly in areas where progress is seen, and will support financial flows being directed in ways that accord with global policy objectives. Disclosure is being assisted by the development of globally applicable methods to monitor aspects of the plastics economy, harmonised reporting metrics and sustainable finance taxonomies. Examples include the 'guidelines for harmonising ocean surface microplastic monitoring methods' (Ministry of Environment Japan 2020), GESAMP 'guidelines or the monitoring and assessment of plastic litter and microplastics in the ocean (GESAMP 2019), UNEP's 'national guidance for plastic pollution hot spotting (UNEP 2020a), the 'national analysis and modelling tool' by the WEF's Global Plastic Action Partnership, WWF's footprint tracker and corporate reporting initiatives such as that being developed by CDP.

# Conclusion

Photo: Getty Images

## Countries around the world are taking aim at ending plastics pollution.

As this report has demonstrated, the current approach to tackling the global plastic pollution crisis has not proven sufficient. Plastic production continues to rise, and concerns over well-documented human health risks from plastic pollution are increasing (Merkl and Charles 2022; Landrigan *et al.* 2023). While well-intentioned, national policies and actions are fragmented and uncoordinated and lack the scale, scope, connectivity and urgency to make little more than a superficial or incremental contribution to tackling global plastic pollution. As the systems change scenario indicates, only a systemic shift from a linear to a new circular plastics economy can substantively tackle the global plastic pollution crisis.

This report shows that to transform the economics of ending plastic pollution requires reducing the size of the problem by eliminating problematic and unnecessary plastics, coupled with the acceleration of three key market shifts: Reuse, by creating a reuse society not a throwaway economy; Recycling, by creating a fiscal framework that enables recycled materials to compete on a level playing field with virgin materials; and Reorient and diversify, by shaping the market for plastic alternatives to enable safe and sustainable substitutions, avoiding replacing plastic products with alternatives that displace rather than reduce impacts.

The good news is that this market transformation presents significant economic opportunities, with the net creation of 700,000 additional jobs by 2040 (compared to continuing under a BAU scenario), while reducing overall costs both for the private sector (USD 1.3 trillion saved) and governments (USD 70 billion saved). Social and environmental costs (eventually borne by governments or individuals) can also be significantly reduced through the systems change, with a conservative estimate at USD 3 trillion savings from avoided externalities over the period 2021–2040.

In addition to the market transformation, there is an urgent need to deal with the legacy – to collect and dispose responsibly the plastics that cannot be recycled, and/or which are already polluting the environment. This is because about 40 per cent of the impacts and externality costs linked to plastic pollution will still not be resolved in the next 20 to 30 years even with the important market transformations. The economic transformation will require palliative measures dealing with the legacy during the transition period, including a renewed focus on innovation and research and development.

Accelerating the systems change depends on having an ambitious and timely start on policy and legislative changes, which can unlock new business models, infrastructure investments and new funding mechanisms. At a national level, legal instruments chosen by any country will be context specific but may share the common purpose of levelling the playing field with economic rules that reward resource efficiency and disincentivise pollution across value chains and trading channels. Examples include extended producer responsibility to ensure producers have the right incentives to design products meant to be circular; taxes or disincentives for inefficient use of resources; and incentives (e.g. through institutional procurement rules) for reusable or recycled products. System-level actions are interdependent, and effective consumer choice-making requires awareness-raising as well as availability of viable and economic alternative products, services or systems.

Further impulse to the three market shifts will undoubtably come from a global approach which supports internationally consistent measures and definitions to tackle plastic pollution, such as through shared design guidelines or standards. Such a framework would provide a stable environment for innovation and infrastructure investment, increase consistency on policy priorities to help companies across the value chain, especially those operating across countries, to update their strategies, strengthen current efforts, have a level playing field and support knowledge, technology and benefits sharing to accelerate effective approaches. It sets the bar high, and in line with the stated ambition to end plastic pollution.

Crucially, the economics of the systems change scenario are favourable both in terms of direct and indirect costs. There are savings to be had from moving towards a circular plastics economy - with lower costs, more and greener jobs, reduced toxic and greenhouse gas emissions and no plastic pollution. To reach the goal will require shifting prevailing economic incentives from resource-inefficient, linear models to those that reward the first movers and innovators behind circular systems that prevent pollution. There can be no systems change without policy change.

The evidence is clear and compelling: policy-makers and governments, industry and private leads and stakeholders across the board have in their hands the most significant opportunity to turn off the tap and solve plastic pollution. And with this report, a compass on how to get there.

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