POLICY OPTIONS TO ELIMINATE ADDITIONAL MARINE PLASTIC LITTER

BY 2050 UNDER THE G20 OSAKA BLUE OCEAN VISION

This document is an International Resource Panel (IRP) think piece which is a technical or policy paper based on IRP scientific studies and assessments and other relevant literature. It is not a full study and assessment but a collection of science-based reflections, which may catalyze the generation of new scientific knowledge and highlight critical topics to be considered in policy discourse.

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An International Resource Panel Think Piece


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CONTENTS

PREFACE

We know what the impacts of marine plastic pollution are.

Plastic pollution in our ocean is increasing, threatening marine species and ecosystems, impacting human activities and human health, and costing billions of dollars each year. Globally, reliance on inefficient linear economic models is contributing to the climate, biodiversity and pollution crises which in turn are generating huge changes in ocean and terrestrial ecosystems. The cost of inaction exceeds the cost of taking action to protect the environment and human health.

We need to change the way we use plastic to ensure we achieve the Sustainable Development Goals (SDGs) – particularly, SDG 12 for sustainable consumption and production patterns, and SDG 14 for sustainable use and conservation of the oceans, seas and marine resources.

Under the Japanese presidency of the 2019 G20, members agreed to the Osaka Blue Ocean Vision, which commits G20 countries to “reduce additional pollution by marine plastic litter to zero by 2050”, thereby ensuring that by 2050, the net volume of plastic entering the ocean is zero. The Government of Japan on behalf of the G20 commissioned the UN Environment Programme International Resource Panel to undertake this ‘think piece’ to qualitatively consider possible policy options to eliminate additional marine plastic litter entering the ocean by 2050.

This report was produced during 2020 - the global COVID-19 coronavirus pandemic, where we witnessed the stark impacts on the plastics economy. This included huge increases in public health applications of single-use plastic products, disrupted supply chains and the emergence of personal protective equipment as a major source of plastic entering the ocean.

This International Resource Panel think piece provides actionable insights to achieve the Osaka Blue Ocean Vision. It inspires by providing concrete actions to ensure that projected plastic leakage can be reduced by 80% with existing solutions.

Leading businesses and governments are taking actions to reduce plastic use in a systemic way, thus demonstrating this makes both business and political sense. The benefits represent a huge opportunity, and the concerted approach leaves no excuses not to act. We hope this report will encourage further efforts to address marine plastic pollution and help build a future with a clean ocean.

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GLOSSARY[1]

Circular economy

A 'circular economy' is an economic system where the value of products, materials and other resources in the economy is maintained for as long as possible, enhancing their efficient use in production and consumption, thereby reducing the environmental impact of their use, minimising waste and the release of hazardous substances at all stages of their life cycle, including through the application of the waste hierarchy (European Commission 2020). Establishing a circular economy is closely linked with the Osaka Blue Ocean Vision and essential to meet UNEA Resolution 4/1 (Innovative pathways to achieve sustainable consumption and production).

Circular plastics economy

This is the application of the circular economy approach to plastics, in which the value of plastics is maintained in order to minimise waste and support their efficient production and consumption.

Consumption

The use of products and services for (domestic) final demand, i.e. for households, government and investments. The consumption of resources can be calculated by attributing the life-cycle-wide resource requirements to those products and services (for example by input-output calculation).

Cradle-to-gate

Denotes the system boundaries of a life cycle assessment study that only covers the first stages of the life cycle, which in this report refers to the resource extraction and processing stage (including the full supply chain of all inputs and disposal phase of all outputs arising in these stages).

Cradle-to-grave

Denotes the system boundaries of a full life cycle assessment study, considering all life cycle stages, including raw material extraction, production, transport, use and final disposal. Also termed "life cycle perspective".

Decoupling

Refers to removing the link between two variables. It refers to resource decoupling (the delinking of economic growth and resource use) and impact decoupling (the delinking of economic growth and negative environmental impacts). The term double decoupling refers to delinking economic growth from resource use and from environmental impacts. Moreover, decoupling can be relative (the rate of resource use increase is lower than the rate of economic growth) or absolute (resource use declines while the economy grows).

Environmental Impacts

Harmful effects of human activities on ecosystems.

Life Cycle Assessment

Compilation and evaluation of the inputs (resource use), outputs (emissions) and the potential environmental impacts of a system throughout its life cycle (according to ISO 14040).

Macro, Micro and Nano Plastics

Macroplastics are large pieces of plastic greater than 5 mm in diameter (UNEP 2016a). Microplastics and microbeads have been defined as particles of plastic less than 5 mm in diameter (GESAMP 2015). Nanoplastics are particles of plastic less than 100 nm in diameter (Koelmans 2015; Stapleton 2019; Liss 2020).

Marine environment

Marine environment is defined as the oceans, seas, coast, intertidal areas, estuaries and major water bodies (including rivers) that drain into saline regions below the high-water mark.

Marine Litter

Marine litter is any persistent, manufactured or processed solid material discarded, disposed of or abandoned in, or which reaches, the marine and coastal environment (including from terrestrial sources).

1 Definitions are based on IRP 2017 unless stated otherwise.

Resource efficiency

In general terms, resource efficiency describes the overarching goals of decoupling — increasing human well-being and economic growth while lowering the amount of resources required and negative environmental impacts associated with resource use. In other words, this means doing better with less. In technical terms, resource efficiency means achieving higher outputs with lower inputs and can be reflected by indicators such as resource productivity (including GDP/resource consumption). Ambitions to achieve a resource-efficient economy therefore refer to systems of production and consumption that have been optimized with regard to resource use. This includes strategies of dematerialization (savings, reduction of material and energy use) and re-materialization (reuse, remanufacturing and recycling) in a systems-wide approach to a circular economy, as well as infrastructure transitions within sustainable urbanization.

Resources

Resources — including land, water, air and materials — are seen as parts of the natural world that can be used in economic activities to produce goods and services. Material resources are biomass (like crops for food, energy and bio- based materials, as well as wood for energy and industrial uses), fossil fuels (in particular coal, gas and oil for energy), metals (such as iron, aluminium and copper used in construction and electronics manufacturing) and non-metallic minerals (used for construction, notably sand, gravel and limestone).

Shared socioeconomic pathways (SSP)

SSPs are socioeconomic narratives that outline broad characteristics of the global future and country-level population, global domestic product and urbanization projections. SSPs are not scenarios themselves, but their building blocks (Riahi *et al.* 2016).

Sustainable consumption and production

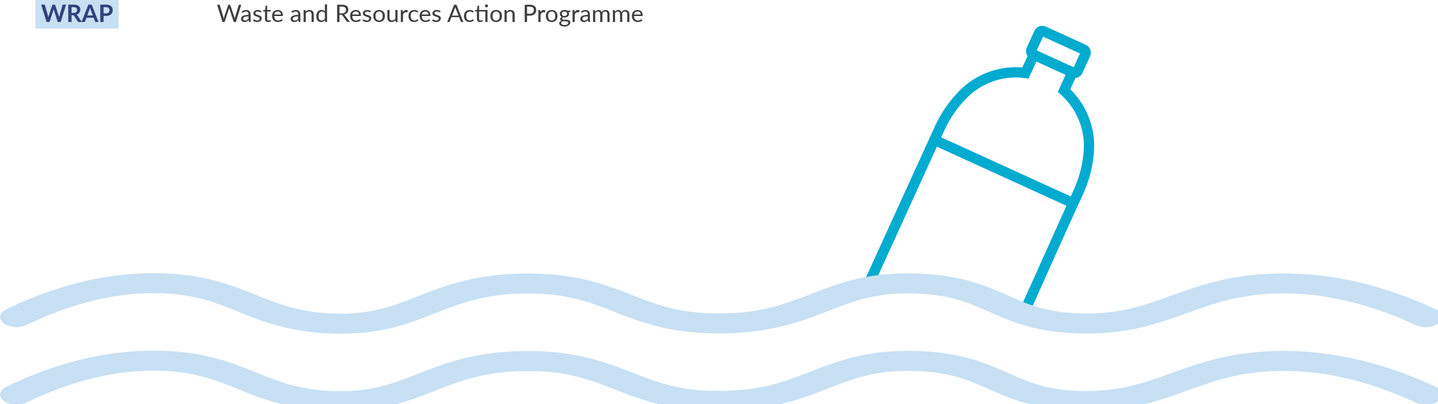
At the Oslo Symposium in 1994, the Norwegian Ministry of Environment defined sustainable consumption and production as: the use of services and related products that respond to basic needs and bring a better quality of life while minimizing the use of natural resources and toxic materials as well as the emissions of waste and pollutants over the life cycle of the service or product (so as not to jeopardize the needs of future generations). Ensuring sustainable consumption and production patterns has become an explicit goal of the SDGs (Goal 12), with the specific target of achieving sustainable management and efficient use of natural resources by 2030. The concept thus combines with economic and environmental processes to support the design of policy instruments and tools in a way that minimizes problem shifting and achieves multiple objectives — such as SDGs — simultaneously.

Sustainable resource management

Sustainable resource management means both (a) ensuring that consumption does not exceed levels of sustainable supply and (b) ensuring that the Earth's systems are able to perform their natural functions (i.e. preventing disruptions like in the case of GHGs affecting the ability of the atmosphere to "regulate" the Earth's temperature). It requires monitoring and management at various scales. The aim of sustainable resource management is to ensure the long-term material basis of societies in a way that neither resource extraction and use nor the deposition of waste and emissions will surpass the thresholds of a safe operating space.

ACRONYMS

AHEG	Ad Hoc Open-Ended Expert Group on marine litter and microplastics
ASEAN	Association of South East Asian Nations
COBSEA	Coordinating Body on the Seas of East Asia
EEA	European Economic Area
EPR	Extended Producer Responsibility
EU	European Union
GESAMP	Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection
GHG	Green House Gas
IPCC	International Panel on Climate Change
IRP	International Resource Panel
MARPOL	International Convention for the Prevention of Pollution from Ships
MSFD	Marine Strategy Framework Directive
NIMBY	Not in my back yard
OECD	Organisation for Economic Co-operation and Development
PHA	Polyhydroxyalkanoates
PLA	Polylactic Acid
RDF	Refuse Derived Fuel
SAPEA	Scientific Advice for Policy by European Academies
SDG	Sustainable Development Goal
SSP	Shared Socioeconomic Pathways
TPS	Thermoplastic Styrenic Elastomers
UK	United Kingdom
UNEA	United Nations Environment Assembly
UNEP	United Nations Environment Programme
WRAP	Waste and Resources Action Programme



EXECUTIVE SUMMARY

The Osaka Blue Ocean Vision, agreed under the Japanese G20 presidency in 2019, voluntarily commits G20 countries to "**reduce additional pollution by marine plastic litter to zero by 2050 through a comprehensive life-cycle approach**", thereby ensuring that by 2050, the net volume of plastic entering the ocean is zero. This UN Environment Programme International Resource Panel 'think piece' was commissioned by the Government of Japan, on behalf of the G20, to qualitatively consider possible policy options to achieve this goal.

The International Resource Panel is an independent scientific Panel hosted by the UN Environment Programme (UNEP) created in 2007 to contribute to a better understanding of sustainable development from a natural resource perspective. In this study, the International Resource Panel worked in partnership with the Government of Japan, SYSTEMIQ and The Pew Charitable Trusts.

The 8 key policy messages are:

1. To deliver the necessary changes for the plastics economy to achieve the Osaka Blue Ocean Vision, the G20 should accelerate its work on marine plastic litter as a priority.

Now is not the time to lose focus. It should be a priority to build support for global action to address marine plastic litter in accordance with the goal of the Osaka Blue Ocean Vision. Action now will prevent the need to do more later.

2. Greater coordination of marine plastic litter reduction policies is urgently needed to deliver the Osaka Blue Ocean Vision.

Instead of isolated actions and bans, coordinated reform of regulatory frameworks, business models, and funding mechanisms, such as establishment of a platform to coordinate and share analysis of existing successful techniques, is needed.

3. A step change in international and national policy ambition is necessary to achieve the Osaka Blue Ocean Vision.

The Osaka Blue Ocean Vision will only be achieved by adopting more progressive policy targets, shaped globally but delivered nationally.

4. Actions that are known to reduce marine plastic litter should be encouraged, shared and scaled up immediately.

These include moving from linear to circular plastic production and consumption by designing out waste, incentivising reuse, and exploiting market-based instruments. These actions can generate 'quick wins' to inspire further policy action and provide a context that encourages innovation.

Business as usual (BAU)

Current commitments
7% reduction in plastics entering the ocean by 2040 compared to BAU (147% increase on 2016 levels)

System Change Scenario
82% reduction in plastics entering the ocean by 2040 compared to BAU

Osaka Blue Ocean Vision
100% reduction in additional plastics entering the ocean by 2050 (Zero marine plastic litter)

Modelling undertaken by The Pew Charitable Trusts and SYSTEMIQ (2020) in "Breaking the Plastic Wave" shows that, through an ambitious combination of interventions using known technology and approaches (called the System Change Scenario), marine plastic litter entering the ocean can be reduced by 82 per cent compared to business as usual by 2040. Through an iterative process including representatives from the plastics industry, researchers, civil society, governments and intergovernmental bodies, policy options to achieve the System Change Scenario were identified. These were assessed to consider their possible contribution towards delivering the Osaka Blue Ocean Vision.

5. Supporting innovation to transition to a circular plastics economy is essential to achieving the Osaka Blue Ocean Vision.

While many technical solutions are known and can be initiated today, these are insufficient to deliver the ambitious net-zero target. New approaches and innovations are needed.

6. There is a significant knowledge gap in the effectiveness of marine plastic litter policies.

An urgent and independent program to evaluate and monitor the effectiveness of plastics policies is required in order to identify the most effective solutions in different national and regional contexts.

7. The international trade in plastic waste should be regulated to protect people and nature.

Transboundary movement of waste plastics to countries with insufficient waste management infrastructure could result in significant plastic leakage to the natural environment. The Basel Convention has made an important initial step towards making global trade in plastic waste more transparent and better regulated.

8. COVID-19 recovery stimulus packages have the potential to support the delivery of the Osaka Blue Ocean Vision.

Measures to reduce marine plastic litter will generate jobs in Greentech and Bluetech sectors and support the delivery of the Osaka Blue Ocean Vision.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1. INTRODUCTION

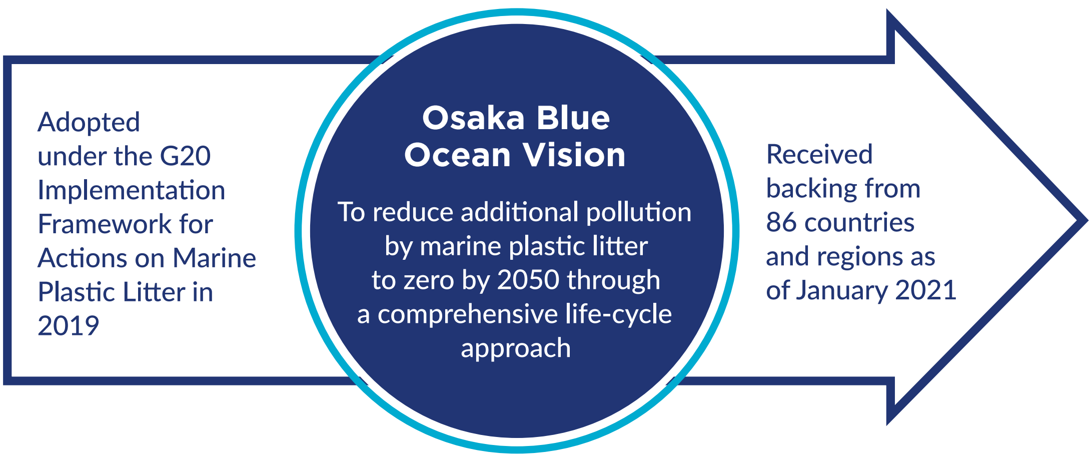
1.1 The ocean plastics challenge

Marine plastic litter entering the ocean is increasing, the impacts of plastic pollution on marine and coastal ecosystems are worsening, and our increasing understanding of the negative impacts of plastic pollution on human health is creating greater urgency to act. Public and political support for meaningful action remains strong.

The G20 Action Plan on Marine Litter (2017) sets out areas of concern and possible policy interventions, and through the voluntary Global Network of the Committed, connects the G20 to aligned global initiatives such as the UNEP Global Partnership on Marine Litter and the Plastic Waste Partnership under the Basel Convention. Continuing the G20's commitment to tackling marine plastic litter, the Osaka Blue Ocean Vision, agreed under the Japanese presidency in 2019, commits G20 countries to "**reduce additional pollution by marine plastic litter to zero by 2050 through a comprehensive life-cycle approach**", thereby ensuring that by 2050, the net volume of plastic entering the ocean is zero.

The annual discharge of plastic into the ocean is estimated to be 11 million tons according to the recently released "Breaking the Plastic Wave" report (The Pew Charitable Trusts and SYSTEMIQ 2020) which has also been published in the journal *Science* (Lau *et al.* 2020). According to that study, without meaningful action, by 2040 municipal solid plastic waste is set to double, plastic leakage to the ocean is set to nearly triple and plastic stock in the ocean is set to quadruple (see Figure 1). The same research shows that current government and industry commitments add up to a mere 7 per cent reduction in plastic pollution to the ocean by 2040 relative to business as usual. However, leakage volumes could be reduced by over 80 per cent with existing technology and solutions if they are implemented concurrently, ambitiously, globally and starting immediately.

Studies have shown that plastic pollution is largely a regional issue with global implications (Napper and Thompson 2019a). An assessment of the impact of mismanaged plastic waste on human health is challenging due to a limited and imbalanced evidence base (SAPEA 2019; Yates *et al*, 2021). However, it is known that toxins in plastic components and products are released into the air when they are burned, such as the release of heavy metals and brominated flame retardants when plastics in e-waste are burned (Sing *et al* 2020), in addition to particulate matter which is well established as a pollutant known to significantly impact health (WHO 2013). Mismanaged plastics also pose the risk to flooding through clogging drainage channels (UNEP 2015a; Verma *et al.* 2016).



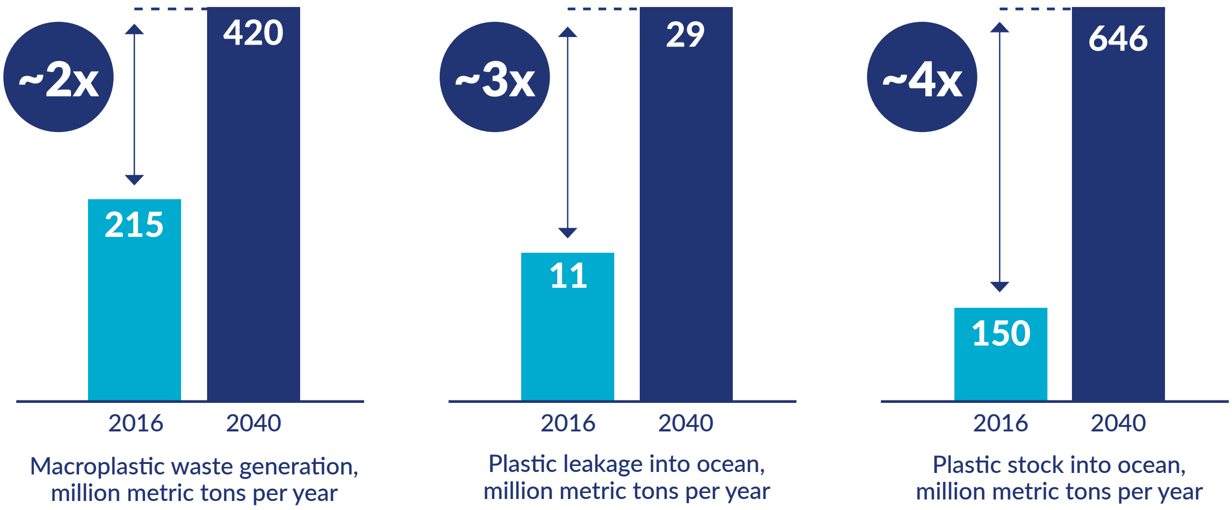


Figure 1. Modelled trends in ocean plastics 2016-2040 (The Pew Charitable Trusts and SYSTEMIQ 2020)

Globally, reliance on inefficient linear economic systems is contributing to the climate, biodiversity and pollution crises which in turn are generating huge changes in ocean and terrestrial ecosystems. This, together with an emerging scientific consensus on the human health and livelihood implications of mismanaged plastic waste, is driving new plastic recovery and re-use policies within government and across industry which are often focused upon improved waste management and the transition to a circular economy (Ghisellini *et al.* 2016). Transitioning away from unsustainable consumption and production is at the heart of the discussion about the reduction of plastic waste entering the ocean.

The UNEP International Resource Panel and many other organisations assert that a transition is needed to a wholly integrated circular economy in which plastic waste is transformed into a valuable resource, thereby minimising its negative externalities, while retaining the significant value to the global economy that plastic provides (Mueller *et al.* 2017). For example, global packaging is valued between $80-120 billion USD per year, 95 per cent of which is lost to the economy as plastic waste which creates externalities of $40 billion USD annually (Ellen MacArthur Foundation 2016). Many nations have begun adopting circular economic principles into policy-making to push towards value retention (e.g. EU Green Deal). Put simply, the cost of inaction is too high. Too high for the environment, too high for communities, too high for society broadly, and too high for business.

1.2 The aim of the think piece

The Government of Japan, on behalf of the G20, commissioned the UNEP International Resource Panel to undertake a 'think piece' **to qualitatively consider possible policy options to reduce additional pollution by marine plastic litter to zero by 2050**. The International Resource Panel is an independent scientific Panel hosted by UNEP created in 2007 to contribute to a better understanding of sustainable development from a natural resource perspective. In this study in particular, the International Resource Panel is working in partnership with the Government of Japan, SYSTEMIQ and The Pew Charitable Trusts. An International Resource Panel think piece is a technical or policy paper based on IRP scientific studies and assessments and other relevant literature. It is not a full study and assessment but a collection of science-based reflections, which may catalyze the generation of new scientific knowledge and highlight critical topics to be considered in policy discourse.

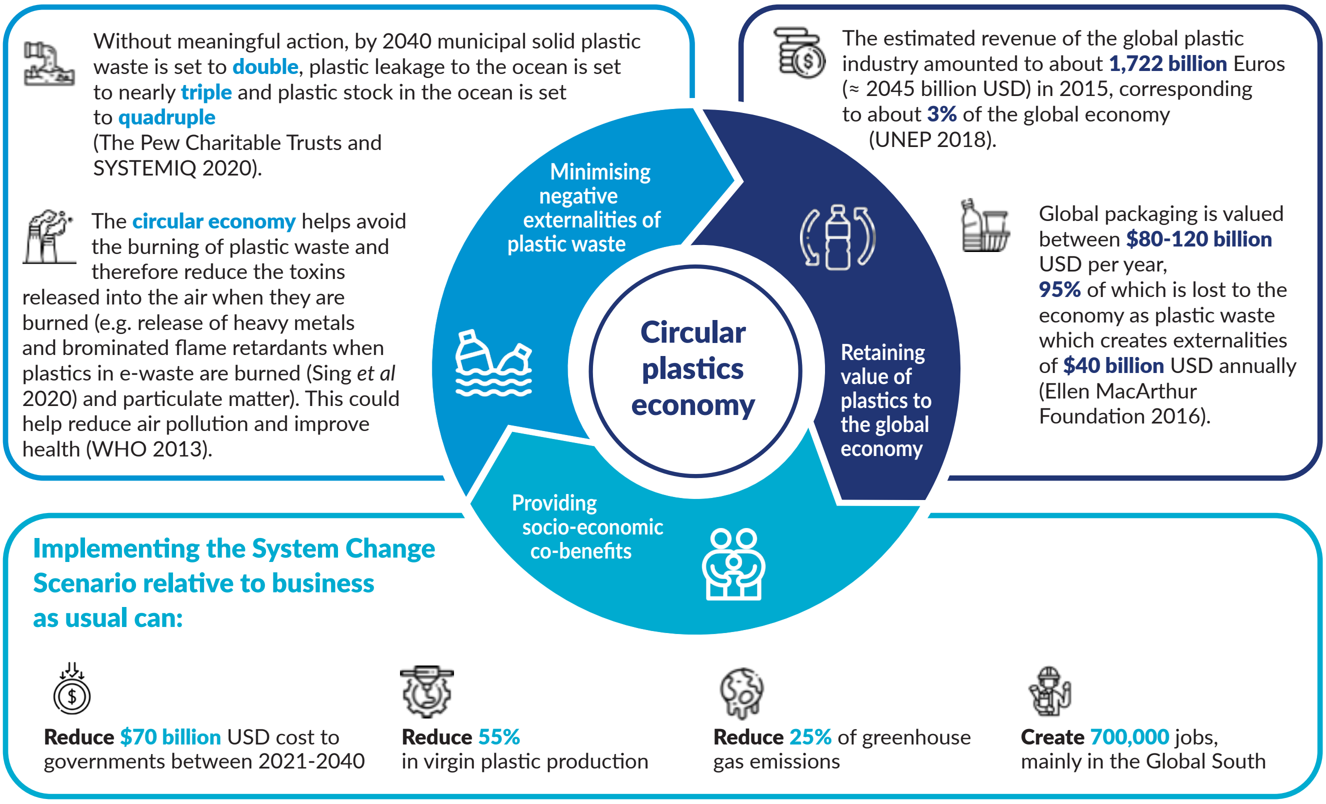


Figure 2. Benefits of a circular plastics economy with examples

1.3 Analytical approach

Central to this think piece is the scenario modelling analysis undertaken by SYSTEMIQ and The Pew Charitable Trusts published in “Breaking the Plastic Wave”. Although the model adopts the end date of 2040 as opposed to 2050 which is the target date to achieve the Osaka Blue Ocean Vision, the modelling shows clear trends relevant to 2050 and is the most comprehensive scenario modelling on marine plastic litter to date[2]. The analysis shows that, through an ambitious combination of interventions using known technology and approaches (called the System Change Scenario), marine plastic litter entering the ocean can be reduced by 82 per cent compared to business as usual by 2040 (Lau *et al.* 2020). The development of the Scenario is explained further in section 2.2. In order to consider the policy options available to deliver the System Change Scenario, a two-day online workshop, was convened by the University of Portsmouth, which brought together 30 sector specialists, including representatives from the plastics industry, researchers, civil society and intergovernmental bodies (a full list of attendees is presented in Annex 1). The intervention areas discussed were: 1) redesign of products and/or packaging; 2) reducing plastic production and consumption; 3) substitution of plastics; 4) mechanical and chemical conversion; 5) disposal mechanisms; and 6) microplastics and their role in discharge rates.

The workshop discussions were divided into thematic blocks focused on each of the main intervention areas. In each session, policy options were developed and captured. The final session of the workshop sought to identify cross-cutting barriers to, and enablers of, effective policy delivery. The policy options were developed with the G20 in mind, with the expectation that they will have relevance to, and influence over, a wider range of countries that have expressed their support for the Osaka Blue Ocean Vision. This report draws heavily from the workshop discussions, which were supplemented by follow-up discussions, and is informed by a review of relevant global research and practitioner

2 The full report can be downloaded at www.systemiq.earth/breakingtheplasticwave. A full description of the data used to construct the model can be found on pages 120-128 of the full report.

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evidence. Members of the UNEP International Resource Panel contributed to the framing of the study and to the development of the arguments presented in this report. This think piece does not undertake a full study assessment of these policy options and does not attempt to undertake a full socioeconomic analysis at any scale of these options.

1.4 COVID-19 and marine plastic litter

This report was produced during the global COVID-19 coronavirus pandemic throughout which there were stark impacts on the plastics economy. This included huge increases in public health applications of single-use plastic products, disrupted supply chains, the dramatic Q2 2020 drop and subsequent recovery of oil prices, and the emergence of personal protective equipment as a major source of plastic entering the ocean. All these factors have impacted the short-term production of plastic and its subsequent disposal, the latter with potentially significant long-term environmental effects. For example, legal measures have been put in place around the world to require the use of personal protective equipment in non-clinical settings (public transport, shops, enclosed public areas), yet little guidance has been issued on the safe disposal of 'domestic' personal protective equipment, some of which is entering the environment. More broadly, the pandemic has particularly highlighted vulnerabilities in both plastic recycling and downstream demand within the supply chain. Importantly, record low oil prices are threatening the plastic recycling industry because of low cost for virgin plastic. The global community of ~11 million waste pickers has also been severely impacted by the COVID-19 pandemic, putting their health and livelihood at risk (The Pew Charitable Trusts and SYSTEMIQ 2020).

In the future, we are likely to see more home working, less on the go consumption and increased waste produced in citizen's homes. Shopping habits have shifted with a significant acceleration towards online retail provision. Waste compositions are changing, which can cause problems to established waste management processes. However, there is now greater potential for an acceleration of the circular economy with accompanying behaviour change interventions to limit these impacts. A profound social and economic crisis is looming and for most of the world, business as usual does not fit into the new reality. The priority should be keeping all people afloat, including the most vulnerable, while not losing sight of the need to maintain planetary health and sustainable resource management (IRP 2020). While these are challenging times, there is reason for hope. Evidence from the System Change Scenario suggests that achieving the Osaka Blue Ocean Vision could reduce public sector costs, reduce private sector costs, reduce plastic pollution in the environment, reduce greenhouse gas emissions and increase employment – this is precisely the "building forward better" approach the world so desperately needs. However, such optimism should not come at the expense of naivety.

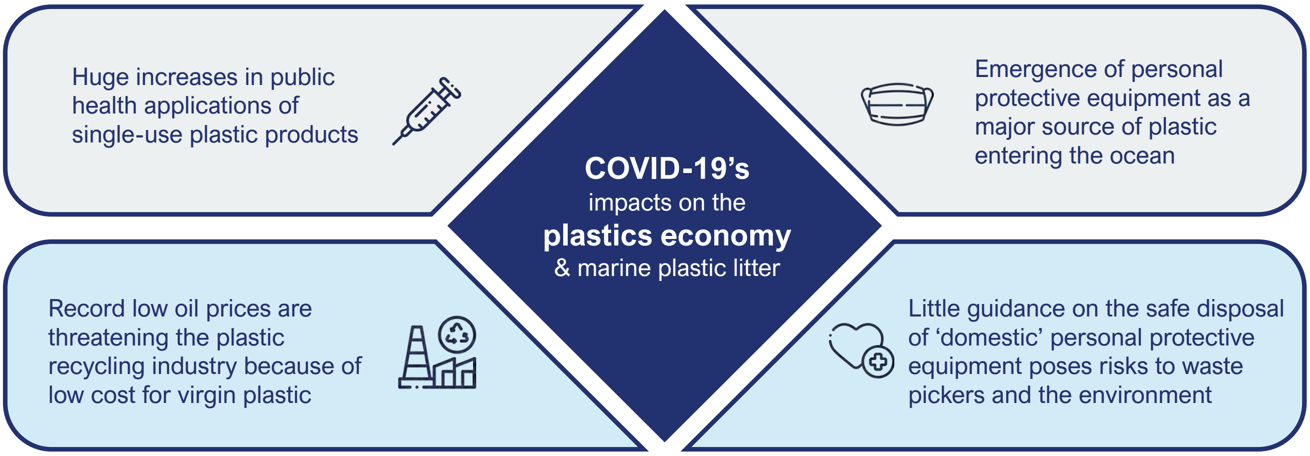

Figure 3. Example of COVID-19's impacts on the plastics economy and marine plastic litter

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2. TACKLING MARINE PLASTIC LITTER THROUGH SYSTEM CHANGE

2.1 Plastic pathways to the ocean

There are many pathways through which marine plastic litter can enter the ocean, as shown in Figure 4. This shows that the immediate entry to the ocean is a result of mismanaged waste, but that contributors to mismanaged waste arise from pre-consumer production and consumption, and through post-consumer collection and sorting, recycling, and disposal. Maritime sources of pollution, such as fishing and shipping, are not included in Figure 4, nor the following analysis, but also constitute an important source of leakage to the ocean.

2.2 The System Change Scenario

The "Breaking the Plastic Wave" report (The Pew Charitable Trusts and SYSTEMIQ 2020) presents a model designed to quantify key plastic flows and stocks in the global plastic system as well as to estimate the quantity of marine plastic litter expected under six scenarios between 2016 and 2040. The model also allows the economic, environmental, and social impacts of the principal interventions included in the model to be assessed. The analysis incorporates all major land-based sources of macroplastic and microplastic marine plastic litter. The effects of COVID-19 were not included in the modelling, which was undertaken prior to the pandemic. The System Change Scenario is the most ambitious of the six scenarios modelled. It shows how, using a combination of existing approaches and technology, a reduction in plastic entering the ocean of 82 per cent can be achieved by 2040 relative to business-as-usual, but only if both upstream (pre-consumer) and downstream (post-consumer) interventions are combined. In addition to the reduction in plastic pollution, this scenario has multiple co-benefits relative to business-as-usual by 2040, including a $70 billion USD cost reduction to governments between 2021-2040, a 25 per cent reduction of greenhouse gas emissions, a 55 per cent reduction in virgin plastic production and the net creation of 700,000 jobs, mainly in the Global South. To achieve these results, the System Change scenario requires the global implementation of the following system interventions:

- Reduce growth in plastic production and consumption, including through market-based instruments (e.g. extended producer responsibility, modular fees), to avoid nearly one-third of projected plastic waste generation through elimination, reuse, and new delivery models.
- Substitute plastic with paper and compostable materials, switching one-sixth of projected plastic waste generation.
- Design products and packaging for recycling to expand the share of economically recyclable plastic from an estimated 21 per cent to 54 per cent.
- Expand waste collection rates in the middle-/low-income countries to 90 per cent in all urban areas and 50 per cent in rural areas and support the informal collection sector.
- Double mechanical recycling capacity globally to 86 million tons per year.
- Scale-up chemical conversion capacity globally to 26 million tons per year.
- Build facilities to dispose of the 23 per cent of plastic that cannot be recycled economically, as a transitional measure.
- Reduce plastic waste exports to countries with low collection and high leakage rates by 90 per cent.
- Roll out known solutions for four microplastic (<5mm) sources – tyres, textiles, personal care products and production pellets – to reduce annual microplastic leakage to the ocean by 1.8 million tons per year (from 3 million tons to 1.2 million tons) by 2040.

The combined effect of implementing all of these system interventions is represented in Figure 5. To achieve the 82 per cent reduction in plastics entering the ocean compared to business as usual by 2040, all system interventions need to be implemented concurrently, ambitiously, globally and beginning immediately. Even with this immediate and concerted action, under the System Change Scenario, 710 million metric tons of plastic would still cumulatively enter aquatic and terrestrial ecosystems by 2040 (Lau *et al.* 2020). Current commitments are projected to only decrease plastic leakage into the ocean by 7 per cent compared to business as usual, which represents a 147 per cent increase on 2016 levels.

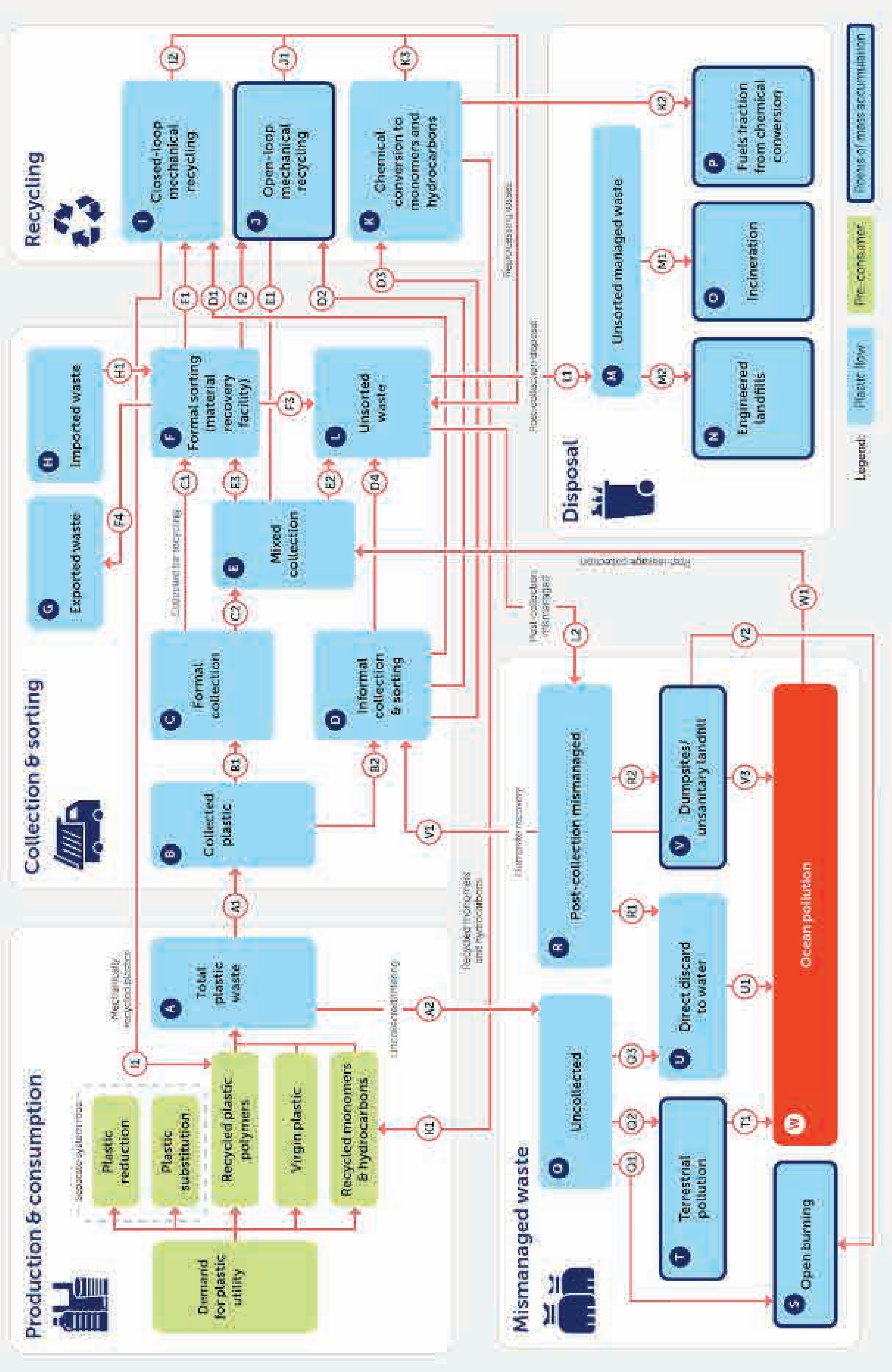

Figure 4. The pathways through which plastics enter the ocean (The Pew Charitable Trust and SYSTEMIQ 2020)

This analysis starkly demonstrates that even with extensive concerted interventions at the global scale, marine plastic litter will continue to enter the ocean at significant levels. It is possible that currently unknown approaches may be available to prevent more plastic entering the ocean, but current modelling suggests that even reaching near-zero marine plastic litter input to the ocean by 2040 is unrealistic. The removal of plastic from the ocean was not included in the model and may present an opportunity, provided that current extraction methods can be significantly scaled up, to reach net-zero marine plastic litter input to the ocean. Furthermore, the analysis shows that current policy initiatives will make a comparatively limited contribution to marine plastic litter reduction and that a stronger policy framework is required.

As the Systems Change Scenario is a materials-flow economic analysis, it estimates changes in global greenhouse gas emissions as a consequence of changes in the way we produce/consume plastic or the way we deal with plastic waste (but does not account for decarbonization of specific technologies). However, it does not model implications for climate change at a planetary systems level. It is possible on the other hand, to put it in the context of work happening in the broader earth systems modelling community by comparing the baseline trajectories it uses for population and economic growth to the 'Shared Socioeconomic Pathways' (SSPs). The SSPs that underpin the modelling in the International Panel on Climate Change (IPCC) sixth assessment report are an important tool for the climate modelling community because they take into account how socioeconomic development as a result of societal choices will impact climate change. The Systems Change Scenario is most closely associated with the second (of five) SSP pathways, the 'Middle of the Road' pathway. In this SSP, global trends in population growth, education, urbanization and economic growth do not shift noticeably from historical patterns, resulting in 'mid-level' challenges to mitigation and adaptation. There are elements of the Systems Change Scenario that could be considered part of SSP1 – the 'Sustainability Scenario' - due to its optimistic approach to rapid technological development, policy/regulation development and consumer behaviour trends. This means that the Systems Change Scenario can be achieved in the context of middle-of-the-road predictions of the level of climate heating. However, as the SSPs and the Systems Change Scenario are not aligned, it is suggested that additional modelling should be conducted to ensure that the results of the modelling presented in this paper, can be usefully applied to the SSPs.

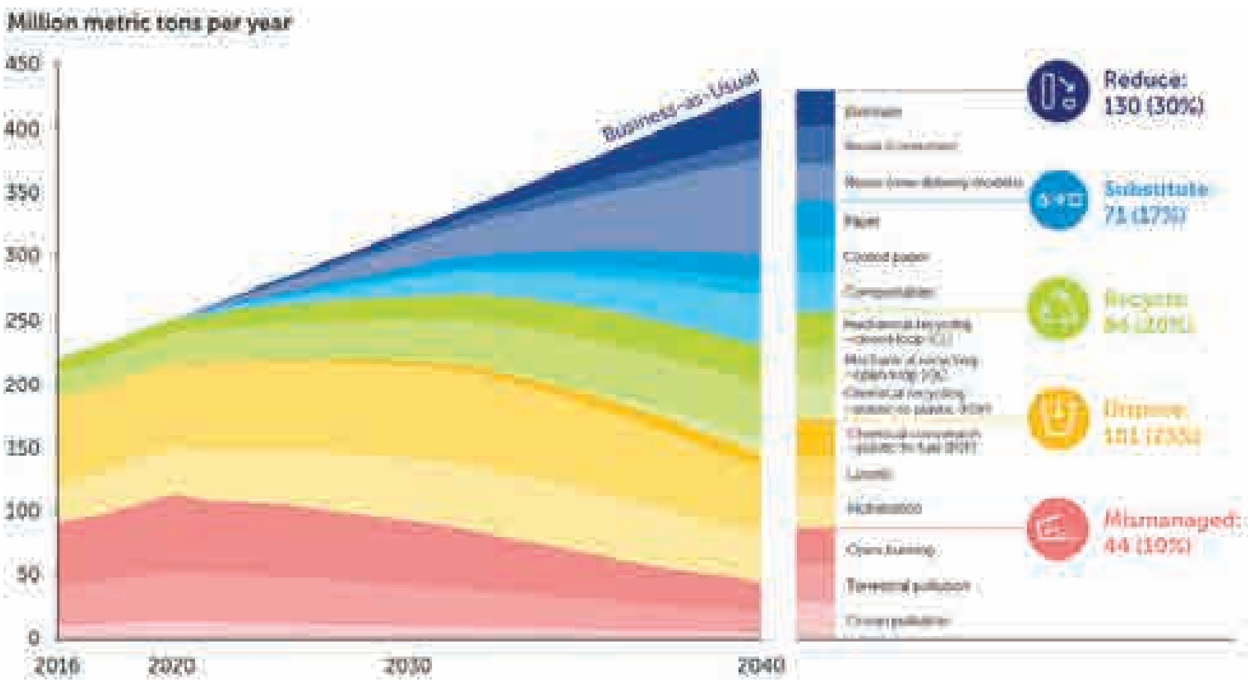

Figure 5. Business as usual increase in plastic use and production with minimal interventions in place.

The colour wedges show where plastic use can be reduced (dark blue), substituted with suitable alternatives (light blue), recycled and returned into the system (green), controlled and managed end of life treatment (yellow) and the remaining mismanaged (red). (The Pew Charitable Trusts and SYSTEMIQ 2020).

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3. ENABLING THE SYSTEM CHANGE SCENARIO THROUGH POLICY

3.1 Introduction

Achieving the outcomes modelled under the System Change Scenario, and by extension the Osaka Blue Ocean Vision, will require substantial change across the entire plastics economy at the global scale, including to business models, the recycling and waste disposal industries, investment strategies, product design, and consumer behaviour. In order to assess the policy changes needed to generate these changes, this chapter examines the existing plastics policy landscape and then explores policy options to reduce marine plastic litter in line with the Osaka Blue Ocean Vision.

3.2 The current plastic policy landscape

In order to assess the current plastics policy landscape, a global Plastics Policy Inventory of laws, policy statements and regulations at the international, national and sub-national level (from January 2000 to July 2019) was developed by Duke University's Nicholas Institute for Environmental Policy Solutions. The inventory is intended to support the rigorous monitoring of government responses to the global plastic pollution problem, as called for in Resolution 4/6 of the 2019 United Nations Environment Assembly (UNEA) meeting, and to inform future public policies (Karasik *et al.* 2020). The policy analysis presented here includes 291 public policies aiming to address leakage of plastics at some stage in its life cycle (in addition to general solid waste management policies, which are considered applicable but part of the baseline upon which specific responses were introduced). As such, it can be considered comprehensive for policies at the international level, indicative of policies at the national level, and only includes scattered examples at the sub-national level (Karasik *et al.* 2020).

3.2.1 Policy trends

Overall, analysis of the Plastics Policy Inventory showed a clear upward trend in the number of public policy responses to the plastic pollution problem over the last decade, at global, regional and national levels. At the global level, there is no binding, specific and measurable target agreed to reduce plastic pollution. However, there has been a continuous effort by UNEA to address the problem of plastics in our environment, including Resolution 1/6 on marine plastic debris and microplastics, Resolution 2/11 on marine plastic litter and microplastics, Resolution 3/7 on marine litter and microplastics, and Resolution 4/9 on addressing single-use plastic products pollution. Furthermore, through the ad hoc expert group on marine litter and microplastics (AHEG), established under Resolution 3/7 and whose mandate has been extended through Resolution 4/6, Member States and other stakeholders have discussed possible response options at the national, regional and global level, including national action plans and their implementation, regional and international cooperation to facilitate national actions, strengthening existing instruments, and a new global instruments (e.g. a new global agreement, framework, and other form of instrument). There has also been a growing catalogue of resources to support plastics policy development, including a summary of national level approaches to regulate pollution from plastics in Pacific Island Countries (Secretariat of the Pacific Regional Environment Programme 2018), a factsheet for policymakers on single use plastics (UNEP online), a toolkit for policymakers on marine litter legislation (UNEP 2016c), and a Foresight brief on plastic pollution in the oceans (UNEP 2020d).

The Osaka Blue Ocean Vision makes strides towards a global commitment with 86 countries and regions endorsing its vision (January 2021). Policies at the regional level were largely a European phenomenon (62 per cent of regional policies in the Inventory). At the national level, the upward trend in policy responses over the last decade largely reflects new policies introduced solely to address pollution from plastic bags. For national-level policies, the instrument used most frequently by policies in the Inventory was a regulatory ban on plastic at some stage in the life cycle. National governments used regulatory instruments 3.5 times more frequently than economic instruments in the sample analyzed, and 3 times more frequently than information and/or behaviour change instruments in that sample. The number of policy responses according to national income level is shown in Figure 6. This shows that high income countries do not typically have more plastics-related policy responses than any other category of actor.

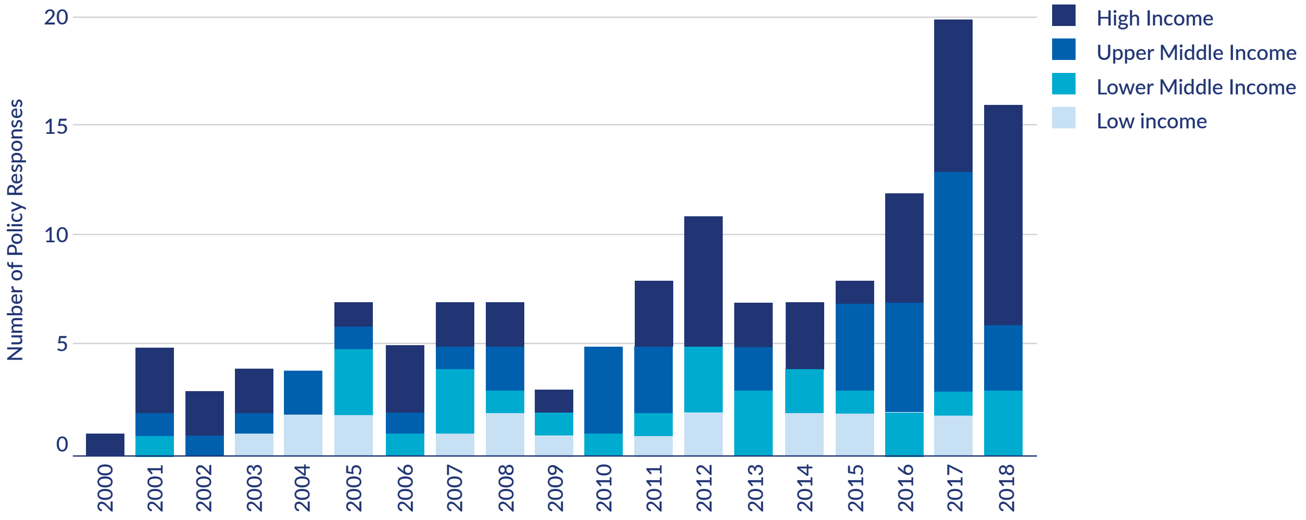


Figure 6. National Policy Responses by Income Levels (Karasik et al. 2020).

The national policies in the Inventory that introduced a ban, tax or levy on some form of plastic bags were largely a phenomenon in low income and lower-middle income countries. Of the 43 countries where national governments introduced a ban, tax or levy on some form of plastic bags in the Inventory, 33 were in Sub-Saharan Africa, Pacific Island countries or territories, or Latin America and the Caribbean. Some form of plastic packaging or other single-use plastic product (excluding plastic carrier bags) was banned in at least 25 countries in the Inventory, representing a population of almost 2 billion people in 2018. However, the vast majority of this population was covered by two policies in India and Pakistan, for a total of 1.56 billion. The remaining 23 countries, covering a population of only 355 million in 2018, have legislation including some form of national ban.

3.2.2 Regional scale plastics policy

Regional plastics policies are comparatively rare, but potentially very influential. For example, the 'European Strategy for Plastics in a Circular Economy' (European Commission 2018) adopted in January 2018 aims at transforming the way plastic products are designed, used, produced and recycled in the EU. Better design of plastic products, higher plastic waste recycling rates, more and better quality recyclates will help boost the market for recycled plastics. As part of this strategy, in 2019, the European Union adopted Directive 2019/904 on the reduction of the impact of certain plastic products on the environment which introduces new restrictions on certain single-use plastic products and on fishing and aquaculture gear containing plastic. The new rules ban the use of certain throwaway plastic products for which alternatives exist. Member states have agreed a 90 per cent collection target for plastic bottles by 2029, and plastic bottles will have to contain at least 25 per cent of recycled content by 2025 and 30 per cent by 2030. Elsewhere, the Association of South East Asian Nations (ASEAN) Framework of Action on Marine Debris (2019), provides actions and suggestions for further collaboration in the ASEAN region on four priority topics: policy support and planning; research, innovation, and capacity building; public awareness, education, and outreach; and private sector engagement (ASEAN Thailand 2019). In addition, some Regional Seas Conventions have already established action plans to tackle marine litter at the regional scale, such as the Coordinating Body on the Seas of East Asia (COBSEA).

3.2.3 Policies to tackle microplastic pollution

At the opposite end of the spectrum, there were relatively few policy responses to microplastic pollution in the Inventory. At the national level, only eight national governments had a total of ten policy responses to microplastic pollution by the end of July 2019, and eight of these were adopted within the last five years, largely in Europe and North America. Throughout these initial responses, the problem has largely been defined in terms of plastic microbead ingredients in cosmetic products, as only one policy in the analysis is targeted to microplastic pollution from synthetic car tyre abrasion (Karasik *et al.* 2020).

3.2.4 Policy effectiveness

To complement this analysis of the Plastics Policy Inventory, a review of the literature on the effectiveness of plastic policy responses was conducted. This review suggests that there is a significant research gap on the effectiveness of plastic policy instruments, particularly in relation to low value plastics, with the notable exception of the UNEP assessment of the effectiveness of relevant international, regional and subregional governance strategies and approaches (UNEP 2018b). This gap is perhaps due in part to the time lag found between the introduction of policies in the Plastics Policy Inventory and the publication of effectiveness studies in the scientific literature (on average 6.5 years) as well as a lack of sufficient monitoring of plastic litter in coastal and marine environments. Diversity of approaches to monitoring marine plastics is a constraint on comparative assessments of policy effectiveness, although a globally applicable approach has recently been proposed by the Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP 2019). Additionally, some two-thirds of the studies in the scientific literature reviewed were limited to Europe and North America (potentially reflecting a language bias in the databases searched).

Finally, the policy instruments studied in the scientific literature have largely been confined to those targeting plastic bag pollution (82 per cent of which effectiveness measures were reported). The majority of these studies measured short-term effects (less than 24 months), and typically suggested significant impacts on plastic bag consumption when instruments were enforced, though not necessarily eliminating plastic bag pollution or completely changing consumer behaviour. Additionally, the literature consistently documented examples of unintended consequences where demand for plastic bags shifted into alternatives (e.g. paper bags or plastic garbage bags).

Throughout the scientific literature on policies aiming to address plastic pollution, a consistent set of recommendations emerged. These included recommendations to increase the use of information instruments to complement other instruments aiming to address land-based sources of plastic pollution, e.g. education or outreach campaigns to consumers about regulatory bans. More broadly for land-based sources, improved solid waste management systems are consistently noted as fundamental to solving the global plastic pollution problem (particularly in lower and middle-income countries), as well as policy instruments that extend producer responsibility. Beyond plastic carrier bags, some researchers suggest that regulatory bans could be extended to other products, at least in the short-term (taking into consideration consequences of increased demand for alternatives). For microplastic pollutants, regulatory bans of plastic microbeads in all types of cosmetic and personal care products are recommended at all levels, even in countries with complete coverage of tertiary wastewater treatment programs.

Across all land and sea-based sources of plastic pollution, scientists, governments and NGOs are calling for a binding global treaty (e.g. Dauvergne 2018; Haward 2018; Raubenheimer and McIlgorm 2018; Worm *et al.* 2017, WWF *et al.*, 2020), though there are also a number of governments supporting existing frameworks. This generally includes at least two key elements: (i) binding and measurable targets for plastic pollution reduction, and (ii) robust monitoring, reporting and enforcement mechanisms. A business case report in favour of a global agreement, supported by a group of major businesses, has recently been published (WWF, The Ellen MacArthur Foundation and BCG 2020). There are a number of precedents or models for such a treaty, notably the Montreal Protocol, the Stockholm Convention and the Basel Convention. The Montreal Protocol, for example, demonstrates an effective regulatory ban of products (ozone-depleting substances) at a large scale, though not necessarily of products at the scale of plastics production.

Recent amendments to the Basel Convention have incorporated plastic waste into a legally-binding framework making global trade in plastic scrap and waste more transparent and better regulated, to help ensure that its management is safer for human health and the environment. The amendments subject transboundary movements of most plastic scrap and waste to prior informed consent requirements such that exports of most plastic scrap and waste are only allowed with the written consent of the proposed importing country and any transit countries. In addition, the Plastic Waste Partnership was established under the Basel Convention to "mobilise business, government, academic and civil society resources, interests and expertise to improve and promote the environmentally sound management of plastic waste at the global, regional and national levels and to prevent and minimize its generation" (Basel Convention 2019).

The International Convention for the Prevention of Pollution from Ships (MARPOL) minimizes the discharge of plastics into the ocean through Annex V, where, for example intentional discharge of plastics from ships are banned and the loss of fishing equipment is required to be reported. Any policies involving discharges from maritime vessels need to be developed in cooperation with the International Maritime Organization. Alongside policy interventions, voluntary arrangements such as the Ellen MacArthur Foundation's New Plastics Economy Global Commitment and the Plastic Pact network, can enable a network of local and cross border initiatives to bring key stakeholders together to work towards common goals. These voluntary agreements aim to take advantage of retaining the value within the product and material without the need for, or ahead of, any direct policies and legislation implementation.

3.3 International Resource Panel plastics policy recommendations

In 2019, the International Resource Panel published its first Global Resource Outlook, which identified the need for fundamental change in the global resource economy. This included shifting to a system of sustainable consumption and production aligned with circular economic principles in which economic growth is decoupled from environmental harm. In combination, these changes will improve human wellbeing and promote the better stewardship and recovery of natural capital, as well as supporting progress towards the Sustainable Development Goals. The report presented an analysis of a 'Towards Sustainability' scenario (in which policies were focused upon resource efficiency and decoupling) and a 'Historic Trends' scenario (more orientated towards business as usual).

The benefits of Towards Sustainability compared to Historic Trends include boosting economic growth by 8 per cent, the growth of resource use is slowed significantly, incomes and other wellbeing indicators improve, key environmental pressures fall, economic growth offsets the cost of near-term costs of shifting to a 1.5 degree Celsius climate pathway, and there is a more equal distribution of income and access to resources (IRP 2019). Finally, resource efficiency policies reduce greenhouse gas emissions by 19 per cent compared to Historical Trends and when combined with other climate measures results in global emissions falling by 90 per cent in 2060. In order to achieve the sustainable transitions presented in the Towards Sustainability scenario, well-designed and concerted policy packages are required which are underpinned by eight key elements of multi-beneficial policymaking, as shown in Figure 7 (IRP 2019). These are generalised qualities of policymaking that are thought to promote resource efficiency, decoupling and sustainable consumption and production and as such can be applied in a range of resource contexts, including plastics.

In addition to the elements of beneficial policymaking, the Global Resource Outlook (IRP 2019) identifies the main causes of plastic mismanagement and identifies specific policy recommendations to address them, although no consideration is given to national differences in geographical or development status. The causes of mismanagement are: 1) the rapid increase in production, diversity, and complexity of virgin plastics (and additives therein); 2) difficulties

Figure 7. Elements of multi-beneficial policymaking (adapted from IRP 2017)

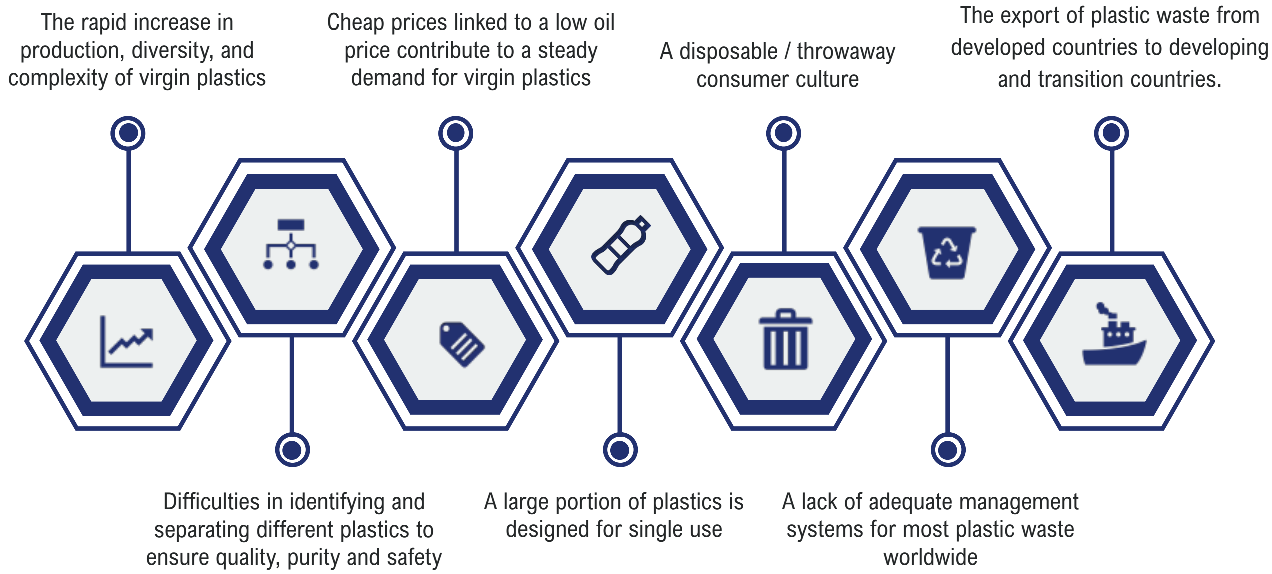


Figure 8. Causes of plastic mismanagement

in identifying and separating different plastics to ensure quality, purity and safety; 3) cheap prices linked to a low oil price contribute to a steady demand for virgin plastics; 4) a large portion of plastics is designed for single use; 5) a disposable / throwaway consumer culture; 6) a lack of adequate management systems for most plastic waste worldwide (including collection, sorting and recycling); and 7) the export of plastic waste from developed countries to developing and transition countries. The policies suggested to tackle these problems are (IRP 2019):

- Environmentally sound waste management, including wastewater management and marine litter plans.
- Use of economic instruments, such as extended producer responsibility and deposit-refund schemes.
- Capacity development of competent authorities.
- Encouraging the development and uptake of innovations.
- Best production practices, including (1) reduction of harmful substances and waste, (2) prevention of plastic pellet loss, (3) take back, reuse and recycling of plastic products, and (4) transparency about ingredients and production process.
- Prevention and reduction (for example new materials) to do more with less plastic.
- Reduction/elimination of unnecessary single-use plastics, using, for example, existing prohibition and discouragement via economic penalties for microbeads and carrier bags.
- To educate and incentivize consumers to reduce plastic waste littering, for instance by using instruments such as bottle deposits to increase collection of recyclables and by fostering responsible disposal of non-recyclables.

The elements of beneficial policymaking and existing IRP policy recommendations on plastic pollution will be revisited in the conclusion of this report to determine their relevance to the delivery of the Osaka Blue Ocean Vision.

3.4 Policy options to achieve the Osaka Blue Ocean Vision

It is estimated by Lau *et al.* (2020) that current policy commitments will reduce marine plastic litter by no more than 7 per cent. Therefore, to achieve the Osaka Blue Ocean Vision, the prevailing plastic policy mix needs to be considerably strengthened in breadth and ambition. In this section, nine policy areas are explored to consider their potential role in marine plastic litter reduction, as shown in Figure 9. Each of the policy areas are further dissected into specific policy measures that policymakers should consider to achieve the System Change Scenario. The relevance of each policy area to specific countries, types of countries, or regions is treated cautiously in this think piece. A key message in this report is that isolated actions in geographically discrete places will not bring about the scale of change necessary to tackle marine plastic litter effectively. Rather, global systemic change is needed.

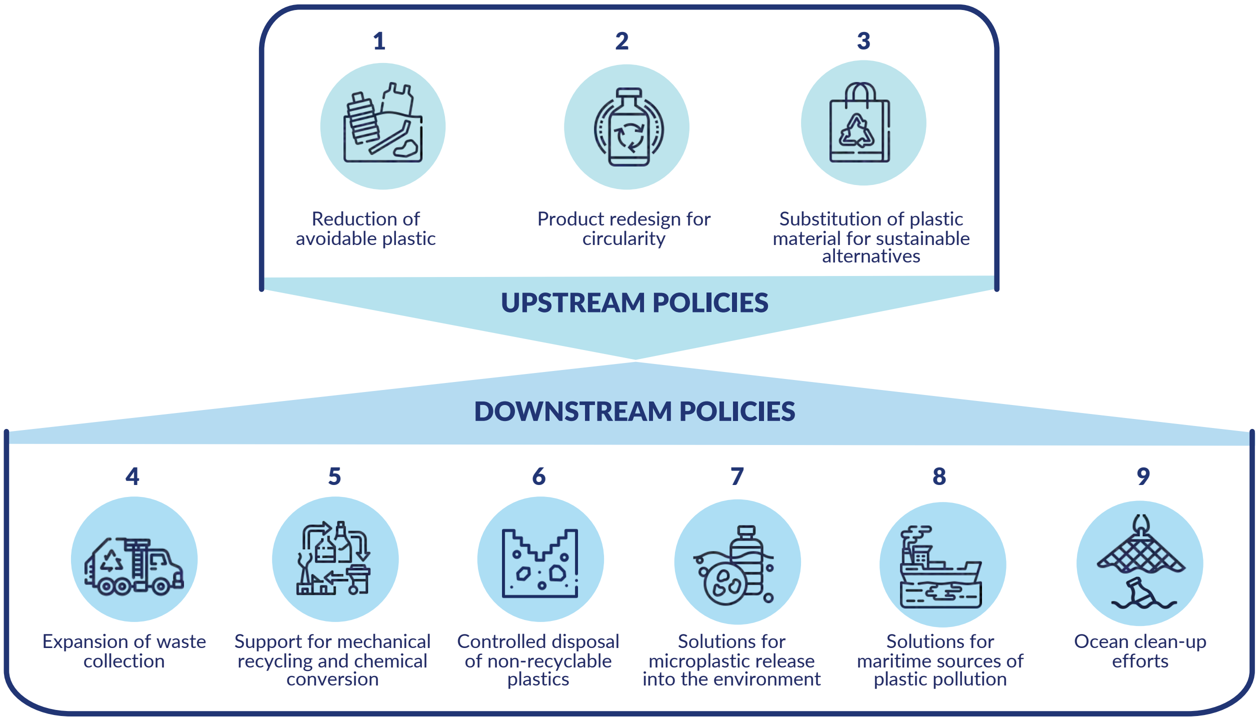


Figure 9. Upstream and downstream policy areas

In recognition of the need to consider policy interventions across the plastics lifecycle, the policy areas in Figure 9 are separated into upstream and downstream groupings, in which upstream refers to the interventions prior to the consumption of a plastic product, while downstream interventions occur post-consumer. There is often an interdependency between upstream and downstream policy interventions, and it is arguably unrealistic to consider them separately. For example, an upstream policy to ensure that products are designed to enable the recycling of any plastic components will rely on the existence of downstream policies to ensure that effective plastics collection, separation, and recycling facilities exist. Often, the policy join-up is weak which undermines efforts to reduce marine plastic litter. In general, upstream policy interventions (such as plastic substitution) are considered as critical in the reduction of marine plastic litter as they tackle the plastic problem at source and do not rely on post-hoc solutions to prevent plastics leaking out of well-managed waste systems. As "Breaking the Plastic Wave" showed, implementing either upstream or downstream solutions in isolation will not reach a meaningful reduction in plastic pollution. It is only the combination of ambitious upstream and downstream solutions that have a chance at substantially reducing plastic pollution.

Upstream policy interventions focused on resource efficiency and reducing waste in the system offer multiple benefits including reduced business costs, decreased vulnerability to unreliable supplies, decreased dependence and extraction of declining primary resources, reduced greenhouse gas emissions, and reduced risk to public health and the environment (UNEP 2015a). Many examples of upstream processes to reduce plastic waste and their impacts on the marine environment are described in detail within multiple UNEP reports (UNEP 2015b; UNEP 2017 and UNEP 2020a). Upstream policy interventions should aim to shift the burden of plastic pollution onto plastic producers, increase end-of-life value of plastics, and incentivize producers to account for end-of-life during design of products, materials and business models.

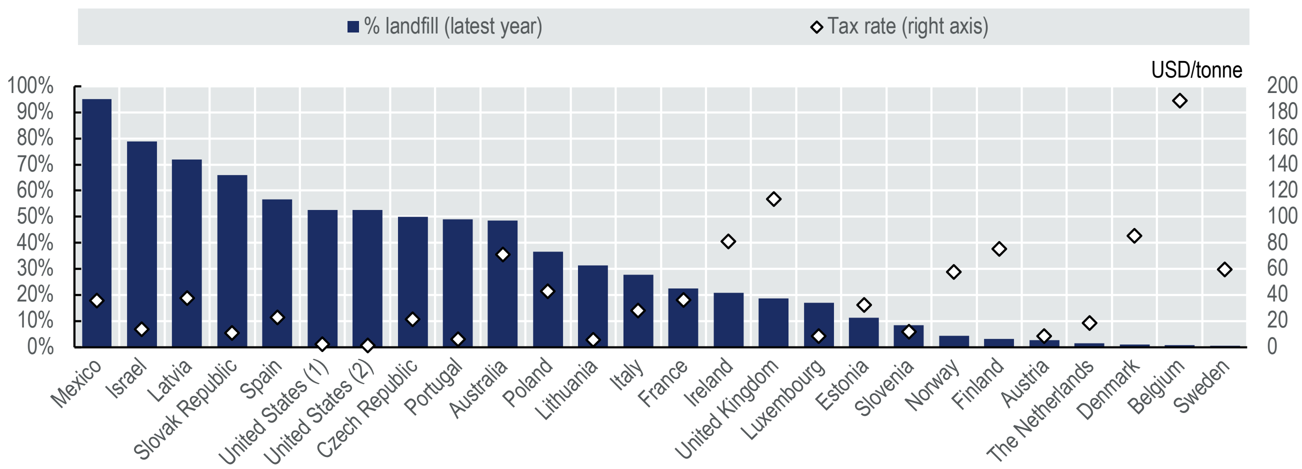
Downstream policy interventions are often seen as an 'end of pipe' solution, typically placing the responsibility on the consumer and local solid waste management systems to manage plastic waste, although today it is increasingly important to see plastic producers as having a role to support downstream interventions. Since the 1990s, there has been increasing effort to move away from linear downstream policy interventions such as incineration and landfill, towards recovery pathways – particularly recycling. For example, in many European countries, the introduction of a tax on waste sent to landfill has prompted a marked decrease in material being disposed of in landfill and an increase in material recovery facilities and mechanical and biological treatment facilities (OECD 2019a). As shown in Figure 10, countries with higher landfill tax rates exhibited lower landfill rates to those with lower tax rates (OECD 2019a). This punitive measure has enabled potentially more resource efficient, but more costly, interventions to be competitive. It has also had the added impact of producing an export market for plastic (and other) waste that would otherwise have been disposed of within the source country.

Downstream policy interventions, however, remain common throughout the world and typically include established solid waste management systems (such as material recovery facilities, landfill, anaerobic digestion, composting and incineration). The recovery of ocean plastic is a downstream solution that has typically been the focus of boutique activity (usually to make small numbers of high value products, such as carpets and furniture). Ocean plastic recovery is a key element of the Osaka Blue Ocean Vision to balance the remaining flows of plastic into the ocean in 2050 to net zero, yet it has significant challenges, as discussed in section 3.6.

3.5 Upstream policy interventions

POLICY AREA #1
Reduction of avoidable plastic

The Pew Charitable Trusts and SYSTEMIQ (2020) assert that 500,000 people need to be connected to waste collection services every day until 2040 to close the waste collection gap. Given this is unlikely, reducing the amount of plastic in the system should be a top priority for policy makers because waste management systems cannot scale quickly enough. The use of plastic can be reduced, minimized, or avoided entirely in many circumstances through intentional design changes to a product. The removal of avoidable plastics from products can often be undertaken immediately and require minimal or no design changes, such as overpackaging, which can simply be removed. Flexible plastics and multi-layer plastics have a disproportionate rate of leakage because they have the least material value (and hence lowest collection rates and are rarely recycled) and therefore should be a priority for reduction. Reuse models (such as refillable packaging; reusable



Note: Caution must be exercised in interpreting these data due to (a) the lag between application of a tax rate and its effects on the landfill rate, and (b) the relationship between local tax rates and nationwide landfill rates.

Figure 10. Rate of municipal waste sent to landfill (left axis) and landfill tax rates (in USD per tonne) (right axis) in 2019 for selected countries (OECD 2019a)

packaging and reverse logistics) in contrast, rely on a combination of consumer behaviour, intelligent product design and appropriate market infrastructure (Ellen MacArthur Foundation 2016). The System Change Scenario requires that 30 per cent of plastic be removed from the economy relative to business-as-usual by 2040 on a global scale. Three main policy interventions may help achieve this ambitious target are: (a) shifting burden of plastic pollution from consumers to plastic producers; (b) plastic product bans; and (c) financing of consumer behaviour shift programs.

a. Policies that shift the burden of waste generation from consumers to producers can 'level the playing field' for new business models and zero-packaging solutions. Extended Producer Responsibility (EPR) schemes, for example, have three objectives: 1) to internalize some of the externalities of plastic relating to the cost of its post-consumer management; 2) to generate a source of funding to deal with plastic pollution; and 3) to create direct financial incentives for producers and users of plastics to follow principles of responsible use and good design. On occasions, EPR schemes can unintentionally incentivize shifts to unrecyclable materials and formats, yet this can be de-risked by the introduction of taxes on producers for un-recycled waste, as distinct from landfill taxes (Dubois 2012; Dubois 2016).

When deployed correctly, EPR schemes have been very effective at creating a more sustainable plastic system. It is therefore no surprise that many businesses have recently publicly supported the implementation of EPR schemes in more markets. This requires that EPR fees are modular to reflect the difficulty and cost to recover and recycle each material. Other financial mechanisms include taxes on virgin plastic, taxes on single-use plastics, removing/reducing subsidies for oil and gas, and increasing landfill tipping fees and fees for waste to energy. Current EPR schemes have been successful in cost recovery, but there is currently limited evidence on the use of eco-design in packaging as a result of EPR schemes. This is likely to change as initiatives are enacted over the next five years such as those within the EU Waste Framework Directive.

b. A number of plastic products, formats and polymers are problematic and therefore measures should be taken to reduce their use. This includes plastics that are extremely difficult to recycle or that contaminate the waste stream, such as polystyrene and expanded polystyrene. Small format plastics are incredibly difficult to deal with economically and need to be revisited. Streamlining the number and variety of polymers would significantly improve the economics and scale of plastic recycling because it would reduce reliance on effective plastic sorting and enable consumers to recycle more plastics. Setting reusable packaging targets may facilitate reuse models as well as address hygiene concerns regarding food contact materials.

c. Consumer behaviour shift has an important part in creating demand for more sustainable options. Governments can support this shift by funding and supporting consumer awareness and action campaigns. For example, consumers could be encouraged to adopt appropriately tailored plastic footprint management techniques which measure and seek to reduce plastic reliance (Boucher *et al.* 2019).

Plastic reduction can also be achieved through light-weighting. This is particularly useful in situations where the use of recycled feedstock can be problematic (e.g. food packaging) and offers substantial advantages when the material is essential and cannot be recovered with conventional technologies. This also reduces the weight for product transport reducing greenhouse gas emissions in the production, transportation and disposal per item. While this method can reduce the amount of plastic in the system, it can present both technical and economic difficulties downstream. Notably, analysis by Waste and Resources Action Programme (WRAP) (McKinlay 2018) indicates that PET flakes should be 0.05 mm or thicker to avoid technical difficulties in recycling material and preventing the accumulation of moisture between layers, lowering the calorific value if sent for incineration. While this is not insurmountable, it illustrates that upstream light-weighting requires careful consideration of its appropriateness and cannot be used wholesale.

In conclusion, it is socially, technically, and economically feasible to reduce plastic consumption by 30 per cent by 2040, compared to business as usual. This would decouple economic growth from plastic production, so that global plastic consumption per person would remain approximately flat, rather than the 60 per cent increase expected under business as usual. Economic co-benefits from the reduction of avoidable plastics are potentially significant, with new or redesigned products, materials, and manufacturing processes all offering opportunities for technical and business innovation.

POLICY AREA #2
Product re-design for circularity

Product design is the policy area with the greatest potential to prompt long term systemic change in the plastics lifecycle and ultimately reduce marine plastic pollution. Product design marks the beginning of the plastic product lifecycle and the choices made at the design stage have implications for all other points in the lifecycle. Product design can deliver extremely favourable outcomes including reducing the need for plastic components within a product, designing products to have a long-life and be reusable to reduce the number of products needed, design to enable a product to be refurbished, remanufactured or repurposed to retain the plastic components in the resource system, and to select plastics for the design that can be easily recycled. As such, product design is key to plastic resource efficiency. Within the design of plastic packaging in particular, there is a movement to design in circularity and design out complexity and avoidable plastic waste.

The System Change Scenario requires the share of economically recyclable plastic to increase from an estimated 21 per cent to at least 54 per cent. This can be achieved by (a) incentivizing producers to design with end-of-life considerations and (b) providing clear guidelines on “design for circularity”.

a. An effective way to incentivize producers to account for end-of-life considerations when designing products is by developing policy interventions that promote the use and increase the value of recycled polymers. Examples include design for recycling standards, recycling targets, minimum recycled content targets, and taxes on the use of virgin plastic feedstock. A minimum recycled content requirement could be delivered through compliance schemes, such as packaging recovery notes and extended producer responsibility schemes. Increasing the recycled content of new products would require an increase in both the quality and volume of available recyclate, which in turn would require enhancements to downstream collection, sorting and solid waste management infrastructure.

b. A critical relationship exists between product design and end of life treatment. This is however, confounded by tremendous diversity in municipal plastic collection and recovery approaches, which offers little certainty to product designers about how the plastics within a product might be treated. Enhanced harmonisation of plastic collection and recovery methods would help to inform product designers of the processes available for any given product and provide the confidence to align design with

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end-of-life options. Policies prompting harmonised plastic collection and recovery methods, and which define a limited range of preferred recyclable plastic types, have the potential to unlock a shift in product design to a more reliable circular system. International and/or industry-wide agreement is potentially needed to achieve such standards. Clear guidelines on 'design for circularity' would further assist the role of design in the reduction of marine plastic litter. A series of minimum standards could be produced that will dictate to some degree the reusability and general recyclability of a product, with all plastic packaging needing to meet defined standards. This could then be used to inform both product design and recovery infrastructure needs, enabling targeted investment.

While there are many different ways to design products for recycling – shifting multi-material packaging to mono-material; redesigning (or removing) dyes, plastic pigments, and additives; increasing homogeneity and cleanliness of recycling inputs and eliminating problematic polymers and packaging formats; and improving labelling – it may be sufficient for policy makers to focus on total recycling targets and let businesses find the most cost-efficient way of achieving them. Economic co-benefits are focused on innovation and design, with a substantial opportunity opening for those companies and designers who can incorporate 'design for circularity' into their models and actions.

POLICY AREA #3

Substitution of plastic material for sustainable alternatives

Alternative materials, including bio-based polymers, card, paper, compostables, metal and glass can, in certain circumstances, replace the use of traditional plastics (UNEP 2017). The substitution of plastics with other non-plastic materials creates the potential for unintended consequences. These include, but are not limited to land use change, increases in greenhouse gas emissions, increases in nutrient demand, contamination within the waste streams, and impacts on human health. To both offset the risk of unintended outcomes and to assess functional comparability of the incoming material, the substitution should be considered at the entire product-level life cycle (UNEP 2020b; UNEP 2020c) with appropriate testing to ensure the products comply with sustainability and national health standards. The need to effectively communicate to consumers any new disposal processes or opportunities, will influence compliance. When applied appropriately, sustainable alternatives may also generate additional advantages such as increased employment and increased household incomes.

The System Change Scenario requires that approximately 17 per cent of plastic be substituted relative to business as usual by 2040 on a global scale. Three main policy interventions may help achieve this ambitious target: (a) levelling the playing field between plastic and alternative materials; (b) funding innovation in new materials directly or indirectly; and (c) set standards for compostables, support for certification schemes and the scaling of infrastructure.

a. Targeted economic incentives can create a level playing field for plastic and other materials across the life cycle, including through the removal of extraction subsidies for oil and gas, taxes on virgin plastic content, or Extended Producer Responsibility-type schemes.

b. Many innovative new materials have emerged over the last few years, some with promising economics, material performance and consumer convenience. Yet funding these innovations is often extremely challenging given many commercial investors do not know how to assess these materials, nor are they able to support the necessary extensive capital investment. Public sector programs can support these innovations directly or indirectly.

c. Compostable materials may play a significant role as plastic alternatives, but to scale these materials, they need to be supported by policy through development of infrastructure, regulation that ensures separate treatment of organic waste, standard setting that defines acceptable compostable materials according to locally available waste infrastructure, and clarity around definitions of terms such as "biodegradable".

In conclusion, considering the full life cycle and environmental impacts is essential when balancing virgin plastic with possible alternatives. This is particularly important when considering packaging for perishable food items, whereby there is a need to balance packaging waste against food waste. There is also concern with moving too rapidly towards biopolymers and igniting a "food for plastic" debate and the potential to stimulate habitat loss. However, biomass-based biopolymers such as Polylactic acid (PLA), Polyhydroxyalkanoates (PHA) and Thermoplastic styrenic elastomers (TPS) show potential and there is scope to increase the use of agricultural and horticultural waste as alternative feedstocks (UNEP 2017). Multiple reports have been published that develop plans and route maps to alternative materials to reduce marine plastic litter (UNEP 2017). These can be explored further to help inform a unified set of standards or policies to increase the impact that these interventions can have. Economic co-benefits of plastics substitution are potentially significant, with many plastic alternatives already trading successfully in the marketplace and a considerable opportunity for growth in this activity as plastics are increasingly phased out of products.

3.6 Downstream policy interventions

POLICY AREA #4
Expansion of waste collection

Collection is considered by many as the most important part of waste management. Yet by 2040, an additional 3.7 billion people will need to be connected to collection services (2 billion who lack it today plus 1.7 billion population growth). This would require 500,000 more people being added to collection services every single day until 2040. There are significant risks associated with uncollected waste above and beyond plastic pollution, including possible health and climate risks from waste that is burned (estimated at 49 million tonnes per year) and spread of disease from living near uncollected waste (Williams *et al.* 2019). Given the vast majority of the collection gap is in the Global South where funding is least available and in rural areas where collection is more logistically difficult and more expensive (because of low waste density), it is highly unlikely that the funding will be found to close the collection gap within the current system. However, potential funding streams should be pursued, and the informal sector supported. Therefore, closing the collection gap will require: (a) increasing the value of materials; (b) recognition of the role of informal waste pickers; (c) interventions to improve the quality of waste collection or prevent illegal dumping; and (d) improved collection governance and citizen behaviour change campaigns.

a. Governments can support the expansion of market-driven collection by creating a policy environment where the value of materials is higher than the cost of collection. Governments can promote waste collection by requiring the use of recycled content, incentivizing design for recycling and re-use, reducing the diversity of polymers to reduce the need for sorting, and supporting local markets for the informal recycling sector. Governments should also examine the possibility of modifying legislation and regulations related to chemical and waste safety which in some cases prevents the use of recycled plastics and depresses demand for plastic waste.

b. The contribution of the informal waste collection sector to reducing marine plastic litter has largely gone unrecognized and underpaid. However, the positive impact of these actions can be quantified. In Pune (India) the informal sector is able to achieve impressive waste segregation and recycling rates, diverting 52 per cent of plastic waste from landfill and saving 50,000 tonnes of CO2 equivalent annually (Moora 2019). In the SaiMai District of Bangkok (Thailand) the informal waste collection sector reduces the cost of municipal waste collection, saving the city $316,000 USD per year in waste disposal fees (Johnson and Trang 2019). An increase in plastic material value through design for recycling, as well as the implementation of new technologies, can significantly increase the retained of plastics value for waste pickers and contribute to improvements in their health and welfare.

c. The illegal dumping of waste into the environment happens in many countries, with compliance undermined by weak regulations, corruption, and limited enforcement capacity. Options to improve the quality of waste collection or prevent illegal dumping include results-based financing, performance-based remuneration, stronger regulations and enforcement, and capacity development of relevant institutions and individuals, particularly in the Global South. Working with citizens to ensure appropriate household waste management practices are employed is a further area of attention.

d. Consideration could be given to how the expansion of waste collection is prioritized given the explicit target within the Osaka Blue Ocean Vision of tackling marine plastic litter. For instance, it may be more effective to prioritize the expansion of waste collection in coastal cities that generate high levels of plastic waste.

POLICY AREA #5
Support for mechanical recycling and chemical conversion

Today's plastic recycling system is failing us. Globally, only around 14-18 per cent of plastic packaging is returned into the system by recycling, with only 15 per cent of that material effectively recycled, with 57 per cent recycled into lower grade products and the remainder lost in the process (Geyer *et al.* 2017; Citi GPS 2018). The material that is not recycled (86 per cent) is either sent for energy recovery/incineration (14 per cent), landfilled (40 per cent) in both properly managed engineered landfills and illegal landfills or leaks from the system (32 per cent) (Citi GPS 2018).

Mechanical recycling is a particular focus for innovation with the ambition to find engineering solutions that remove waste sorting responsibility from the consumer. A situation in which poorly sorted or unsorted domestic waste does not compromise recycling rates is a highly desirable outcome. At present, domestic sorting is a major constraint for recycling efforts, as waste streams are easily contaminated by sorting errors, exacerbated by highly variable recycling rules that are sometimes poorly communicated. Mechanical recycling typically also exists within highly diverse plastics collection and sorting approaches, which undermine efficiency gains by requiring a diversity of waste management practices and infrastructure. Policy approaches that encourage greater harmonization of plastics collection and sorting approaches is critical to effective recycling. A further complication is that current recycling infrastructure is often difficult to adapt due to the long payback timescales and contractual arrangements associated with large infrastructure projects which typically leave critical waste infrastructure outside the direct control of municipal governments. Recycling infrastructure policies affect millions of people, potentially for 25-30 years over the lifespan on the infrastructure, therefore it is essential that decisions are informed by up-to-date scientific and technological approaches that support effective recycling (Roberts *et al.* 2018). Otherwise, such infrastructure will become rapidly outdated creating "stranded assets", as can be seen with incineration infrastructure within Northern Europe (Malinauskaite *et al.* 2017). It is possible that NIMBYism (not in my backyard) also plays a role in the location and scale of waste management infrastructure.

The System Change Scenario requires mechanical recycling output to grow by nearly 3 times by 2040. Achieving this requires improving the economics of recycling, which governments can support by: (a) improving demand for recycled content; (b) streamlining the variety of polymers used; (c) improving sorting of plastic waste at the source; and (d) supporting design for recycling.

a. Governments can set minimum recycled content requirements or provide tax benefits for companies who meet a minimum recycled content threshold. This can increase the demand for recycled plastic, support the price of recycled content and improve recycling economics. It will also lead to increased supply of recycled content, which will enable companies to fulfil their recycling targets, which is not easy to do in today's environment. This is especially critical given the dramatic declines in oil prices in 2020 because of COVID-19 which are making

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virgin plastic even more affordable and hurting the recycling industry. Taxation of linear disposal systems such as landfill and incineration can also support recycling economics, as recycling becomes a viable circular alternative. Public procurement policies can also drive demand for recycled content.

b. Streamlining the number and variety of polymers would significantly improve the economics and scale of plastic recycling because it would reduce the requirements on plastic sorting and enable recycling of more plastics. Policy-makers have an important role in setting standards that harmonize the diversity of polymers in the market.

c. Policymakers can incentivize the increase of source separation in collection systems through regulation, investment in local waste infrastructure and by funding public education campaigns to separate waste.

d. Governments have a critical role to play in supporting design for recycling, as explained in Policy Area #2.

Chemical recycling is considered as a complement to mechanical recycling and a potential recovery route for plastics that cannot be mechanically recycled, including (but not limited to) multi-laminated films, contaminated plastics, plastics containing legacy additives, and composites. Chemical recycling processes have achieved technology demonstrator scale and expectations are that these will begin to achieve scale in the next 5-10 years. Several large plastics producers have announced plans to invest in chemical recycling facilities to provide new feedstocks. In Europe, the Waste Framework Directive makes it clear that the production of fuels from such a route is not classed as recycling. As innovations are refined and become mainstreamed within product design and recycling technologies, a potential feedback loop will increase the purity of recovered plastics. This would then increase its quantity and value, enabling a greater proportion of recovered material in products. There is potential for enzymes or other chemical degradation methods to de-polymerize plastics for continued re-use. However, there is a need to explore these potentially disruptive technologies to supplement the physical recycling technologies that exist, with adequate life cycle assessments undertaken to determine their suitability and climate impacts.

The System Change Scenario estimates that the chemical conversion industry could grow to 26 million tons by 2040, relative to approximately 1 million tons today. In addition to the policy interventions outlined for mechanical recycling, governments may consider supporting chemical conversion by counting plastic-to-plastic chemical conversion (but not plastic-to-fuel) as "recycling" for national/company targets. In conclusion, mechanical recycling and chemical conversion are complementary—not competing—technologies as they handle different feedstock. For low-value or contaminated plastic not suitable for mechanical recycling, chemical conversion has the potential to provide a method of reintroducing the plastic polymers back into the system and closing the loop. While recycling is a critical part of the solution, and it must be scaled quickly, we will never solve the plastic pollution challenge through recycling alone. Hence, it is important that governments and industry support upstream solutions as well, and do not treat recycling as a silver bullet.

POLICY AREA #6
Controlled disposal of non-recyclable plastics

Currently not all plastic is suitable for recovery, and it is likely that a significant proportion of plastics will require some form of disposal. Redirection of plastic streams away from landfill will reduce marine plastic litter, provided that suitable alternatives are in place. Essential single use plastics unsuitable for recovery should be disposed of safely to minimize their environmental and potential human health impacts. This should offset the risk of certain plastics being overtly avoided to the detriment of product performance, economic competitiveness and environmental sustainability. Composting technologies and anaerobic digestion are currently used to treat compostable plastics (defined by specific standards ASTM D6400 (in the U.S.) or EN 13432 (in Europe) for biodegradation in an industrial composting facility in a defined length of time) that are often contaminated with organic material. However, many consumers may not know that the conditions in home composters and in the open environment are very different compared to industrial composting plants. This affects the rate and extent of breakdown. Whether a biodegradable or compostable plastic item biodegrades, and how quickly that happens, strongly depends on the conditions to which it is exposed. Because the marine environment hosts extremely different conditions there are no standards for marine biodegradability in an acceptable length of time short enough to avoid negative effects on the environment.

Non-recyclable plastics can also be used as refuse derived fuel (RDFs). Proponents of this state that this approach diverts plastic waste from landfill while providing a source of heat and power. However, it is important to note that this releases carbon which would otherwise be sequestered in plastic products, potentially exacerbating climate change. Therefore, careful consideration of the full consequences of RDFs is required. Extended producer responsibility schemes may scale up plastics recovery and reduce the volume of plastic sent for disposal. Investment in innovation to minimise the volume of plastic sent for disposal will be necessary. A potential approach to secure investment may be to levy plastics with no recycled content sent for disposal. Extended producer responsibility and investment in innovative end of life facilities, may also help reduce transboundary movement of plastic waste to countries that do not have adequate capacity to manage it in an environmentally sound manner.

While controlled disposal is the least preferred option because it is not part of the circular economy, for plastic that cannot be reduced, substituted, or recycled, it is important to dispose of it in a controlled facility that prevents leakage. This will require significant investments into disposal facilities, mainly landfills. It is important that landfills are isolated from waterways to minimize the risk of flooding. Additionally, if landfills are not managed effectively with daily and intermediate cover, plastic waste may be just as likely to leak into the environment as in an open dumpsite. Coastal erosion also threatens to release pollution from historic coastal landfill sites.

There have been suggestions that the mining of legacy landfills could yield valuable materials, particularly metals with declining concentrations in conventional mines. This may cause the release of sequestered plastics into the environment, particularly if landfill mining processes are poorly executed without appropriate environmental safeguards. Landfill mining is unlikely to occur in sites created and used prior to the 1950s, as they will contain lower volumes of plastics, and indeed metals. Of greater interest are landfills used between the 1950s and early 2000s as mass efficient recycling of plastics was still in its infancy globally. Policies should approach disposal from multiple angles, by incentivizing consumers, producers and waste managers whilst encouraging innovation from the private sector. There will likely be resistance to change, and this is where targeted, unified policies will be needed. Incineration is often seen as a legacy technology similar to that of engineered landfills. As upstream methodologies are adopted that incorporate circular principles and downstream reuse and recycling methods improve – causing the value of plastics to be retained throughout its lifecycle – there is expected to be a reduction in material (particularly packaging) incinerated.

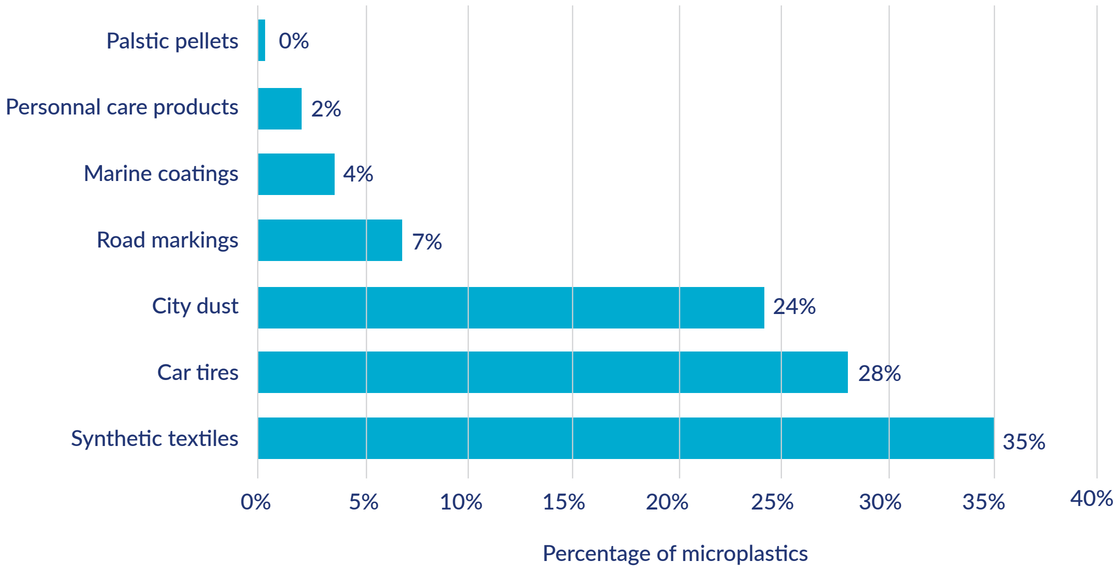
POLICY AREA #7

Solutions for microplastic release into the environment

Of increasing concern is the discharge of microplastics into the marine environment, with reports of remote areas and the deepest parts of the ocean now contaminated. Their environmental and health impacts within the marine environment are gradually being researched but at present exposure does not necessarily equate to risks for aquatic ecosystems and humans (Everaet *et al* 2018). The issue, however, goes well beyond the oceans, as micro and nanoplastics are found in all environmental settings and have been detected in drinking water and food. Microplastics can enter the marine environment through multiple routes as shown in Figure 11, but are primarily from the degradation of larger materials, particularly clothing and tyres. Figure 11 does not include degradation of macroplastics within the environment which are likely to be the largest source of microplastics. Marine microplastic pollution has also shown to interfere with the extent to which oceans are able to capture carbon (Villarrubia-Gómez *et al.* 2018). Personal care product "microbeads" are an area of policy focus, with some countries banning their use and major brands removing such items from their products. Other sources are more difficult to remove and will likely require changes upstream in their design alongside how the product is used to reduce microplastic formation combined with novel recovery mechanisms, such as microplastic filters added to washing machines, now required in France.

In its report on the Environmental and Health Risks of Microplastic Pollution[3], April 2019, the European Commission's Group of Chief Scientific Advisors, informed by a scientific evidence review report by the Scientific Advice for Policy by European Academies (SAPEA) consortium, concluded that while at present levels of plastic concentration in the environment, uncertainty surrounds the extent of ecological risks and, in particular, the health risks of microplastic pollution, these risks will increase in the future if microplastic pollution continues at its present rate. Widespread ecological risks are likely in the coming decades, but the absence of population-wide studies means that it is not yet possible to assess risks for human

3 https://ec.europa.eu/info/publications/environmental-and-health-risks-microplastic-pollution_en



Note: **This figure does not include the degradation of macro plastics in the environment.**

Figure 11. Percentage composition of global microplastics entering the ocean (Citi GPS 2018)

health. The report makes the following recommendations as a precaution against these future risks:

- Coordinate an international response consisting of research collaboration (including filling knowledge gaps on nanoplastic pollution), data sharing and standards development for measurement, monitoring and risk assessment;
- Broaden existing policy to prevent and reduce microplastic pollution in both marine and freshwater environments, and in air and soil, and prioritise substance- and context-specific measures for high-volume, high-emission sources;
- Ensure that any new measures are of benefit to society by undertaking cost/ benefit and similar analyses.

Microplastics are comparatively poorly understood by the general public, with a substantial disconnect between everyday actions and microplastics within the ocean (Henderson & Green 2020). Currently there are relatively few policies targeting microplastics specifically, with successful legislation and voluntary actions reducing micro-beads within cosmetics an exception (UNEP 2018a). Given the success of countries who have implemented these bans, there are calls for governments that have not done so yet implement similar measures to limit the inclusion of microplastics into personal care products. While this is not the largest share of leakage, it can have a significant impact given these products are washed straight to watercourses. As a first step towards reducing the release of microplastics into the environment, the European Chemicals Agency has proposed significant restrictions of the intentional use of microplastics in products in the EU/EEA market which could prevent the release of 500,000 tonnes of microplastics over a 20-year period. If approved by EU member states, the restrictions could be adopted in 2022.

Research in the area of microplastics is relatively new, with research moving towards nanoplastics that can impact cellular activity. Workshop participants identified well-framed policies on microplastics as a priority in order to rapidly address microplastic leakage. Preventing macroplastics entering the marine environment will help decrease the formation of new microplastics. Given the uncertainties related to microplastics, a precautionary focus should be placed on their capture and disposal (or recovery). Through an iterative process of policy development and testing, successful policy options could be converted into a toolbox for global dissemination. This will facilitate knowledge exchange and focus finite resources on infrastructure and capacity development. Particularly focusing on interventions that are bespoke to the needs and conditions of different cultures, practices and geographic regions; such as media campaigns and special education, focused on societal values and an awareness/knowledge of the causes of plastic pollution will be critical (Dumbili and Henderson 2020).

POLICY AREA #8

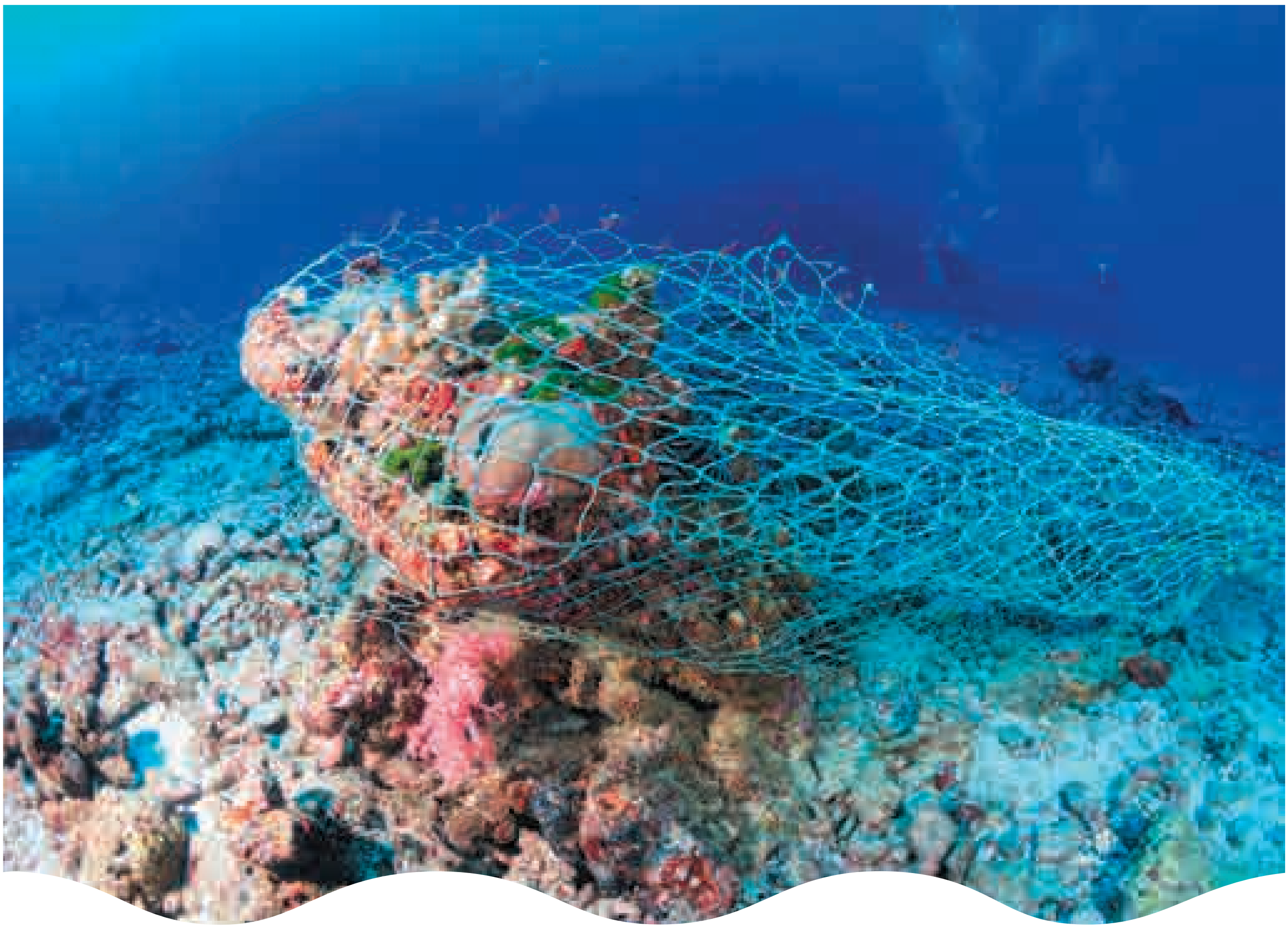
Solutions for maritime sources of plastic pollution

Maritime sources of ocean plastic pollution, defined here as all plastic that enters the environment from seagoing vessels (including from fishing activities), are some of the most visible contributors to ocean plastic pollution (Lebreton *et al.* 2018). Despite limited data, it is important to address this source of pollution urgently. Of all the sources of ocean plastic pollution, abandoned, lost or otherwise discarded fishing gear, also known as "ghost gear", ranks among the most damaging to marine ecosystems (Macfadyen *et al.* 2009). The deliberate dumping of plastic from maritime vessels is illegal under international law under MARPOL Annex V. Nevertheless, the practice is believed to be widespread and increasing (Ryan *et al* 2019). Shipping litter includes general plastic waste generated and accidentally or intentionally disposed of overboard on shipping, fishing, and recreational vessels and cruise ships. Measures available to combat shipping litter include:

a. Targeted and increased inspection regime in ports and on vessels; mechanisms that ensure free disposal of waste at ports, funded through indirect fees on all ships depending on their expected waste generation; administrative fee systems, in which ships pay for docking and the amount of waste delivered, but get a refund on the docking fee when waste is delivered; and digital reporting of waste notification and waste receipt information, harmonized and shared among governments.

b. Enforcement of MARPOL Annex V to ensure appropriate capacity and quality of waste disposal facilities at ports, standardized reporting by ships and ports, and the inclusion of adequate waste storage facility on vessels.

Achieving this will require increased international cooperation on shipping litter among governments, international organizations and other regulators, for example, through the harmonization of reporting waste, codes of practices, and communication protocols, as outlined in MARPOL Annex V.



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POLICY AREA #9
Ocean clean-up efforts

The removal of marine plastics from the ocean will be required to protect and restore ecosystem functionality in hot spots of accumulation and to meet the net-zero ambitions of the Osaka Blue Ocean Vision. Ocean clean-up efforts have garnered a lot of attention in recent years and continue to contribute to the growth in public awareness of the effects of marine plastic litter. In addition, ocean clean-up may serve as a useful transitional effort until a circular plastics economy is established.

While the exact potential scale of these solutions is still unclear, there are a number of risks with a strategy that relies on ocean clean-up instead of leakage prevention. First, it is extremely difficult to find plastic in the ocean given the gigantic size of the ocean and the relatively low pollution density, even with advanced technologies. The fact that plastic in the ocean breaks down to microplastic exacerbates the technical challenge even further. Second, even if it were technically feasible, it is estimated that ocean clean-up efforts would be expensive compared to preventative measures. Thirdly, even if it were technically and economically feasible, by the time the plastic is collected from the ocean it will have already done much damage to ecosystems. Lastly, a key issue will be the possible erosion of commitment to marine plastic litter reduction in the knowledge that the mechanical removal of plastics from the ocean is under consideration or being implemented.

There are also questions to be considered about the treatment of ocean recovered plastic and the carbon emissions associated with ocean plastic removal. River trap technologies that capture plastic flowing in a river may be more effective than ocean clean-ups. But these should also be implemented carefully to ensure that rivers don't become our waste management systems. More generally, any ocean clean-up activity should be sustainable and environmentally friendly.

3.7 Acknowledging trade-offs

Not every approach to marine plastic litter reduction will result in win-win outcomes. In reality, as well as the benefits they generate, every policy option and practical action to tackle marine plastic litter carries a financial, social and environmental cost. In financial terms, the cost of the interventions may not be recouped through job growth, business development, or reduced expenditure on environmental controls or remediation. Some strategies will present environmental trade-offs. In particular, the shift away from plastic packaging (to prolong the life of food) to other materials is likely to cause an increase in greenhouse gas emissions. This is because plastic is usually lightweight (especially relevant to the transport of goods) meaning that in a life-cycle basis it generates fewer greenhouse gas emissions. More obviously, some interventions will simply generate more greenhouse gas emissions than others for a comparable reduction in marine plastic litter. For example, it is likely that ocean clean-up will generate more greenhouse gas emissions than 'designing out' plastics during the product design stage. Similarly, the social impacts of tackling marine plastic litter may, for example, involve unpopular planning decisions to locate waste management facilities near population centres, or the introduction of new technologies or business models which may undermine job security. In any decision about how we tackle marine plastic litter, the trade-offs must be identified and weighed-up in order to make informed choices. Realistically, given the scale of the marine plastic litter problem, it is very likely that *any* intervention will be costly and will cause some social and/or economic disruption to the status quo. This does not mean that the interventions should be watered-down or avoided, but fairly considered in the context of their wider effects - both positive and negative.

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4. DELIVERING THE OSAKA BLUE OCEAN VISION

4.1 Introduction

This section of the report reflects on the challenge of achieving the Osaka Blue Ocean Vision, considers some broad conclusions from the analysis presented in this report, and finally identifies policy options and support actions to assist the delivery of the Osaka Blue Ocean Vision.

4.2 Outlook for the Osaka Blue Ocean Vision

The Osaka Blue Ocean Vision objective of achieving net-zero marine plastic litter entering the ocean by 2050 is ambitious and the level of system-wide change necessary to achieve this objective should not be underestimated. As the modelling by The Pew Charitable Trusts and SYSTEMIQ shows, even under the System Change Scenario, an estimated 710 million tonnes of marine plastic litter will still enter the ocean by 2040 (Lau *et al.*, 2020), a figure likely to be even higher by the Osaka Blue Ocean Vision's target delivery date of 2050. The difficulty lies in the sheer complexity and diversity of our societal relationship with plastics, compounded by fundamental differences in marine plastic litter reduction strategies between countries, and which is currently further complicated by the COVID-19 pandemic and its possible legacy. As such, achieving the Osaka Blue Ocean Vision will be extremely challenging under the current plastics economy.

Given the scale and complexity of the global plastics problem, the voluntary actions of consumers and companies alone cannot achieve the Osaka Blue Ocean Vision. There is currently no legally binding global-scale agreement designed to eliminate plastic entering the ocean, although there are calls, and support, for a global plastics treaty agreement from many countries. The Osaka Blue Ocean Vision, while not legally binding, has received backing from 86 countries and regions as of January 2021, and therefore presents a key opportunity to drive coordinated global action to reduce and eliminate marine plastic litter, under the auspices and leadership of the G20. There is a particular emphasis on governments at all levels to create policy frameworks that support positive social and environmental outcomes while incentivizing innovation and investment.

In the short term, there is an urgent need for actions that are known to contribute to marine plastic litter to the ocean to be halted, and actions that actively reduce marine plastic litter to be shared and scaled up. For example, we know that encouraging plastics reuse through extended producer responsibility schemes and deposit-return schemes keeps plastic out of the ocean. These schemes are also known to encourage circular design, provide financial incentives for positive consumer behaviour change (Zero Waste Europe 2017), and provide sources of well-sorted high-quality plastic waste which provides the stability needed for innovation (UNEP 2020a). Sharing effective practices and incentivizing an expansion of these schemes would be very beneficial.

National level strategies driven by science-based targets with coordination/delivery mechanisms that work at a high level across ministries, private sector and civil society would support the delivery of these measures, as is beginning through the Global Plastic Action Partnership and the Plastic Waste-Free Islands initiative (IUCN 2020). More broadly, the preceding analysis of policy options (section 3) highlights the importance of legislation, including clear and comprehensive measures (such as measures regulating extended producer's responsibility/deposit refund scheme or even labour standards for waste pickers and other informal workers in this area) and strong institutional capacities (to enable implementation and enforcement of the existing legislation), which are necessary to materialize recommended policies and actions.

We also know that the unnecessary inclusion of plastic in consumer products increases the volume of plastics in circulation which increases the overall volume of plastics entering the ocean. In other words, to reduce the amount of plastic entering the ocean, we must reduce the amount of plastic in the system – simply scaling up waste management will not be sufficient. As demonstrated by the challenges involved in delivering the System Change Scenario, the changes required to deliver the Osaka Blue Ocean Vision, which goes considerably further than the Scenario, are enormous and touch all elements of the plastic economy at the global scale. Given the diversity in the plastics economy, it is certain that solutions will need to be tailored to specific geographical and socio-economic settings, and this will need much further consideration.

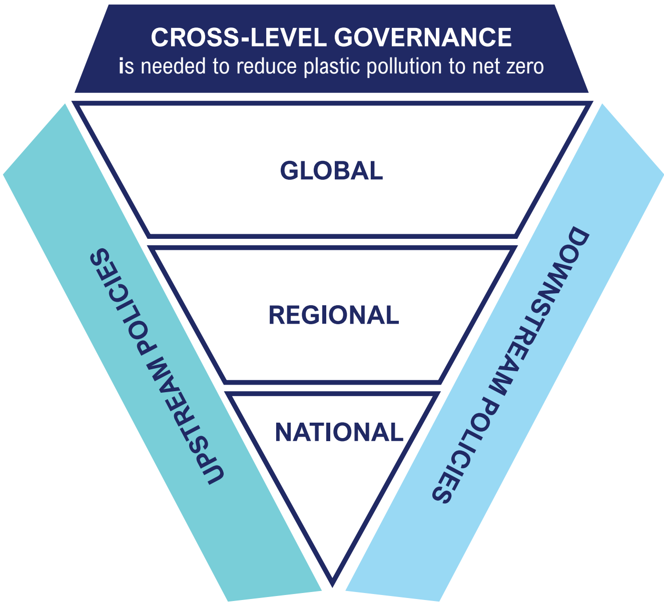

Figure 12. Cross-level governance and upstreams and downstream policies

A potential strategy to deliver the goal of net-zero additional plastic entering the ocean by 2050 is the acceptance within the Osaka Blue Ocean Vision of the role of ocean clean-up as a method to offset remaining plastic flows into the ocean once 'terrestrial' solutions within the plastics economy are in place. It is widely acknowledged that ocean plastic removal has many challenges but organisations such as The Ocean Cleanup are forging ahead with ocean plastic removal. At present, there is no reliable estimate of the volume of plastic removed from the ocean by clean-up activities. However, it has been suggested that ocean plastic removal can make a meaningful impact on total plastic levels if accompanied by river barriers (Hohn *et al* 2020).

4.3 Conclusions and policy options to deliver the Osaka Blue Ocean Vision

Based on the analysis presented in this report, the broad conclusions and policy options arising from this think piece are:

CONCLUSION #1. To deliver the necessary changes for the plastics economy, the G20 should accelerate its work on marine plastic litter as a priority.

The evidence presented in this report suggests that systematic changes to the plastics economy are needed immediately if the Osaka Blue Ocean Vision's target of 2050 is to be achieved. Now is not the time to lose focus. Action now will prevent the need to do more later.

Policy options:

➔ Maintaining and growing international support for the goal of the Osaka Blue Ocean Vision is necessary to catalyse global action to address marine plastic litter. There is also increasing, but not universal, interest in the potential of a legally binding global agreement to tackle marine plastic litter. These developments present significant opportunities to build upon the growing consensus for action developed through the agreement and subsequent international uptake of the Osaka Blue Ocean Vision.

CONCLUSION #2. Greater coordination of marine plastic litter reduction policies is urgently needed to deliver the Osaka Blue Ocean Vision.

Despite the widespread public and political acceptance of the ecological and human effects of marine plastic litter, the current suite of marine plastic litter reduction policies will not even come close to delivering the Osaka Blue Ocean Vision. Most existing plastic reduction policies are at the national scale, and are generally focused on eliminating specific items, or groups of items, rather than seeking to create systemic shifts in the plastics economy or seeking to target specific plastic leakage pathways. Isolated and uncoordinated interventions are not enough. Instead coordinated reform of regulatory frameworks, business models, and funding mechanisms is needed.

Policy options:

➔ Establish a platform under the auspices of the Osaka Blue Ocean Vision to drive the co-ordination of plastics reduction policies and strategies at national, regional and global scales. This would support aligned actions across the plastics lifecycle, including between upstream and downstream interventions, and which in the longer term contribute to systemic change in the plastics economy.

➔ Support more national- and regional-level actions to tackle marine plastic litter by sharing effective and transferable practical interventions that are known to reduce plastics entering the ocean and which contribute to systemic change in the plastics economy.

➔ In order to support new actions, undertake and share analyses of how existing successful marine plastic litter reduction techniques, technologies and policies can be transferred to other locations and contexts - perhaps in the form of a policy 'toolbox' or compendium of examples, which highlights the key transferable success factors of policies or other interventions.

➔ Support collaboration among different levels of government (to ensure national and regional policies are aligned with waste management programs at municipal level); across borders (to set global standards for materials, trade, and reporting); between the public and private sectors (to reduce investment risk and develop infrastructure); and among the value chains of different material types, (to ensure a holistic approach to resource efficiency and environmental sustainability).

CONCLUSION #3. A step change in international and national policy ambition is necessary to achieve the Osaka Blue Ocean Vision.

As the System Change Scenario demonstrates, the scale of changes needed to deliver the Osaka Blue Ocean Vision is enormous and will only be achieved by adopting more progressive policy targets, particularly at the international and national scales. As well as sharing and coordinating effective practices (conclusion #1), a step change is necessary in the ambition of the global plastics policy agenda.

Policy options:

➔ Focus the Osaka Blue Ocean Vision on achieving the holistic transformation of the plastics economy as the route to net-zero marine plastic litter. This would include strategies to promote the uptake of new regulatory frameworks and business models, infrastructure investments, and funding mechanisms to drive innovation.

➔ The development of Osaka Blue Ocean Vision marine plastic litter reduction plans at the national scale, aligned with the broader ambition of systemic reform of the plastics economy, will provide a staged and costed approach to marine plastic litter reduction. These plans will contain national plastics reduction targets and indicators and use a policy mix appropriate to the relevant nation or region to achieve net-zero marine plastic litter by 2050.

➔ The development of trans-boundary regional Osaka Blue Ocean Vision strategies, most likely developed in collaboration with sympathetic existing structures (such as the UNEP Regional Seas and Action Plans), to provide a supportive regional context and framework for national action. The proposed regional strategies would assist countries to focus their efforts on regional key plastic leakage points and facilitate technology exchange, capacity development, and partnership working. It may also be possible that they could identify finance opportunities and foster scalable research and innovation.

CONCLUSION #4. Actions that are known to reduce marine plastic litter should be encouraged, shared and scaled up immediately.

There are many examples of interventions that are known to reduce marine plastic litter very quickly, once they are in place. These should be encouraged, shared and scaled up. These will generate 'quick wins' which may inspire further policy action and provide a context that encourages innovation. Technology transfer to support leapfrogging should be actively considered to support these actions.

Policy options:

➔ Promote coordination of a voluntary ban of single use and throw away plastic products for which sustainable alternatives already exist.

➔ Focus on product design as a key opportunity to 'design out' plastics and to move from a linear to a circular model of plastic production and consumption. Designing out plastics would take pressure off downstream interventions, and could be supplemented by setting a target date to reduce and ultimately eliminate the use of unnecessary plastic in products.

➔ Promote a reduction in the diversity of plastic used in everyday products in order to enable more efficient downstream collection, recycling and re-use. In the longer term, reducing plastic diversity will provide the stability to unlock investment in innovation and infrastructure.

➔ Focus on schemes that remove the need for domestic sorting and disposal of plastics, such as deposit return schemes. Where such schemes are not available, share and scale up effective behaviour change approaches that encourage high quality domestic sorting and disposal practices that are aligned to the prevailing plastic waste management infrastructure.

CONCLUSION #5. Supporting innovation to transition to a circular plastics economy is essential to achieving the Osaka Blue Ocean Vision.

While many technical solutions are known and can be initiated today, these are insufficient to deliver the ambitious net-zero target of the Osaka Blue Ocean Vision. New technical and business approaches and innovations are needed that support the transition to net-zero in both the policy and technical domains. Life-cycle analysis should be used to ensure any innovations adopted do not generate new or more severe environmental challenges.

Policy options:

➔ Develop guidance on effective practices which support innovation in the plastic economy, targeted at governments and the private sector, to identify, invest in, and scale up technologies with the potential to reduce marine plastic litter.

➔ Develop collaborative plastic innovation clusters (actual or virtual) which bring together the private sector, governments, researchers and civil society to innovate and develop new approaches to marine plastic litter. This is an approach employed in other sectors (e.g. conservation) to generate benefits well beyond the scope of any one single organization or conventional partnership.

➔ Concerted innovation focus is needed to support the scaling up of ocean plastic recovery. It is unlikely that even an immediate and systemic change in the plastics economy will result in net-zero plastics entering the ocean by 2050. Recovery of ocean plastics is a plausible strategy to close the plastics leakage gap but requires considerable research and development activity to reach the necessary scale to be useful to deliver the Osaka Blue Ocean Vision.

CONCLUSION #6. There is a significant knowledge gap on the effectiveness of marine plastic litter policies.

It is critical to get marine plastic litter policy right first time, yet there is very little analysis of plastics policy, experience sharing or capacity development. The current approach risks misdiagnosing or underestimating the scale of the plastics problem, wasting resources on ineffective policies (which may have long-term implications – e.g. misjudged infrastructure becoming stranded assets), and failing to focus on the key leakage points of marine plastic litter into the ocean.

Policy options:

➔ Establish protocols to support effective evaluation of marine plastic litter reduction policies. These should be relatively simple to complete and contribute to a global evidence base of lessons learned. Regular sharing of analyses will enable the most up-to-date evidence to be used to support marine plastic litter policy development and adaptation. The "G20 Report on Actions against Marine Plastic Litter" updated yearly could be utilized, at least in part, for this purpose.

➔ Establish test sites, at which marine plastic litter reduction policies and technological interventions (e.g. extended producer responsibility schemes) can be implemented, evaluated and refined for scale-up, as appropriate. This analysis will support fast-tracking of new policy or technical interventions and build confidence in their transferability.

➔ Initiate a program to continuously monitor the movement, composition and volume of plastic entering the ocean. This will produce a continuous baseline to monitor the impact of policy and other interventions, including the success of the Osaka Blue Ocean Vision. This could use the guidelines developed by GESAMP (2019).

➔ Engage existing knowledge platforms (such as the Global Partnership on Marine Litter) that bring together representatives of all key plastics sectors and interests to generate and share actionable research, potentially in the areas of education and stakeholder engagement to tackle marine plastic litter and other plastics-related challenges. These will also support exchange of marine plastic litter reduction experiences at multiple scales.

➔ Extend the modelling of plastic waste generation and its subsequent discharge into the ocean as marine plastic litter to 2050 and test specific policy interventions over the 30-year time horizon of the Osaka Blue Ocean Vision. The modelling presented in the "Breaking the Plastic Wave" report shows clearly that delivery of the Osaka Blue Ocean Vision is way off track.

CONCLUSION #7. The international trade in plastic waste should be regulated to protect people and nature.

There is widespread evidence that the international trade in plastic waste, particularly where plastic is moved from the

Global North to the Global South (in which plastics are generally exported from countries with reasonably good waste treatment to countries, in general, with poorer waste treatment facilities) can result in significant plastic leakage to the environment and potential damage to human health. Although new requirements for trade in most plastic scrap and waste have been adopted under the Basel Convention, there is scope for more principles-based measures to be developed.

Policy options:

➔ Further work should be done under the auspices of the Basel Convention, building on its latest decisions, to ensure that trade in plastic waste is really sustainable, in particular that 1) plastic waste should only be exported to countries with higher standards of plastic treatment than the exporting country; and 2) that countries receiving exported plastic waste must already be adequately treating their domestic waste and have sufficient capacity to treat the imported plastic waste.

➔ Support the presumption that plastic waste should be treated in the same country (or where appropriate, region) in which it is generated in order to support the transition to a circular plastics economy, unless there is a compelling human or environmental reason why this is impractical.

CONCLUSION #8. COVID-19 recovery stimulus packages have the potential to support the delivery of the Osaka Blue Ocean Vision.

Many billions of US dollars are being committed to support recovery from the economic shock, and its ongoing legacy, of the COVID-19 pandemic. In some cases, the recovery packages include the idea of 'building back better' and contain an emphasis on green economic growth and transitions. Including measures to reduce marine plastic litter will generate jobs in Greentech and Bluetech sectors and support the delivery of the Osaka Blue Ocean Vision.

Policy options:

➔ Lead the establishment of an agreement under the auspices of the Osaka Blue Ocean Vision that COVID-19 recovery packages support the pivot of the plastics economy towards the delivery of the Osaka Blue Ocean Vision.

➔ Encourage signatories of the Osaka Blue Ocean Vision to ensure that their COVID-19 recovery strategies support lower carbon and more circular approaches that reduce marine plastic litter.

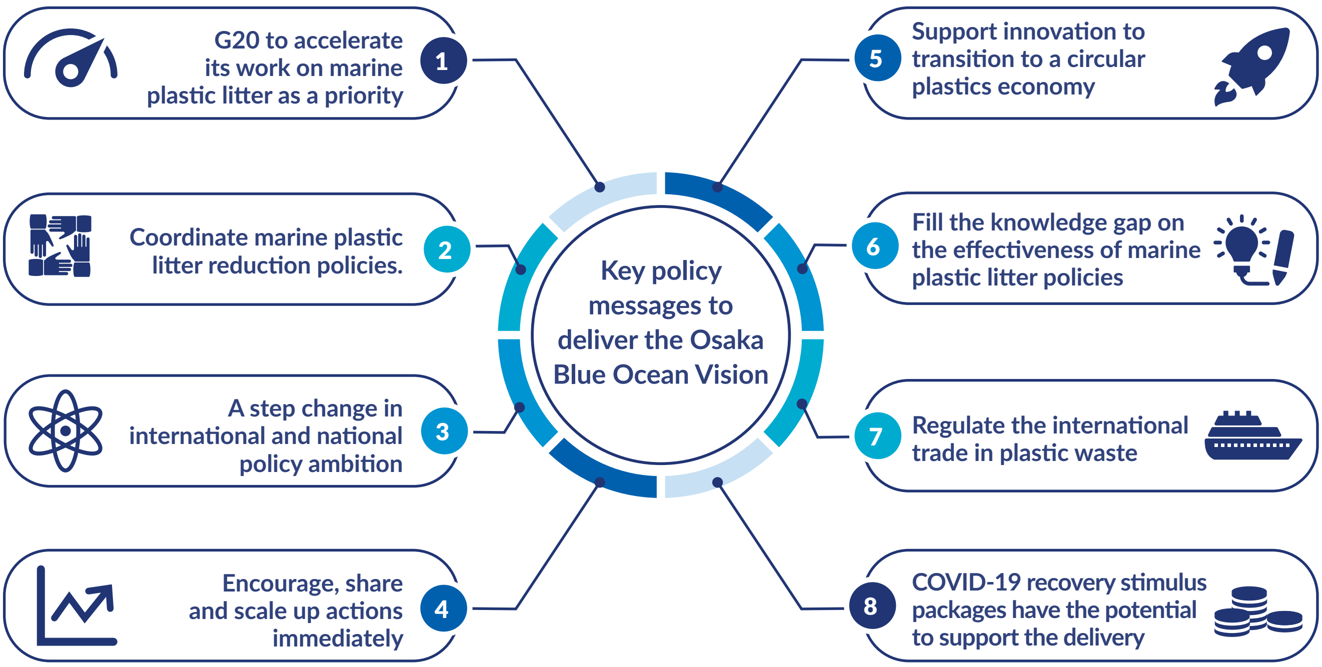

Figure 13. Key conclusions/policy messages to deliver the Osaka Blue Ocean Vision

4.4 Reflections on multi-beneficial policymaking and the future role of modelling

The multi-beneficial approach to policymaking advocated by the International Resource Panel (see Figure 7 and explanation in section 3.3) was found to be well aligned to the conclusions and policy options identified in section 4.3 as shown in Table 1 below. At least three elements of multi-beneficial policymaking were evident in each conclusion and the more holistic conclusions and associated policy options exhibited more elements of multi-beneficial policymaking. This both demonstrates the complexity of addressing the ambitions of the Osaka Blue Ocean Vision and confirms the widespread applicability of the elements of multi-beneficial policymaking in resource management contexts.

This report was limited by the available modelling only looking ahead to 2040 rather than 2050 when the net-zero marine plastic litter target of the Osaka Blue Ocean Vision expires. Whilst the 10-year modelling gap generates some uncertainty, the trends identified through the modelling are clear as is the enormous scale of the systemic change needed to achieve even a moderate reduction in plastics entering the ocean. Omissions from the modelling used in the report include maritime-sourced plastics and any future efforts to scale up plastic ocean recovery. The latter in particular would be useful to model as this is a key part of the Osaka Blue Ocean Vision's approach to achieve net-zero marine plastic litter by 2050. The model does not contain reference to the effects of COVID-19.

In summary, this report highlights the immense scale of the marine plastic litter challenge and the inadequacy of current policy approaches. The conclusions and associated policy options advocate a wholesale change in the plastics economy from a linear and wasteful system in which value is lost at all stages, to a circular plastics economy in which value is retained and leakage to nature is minimized. In order to achieve the Osaka Blue Ocean Vision, emphasis must be placed on identifying, sharing and scaling up policies that are proven to be effective, actively supporting policy and technological innovation, and developing national strategies and regional and global agreements to reduce marine plastic litter to net-zero.

Table 1. Elements of multi-beneficial policymaking present in the conclusions and policy options to deliver the Osaka Blue Ocean Vision.

Elements of multi-beneficial policymaking	Conclusions							
	1	2	3	4	5	6	7	8
Indicators and targets		✓	✓		✓	✓		
National plans	✓	✓					✓	
Policy mix	✓	✓	✓	✓	✓	✓	✓	
International exchanges	✓			✓	✓	✓		
Sustainable financing		✓					✓	
Unlocking resistance to change	✓	✓		✓	✓		✓	✓
Policies for the circular economy	✓	✓	✓			✓	✓	
Leapfrogging			✓		✓			


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ANNEX 1. WORKSHOP ATTENDEES

Name	Title	Organisation	Country
Prof. Steve Fletcher	Director, Revolution Plastics and IRP Panel Member	University of Portsmouth	UK
Dr. Keiron Roberts	Research Fellow - Clean Carbon Technologies	University of Portsmouth	UK
Sayyidah Salam	Research Assistant, Revolution Plastics Initiative & GCRF	University of Portsmouth	UK
Samuel Winton	Research Assistant, Revolution Plastics	University of Portsmouth	UK
Simone Malaika Retif	International Resource Panel Secretariat	UNEP/IRP	France
Simon Reddy	Director, International Environment	The Pew Charitable Trusts	UK
John Virdin	Director, Oceans & Coastal Policy Program	Duke University	USA
Dr. Anne-Gaelle Collot	Senior Manager Environmental Affairs	Plastics Europe	Belgium
Dr. Lesley Henderson	Reader in Sociology and Communications	Brunel University London	UK
Heidi Savelli-Soderberg	Marine Plastics Coordinator	UNEP/ Global Partnership on Marine Litter	Kenya
Kathryn Marie Youngblood	Research Engineer	University of Georgia	USA
Adrian Whyle	Head of Resource Efficiency	Plastics Europe	UK
Siegfried Anton Schmuck	Marine Litter Policy Officer	Sciaena	Belgium
Sanna O'Connor	Associate	SYSTEMIQ	UK
Gaelle Haut	EU Affairs Project Manager	Surfrider Foundation Europe	Belgium
Dr. Andrea Winterstetter	R&D Associate - Expert Sustainable Materials Management	VITO NV	Belgium

Name	Title	Organisation	Country
Ivan Conesa Alcolea	Policy Officer	European Commission	Belgium
Peter Börkey	Environment and Economy Integration Division	OECD	France
Joanna Kulczycka	Panel Member International Resource Panel	IRP	Poland
Delphine Arri		World Bank	USA
Chika Aoki-Suzuki	Senior Researcher/Programme manager	IGES	Japan
Ralph Schneider	Sustainability Lead	World Plastics Council	
Llorenç Milà i Canals	Head of the Secretariat, Life Cycle Initiative	UNEP/ Life Cycle Initiative	France
Prof. John McGeehan	Director, Centre for Enzyme Innovation	University of Portsmouth	UK
Yoni Shiran	Partner	SYSTEMIQ	UK
Joana Mira Veiga	Marine Litter expert Unit Marine & Coastal Systems	Deltare	
Elena Buzzi		OECD	France
Frithjof Laubinger		OECD	France
Claudia Giacovelli	Programme Officer	UNEP/ Life Cycle Initiative	France

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About the International Resource Panel

Aim of the Panel

The International Resource Panel was established to provide independent, coherent and authoritative scientific assessments on the use of natural resources and their environmental impacts over the full life cycle. The Panel aims to contribute to a better understanding of how to decouple economic growth from environmental degradation while enhancing well-being.

Benefiting from the broad support of governments and scientific communities, the Panel is constituted of eminent scientists and experts from all parts of the world, bringing their multidisciplinary expertise to address resource management issues. The information contained in the International Resource Panel's reports is intended to:

- be evidence based and policy relevant,
- inform policy framing and development, and
- support evaluation and monitoring of policy effectiveness.

Outputs of the Panel

Since the International Resource Panel's launch in 2007, more than 30 assessments have been published. The assessments of the Panel to date demonstrate the numerous opportunities for governments, businesses and wider society to work together to create and implement policies that ultimately lead to sustainable resource management, including through better planning, technological innovation and strategic incentives and investments.

Following its establishment, the Panel first devoted much of its research to issues related to the use, stocks and scarcities of individual resources, as well as to the development and application of the perspective of 'decoupling' economic growth from natural resource use and environmental degradation. These reports include resource-specific studies on biofuels, water and the use and recycling of metal stocks in society.

Building upon this knowledge base, the Panel moved into examining systematic approaches to resource use. These include looking into the direct and indirect impacts of trade on natural resource use; issues of sustainable land and food system management; priority economic sectors and materials for sustainable resource management; benefits, risks and trade-offs of low-carbon technologies; city-level decoupling; and the untapped potential for decoupling resource use and related environmental impacts from economic growth.

Upcoming work

In the forthcoming months, the International Resource Panel will focus on scenario modelling of natural resource use, the socioeconomic implications of resource efficiency and the circular economy, the role of resources in environmental displacement and migration, and the connections between finance and sustainable resource use, among others.

More information about the Panel and its research can be found at:
Website: www.resourcepanel.org
Twitter: https://twitter.com/UNEPIRP
LinkedIn: https://www.linkedin.com/company/resourcepanel
Contact: unep-irpsecretariat@un.org

POLICY OPTIONS TO ELIMINATE ADDITIONAL MARINE PLASTIC LITTER

BY 2050 UNDER THE G20 OSAKA BLUE OCEAN VISION

The International Resource Panel (IRP) was established to provide independent, coherent and authoritative scientific assessments on the use of natural resources and their environmental impacts over the full life cycle. The Panel aims to contribute to a better understanding of how to decouple economic growth from environmental degradation while enhancing well-being. The Secretariat is hosted by the United Nations Environment Programme.

An International Resource Panel think piece is a technical or policy paper based on IRP scientific studies and assessments and other relevant literature. It is not a full study and assessment but a collection of science-based reflections, which may catalyze the generation of new scientific knowledge and highlight critical topics to be considered in policy discourse.

This IRP 'think piece' was commissioned by the G20, to qualitatively consider possible policy options to achieve the Osaka Blue Ocean Vision, which voluntarily commits G20 countries to "reduce additional pollution by marine plastic litter to zero by 2050 through a comprehensive life-cycle approach", thereby ensuring that by 2050, the net volume of plastic entering the ocean is zero.

In this endeavor, the think piece shows, through the scenario modelling analysis published in "Breaking the Plastic Wave", the marine plastic litter trends relevant to 2050, summarizes the current plastic policy landscape and explores policy upstream and downstream interventions to achieve the Osaka Blue Ocean Vision. Based on the analysis presented, it concludes with a set of policy messages to deliver on the Vision and to transition to the systemic changes needed to the plastic economy.

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