Breaking the Plastic Wave

A COMPREHENSIVE ASSESSMENT OF PATHWAYS TOWARDS STOPPING OCEAN PLASTIC POLLUTION

THE PEW CHARITABLE TRUSTS

SYSTEMIQ

Thought Partners

UNIVERSITY OF OXFORD

UNIVERSITY OF LEEDS

ELLEN MACARTHUR FOUNDATION

Common Seas

EXECUTIVE SUMMARY

About The Pew Charitable Trusts

The Pew Charitable Trusts is driven by the power of knowledge to solve today's most challenging problems. Pew applies a rigorous, analytical approach to improve public policy, inform the public, and invigorate civic life. As the United States and the world have evolved, we have remained dedicated to our founders' emphasis on innovation. Today, Pew is a global research and public policy organization, still operated as an independent, nonpartisan, nonprofit organization dedicated to serving the public.

Informed by the founders' interest in research, practical knowledge, and public service, our portfolio includes public opinion research; arts and culture; civic initiatives; and environmental, health, state, and consumer policy initiatives.

Our goal is to make a difference for the public. That means working on a few key issues, with an emphasis on projects that can produce consequential outcomes, foster new ideas, attract partners, avoid partisanship or wishful thinking, and achieve measurable results that serve the public interest.

Learn more at https://www.pewtrusts.org/en

For more information, contact us at PreventingOceanPlastics@pewtrusts.org

About SYSTEMIQ

SYSTEMIQ Ltd. is a certified B Corp with offices in London, Munich, and Jakarta. The company was founded in 2016 to drive the achievements of the Paris Agreement and the United Nations Sustainable Development Goals by transforming markets and business models in three key economic systems: land use, materials, and energy. Since 2016, SYSTEMIQ has been involved in several system change initiatives related to plastics and packaging, including the New Plastics Economy initiative (Ellen MacArthur Foundation) and Project STOP (a city partnership programme focused on eliminating plastic pollution in Indonesia), among others. At the heart of our work is the core belief that only a smart combination of policy, technology, funding, and consumer engagement can address system-level challenges. The global plastics challenge is no different.

Learn more at https://www.systemiq.earth/

For more information, contact us at OceanPlastics@systemiq.earth

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Preface

In recent years, an increasing number of studies and reports have advanced the global understanding of the challenge posed by ocean plastic pollution. But most leaders across industry, government, and civil society have noted a critical gap: an evidence-based roadmap to describe the pathways available and to foster convergent action.

As a step towards building that roadmap, The Pew Charitable Trusts partnered with SYSTEMIQ to build on previous research and create this first-of-its-kind model of the global plastics system, with results suggesting that there is an evidence-based, comprehensive, integrated, and economically attractive pathway to greatly reduce plastic pollution entering our ocean. The findings of our analysis were published in the peer-reviewed journal, *Science* on 23 July 2020.

The speed at which ocean plastic pollution has climbed up the public agenda has been surprising. Yet, even as the world starts to comprehend the enormity of the challenge, major actors disagree on the solution. In preparing "Breaking the Plastic Wave: A Comprehensive Assessment of Pathways Towards Stopping Ocean Plastic Pollution," we consulted an extensive group of stakeholders from academia, industry, government, and nongovernmental organizations, who without exception shared the concern and demonstrated willingness to act—but often offered contradictory solutions.

We then developed perhaps the most comprehensive plastic system modelling tool to create a global analysis that evaluates various strategies to reduce ocean plastic flows and quantifies the associated economic, environmental, and social implications of each pathway. The ultimate aim of this work is to help guide policymakers, industry executives, investors, and civil society leaders through highly contested, often data-poor, and complex terrain. Our analysis includes several key findings that could help define changes to the global system that are necessary to stop plastic pollution from flowing into the ocean.

The research supporting this report involved 17 experts from across the spectrum of people looking at the plastic pollution problem and with broad geographical representation, and was undertaken by our two independent organizations in collaboration with four partner institutions—the University of Oxford, University of Leeds, Ellen MacArthur Foundation, and Common Seas.

In addition, the project team drew upon major publications, analyses, and reports, and consulted more than 100 independent experts, to develop and populate the model. These experts represented the plastic supply chain, academia, and civil society, and neither they nor their institutions necessarily endorse the report's findings.

"Breaking the Plastic Wave" follows two reports from the Ellen MacArthur Foundation that established the vision of a circular economy, aimed at eliminating waste and encouraging the continual use of resources by reusing, redesigning, and recycling. This concept has garnered unprecedented support across the global plastics system.

By highlighting the systemic link between better plastic design, reuse, improved recycling economics, and increased collection incentives, these reports provided a central theme for the challenge addressed in "Breaking the Plastic Wave": how to apply the concept of a circular economy—along with increased reduction and substitution of plastics, and better waste management—in a way that urgently addresses this serious environmental challenge.

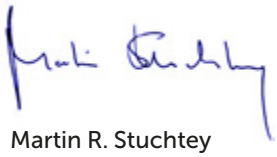
The model is already being applied at the national level in Indonesia under the public-private collaboration Global Plastic Action Partnership. Our hope is that the results of "Breaking the Plastic Wave" can serve as a map for policy leaders, decision-makers, and businesses in search of solutions to stem the flow of plastic into the ocean. This model can also be updated by stakeholders on an ongoing basis to inform solutions to the plastics pollution problem.

The problem of ocean plastic pollution was created in a lifetime, and we have reason to believe that it can be solved within a generation, or sooner. But such a solution requires political leaders, policymakers, business executives, and investors to shift from incremental to systemic change.

Among our findings, one is particularly stark: On the current trajectory, which we call Business-as-Usual, annual flows of plastic into the ocean could nearly triple by 2040. What's more, even if all current major industry and government commitments are met, the world would see a reduction in annual rates of plastic pollution flowing into the ocean of only 7 per cent from the Business-as-Usual scenario.

Yet we also show that if the world were to apply and robustly invest in all the technologies, management practices, and policy approaches currently available—including reduction, recycling, and plastic substitution—in 20 years there would be about an 80 per cent reduction from the current trajectory in the flow of plastic into the ocean. And the new solutions recommended in this report would provide consumers with the same services that plastic delivers today—at a lower cost to society.

We hope that the "Breaking the Plastic Wave" concepts, data, and analyses inform decision-makers who are responsible for setting industry and government action. The report's most important message is that, with the right level of action, tackling the problem of plastics pollution may be remembered as a success story on the human ability to rethink and rebuild systems that can sustainably support lives and livelihoods while the environment thrives.



Martin R. Stuchtey
Founder & Managing Partner
SYSTEMIQ

Tom Dillon
Vice President & Head of Environment
The Pew Charitable Trusts

Endorsements

Inger Andersen, U.N. under-secretary-general and executive director, United Nations Environment Programme (UNEP)

"Breaking the Plastic Wave: A Comprehensive Assessment of Pathways Towards Stopping Ocean Plastic Pollution" comes at a critical time to inform global discussions and help decision-makers evaluate options that will eliminate the long-term flow of plastic and microplastics into the ocean. By providing the evidence base for a way forward, the study convincingly shows the need for system-wide change and urgent action across the entire value chain. It inspires by demonstrating that projected plastic leakage can be reduced by 80% with existing solutions. The next two years will be critical in getting the world on a zero-plastic pollution path. We need to catalyse rapid transition; we need to act now!"

Marisa Drew, CEO, impact advisory and finance department, Credit Suisse

"Despite the awareness-raising and global efforts to reduce plastic production, consumption, and waste in our oceans, the current trajectory points to a dire outcome without a concerted effort to mobilise industry, civil society, and governments to address this critical environmental issue. This well-researched, peer-reviewed report from The Pew Charitable Trusts and SYSTEMIQ provides a roadmap for the investment and innovation required to tackle the challenge. The report also shows us that economically viable solutions exist today that are implementable if all relevant stakeholders across the value chain act with urgency.

Professor Juliet A. Gerrard, chief science advisor to the Prime Minister of New Zealand

"This is a seminal piece of work on a topic of global importance. It will guide countries to align and unite as we move to conquer the plastic problem."

Von Hernandez, global coordinator, Break Free From Plastic

"Break Free From Plastic (BFFP) welcomes "Breaking the Plastic Wave" as a helpful addition to the global conversation about this rapidly growing threat to human and ecosystem health. "Breaking the Plastic Wave" demonstrates that no solution to the plastic crisis is possible without prioritizing urgent action to reduce the quantity of plastic used and produced. The report makes clear that existing private-sector commitments and public policies to limit plastic pollution are wholly inadequate and demonstrates that industry's expansion plans will produce even more staggering quantities of plastic pollution, greenhouse gas emissions, and irreversible damage to the ocean. While we agree with the report's general recommendation calling for a radical system change in how the world deals with plastic, we disagree that certain technologies analyzed in the report—including incineration, chemical recycling, and plastic-to-fuel—are part of that solution, as they will only perpetuate the problem as we see it. Above all, this report should serve as a wake-up call to governments: They must step in to halt the expansion of plastic production. Only then can we begin to see significant and sustained decline of plastic leakage into the oceans and to the environment."

Her Excellency Ms. Thilmeeza Hussain, ambassador of the Maldives to the United States and permanent representative of the Maldives to the United Nations

"This report is an important contribution to understanding the nature of the marine plastic pollution problem and provides many important ideas and proposals that diplomats and other actors will need to consider in deciding how the global community can effectively address this pressing problem."

Ramon Laguarta, chairman and CEO, PepsiCo

"Addressing the challenge of plastic waste is both urgent and complex and will require accelerated, collective action and a transformation of the way society thinks about single-use plastics. This report calls for immediate bold action in the global effort to stem the tide of ocean plastics. It makes clear that through increased collaboration, across industries, we can help create systems change, build a circular economy for packaging, and turn the corner on ocean plastics."

Dame Ellen MacArthur, founder and chair of trustees, Ellen MacArthur Foundation

"Breaking the Plastic Wave" brings an unprecedented level of detail into the global plastic system, confirming that without fundamental change, annual flows of plastic into the ocean could nearly triple by 2040. To turn the tide on plastic waste and pollution, we need to radically increase our efforts and speed up the transition to a circular economy. We must eliminate the plastics we don't need, and drastically reduce virgin plastic use. We need to innovate to create new materials and business models based on reuse and refill systems. And we need improved infrastructure to ensure that all plastics we use are circulated in the economy and never become waste or pollution. The question is not whether a circular economy for plastic is possible, but what we will do together to make it happen."

Grant Reid, CEO, Mars Inc.

"We applaud the depth and rigor of this report on what's necessary to stop ocean plastic pollution. Mars is committed to being a part of the transformational system change that this issue requires. We're taking action by removing packaging we don't need, exploring reuse models, redesigning what we do need for circularity, and investing to close the packaging waste loop with recycling systems that work for business and communities. We have much to do, so we must work together as a global community like never before."

Erin Simon, head, plastic and business, World Wildlife Fund

"If we're going to significantly reduce ocean plastic pollution, we need an innovative and rigorous approach to ensure that the strategies we design are set up to delivering results. This research does exactly that. By identifying a modelling approach that looks at plastic pollution holistically, we're able to better measure the environmental, economic, and social impact of the strategies being considered, and call for a greater level of ambition and immediate action from all stakeholders. This deeper understanding will help companies, governments, and other stakeholders to strengthen their efforts on plastic pollution. It will continue to be crucial to monitor and evaluate strategies on the ground to ensure that we as a society are delivering against our ambition."

Andrew Steer, president and CEO, World Resources Institute

"The ocean is being filled with plastic—hurting sea life and the billions of people who depend on the ocean for food, livelihoods and recreation. This is entirely unnecessary and unacceptable. This new important report, "Breaking the Plastic Wave" presents important solutions that can reduce plastic flows by 80% over the next 20 years. It is urgent that industry and government leaders follow these recommendations – starting today."

Laura Tuck, vice president for sustainable development, World Bank*

"The plastic problem took a lifetime to create and could be solved in a generation. That's the stark message of "Breaking the Plastic Wave," a welcome and comprehensive look at what we need to do—at every layer of society—to clean up the mess we are making. Its positive message is that we already have the solutions we need to address the challenge. But we will need to step up with multi-stakeholder coalitions that can tackle each element of the agenda as they are laid out here."

* Retired from the World Bank as of April 1, 2020

Melati Wijsen, founder, Bye Bye Plastic Bags

"Since starting to campaign against plastic pollution at 12 years old, I have seen numerous efforts come and go. Being born and raised in Bali, Indonesia, it was like watching the problem of plastic grow up with you. This is why we understood early on the importance of data and consistency. It is beyond exciting to hear that my home country has already applied the model featured in "Breaking the Plastic Wave." The only way forward is collaboration and persistence; let's turn the tide on plastic pollution once and forever."

Executive Summary

10 critical findings

Plastic waste lines the shore of a lake.
Sergey/Adobe Stock

The flow of plastic into the ocean is projected to nearly triple by 2040. Without considerable action to address plastic pollution, 50 kg of plastic will enter the ocean for every metre of shoreline. Our analysis shows that a future with approximately 80 per cent (82 ±13 per cent*) less annual plastic leakage into the ocean relative to business as usual is achievable by 2040 using existing technologies. This pathway provides benefits to communities, to governments, and even to industry. However, it depends on the immediate, ambitious, and concerted global implementation of solutions across the entire plastics value chain. This vision for system change represents an attractive and viable way forward.

Plastic pollution in the ocean is a major environmental challenge, yet a coherent global strategy to solve this growing crisis remains elusive. It is a by-product of fundamental flaws in an essentially linear plastic system in which 95 per cent of aggregate plastic packaging value—US$80 billion-US$120 billion a year—is lost to the economy following a short first-use cycle.[1]

Very different responses to the crisis have been proposed, from eliminating plastic entirely to turning it into fuels, and from developing biodegradable substitutes to recycling plastic back into usable products. Each solution comes with advantages and drawbacks. Understanding the effectiveness of different solutions, and the related economic, environmental, and social implications, is crucial to making progress towards stopping ocean plastic pollution.

Here we lay out our report's 10 critical findings, showing that a path forward to a low plastic pollution future already exists—now we have to make the choice to walk this path.

1

Without action, the annual flow of plastic into the ocean will nearly triple by 2040, to 29 million metric tons per year (range: 23 million-37 million metric tons per year), equivalent to 50 kg of plastic per metre of coastline worldwide.

Owing to four compounding trends—continued population growth; increases in plastic use per capita driven in part by increasing production of cheap virgin plastic; shifts to low-value/nonrecyclable materials; and the growing share of plastic consumption occurring in countries with low rates of collection—annual plastic flows to the ocean are expected to grow from 11 million metric tons (range: 9 million-14 million metric tons per year) in 2016 to 29 million metric tons in 2040 (range: 23 million-37 million metric tons per year), with consequences for communities, businesses, and ecosystems. Under our Business-as-Usual (BAU) Scenario, about 4 billion people are likely to be without organized waste collection services by 2040, contributing significantly to the expected mass of plastic leakage to the ocean. The cost of inaction is high to businesses, communities, and ecosystems; particularly stark is the US$100 billion annual financial risk that businesses face if governments require them to cover waste management costs at expected volumes and recyclability.

2

Governments and industry leaders are stepping up with new policies and voluntary initiatives, but these are often narrow in focus or concentrated in low-leakage countries. By 2040, current government and industry commitments are likely to reduce annual plastic leakage to the ocean by only 7 per cent (±1 per cent) relative to the Business-as-Usual Scenario.

A review of the key government initiatives worldwide—such as the European Union's single-use plastics directive and the growing number of national plastic policies—often reveals a narrow focus on select items (e.g., straws, bags, cups, stirrers, cotton swabs, and bottles), which severely limits the reduction in total leaked plastic mass. Industry has also made high-profile commitments, but these are primarily focused on post-consumer downstream solutions and often in low-leakage countries. Our results indicate that a far greater scale of action at the system level will be needed to meaningfully address the challenge of plastic pollution. Government policies and leadership by consumer goods companies will be critical in driving upstream action on reduction, reuse, and redesign as well as downstream action to improve collection and recycling. Governments and investors also need to curtail the planned expansion in plastic production capacity to prevent locking us deeper into the status quo..

3

There is no single solution to end ocean plastic pollution. Upstream and downstream solutions should be deployed together.

To date, much of the debate has focused on either "upstream" (pre-consumer, such as material redesign, plastic reduction, and substitution) or "downstream" solutions (post-consumer, such as recycling and disposal). Our analysis shows that this is a false dichotomy. Upstream solutions that aim to reduce or substitute plastic use are critical and should be prioritized but will need to be scaled carefully to limit adverse social or environmental effects. Downstream solutions are also essential but limited by economic viability and the realistic speed of infrastructure development in the face of growing plastic waste production. Moreover, given the potential negative impacts on human health and the environment of some downstream disposal technologies, their use should be weighed against different trade-offs and carefully controlled. Modelled on their own, no "single-solution" strategies reduce annual leakage of plastic to the ocean even below 2016 levels by 2040. An ambitious recycling strategy, for example, with ambitious scale-up of

* All figures stated in parentheses are 95 per cent confidence intervals, unless otherwise specified. The range is given where distributions are not symmetrical.

[1] World Economic Forum, Ellen MacArthur Foundation, and McKinsey & Co., "The New Plastics Economy: Rethinking the Future of Plastics" (2016), https://www.ellenmacarthurfoundation.org/publications/the-new-plastics-economy-rethinking-the-future-of-plastics.

collection, sorting, and recycling infrastructure coupled with design for recycling, reduces 2040 leakage by 38 per cent (±7 per cent) relative to BAU, which is 65 per cent (±15 per cent) above 2016 levels. Similarly, an ambitious reduction and substitution strategy, without massive expansion of downstream infrastructure, reduces 2040 leakage by 52 per cent (±9 per cent) relative to BAU, 28 per cent (±5 per cent) above 2016 levels. An integrated approach with new ways to deliver the benefits of today's plastic is needed to significantly reduce ocean plastic pollution.

4

Industry and governments have the solutions today to reduce rates of annual land-based plastic leakage into the ocean by about 80 per cent (82 ±13 per cent) below projected BAU levels by 2040, while delivering on other societal, economic, and environmental objectives.

It is not the lack of technical solutions that is preventing us from addressing the ocean plastic crisis, but rather inadequate regulatory frameworks, business models, and funding mechanisms. Although the technical solutions exist, the incentives are not always in place to scale up these changes fast enough. A reduction of plastic production—through elimination, the expansion of consumer reuse options, or new delivery models—is the most attractive solution from environmental, economic, and social perspectives. It offers the biggest reduction in plastic pollution, often represents a net savings, and provides the highest mitigation opportunity in GHG emissions.

As modelled in our integrated System Change Scenario, annual land-based plastic leakage into the ocean can be reduced by around 80 per cent (82 ±13 per cent) by 2040, compared with BAU, through the concurrent, ambitious, and global implementation of multiple synergistic system interventions:

Reduce growth in plastic production and consumption 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 metric tons per year.

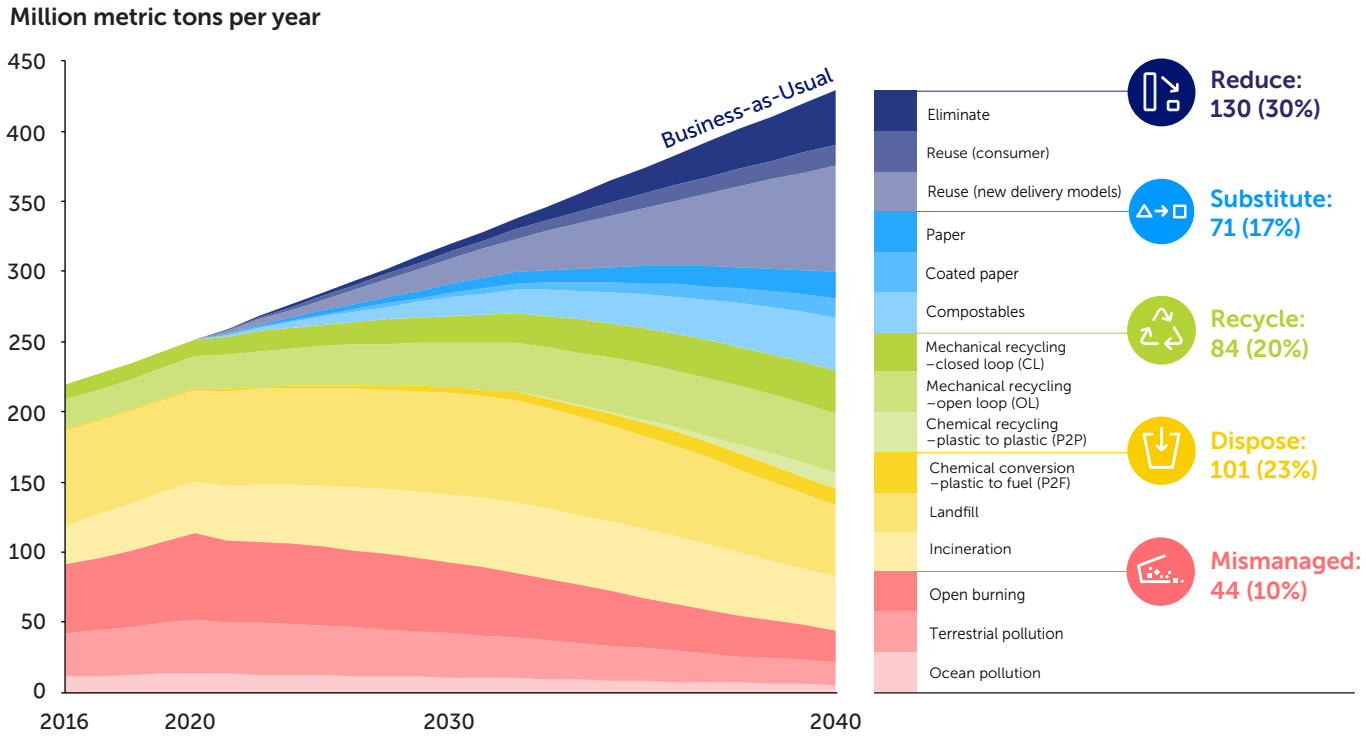
Develop plastic-to-plastic conversion, potentially to a global capacity of up to 13 million metric tons per year.

Build facilities to dispose of the 23 per cent of plastic that cannot be recycled economically, as a transitional measure.

Reduce plastic waste exports by 90 per cent to countries with low collection and high leakage rates.

Figure 1: Plastic fate in the System Change Scenario: a 'wedges' analysis

There is a credible path to significantly reduce plastic leakage to the ocean but only if all solutions are implemented concurrently, ambitiously, and starting immediately



This "wedges" figure shows the share of treatment options for the plastic that enters the system over time under the System Change Scenario. Any plastic that enters the system has a single fate, or a single "wedge." The numbers include macroplastic and microplastic.

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 metric tons per year (from 3 million metric tons to 1.2 million metric tons) by 2040.

Taken together, these system interventions describe a credible scenario for dealing with ocean plastic pollution. Under the System Change Scenario, 30 per cent (range: 27 per cent-32 per cent) of BAU plastic demand is reduced, 17 per cent (range: 15 per cent-18 per cent) is substituted, 20 per cent (range: 18 per cent-21 per cent) is recycled, 23 per cent (range: 22 per cent-26 per cent) is disposed of and 10 per cent (range: 9 per cent-12 per cent) remains mismanaged, as shown in Figure 1.

5

Going beyond the System Change Scenario to tackle the remaining 5 million metric tons per year (range: 4-7 million metric tons per year) of plastic leakage demands significant innovation across the entire value chain.

In 20 years, we can break the seemingly unstoppable wave of plastic pollution, but the System Change Scenario still does not go far enough. It leaves 5 million metric tons (range: 4 million-7 million metric tons) of plastic flowing into the ocean in 2040—which represents a 52 per cent (±8 per cent) reduction from 2016 rates. Achieving the vision of near-zero ocean plastic pollution will require technological advances, new business models, significant spending, and, most crucially, accelerating upstream innovation. This massive innovation scale-up requires a focused and well-funded R&D agenda exceeding US$100 billion per year by 2040, including moon-shot ambitions, to help middle-/low-income countries to leapfrog the unsustainable linear economy model of high-income countries. Most crucial will be solutions that focus upstream and can work in rural/remote areas (where collection economics are challenging), that replace multilayer and multimaterial plastics (e.g., new delivery models or new materials), and that lead to new tyre designs to reduce abrasion of microplastic particles while maintaining safety standards. Innovation will also be critically needed in financing and policy. The alternative is to greatly increase the ambition levels above the maximum foreseeable levels modelled under the System Change Scenario.

6

The System Change Scenario is economically viable for governments and consumers, but a major redirection of capital investment is required.

The present value of global investments in the plastic industry between 2021 and 2040 can be reduced from US$2.5 trillion (±US$800 billion) to US$1.2 trillion (±US$300 billion), but the System Change Scenario will require a substantial shift of investment away from the production and conversion of virgin plastic, which are mature technologies perceived as "safe" investments, to the production of new delivery models, plastic substitutes, recycling facilities, and collection infrastructure, some of which are less mature technologies and perceived as riskier. This shift will require government incentives and risk-taking by industry and investors. The total global cost to governments of managing plastic waste in this low-leakage System Change Scenario between 2021 and 2040 is estimated to be US$600 billion (range: US$410 billion-US$630 billion) in present value, compared with the US$670 billion (range: US$450 billion-US$740 billion) cost to manage a high-leakage system under BAU.

7

Reducing approximately 80 per cent (82 ±13 per cent) of plastic leakage into the ocean will bring to life a new circular plastics economy with major opportunities—and risks—for industry.

Plastic pollution presents a unique risk for producers and users of virgin plastics given regulatory changes and growing consumer outrage. But it is also a unique opportunity for providers of new and existing circular business models and materials. Embarking on the trajectory to get to about 80 per cent (82 ±13 per cent) leakage reduction will create significant opportunities for companies ahead of the curve, ready to embrace new business opportunities that unlock value from a circular economy that derives revenue from circulation of materials rather than one based on the extraction and conversion of fossil fuels. Large new value pools can be created around better design, better materials, better delivery models, improved sorting and recycling technologies, and smart collection and supply chain management systems. Our analysis shows that through integrated application of upstream and downstream interventions under the System Change Scenario, we could fulfil the growing global demand for "plastic utility" in 2040 with roughly the same amount of plastic in the system as today, and 11 per cent (±1 per cent) lower levels of virgin plastic production, essentially decoupling plastic growth from economic growth. However, in the meantime, hundreds of billions of dollars are being invested in virgin plastic production plants, locking us deeper into a BAU trajectory every day and making system change ever more urgent.

8

A system change would require different implementation priorities in different geographies and for different plastic categories.

Different regions of the world have fundamentally different contexts and jumping-off points: different sources of plastic leakage, waste composition, collection rates, policy regimes, labour and capital costs, infrastructure, population demographics, and consumer behaviour. Our model highlights the most urgently needed interventions and the unique set of outcomes projected for different geographies under the System Change Scenario. High-income countries should prioritize addressing microplastic leakage (which represents 62 per cent [range: 29 per cent-76 per cent] of leakage in high-income countries), technological and policy innovation to incentivize reduction and substitution, and further increasing recycling rates. Middle-/low-income countries should prioritize expanding formal collection, decreasing overall plastic consumption, investing in sorting and recycling infrastructure, and reducing post-collection leakage. However, universally, the top priority is reducing

avoidable plastic—of which we estimate there will be 125 million metric tons (range: 110 million metric tons-142 million metric tons) globally by 2040 under BAU. Similarly, we should universally prioritize solutions for the highest-leakage plastic categories. Flexible packaging (bags, films, pouches, etc.), multilayer and multimaterial plastics (sachets, diapers, beverage cartons, etc.), and the microplastics that we modelled account for a disproportionate share of plastic pollution compared with their production, making up 47 per cent (range: 34 per cent-58 per cent), 25 per cent (range: 17 per cent-34 per cent) and 11 per cent (range: 6 per cent-17 per cent) of the leakage mass, respectively.

9

Addressing plastic leakage into the ocean under the System Change Scenario has many co-benefits for climate, health, jobs, working conditions, and the environment, thus contributing to many of the United Nations Sustainable Development Goals.

Our analysis suggests that addressing the ocean plastic pollution crisis helps reduce greenhouse gas (GHG) emissions relative to BAU. The integrated System Change Scenario results in 25 per cent (±11 per cent) lower plastic-related GHG emissions in 2040; however, it still represents an increase in emissions relative to today. As such, it will be vital to scale up measures offering the greatest GHG savings and further decarbonize energy sources. In the System Change Scenario, peak virgin plastic is reached by 2027. In addition, net direct employment in the value chain (including manufacturing, collection, recycling, and new delivery models) increases by 6 per cent (±1 per cent) relative to BAU by 2040. That's equivalent to 700,000 jobs (range: 541,000-795,000), redistributed among sectors and geographies, with almost all of the job growth occurring in middle-/low-income countries. The System Change Scenario also represents a positive social vision for the global community of 11 million waste pickers, who in 2016 were responsible for 60 per cent (range 56 per cent-65 per cent) of global plastic recycling. To date, their contribution to preventing ocean plastic pollution has largely gone unrecognized and typically underpaid. An increase in plastic material value through design for recycling can contribute to social justice by increasing the retained value for waste pickers and improving working conditions. Health hazards are also significantly reduced under this scenario, including the reduction relative to BAU of 109 million metric tons per year (range: 108-111 million metric tons per year) of open burning of plastic waste—a process that releases airborne particulates, carcinogens, and other toxins.

10

The time is now: If we want to significantly reduce plastic leakage, we have the solutions at our fingertips. An implementation delay of five years would result in an additional ~80 million metric tons of plastic going into the ocean by 2040.

All elements of the System Change Scenario exist today or are under development and near adoption. A system-wide implementation delay of five years would result in ~80 million metric tons more plastic stock in the ocean by 2040. That is equivalent to approximately half of today's stock. Delays in implementing the eight interventions would likely take the world off the path towards near-zero leakage. The next two years will be pivotal for breaking the trend and implementing a first horizon of change that will allow key milestones to be met by 2025, including stopping the production of avoidable plastic, incentivizing consumers around reuse, improving labelling, and testing innovations such as new delivery models. This work will lay the groundwork for the second and third horizons of change to take place by 2025 and 2030, and enable the implementation of further systemic solutions required in 2030-2040.

Achieving the outcomes modelled under the System Change Scenario would require substantial changes in the business models of firms producing and using plastics and their substitutes; overhauls to the recycling and waste disposal industries; transformation of the criteria used by investors; and modification of consumer behaviour.

Although these changes are feasible, they are unlikely to materialize unless governments create significant incentives for more sustainable business models and remove the cost advantage that virgin plastic feedstock has over recycled materials. Policies that create a clear and stable set of incentives and targets will make the conditions required under the System Change Scenario possible.

Industry, at the same time, should stop placing avoidable, single-use, and hard-to-recycle plastic on the market, invest in material and business model innovations, and join with governments to help finance waste collection and sorting. To achieve an approximately 80 per cent (82 ±13 per cent) reduction in annual plastics leakage into the ocean by 2040, public-private collaborations will be required to set higher standards on materials, formats, reuse, and recyclability. Fortunately, there are promising existing efforts to build on. The Ellen MacArthur Foundation's New Plastics Economy initiative, for example, has already united more than 400 organizations behind a vision for a circular economy under a global commitment for plastic that is a good first step towards pursuing the systemic changes identified in this report. There are also early discussions regarding strengthening an international agreement to prevent plastic pollution that may help provide the global policy framework for united government action.

Conclusion

Taken together, our findings on plastic pollution substantiate catastrophic outlooks for the ocean if we continue on the current trajectory. They also highlight the economic exposure to the plastic industry in the absence of resolute action. Yet our report gives us some cause for optimism: It shows that an approximately 80 per cent (82 ±13 per cent) reduction in projected plastic leakage is possible—without compromising social or economic benefits. Achieving the potential of such a rapid and holistic pathway towards the goal of near-zero ocean plastic leakage is within reach, but it will require enhanced ambitions.

A fisherman in Sri Lanka hauls in fish caught in his synthetic net. Nets like these are sometimes abandoned in the ocean, entangling marine life, leading to injury or death.

SmallWorldProduction/Adobe Stock

FAST FACTS

‘Breaking the Plastic Wave’ in numbers

Scale of the problem

11 million metric tons of **plastic leaked into the ocean** in 2016

29 million metric tons of **plastic leakage into the ocean** in 2040

40% of today’s global plastic waste ends up **in the environment**

7% reduction of leakage if all current **government and industry commitments** were implemented by 2040

500,000 people need to be connected every day until 2040 to close the **collection gap**

11% of leakage is **microplastic** in 2016

By 2040:

2x plastic generation

3x plastic leakage into the ocean

4x plastic stock in the ocean

US$100B **financial risk** to industry under BAU in 2040

45% of today's leakage is from **rural areas,** where collection economics don’t work

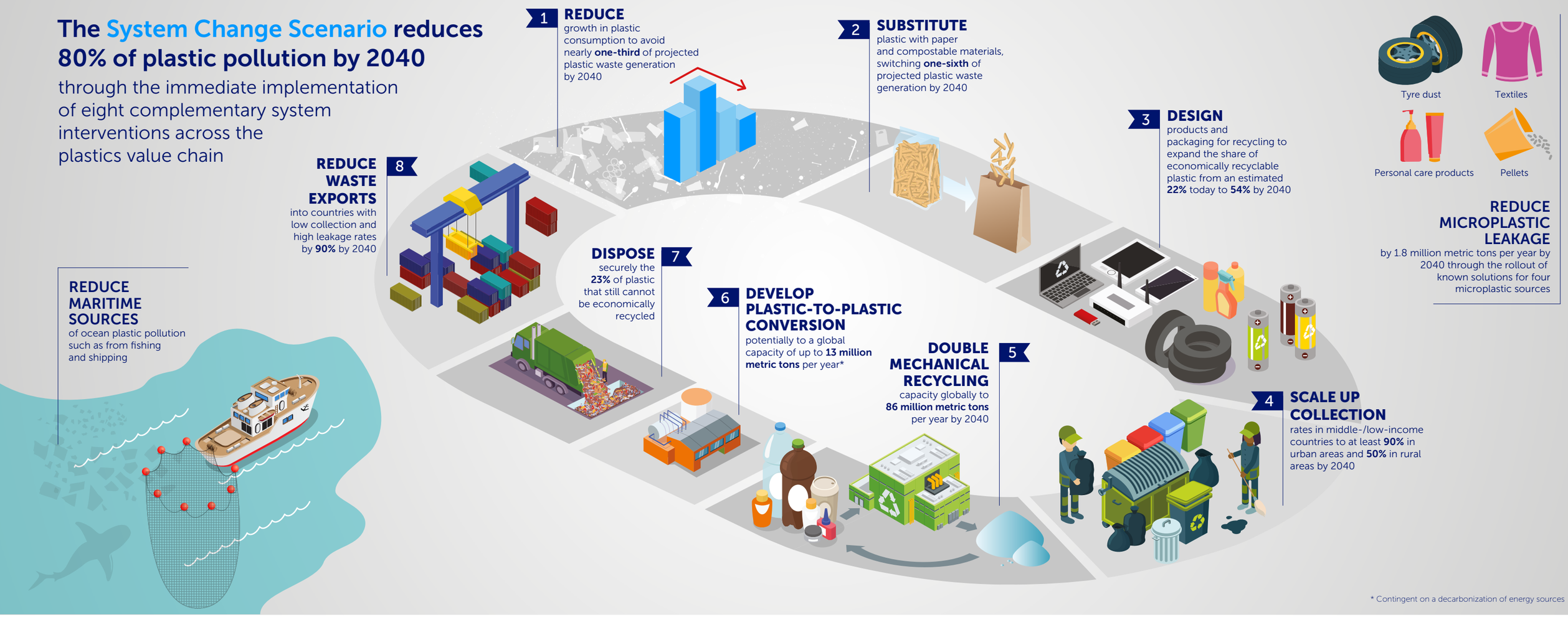
21% of plastics are **economically recyclable** (but only 15% are actually recycled) in 2016

19% share of **carbon budget** used by plastic industry by 2040 under BAU to stay under 1.5°C

80% share of leakage from **flexible and multilayer** plastics in 2016

The System Change Scenario reduces 80% of plastic pollution by 2040

through the immediate implementation of eight complementary system interventions across the plastics value chain



* Contingent on a decarbonization of energy sources

Integrated system change achieves social, environmental, and economic benefits

80% reduction in **plastic leakage into the ocean** by 2040 relative to BAU

US$70B saving for **governments** over 20 years relative to BAU

700,000 **jobs created** by 2040 relative to BAU

25% reduction in annual **GHG emissions** by 2040 relative to BAU

55% reduction in **virgin plastic demand** by 2040 relative to BAU

195 million metric tons reduction in other environmental leakage (land and atmosphere)

Developed by The Pew Charitable Trusts and SYSTEMIQ, "Breaking the Plastic Wave: A Comprehensive Assessment of Pathways Towards Stopping Ocean Plastic Pollution" presents a first-of-its-kind model of the global plastics system. It is an evidence-based roadmap that describes how to radically reduce ocean plastic pollution by 2040 and shows there is a comprehensive, integrated, and economically attractive pathway to greatly reduce plastic waste entering our ocean.

The research supporting this report was co-developed with 17 experts from across the spectrum of professionals looking at the plastic pollution problem, with broad geographical representation. The findings of our analysis were published in the peer-reviewed journal, *Science*.

The aim of this work is to help guide policymakers, industry executives, investors, and civil society leaders through highly contested, often data-poor, and complex terrain.

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