PACE
Platform for Accelerating the Circular Economy

Circular Economy Action Agenda

PLASTICS

In partnership with accenture

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WHO WE ARE

PACE is a global community of leaders working together to accelerate the transition to a circular economy. We bring leaders together from across business, government and civil society to develop a collective agenda and drive ambitious action.

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PACE would like to thank all its donors for sharing our commitment to accelerate towards a global economic system that simultaneously enables human and environmental wellbeing.

IN SUPPORT OF THE CIRCULAR ECONOMY ACTION AGENDA

INGER ANDERSEN | Executive Director, UN Environment Programme

"Scaling up circularity and sustainable consumption and production is essential to address the three planetary crises we are facing: the climate crisis, the biodiversity and nature crisis, and pollution and waste crisis. The calls-to-action should inspire and redirect the efforts of government, business and finance, and consumers, because at the end of the day, each and every one of us has the power and responsibility to contribute to the transition."

TIM BENTON | Research Director, Emerging Risks, and Director, Energy, Environment and Resources Programme, Chatham House

"An inclusive circular economy that promotes sustainability and decent work will help countries to build prosperous economies and just societies. The economic recovery from the COVID pandemic is an opportunity for governments to collaborate and accelerate this shift from linear to circular internationally."

MARTIJN LOPES CARDOZO | CEO, Circle Economy

"The Circular Economy Action Agenda delivers the necessary insights and a strong narrative for action within four areas where urgent change is needed. By enabling cross-sectoral partnerships to tackle these challenges, PACE is proving itself as a conductive change agent to help close the global circularity gap. We look forward to collaborating and delivering results within these key areas together".

FRANS VAN HOUTEN | CEO, Royal Philips

"Transitioning to a circular economy requires all of us to team up and commit to doing things fundamentally different. The PACE Action Agenda will help guide and drive circular ways of working across the board, changing how we create value without devastating environmental impact. I call on all leaders to join PACE and commit to adopt climate actions and prioritize circularity."

NAOKO ISHII | Executive Vice President and Director, Center for Global Commons, The University of Tokyo

"Plastic permeates every aspect of our daily lives, and there is no single silver bullet solution to get rid of plastics. It requires a comprehensive approach. This paper will help us overcome the system stalemate in cooperation with each other."

PETER LACY | Chief Responsibility Officer and Global Sustainability Services Lead, Accenture

"The circular economy offers an opportunity to unlock value and decouple growth from the use of scarce and harmful resources. This Action Agenda lays a foundation for the collaboration and innovation that is necessary to make production and consumption more sustainable for people and our planet. Now is the time to embrace end-to-end transformations that can create value while ensuring a more sustainable future."

DAME ELLEN MACARTHUR | Founder, Ellen MacArthur Foundation

"The circular economy is a solution framework that offers better growth while addressing the most pressing global challenges. The calls-to-action help reinforce the need for transformation of our most iconically linear value chains, towards an economy that eliminates waste, preserves the value of resources, and helps regenerate natural systems."

LLORENÇ MILÀ I CANALS | Head of Secretariat, Life Cycle Initiative (UNEP)

"The key for a transition to sustainable consumption and production patterns is anchored in the value chains—where circularity strategies are supported by strong life cycle thinking and assessment. We are proud to work with PACE partners in ensuring the calls-to-action address the key hotspots along these value chains' life cycle, to ensure we shift the needle on the planetary crises we face."

JANEZ POTOČNIK | Co-chair, International Resource Panel (UNEP)

"It was a pleasure to contribute to the development of the Action Agenda with our expertise in resource management issues. We are pleased with the clarity to which the reports have contributed. Now is the moment for stakeholders across all sectors to come together and pick up the calls-to-action."

STEVE SCHMIDA | Co-founder and Chief Innovation Officer, Resonance

"If we are to achieve the SDGs, circularity must be embedded into the very fabric of how industries and economies operate. The Circular Economy Action Agenda lays out a clear vision for how leaders from across business, government and civil society can partner together to drive sustainable, equitable action."

CAROLINA SCHMIDT | Minister of Environment, Chile

"We already know how the circular economy can make a key contribution to mitigate climate emissions. Now it's time to act. PACE's Action Agenda condenses and highlights the most urgent and effective pathways to unleash the transformation to a circular economy at a global level. Policy makers, scientists, businesses and citizens everywhere should put this powerful agenda into practice—today."

ANDREW STEER | President and CEO, World Resources Institute

"Circularity is the shape of the future. Shifting from the destructive take, make, waste model of the past is crucial if we are to achieve the SDGs. The new Circular Economy Action Agenda, which brings together insights from scientists, government officials, and business executives, presents a bold and clear way forward to a more sustainable approach that will benefit people and the planet."

MARIE FOSSUM STRANNEGÅRD | CEO, IVL Swedish Environmental Research Institute

"The Action Agenda is crucial reading for anyone working to improve social and environmental wellbeing through circular economy. We were glad to be part of the process to develop the reports and to be able to contribute with our decades of experience in translating environmental science into improvements in the society."

ELS VAN SCHIE | Director of Environment and Safety Department, RIVM

"Plastics can serve human health and environment very well, but the current way we deal with plastics is not sustainable. The circular economy goals amplify the needs to tackle these negative effects. To reach these goals we need a much more proactive strategy on reduction and substitution in the relevant sectors, underpinned by knowledge on safety, health and sustainability."

STIENTJE VAN VELDHOVEN | Minister for the Environment, The Netherlands

"The circular economy is our secret weapon for achieving our climate and sustainable development goals. PACE's Action Agenda demonstrates the need for a fundamental shift in the way we produce and consume. It contains concrete examples of a new economic reality taking shape. Let's use the Agenda to upscale cross-regional collaboration, build cross-sectoral partnerships and continue to build a circular world."

DOMINIC WAUGHRAY | Managing Director, Centre for Global Public Goods, World Economic Forum

"The twin crises of the pandemic and climate have underscored the need for more sustainable consumption and production. We must build on this momentum to forge new collaborations with policy makers, business leaders and consumers to ensure that resources are maximized, value chains are transformed and the circular transition can become a reality. The time is now."

MARINKE WIJNGAARD | Managing Director Circular Economy & Environment, TNO

"TNO fully supports the Action Agenda. An acceleration to a circular plastic economy is urgently needed. New business models for the ecosystem will strengthen the economy. Crucial solutions are (1) stimulate responsibility of both producer and consumer; (2) create circular value chains; (3) accelerate new recycling technology and (4) implement true costing."

FOREWORD

We call on businesses, governments, and civil society leaders around the world to join us in raising the level of ambition to create a circular economy. Investing in a circular economy will be crucial to helping us realize the social, environmental, and economic benefits of the 2030 Agenda and the Paris Agreement, as well as to build a sustainable economic recovery from COVID-19.

This year over 200 circular economy experts from 100 businesses, governments and civil society organizations joined hands through PACE to develop the Circular Economy Action Agenda. The calls-to-action in the Agenda provide clear priorities for leaders around the world to join us in solving critical issues and taking advantage of open innovation opportunities.

Circular Action Means Impact. Embedding circular principles and goals across industries and governments' priorities will be crucial to reaching our 2050 net zero commitments. Changing the way we make and use products can contribute to addressing 45% of global greenhouse gas emissions, making a critical contribution to mitigating the impending climate crisis. Along the way, the widescale adoption of circular business models presents a US$4.5 trillion economic opportunity.

Circular Action is Urgent. Our current economic system is based on linear principles of extracting natural resources, using them up, and creating huge volumes of waste. Our use of resources has tripled since 1970, and could double again by 2060 if we continue business as usual. Despite advances in technology, the growth rate in material consumption continues to increase faster than our population growth, with many social and environmental impacts resulting from inequities in consumption and production.

Not only is this linear model unsustainable, the economic impacts of COVID-19 have shown how vulnerable we are to economic shocks resulting from any disruption in the current flow of resources.

There is another way. By working towards a circular economy we can transition to a system that is designed to prevent waste and pollution, keep products and materials in use, and regenerate natural systems—leading to a more resilient economy.

Circular Action is Clear. While we have experienced an increase in interest in the circular economy, investments and scale are not happening fast enough. We believe that more alignment among leaders is required to show the way forward. These reports set out clear priorities for action in five critical focus areas—plastics, electronics, textiles, food, and capital equipment—providing important lessons that can be applied elsewhere.

There is much that can be done. Governments can set policy, companies can adapt their business models, the finance sector can invest, researchers can provide the scientific backing, and we can all do our part as individuals. But the biggest challenges mandate that we work together. That is why we join hands at PACE: creating the space for collaboration across sectors so that we can identify new solutions and scale up what works.

Join us as we take bold steps forward to create the better world we know is possible.

David B. McGinty
Global Director, PACE

EXECUTIVE SUMMARY

The Circular Economy Action Agenda has been designed to accelerate the transition to a circular economy—and to a better future for people and nature. It transforms existing knowledge into a collective agenda that will inform and mobilize action.

Plastics have become omnipresent in modern lives, thanks to their exceptional properties. At the same time, the negative ecological and social consequences of this fast-growing material stream have become a global concern: from plastic waste in oceans and on land to greenhouse gas emissions and toxic additives. The magnitude and urgency of this challenge has been aggravated by COVID-19. We need to ensure plastics are managed responsibly throughout their lifecycle, to continue delivering their benefits without causing damage to the planet.

How can circular strategies contribute? Four objectives are formulated based on a common vision of a circular economy for plastics: problematic or unnecessary plastics are eliminated; material inputs for plastics are safe, recycled, or renewable; plastics are reused more; and plastics are recycled or composted at end-of-use.

The circular economy originated from using natural resources more efficiently and sustainably, yet its impact goes well beyond resource use. Most of the objectives in a circular economy for plastics, including reducing plastics (through either elimination or reuse), safe and recycled inputs, and recycling are expected to deliver benefits not only in resource use, but also climate change, human health, biodiversity, economic wellbeing, and decent work.

There are also points of attention and knowledge gaps. The environmental and socio-economic impacts of bio-based plastics require further research, in particular the effect on agriculture land use. Holistic, science-based assessments are needed before elimination or substitution decisions, to ascertain that change leads to net environmental and social benefits. Furthermore, targeted efforts are needed to ensure the transition is just and inclusive.

Despite the dire need and important opportunities, a circular transition of the plastics value chain faces many barriers beyond the control of any individual stakeholder. From literature study and interviews carried out for this report, 14 key barriers have been identified that work collectively to slow progress towards a circular economy for plastics.

Building on the impact and barrier assessments, we put forward 10 calls-to-action. Each call-to-action is a priority area where actions are most needed today, in order to overcome key barriers and to optimize the impact of the transition:

1. Agree Which Plastics Can be Eliminated and Prepare the Market to Phase Them Out
2. Incentivize and Support Product Design for Reuse and Recycling of Plastics
3. Address Hygiene and Safety Concerns to Promote Plastics Reuse
4. Stimulate Consumer Adoption of Plastic Reuse
5. Guide and Support New Business Models for Environmental, Financial, and Social Triple-Win
6. Set up Functioning Collection Systems
7. Strategically Plan Sorting and Recycling Facilities, in Compliance with Trade Regulations
8. Make the Recycled Plastics Market Competitive
9. Integrate and Advance Decent Work in the Transition to a Circular Economy for Plastics
10. Investigate Environmental and Socio-Economic Impacts of Renewable Material Inputs for Plastics

A variety of actions can be taken up by different stakeholders under each call-to-action. Some examples are given. We invite every changemaker to come up with ideas and initiatives to address these calls-to-action, adapting them to different contexts.

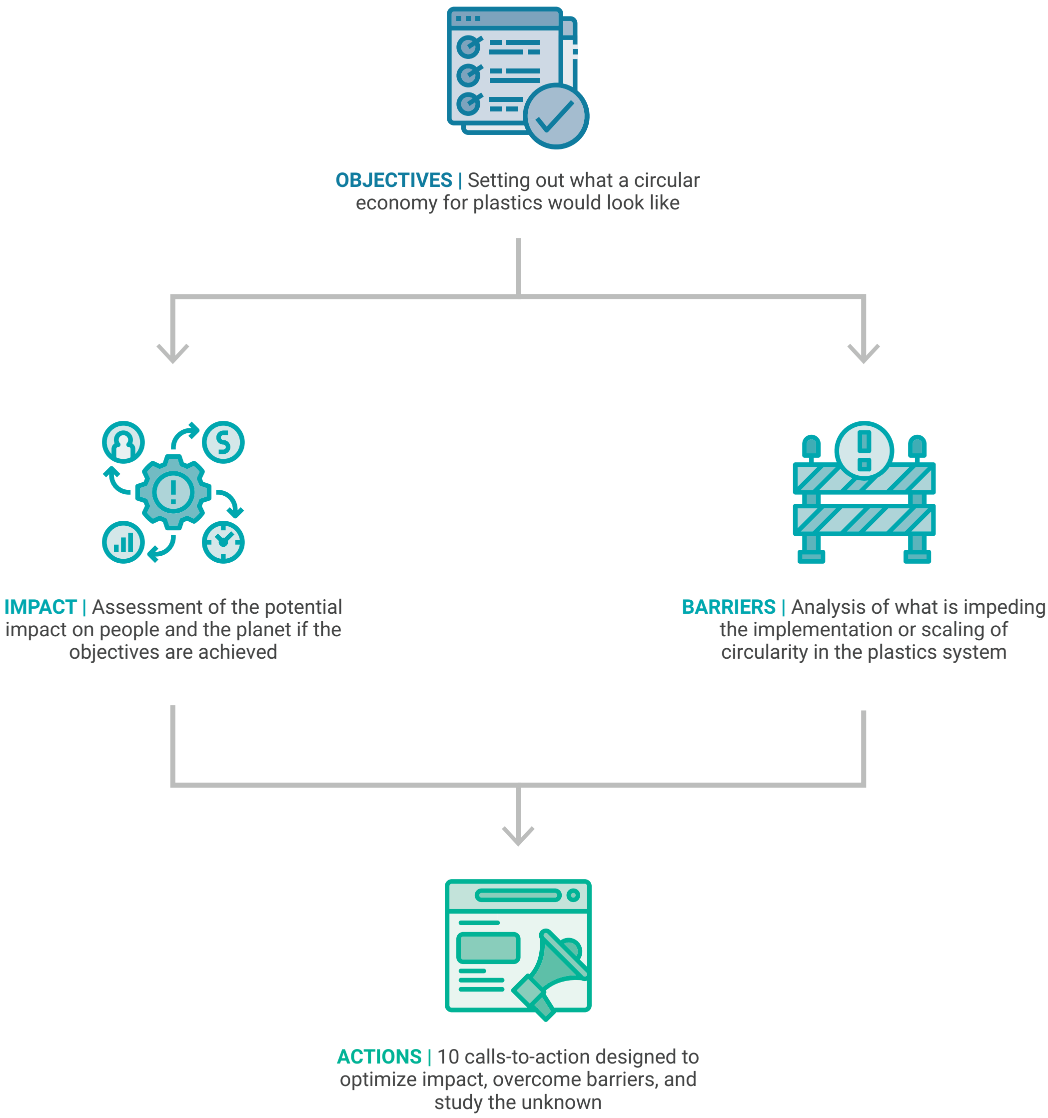
ABOUT THE ACTION AGENDA

The Circular Economy Action Agenda is designed as a rallying call for business, government, and civil society. It is currently made up of five publications: electronics, plastics, textiles, food, and capital equipment. The aim is to transform existing knowledge into a collective agenda that will inform and mobilize action within the PACE community and beyond.

Our economy has been highly successful in increasing productivity and elevating the living standards of parts of the population. In doing so, it has also created many challenges, both environmentally and socially. The need for solutions is more urgent than ever. A circular economy has been proposed as a way to address these challenges, with the ambition to harmonize economic and ecological goals.

Researchers have already documented the challenges from the plastics value chain today, the need for a transition to circular economy, and the systemic change required for the transition.[1] This report builds on the existing literature to identify the actions needed for a better and faster transition to a circular economy for plastics. Each report has four main chapters: Objectives, Impact, Barriers, and Actions (see Figure 1).

FIGURE 1 • Structure of the Action Agenda Reports



How we developed the Action Agenda

PACE brings leaders together from across sectors and industries to develop a collective agenda and drive ambitious action, creating a space for leaders to work in partnership and overcome challenges together. The Action Agenda is the result of collective efforts by working groups made up of representatives from business, government, civil society, finance, and research organizations, collaborating throughout 2020. In total, more than 200 experts from over 100 organizations have contributed via over 80 phone interviews, more than 20 group discussions and substantial written inputs. The reports try to integrate all insights, balance different viewpoints, and identify where further alignment is needed. We believe that this diversity of viewpoints is crucial for designing and realizing a better transition.

OBJECTIVES | What Do We Mean by a Circular Economy for Plastics?

We all desire and strive for a future of human and environmental wellbeing. The circular economy is a key path towards that future. This chapter explains how the community currently sees circular strategies being applied to plastics, and sets out four objectives.

Plastics are omnipresent in our modern lives, with global consumption increasing twentyfold in the past 50 years (Ellen MacArthur Foundation 2020b). Plastics have become the backbone of many products thanks to their highly adaptable qualities: they can be flexible, durable, water-resistant, strong yet light-weight. However, plastics have also increasingly come under public scrutiny, primarily due to waste littered throughout nature and the environment, but also due to fossil resource and energy use in their production, as well as health risks from toxic additives and microplastics.

Around 40% of plastics are used for packaging, often short-life and single-use, posing an overwhelming challenge for collection systems (Bauman 2019; PlasticsEurope 2019). The natural capital costs of plastic packaging in the consumer goods sector, including degradation of natural systems, greenhouse gas emissions, and health and environmental impacts from substances of concern, have been estimated at $40 billion (UNEP 2014, Ellen MacArthur Foundation 2016). The COVID-19 induced global crisis is estimated to have increased single-use plastic products (SUPP) by up to 300% (The Economist 2020). The pandemic heightened the perception that SUPP is safer than reusables, slowing down progress on increasing reuse models as well as putting a hold on bans of certain plastic packaging (Laville 2020). The question is, how can we ensure plastics are managed responsibly throughout their lifecycle from design to end-of-use treatment, continuing to serve as an enabling material across industries, while minimizing their environmental damage?

The magnitude and urgency of the plastics challenge has sparked global action from NGOs, companies, and governments. To date, over 500 organizations have signed the New Plastics Economy Global Commitment and its vision of a world where plastic never becomes waste (Ellen MacArthur Foundation n.d.). Cross-sectoral coalitions, such as Global Plastic Action Partnership and Alliance to End Plastic Waste, have been set up to scale the transition. The international community is converging around a common vision for a circular economy for plastics: the New Plastics Economy vision has already been endorsed by more than 1,000 organizations since its launch (Ellen MacArthur Foundation and UNEP 2020). Four objectives have been formulated based on this common vision, forming the basis of further analysis in this report:

1. Problematic or unnecessary plastics are eliminated
2. Material inputs for plastics are safe, recycled, or renewable
3. Plastics are reused more
4. Plastics are recycled or composted at end-of-use

1. PROBLEMATIC OR UNNECESSARY PLASTICS ARE ELIMINATED

This objective looks to eliminate those plastics that have been recognised as being 'problematic' or 'unnecessary', based on lifecycle assessments. WRAP defines a plastic as unnecessary or problematic if (1) its use is avoidable, or reusable options are available (with consideration of the environmental impact of the alternative reusable option), (2) it is not recyclable, or actively hampers the recycling process, or (3) it easily leaks out of collection systems and pollutes our environment (WRAP 2019). The New Plastic Economy Global Commitment includes an additional principle identifying plastic as problematic if (4) its manufacturing requires hazardous chemicals that pose a significant risk to human health or the environment (Ellen MacArthur Foundation 2020a). Some plastic products have already been categorized as problematic or unnecessary based on lifecycle assessments, such as polystyrene packaging and PVC packaging (WRAP 2019). Others under investigation include plastic bags, plastic film packaging, and multipack rings for canned drinks. It is crucial to conduct full lifecycle assessments to ensure that elimination (or substitution) has a net positive impact.

2. MATERIAL INPUTS FOR PLASTICS ARE SAFE, RECYCLED, OR RENEWABLE

For plastics not deemed unnecessary or problematic, this objective is about shifting production away from virgin fossil feedstock to recycled or renewable inputs. Recycled inputs can come from either mechanical or chemical recycling of end-of-use plastics. Renewable feedstock can be produced from a variety of sources such as corn, sugarcane, algae, and agriculture/food waste (their lifecycle impact implications will be discussed in the next chapter). In addition, additives to plastic packaging can be potentially hazardous in production, use or post-use stages, depending on their concentration and the conditions under which they are applied. These substances of concern, such as flame retardants, plasticizers, and heavy metals, should be phased out where they are deemed to be a safety concern.

3. PLASTICS ARE REUSED MORE

This objective complements the first objective to reduce the overall consumption of plastics. Wherever appropriate, reuse models should be adopted as a preferred option, reducing the need for SUPP. There are already many different reuse models for plastic packaging, for example, (1) reusable packaging can be returned by consumers to businesses either through a collection service from home or through a drop-off point—the businesses clean and refill the packaging for use by the next (or same) consumer; (2) the use of refillable containers at home, where customers buy a concentrated or lightweight form of a product and dispense into reusable containers; (3) allowing or encouraging consumers to bring their own reusable containers to refill at a business—this can range from coffee cups to durable bags, to jars used for bulk dispensers of food such as rice, nuts, or beans (Ellen MacArthur Foundation 2019b).

4. PLASTICS ARE RECYCLED OR COMPOSTED AT END-OF-USE

When plastics cannot be used or reused any longer they should be collected, then recycled or composted. Plastics can be recycled through either mechanical or chemical recycling. In mechanical recycling, plastics are sorted, cleaned, ground, and melted into flakes or granules that then become feedstock for new products. Chemical recycling turns polymers into monomers, which can then be used as feedstock for new plastics. Composting biodegradable plastics is a complementary end-of-use management option, where recycling is not a viable solution. It is important to note that most biodegradable plastics need to be treated in industrial composters with specific conditions such as temperature and time. Increasing recycling rates will require changes throughout the value chain: products designed to be recyclable in an economic way; consumers disposing of them properly; and collection/sorting systems that effectively separate different plastic waste streams to avoid cross-contamination in recycling and increase upcycling.

PRODUCT SCOPE

This Action Agenda for Plastics focuses on plastic packaging, defined as all packaging made from plastic material, including rigid (e.g. bottles, cups, containers, and clamshells) as well as flexible forms (e.g. bags, films, and pouches), for both consumer and industrial applications (Ellen MacArthur Foundation 2016). In this report, "single-use plastic products (SUPP)", "packaging", and "plastics" are used to refer to the abovementioned scope of plastic packaging.

Excluded from this scope are other plastic products and applications, such as textile fiber blends, construction materials, electronic devices, and durable products such as toys, furniture, and automobiles, though some of the analysis and recommendations in this report may apply to these other plastics products as well.

FIGURE 2 • Major Challenges in Plastics Packaging Today and the Circular Objectives

IMPACT | How Might a Circular Economy for Plastics Affect People and Planet?

This chapter presents a literature-based assessment of how circular strategies may have an impact on the world, if achieved. Circularity alone cannot solve all today's problems. No solution alone can. It is therefore important to understand where circularity can deliver benefits, as well as areas that require attention or further research.

Circularity is not the end goal. It is, however, an important pathway contributing to the end goal, which is achieving greater human and planetary wellbeing—as described by the Sustainable Development Goals and the Paris Agreement. It is crucial to keep this north star in focus, and to steer the circular transition accordingly for a balanced, positive outcome.

The environmental and socio-economic impacts of plastics today are already thoroughly documented (e.g. Ellen MacArthur Foundation 2016; UNEP 2018; WWF 2019a; The Pew Charitable Trusts and Systemiq 2020). In this Action Agenda, we look to the future and ask the question: *if the circular objectives are achieved, how might people and planet be affected?* It is important to understand where the circular economy can deliver benefits, as well as where points of attention and knowledge gaps exist.

Science-based, forward-looking impact assessment of increased circularity is still a relatively new field. As an initial step towards this understanding, the four objectives defined in the previous chapter were assessed by a group of scientific experts (see Appendix), based on existing literature along five impact categories:[2]

- **Resource use**: use of minerals and fossil resources.
- **Climate change**: greenhouse gas emissions from the value chain.
- **Human health and biodiversity**: largely as a consequence of land, water, and chemical use, as well as air, water, and soil pollution.
- **Economic wellbeing**: a broad category covering income, wealth, value added, and their distribution; trade, productivity, competitiveness, entrepreneurship, resilience, and investment.
- **Decent work**: a broad category that includes the promotion and realisation of standards and fundamental principles and rights at work, creating greater opportunities for women and men to decent employment and income, enhancing social protection, and strengthening social dialogue.[3]

The figures below give an impression of how each circular objective may affect the five impact categories: could it bring benefits, trade-offs, risks, or is it uncertain due to insufficient knowledge or evidence? A more detailed analysis can be found in the Appendix. It should be cautioned that impacts are almost always complex, with boundary conditions, caveats and exceptions, and always evolving, e.g. as new technologies emerge and mature. Therefore, these qualitative labels should never be seen as absolute or static. Monitoring, data sharing, and iterative learning processes around progress and impacts will be critical.

Any complex transition comes with pros and cons. We should not be locked into inaction for fear of the risks and uncertainties. Quite the opposite; we should take proactive action to optimize the impact of a circular transition, including leveraging win-wins for maximum benefits, mitigating trade-offs and risks, and investigating the yet unknown.

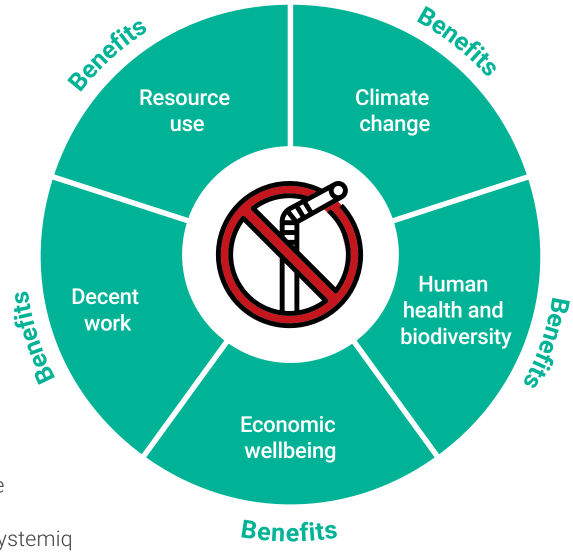
FIGURE 3 • Expected Impact of Eliminating Problematic or Unnecessary Plastics

RESOURCE USE | Elimination will reduce fossil resource use provided that 1) reduced use of packaging does not lead to increased product disposal (e.g. more food waste); 2) substitute approaches, either with other plastics or alternative materials, do not lead to reduced recyclability or consume relatively more resources. Dematerialization approaches such as reducing thickness of packaging can also reduce fossil resource use, if they don't lead to reduced recyclability.

CLIMATE CHANGE | Similarly, elimination will reduce energy use and greenhouse gas emissions related to plastics production (production emission estimated at ~4-4.5 tCO_2e per ton of plastics [The Pew Charitable Trusts and Systemiq 2021]) and disposal through incineration or landfill, if it does not lead to increased product disposal and reduced recyclability.

HUMAN HEALTH AND BIODIVERSITY | Elimination may mean less toxic emissions in production, lower presence of hazardous substances, and less potential exposure to toxins in the use of plastics. Eliminating plastics that would otherwise leak into land and ocean environments benefits both biodiversity and human health. Attention should be paid to avoiding increased product disposal or substitute materials with similar or more hazards.

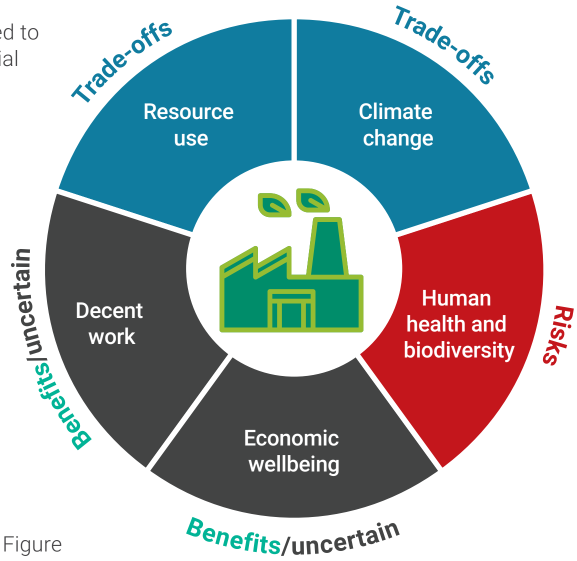
ECONOMIC WELLBEING[4] | Total system costs[5] of higher plastic circularity are expected to be comparable to business-as-usual, while investments will shift from upstream to mid/low-stream in the value chain; globally, it is expected to help governments save on plastic waste management costs, though for low- and middle-income country governments the costs may increase (The Pew Charitable Trusts and Systemiq 2020). The economic case becomes stronger when indirect effects and externalities are also considered. For example, stopping and reversing ocean plastic leakage will have significant benefits for tourism and fishery industries.[6]



DECENT WORK | Removing unrecyclable plastics from the waste stream can improve working conditions and income of (informal) workers in collection, transport, and recycling of plastic waste. There may be limited job losses from decreased plastic production.

FIGURE 4 • Expected Impact of Ensuring Material Inputs for Plastics are Safe, Recycled, or Renewable

RESOURCE USE | Using recycled content will reduce dependence on fossil resources. Increasing renewable inputs will also reduce fossil resource dependence, but crop-based plastics may increase fertilizer, water, and pesticide use (Gironi and Piemonte 2011). Using microalgae or organic waste as renewable inputs holds the potential to reduce the need for virgin fossil resources without increasing other resource use, though they are still relatively new and further research on the impacts and viability of industrial application is needed.



CLIMATE CHANGE | Using recycled material inputs for plastics is expected to decrease greenhouse gas emissions in production. The reduction potential strongly depends on the recycling technology (see Figure 6). The climate impact of renewable inputs in plastics can be highly variable, dependent on the type of plastic, feedstock, region, or production process (Piemonte and Gironi 2011; Walker and Rothman 2020). Increased crop production can lead to deforestation and higher carbon emissions (Piemonte and Gironi 2011).

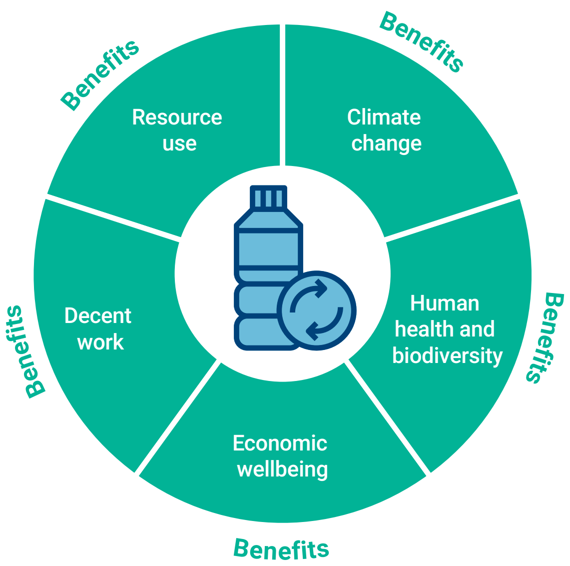
HUMAN HEALTH AND BIODIVERSITY | Recycled plastics may contain unknown concentrations of hazardous chemical mixtures (Groh et al. 2019). Increasing renewables in plastics will increase land use and water footprint, leading to health and environment concerns. Direct land use change (e.g. deforestation) can pose risks for biodiversity; indirect land use change (e.g. displaced food crops) can increase pressure on food security. Increased fertilizer and pesticide use in crop production, and the conversion process to plastics, may exacerbate risks to human health and biodiversity (Walker and Rothman 2020; Hottle, Bilec, and Landis 2017).

ECONOMIC WELLBEING | For recycled inputs, see Economic Wellbeing in Figure 3. There is still a lack of literature on the economic impact of renewable inputs in plastics (Spierling et al. 2018).

DECENT WORK | Increasing recycled material inputs presents an opportunity for more formal jobs in collection and recycling, as well as increased income and recognition for waste pickers (The Pew Charitable Trusts and Systemiq 2020). For the social impact of renewable materials in plastics, there is still a lack of literature (Spierling et al. 2018).

FIGURE 5 • Expected Impact of Reusing Plastics More

RESOURCE USE, CLIMATE CHANGE, HUMAN HEALTH AND BIODIVERSITY | Reducing SUPP is expected to reduce fossil resource use and greenhouse gas emissions from production. Less leakage into land and ocean environments benefits both biodiversity and human health. The environmental benefits of reusable packaging solutions can outweigh the environmental costs of heavier materials and increased logistics, as long as they are reused an adequate number of times (Ross and Evans 2003). Reusable packaging should be designed for reuse, in order to avoid increased microplastic release due to repeated use and wear. When reuse takes place in new applications different from the product's original designed purpose, caution should be given not to introduce unintended exposure of users and the environment to hazardous substances (Beekman et al. 2020).



ECONOMIC WELLBEING | See Economic Wellbeing in Figure 3.

DECENT WORK | Increasing plastic reuse provides an opportunity for more formal jobs in new delivery models.

FIGURE 6 • Expected Impact of Recycling or Composting Plastics at End-Of-Use

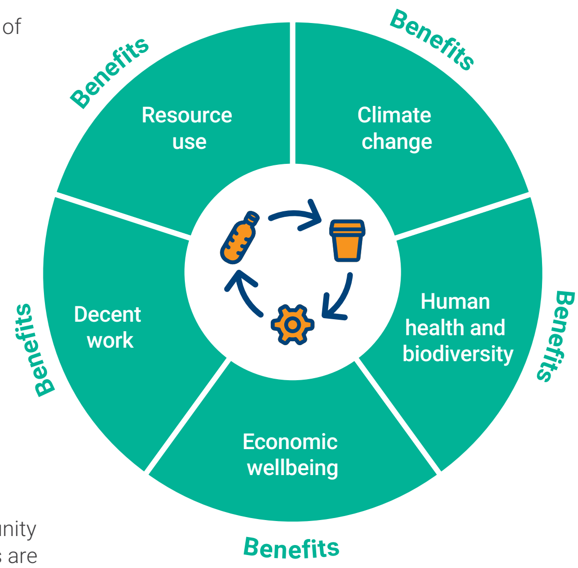
RESOURCE USE | Plastics recycling will reduce dependence on fossil resources in that it (partially) replaces the virgin feedstock used for production.

CLIMATE CHANGE | Energy use and greenhouse gas reduction potential of plastics recycling strongly depends on the technology. Compared to landfill, it is estimated that mechanical recycling can save up to 50% in lifecycle greenhouse gas emissions (The Pew Charitable Trusts and Systemiq 2020), and even greater reductions compared to incineration. Lifecycle greenhouse gas emissions of chemical recycling are currently similar to landfill, and lower than incineration.

HUMAN HEALTH AND BIODIVERSITY | Increased plastics recycling instead of open burning, incineration, or landfill will reduce air, water, and land pollution and associated health hazards (The Pew Charitable Trusts and Systemiq 2020). Better collection will reduce leakage of plastic waste into land and ocean, lowering the risk to biodiversity. Microplastics released from mechanical recycling should be collected to avoid leakage into the natural environment (Groh et al. 2019).

ECONOMIC WELLBEING | See Economic Wellbeing in Figure 3.

DECENT WORK | Increasing recycling or composting presents an opportunity for more formal jobs in collection, sorting, and recycling. Targeted efforts are needed in skills training, education, work formalization, and social inclusion to ensure a just transition to more decent work and compensation, especially in low- and middle-income countries with larger informal workforces.



"The Action Agenda by PACE helps create the systemic change needed for transitioning to a circular economy in key sectors. The calls-to-action provide us an opportunity to reach multiple goals, from our climate goals to halting biodiversity loss, reducing our overconsumption of resources, and increasing societal wellbeing by transitioning to a circular economy."

Mari Pantsar,
Director, Sustainability Solutions, The Finnish Innovation Fund Sitra

BARRIERS | What is Hindering the Transition to a Circular Economy for Plastics?

This chapter analyzes what is currently impeding the implementation or scaling up of circular strategies, considering all angles including policy, business models, finance, technology, information, culture, and behavior.

The impact assessments indicate that the transition toward a circular economy for plastics is not only an environmental necessity, it can also bring economic and social benefits. Stakeholders across society have been taking action. More than 100 countries have put in place some form of plastic bag legislation, and many have banned SUPP (UNEP 2018a). In addition to bans, some countries have also enacted positive stimulation such as tax breaks for manufacturers to recycle or produce reusable bags (UNEP 2018a). To date, companies representing more than 20% of all plastic packaging produced globally have signed up to the New Plastics Economy Global Commitment, and set actionable targets by 2025 (Ellen MacArthur Foundation and UNEP 2020). Consumers are increasingly conscious about a brand's purpose, and the social and environmental impacts of their purchases. Accenture estimates that globally, about 50% of consumers believe providing credible "green" credentials, minimizing harm to the environment, and investing in sustainability makes a company more relevant and attractive (Accenture 2020).

However, despite the benefits and ongoing momentum in the transition to a circular economy for plastics, between 2000 and 2015 the proportion of plastic packaging in total global packaging volumes increased from 17% to 25%. Plastic packaging volumes are expected to continue their strong growth, more than quadrupling by 2050 to 318 million tonnes annually (World Economic Forum 2016). From literature study (labeled as * in the References) and interviews, we have identified 14 key barriers that may work collectively to slow progress towards the circular objectives for plastics. There are links, connections, and overlaps between these, depending on the perspective of analysis. The goal is not to produce an exhaustive list of all barriers, but rather critical ones where collaborative action is needed to overcome them. Due to the overall uncertainty of the environmental and socio-economic impacts of bio-based plastics, these are not included in the barrier assessment. Instead, we call for further investigation into the impacts of bio-based plastics, before looking into how to accelerate their scaling (see the Actions chapter).

Cross-Cutting Barriers

Externalities are not accounted for – externalities are consequences of an industrial activity that affect another party who did not choose to incur the cost or benefit, and can be negative or positive. Current price points of plastics do not account for their negative externalities, including greenhouse gas emissions, health hazards, biodiversity loss, and resource depletion. This puts products that reduce externalities (such as those with increased circularity) while incurring higher costs in doing so, at a competitive disadvantage.

Sustainability is not consumers' most important purchasing decision driver – while there is increasing awareness of the environmental and social impact of consumption, research suggests that price and quality continue to be the most commonly considered factors when consumers make a purchasing decision (Accenture 2019). If a more sustainable product or business model has higher price points or function trade-off, or requires extra effort (e.g. cleaning or carrying a reusable container), market adoption is likely to be limited. Circular models may bring additional value to consumers in new ways, these elements are often overlooked or undervalued by customers who make "like-for-like" comparisons with linear models that typically do not involve these value drivers.

Lack of incentives to design for reuse and recycling – design decisions often fail to consider how a product can extend its use cycles, and how materials can be looped back into productive use at end-of-use. Adding these requirements to plastic material and product design may require investment, new collaborations and higher costs, which are currently not rewarded by the market (e.g. through premium price points) or by policy (e.g. tax incentives). There needs to be an effective incentive mechanism for companies to initiate and sustain circular design changes.

Barriers to Eliminating Problematic or Unnecessary Plastics

Lack of alternative materials with comparable price and functionality – the prevalence of plastics is a result of their extraordinary functionalities and low price points. Alternatives to plastics are often more costly, can differ in functionality, and do not always have a lower environmental footprint throughout their lifecycle. It is challenging to phase out plastics without a viable and versatile substitute, and the substitution would be meaningless if it does not deliver a net improvement environmentally.

Barriers to Increasing Recycled Feedstock

Accessibility of inexpensive virgin oil-based plastics – virgin plastics are often cheaper than recycled plastic inputs, which provides little incentive for businesses to source recycled feedstock. The supply of cheap virgin oil-based plastics shows little sign of slowing, as many oil companies are pursuing greater production of plastics to help compensate for declines in other markets such as energy. The oil and gas industry plans to spend around $400 billion over the next five years on plants used to make raw materials for virgin plastics (Carbon Tracker 2020). Additionally, oil production is often subsidized, which provides a perverse incentive for the circularity of plastics.

Barriers to Increasing Reuse

Reuse often lacks a strong business case and is perceived as risky – while some refillable systems have been financially successful, many reuse models—especially the ones with return systems—incur higher operational costs through reverse logistics, cleaning, organizing, and handling the returned packaging (Coelho et al. 2020). Alternative materials use in reusable packaging could also bring additional costs, with increased weight or variances in shape that impact on logistics. These additional costs inhibit the uptake and scaling of these business models. They are often seen by traditional financial assessments as more risky, due to legal complexities and lack of a proven track record.

Reuse requires consumer behavior change – reuse often requires consumers to do things differently, with more effort. For example, bringing reusable packaging to a collection point, bringing their own reusable containers to refill at a business, cleaning reusable packaging between uses, or diluting concentrates. Although consumer awareness on the environmental issues of SUPP is rising, it is also well-known that information by itself often does not change behavior, especially when the convenience of daily life is compromised.

Concerns over hygiene and safety – concerns over hygiene and safety from consumers, businesses, and regulators, coupled with variances in reuse policies, have been hindering the implementation and scaling of plastic reuse models. These concerns have been heightened further amidst the COVID-19 pandemic. They have been recognized, for example, as a top priority to address in order to realize the tourism sector's ambition to tackle plastic pollution (Global Tourism Plastics Initiative 2020). While the pandemic will one day end, many anticipate it having a lasting impact on consumer behavior, with people permanently adopting stronger health-focused preferences. The challenge of instilling consumer and regulatory confidence in reuse options is becoming increasingly relevant and significant.

Barriers to Increasing Recycling Rates

Mixed and contaminated post-consumer plastics – post-consumer plastic waste comes with a large diversity in types (e.g. PET, HDPE, PVC, PS), forms (rigid or flexible), and colors, and is often contaminated. Furthermore, thousands of chemical additives are used in plastics to enhance their properties. This large diversity poses a significant challenge to sorting, and severely compromises the quality and safety of recycled plastic outputs. Efforts to reduce resource intensity and packaging innovation often involve new chemicals and compositions that current end-of-use solutions may not yet be equipped to handle.

Improper disposal at end-of-use – lack of awareness or willingness of consumers to sort and bring back their waste, unclear or complex instructions on which plastics can be collected through different streams, combined with insufficient collection points or services, have led to a prevalent improper disposal of plastic waste (The Pew Charitable Trusts and Systemiq 2020; UNEP 2019).

Composition labels, chemical markings, and recyclability or biodegradability labels vary by geography, can be inconsistent or misleading, and often result in consumer confusion (UNEP and Consumers International 2020). This inhibits recycling when infrastructure depends on the collection of separated plastics from consumers.

Limited financing models for plastic waste collection – collection is key to preventing leakage into the natural environment and to secure feedstock for recycling. However, plastic waste collection poses a logistical and economic challenge. How do we connect billions of households and businesses, especially in rural areas, to a network of collection points in an economically viable way? Despite its significance in reducing externality costs, plastic waste collection is usually a cost in itself, with limited direct financial return to justify the investment. Governments, especially in low-income countries, often also lack the financial means to support better collection.

Changing landscape and fragmentation of the waste trade globally – evolving regulations and differences between countries causes complexity and costs that can result in leakage and disincentivize the transport of plastics intended for recycling. This includes variation in regulations on the transboundary movement of waste, and the categorization of plastics as "waste" or "hazardous waste". While regulations are needed to serve as protection for importing countries, there may be unintended consequences if approval processes also hinder legal trading for proper recycling. Additionally, the shifting regulation landscape can add to uncertainty around investments in reverse logistics and recycling infrastructure.

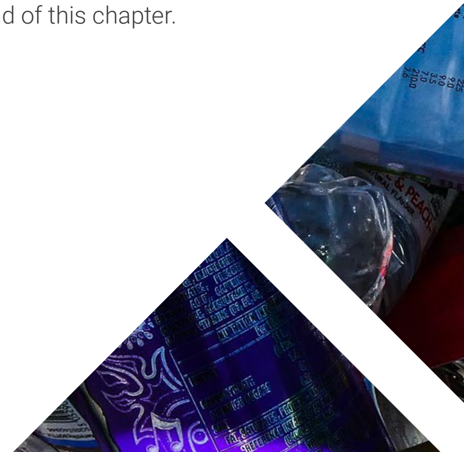
High cost of sorting plastics – mechanical recycling, the dominant recycling technology today, requires a clean and homogeneous plastic waste feedstock (such as PET water bottles) in large quantities to be economically viable. The sorting and cleaning processes are laborious and expensive. Consequently, plastic recyclers struggle to secure feedstock for their facilities, and the profitability of sorting is limited to relatively few plastics for which there is an established recycling market.

Lack of scalable high quality recycling technology – a major limitation of mechanical recycling is that the quality of recycled plastics is degraded. It is estimated that PET can typically be recycled a maximum of two to three times (Sedaghat 2018). Chemical recycling may turn unsorted, uncleaned plastic waste into virgin quality feedstock, and can theoretically be recycled infinitely (Laermann 2019; Tullo 2019). However, concerns are also raised about its high energy intensity. The European Union, for example, is yet to undertake an in-depth review of chemical recycling (Simon 2020). This policy uncertainty in turn discourages investment in research and development as well as scaled facilities, keeping chemical recycling at low technical and financial maturity.

ACTIONS | Where is Action Needed Most for a Better and Faster Transition?

Findings from the impact and barrier analysis are synthesized into 10 calls-to-action to overcome the barriers towards a circular economy for plastics, and to optimize impact by amplifying wins, mitigating trade-offs, and researching the yet unknown.

Building on the impact and barrier assessment presented in previous chapters, we put forward 10 calls-to-action for a better, just and faster transition to a circular economy for plastics. This is not a complete list of everything that needs to be done. Nor should the list stay static, as the world evolves rapidly. Instead, each call-to-action is an area where actions are most needed today, to overcome key barriers to a transition and to optimize impact. Under each call-to-action, a variety of actions can be taken up by different stakeholders. Some examples are given in this report, though they are neither exhaustive nor prescriptive. We invite every changemaker to come up with ideas and initiatives to address these calls-to-action, adapting them to different contexts. A summary of how each stakeholder group (governments, businesses, civil society, finance, research organizations) can drive the change can be found at the end of this chapter.



CALL-TO-ACTION 1 |

Agree Which Plastics Can be Eliminated and Prepare the Market to Phase Them Out

The first step is to identify which plastics are problematic or unnecessary, and what the impacts of their elimination will be. This entails not only assessment of the plastics in question, but also their potential substitutes such as glass, paper, and aluminium, as well as scenarios in which no substitutes are used. For example, in the case of food packaging, it is important to consider the potential impacts on food shelf-life, loss, accessibility, and affordability. A thorough understanding of the impacts of elimination, including trade-offs, will be critical for deciding which plastics are "problematic" and which are "unnecessary", whether they should be replaced and with which materials, in order to ensure their phasing out provides a net environmental/social benefit. It is important that the assessment is holistic, scientific, and adapts to local contexts, and that different stakeholder groups are consulted before reaching a decision.

Once it is agreed which plastics should be eliminated (or substituted), it is key to properly prepare the market, including both industry and consumers, for the transition. Abrupt bans have been shown to be ineffective. Bans have had to be shelved because of disruption to unprepared supply chains that lack viable alternatives (Wan 2018). If bans are enforced without good substitutes, businesses and consumers may shift to alternatives with more damaging environmental, health, or social impacts. Preparing the market for the phase-out requires cross-sectoral collaboration, including communicating the rationale of the change, developing, testing, and scaling the supply of substitutes, facilitating the value chain to shift, and supporting businesses and workers who may be negatively affected, as well as monitoring and evaluating the impacts of the transition.

WHERE CAN WE START:

- **Research organisations can support governments in identifying "unnecessary" and "problematic" plastics in the local context**, using scientific methods to assess the impact of their elimination or replacement.
- **Governments and civil society can conduct value chain stakeholder consultations** to evaluate the readiness for and consequences of the phase-out, and develop a step-by-step plan including communications, policy intervention, timing, and needed support (e.g. reskill programs for those whose jobs may be negatively affected).
- For plastics identified as problematic but difficult to replace (such as multi-layered food packaging that cannot be recycled), **businesses and research organizations can collaborate on research and development,** to develop either new recycling solutions or new substitute materials with better environmental impacts.
- **Civil society can facilitate inter-governmental conversations** to co-develop policy frameworks that can be adapted globally for tackling "problematic" or "unnecessary" plastics, to ensure regulation is coherent across borders and harmonized where possible/relevant, to make it easier for businesses to adapt and scale their solutions across markets.
- **Governments and civil society can design and conduct communication campaigns** to help businesses and consumers understand why the change is needed, how it will take place and how they can support/be supported in the transition.
- Alongside businesses, **governments can eliminate the use of "unnecessary" or "problematic" plastics in public procurement contracts.**

CALL-TO-ACTION 2 | Incentivise and Support Product Design for Reuse and Recycling of Plastics

Plastic packaging which is considered necessary needs to be designed for reuse and recycling. Design for reuse is necessary, in order to avoid increased microplastic release and associated hazards due to repeated use and wear. Design for recycling needs to consider safety (additives can introduce toxic substances in recycled plastics), easy separation (for example, multi-layered food packaging or plastic bottle caps are difficult for separation), as well as compatibility with sorting and recycling processes (e.g. plastic packaging with reduced thickness may fall through sorting and end up as residual waste). These requirements need to be met without increasing product disposal or overall resource use for packaging.

Designing for circularity may entail higher costs for businesses in, for example, research and development, new equipment and supply chain changes. Such efforts are often not yet rewarded either by the market or by policies. There are also technical challenges, for example how to translate principles and guidelines into practical solutions, how to balance different design requirements, and how lifecycle assessments should be properly conducted.

Governments can play a crucial role in stimulating design for circularity. Metrics can be used either as regulatory requirements, or as a basis for economic incentives such as procurement criteria, reward/penalty in taxation rates, or Extended Producer Responsibility (EPR) fees. Policies can mandate circular design, as the broadened Ecodesign framework in the European Commission's Circular Economy Action Plan aims to do (European Commission 2020). Bans on unsafe inputs, such as toxic additives, can be effective in ensuring widespread adherence. Packaging designers, recyclers, and researchers should work together to align product design and material innovation with existing and emerging recycling solutions. Knowledge sharing around design solutions and best practices is important, such as the Upstream Innovation guide (Ellen MacArthur Foundation 2020c), especially in facilitating adoption among small and medium-sized businesses with limited in-house resources.

WHERE CAN WE START:

- **Governments, businesses, and researchers can collaborate to develop an adaptable metric system** to score packaging "recyclability", taking into consideration collection/sorting/recycling processes in practice, and packaging "reusability", in order to inform purchasing and as an incentive mechanism for improving packaging design.
- **Governments, businesses, and researchers can develop, assess, and implement packaging design standards** to expedite wider business adoption, as well as to streamline new material introduction to align with end-of-use operations (collection, sorting, and recycling).
- **Governments can assess policy instruments** such as ecodesign and public procurement to incentivize design for circularity.
- **Governments can leverage financial instruments** (e.g. taxation or EPR fees) to help ensure the environmental costs of production and consumption are more accurately reflected in market prices.
- **Civil society and governments can work with businesses to measure, monitor, and track** packaging design commitments.
- **Civil society can work with researchers and businesses to identify and share best practices** around designing for reuse and recycling.
- **Financers can fund development of materials** that meet circular design requirements without functionality or aesthetic trade-offs.

"The Dutch Sustainable Growth Coalition was founded on the conviction that companies have a responsibility towards society to help offer solutions for the major issues of our time. Game-changing innovations and policies are urgently needed to turn the tide, which can be realised through a joint approach from business, governments, knowledge institutes and civil society."

Jan Peter Balkenende, Chairman, Dutch Sustainable Growth Coalition

PARTNERS IN ACTION | Beyond the Bag

Scaling Ocean-Friendly Alternatives to Plastic Bags

Ocean Conservancy research shows that plastic bags are among the deadliest forms of marine debris (Wilcox et al. 2016), and they figure among the top 10 items found on beaches and waterways worldwide during Ocean Conservancy's annual International Coastal Cleanup.

To help curb this ocean menace, Ocean Conservancy is serving as an Environmental Advisory Partner to Closed Loop Partners' Beyond the Bag Initiative, which brings together a growing list of retail giants including CVS Health (also a member of Ocean Conservancy's Trash Free Seas Alliance®), Target, Walmart, Kroger, Walgreens and others to develop, test, and scale alternative designs and models to the traditional retail plastic bag. First announced in July 2020, the $15 million initiative is expected to announce an initial round of winning designs in early 2021, before launching the testing and incubation phase. "Plastic bags are among the most insidious types of waste ending up in our ocean, and we are thrilled to share our decades of expertise on this issue with private sector leaders and innovators to change the paradigm," said Ocean Conservancy's Plastics Initiative Director, Chever Voltmer.

PARTNERS IN ACTION | European Plastics Pact

Aligning Efforts to Reduce Single-Use Packaging

The European Plastics Pact was initiated by the Netherlands, France, and Denmark to accelerate the transition towards a circular plastics economy in Europe. By signing it, 15 governments and 82 companies committed to significantly reduce their use of virgin plastics and increase recycling and reuse rates by 2025. The initiative joins the Ellen MacArthur Foundation's growing global Plastics Pacts Network, which now involves countries collectively representing more than 30% of the world›s GDP.

"We applaud the leadership shown by the Dutch, French, and Danish governments to develop this ambitious plan joining forces with governments and businesses across Europe," says Sander Defruyt, Lead of the New Plastics Economy initiative at the Ellen MacArthur Foundation. The day-to-day management of the European Plastics Pact is provided by The Waste and Resources Action Programme (WRAP). "I'm delighted that WRAP has been chosen to play a leading role in The European Plastics Pact; not least because the Pact's collaborative, evidence-based approach absolutely epitomises how WRAP operates," says David Rogers, Head of International Resource Management at WRAP.

All voluntary participants are developing different measures for implementing the pact in their country or organisation, but have committed to engage in cross-border cooperation and report their progress annually. The Dutch government, for example, has increased taxes on landfill, incineration, and export of plastic waste, and included eco-based modulation in its EPR scheme for packaging to incentivize recyclable packaging. "In jointly setting targets for each step of the transition to a circular plastics economy, we are sending a strong signal to our partners in the European Union and beyond," says Arnoud Passenier, Strategic Advisor Circular Economy International to the Dutch government.

CALL-TO-ACTION 3 | Address Hygiene and Safety Concerns to Promote Plastics Reuse

Salient concerns over hygiene and safety have always been a challenge for plastics reuse, particularly for food and drink packaging. From a regulatory side, governments and businesses have enacted safety standards that aim to address the potential risk of contamination for both consumers and workers involved in the immediate value chain. While regulations are crucial for ensuring the safety of reuse, and can help build consumer confidence in reusable products, in some cases their implementation can have the unintended consequence of stifling the feasibility of reuse models and pushing the market to opt for SUPP. There have been cases where consumers are prohibited from bringing their own containers, or when employees are not allowed to collect used containers for cleaning.

Guidelines and policies are currently set by both governments and individual businesses, which results in varying rules even within the same geography, posing a challenge for widespread consumer adoption, creating confusion, and inhibiting the effective scaling of reuse models. The COVID-19 pandemic has heightened hygiene concerns, causing governments to lift single-use plastic bans, businesses to shelf reusable options, and consumers to shift back to disposables. This has occurred despite experts reassuring the public that reusable containers do not increase the chance of transmitting the virus relative to SUPP options handled in the same way (Laville 2020).

It is now more evident than ever that, not only are hygiene and safety necessary prerequisites for the wide adoption of reuse systems, but practical guidelines that ensure trust without stifling reuse feasibility are critical. To ensure hygiene and safety for reusable plastics, there is a need for collaboration between health experts, governments, and businesses to proactively identify, assess, and develop guidelines to address the potential risks of plastics reuse, in a way that ensures safety for all value chain actors while also remaining feasible for consumers and businesses to adopt. There must also be increased communication of research on the health risks between the scientific and corporate communities, so that these emerging understandings can be applied to the specific context of businesses across industries as more companies consider reuse models.

WHERE CAN WE START:

- **Research organizations can scientifically assess hygiene and safety risks of reuse models**, communicate the findings effectively to governments, businesses, and consumers, and make recommendations on regulations, operations, and consumption for safe reuse.
- **Research organizations, governments, and business can work together to understand the implications of guidelines and regulations**, assessing efficacy and feasibility.
- **Governments can work to harmonize guidelines and regulations across geographies**, where applicable, to streamline business adoption and scaling of reuse models.
- **Governments and civil society can share science-based information** on the health and safety of reuse models with consumers.
- **Researchers can collaborate with businesses to better understand consumer perception**, identifying where hygiene and safety assurance is needed most.
- **Researchers and governments can provide guidance on designing reusable packaging** that is safe in use and post-use.

CALL-TO-ACTION 4 |
Stimulate Consumer Adoption of Plastic Reuse

This call-to-action focuses on the consumption side of the equation, with "consumer" referring broadly to individuals, governments, businesses, and organizations buying and using products with plastic packaging. Despite increased awareness, sustainability remains low among purchasing decision drivers, and the behavior change required by many plastic reuse models is a major barrier to their wider adoption (Accenture 2019; Ellen MacArthur Foundation 2019b). Shifting consumer preferences will be a powerful market mechanism toward moving the needle in the supply chain, rewarding those investing in design for reuse and reuse business models, and motivating those who still need to make the move.

To stimulate consumer adoption of plastic reuse, in addition to hygiene and safety assurances as discussed in the previous call-to-action, a combination of awareness raising, product and business model innovation, infrastructure investment, and policy support is needed. Consumers need to understand why the shift is important, as well as how the shift may be made in a practical way. Businesses providing reusable plastic products and services should consider how to optimize consumer experience, increase convenience and appeal, and unlock new value propositions—an example is combining a reusable cup with contactless payment (Ellen MacArthur Foundation 2019b). Infrastructure, such as bring-back or collection points, needs to be designed and deployed to make the needed behavior change easier. Policies can be used to create a favourable environment for reuse models, lowering the financial barrier for adoption and further nudging behavior change.

WHERE CAN WE START:

- **Civil society can raise consumer awareness** about the necessity of plastic reuse, and **provide information on how to make the shift** in a practical way in the local context.
- **Researchers, businesses, and civil society can work together to better understand consumer behavior,** including adoption barriers and drivers, how to effectively nudge for change, improving experience, and making the new habit stick.
- **Businesses and municipalities can partner to co-develop return systems**, such as Loop's pursuit of partnerships with bricks and mortar stores serving as storage and reverse logistics drop sites for reusable containers.
- **Businesses and municipalities can co-invest in infrastructure to provide consumers with convenient return-from-home channels**, collecting reusables through a curb-side collection process and returning to point of purchase for customers to easily access again.
- **Governments can address cost barriers for consumers** by providing targeted subsidies that address premium pricing on reuse options, with a focus on reuse items with the most significant environmental impact.
- To address costs and shift customer habits, **businesses can pilot pricing schemes** that encourage customers to choose reusables, as Starbucks did with their disposable cup charge trials.

CALL-TO-ACTION 5 | Guide and Support New Business Models for Environmental, Financial, and Social Triple-Win

New business models, in particular those for reuse, hold significant potential as a pathway to achieving circular objectives. However, both the impact and barrier assessments reveal the challenges these new models face to scale and deliver real impact. On the environmental side, reuse models may replace SUPP with materials that use more raw materials and energy to produce, making them only environmentally beneficial when exceeding a certain use life. For example, reusable polypropylene Tupperware food savers need to be reused from 16 to 208 times, depending on the impact category considered, to have an impact equal to an extruded polystyrene food container (UNEP 2020). Moreover, reuse models may require more transport and cleaning, which has greenhouse gas, water, and chemical footprints. On the financial side, reuse models, such as return and refill systems, often incur higher operational costs (in, for example, reverse logistics and customer service), need higher upfront investment, and have longer pay-back compared to linear business models. Understanding of the social impacts of new business models is still just beginning.

New business models need to achieve environmental, social, and financial triple-win, to thrive and scale and contribute in a meaningful way to the wellbeing of people and planet. Research organizations need to develop science-based tools to guide business model design and implementation for net positive environmental and social outcomes. Governments and finance need to provide policy and financial support to the new business models, based on metrics measuring their actual environmental and social impact. Civil society needs to mobilize business process innovation in, for example, accounting, legal, asset and risk management to make these new business models more successful, as well as to make the new processes and tools readily available for businesses, especially small and medium-sized companies that may lack in-house resources. Businesses need to collaborate, share pain points and lessons learned, co-develop solutions for common barriers, and champion successes.

WHERE CAN WE START:

- **Research organizations, businesses, governments, and finance can collaborate to develop metrics** that measure the environmental and social impacts of new business models.
- **Research organizations can develop science-based methodology and tools** to guide new business model design, forecast their impact and measure actual impacts, along the abovementioned metrics.
- **Governments and finance can provide policy and financial support** to companies implementing new business models, based on their performance along the abovementioned metrics.
- **Finance and government can evolve accounting methods and financing models** to provide a level playing field for new business models and increase their access to financing.
- **Civil society can mobilize and increase access to business process innovation**, especially for small and medium-sized companies.
- **Businesses can collaborate to share both success stories and learnings**, join forces to develop solutions, and advance triple-win business models in a pre-competitive environment.

CALL-TO-ACTION 6 |
Set up Functioning Collection Systems

Functioning collection systems are key to reducing plastic waste in the environment, and to increasing recycling. A total of 11% of all plastic waste was uncollected in 2016 (WWF 2019b), and only 14% of plastic packaging is collected for recycling (Ellen MacArthur Foundation 2016). Plastic collection systems are often seen as a cost burden, and struggle to attract funding. The majority of today's plastic waste in the environment is from rural areas and developing countries, where it is even more challenging to set up cost-effective plastic collection (The Pew Charitable Trusts and Systemiq 2020). Average collection rates in low-income countries are below 50% (Ellen MacArthur Foundation 2016). In countries with plastic collection systems, they are typically designed and managed at regional or municipal levels, therefore are highly fragmented and can vary from city to city. Instructions are not always clear and consistent, leaving consumers unaware or confused about which plastic waste can be collected and which cannot. Incorrectly collected waste may contaminate the material stream and do more harm than good for recycling.

Governments need to collaborate with the private sector to design and deploy financing models for plastic collection systems. In particular, more investment in collection is needed in low- and middle-income countries. Clear distinction should be made between mixed municipal solid waste collection and separated collection for reuse or recycling. Collection systems need to be designed in a convenient and intuitive way to encourage consumers to properly separate and dispose of plastic waste. Collection systems need to be planned in a coordinated manner across different municipalities and hand-in-hand with recycling facilities, to increase both the volume and quality of input materials for recycling. The role of the informal sector in collection systems needs to be recognized with improved integration and formalization.

WHERE CAN WE START:

- **Governments can set collection targets.**
- **National and municipality governments can collaborate to design waste collection systems**, taking into consideration the local ecosystem (e.g. recycling infrastructure), residential density, and cultural and socio-economic impact (Collectors n.d.), agreeing on where harmonization or adaptation to local contexts should apply.
- **Governments can enforce EPR schemes,** requiring businesses to collect and take back packaging or support funding of third-party collection systems.
- **Governments, businesses, and finance can develop financing models for plastic collection systems**, especially for low- and middle-income countries and rural areas.
- **Research organisations and civil society can identify and promote best practices,** e.g. in convenient and intuitive collection systems with clear instructions for proper disposal.
- **Civil society and governments can conduct school educational programs and consumer campaigns**, to raise awareness and help people understand how to properly dispose of their plastic waste.

"An effective waste management system is at the heart of any functioning circular economy. The framework for Ghana's National Plastics Action Partnership (NPAP) aims to tackle the logistics challenge of plastic recycling by developing the necessary infrastructure to collect, transport, sort and store waste efficiently as secondary resource material. This way, we can enable recyclers and re-users to access the fractions they need to do their work profitably. We are happy to share our learnings with the PACE community and hope that the PACE Action Agenda will spur the cross-sector collaboration needed to scale similar initiatives and export them to other countries in our region."

Oliver Boachie, Special Advisor to the Minister of Environment, Science, Technology and Innovation, Ghana

PARTNERS IN ACTION | Cif Ecorefill

Making Reuse More Convenient for Consumers

In an effort to reduce their use of single-use packaging, Unilever has been testing refill and reuse options with multiple brands. For Cif cleaning products, Unilever has developed an 'ecorefill' option for the trigger spray products, where a concentrated form of the same product is bought and then mixed with water at home in a reusable container.

"These containers are designed to be used approximately 15 times but often get discarded after only one use, and recycled at best," says Willem Brandt, Vice-President Home Care Europe at Unilever. "The 'ecorefill' option provides consumers with the possibility to reuse containers—and makes consumers aware how easy it is to produce a like-new product with identical product performance at home." Unilever calculated that 'ecorefill' requires 75% less plastic; it also cuts transportation emissions by 87%, as the concentrated products are significantly lighter than traditional ones.

PARTNERS IN ACTION | Loop

Creating a Zero-Waste Reuse System

TerraCycle's global reuse system Loop unites some of the world's largest consumer goods companies including Coca-Cola, Unilever, Nestlé, and P&G, and retailers such as Carrefour and Tesco, behind a shared mission: creating a zero-waste system by replacing single-use plastics with reusable packaging. Launched in 2019, Loop is available in the US, UK, and France, where Carrefour is now offering Loop instore. In 2021, Loop will become available in Canada, Japan, and Australia.

"We enable consumer goods companies to deliver their products in durable packaging that is collected at end of use, cleaned, refilled, and reused," says TerraCycle and Loop CEO Tom Szaky. "We want to create an ecosystem that links businesses, enabling consumers to buy anywhere and return anywhere." With support from the World Economic Forum, a multi-stakeholder group of civil society and public sector representatives are working together to guide and help Loop improve their efficacy, sustainability, and social inclusion. This is a highly promising and cutting-edge example of cross-sector collaboration to increase reuse and reduce single-use plastics in consumer goods.

CALL-TO-ACTION 7 |
Strategically Plan Sorting and Recycling Facilities, in Compliance with Trade Regulations

The banning of plastic waste imports by China, followed by other countries including Thailand and Malaysia, created great urgency in developing domestic plastic waste management facilities worldwide. The Basel Convention Plastics Waste Amendments, coming into effect from January 2021, will enhance the control of transboundary movements of plastic waste (Secretariat of the Basel Convention. n.d.). Sorting and recycling facilities are large capital investments with a lock-in of decades. Therefore, they need to be carefully planned, with holistic considerations that ensure economic viability as well as environmentally sound management. The location is important: will there be a constant inflow of high-quality after-use plastics? Will such inflow involve transboundary movement, and can compliant and efficient processes be set up? Are there relevant industries in the vicinity to take up recycled materials? How can we reduce the carbon footprint of the (reverse) logistics? Technology choice is also crucial. Mechanical recycling has a lower greenhouse gas footprint, but chemical recycling can generate a higher quality feedstock. It is widely foreseen that the future of plastic recycling will involve a combination of both technologies (The Pew Charitable Trusts and Systemiq 2020). The capacity of complementary recycling technologies and individual portions of the recycling system need to be well planned for balanced, optimal outcomes.

There is also a need to increase dialogue between countries and public-private sectors, to discuss regional collaborations that are supported by all stakeholders. A better understanding of the social, environmental, and economic consequences of different global or local recycling models is an important basis for these discussions. Developing countries may need more support to plan and invest in high quality sorting and recycling facilities.

WHERE CAN WE START:

- **Businesses and governments can work together to scope regional collaborations** to develop sorting and recycling ecosystems, for example a regional hub or a more distributed value chain, planning a balanced mix of recycling technologies and infrastructure.
- **Research organizations and civil society can develop data and knowledge about the economic, environmental, and social impacts of different global/local recycling models**, to inform strategic decision-making.
- **Research organisations can evaluate different recycling technologies,** monitor progress, share best practice, and advise governments on desirable technology mix and capacity planning.
- **Businesses, governments, and finance can work out blended financing models** for plastic sorting and recycling infrastructure.
- **Governments and development banks can provide seed funding and help kick-start sorting/recycling infrastructure in developing countries** through pragmatic projects that are inclusive of informal workers.

CALL-TO-ACTION 8 |
Make the Recycled Plastics Market Competitive

In order to truly scale up plastics recycling, recycled plastics must be able to compete with virgin plastics on quality (such as durability, flexibility, strength, color), safety (abiding to health and safety regulations, including for chemical additives, as seen in the EU's REACH standards [European Commission 2020c]), price, and supply capacity. Only when recycled plastics are market competitive can businesses adopt them on a significant scale, and in turn further stimulate the development of the recycled materials supply chain. Currently, recycled plastics are often more expensive than virgin plastics, have limited or inconsistent availability, may contain unknown concentrations of hazardous chemical mixtures (which limits high value applications), and can be aesthetically unappealing.

All stakeholder groups need to work together to improve the market competitiveness of recycled plastics, from both the supply side and the demand side. Several other calls-to-action, including design for recycling and strategically planning infrastructure, are all important for making recycled plastics more market competitive. Furthermore, innovation in sorting and recycling technology is key to increasing quality and safety while reducing the costs of recycled plastics. Governments need to provide clear policy guidance with regard to recycling technology development and investment. On the demand side, increased sourcing of recycled plastics is crucial. Corporates and governments, as large buyers, have a critical role to play here. Civil society can raise consumer awareness for more acceptance and preference of products with recycled content. Governments can also use other policy instruments to help create a more favorable environment for recycled plastics.

WHERE CAN WE START:

- **Research organizations and financers can accelerate research and development** in high-quality and cost-effective plastic sorting and recycling technologies.
- **Governments can develop and enforce quality and safety standards** for sorting and recycled plastic outputs.
- **Businesses can commit to sourcing recycled contents** and work proactively to achieve these commitments.
- **Civil society and businesses can raise consumer awareness** of plastics with recycled content for more acceptance and preference in purchasing decisions.
- **Governments can include plastics with recycled content in public procurement guidelines.**
- **Civil society can convene value chain actors and foster collaboration to improve recycling economics**, with shared responsibilities and benefits across the value chain.
- **Governments and researchers can evaluate other policy instruments,** such as EPR schemes, mandating recycled content, tax benefits for producing/sourcing recycled plastics, and shifting subsidies from virgin plastics to recycled plastics.
- **Governments should ensure that policies to stimulate recycling do not unintentionally incentivize shorter use life of plastics** and increase plastic waste volumes.

PARTNERS IN ACTION | DSM and Neste's Strategic Partnership

Turning Waste into High Performance Polymers

Two global frontrunners of circular solutions in the chemical industry, DSM and Neste, have recently joined forces to realize the production of sustainable high performance polymers. Neste provides DSM with 100% bio-based and recycled waste plastic-based hydrocarbons. DSM uses this sustainable feedstock to replace a substantial proportion of the fossil feedstock currently used in the production of high performance polymers.

For DSM, the strategic partnership with Neste marks an important step in realizing their commitment to sustainability. "It's our ambition to further reduce our footprint and to offer a full alternative range of our existing portfolio based on bio- and/or recycled-based materials by 2030," says Shruti Singhal, President, DSM Engineering Materials. "Together with our upstream partner Neste and other value chain partners we're ready to drive our industry forward, seize the sustainable opportunities ahead, and deliver on our purpose of creating brighter lives for all."

PARTNERS IN ACTION | The Global Action Partnership

Fostering Cross-Sector Partnerships to Address Plastic Pollution

To translate individual commitments into a cohesive global agenda and accelerate the eradication of plastic pollution, the World Economic Forum (WEF) brought together a coalition of important stakeholders across the public and private sectors in 2018. The Global Action Partnership (GPAP) aims to shape a more sustainable and inclusive world through the eradication of plastic pollution. It provides a platform for policymakers, experts, business leaders, entrepreneurs, and civil society to align on shared approaches, build a common knowledge base, and scale proven solutions across the globe with the help of strategic financing.

"Plastic pollution is a global challenge, so we must join forces on a global level," says Kristin Hughes, Director of the Global Plastic Action Partnership and member of the Executive Committee at WEF. "But there is no one-size-fits-all approach for curbing plastic pollution on a national level, which is why we work with local partners to build National Plastic Action Partnerships (NPAP)." To date, GPAP has launched three NPAPs—in Indonesia, Ghana, and Vietnam. These locally-led task forces set national goals, such as Indonesia's pledge to reduce plastic leakage by 70% by 2025, and work closely together to achieve them.

CALL-TO-ACTION 9 |

Integrate and Advance Decent Work in the Transition to a Circular Economy for Plastics

As discussed in the impact chapter (see also Appendix), a transition to a circular economy for plastics is expected to bring opportunities for more decent work overall, by creating new formal jobs as well as improving the work conditions, income and recognition of informal workers. However, there is uncertainty regarding both the quantity and quality of jobs that can be generated, and any improvements in work conditions will not take place automatically. For the transition to be effective and socially inclusive, the decent work aspect must be integrated from the beginning, in line with the ILO Guidelines for a Just Transition, and in consultation with employers' associations and workers' organizations (ILO 2015).

Governments, businesses, and civil society need to enact targeted efforts in skills training, education, and social inclusion, especially in low and middleincome countries. Workers need to be part of the transition, and should be included in social dialogue among local governments, employers', and workers' organizations. Since the formalization of plastic waste workers, enterprises, and cooperatives cannot be realized within months or years, pragmatic solutions to quickly improve the health and safety of plastic waste workers and extend social security to these workers are required. Re- and upskilling programs can help workers develop the skills needed in new formal jobs of the circular economy value chain.

WHERE CAN WE START:

- **Governments have a duty to adopt, implement, and enforce labor laws and regulations,** to ensure that fundamental principles and rights at work and ratified international labor conventions protect and apply to all workers engaged in the plastics value chain, and to create an enabling environment for social dialogue among actors from government, employers', and workers' organizations.
- **Governments and workers' organizations can identify metrics** and set goals for a just transition**.**
- **Governments, employers', and workers' organizations can develop and implement measures to support the formalization of enterprises**, creating an enabling environment for enterprises that provide sustainable services in reuse and waste management.
- **Businesses can extend supply chain auditing to downstream partners including collection, sorting, and recycling,** leverage their position in the value chain for better working conditions, and help enforce compliance with safety and other labor regulations.
- **Governments, employers', and workers' organizations can specifically include informal workers in the development of professional collection and recycling infrastructure**, protect their health and safety, extend the coverage of social protection to waste workers and their families, invest in up- and re-skilling programs, and support workers to transition into formal employment.
- **Governments, researchers, and civil society can collect data and improve knowledge about labor conditions** in the plastics value chain, and the implications of a transition to a circular economy, using data to raise awareness of externalities and design effective policies.

CALL-TO-ACTION 10 |
Investigate Environmental and Socio-Economic Impacts of Renewable Material Inputs for Plastics

Although plastics derived from renewable inputs can help reduce dependence on fossil resources, their lifecycle impacts on the planet and society still require further research and better understanding. A major concern about switching to bio-based plastics using crop feedstock is the increase in agricultural land use, which will compete with food production and put more pressure on the already over-stretched environmental burden from agriculture (see impact chapter and Appendix). Bio-plastics based on algae or waste may be exceptions, but literature data is still too limited to assess the overall impacts. The climate impact of bio-based plastics can be highly variable, depending on the type of plastics, feedstock, region, or production process. Some bio-based plastics, if not separated from fossil-based plastic waste streams, can contaminate and disturb the recycling process (Alaerts, Augustinus, and Van Acker 2018). There is also a lack of literature on the socio-economic impacts of bio-based plastics.

In order to determine the appropriate role of bio-based plastics with different feedstocks (including crops, non-crop plants, agricultural waste, algae) in the circular transition, we need a more thorough understanding of their environmental and socio-economic impacts. We need a scientific evidence base to inform policy and investments in the space.

WHERE CAN WE START:

- **Research organizations can conduct science-based analysis on lifecycle environmental and socio-economic impacts of bio-based plastics**, differentiating between different feedstocks.
- **Businesses can collaborate with researchers** by collecting and providing data needed for such quantitative studies.
- **Government and civil society can finance such economic studies.**
- Based on the outcome of the studies, **governments and researchers can develop policy interventions** to best position the role of bio-based plastics in the transition towards a circular economy.
- **Businesses can work with researchers to better understand the impacts of different bio-based plastics** when considering shifting sourcing.
- **Businesses and governments can develop labeling, collection, and sorting schemes that allow for the separate handling of bio-based plastics**, to avoid contamination of recycling processes.

How Can I Drive the Change?

GOVERNMENTS

Governments can drive the transition towards a circular economy for plastics by creating a business environment in which negative externalities are internalized, thereby aligning economic incentives with positive environmental and social outcomes. This can include:

- Define holistic indicators and set balanced targets for the transition.
- Prepare and guide the market to phase out unnecessary and problematic plastics.
- Provide policy incentives for the uptake of circular design, reuse, recycling, and sourcing of recycled content.
- Harmonize hygiene and safety regulations for reuse, and ensure adherence.
- Plan and (co-)invest in collection, sorting, and recycling infrastructure. Modulate technology mix and capacity.
- Implement and enforce adequate legal frameworks for decent work, including support for the integration of informal workers.

BUSINESSES

The critical actions of businesses will depend on their position in the value chain. Here are a few starting points where businesses can take the lead:

- **Material suppliers** can: commit to circularity at the leadership level; shift from virgin to recycled feedstock; eliminate hazardous inputs; integrate recyclability in design decisions; and collaborate with recyclers.
- **Brands** can: commit to circularity at the leadership level; increase sourcing of plastics with recycled content; integrate dematerialization, reuse, and recyclability in design decisions; harmonize labeling standards for proper disposal; evolve value propositions and improve consumer experience with reuse business models; finance collection/sorting/recycling; and extend supply chain auditing to downstream partners to advance decent work.
- Major **users** of plastics, such as airlines and the hospitality industry, can: increase adoption of reuse models; increase sourcing of products designed for circularity; and collaborate in developing B2B collection systems.
- Collaborating with other value chain actors, **sorters and recyclers** can: co-develop standards and certification for secondary materials; help product designers better understand how to design for recyclability; co-deploy collection mechanisms and EPR schemes; identify innovation opportunities in sorting and recycling technologies; and integrate informal workers in the development of professional collection, sorting, and recycling infrastructure.

CIVIL SOCIETY

Organizations across the spectrum of civil society can spur action in a multitude of ways. Key actions include:

- Convene cross-sectoral, multinational stakeholders to develop and implement coordinated circular transition strategies and measures.
- Coordinate the development of standards in, for example, circularity definitions, metrics, secondary material quality, and certification.
- Identify and share best practices in e.g. phasing out unnecessary/problematic plastics, circular design, reuse models, collection systems, sorting and recycling technologies. Raise awareness on the environmental, social, and health impacts of the plastics lifecycle. Share practical information on how to shift to more circular solutions. Nudge consumer behavior change in, for example, reuse models and proper disposal.
- Elevate and connect circularity of plastics with broader transformations such as the SDGs and the Paris Accord.
- Collect data and improve knowledge about labor conditions in the plastics value chain, and implications of higher circularity across the supply chain, in order to advance decent work in the transition.

FINANCE

Significant investments are required to scale the transition to a circular economy for plastics. Different types of financial organizations can play different roles in enabling the change:

- Coalitions of banks, private investors, and foundations can develop innovative financing mechanisms to unlock capital for investment in the action agenda across value chains, from new material development and collection systems to high quality, cost-effective sorting and recycling.
- Development banks can provide seed funding to support the establishment of plastic collection, sorting, and recycling infrastructure in emerging markets.
- Asset managers and impact investors can support access to capital for private sector investments in clean technologies and circular business models via dedicated funds.
- Risk managers can adopt a longer-term perspective and price-in resilience of business models and value chains.
- Financial advisors can support companies to develop green bonds for investment in products or services with higher circularity, taking into consideration their actual environmental and social impacts.

RESEARCH

Research organizations are critical for continuing to develop the knowledge base to guide and support the complex and interdependent transition to a circular economy in plastics, including:

- Use scientific methods to evaluate various circular measures, such as elimination or replacement of identified unnecessary or problematic plastics, hygiene and safety of reuse, and different recycling technologies.
- Advance understanding of the environmental and socio-economic impacts of different types of bio-based plastics.
- Translate scientific findings into advice, such as decision support for material/product design, business models and policies, to balance and optimize impacts over the lifecycle.
- Understand behavior and change management. Develop effective strategies for both consumer behavior and organizational change.
- Develop technologies in areas such as high performance, high efficiency and cost-effective sorting and recycling.
- Develop metrics to measure impact and progress.

CONCLUSION

A circular economy is key for the much-needed transformation of how plastics are produced, used, and treated at end-of-use. In a circular economy for plastics, problematic or unnecessary plastics are eliminated; material inputs for plastics are safe, recycled, or renewable; plastics are reused more; and plastics are recycled or composted at end-of-use.

In the transition into a circular economy for plastics, **let's keep aligned to the north stars** of greater human and planetary wellbeing. Circularity is not the end goal in itself, but an important means towards the end goal, a global economic system that enables human and environmental wellbeing. A circular economy for plastics can have profound effects across resource use, climate change, human health, biodiversity, economic wellbeing and decent work outcomes. Actions are needed to remove barriers and amplify the benefits, as well as to investigate the yet unknown—such as the potential impact of increasing bio-based plastics. **Let's be guided by science**, to develop holistic indicators and set balanced targets, which are crucial to design the transition, monitor the progress and evaluate the impact, in alignment with the north stars.

The transition path to circular economy is challenged by barriers, many beyond the control of any individual stakeholder. Governments, businesses, civil society, finance institutions, research organizations—**let's team up** to take actions to move the needle. Each of us has a role to play in the calls-to-action, and there are specific actions that we can already take up today. Many leaders across the PACE community and beyond are already taking action. **Let's take ownership** and do what we can to drive the change. The PACE Secretariat looks forward to hearing from and working with you, to map progress, co-create actions, build new partnerships, demonstrate best practices, share learnings, and drive new commitments throughout the year and beyond to drive plastics system change at scale.

Let's get to work!

APPENDIX | Impact Assessment

This Appendix provides more details of the Impact Assessment, synthesized based on inputs from Leonardo Gonçalo Melo (TNO), Janot Tokaya (TNO), Hettie Boonman (TNO), Elmer Rietveld (TNO), Patrick Schröder (Chatham House), Susanne Waaijers-van der Loop (RIVM), Michiel Zijp (RIVM), François Saunier (CIRAIG/Life Cycle Initiative), Jean-François Ménard (CIRAIG/Life Cycle Initiative), Sophie Fallaha (CIRAIG/Life Cycle Initiative), Yoni Shiran (SYSTEMIQ), and several other working group members.

Problematic or Unnecessary Plastics Are Eliminated

RESOURCE USE

Eliminating unnecessary or problematic plastics will diminish resource use, provided that reduced use of packaging does not lead to increased product disposal (for example, more food waste); and that substitute approaches, either by other plastics or alternative materials, do not lead to reduced recyclability or consume relatively more resources (Ellen MacArthur Foundation 2016).

Dematerialization approaches such as reducing the thickness of packaging can reduce fossil resource use if they do not lead to reduced recyclability. For instance, an eco-design effort to reduce the packaging weight by 14% for a billion PET bottles in France (i.e. roughly 2g per bottle, which is a major effort), would save 4,700 tons of plastic (Dépoues and Bordier 2015).

CLIMATE CHANGE

Similarly, eliminating unnecessary or problematic plastics will reduce energy use and greenhouse gas emissions related to plastics production, if the elimination does not lead to increased product disposal and reduced recyclability. For reference, the greenhouse gas emissions from the production of one ton of plastics are estimated to be ~4-4.5 tCO_2e (The Pew Charitable Trusts and Systemiq 2020). Additionally, elimination can contribute to lower landfill and incineration volumes, resulting in net reductions to greenhouse gas emissions associated with these disposal activities.

HUMAN HEALTH AND BIODIVERSITY

Eliminating unnecessary and problematic plastics may lessen toxic emissions from the production process and reduce exposure to potential emissions of toxins in the use of plastics (Beekman et al. 2020). Eliminating unnecessary and problematic plastics that would otherwise leak into land and ocean environments will have benefits for wildlife and human health. For reference, 90% of floating marine debris is plastic, of which nearly 62% is food and drink packaging (UNEP 2019); recent studies report that higher concentrations of plastics are found beneath the surface (Pabortsava and Lampitt 2020).

If reduced use of packaging leads to increased product disposal (for example, more food waste), the impacts on human health and biodiversity from a higher production of, in this case, food, may increase. Attention should be given to the possibility of these plastics being replaced by other kinds of materials that do not necessarily result in a reduction in the risks for human health and environment. For instance, replacing problematic or unnecessary plastic packaging by (recycled) paper would result in a shift from emissions of toxins in the plastic lifecycle to emissions in the paper lifecycle (Geueke, Groh, and Muncke 2018).

ECONOMIC WELLBEING

Eliminating unnecessary and problematic plastics may negatively impact those whose income is dependent on the production and distribution of these plastics. However, in a system change scenario including reduction, substitution, collection, recycling, and waste-to-energy, the costs to governments and business is estimated to be lower than business-as-usual, even without accounting for externalities (Pew Charitable Trusts & Systemiq 2020). Increased waste management costs are offset by savings from reduced plastic production and more revenues from recyclate sales or generated energy (Lau et al. 2020). Investments will shift from upstream to mid/downstream in the value chain. When externalities are counted, the economic benefits are significant: less ocean plastics leakage will benefit tourism and fishery industries and the provision of marine ecosystem services. For reference, marine plastic pollution is responsible for $13 billion of business costs per year for fisheries, tourism, and infrastructure operators, among others (The Pew Charitable Trusts and Systemiq 2020).

DECENT WORK

Unnecessary and problematic plastics are often not recyclable. Removing them from the waste stream can improve working conditions and value capture of (informal) workers in collection, transport, and recycling of plastic waste (Chatham House 2020). Eliminating unnecessary and problematic plastics may negatively impact those whose employment is dependent on the production and distribution of these plastics (see above).

Material Inputs for Plastics are Safe, Recycled, or Renewable

RESOURCE USE

Using recycled content will reduce dependence on fossil resources (Hopewell, Dvorak, and Kosior 2009). Since chemical recycling is capable of producing monomers of the same quality as virgin feedstock, it has the potential to displace more virgin fossil resource use compared to mechanical recycling. However, more research is needed on the impacts of chemical recycling at the industrial level (Crippa et al. 2019).

Increasing renewable inputs in plastics will also reduce fossil resource dependence, but may increase fertilizer, water, and pesticide use (Gironi and Piemonte 2011). Based on a lifecycle assessment of several crop-based and fossil-based plastics, the water footprint of plastics made from renewable inputs is usually quite significant (Hatti-Kaul et al. 2020). Considerable amounts of land to grow renewable feedstock may also be required. If the current global production level (360 million tons per year) were switched entirely to bio-based plastics, it would require about 3% of the total global agricultural area (European Bioplastics 2016; Bauer et al. 2018). Other studies suggest that this figure would be higher and that, in order to meet the growing demand for plastics with bio-based material inputs, serious competition between using land to grow crops for food or plastic would take place (Rhodes 2019). The risk for competition between food, feed, and the production of renewable inputs for bio-plastics needs to be better understood.

Alternatively, using microalgae as a renewable input may require less land, pesticides, and herbicides than terrestrial crops, reducing the resource use of plastic production (Bussa et al. 2019). Similarly, using the organic fraction of municipal solid waste and agricultural waste as material inputs could negate the need for virgin fossil resources without increasing other resource use (Ebrahimian, Karimi, and Kumar 2020; Maraveas 2020). These methods of renewable material input production are still relatively new and further research on the impacts and viability of industrial application is needed.

CLIMATE CHANGE

Using recycled material inputs for plastic is expected to decrease greenhouse gas emissions. A study comparing the emissions from the production of PET from primary material and rPET from recycled material inputs found that the emissions were 3,270 $kgCO_2e/t$ and 202 $kgCO_2e/t$, respectively (Dépoues and Bordier 2015). Each ton of plastic recycled reduces greenhouse gas emissions by 0.9-1.3 tons, compared to the production of virgin plastic (Dépoues and Bordier 2015). In France, extending sorting to all plastic household packaging, and promoting its recycling, would avoid the emission of 500,000 tons of greenhouse gases (Dépoues and Bordier 2015).

The climate impact of renewable materials for plastics can be highly variable, depending on the type of raw material used, region, or production process (Piemonte and Gironi 2011; Walker and Rothman 2020). For example, significant savings of non-renewable energy use (40–50%) and greenhouse gas emissions (45–55%) have been reported for the production of bio-based plastics, compared with the cradle-to-grave impact of conventional plastic (Gironi and Piemonte 2011). With current technology, the lowest greenhouse gas emissions of plastics are achieved when sugar cane is used (Joint Research Centre 2015). Sugar beet potentially has an even lower greenhouse gas emission, but this crop is not often used yet. Increased crop production for bio-plastics can lead to deforestation and increased carbon emissions associated with land use change (Piemonte and Gironi 2011). If renewable material inputs come from perennials grown on degraded cropland, carbon debts will be minimized (Piemonte and Gironi 2011). Aboveground and soil carbon will likely increase if perennials substitute conventional cropland (Piemonte and Gironi 2011). The results of comparative lifecycle assessments on the emissions derived from the production of microalgae-based and fossil-based plastics are still inconclusive, but a lower global warming potential for the former is expected (Bussa et al. 2019). The greenhouse gas savings of using renewable material inputs for plastics are dependent on the type of energy being used in the production of these materials (Piemonte and Gironi 2011; Odegard et al. 2017). However, this is also a factor for fossil-based plastics (Odegard et al. 2017). Overall, more research is needed in order to adequately compare fossil-based and renewable polymers in terms of greenhouse gas emissions (Walker and Rothman 2020).

HUMAN HEALTH AND BIODIVERSITY

Recycled plastics may contain unknown concentrations of hazardous chemical mixtures (Groh et al. 2019; Beekman et al. 2020). Examples of plastic toxins include: bisphenol-A (BPA), cadmium, benzene, brominated compounds, phthalates, lead, tin, antimony, and volatile organic compounds (VOCs) (Rollinson and Oladejo 2020). Recycled material inputs introduce unknown concentrations of mixtures of these substances in the material stream, and thus increase the risk of emissions and migration in their production, use, and disposal phase (De Blaeij et al. 2019; Beekman et al. 2020).

Lifecycle assessments of renewable material inputs for plastics show highly variable human health and biodiversity-oriented indicator results, depending on the specific polymer, the region where it was grown, and the production process (Walker and Rothman 2020; Odegard et al. 2017). In general, more land is used to produce polymers from crops than from fossil fuels (Odegard et al. 2017). Direct land use change (e.g. deforestation) can pose risks to biodiversity; indirect land use change (e.g. displaced food crops) can increase pressure on food security. Increased fertilizer and pesticides used for crop production may exacerbate risks to human health and biodiversity (Walker and Rothman 2020). The use of agricultural feedstocks to produce ethylene, just as with fossil-based ones, can have significant impacts and emissions derived from their farming, distillation, and dehydration, which cause significant ozone depletion, smog, acidification, carcinogens, and respiratory effects (Hottle, Bilec, and Landis 2017). This underpins the importance of a holistic view and assessment for any resource that is used for plastics—and why reduction should be primarily considered.

In general, the environmental benefits of microalgae-based and waste-based production are inconclusive, as the field is still fairly young. Nevertheless, researchers often note the improvement potential of such production systems in the future, and expect that the reductions in land, fertilizer, and pesticide use will result in benefits to human health and biodiversity (i.e. reduced ecotoxicity, eutrophication, and acidification potential) compared to other renewable and conventional feedstocks (Onen Cinar et al. 2020; Bussa et al. 2019; Maraveas 2020).

ECONOMIC WELLBEING

For the recycled part of this objective, see Economic Wellbeing under "Problematic or Unnecessary Plastics are Eliminated" and "Plastics are Recycled or Composted at End-of-Use" for more details.

If recycled and renewable materials displace inputs based on fossil resources, there might be a trade-off where some value creation shifts from the oil extraction industry to e.g. recyclers and renewable materials producers. Nonetheless it is not expected to be major, as the share of extracted oil used for plastics accounts for 6% of total fossil resources extracted (World Economic Forum 2016). Overall, the economic impact of renewable inputs in plastics still requires further quantitative assessments (Spierling et al. 2018).

DECENT WORK

Increasing recycled materials input presents opportunities for more formal jobs in collection and recycling, as well as increased value capture and recognition for waste pickers (The Pew Charitable Trusts and Systemiq 2020). If recycled and renewable material inputs displace inputs based on fossil resources, there might be a trade-off with jobs in the oil extraction industry and in oil exporting countries. Working conditions in the recycled or renewable plastics sector may not necessarily be fair or healthy to employees (WBCSD 2016). For the social impact of renewable materials in plastics, there is still a lack of literature (Spierling et al. 2018).

Job losses in oil exporting countries as recycled inputs substitute virgin inputs is expected to be minimal, as the oil extraction industry is a very automized sector and the share of extracted oil used for plastics is small (i.e. 6% of total fossil resources extracted (World Economic Forum 2016)).

Plastics Are Reused More

RESOURCE USE

If plastic reuse leads to a decrease in the demand and use of plastic products, a reduction in fossil resources use is expected. It is estimated that 20% of plastic packaging could be replaced by reusable systems (Ellen MacArthur Foundation 2016). Even though its reusable counterpart requires more material than the lightweight single-use alternative, total annual plastic demand for reuse systems is expected to be lower.

CLIMATE CHANGE

The reduction in greenhouse gas emissions from an increase in plastic reuse will be dependent on the effective displacement of new plastic production. For reference, greenhouse gas emissions related to virgin plastic production are 4-4.5 tCO_2e/t of plastics (The Pew Charitable Trusts and Systemiq 2020). It is estimated that 20% of plastic packaging could be replaced by reusable systems, leading to avoiding 33 megatons of primary production (Ellen MacArthur Foundation 2016), i.e. up to 150 megatons CO_2eq of greenhouse gas emissions.

HUMAN HEALTH AND BIODIVERSITY

The environmental benefits of reusing plastics can outweigh the environmental costs of more materials and increased logistics, so long as they are reused an adequate number of times (Ross and Evans 2003). Assuming that increased plastic reuse displaces new production, it can result in less toxic emissions derived from extraction and processing of plastic materials. Assuming that reuse leads to less disposals, less leaching (e.g. in landfills) may also occur. If plastics intended for a specific purpose are given a use other than the one they were designed for, new or different risks may arise related to their new applications, different legal frameworks, and safety aspects (Beekman et al. 2020; De Blaeij et al. 2019).

ECONOMIC WELLBEING

See Economic Wellbeing under "Problematic or Unnecessary Plastics are Eliminated" for more information. Increasing the reuse of plastics is expected to reduce the costs of waste management and create new businesses. Nonetheless, the economic impact of this objective alone still requires more quantitative assessment.

DECENT WORK

Trade-offs are expected from an increase in plastic reuse. On the one hand, job losses may occur from decreased virgin plastic production. On the other hand, increasing plastics re-use provides the opportunity for more formal jobs in new delivery models. Making products reusable will not have a significant direct impact on achieving better working conditions.

Plastics are Recycled or Composted at End-of-Use

RESOURCE USE

Plastics recycling will reduce fossil resource use if it displaces virgin inputs (see above).

CLIMATE CHANGE

Increased recycling is expected to decrease greenhouse gas emissions, given that recycled materials displace production using virgin inputs. The greenhouse gas reduction potential of plastics recycling strongly depends on the recycling technology. It is estimated that mechanical recycling saves 48% of greenhouse gas emissions in the full lifecycle compared to virgin plastic production, while chemical recycling has a similar lifecycle greenhouse gas footprint to virgin plastics, but smaller than incineration (The Pew Charitable Trusts and Systemiq 2020; Cosate de Andrade et al. 2016). However, chemically recycled materials are of a higher quality than mechanically recycled ones. Therefore, the former have a higher potential of displacing virgin material extraction and production and their associated greenhouse gas emissions.

HUMAN HEALTH AND BIODIVERSITY

Better collection and waste management for plastic recycling and composting will reduce the chances of plastic waste being disposed of haphazardly (UNEP 2019). This will diminish the leakage of plastic waste into land and ocean, lowering the health risks to biodiversity and humans (Jambeck et al. 2015). For reference, Lau et al. (2020) report that, in 2016, 12% and 20% of total mismanaged waste (i.e. 91 megatons) ended up as aquatic and terrestrial pollution, respectively. In addition, increased plastics recycling and composting instead of open burning or landfill will reduce air, water, and land pollution and associated health hazards (The Pew Charitable Trusts and Systemiq 2020).

When recycling is not carried out in a sound manner it poses a risk for human health and biodiversity, as potentially dangerous additives (e.g. flame retardants, colorings) present in polymers may be released during the various recycling and recovery processes, as well as during the use phase of products produced from recycled materials. As a consequence, it may expose biodiversity and humans to these substances (Hahladakis et al. 2018; De Blaeij et al. 2019). Even if recycling is carried out in a sound manner, biological, physical, and chemical risks may arise. Assessing the potential risks, as well as increasing transparency on both material stream content and processing techniques, will allow better understanding of the impacts of plastic recycling (Quik, Lijzen, and Spijker 2019). Finally, more mechanical recycling (i.e. shredding) may also lead to an increase in microplastics emissions if leakages occur (RIVM 2020). How severe these emissions are compared to other sources should be investigated further.

Composting could lead to reductions in ozone depletion and eutrophication, especially when compared to impacts associated with landfilling. However, recycling provides the greatest benefits at end-of-life (Hottle, Bilec, and Landis 2017).

ECONOMIC WELLBEING

Recycling or composting plastics at end-of-use is expected to help governments save on plastic waste management costs, though for low- and middle-income country governments the costs may increase as they may need to create new collection frameworks (The Pew Charitable Trusts and Systemiq 2020). Collecting plastics at end-of-life for recycling or composting will prevent ocean plastics leakage, which will provide significant benefits to the tourism and fishery industries as well as in terms of ecosystem services, as discussed earlier.

It is estimated that about 95% of the value of plastic packaging – worth some 105 billion euros – is lost to the economy every year (Calleja, 2019). Increased recycling and composting will allow for this value to stay in the system for longer, while providing economic benefits. For instance, increasing plastic recycling rates within the EU to 55% is expected to bring net positive economic gains (Deloitte 2017). After subtracting the estimated costs needed to achieve such a target, the net benefit may reach up to €1,872 million by 2025, depending on final investment costs and the price of recycled plastics. It is noted that the energy recovery sector may be negatively affected by increased plastics recycling, with estimated losses of over €250 million (Deloitte 2017). A study looking at a scenario where Sweden increases its ambition over the 55% recycling rate shows a net profit of €1.2 million per year, indicating that increasing domestic recycling and avoiding the export of plastic waste can lead to an overall profitable situation (Milios, Esmailzadeh Davani, and Yu 2018).

DECENT WORK

Increasing recycling or composting presents an opportunity for more formal jobs in collection, sorting, and recycling (The Pew Charitable Trusts and Systemiq 2020). For instance, the EU estimates that making all plastic packaging recyclable (and reusable) by 2030 could create 200,000 jobs in member countries, but only if recycling capacity was multiplied fourfold (UNEP 2019). If recycling is done locally, this may lead to a geographical redistribution of jobs. For instance, the reduction of extra-EU exports of plastic waste will transfer jobs from Asian countries to the EU (Deloitte 2017). On the other hand, increased recycling may lead to job losses in the energy recovery sector if plastics are diverted from incinerators to recycling facilities (Milios, Esmailzadeh Davani, and Yu 2018).

In many developing economies, women, children, the elderly, and the unemployed carry out informal recycling activities (UNEP 2019). Increasing recycling or composting may increase value capture and recognition for waste pickers, if they are properly supported and organized (Gall et al. 2020). Additionally, innovative configurations of the relationship between waste pickers and mechanical plastic recycling companies may be able to produce high quality materials while providing socio-economic benefits (i.e. create employment, improve local industrial competitiveness, reduce poverty and decrease municipal spending) (Gall et al. 2020). Nevertheless, working conditions in the recycling sector may not always be fair or healthy to employees (WBCSD 2016). Targeted efforts are needed in skills training, education, and social inclusion to ensure a just transition to more decent work, especially in low- and middle-income countries.

It should be noted that actual impacts, in any of the five areas assessed, are affected by many different factors and trends in society, for example global population, behavioral and consumption patterns, and cultural and socio-economic context. How each of the impact areas will change over time is an aggregated result of forces often pulling in different directions. A circular transition is just one of these forces, and by itself cannot guarantee the net impact to move in a certain direction. This report analyzes possible impact from increased circularity alone, without considering other ongoing changes.

ENDNOTES

1. Interested readers can refer to the work of Ellen MacArthur Foundation, United Nations Environment Programme, and World Wildlife Fund.

2. All five impact categories are affected by many different factors and trends in society. How each of them will change over time is an aggregated result of forces often pulling in different directions. Circular transition is just one of these forces, and by itself cannot guarantee the net impact to move in a certain direction. This report analyzes possible impacts from increased circularity alone, without considering other ongoing changes.

3. A full definition of decent work by the International Labour Organization is: "Decent work sums up the aspirations of people in their working lives. It involves opportunities for work that is productive and delivers a fair income, security in the workplace and social protection for families, better prospects for personal development and social integration, freedom for people to express their concerns, organize and participate in the decisions that affect their lives, and equality of opportunity and treatment for all women and men."

4. Label is based on the estimated impact of the four circular objectives combined.

5. Referring to the costs to governments and business in a system change scenario with reduction, substitution, collection and recycling of plastics, as developed by The Pew Charitable Trusts and Systemiq (2020).

6. Marine plastic pollution is responsible for significant business costs to fisheries, tourism, and infrastructure operators, among others, estimated at $13 billion per year (The Pew Charitable Trusts and Systemiq 2020).

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PHOTOS

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