CENTER for INTERNATIONAL ENVIRONMENTAL LAW

Beyond Recycling

Reckoning with Plastics in a Circular Economy

Executive Summary

The original conception of circularity focused on two key pillars: the protection of natural resources and the elimination of externalized costs of production. The concept has reflected the critical need for the human economy to function within the planet's boundaries and without harm. Yet the use of the term 'circular economy' has strayed quite far from these original pillars, seriously undermining the validity of the concept in national and global policy discussions.

This briefing first gives an overview of the differing definitions and understandings of the term 'circular economy,' revealing how many of them fail to consider the resource use and externalities across the full plastics life cycle and supply chain, focusing rather disproportionately on waste management and disposal. The briefing then outlines key principles on which a circular economy framework must be built, including considerations along the full plastics life cycle, from resource extraction, production, manufacture, transport, and consumption, through to disposal, leakage, and contamination of flora and fauna, including human bodies.

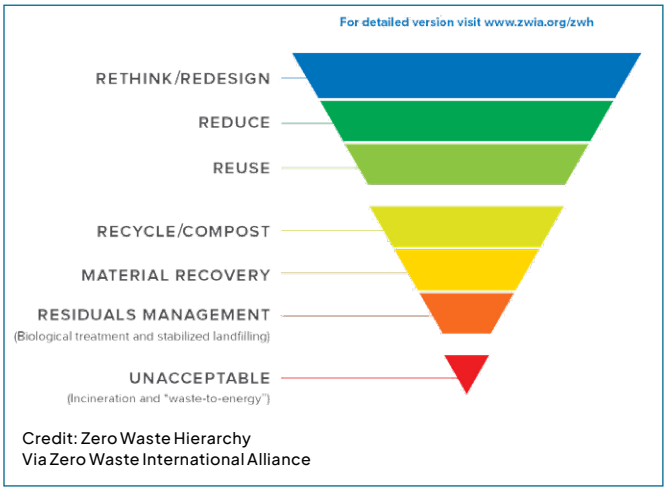
As decision makers consider policies and practices to bring about a circular economy, they must consider the following principles:

- **Toxics poison the circle.** Toxic additives and hazardous chemicals are used throughout feedstock extraction and plastics production, manufacture, use, and disposal, representing a major obstacle to any kind of 'circularity' for plastics.
- **Burning is not circular.** The 'circular' label is often misapplied to the burning and inadequate recycling of plastic waste, contrary to the principles of circularity.
- **Safe design can be circular.** Policies to advance a circular economy must focus first on non-toxic redesign for reuse, rather than normalizing the production of toxic materials and waste.
- **Upholding human rights is circular.** The implementation of circularity for all materials in the economy — especially plastics — must ensure that human rights are upheld for all people, with specific care for those made most vulnerable to harm.

As this brief explains, policies or technical processes that require the continuation and expansion of plastics production cannot be labeled circular, and they should thus not be considered solutions to the global plastics crisis. Any steps taken toward applying the label of 'circularity' to plastics must address the serious toxics and human rights concerns associated with not only the disposal of plastics but also their use and production. For this reason, this brief makes clear that in a circular economy, there is no place for the current production and use of plastics.

This analysis concludes with the following recommendations:

- Plastics manufacture and use should be capped by 2025, followed by a managed decline in the annual tonnage of plastics produced.
- Toxic chemicals should be targeted for elimination in the new global agreement on plastics. Efforts should be made to remove them from production and manufacturing processes and along the full life of the material, ensuring that any waste management initiatives do not recirculate or generate new toxic substances and greenhouse gases into the biosphere, thus aggravating the triple planetary crises.
- Toxic, climate-damaging practices for managing plastics waste — such as thermal processing technologies — must not be erroneously characterized as 'circular,' particularly with regard to approaches recommended or mandated by a new global plastics agreement.
- Policies to address the global plastics crisis should prioritize innovations that reduce resource extraction for the production and use of plastics, centering those innovations on just, culturally appropriate alternatives — particularly reuse, refill, repair, and the elimination of unnecessary plastics — before considering waste management options.
- To effectively end plastics pollution, efforts must be made to uphold the rights to information, public participation, access to an effective remedy, and a healthy environment throughout the full, global supply chain of plastics and plastics waste. Governments and the private sector must undertake urgent action to ensure that any communities suffering from the externalities of extraction of feedstocks for plastics, plastics production and manufacture, use, waste management, and disposal have access to adequate remedy and that those harms are stopped.



Credit: Zero Waste Hierarchy
Via Zero Waste International Alliance

Introduction

As the world considers how to address the growing impacts of the triple planetary crises of pollution, climate change, and biodiversity loss, many discussions point toward a circular economy approach as a much-needed solutions pathway. The term circular economy is routinely used in conversations and policy discussions that center on re-envisioning the full system of plastics, from the extraction of feedstocks to manufacture and production, design, use, and waste and disposal, and considering all the pollution and emissions throughout that system. However, there is ongoing confusion on the exact meaning of the term and its application to plastics. Despite this lack of clarity, the facts are clear: The gap between the idea of circularity and its practical applications within the economy has been widening, not shrinking, threatening the world's ability to address significant pollution crises.[1]

This caution is especially pertinent in the context of the negotiations toward a new global instrument to end plastics pollution pursuant to the United Nations Environment Assembly (UNEA) mandate and in the ongoing discussions at the World Trade Organization (WTO) regarding the growing global threat of pollution from plastics (both under the Informal Dialogue on Plastics (IDP) and the Trade and Environmental Sustainability Structured Discussions (TESSD).

Before States adopt policy responses that center on a circular economy approach in addressing the plastics crisis, *it is essential* to establish a common understanding of what should (and should not) be considered circular. It is also necessary to determine whether such an approach can **meaningfully deliver** on policymakers' intentions and the public's demands.

The problem of plastics pollution is broader than just concern over single-use plastics. Therefore, the push toward a circular economy must be broader than solely an effort to address the issue of plastics pollution. Solutions to this crisis and moves toward a circular approach must extend well beyond, for instance, reducing the need for

single-use plastic products in two key ways. First, it must be about reducing linearity for all materials, not just plastics, so simply substituting one material for another is not a circular solution. Second, plastics wreak harm on the environment, the climate, and public health across the system of feedstock extraction, manufacture, use, and disposal, regardless of the durability of their application; so, addressing only single-use products will similarly not achieve circularity. This brief focuses primarily on plastics, but it also addresses the broader concerns regarding how decision- and policymakers should address circularity.

The Intergovernmental Negotiating Committee (INC) for a new legally binding agreement to "end plastic pollution" began its negotiations in November 2022. The UNEA mandate specifically directs the INC to consider provisions "[t]o promote sustainable production and consumption of plastics through, among other things, product design and environmentally sound waste management, including through resource efficiency and circular economy approaches."[2] Members of the INC should closely consider the cautions in this and other analyses[3] in their efforts to articulate policies toward any degree of circularity for plastics or other materials in the economy.

A multi-faceted and global systems change is needed to sustainably shift the world's economy away from linearity and toward circularity for all resources, materials, and products, to address all three of the planet's current crises. Circularity must apply to how materials like plastics move through the economy in addition to limits to production and consumption. Moving toward a circular economy will require significant coordination across geographies and business models; innovations in materials, product design, infrastructure, and logistics; and shifts in market incentives. As such,

> the application of a circular economy approach to ensure sustainability for plastics production and consumption can *only* be achieved through **systemic changes:** making plastics safer (i.e., toxic-free), more likely to be collected and safely recycled, and *ultimately unnecessary* through **adaptation** and **innovation.**

Establishing a circular economy necessitates a coordinated cap on resource extraction, production, and product manufacturing. For plastics, world leaders can best achieve this through the negotiation and adoption of a new legally binding instrument that includes shared definitions of key concepts, including with regard to advancing a circular economy.

1. Principled Definitions

While several institutions have laid out different frameworks to advance an understanding of circular economy, there is currently no stabilized or standardized international definition of the concept.[4] Understanding of the concept has changed dramatically over time and between cultures, with varying relevance toward sustainability goals.[5] Without cultivating a shared vocabulary and definitions around these ideas, policymakers risk intending one outcome while allowing for another, divergent one. Aligning behind a standard definition is, therefore, both prudent and essential for policymaking at all levels.

The original concept termed 'circular economy' focused on two key pillars. First, the protection of natural capital (and thus the minimization of resource extraction). Second, the elimination of externalized costs[6] — i.e., 'externalities,' or harmful impacts from a material's production or use whose costs are paid by the public, rather than those responsible for (and profiting from) those risks or harms. The concept of circularity points toward the critical need for the economy to function within the planet's boundaries, and without harm.[7] A 2022 study warns that pollutants, including plastics, are pushing the planet past the 'safe operating space' in six areas, including climate change, land systems change, and biogeochemical flows, with unknown effects on the planet.[8] As understanding has deepened of the causes of the pollution and biodiversity crises facing our planet, circularity has further come to encompass concepts of regeneration,[9] restoration,[10] repair, and considerations of equality and justice in necessary approaches.[11] As many researchers and sociologists have warned: "if circular systems are (re)generative of inequalities that have been entrenched into linear systems...we must ask if this is a new sustainability paradigm or a novel form of greenwashing."[12]

There remains significant variation in how the term is applied and the policy solutions that stem from it. For instance:

- Some prominent conceptions of circular economy, like that put forward by the Ellen MacArthur Foundation, call for the "decoupl[ing]" of plastics use from the extraction of natural resources and reinforce the need to respect human rights.[13]
- The plastics industry itself frames the circular economy as "one where used materials are recovered and recycled to make new products."[14]
- Despite its oft-cited relevance to the UN Sustainable Development Goals,[15] the practical application of the circular economy often focuses on economic growth rather than policies for sustainable (or reduced) production or consumption.[16]
- "[Circular economy (CE)] must be understood as a fundamental systemic change instead of a marginal adaptation of the status quo. **Yet only around 40 percent of definitions conceptualize CE from a systems perspective."**[17] (emphasis added)
- Recycling is the waste prevention approach most commonly found across circular economy definitions,[18] which contradicts the evidence that simply recycling plastics is not truly circular, sustainable, or sufficient to meet the current crisis.[19]
- UNEA has previously defined a circular economy as one "in which products and materials are designed in such a way that they can be reused, remanufactured, recycled or recovered and thus maintained in the economy for as long as possible, along with the resources of which they are made."[20]

These widely varying approaches to defining the concept — including aligning with a perpetual growth ideology, marginal adjustments to the status quo, or unjustified reliance on recycling technologies with questionable track records[21] — are quite far from its original twin pillars. The concept risks weakening to the point of irrelevance if one or two instances of reuse, or the reprocessing of toxic material through a limited number of production cycles, can be equated to resource use reduction or externality elimination.

The very nature of plastics and their related challenges appear incompatible with circularity. Plastics are almost universally made from non-renewable feedstocks of fossil fuels. All plastics, even those made from bio-based or recycled feedstocks, incorporate additives made of similarly non-renewable fossil feedstocks. Further, they all shed or deteriorate over time into micro- and nanoplastics (less than 5 millimeters and approximately 1 to 100 nanometers, respectively), leaching toxic chemicals into surrounding products and environments, and often absorbing other pollutants, which can then wreak havoc on human and animal health.[22] As discussions, promises, and pledges toward circularity have expanded over the last decade, they have strayed far from the original twin pillars of the concept of 'circular economy.'[23]

Rather than adjusting the definition of circular economy to ensure that an overreliance on downstream waste management fits within its scope, it is necessary for decision makers to pay attention to the **divergence** between the *concept of circularity* and the *very nature of plastics* as a material — especially in single-use applications.

For recycling of any material to be considered circular, the process must be non-toxic and keep the material perpetually in use as feedstocks for new products. Recycling plastics does not meet either of these criteria. For recycling to impact a material's circularity, the recycled material must displace some amount of primary production of new material.[24] However, the processing of waste plastics (along with the very additives to give plastics their desirable properties) degrades the integrity of the polymer such that for the resultant material to be useful, it must be effectively downcycled into secondary products.[25] The definition of 'recycling' plastics itself is unclear. Therefore, it is easy to misapply the assumptions of cyclical and repeated reuse of the material. In reality, plastics are only delayed in their journey to the landfill or the incinerator rather than meaningfully kept in production.[26] Yet in plastics policies, discussions of the circular economy often focus on the futile pursuit of recycling as a solution for the rampant over-production and use of a material with significant burdens of risk and harm.

Even when plastics are recycled, manufacturing products from recycled plastic materials also requires a constant input of virgin plastics to be mixed with the recycled material. The resulting post-consumer recycled products are often of lesser quality.[27] **This degradation, among other practical constraints, limits the number of cycles that any given plastic object can undergo before it inevitably becomes unusable waste.**[28] These limitations must be considered during discussions on policies on advancing a circular economy to ensure that recycling is not used as a justification for more plastics production.

The plastics industry has also begun to label alternative thermal processing technologies as 'advanced recycling' despite their resource- and energy-intensity, toxic emissions, and poor track record for producing useful recyclate feedstocks.[29] Merely recycling plastics as they are currently manufactured does not reduce toxic impacts. It perpetuates them by recirculating toxic materials throughout the supply chain.[30] Thus, recycling in any form only affects resource extraction marginally,[31] and it does not address the issue of externalities — the

central tenets of a circular economy approach. Furthermore, the recycling industry itself rejects the conception of 'advanced' or chemical recycling as separate from mechanical recycling. Instead, it seeks to count only plastics-to-plastics manufacturing processes as 'recycling.'[32]

When policymakers seek to incorporate the concept of circularity into policies and governance to address the plastics crisis, they should strive to use a shared definition of circular economy that prioritizes zero-waste approaches to circularity — meaning that everything produced or consumed is returned safely to nature or society.[33] Circularity, thus defined, is not a new concept, as Indigenous Peoples in many geographies have formed and thrived in beneficial circular systems for millennia. A wealth of Indigenous-authored research offers UN Member States insights on how to rethink current systems and achieve circularity in the modern economy.[34] Policymakers must be sure not to equate 'circular economy' for plastics with mere recycling or downcycling. Instead, they must lean on the knowledge, practices, and innovations of Indigenous and traditional peoples, and the key twin principles of a circular economy.

Key takeaway: A circular economy must be defined as a systems change for reducing resources used and eliminating the externalized cost and pollution burdens. Merely recycling toxic plastics currently being produced does not meet that definition.

2. Toxics Poision the Circle

Toxic substances that form the base of, are added to, and are used in the production of plastics and manufacturing plastic products are of great concern to human health. Common chemicals found in plastics include chlorinated paraffin, lead, cadmium, brominated compounds, perfluorinated chemicals (PFAS), phthalates, and bisphenols.[35] Harmful chemicals in plastics and other materials pose an enormous barrier to circularity for this material. Many plastics are made from toxic building block chemicals. They commonly contain toxic stabilizers, plasticizers, softeners, antioxidants, coatings, catalysts, flame retardants, and other modifiers and substances, which negatively impact both environmental and human health.[36] In fact, plastics contain tens of thousands of additives, many with known harmful health impacts, that are largely unregulated or even untested.[37] Many of these chemicals persist and wreak havoc on human health and the environment throughout the plastics supply chain.[38] The very presence of such substances goes against the core notions of circularity. According to the UN Special Rapporteur on human rights and toxics, "[o]ne of the greatest constraints to plastics joining the...circular economy is the toxic chemical additives they contain."[39]

One recent scientific study examining plastic additives noted, "[i]t needs to be stressed that additives, in nearly all cases, are not chemically bound to the plastic polymer,"[40] meaning they easily migrate into the surrounding environment.[41] Chemicals used to make plastics have been linked to numerous detrimental health impacts, including hormone disruption, neurodevelopmental issues, decreased fertility, obesity, heart disease, and certain types of cancer.[42] Replacing these additives under regulatory or consumer pressure often results in regrettable substitution with a similar 'chemical cousin' demonstrating similar (or sometimes even worse) risk profiles. Such is the case in substituting Bisphenol A with Bisphenol S or Bisphenol F.[43] Substitution further poses challenges for substances frequently found in plastics that were not intentionally added but contaminate food and other products anyway.[44]

The serious lack of transparency governing the life cycle and plastics supply chain compounds the issue of toxicity.[45] Few attempts have been made by governments to require that producers catalog and analyze the complete list of all chemicals used in manufacturing plastics, as that information is not readily available.[46] Where such data on contaminants and constituent chemicals are disclosed by resin producers or product manufacturers, a significant percentage of the reported constituent chemicals pose known hazards to human and environmental health.[47] To communities living alongside plastics production facilities or waste processing centers, the risks to human health and well-being are acute, inter- and/or transgenerational, and unavoidable.[48] The impacts of those risks worsen when these sites are permitted by governments for construction in places already ravaged by historic and present forms of colonialism, exploitation, and toxic value systems,[49] as is often the case.[50]

Toxic chemicals also pose problems when plastics are disposed of. Although disposal is often referred to as the 'end of life,' for plastics it is certainly not the end of their impacts. Harmful additives can leach into surrounding water and soil when plastics are disposed of in landfills or dumpsites or when they escape into

the wider environment. Burning plastics in open pits or thermal treatment plants creates highly toxic air pollution.[51] Toxic plastic additives or non-intentionally added substances (NIAS) do not disappear during the recycling process. Instead, they are released into the environment or recycled into new plastic products, triggering more exposure and toxic impacts.[52] As a result, **even for the limited proportion of plastics being recycled (9 percent globally), these toxic chemicals in the resulting material pose insurmountable challenges to the notion of circularity, precaution, and justice.**

The real-life implications of plastics toxicity show that this is not a theoretical concern: One study of toys made from recycled plastics purchased in twenty-six countries found that 90 percent of them contained toxic flame-retardant chemicals found in electronic waste.[53] The authors of this study note that "[r]ecycling materials that contain persistent organic pollutants and other toxic substances contaminates new products, continues human and environmental exposure, and undermines the credibility of recycling."[54]

The international trade in chemicals and plastics[55] is significant to the global economy. Yet, as countries and institutions consider circularity in all forms of trade, they must maintain the core objectives of a circular economy: reducing resource use, eliminating externalities and inequities, and upholding justice. For plastics to find a place in a circular economy, policies should seek to eliminate the use of toxic substances from the whole life cycle of plastics, which does not seem actionable under current production methods.

Key takeaway: Toxic additives and hazardous chemicals are used throughout feedstock extraction and plastics production, manufacture, use, and disposal, representing a major obstacle to any kind of circularity for plastics.

Recycling Does Not Reduce Plastics Production or Keep Fossil Fuels in the Ground

The main components and additives that comprise plastics and give them their desirable material characteristics originate from fossil fuels, the origin of the world's climate crisis. Starting with their origins at the wellhead, plastics emit greenhouse gas emissions at every stage of their life cycle. If plastics production continues to grow at the current estimated levels, these emissions could reach 1.34 gigatons per year — equivalent to the emissions released by more than 295 new 500-megawatt coal-fired power plants. By 2050, the cumulation of these greenhouse gas emissions from plastics could reach over 56 gigatons — roughly 13 percent of the entire remaining carbon budget.[56] In 2020, the International Energy Agency warned that new fossil fuel infrastructure development must stop if the world is to keep atmospheric warming below catastrophic levels.[57]

The plastics and fossil fuel industries' co-opting the concepts of 'circular economy,' 'reuse,' and 'resource recovery' into policies supporting plastics and fossil fuel industry growth is particularly concerning. The plastics industry has plans for significant expansion of virgin plastics production even as they make claims of 'sustainability' under a regime of recycling.[58] Some analyses emphasize a circular economy's capacity to expand the oil and gas industry, primarily through increased plastics production.[59] While these industry-funded and -generated analyses apply the term circular economy to imply 'fewer visible plastics loose in the environment,' they are not envisioning a future fundamentally aimed at sustainable production — i.e., production within planetary boundaries — or resource reduction. Additionally, these visions almost universally fail to consider the externalities throughout the plastics supply chain, including their toxic impacts on human health[60] and the climate,[61] from resource extraction, production, manufacture, transport, and consumption, through to disposal, leakage, and contamination of flora and fauna, including human bodies.

3. Burning Is Not Circular

A hot topic in the discussions on addressing the plastics crisis has been the role of heat-intensive technologies in processing plastics waste. Nearly 12 percent of all plastics ever made have been incinerated or otherwise thermally treated, a practice widely considered harmful to both public health and the climate. Influential leaders in the move toward a circular economy, including the Ellen MacArthur Foundation and the European Investment Bank,[62] have taken strong stances against the use of incineration for waste management. Their opposition includes co-incineration (where waste is burned and then used as part of another production process), cement kilns, and any other waste-to-energy processes.[63]

> Yet many **high-profile actors** in the plastics economy are *still pushing* to include methods of thermal processing technologies of plastics under the umbrella of a circular economy.

The processes grouped under the misleading term of 'advanced' or 'chemical' recycling — including pyrolysis, gasification, solvolysis, and chemical depolymerization — are primarily used to turn waste plastics into energy or other chemicals, not back into plastics.[64] Even more troubling, **none of them offset the primary production of plastics, which continues to rise dramatically.**[65] Depending on the nature of the facility and the process, various proportions of toxic byproducts from pyrolysis and gasification will either be released as effluent or slag, or incorporated into the chemical and fuel products resulting from the process, which further pose serious harm to human health and the environment.[66] While the industry touts these technologies as distinct from incineration because they supposedly take place in a vacuum-sealed environment with no added oxygen, studies still show[67] that 'advanced recycling' facilities[68] emit hazardous air pollutants[69] like dioxins, similar to those released by incineration facilities.[70]

As with incineration, depolymerization technologies like pyrolysis and gasification are enormously energy-intensive, requiring the application of extreme heat and sometimes chemicals.[71] The energy required for processing can either come from external fuels or fuels created through depolymerization. **As such, in addition to the toxic emissions from the processing units, thermal processing facilities may emit additional toxic substances and greenhouse gases due to their energy consumption.**[72] These practices do not meet basic sustainability criteria to protect natural resources and eliminate negative externalities and cannot, therefore, be considered sustainable or made to be circular.

An economy predicated on generating toxic materials and transporting the resulting toxic waste for resource-intensive processing into fuel or other industrial products cannot be reasonably labeled as circular. Controls on the plastics waste trade, as through the Basel Convention, will be significant in the world's response to the plastics crisis. However, these controls are not yet sufficient to stop the current flow of toxic plastics waste globally, especially from high-income countries to low- and middle-income countries, let alone the anticipated rise in waste should plastics production continue to expand. Policies intending to achieve circularity in the economy will only be successful if they focus on reducing, not increasing, material production and adopting solutions to manage and control waste that displaces the need for more production.

Key takeaway: The circular label is often misapplied to the burning and inadequate recycling of plastic wastes, contrary to the principles of circularity.

Offsets Are Not Circular

Another scheme gaining attention in circular economy discussions of plastics is the idea of 'offsetting' plastics, achieving some 'plastic neutrality' through clean-up and/or recycling programs, or even claiming recycled content under the concept of 'mass balance.'[73] It is undeniable that there are large volumes of plastic waste in marine and terrestrial environments, and collecting the waste is necessary. However, attempts to collect that waste for 'offsetting' or 'balance' efforts do not address the overall production and consumption issues that underpin the plastics crisis.[74]

Collecting those plastics already polluting the environment (i.e., 'legacy plastics') to offset virgin plastics production does not reduce the myriad harms to human health and the climate caused by plastics production, use, and waste processing. An ever-growing body of research finds that many of these plastics collected from the environment have absorbed other toxins like persistent organic pollutants (POPs) and endocrine-disrupting chemicals (EDCs), which may make them unsuitable and unsafe for recycling.[75] Furthermore, these programs give plastics producers and high-volume consumers of single-use plastics (e.g., consumer goods companies) a license to keep producing and using plastics[76] rather than support a fundamental shift towards eliminating pollution and negative externalities from plastics.[77]

4. Safe Design Can Be Circular

Focusing practices for circularity on only recycling hides a striking reality: **Recycling is often an inadequate bandage on a problem that can only be sufficiently addressed through systemic changes like prevention, reduction, reuse, and redesign.**[78] Capping plastics production (i.e., reduction) and limiting the single-use application of plastics (i.e., reuse) are core policies for achieving the first pillar of a circular economy, as they provide key pathways toward conserving resources. Central to the second pillar of a circular economy (eliminating externalities) are: removing toxic additives from plastics production, increasing transparency in production processes, and requiring that plastics manufacturers be responsible for the harmful impacts and climate emissions throughout the plastics life cycle. In these ways, **redesign can be a bridge to achieving circularity** — but only if governments are committed to the supportive policy changes and controls needed to manifest it throughout the plastics system.[79]

Redesign can include changes in the production of plastics to non-toxic materials, the application and use of plastics in non-toxic products, and the global distribution of goods to be free from waste.

Change	Outcome
Eliminate the production of the most hazardous plastics (such as PVC) and produce safe materials intentionally manufactured for perpetual recycling.	Improve public health outcomes and the reputations of the companies that make and use materials like plastics.[80]
Mandate the redesign of products made of various plastics (or multi-material products with plastic components) to be safely reusable or designed (chemically and physically) for collection and recycling.	Reduce the downstream expenses and harms associated with waste collection and management.
Redesign global systems of distribution, which currently rely on an abundance of plastic products for packaging and packing in logistics.	Create delivery and distribution systems free from plastics or any single-use material, thereby eliminating a major source of single-use plastic waste.

Importantly, many plastics simply cannot be recycled.[81] This limitation is often due to design constraints: Plastics are not designed from the time of production to be reused, collected, or recycled. Plastics applications throughout global supply chains of other products — such as single-use containers, thin plastic films, and multi-layer packaging like cartons — are designed for ease of transport and simplicity of logistics, not for reuse, refill, or reprocessing into other useful materials. Furthermore, municipal waste management systems, both formal and informal, are primarily designed to collect and process only those plastics with the highest post-use material demand, like single-layer polyethylene terephthalate (PET) and high-density polyethylene (HDPE). The vast majority of plastics in the global supply never have the opportunity to be recycled, and only a small portion of those collected for recycling are recycled.[82] Recycling plastics — whether mechanical, chemical, or advanced — has repeatedly been proven to be insufficient and ineffective at stopping the global plastics crisis.[83]

Unfortunately, current financial incentives and subsidies perpetuate the system of plastics over-production, under-reuse, and under-recycling.[84] As one analysis made clear, "the extraction of raw materials, landfilling, and incineration are still cheaper alternatives to recycling, recovery of nutrients, or designing for refurbishment."[85] Until plastics companies are required to internalize the actual costs and harms of their produced materials, plastics will remain falsely 'cheap' and, therefore, pervasive as materials and products throughout the economy.

Key frameworks exist for building a more circular economy. They include the waste hierarchy, devised and adopted by global policymakers in the late 20th century, and various models of relationship to resources and place, developed and maintained over many generations in Indigenous communities and those in the Global South. As outlined by the European Union's Waste Framework Directive and other governments and agencies worldwide, the zero-waste hierarchy prioritizes prevention as the first step in waste management. And it relies on the polluter pays principle in policy, if not also in practice.[86]

The waste hierarchy model is not without its shortcomings, including its starting point of waste rather than whole systems,[87] and has been imagined differently by communities and groups around the world.[88] Several models of waste prevention in the Global South and among Black and Indigenous peoples of the Americas emphasize the systemic approach to addressing the problem. They include (re)localizing food systems to avoid unnecessary packaging, often plastic;[89] reevaluating scientific models and methods of knowledge acquisition and value;[90] and shifting our collective understanding of justice,[91] especially as it applies to communities harmed by globalized waste systems. Indeed, the waste hierarchy and circular economy may not be innovative or new ideas, but principles found readily in communities that are often excluded from the political and scientific discourse.[92] Therefore, active participation and representation from those communities is essential when developing crafting policies such as the global plastics treaty.

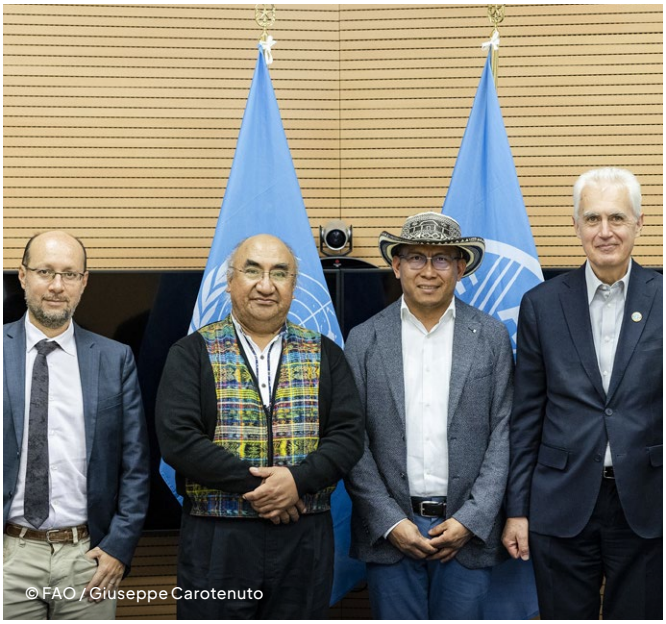
It is necessary for decision makers to approach efforts emphasizing recycling over other systemic approaches to entirely eliminating the need for plastics or single-use with a critical eye.[93]

Any *'solutions'* to plastics pollution that require **continued fossil fuel extraction** or **do not mitigate harms** from the full material life cycle **do not align** with the core circular economy principles of minimizing resource extraction and eliminating negative externalities.

Rather, it is essential to redirect investments, research and development resources, and financial and technical support across countries and regions to designing safe and toxic-free plastics production, product manufacture, and plastic-free delivery systems. Such efforts will help to urgently incentivize the move toward a safe, regenerative, and just circular economy.

Key takeaway: Policies to advance a circular economy must focus first on non-toxic redesign for reuse, rather than normalizing the production of toxic materials and waste.

5. Upholding Human Rights Is Circular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"The circular economy will not be socially just by default."[94] Both the current linear economy and the theorized circular economy face an essential and significant challenge: meeting people's needs while protecting human rights and upholding justice. Plastics across the global supply chain have already wreaked decades of harm and environmental degradation.[95] The public has a right to justice and remedy for that damage. Circularity for any material or resource must be deeply rooted in protection and respect for the lives and livelihoods of all people across the global supply chain and use system. Policy approaches for a circular economy that fail to include principles grounded in justice to prevent future harm will fall short of addressing the crisis.

Plastics production, use, and disposal pose significant threats to human rights. In 2021, the UN Special Rapporteur on toxics and human rights issued a report[96] outlining those threats, which offers a valuable roadmap for the human rights to protect under the label of circularity:

- **Right to information:** People everywhere must be fully and actively informed about plastics' risks, hazards, and harms.[97] This should include, among other things, freely and easily available information on air and water emissions from plastics production; labeling disclosures for plastic products and packaging; and transparency regarding the impacts of local plastic burning, thermal processing, or disposal.
- **Right to full and meaningful participation:** A fully informed public should be actively involved in key decisions at every stage of the circular economy for plastics. This includes: the amount and purpose of plastics resin production; construction of waste management facilities of any kind; and the inclusion of additives in recycled plastics that might be toxic to workers, local communities, or consumers. In particular, Indigenous Peoples have the right to free, prior, and informed consent, as they shall be protected from, among other scenarios, the storage or disposal of hazardous material on their lands.[98]
- **Access to accountability and remedy:** The plastics industry and recyclers should be accountable for the harms wrought by their products and processes along their life cycles.[99] People have a right to remedy for any harm caused, and this remedy should include a global mechanism for liability and compensation. The Special Rapporteur on toxics and human rights' report specifically highlights the need for processes to overcome the fact that "the plastics industry has deliberately spread disinformation on the false promises of recycling in order to delay controls, divert attention to consumer responsibilities and escape effective accountability for the risks and harms posed by plastics."[100]

The right to a clean, healthy, and sustainable environment, recognized by the UN General Assembly in July 2022, will further need to be considered in the (re)design of plastics and materials for circularity. As the UN High Commissioner for Human Rights said, "environmental degradation and climate change [are] interconnected human rights crises,"[101] and the current system of plastics production and use threatens the environment, climate, biodiversity, and human health.

Common principles under international environmental law must also be prioritized in (re)designing plastics for circularity, including:

- **Precautionary approach:** Given the relative lack of public data on most additives and fillers used in plastics, these should be banned unless and until ample evidence indicates their non-toxicity. "A chemically safe circular economy begins with a design of products that reduces material input, avoids the use of toxic chemicals and enables reuse and recycling."[102]
- **Polluter pays:** Regulations that limit toxic additives must complement any system of extended producer responsibility or circular economy for plastics in order to prevent harm to public health. Furthermore, assurance of the quality of life, prevention of harm to the environment, and ecological reparation by the polluting entities are essential for a human rights-based approach to a circular economy.[103]

Key takeaway: The implementation of circularity for all materials in the economy — especially plastics — must ensure that human rights are upheld for all people, with specific care for those made most vulnerable to harm.

A Safe(r) Circular Economy for Plastics

A factsheet recently published by the UN Environment Programme (UNEP) outlines steps toward a "safe(r)" circular economy for plastics. It implies a key takeaway of this briefing: If the world is to prioritize the foundational principles of the circular economy, there can be no role for the continued over-production and use of plastics.[104] These recommendations are instructive as the world transitions to a safe, toxic-free, and human rights-supportive economy. Governments must take the right policy steps to uphold human rights and prevent harm across both the plastics supply chain and full life cycle when considering options to end pollution. A full life cycle approach to plastics, with mandatory global targets for reductions in production and use, can best address the scourge of pollution from plastics.

Safe Supply

Pre-production pellets and plastic products and packaging

- Toxic and hazard free
- Energy efficient
- Regulated renewable feedstocks
- Caps on virgin plastics and plastic products

Safe Supply and Safe Design and Manufacture

Plastic products and packaging

- Toxic and hazard free
- Essential
- Durable
- Reusable
- Recyclable
- Targets for recycled content

Safe Work

Protection of the health, safety, and rights of formal and informal workers along the full lifecycle of plastics (supply, design and manufacture, recycling, tourism, fishing, and retrieval).

Safe Transport

- Standardised protocols, monitoring, and reporting
- Energy efficiency
- Short supply chains
- Reverse logistics

Minimal Leakage

- Minimise material leakage
- Minimise CO_2 emissions
- Minimise toxic chemical emissions

Safe Consumption

- Ecolabelling (inform consumer about toxic content, safe handling, and recycling post-consumption)
- Toxic and hazard free plastics
- Safe, convenient, affordable, and accessible reusables

Safe Recycling

- Hazardous plastic monomers and additives in plastics minimized or removed
- Recyclability and recycled content of materials maximized and targets set
- Targets set to reduce overall volume of plastics materials in circulation
- Toxic chemical, energy, water, and material leakage minimized

Safe Tourism

- Ecolevies
- Bans on single-use plastics on ships and planes
- 'Pack it in; pack it out' policy
- Plastics pollution prevention information
- Incentives for retrieval

Safe Reuse, Refill, Repurpose, and Repair

- Prioritised investment in safe plastic-free delivery systems and products
- Energy and water efficient
- Durability and safety standards
- Short supply chains
- Accessible
- Incentivised
- Affordable
- Non-profit managing agency

Safe Fishing

- Durable fishing gear
- Marked fishing gear
- Incentivised Indigenous plastic-free fishing gear
- Reporting of lost and discarded fishing gear
- Incentivised retrieval and repair
- Regulated fish aggregating devices
- Standardised auditing of plastics onboard
- Container return schemes (e.g., for fish bins)
- Port reception facility upgrades
- Reduced, reused, repaired and recycled plastics in land and sea-based operations

Safe Retrieval

- Standardised protocols, monitoring, and reporting
- Incentivised retrieval
- Energy efficiency
- Port reception facility upgrades
- Repatriation/ safe end-of-life management

Credit: United Nations Environment Programme (2021). A Safe(r) Circular Economy for Plastics in the Pacific Region. https://wedocs.unep.org/20.500.11822/37410.

Conclusion

Circularity is not new. Rather, plastics and the conceptions of single-use are what is new to the economy and the human experience. Despite the relatively recent explosion of plastics into global markets, homes, and environments, plastics' harmful impacts on human health and the environment are more evident every day. The harms from plastics run contrary to widely understood principles of circularity, including notions of resource use reduction, eliminating externalities, and the need to maintain our economy within planetary boundaries that can support thriving human communities.

When considering if and how the concept of circularity can apply to the current design, production, use, and elimination of plastics, it is important to stay grounded in the core principles of a circular economy. **The critical question in policy decisions is not 'how can we build a circular economy for plastics?' but rather 'how can we redesign our economy to reduce the total volume of materials and products in it, and thus to be more circular?'**

Implementing circularity for any plastics in ways true to the original idea of a circular economy would require policies that prioritize minimizing plastics use and eliminating hazards along the supply chain. As this analysis demonstrates, a policy approach that merely emphasizes recycling or burning plastics and allows for their continued mass production is not and cannot be circular. Recycling technologies — both mechanical and advanced — do not effectively replace new plastic feedstocks and have staggeringly low yields.

As the world grapples with the recognition that system changes are underpinning such an approach, numerous competing interpretations of circular economy have been promoted by governments, the plastics industry, and others, some of which merely relabel waste management practices as 'circular.' Such formulations are a function of greenwashing meant to shield the plastics industry from justifiable accountability for the risk their chemical products pose to the environment and the future of our economy.

If policymakers seek to embed principles of circularity into global governance to end plastic pollution and the global plastics crisis, they must do so by returning to the initial intent of circularity and abandoning concepts often erroneously pushed as part of a circular economy. The pillars of a new global agreement on plastics, for instance, must be predicated on restrictions on plastics production and the elimination of toxic chemicals in the plastics supply chain (including whole classes of problematic additives, like bisphenols). Such an agreement should further encompass standards for the fundamental redesign of delivery and manufacturing systems to reduce the demand for plastics, especially (but not limited to) packaging.

To that end, we offer the following recommendations:

- Plastics manufacture and use should be capped by 2025, followed by a managed decline in the annual tonnage of plastics produced.
- Toxic chemicals should be targeted for elimination in the new global agreement on plastics. Efforts should be made to remove them from production and manufacturing processes and along the full life of the material, ensuring that any waste management initiatives do not recirculate or generate new toxic substances and greenhouse gases into the biosphere, thus aggravating the triple planetary crises.
- Toxic, climate-damaging practices for managing plastics waste — such as thermal processing technologies — must not be erroneously characterized as 'circular,' particularly with regard to approaches recommended or mandated by a new global plastics agreement.
- Policies to address the global plastics crisis should prioritize innovations that reduce resource extraction for the production and use of plastics, centering those innovations on just, culturally appropriate alternatives — particularly reuse, refill, repair, and the elimination of unnecessary plastics — before considering waste management options.
- To effectively end plastics pollution, efforts must be made to uphold the rights to information, public participation, access to an effective remedy, and a healthy environment throughout the full, global supply chain of plastics and plastics waste. Governments and the private sector must undertake urgent action to ensure that any communities suffering from the externalities of extraction of feedstocks for plastics, plastics production and manufacture, use, waste management, and disposal have access to adequate remedy and that those harms are stopped.

Endnotes

1. Circle Economy, The Circularity Gap Report 2022, 1 21–25 (2022), https://www.circularity-gap.world/2022#Download-the-report (last visited Aug 31, 2022).
2. End plastic pollution: towards an international legally binding instrument, UNEP/EA.5/Res.14 United Nations Environment Programme 3(b) (2022), https://undocs.org/UNEP/EA.5/Res.14.
3. International Pollutants Elimination Network (IPEN), How the Resolution "End plastic pollution: towards an international legally binding instrument" Relates to Chemicals and Health, (2022), https://ipen.org/sites/default/files/documents/ipen-unea-how-resolution-relates-to-chemicals-v1_2f-en.pdf (last visited Aug 31, 2022).
4. Heloísa Oliveira, Circular economy: From economic concept to legal means for sustainable development, 7 E-Pública - Rev. Electrónica Direito Público 73, 76 (2020), https://www.academia.edu/47653337/Circular_economy_From_economic_concept_to_legal_means_for_sustainable_development.
5. Josef-Peter Schöggl, Lukas Stumpf, & Rupert J. Baumgartner, The narrative of sustainability and circular economy - A longitudinal review of two decades of research, 163 Resour. Conserv. Recycl., 5–6, 10 (2020).
6. Sébastien Sauvé & Sophie Bernard, Environmental sciences, sustainable development and circular economy: Alternative concepts for trans-disciplinary research, 17 Environ. Dev. 48, see discussion on p. 53 (2016).
7. Kenneth Boulding, The Economics of the Coming Spaceship Earth, in Environmental Quality in a Growing Economy 3 (1966), http://www.zo.utexas.edu/courses/thoc/Boulding_SpaceshipEarth.pdf.
8. Linn Persson et al., Outside the Safe Operating Space of the Planetary Boundary for Novel Entities, 56 Environ. Sci. Technol. 1510 (2022).
9. Ellen MacArthur Foundation, The Nature Imperative: How the circular economy tackles biodiversity loss, 17–19 (2021), https://ellenmacarthurfoundation.org/biodiversity-report.
10. Patrick Schröder, Malena Sell, & Tim Forslund, The role of the circular economy in addressing the global biodiversity crisis, CircularEconomy.earth (2021), https://circulareconomy.earth/publications/the-role-of-the-circular-economy-in-addressing-the-global-biodiversity-crisis (last visited Sep 26, 2022).
11. Circle Economy, Thinking Beyond Borders to Achieve Social Justice in a Global Circular Economy, 28 (2022), https://www.circle-economy.com/resources/thinking-beyond-borders-to-achieve-social-justice-in-a-global-circular-economy (last visited Sep 26, 2022).
12. Brieanne Berry et al., Just by design: exploring justice as a multidimensional concept in US circular economy discourse, Local Environ., 3 (2021).
13. Ellen MacArthur Foundation, Our vision for a circular economy for plastics, https://ellenmacarthurfoundation.org/plastics-vision (last visited Aug 31, 2022).
14. American Chemistry Council, 5 Actions for Sustainable Change: Create a Modern Regulatory System to Develop a Circular Economy for Plastics, (2021), https://www.plasticmakers.org/advocacy/five-actions/ (last visited Oct 3, 2022).
15. Josef-Peter Schöggl, Lukas Stumpf, & Rupert J. Baumgartner, supra note 5.
16. Julian Kirchherr, Denise Reike, & Marko Hekkert, Conceptualizing the circular economy: An analysis of 114 definitions, 127 Resour. Conserv. Recycl. 221, 227 (2017). See also: Wood Mackenzie, How can a circular plastics economy grow the oil industry?, (2018), https://www.woodmac.com/news/feature/circular-plastics-economy.
17. Julian Kirchherr, Denise Reike, & Marko Hekkert, supra note 16 at 229.
18. Id. at 226.
19. Winnie W.Y. Lau et al., Evaluating scenarios toward zero plastic pollution, 369 Science 1455, 1458 (2020); Stephanie Borrelle et al., Predicted growth in plastic waste exceeds efforts to mitigate plastic pollution, 369 Science 1515, 1517 (2020). See also: Joe Brock, Valerie Volcovici, & John Geddie, The Recycling Myth: Big Oil's Solution For Plastic Waste Littered With Failure, Reuters, July 29, 2021, https://www.reuters.com/investigates/special-report/environment-plastic-oil-recycling/ (last visited Aug 31, 2022).
20. Innovative pathways to achieve sustainable consumption and production, UNEP/EA.4/Res.1 United Nations Environment Programme 14 (2019), https://undocs.org/UNEP/EA.4/Res.1 (last visited Aug 31, 2022). See also: End plastic pollution, UNEA Res 5/14, supra note 2.
21. D Patel et al., All Talk and No Recycling: An Investigation of the U.S. "Chemical Recycling" Industry, (2020), http://www.doi.org/10.46556/EJQZ7769.
22. See discussion in: Mariann Lloyd-Smith & Joanna Immig, Ocean Pollutants Guide: Toxic Threats to Human Health and Marine Life, (2018), https://ipen.org/documents/ocean-pollutants-guide (last visited Sep 1, 2022).
23. See, for example, co-optation of the term in Christophe Bellmann, The Circular Economy and International Trade: Options for the World Trade Organization, (2021), https://iccwbo.org/publication/the-circular-economy-and-international-trade-options-for-the-world-trade-organization/ (last visited Aug 31, 2022).
24. Trevor Zink & Roland Geyer, Material Recycling and the Myth of Landfill Diversion, 23 J. Ind. Ecol. 541, 6 (2018).
25. Zoé O. G. Schyns & Michael P. Shave, Mechanical Recycling of Packaging Plastics: A Review, 42 Macromol. Rapid Commun. (2020).
26. Roland Geyer et al., Common Misconceptions about Recycling, 20 J. Ind. Ecol. 1010, 1010 (2015).
27. Zoé O. G. Schyns & Michael P. Shave, supra note 25 at 4.
28. Id. at 13; Roland Geyer, Jenna Jambeck, & Kara Lavender Law, Production, use, and fate of all plastics ever made, 3 Sci. Adv., 3 (2017).
29. Simon Hann & Toby Connock, Chemical Recycling: State of Play, (2020), https://chemtrust.org/wp-content/uploads/Chemical-Recycling-Eunomia.pdf (last visited Sep 1, 2022).
30. See: International Pollutants Elimination Network (IPEN), Plastic's toxic additives and the circular economy, (2020), https://ipen.org/sites/default/files/documents/plastics_and_additives_final-low-o-en.pdf (last visited Aug 31, 2022).
31. Winnie W.Y. Lau et al., supra note 19 at 1458; Stephanie Borrelle et al., supra note 19 at 1517.
32. Megan Quinn, ISRI rejects 'advanced recycling' label, says plastic-to-fuel projects should not count as recycling, WasteDive, August 20, 2022, https://www.wastedive.com/news/isri-chemical-advanced-recycling-policy-plastic/629343/ (last visited Oct 4, 2022).
33. Zero Waste Europe, Sustainable Finance for a Zero Waste Circular Economy, 7 (2020), https://zerowasteeurope.eu/wp-content/uploads/2020/11/zero_waste_europe_report_sustainable-finance-for-a-zero-waste-circular-economy_en.pdf (last visited Aug 31, 2022).
34. See for example: Max Liboiron, Waste Colonialism, Discard Studies (2018), https://discardstudies.com/2018/11/01/waste-colonialism/ (last visited Aug 31, 2022); Kamanamaikalani Beamer et al., Reflections on Sustainability Concepts: Aloha 'Āina and the Circular Economy, 13 Sustainability 2984 (1 (2021); Laura Siragusa & Dmitry Arzyutov, Nothing goes to waste: sustainable practices of re-use among Indigenous groups in the Russian North, 43 Curr. Opin. Environ. Sustain. 41 (2020). End plastic pollution, UNEA Res 5/14, supra note 2. also makes specific reference to local, traditional, and Indigenous knowledge systems, putting them on par for inclusion and consideration with the "best available science" (para 4(d)).
35. See: Center for International Environmental Law et al., Plastic & Health, (2019), https://www.ciel.org/plasticandhealth/ (last visited Aug 31, 2022); Okunola A Alabi et al., Public and Environmental Health Effects of Plastic Wastes Disposal: A Review, 5 J. Toxicol. Risk Assess. (2019).
36. International Pollutants Elimination Network (IPEN), supra note 30.
37. Zhanyun Wang, Helene Wiesinger, & Ksenia J. Groh, Time to Reveal Chemical Identities of Polymers and UVCBs, 55 Environ. Sci. Technol. 14473.
38. Health and Environment Alliance (HEAL), Turning the Plastic Tide: The Chemicals in Plastic that Put Our Health at Risk, 7–8 (2020), https://www.env-health.org/turning-the-plastic-tide-the-chemicals-in-plastic-that-put-our-health-at-risk/ (last visited Oct 3, 2022).
39. Marcos Orellana, United Nations Special Rapporteur on the implications for human rights of the environmentally sound management and disposal of hazardous substances and wastes: The stages of the plastics cycle and their impacts on human rights, 8 (2021), https://undocs.org/A/76/207.
40. John N. Hahladakisa et al., An overview of chemical additives present in plastics: Migration, release, fate and environmental impact during their use, disposal and recycling, 344 J. Hazard. Mater. 179, 184 (2018).
41. Id. at 187. See also discussion and additional resources in Helene Wiesinger, Zhanyun Wang, & Stefanie Hellweg, Deep Dive into Plastic Monomers, Additives, and Processing Aids, 55 Environ. Sci. Technol. 9339 (2021).
42. Okunola A Alabi et al., supra note 35 at 3–4.
43. Jane Muncke, Tackling the toxics in plastics packaging, 19 PLoS Biol., 3 (2021).
44. Food Packaging Forum, Dossier – Non-intentionally added substances (NIAS), (2018), https://doi.org/10.5281/zenodo.1265331.
45. Helene Wiesinger, Zhanyun Wang, & Stefanie Hellweg, supra note 41 at 9339.
46. See: Ksenia J. Groh et al., Overview of known plastic packaging-associated chemicals and their hazards, 651 Sci. Total Environ. (2018).
47. See: Id.
48. See: Center for International Environmental Law et al., supra note 35.
49. Sascha Fuller et al., Plastics pollution as waste colonialism in Te Moananui, 29 J. Polit. Ecol. 534 (2022).
50. Ingrid Waldron, Re-thinking waste: mapping racial geographies of violence on the colonial landscape, 4 Environ. Sociol. 36, 40 (2018).

51. See discussion in Okunola A Alabi et al., supra note 35. See also discussion in Center for International Environmental Law et al., supra note 35 at 43–49.
52. Lee Bell & Hideshige Takada, Plastic Waste Management Hazards, 75 (2021), https://ipen.org/sites/default/files/documents/ipen-plastic-waste-management-hazards-en.pdf (last visited Aug 31, 2022).
53. Joseph DiGangi, Jitka Strakova, & Lee Bell, POPS Recycling Contaminates Children's Toys with Toxic Flame Retardants, 8 (2017), https://ipen.org/sites/default/files/documents/toxic_toy_report_2017_update_v1_5-en.pdf.
54. Id. at 14.
55. See Diana Barrowclough, Carolyn Deere Birkbeck, & Julien Christen, Global trade in plastics: insights from the first life-cycle trade database (UNCTAD Research Paper No. 53, UNCTAD/SER.RP/2020/12) (2020), https://unctad.org/system/files/official-document/ser-rp-2020d12_en.pdf (last visited Aug 31, 2022).
56. Center for International Environmental Law et al., Plastic & Climate, 18–19 (2019), https://www.ciel.org/plasticandclimate/ (last visited Aug 31, 2022).
57. Fiona Harvey, No new oil, gas or coal development if world is to reach net zero by 2050, says world energy body, The Guardian, May 18, 2021, https://www.theguardian.com/environment/2021/may/18/no-new-investment-in-fossil-fuels-demands-top-energy-economist (last visited Aug 31, 2022).
58. D Charles, L Kimman, & N Saran, The Plastic Waste Makers Index, 40–41 (2021), https://cdn.minderoo.org/content/uploads/2021/05/27094234/20211105-Plastic-Waste-Makers-Index.pdf (last visited Aug 31, 2022).
59. See: Wood Mackenzie, supra note 16.
60. Center for International Environmental Law et al., supra note 35.
61. Jim Vallette, The New Coal: Plastics & Climate Change, (2021), https://www.beyondplastics.org/plastics-and-climate (last visited Aug 31, 2022).
62. European Investment Bank, The EIB Circular Economy Guide: Supporting the circular transition, (2020), https://doi.org/10.2867/578286 (last visited Aug 31, 2022).
63. See: United Nations Environment Program, Technical Guidelines on Co-Processing of Hazardous Wastes in Cement Kilns, UNEP/CHW.10/6/Add.3/Rev.1, 8 (2011), http://www.basel.int/COP10/Documents/tabid/2311/Default.aspx (last visited Aug 31, 2022).
64. Greenpeace, Deception by the Numbers, 10–15 (2020), https://www.greenpeace.org/usa/research/deception-by-the-numbers.
65. Trevor Zink and Roland Geyer, supra note 24.
66. See: Okunola A Alabi et al., supra note 35; Ksenia J. Groh et al., supra note 46; Simon Hann & Toby Connock, supra note 29; Ombretta Paladino & Arianna Moranda, Human Health Risk Assessment of a pilot-plant for catalytic pyrolysis of mixed waste plastics for fuel production, 405 J. Hazard. Mater. (2021).
67. See discussions in: Ombretta Paladino & Arianna Moranda, Human Health Risk Assessment of a pilot-plant for catalytic pyrolysis of mixed waste plastics for fuel production, 405 J. Hazard. Mater. (2021); Harish Jeswani et al., Life cycle environmental impacts of chemical recycling via pyrolysis of mixed plastic waste in comparison with mechanical recycling and energy recovery, 769 Sci. Total Environ., 8 (2021); and Jumoke Mojisola Oladejo & Andrew Neil Rollinson, Chemical Recycling: Status, Sustainability, and Environmental Impacts, (2020), http://dx.doi.org/10.46556/ONLS4535 (last visited Aug 31, 2022); Onwughara Innocent Nkwachukwu et al., Focus on potential environmental issues on plastic world towards a sustainable plastic recycling in developing countries, 4 Int. J. Ind. Chem., 10 (2013), https://link.springer.com/article/10.1186/2228-5547-4-34.
68. See discussions in: Ombretta Paladino & Arianna Moranda, Human Health Risk Assessment of a pilot-plant for catalytic pyrolysis of mixed waste plastics for fuel production, 405 J. Hazard. Mater. (2021).; Harish Jeswani et al., Life cycle environmental impacts of chemical recycling via pyrolysis of mixed plastic waste in comparison with mechanical recycling and energy recovery, 769 Sci. Total Environ., 8 (2021).; and Jumoke Mojisola Oladejo & Andrew Neil Rollinson, Chemical Recycling: Status, Sustainability, and Environmental Impacts, (2020), http://dx.doi.org/10.46556/ONLS4535 (last visited Aug 31, 2022); Onwughara Innocent Nkwachukwu et al., Focus on potential environmental issues on plastic world towards a sustainable plastic recycling in developing countries, 4 Int. J. Ind. Chem., 10 (2013), https://link.springer.com/article/10.1186/2228-5547-4-34.
69. NRDC, Recycling Lies: "Chemical Recycling" of Plastic is Just Greenwashing Incineration, 5–6 (2022), https://www.nrdc.org/sites/default/files/chemical-recycling-greenwashing-incineration-ib.pdf (last visited Oct 4, 2022).
70. Lee Bell & Hideshige Takada, supra note 52.
71. Simon Hann & Toby Connock, supra note 29 at 27.
72. See: Center for International Environmental Law et al., supra note 56 at 62.
73. International Chemical Secretariat, The promised land of chemical recycling is clouded by shortcuts like mass balance and book & claim, (2021), https://chemsec.org/the-promised-land-of-chemical-recycling-is-clouded-by-shortcuts-like-mass-balance-and-book-claim/ (last visited Aug 31, 2022).
74. Center for International Environmental Law, Plastic is Carbon: Unwrapping the "net zero" myth, (2021), https://www.ciel.org/reports/plastic-is-carbon-unwrapping-the-net-zero-myth/ (last visited Sep 1, 2022).
75. Frederic Gallo et al., Marine litter plastics and microplastics and their toxic chemicals components: the need for urgent preventive measures, 30 Environ. Sci. Eur. (2018).
76. Lauren Phipps, The Wild West of plastic credits and offsets, GreenBiz (2021), https://www.greenbiz.com/article/wild-west-plastic-credits-and-offsets (last visited Aug 31, 2022).
77. WWF, WWF Position: Plastic Crediting and Plastic Neutrality, 3–4 (2021), https://c402277.ssl.cf1.rackcdn.com/publications/1429/files/original/newWWF_Position_on_Plastic_Crediting_and_Plastic_Neutrality_.pdf?1611957221 (last visited Aug 31, 2022).
78. Winnie W.Y. Lau et al., supra note 19 at 1458; Stephanie Borrelle et al., supra note 19 at 1517.
79. Ruth Jebbe, The U.S. Plastics Problem: The Road to Circularity, 52 Environ. Law Report. 10018, 10029 (2022), https://www.elr.info/sites/default/files/files-general/52.10018.pdf.
80. International Chemical Secretariat, The missing piece: Chemicals in Circular Economy, 9 (2019), https://chemsec.org/app/uploads/2019/03/The-missing-piece_190313.pdf.
81. See: Circular Claims Fall Flat: Comprehensive U.S. Survey of Plastics Recyclability, https://www.greenpeace.org/usa/wp-content/uploads/2020/02/Greenpeace-Report-Circular-Claims-Fall-Flat.pdf.
82. Roland Geyer, Jenna Jambeck, & Kara Lavender Law, supra note 28 at 3.
83. See: Winnie W.Y. Lau et al., supra note 19; Stephanie Borrelle et al., supra note 19; Lee Bell & Hideshige Takada, supra note 52.
84. As the 2020 report from Nordic Council of Ministers highlighted, "the trade impacts of fossil fuel subsidies are not only felt in fossil fuel markets but also in the markets for energy-intensive products that rely on fossil fuel products as an important input, such as fertilizers and plastics... Fuel subsidies can affect underlying market conditions that can block the emergence and dissemination of alternative, potentially non-like products and services." from Harro van Asselt & Tom Moerenhout, Fit for Purpose? Toward trade rules that support fossil fuel subsidy reform and the clean energy transition, 17 (2020), http://dx.doi.org/10.6027/temanord2020-539.
85. Heloísa Oliveira, supra note 4 at 83.
86. European Commission, Waste Framework Directive, https://environment.ec.europa.eu/topics/waste-and-recycling/waste-framework-directive_en (last visited Aug 31, 2022).
87. S. Van Ewijk & J.A. Stegemann, Limitations of the waste hierarchy for achieving absolute reductions in material throughput, 132 J. Clean. Prod. 122, 125 (2016).
88. For discussion on this reimagining in the Maori context, see: Trisia Farrelly, Stephanie Borrelle, & Sascha Fuller, The Strengths and Weaknesses of Pacific Islands Plastic Pollution Policy Frameworks, 13 Sustainability, 16–17 (2021).
89. Tina Ngata & Mix Liboiron, A Māori Approach to Starting Research from Where You Are, 7 Catal. Fem. Theory Technoscience 1, 5 (2021), https://catalystjournal.org/index.php/catalyst/article/view/37648/28656 (last visited Aug 31, 2022).
90. Deborah McGregor, Indigenous Environmental Justice, Knowledge, and Law, 5 Kalfou 279, 281 (2018).
91. See: Deborah McGregor, Steven Whitaker, & Mahisha Sritharan, Indigenous environmental justice and sustainability, 32 Curr. Opin. Environ. Sustain. 35 (2020).
92. Laura Siragusa & Dmitry Arzyutov, supra note 34 at 44–45.
93. Christophe Bellmann, supra note 23.
94. Circle Economy, supra note 11 at 5.
95. Center for International Environmental Law, Earthworks, & Center for Biological Diversity, Formosa Plastics Group: A Serial Offender of Environmental and Human Rights (A Case Study), 65 (2021), https://www.ciel.org/reports/formosa-plastics-group-a-serial-offender-of-environmental-and-human-rights/ (last visited Oct 5, 2021); United Nations Environment Programme, Neglected: Environmental Justice Impacts of Marine Litter and Plastic Pollution, 10–11 (2021), https://wedocs.unep.org/handle/20.500.11822/35417 (last visited Sep 1, 2022); Max Liboiron, supra note 34.
96. See in depth: Orellana, supra note 39.
97. Id. at 18.
98. Id. at 19.
99. United Nations Environment Programme, supra note 95 at 51.
100. Orellana, supra note 39 at 19–20.
101. Access to a healthy environment, declared a human right by UN rights council, United Nations News, October 8, 2021, https://news.un.org/en/story/2021/10/1102582 (last visited Sep 1, 2022).
102. Orellana, supra note 39 at 21.
103. Id.
104. United Nations Environment Programme, A Safe(r) Circular Economy for Plastics in the Pacific Region, (2021), https://wedocs.unep.org/20.500.11822/37410 (last visited Sep 1, 2022

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