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FACT SHEET

THE WORST OF THE WORST:
HIGH-PRIORITY PLASTIC MATERIALS, CHEMICAL ADDITIVES, AND PRODUCTS TO PHASE OUT

Plastic waste is everywhere in the modern world. An estimated 242 million metric tons of it is generated globally every year, polluting our cities and our bodies and clogging the oceans, and the United States is one of the top generators.[1] Plastic pollution has been linked to everything from infertility and cancer in humans to severe injury and death in wildlife.[2] Front-line communities are being particularly impacted by toxic air and water pollutants emitted by plastic production and disposal facilities.[3]

Ninety-nine percent of all plastics are made from fossil fuels and contribute to toxic pollution throughout their life cycle.[4] During use and recycling, or when discarded into the environment, plastics shed and break down into microplastics—tiny pieces less than 5 millimeters long—that are suspected to pose digestive, reproductive, and respiratory hazards.[5] Many plastics can also leach harmful compounds into our food, water, and environment both during everyday use and at the end of their life.[6]

We will never put an end to the plastics crisis without reducing the amounts of plastic and toxic additives we put into the world. We should start by immediately phasing out the production and use of plastic polymers, chemical additives, and types of plastic products that pose the greatest hazards and/or are unnecessary. For uses or functions of plastic that are currently essential, we must transition to safer materials.[7]

Pieces of discarded plastic, including shopping bags, floating in the ocean.

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The types of plastics, additives, and products covered in this fact sheet have one or more of the following characteristics:

- They pose significant hazards to human health and the environment.
- They are difficult to recycle and/or interfere with mechanical recycling systems.
- They are unnecessary.

We should immediately phase out these high-priority targets.

Some of these materials, products, and additives have already been recognized as problematic and/or unnecessary by the international voluntary public–private initiative known as the Plastic Pact, which focuses on reducing plastic pollution from packaging (see Appendix).[8] Companies that have signed on to regional Plastic Pacts commit to voluntarily eliminating the plastic products they consider problematic and/or unnecessary. While helpful, it should be noted that the Plastic Pact is heavily influenced by industry and has overlooked concerns related to plastic's health, toxicity, and life cycle impacts. The Pact is also voluntary, so there is little accountability when companies fail to meet their commitments, which consistently happens.[9]

Instead, we need binding policies at the international, federal, state, and local levels that require source reduction (producing and using less plastic), quickly phase out the most problematic forms of plastic, promote nontoxic reuse and refill systems, and ensure that all materials are safe and sustainable by design.

HIGH-PRIORITY PLASTIC POLYMERS

All plastics are polymers—that is, their chemical structure is made of repeating units, called monomers, like beads on a necklace. The high-priority polymers identified here are made of particularly toxic monomers, are not safely and readily recyclable, and some have additional concerns. The toxicity issues detailed below are inherent to these chemistries, whether they are made from fossil-fuel or bio-based feedstocks. For example, bio-based polyvinyl chloride poses the same toxicity concerns as polyvinyl chloride made from fossil fuels.

Polyvinyl chloride and polyvinylidene chloride

About: Polyvinyl chloride (PVC), used in many products including packaging, flooring, and construction materials, is widely considered to have the most toxic life cycle of all plastics.[10] A lesser-known but related compound called PVDC (polyvinylidene chloride) is frequently used as food-contact shrink wrap and in other packaging applications.[11]

Concerns: PVC and PVDC are made from the monomer vinyl chloride, a known carcinogen linked to toxic effects in nearly every major organ system.[12] Both PVC and PVDC often contain toxic additives like phthalates (see chemical additives section, below). Highly toxic chemical compounds called dioxins are created when PVC and PVDC are produced or burned. The 2023 train derailment in East Palestine, Ohio, released and burned five rail cars' worth of vinyl chloride, with serious health and environmental impacts on the surrounding community.[13] PVC is recognized as problematic/unnecessary by Plastic Pacts in the United States, Chile, France, Kenya, Poland, Portugal, South Africa, and the United Kingdom; PVDC is similarly recognized by several Plastic Pacts, including the U.S. Pact.

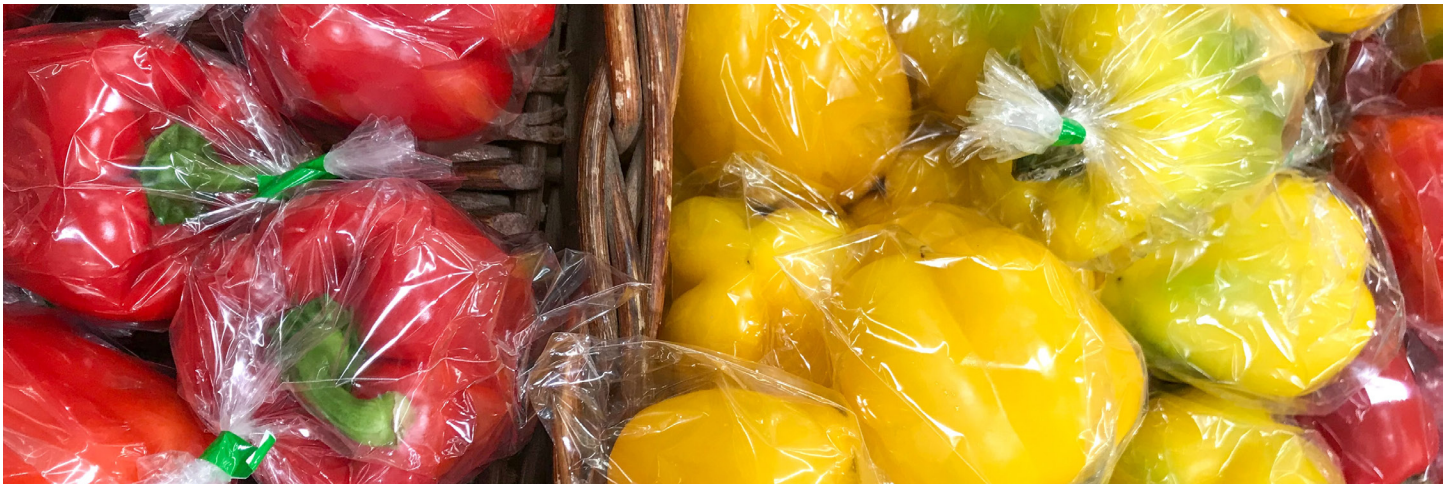
Safely and readily recyclable? No.

Polystyrene

About: Polystyrene plastic can take many forms, including rigid polystyrene, extruded polystyrene foam (XPS), and expanded polystyrene foam (EPS). It is used to make packaging, single-use foodware (plates, cutlery, food containers, etc.), and insulation, as well as other products.

Concerns: All forms of polystyrene are made from the monomer styrene, which is a known carcinogen.[14] EPS is one of the most common forms of plastic litter and causes significant wildlife impacts.[15] It is recognized as problematic/unnecessary by Plastic Pacts in the United States, Chile, France, Kenya, Poland, Portugal, and the United Kingdom.

Safely and readily recyclable? No.



Bell peppers wrapped in unnecessary plastic at a supermarket.

Polycarbonate:

About: This hard plastic is used in 3D printing, as well as to make packaging, water bottles, foodware, building materials, and other goods.

Concerns: Polycarbonate is made from monomer bisphenol chemicals such as bisphenol A (BPA) or similar compounds. Bisphenols are hormone disruptors linked to infertility, cancer, diabetes, metabolic disorders, and other health effects.[16]

Safely and readily recyclable? No.

Polyurethanes:

About: These are used for many applications, including foam insulation, furniture cushions, coatings, sealants, and adhesives.

Concerns: Polyurethanes are made from monomers called diisocyanates (such as methylene diphenyl diisocyanate, or MDI), which are respiratory-tract sensitizers and the leading cause of work-related asthma.[17] Diisocyanates are also skin and immune sensitizers, meaning that they can cause skin inflammation and other kinds of allergic responses.[18]

Safely and readily recyclable? No.

Melamine:

About: Melamine formaldehyde, often called simply melamine, is a resin (sometimes mixed with bamboo) that is used to make reusable foodware such as cups and plates, as well as flooring, laminated surface finishes, and foam insulation.

Concerns: Melamine is made from the monomer formaldehyde, a known carcinogen.[19] The German government has found that formaldehyde can migrate from melamine tableware at levels of concern to human health.[20]

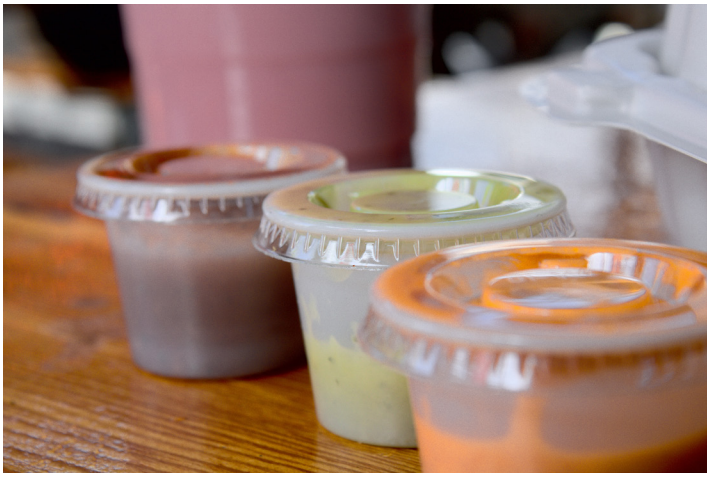
Safely and readily recyclable? No.

HIGH-PRIORITY CONCERN: PFAS + PLASTIC

Toxic PFAS (per- and polyfluoroalkyl substances) are known as "forever chemicals" due to their tendency to remain in the environment for decades, centuries, or millennia. PFAS are associated with plastic in several ways (described below), all of which are of concern. PFAS are harmful even at ultralow levels and are linked with cancer, hormone disruption, liver and thyroid problems, interference with vaccine effectiveness, reproductive harm, and abnormal fetal development. They contaminate water, human bodies, and wildlife worldwide.[21] PFAS compounds that are intentionally added to plastic packaging or used during its manufacture have been listed as problematic/unnecessary by the U.S. Plastic Pact.

All uses of PFAS in plastic are of high concern, including:

- **PFAS processing aids:** PFAS is used as a processing aid in plastic production, which can lead to PFAS emissions and contamination during the manufacturing process.[22]
- **PFAS-based plastics:** Some plastics are actually forms of PFAS, including fluoropolymers and side-chain fluorinated polymers. PFAS-based plastics are used in many applications including nonstick cookware, clothing, building materials, and personal-care products and are not safely or readily recyclable. Manufacturing them creates toxic PFAS pollution and can also emit climate super-pollutants (greenhouse gases with hundreds to thousands of times the heat-trapping power of carbon dioxide) and ozone-destroying substances. For example, HCFC-22 (hydrochloroflurocarbon-22), a major feedstock chemical for certain fluoropolymers, is an ozone destroyer and potent greenhouse gas with 1,760 times the global warming potential of carbon dioxide.[23]
- **Fluorinated plastics:** Some ordinary plastics—especially high-density polyethylene (HDPE) plastic packaging—are treated with fluorine gas to alter their material properties, such as permeability. Research by the U.S. Environmental Protection Agency and other laboratory testing have shown that the fluorination process creates toxic PFAS that can leach into the contents of fluorinated plastic containers.[24]



Single use plastic condiment containers at a restaurant.

HIGH-PRIORITY PLASTIC PRODUCTS

Some products are of concern no matter what type of polymer or materials they are made of and regardless of whether they can be readily recycled. They are simply unnecessary and harmful and should not be produced or used.

- **Single-use plastics:** Half of all plastic produced is for throwaway items like disposable or single-use cups, straws, and bags; yet plastic takes hundreds of years, and in some cases even longer, to fully degrade.[25] The production, use, and disposal of single-use plastics have well-documented impacts on human health, animal health, air, water, and climate.[26] A variety of single-use plastic products have been listed as problematic/unnecessary by Plastic Pacts in the United States, Chile, France, Kenya, Poland, Portugal, South Africa, and the United Kingdom.

- **So-called "Oxo-degradable" plastics:** This is a greenwashing term referring to plastics made with chemical additives said to help fragment them into tiny pieces. These pieces don't actually degrade but simply remain in the environment as microplastics.[27] And these plastics can interfere with recycling.[28] They are listed as problematic/unnecessary by Plastic Pacts in the United States, Kenya, Portugal, South Africa, and the United Kingdom.
- **So-called "Biodegradable" plastics:** Most consumers interpret *biodegradable* to mean that products will completely break down and return to nature in a reasonable time frame. However, in part because the term doesn't have a clear definition, plastics labeled as biodegradable often aren't.[29] In reality, plastic products claiming to be biodegradable may persist in the environment long enough to constitute litter, blight, and/or a danger to land-based and marine animals that may ingest or become entangled in these products.[30]
- **Intentionally added microplastics:** Microplastics are commonly added to personal-care products, cleaning products, paints, polishes, and other goods. They get washed down the drain or weathered away and eventually end up in the environment.[31] While all plastics eventually break down into microplastics, the intentional addition of microplastics is both unnecessary and problematic, especially given that alternatives are available. They are listed as problematic/unnecessary by the South Africa Plastic Pact.

HIGH-PRIORITY TOXIC CHEMICAL ADDITIVES USED IN PLASTIC

Many thousands of chemicals are commonly added to plastics to improve their physical properties.[32] These additives are found in all types of polymers/materials and all types of products, including packaging, textiles, and building materials. The additives identified here are known toxic chemicals that present significant risks to human and environmental health. The toxicity concerns detailed below are inherent to these chemistries, whether they are made from fossil-fuel or bio-based feedstocks.

- **Ortho-phthalates:** Added as plasticizer chemicals to make plastic softer or more flexible, ortho-phthalate chemicals are linked to a wide range of health effects including developmental and reproductive problems, cancer, obesity, hormone disruption, cardiovascular disease, and early mortality.[33]
- **Bisphenols:** Chemicals like bisphenol A (BPA) are basic building blocks for polycarbonate plastics and epoxy resins; they are also used as additives in PVC plastic and some kinds of synthetic textiles.[34] Bisphenols can cause cancer, reproductive harm, cardiovascular disease, and diabetes.[35]
- **Halogenated flame retardants:** Added to plastic to reduce flammability, these chemicals are now global contaminants linked to cancer, reduced IQ, hyperactivity, and harm to wildlife.[36] While chemical flame retardants may sometimes be needed, fire safety can often be better achieved through alternative, less toxic means.[37]
- **UV-328 and related UV stabilizers:** Used to protect plastic from UV light, these persistent, bioaccumulative, and toxic chemicals can cause liver and kidney damage and disrupt hormones.[38] UV-328 has been recommended for global phase-out under the Stockholm Convention.[39] UV-328 is also a member of a larger chemical class raising similar environmental concerns.
- **Perchlorate:** An antistatic agent used in plastic, perchlorate is a hormone disruptor that interferes with proper functioning of the thyroid gland. It has also been linked to impaired brain development.[40]
- **Benzophenone and related chemicals:** This common UV-blocking plastic additive has been linked to cancer and hormone disruption and banned for some food contact uses.[41] Several chemical derivatives of benzophenone pose health and aquatic toxicity concerns.[42]
- **Heavy metals:** Heavy metals such as lead, mercury, cadmium, and hexavalent chromium are highly toxic compounds linked to a wide range of health conditions including impaired brain development, cardiovascular disease, and cancer.[43] Some heavy metals are used intentionally as catalysts, pigments, and stabilizers in plastic production; and in other cases heavy metals can contaminate the plastic production process.[44]
- **Nonylphenols:** Nonylphenols are used as antioxidants, stabilizers, and plasticizers in many kinds of plastic products, including food containers.[45] They can migrate from these products into water and food; if ingested they can cause hormone disruption and impair fertility in humans, and they are highly toxic to aquatic life.[46]
- **Chlorinated paraffins:** Chlorinated paraffins—persistent, bioaccumulative, toxic chemicals used as plasticizers and flame retardants—pose serious aquatic toxicity concerns.[47] Certain forms have already been banned, but others remain in use.[48]
- **Antimicrobials:** Added to make plastic resistant to microbial growth, many antimicrobials are toxic and hazardous and can cause hormone disruption, skin sensitization, and aquatic toxicity. Some of the most concerning antimicrobials are triclosan, organotin compounds, arsenic compounds, and quaternary ammonium compounds.[49]

A worker holding plastic pellets at a factory.

HIGH-PRIORITY PRODUCT DESIGNS THAT INTERFERE WITH RECYCLING

While some plastics such as the polymers identified above are not readily recyclable, other types of plastics are. Yet, among these recyclable plastics, there are products whose design interferes with the ability to safely and readily recycle them. The product designs below are unnecessary and cause the entire product to not be recycled or cause contamination of recycled plastic.

- **Non-detectable pigments added to plastic:** Black plastic can't be recognized by the sorting equipment used by most recycling facilities; even when sorted it has a limited resale market and is of very low value. Virtually all black plastic, therefore, ends up being landfilled or incinerated.[50] Some other dark-colored plastics face the same issues.[51] Additionally, the plastic coloring agent known as "carbon black" is carcinogenic when inhaled and is a major source of polycyclic aromatic hydrocarbons (PAHs), also carcinogens, in plastic.[52] Non-detectable pigments such as carbon black are listed as problematic/unnecessary by the Plastic Pacts in the United States, France, Poland, Portugal, and the United Kingdom.
- **Packaging made from PETG:** Polyethylene terephthalate glycol (PETG) is a plastic used in packaging that is similar to, but distinct from, the polyethylene terephthalate (PET) that is commonly used in single-use soda and water bottles. Separating the two plastics during recycling is difficult. Because its melting point is different from that of traditional PET, PETG contamination decreases recycled PET quality and disrupts recycling equipment.[53] It is listed as problematic/unnecessary by Plastic Pacts in the United States and Kenya.
- **Opaque or pigmented PET bottles:** Since recycling markets are strong only for clear PET, recyclers typically discard colored and opaque bottles, which then get sent to landfills or incinerators. These bottles are listed as problematic/unnecessary by Plastic Pacts in the United States and France.
- **Problematic label chemistries:** Labels made from certain materials including PVC and PETG can create issues for recycling, decreasing recycled plastic quality and sometimes creating harmful by-products.[54] Even tiny concentrations of PVC can lead to toxic benzene contamination in recycled PET, for example.[55] These labels are listed as problematic/unnecessary by Plastic Pacts in the United States and Kenya.

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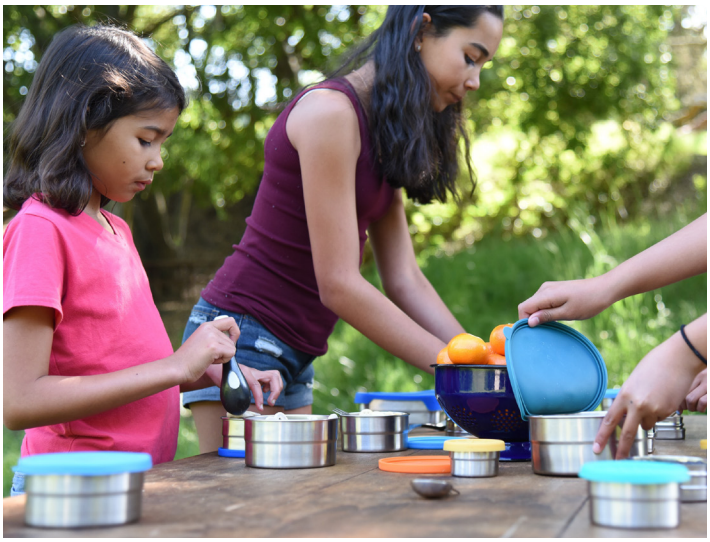
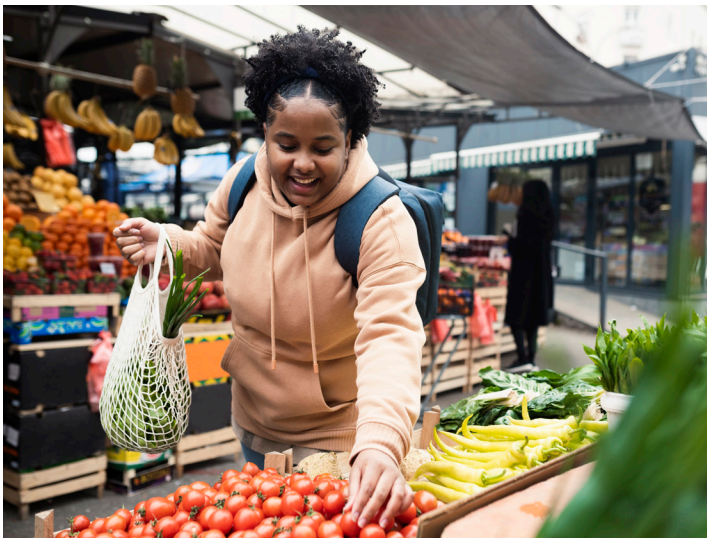


A group enjoying a zero-waste picnic using reusable foodware.

Getty Images ©



A young adult with a reusable bag buying vegetables at a market.

ALTERNATIVES EXIST FOR HIGH-PRIORITY PLASTICS, ADDITIVES, AND PRODUCTS

Safer alternatives are available for many uses of the very worst plastic materials, additives, and products. Below are just a few examples of how elimination is indeed possible:

PVC: Several countries and many corporations have banned or restricted the use of PVC in packaging, demonstrating that safer alternative materials are available and already in use.[56] Many safer and affordable alternatives also exist for the toxic PVC flooring being marketed as "luxury vinyl tile" such as linoleum and ceramic tile.[57]

PFAS: The European Union has identified safer alternatives for many uses of PFAS in plastic and has proposed banning all forms of PFAS, including plastic processing aids and PFAS-based polymers.[58]

Single-use plastics: Nontoxic reuse and refill systems are replacing certain types of single-use plastics, especially in food packaging and foodware, and we need to expand these systems.[59] Important reductions in single-use plastic can also be achieved through the elimination of unnecessary packaging.

POLICY RECOMMENDATIONS

To protect the health of communities on the front lines of plastic production and disposal, as well as the general public, wildlife, and ecosystems, we need mandates on the international, federal, state, and local policy levels that stem the tide of plastic production, starting with phasing out the high-priority targets identified here. Policies at all levels should aim to:

- Reduce and eliminate where possible production and use of single-use plastics
- Ban high-priority problematic plastic materials, additives, and product designs in favor of safer alternatives
- End government purchasing of single-use plastics
- Prioritize plastic reduction over increased plastics recycling
- Promote nontoxic refill and reuse systems
- Invest in research on chemicals and materials that are safe and sustainable by design
- Mandate full product and chemical transparency for plastics
- Prohibit misleading recyclability and degradability claims

Implementing these policies will start to transform our systems of materials production, use, and disposal from those that harm communities and the environment to those that instead support people's health and ability to thrive.

APPENDIX: SUMMARY OF COMPONENTS DEEMED TO BE PROBLEMATIC/UNNECESSARY BY NATIONAL PLASTIC PACTS

Problematic/Unnecessary Plastics, Additives, Products, and Product Designs	National Plastic Pacts							
	United States	Chile	France	Kenya	Poland	Portugal	South Africa	United Kingdom
Polyvinyl chloride (PVC)	X	X	X	X	X	X	X	X
Polystyrene	X	X	X	X	X	X		X
Intentionally added PFAS	X							
Single-use plastics	X	X	X	X	X	X	X	X
"Oxo-degradable" plastics	X			X		X	X	X
Intentionally added microplastics							X	
Non-detectable pigments	X		X		X	X		X
PETG in rigid packaging	X			X				
Opaque or pigmented PET bottles	X		X					
Problematic label chemistries	X			X				

Source: Ellen MacArthur Foundation.[60]

ENDNOTES

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