Plastics:
From Innovation to Catastrophe

A policy note from
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SUMMARY

The overabundance of plastics has contributed to global challenges, such as climate change, plastics pollution and a rise in health problems. It has also posed ethical concerns, as a result of its connection to fossil fuels, the widespread misinformation about recycling and the placement of petrochemical facilities in marginalized communities. The production of more plastics will manifest into more problems, so it is imperative that regulations are established to cover the entire plastics life cycle, prioritizing environmental justice and the elimination of harmful chemicals.

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I. Plastics: Everything and Everywhere

Plastics are some of the most widely used and versatile products in the world. They can be molded into countless forms: soda bottles, phones, medical syringes and clothing. Within the last 150 years, plastics have revolutionized the production of consumer and commercial goods. Humans produced 8.3 billion tons of plastic from 1950 to 2015—half of which was generated in the last 13 years of this period.[1]

Unfortunately, this revolution was already well underway before researchers and advocates could raise the alarm over the unprecedented hazards that plastics pose to environmental and human wellbeing at all stages of their life cycle, from production, to distribution, to disposal.

Prior to the development of synthetic plastics in the nineteenth century, plant cellulose, elephant ivory and hawksbill turtle shells[2] were frequently used for products that needed to be shaped or molded. But fears of dwindling supplies ignited the search for alternatives. In 1863, the New York-based company Phelan & Colander offered a $10,000 reward[3] (worth nearly $250,000 today) to anyone who could develop an alternative to the elephant ivory that was used to make billiard balls.

Hoping to win the prize, John Wesley Hyatt, a serial inventor, created celluloid, considered to be the first artificial plastic.[4]

Although this was a major step, it wasn't until 1906 that Leo Baekeland derived plastic from phenol, an acid found in coal tar. This new plastic, dubbed "Bakelite," was the first fully synthetic plastic that was heat resistant, easily molded and cheap to manufacture on a commercial scale. The industry grew dramatically with electrification, and by the 1930s, researchers had commercially developed a host of new plastics: polystyrene, polyvinyl chloride, acrylic, nylon and polyethylene. During World War II, the burgeoning plastics industry expanded even further, mobilizing to meet military production needs. Plastics were ideal for military equipment, and were used to make everything from ropes and parachutes to helmet liners, body armor and plexiglass for aircrafts.[5] During the war, U.S. plastics production increased by 300%. In the postwar period, the plastics industry found its next market: consumer goods.[6]

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Today, broadly defined, plastics are materials made from polymers—long, repetitive chains of organic molecules. Although the polymers that make up plastic are synthetic, many polymers can be found in the natural environment,[7] including in the proteins that bind together DNA. The arrangement of atoms and the addition of different elements produce different types of polymers, but most polymers—and plastics—contain hydrocarbons (chains of hydrogen and carbon). For instance, polyvinyl chloride (PVC),[8] commonly used for an assortment of items like packaging, building materials and hospital supplies, is an assortment of carbon, hydrogen and chlorine atoms. Polyethylene, commonly used for plastic bags and food containers, is composed of just hydrogen and carbon.

II. Plastics and Fossil Fuels

The plastics crisis is inseparable from the climate change crisis, primarily because of the intimate relationship between the plastics and fossil fuel industries. More than 99% of plastics are produced from chemicals sourced from fossil fuels, called petrochemicals. For example, naphtha is another compound derived from heating and condensing crude oil. To produce naphtha, different compounds (including petroleum gas, gasoline and diesel) are separated into different compartments of a fractionating column by weight and boiling point.[9] Once naphtha is refined, it undergoes the "cracking" process, which involves breaking down large hydrocarbons into smaller ones that are useful ingredients for plastics, such as ethylene and propylene. Most plastics rely on these two industrial chemicals as building blocks.[10] Then additives and shaping processes help create the desired product.

Natural gas is subjected to a similar process to extract ethane,[11] another building block of plastics. Once separated, the odorless, colorless and gaseous hydrocarbon is liquified and processed in an ethane cracker.

Because modern methods of plastics production rely on petrochemicals, the plastics industry and fossil fuel industries are intimately linked. As the burning of fossil fuels releases heat-trapping gases in the earth's atmosphere, plastics produced using petrochemicals pollute the air, ground and water at all levels of the production chain.

According to the United Nations Environment Programme, 20% of oil consumption could go toward plastics production by 2050.[12] As renewable energy becomes even more accessible and reliable, big oil and gas companies will see less demand for fuel to heat houses or power cars. The fossil fuel industry envisions the petrochemical buildout as a way to keep demand for fossil fuels afloat and to claim that they are boosting their sustainability goals.[13] Big Oil is already profiting immensely from plastics production: BP, Chevron, ExxonMobil, Shell and China National Petroleum account for more than half of naphtha sales globally.[14] ExxonMobil is also the world's leading producer of single-use plastics waste.[15]

III. Targeting Vulnerable Communities

Although petrochemical facilities are found all throughout the U.S., manufacturers are notorious for targeting low-income and marginalized communities when establishing plants. These areas are chosen often because of the imbalance of power that local agencies and private enterprises hold over communities, which can be easily amplified. The health and safety of these residents are sacrificed under the guise of job growth, tax revenue and prosperity.

U.S. petrochemical facilities are clustered in two regions: the Gulf Coast and "Cancer Alley," an 85-mile stretch of Louisiana. These areas were chosen for two reasons. First, because local residents are largely poor and marginalized, with little political power to stop polluting industries. Second, because of their proximity to fossil fuel partners. Since the mass production of plastics relies on sourcing fossil fuels, it benefits from proximity to oil and gas infrastructure. The Permian Basin, located in western Texas and southeastern New Mexico, contains huge amounts of petroleum, natural gas and potassium deposits, accounting for almost 40% of all U.S. oil production.[16] The oil and gas industry expects the extractive resources from the Permian Basin to be a dominant source of raw material for processing[17] (also referred to as feedstock) as oil demand grows for plastic. A Gulf Coast location also allows for easier transportation and exportation of petrochemicals.

The health impacts of plastics polluters in Cancer Alley are dire. More than 200 industrial plants are located in this area, where residents are predominantly Black and low income.[18] Because of this, Cancer Alley residents were exposed to a level of health risk 10 times higher than those living elsewhere in the state.[19] In a Tulane University study, Louisiana neighborhoods with above-average poverty rates and the most toxic air pollution had increased incidence of cancer.[20] Cancer Alley has an average cancer rate of 502 cases per 100,000 people, compared with neighborhoods with low toxic air pollution and the overall state average (478.8 and 480.3 cases per 100,000 people, respectively).

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Exacerbating Health Risks Throughout the Supply Chain

Plastics affect human and ecosystem health throughout their entire life cycle. Beginning with the feedstocks, fossil fuels must be extracted, transported and separated into components. The upstream and midstream operations contaminate the air and create wastewater filled with toxic chemicals.[21] Methane, which composes most of natural gas, leaks are extremely common throughout the gas supply chain; this potent greenhouse gas traps 80 times more heat in the atmosphere than carbon dioxide over a twenty year period.[22] With the flaring of excess natural gas, greenhouse gas emissions, and wastewater leaks, air pollution and water pollution are inevitable. The infrastructure required for these large-scale operations occupy an immense tracts of land, compromising wildlife habitats and infringing on local communities. Transporting chemicals and plastic goods from manufacturers to consumers causes massive greenhouse gas emissions. At the disposal stage, plastic products end up in landfills or waterways, where they shed microplastics in the air, land and water.

Transportation of Petrochemicals Endangers Health in Ohio

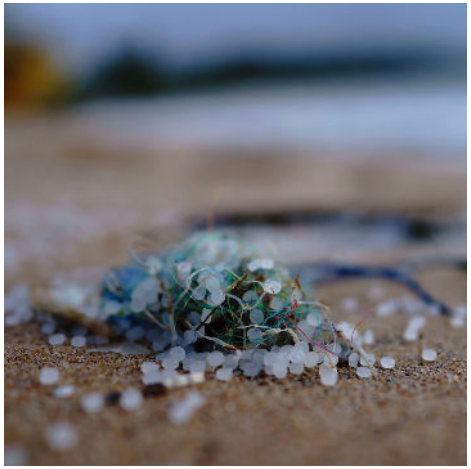
Transporting petrochemicals throughout the supply chain endangers workers and communities. In February 2023, several train cars carrying vinyl chloride derailed in East Palestine, Ohio. Vinyl chloride is used to make polyvinyl chloride (PVC), a hard plastic resin used for various plastic products. Exposure to it increases the risk of numerous types of cancer, including liver, brain and lung cancer.[23]

Authorities burned the vinyl chloride in a controlled release, introducing highly irritative and toxic gases, phosgene and hydrogen chloride into the air.[24] After a brief evacuation, residents were returned to their homes, but many still had concerns about dioxin contamination—pollutants resulting from the incineration of plastic—of their soil, water supply and air for decades.[25] About three weeks after the derailment, the Ohio Department of Natural Resources reported that more than 43,000 animals died in and around East Palestine.[26] Residents reported experiencing headaches, nausea, and coughing, among other symptoms.[27] They are still uncertain about their health and safety, despite the unilateral administrative order to Norfolk Southern Railway Company to conduct remediation activities under the oversight of the EPA.[28] Advocacy efforts for better rail safety, emergency planning and banning vinyl chloride are still ongoing.

IV. Hazards of Small Plastics

A plastic material's life cycle spans far beyond human use. About 40% of plastics are designed for single use,[29] increasing plastic waste under the guise of convenience. It inevitably ends up in landfills or in oceans, where it remains anywhere between 20 to 500 years to break down.[30] However, they are never fully eliminated from our environment. Over time, plastics break down microplastics and nanoplastics. Microplastics are plastic particles less than 5 mm in length; nanoplastics are even smaller, less than 0.1 micrometer. These particles are small enough to enter the bloodstream and travel through the blood-brain barrier,[31] a semipermeable membrane meant to protect the brain against viruses and bacteria. Once past this barrier, they can lodge deep into the tissue. The particles can bioaccumulate in the heart and lungs, leading to a higher risk of heart attack, stroke or death.[32] Plastic particles in the body can also damage reproductive health—microplastics have now been found in the placenta, breast milk and semen.[33]

Microplastics have been found everywhere from tap water, to soil and food, to snow in the Arctic and the Alps, and in the clouds above Mount Fuji.[34] Scientists still do not yet understand all the implications of this spread, but initial research suggests that microplastics in clouds could affect the rate at which clouds convert into rain. Microplastics also seem to influence the duration of the cloud's life cycle. As sunlight hits the clouds, it can degrade the microplastics even more, releasing greenhouse gasses into the atmosphere.



V. Greenwashing Concerns

Recycling is a false solution to the problem of plastic pollution. The plastics industry has known about the ineffectiveness of plastics recycling for more than 50 years, as evidenced by documents produced by their own industry groups.[35] Despite knowing the technical and economic limitations to recycling, the plastics industry increased plastics production and intentionally misled consumers through carefully crafted marketing campaigns and labeling systems.[36]

As the public becomes aware that conventional recycling practices are actually just greenwashing, the plastics industry is touting chemical recycling and plastics credits as new "solutions." Chemical recycling is a murky term[37] used to describe industrial technologies that chemically process plastic waste by melting or boiling it down into chemicals or fuels. A process known as pyrolysis uses heat and chemical processes to break plastic down and turn it into fuel. Conversely, to convert a plastic product into another product, heat and solvents are used to create feedstocks. These processes are energy intensive, produce hazardous waste and air pollutants and are often located near overburdened communities.

There is now a rising demand for a plastics credit market, which is structured similarly to the carbon credit market. Companies can purchase plastic credits, issued to represent one ton of plastics waste collected or recycled, to offset production. Although there is no global standard or agency that verifies these credits, many entities and investors consider the idea a worthwhile option. The World Bank, a multilateral development bank, and Citibank have launched a $100 million bond that will fund recycling projects in Ghana and Indonesia.[38] The bond partially relies on the sale of plastics and carbon offset credits.

Even if plastics credits should become verifiable, the plastics disposal market underscores a major ethical concern of plastics pollution. High income countries have leveraged the power imbalance to export their plastics waste to low-income countries, where those materials inundate local communities.[39] The waste is either landfilled or incinerated. Waste exports become a way to evade responsibility.

> **Ecocentrism recognizes the interconnectedness of all living organisms and ecosystems and prioritizes the well-being of the environment over short-term gains for humans as a result of exploitation.**

Greenwashing is not the way forward. Even so-called eco-friendly materials like bioplastics can be just as bad or even worse than conventional plastic.[40] There are ample opportunities to reduce the production and consumption of plastics by investing in alternative products and systems instead. Something as simple as restaurants creating a reuse system for food takeout would drastically reduce the need for single-use plastic packaging.[41] Working towards a zero-waste economy will mean that humans need to confront their complacency with throwaway culture and encourage a deeper lifestyle change.

The transition away from plastics will require a shift to ecocentrism—a worldview that centers nature rather than humans. Ecocentrism recognizes the interconnectedness of all living organisms and ecosystems, and prioritizes the well-being of the environment over short-term gains for humans as a result of exploitation.

Values, culture and spirituality offer invaluable tools and resources for facilitating the shift to ecocentrism. Since time immemorial, the world's religious, spiritual and wisdom traditions have helped people situate their individual lives within a more expansive story—one that recognized the interconnectedness of all living beings. These traditions preserve a diverse array of practices, rituals, ceremonies, texts, songs and prayers that help people ground themselves in a larger sense of self. In recent years, religious scholarship has contextualized these ancient traditions within the ecological crises of our times, including Pope Francis' *Laudato Si': On Care for our Common Home*[42] and *Al-Mizan: A Covenant for the Earth*,[43] produced by a delegation of Muslim scholars.

VI. INC-4

Global regulations must also be implemented to shift from plastics. In 2022, the United Nations Environment Assembly passed resolution 5/14 to develop a legally-binding instrument[44] that would address plastics' full life cycle, from production to disposal. Five Intergovernmental Negotiating Committee sessions were scheduled to finalize a text. After little progress resulting from the first two sessions, it was clear that intersessional work was needed to break new ground. Work between sessions produced a zero draft, which provided a skeleton framework with placeholders to help facilitate negotiations.

At INC-4, taking place in Ottawa, Canada in April 2024, delegates will negotiate the draft text, which has ballooned from about 30 to 70 pages, with sections including multiple options.[45] The oversaturated text reflects a central tension between parties lobbying for international guidelines and standards, and parties that want individual nation-states to define their own standards. Some countries also want to restrict the treaty's scope by asserting that the life cycle of plastics only pertains to disposal in the marine environment. Different coalitions have emerged, such as the High Ambition Coalition, whose members generally favor global regulations and targeting the entire life cycle. The Like-Minded Group of major oil-producing countries, including Iran and Saudi Arabia, want to protect their oil interests; they favor nationally-determined approaches and waste management targets rather than production targets.

An effective solution to the plastics crisis requires strong standards to eliminate hazardous chemicals, scaled-up alternatives to plastics and reduced plastics production—starting with single-use and virgin plastics, brand new plastics produced from fossil fuels. A robust plastics treaty will include:

Regarding the Life Cycle of Plastics

- A scope spanning from extraction and remediation; define goals, set targets, establish metrics and unify data collection methods.
- Mandatory and time-bound global reductions and targets; create a universal framework to monitor plastics across production, trade, waste, pollution and biota, supported by sustainable funding mechanisms.
- Encourage research and development for reuse, refill and plastics-free alternatives with evidence-based decision making to prevent regrettable substitutions.

Regarding Human Rights and Environmental Justice

- Implement measures for a just, equitable transition for all individuals involved in the supply chain.
- Prioritize environmental justice; provisions for remediation and restoration efforts—economic, health and ecological—for those living in areas dubbed by advocates as "sacrifice zones."
- Institute provisions and protections for plastics workers, including waste pickers, to protect their health and economic needs.
- Prioritize decommissioning plastics incinerators and chemical recycling plants, particularly those in vulnerable communities.
- Address the root causes of environmental injustice related to plastics, such as unsustainable production and waste management practices, and promote sustainable solutions that benefit all communities regardless of socio-economic status or geographic location.
- Include provisions for fair access to resources, participation in decision-making processes and remediation efforts.
- Prioritize equitable distribution of environmental benefits and burdens to ensure that marginalized communities are not disproportionately affected by plastics pollution.

Regarding the Life Cycle of Plastics

- Eliminate harmful chemicals and toxins throughout the entire lifespan of plastics.
- Prohibit recycling plastics that contain dangerous chemicals.
- Mandate safer, sustainable materials to foster a circular economy free from toxins.
- Curb toxic and climate pollutants from being included in plastic materials.
- Implement stringent safety and sustainability standards for chemical use in product design, prohibiting harmful additives. Enhance repairability and recyclability.

CONCLUSION

The invention and widespread use of plastics displays the hubris and unlimited ambitions of humans to distance our species from the environment. Plastics were initially made of natural materials, but they have been transformed into something completely synthetic. Now it damages wildlife, land, water, air and human health. The scale and risks associated with the plastics crisis mandates bold action and international cooperation.

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