EXECUTIVE SUMMARY

Plastic & Climate

THE HIDDEN COSTS OF A PLASTIC PLANET

Plastic Proliferation Threatens the Climate on a Global Scale

The plastic pollution crisis that overwhelms our oceans is also a significant and growing threat to the Earth's climate. At current levels, greenhouse gas emissions from the plastic lifecycle threaten the ability of the global community to keep global temperature rise below 1.5°C. With the petrochemical and plastic industries planning a massive expansion in production, the problem is on track to get much worse.

Greenhouse gas emissions from the plastic lifecycle threaten the ability of the global community to keep global temperature rise below 1.5°C. By 2050, the greenhouse gas emissions from plastic could reach over 56 gigatons—10-13 percent of the entire remaining carbon budget.

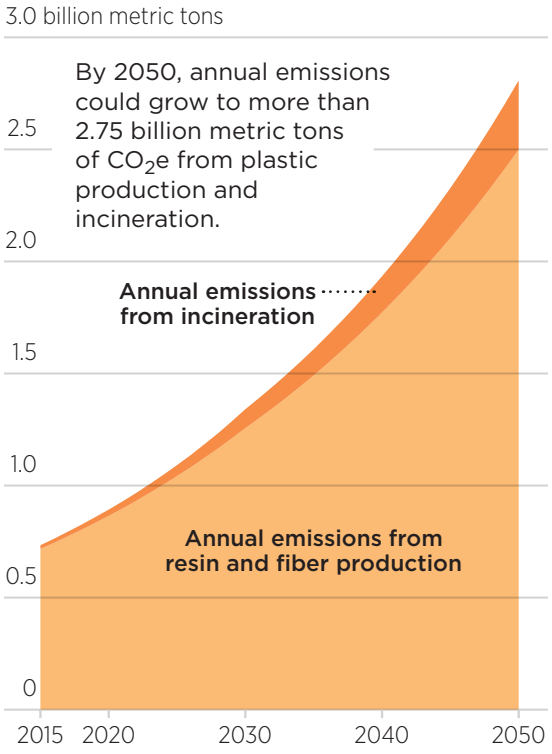
If plastic production and use grow as currently planned, by 2030, these emissions could reach 1.34 gigatons per year—equivalent to the emissions released by more than 295 new 500-megawatt coal-fired power plants. By 2050, the cumulation of these greenhouse gas emissions from plastic could reach over 56 gigatons—10–13 percent of the entire remaining carbon budget.

Nearly every piece of plastic begins as a fossil fuel, and greenhouse gases are emitted at each of each stage of the plastic lifecycle: 1) fossil fuel extraction and transport, 2) plastic refining and manufacture, 3) managing plastic waste, and 4) plastic's ongoing impact once it reaches our oceans, waterways, and landscape.

This report examines each of these stages of the plastic lifecycle to identify the major sources of greenhouse gas emissions, sources of uncounted

FIGURE 1

Annual Plastic Emissions to 2050

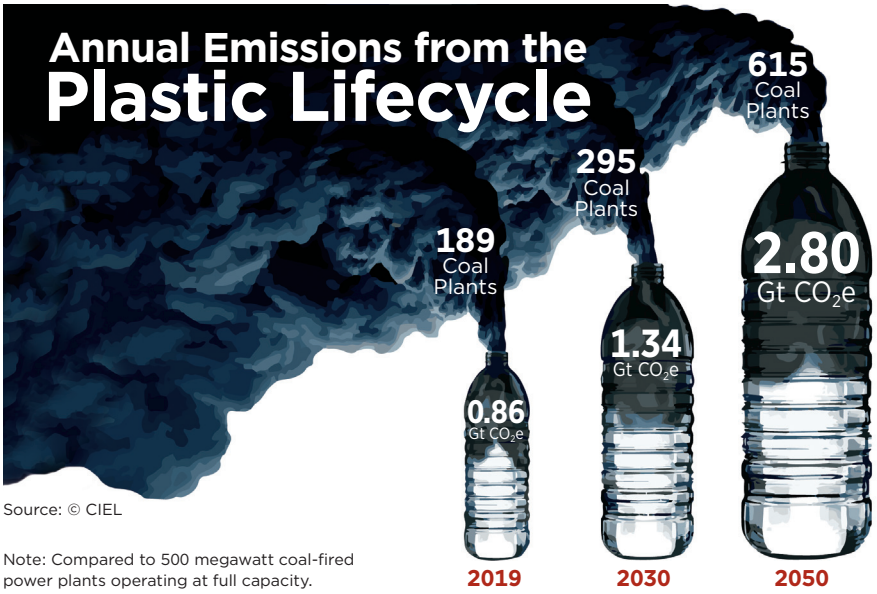


Source: CIEL

Photo: © iStockphoto/Kyryl Gorlov

FIGURE 2

Emissions from the Plastic Lifecycle



Source: © CIEL

Note: Compared to 500 megawatt coal-fired power plants operating at full capacity.

In 2019, the production and incineration of plastic will produce more than 850 million metric tons of greenhouse gases—equal to the emissions from 189 five-hundred-megawatt coal power plants.

emissions, and uncertainties that likely lead to underestimation of plastic's climate impacts. The report compares greenhouse gas emissions estimates against global carbon budgets and emissions commitments, and it considers how current trends and projections will impact our ability to reach agreed emissions targets. This report compiles data, such as downstream emissions and future growth rates, that have not previously been accounted for in widely used climate models. This accounting paints a grim picture: plastic proliferation threatens our planet and the climate at a global scale.

Due to limitations in the availability and accuracy of certain data, estimates in this report should be considered conservative; the greenhouse gas emissions from the plastic lifecycle are almost certainly higher than those calculated here. Despite these uncertainties, the data reveal that the climate impacts of plastic are real and significant, and they require urgent attention and action to maintain a survivable climate.

The report includes recommendations for policymakers, governments, nonprofits, funders, and other stakeholders to help stop the expanding carbon emissions of plastic. The most effective recommendation is simple: immediately reduce the production and use of plastic. Stopping the expansion of petrochemical and plastic production and keeping fossil fuels in the ground are a critical element to address the climate crisis.

KEY FINDINGS

Current Greenhouse Gas Emissions from the Plastic Lifecycle Threaten Our Ability to Meet Global Climate Targets
In 2019, the production and incineration of plastic will add more than 850 million metric tons of greenhouse gases to the atmosphere—equal to the emissions from 189 five-hundred-megawatt coal power plants. At present rates, these greenhouse gas emissions from the plastic lifecycle threaten the ability of the global community to meet carbon emissions targets.

Extraction and Transport

The extraction and transport of fossil fuels to create plastic produces significant greenhouse gases. Sources include direct emissions, like methane leakage and flaring, emissions from fuel combustion and energy consumption in the process of drilling for oil or gas, and emissions caused by land disturbance when forests and fields are cleared for wellpads and pipelines.

In the United States alone in 2015, emissions from fossil fuel (largely fracked gas) extraction and transport attributed to plastic production were at least 9.5–10.5 million metric tons of CO_2 equivalents (CO_2e) per year. Outside the US, where oil is the primary feedstock for plastic production, approximately 108 million metric tons of CO_2e per year are attributable to plastic production, mainly from extraction and refining.

Refining and Manufacture

Plastic refining is among the most greenhouse-gas-intensive industries in the manufacturing sector—and the fastest growing. The manufacture of plastic is both energy intense and emissions intensive in its own right, producing significant emissions through the cracking of alkanes into olefins, the polymerization and plasticization of olefins into plastic resins, and other chemical refining processes. In 2015, 24 ethylene facilities in the US produced 17.5 million metric tons of CO_2e, emitting as much CO_2 as 3.8 million passenger vehicles. Globally in 2015, emissions from cracking to produce ethylene were 184.3–213.0 million metric tons of CO_2e, as much as 45 million passenger vehicles driven for one year. These emissions are rising rapidly: a new Shell ethane cracker being constructed in Pennsylvania could emit up to 2.25 million tons of CO_2e each year; a new ethylene plant at ExxonMobil's Baytown, Texas, refinery could release up to 1.4 million tons. Annual emissions from just these two new facilities would be equal to adding almost 800,000 new cars to the road. Yet they are only two among more than 300 new and expanded petrochemical projects being built in the US alone—primarily for the production of plastic and plastic feedstocks.

Waste Management

Plastic is primarily landfilled, recycled, or incinerated—each of which produces greenhouse gas emissions. Landfilling emits the least greenhouse gases on an absolute level, although it presents significant other risks. Recycling has a moderate emissions profile but displaces new virgin plastic on the market, making it advantageous from an emissions perspective. Incineration leads to extremely high emissions and is the primary driver of emissions from plastic waste management. Globally, the use of incineration in plastic waste management is poised to grow dramatically in the coming decades.

US emissions from plastic incineration in 2015 are estimated at 5.9 million metric tons of CO_2e. For plastic packaging, which represents 40 percent of plastic demand, global emissions from incineration of this particular type of plastic waste totaled 16 million metric tons of CO_2e in 2015. This estimate does not account for 32 percent of plastic packaging waste that is known to remain unmanaged, open burning of plastic, incineration that occurs without any energy recovery, or other practices that are widespread and difficult to quantify.

Plastic in the Environment

Plastic that is unmanaged ends up in the environment, where it continues to have climate impacts as it degrades. Efforts to quantify those emissions are still in the early stages, but a first-of-its-kind study demonstrated that plastic at the ocean's surface continually releases methane and other greenhouse gases, and that these emissions increase as plastic breaks down further. Current estimates address only the one percent of plastic at the ocean's surface. Emissions from the 99 percent of plastic that lies below the ocean's surface cannot yet be estimated with precision. Significantly, this research showed that plastic on the coastlines, riverbanks, and landscapes releases greenhouse gases at an even higher rate.

Microplastic in the oceans may also interfere with the ocean's capacity to absorb and sequester carbon dioxide. Earth's oceans have absorbed 20–40 percent of all anthropogenic carbon emitted since the dawn of the industrial era. Microscopic plants (phytoplankton) and animals (zooplankton) play a critical role in the biological carbon pump that captures carbon at the ocean's surface and transports it into the deep oceans, preventing it from reentering the atmosphere. Around the world, these plankton are being contaminated with microplastic. Laboratory experiments suggest this plastic pollution can reduce the ability of phytoplankton to fix carbon through photosynthesis. They also suggest that plastic pollution can reduce the metabolic rates, reproductive success, and survival of zooplankton that transfer the carbon to the deep ocean. Research into these impacts is still in its infancy, but early indications that plastic pollution may interfere with the largest natural carbon sink on the planet should be cause for immediate attention and serious concern.

Plastic Production Expansion and Emissions Growth Will Exacerbate the Climate Crisis

The plastic and petrochemical industries' plans to expand plastic production threaten to exacerbate plastic's climate impacts and could make limiting global temperature rise to 1.5°C impossible. If the production, disposal, and incineration of plastic continue on their present growth trajectory, by 2030, these global emissions could reach 1.34 gigatons per year—equivalent to more than 295 five-hundred-megawatt coal plants. By 2050, plastic production and incineration could emit 2.8 gigatons of CO_2 per year, releasing as much emissions as 615 five-hundred-megawatt coal plants.

Critically, these annual emissions will accumulate in the atmosphere over time. To avoid overshooting the 1.5°C target, aggregate global greenhouse emissions must stay within a remaining (and quickly declining) carbon budget of 420–570 gigatons of carbon.

If growth in plastic production and incineration continue as predicted, their cumulative greenhouse gas emissions by 2050 will be over 56 gigatons CO_2e, or between 10–13 percent of the total remaining carbon budget. As this report was going to press, new research in *Nature Climate Change* reinforced these findings, reaching similar conclusions while applying less conservative assumptions that suggest the impact could be as high as 15 percent by 2050. By 2100, exceedingly conservative assumptions would result in cumulative carbon emissions from plastic of nearly 260 gigatons, or well over half of the carbon budget.

Urgent, Ambitious Action is Necessary to Stop the Climate Impacts of Plastic

This report considers a number of responses to the plastic pollution crisis and evaluates their effectiveness in mitigating the climate, environmental, and health impacts of plastic. There are high-priority actions that would meaningfully reduce greenhouse gas emissions from the plastic lifecycle and also have positive benefits for social or environmental goals. These include:

- ending the production and use of single-use, disposable plastic;
- stopping development of new oil, gas, and petrochemical infrastructure;
- fostering the transition to zero-waste communities;
- implementing extended producer responsibility as a critical component of circular economies; and
- adopting and enforcing ambitious targets to reduce greenhouse gas emissions from all sectors, including plastic production.

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Complementary interventions may reduce plastic-related greenhouse gas emissions and reduce environmental and/or health-related impacts from plastic, but fall short of the emissions reductions needed to meet climate targets. For example, using renewable energy sources can reduce the energy emissions associated with plastic but will not address the significant process emissions from plastic production, nor will it stop the emissions from plastic waste and pollution. Worse, low-ambition strategies and false solutions (such as bio-based and biodegradable plastic) fail to address, or potentially worsen, the lifecycle greenhouse gas impacts of plastic and may exacerbate other environmental and health impacts.

Ultimately, any solution that reduces plastic production and use is a strong strategy for addressing the climate impacts of the plastic lifecycle. These solutions require urgent support by policymakers and philanthropic funders and action by global grassroots movements. Nothing short of stopping the expansion of petrochemical and plastic production and keeping fossil fuels in the ground will create the surest and most effective reductions in the climate impacts from the plastic lifecycle.

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Available online at **www.ciel.org/plasticandclimate**

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