Policy brief

Plastic Production Reduction: The Climate Imperative

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Introduction:

Negotiations are underway to draft a new, global treaty to end plastic pollution, one of the world's fastest-growing environmental problems. One of the most challenging questions is how to tackle the ongoing, rapid expansion of plastic production. Previous studies have made clear that deep cuts in plastic production are required to reduce plastic leakage into the marine environment.[1] Now, a major new study from Lawrence Berkeley National Laboratory (LBNL)[2] reveals that deep production cuts are also required to align with climate targets.[3] We have created thisvbriefing to draw policy inferences from the LBNL study.

1 Bergmann et al., "A Global Plastic Treaty Must Cap Production"; Borrelle et al., "Predicted Growth in Plastic Waste Exceeds Efforts to Mitigate Plastic Pollution."

2 The Lawrence Berkeley National Laboratory is a government-funded research laboratory of the U.S. Department of Energy in partnership with the University of California at Berkeley.

3 Karali, Khanna, and Shah, "Climate Impacts of Plastics Production."

Key take-aways:

To address plastic's greenhouse gas emissions, the treaty must take a full life cycle approach that includes cuts in polymer production.

The full life cycle of plastic starts with the extraction of fossil fuels, which provide both the feedstock and the energy source for plastic production. 75% of all greenhouse gas emissions from primary plastic production happen during the production of monomers and preceding stages, crucial for plastic production.[4] To fully understand, measure, evaluate and address plastic pollution, assessment and regulatory controls must consider the full lifecycle, beginning with extraction.

Growth in plastic production alone will doom international climate goals. Even if every other source of greenhouse gas emissions – transportation, electricity, agriculture, heavy industry, etc. – were to miraculously and completely decarbonize in 2024, at current growth rates, primary plastic production alone would completely consume the global carbon budget as early as 2060 and no later than 2083.

Deep, rapid cuts in plastic production are required to align with the Paris Agreement. To avoid breaching the 1.5°C limit set by the Paris Agreement, primary plastic production must decrease by at least 11.8% to 17.3% per year, starting in 2024.

4 The early stages of plastic production include the extraction of fossil fuels, hydrocarbon production, intermediate chemicals production, and monomer production. See Figure 1.

An oil refinery in Salt Lake City © Flickr / Art Prof

Background and New Findings:

In 2015, the Paris Agreement established the goal of restraining global temperature rise to 1.5°C above pre-industrial levels. With 195 countries ratifying, the Paris Agreement represents a defining global consensus. In 2018, the Intergovernmental Panel on Climate Change (IPCC) issued a special report documenting the dire consequences of breaching the 1.5°C limit.[5] The key to meeting this goal is the carbon budget: the total amount of greenhouse gas emissions that humanity can emit without exceeding 1.5°C rise. Because of uncertainties in the planetary response to emissions, there are two carbon budgets: 400 Gt CO_2 for a 67% chance of keeping temperatures below 1.5°C, and 500 Gt CO_2 for a 50% chance.[6] Importantly, these carbon budgets are cumulative, not annual: high emissions in early years will permanently deplete the budget and reduce what is available for future years. The carbon budgets are indifferent to the source of emissions; societies must decide which sectors and services to prioritize. The greater the emissions from plastic, the less carbon budget will be available to other sectors such as agriculture, energy, transport, etc.

The Lawrence Berkeley National Laboratory study by Karali et al.[7] details the enormous carbon footprint of plastic production: 2.24 Gt CO_2e in 2019, or 5.3% of all fossil-based emissions. The report's detailed, polymer-specific analysis reveals considerably higher emissions than any previous study, and locates them to specific steps in the production chain. This allows us to better understand the potential for various strategies to reduce plastics' greenhouse emissions. In particular, the scope for decarbonized electrification is limited, as both process and energy emissions occur throughout multiple stages of production. The study's focus is on primary plastic production so it does not include the production of recycled plastics nor plastic waste disposal, such as incineration.

In this policy brief, we conduct additional analysis, using these results to address topical policy questions, especially those faced by negotiators in the Intergovernmental Negotiating Committee on Plastic Pollution. Our analysis extends plastic growth trajectories into the future to ask what level of primary plastic production is consistent with the 1.5°C carbon budget.

5 IPCC, Global Warming of 1.5°C.

6 IPCC, "Summary for Policymakers."

7 Karali, Khanna, and Shah, "Climate Impacts of Plastics Production."

Policy Implications:

In launching the treaty negotiation process, United Nations Environment Assembly Resolution 5/14 charged the negotiating committee with addressing the "full life cycle" of plastic.[8] The plastic life cycle begins with the extraction of fossil fuels, which are processed to produce monomers, the chemical building blocks of plastic.[9] The monomers go through a polymerization stage to make primary plastic polymers which are then used by manufacturers to make plastic products. Karali et al. find that 75% of all greenhouse gas emissions from the production of primary plastics occur prior to polymerization: in the extraction and refining of fossil fuels, production of intermediate chemical products, and in producing monomers. Any assessment of the climate impacts of plastic that exclude these upstream production stages will miss the majority of greenhouse gas emissions. Importantly, any attempt to regulate plastic's greenhouse gas footprint will fail unless the upstream emissions are fully included. The plastics treaty must therefore define the "full life cycle" of plastic as beginning with the extraction phase to align with the Paris Agreement and the treaty's own mandate as stated in UNEA Resolution 5/14.

8 United Nations Environment Assembly, "5/14. End Plastic Pollution: Towards an International Legally Binding Instrument - Resolution Adopted by the United Nations Environment Assembly on 2 March 2022 [UNEP/EA.5/Res.14]."

9 Monomers are simple chemicals such as ethylene that are chained together to form polymers. They are an intermediate product in plastic production.

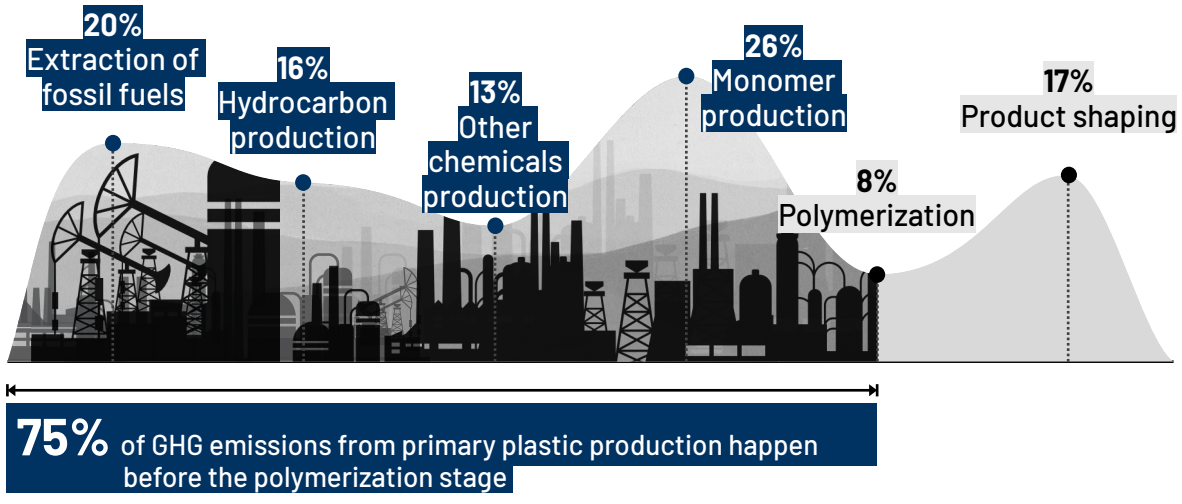

Figure 1: Greenhouse gas emission shares from plastic production, by production phase. Data from Karali et al., 2024.

Karali et al. evaluate the emissions of plastic production to 2050, finding that primary plastic production will consume 21-31% of the global carbon budget in the next quarter-century.[10] The world can ill afford to spend so much of its remaining carbon budget on plastic instead of essentials like food and electricity production. What is even more concerning is what happens after 2050. Under a growth scenario, emissions will not cease by 2050; on the contrary, they will continue growing exponentially. Having spent billions of dollars on plastic production infrastructure, the petrochemical industry may be financially compelled to recoup its investment by operating those facilities for as long as possible – probably well into the 22nd century. **Continuing its historical growth would mean that plastic production alone would consume the world's entire carbon budget as soon as 2060 and no later than 2083 – even if every other sector of the economy were to completely decarbonize in 2024. This makes it clear that continued expansion of plastic production is in direct conflict with climate stability and climate mitigation goals.**

10 The range is due to different projections for the growth of plastic production as well as different carbon budgets. See Methodology for details.

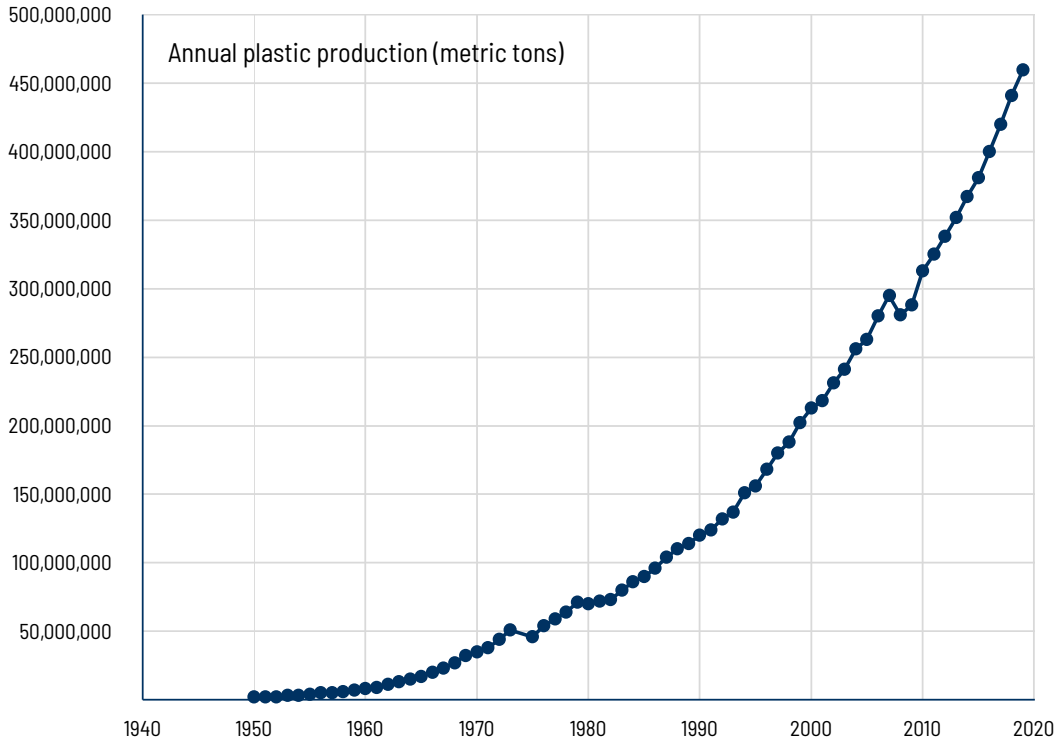

Figure 2: Annual production of plastic polymers between 1950 and 2019, in tonnes. Geyer et al., 2017.

Of course, expecting complete decarbonization of every other sector except plastic is unrealistic. The remaining carbon budget to keep global warming within the 1.5°C global goal is rapidly diminishing. To stay within the carbon budget, plastics, like every other fossil fuel sector, must immediately initiate deep, rapid production cuts. This much is well understood, and the new study allows us to quantify for the first time exactly how deep those cuts must be.

Karali et al. find that plastic production is currently responsible for 5.3% of global greenhouse gas emissions. Assuming plastic continues to consume a steady share of the remaining global carbon budget, a business as usual (BAU) scenario that maintains an average 3.45% growth in annual plastic production will deplete plastic's share of the remaining carbon budget before 2030. **To give the world a 50% chance of staying below 1.5°C temperature rise, production must be cut 11.8 - 12.5% every year beginning in 2024. If we want a 67% chance to stay below 1.5°C, 16.3% to 17.3% of primary plastic production must be cut annually.**

Demand-side measures to reduce plastic production, such as bans and taxes on classes of products, have failed to check plastic's growth. Supply-side measures, such as legal restrictions on primary polymer production, are therefore a necessary and essential component of the treaty to prevent the rapid depletion of the remaining carbon budget.

Rather than establish a long-term drawdown goal without intermediate targets, as the Paris Agreement did without success, we recommend that the plastics treaty establish annual reduction targets. Deep, rapid production cuts are needed to avoid early depletion of the remaining carbon budget and to reverse the ongoing expansion of polymer production. Annual targets will prevent delays in enacting the necessary cuts. **In light of the recent findings from the Lawrence Berkeley National Laboratory, our calculations indicate that the plastics treaty will have to require annual production cuts of at least 11.8% - 17.3% to align with the Paris Agreement and prevent catastrophic global warming.**

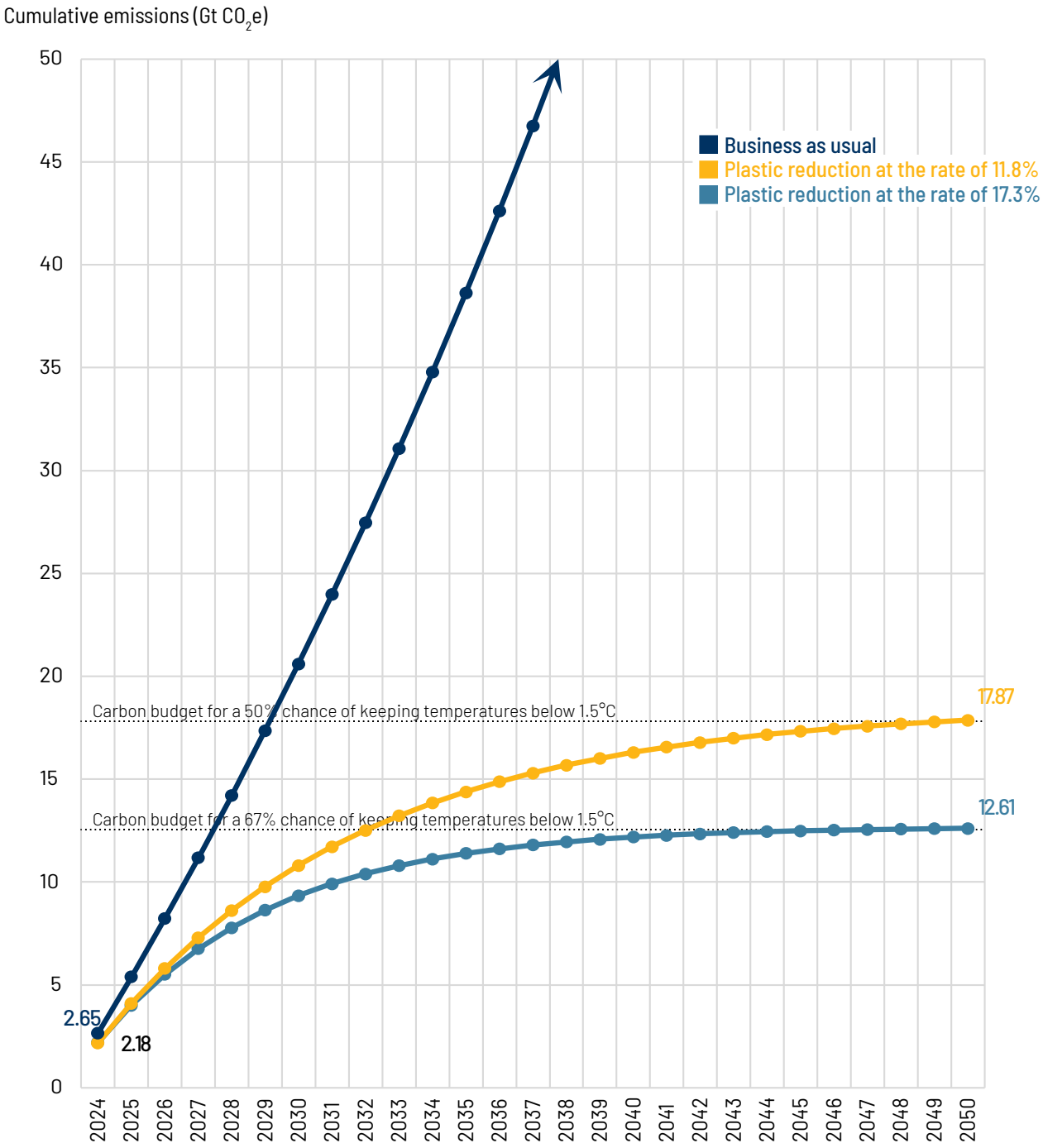

Figure 3: Cumulative greenhouse gas emissions of plastic under select scenarios. BAU shows continued growth at 3.45% annually. "Slow transition" depicts annual reductions of 11.8% and "Ambition" depicts 17.3% annual reductions. Horizontal lines show plastic's share of the carbon budget for a 67% chance and 50% chance of remaining under 1.5°C warming.

Methodology:

Carbon budget: The IPCC estimated the remaining carbon budget at the end of 2019 to be 400 Gt CO_2 for a 67% chance of remaining below 1.5°C, and 500 Gt CO_2 for a 50% chance. We updated these figures with the annual carbon budgets from 2020 to 2023.[11] A more recent analysis finds that the remaining carbon budget is ~30 Gt CO_2 smaller than the IPCC estimates used in this policy brief.[12] This would imply the need for even steeper production cuts. An important caveat is that these figures refer only to carbon dioxide, and not the other greenhouse gasses. Given the current rise in methane emissions and atmospheric concentrations, this certainly results in an overestimation of the remaining carbon budget as of the end of 2023. Allotting shares of the carbon budget to different sectors is a political choice rather than a scientific one. For this calculation, we assume that the share of plastic in global emissions would remain constant at 5.3% even though plastic's contribution to the global economy has been estimated at only 1.1%.[13]

Overshoot: Plastic production has grown between 3.1% and 4.4% per year since 2010, depending on data sources.[14] Karali et al. chose a range of 2.5% to 4% growth trajectories. We extrapolated the range of growth trajectories to find when plastics would consume the entire remaining carbon budget. This entails the highly unrealistic assumption that there are no other greenhouse gas emissions during this time; it is done for illustrative purposes alone.

Drawdown: For more realistic scenarios, we calculated the rate of drawdown required, beginning in 2024, if plastic production is to fit within its allotted carbon budget. The results depend primarily on the allotment of the carbon budget and secondarily on the degree of safety desired around achieving the 1.5°C goal as reflected in the IPCC's likelihood estimate of meeting this goal. We also added a business-as-usual (BAU) scenario based on continued growth with no production cuts. Results from highlighted scenarios are below:

11 Friedlingstein et al., "Global Carbon Budget 2020"; Friedlingstein et al., "Global Carbon Budget 2021"; Friedlingstein et al., "Global Carbon Budget 2022"; Friedlingstein et al., "Global Carbon Budget 2023."

12 Lamboll et al., "Assessing the Size and Uncertainty of Remaining Carbon Budgets."

13 Bachmann et al., "Towards Circular Plastics within Planetary Boundaries."

14 Geyer, Jambeck, and Law, "Production, Use, and Fate of All Plastics Ever Made"; Desalegn and Tangl, "Banning Vs Taxing, Reviewing the Potential Opportunities and Challenges of Plastic Products"; Shanmugam et al., "Polymer Recycling in Additive Manufacturing."

Scenario	Chance of achieving 1.5°C goal	Plastic production growth, 2020-2023	Required production cuts beginning 2024
Ambitious	67%	4.4%	17.3%
Slow transition	50%	2.5%	11.8%
Business as usual (BAU)	50%	3.5%	No cut – growing at 3.45%

Full calculations and additional scenarios are available in the accompanying spreadsheet.

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