Center for
Climate
Integrity

The Fraud of Advanced Recycling

How Big Oil and the plastics industry are promoting a false solution to the plastic waste crisis.

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Photo credit: iStock

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This report is available at climateintegrity.org/advanced-recycling-fraud.

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The Center for Climate Integrity empowers communities and elected officials with the knowledge and tools they need to hold oil and gas corporations accountable for the massive costs of climate change.

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Executive Summary

For decades, Big Oil and the plastics industry have deceived the public about the viability of plastic recycling. "Advanced recycling" is more deception.

Facing renewed pressure to address the plastic waste crisis in recent years, plastics producers have turned to "advanced recycling." But this is just the plastics industry's most recent deception — an effort to preserve its social license to continue producing ever-greater amounts of new plastics.

This report highlights five of the plastics industry's deceptive claims about advanced recycling, contrasting plastic producers' public statements with evidence from industry insiders and chemical recycling experts. It reflects the views of the people and organizations that understand the realities of advanced recycling best: consultants who advise the industry, academic researchers, industry trade organizations, recyclers, and plastics producers themselves.

Advanced recycling is not a new or groundbreaking technology.

Advanced recycling is depicted by the plastics industry as a fundamental breakthrough in recycling technology and a solution for the over 90% of plastic waste that mechanical recycling has been unable to address for decades. But advanced recycling, which is essentially a rebrand of chemical recycling, does not represent a novel solution to the plastic waste crisis at all. The plastics industry has spent decades trying to scale up chemical recycling technologies to little avail.

Advanced recycling is not scaling up in line with industry commitments.

The world's largest plastics producers have made public commitments to expand the use and capacity of advanced recycling, even in the face of overwhelming evidence demonstrating that major economic and technical limitations remain unresolved. Chemical recycling operations continue to flounder as a result of predictable issues, including many of the same factors that industry insiders have identified for years, while companies quietly retreat from their heavily publicized commitments once their public relations value has expired.

Advanced recycling does not address the problem of hard-to-recycle mixed plastics.

The plastics industry frames advanced recycling as a solution to the limitations of mechanical recycling, claiming that the technology can recycle mixed, post-consumer plastic waste that currently ends up in a landfill, is incinerated, or enters the environment. In practice, no chemical recycling processes can accept unsorted or contaminated plastic waste and are therefore subject to many of the same constraints that restrict the effectiveness of mechanical recycling.

Advanced recycling is not environmentally friendly.

Industry advertising frames plastic pollution as a societal problem, shifting blame away from plastics producers and onto society at large, while positioning advanced recycling as an environmentally-friendly solution to the plastic waste crisis. Doing so, however, ignores the environmental impacts associated with chemical recycling processes that experts have expressed concern about for years, ranging from heavy emissions of toxic compounds and severe pollution around chemical recycling facilities to climate impacts caused by the high energy requirements of chemical recycling processes.

Advanced recycling does not enable a circular economy.

Contrary to a common-sense notion of a "circular economy," advanced recycling does not meaningfully keep used plastic in production or offset the need for virgin plastic from fossil fuels. The plastics industry has co-opted the language of circularity while promoting a technological solution and business model that are fundamentally at odds with a circular economy. Companies support their circularity claims with an inherently deceptive mass balance attribution scheme that allows products with little-to-no recycled content to be labeled "circular" or "recycled" — all to promote the continued production and sale of plastic made from virgin fossil fuels.

Faced with the enormity of the plastic waste crisis, the idea of a straightforward solution is appealing for the public, policymakers, and plastics producers alike. The plastics industry's large-scale disinformation campaign is intended to present advanced recycling as that solution. But — especially given the plastics industry's long history of deceptively promoting recycling as a way to relieve public pressure to address the waste they produce — policymakers cannot ignore the overwhelming evidence that the promotion of advanced recycling does not reflect the technical or economic realities of chemical recycling technologies. Rather, it is simply the latest attempt by Big Oil and the plastics industry to deflect attention from the myriad problems with plastics in order to continue producing ever-greater amounts of plastic, regardless of the consequences. The petrochemical companies responsible for this coordinated campaign of deception should be held accountable.

Photo credit: iStock

Introduction

In the face of growing public and governmental pressure to confront the global plastic waste crisis, fossil fuel and petrochemical interests now claim to have found a solution: "advanced recycling." Extensive advertising campaigns announce that this "new" technology will overcome the obstacles that have limited the viability of plastic recycling in the past, enabling genuine circularity for these materials. But beyond the grand claims of plastics producers' marketing, the promise of advanced recycling is far more limited.

Experts familiar with the fossil fuel and petrochemical industry have raised doubts about a variety of the companies' public claims about advanced recycling, providing extensive evidence that the technology will not address plastic pollution at a meaningful scale. Rather, advanced recycling is Big Oil and the plastics industry's latest attempt to protect its social license to expand plastic production and avoid accountability for the growing plastic waste crisis it has created and perpetuated for more than half a century.

Despite their long-standing knowledge that recycling plastic is neither technically nor economically viable at scale, petrochemical companies — independently and through their trade associations and front groups — promoted mechanical or traditional plastic recycling as a genuine solution to the plastic waste crisis. For decades, the idea of recycling has served the plastics industry as a means to protect and expand plastic markets, stalling legislative or regulatory action that would have meaningfully addressed plastic waste and pollution.[1]

The Fraud of Advanced Recycling Begins with the Term Itself

"Advanced recycling" is a term used by Big Oil and the plastics industry to describe various chemical recycling processes. These technologies are meant to break down plastics into their constituent elements through the application of heat and/or chemicals, in contrast to mechanical recycling, which uses machinery to physically shred plastics into smaller pieces. Chemical recycling processes can include conversion technologies (such as pyrolysis and gasification) as well as depolymerization technologies (such as methanolysis and glycolysis), among others.

For decades, chemical recycling processes have primarily been viewed as tools to turn waste plastics into fuels, which does not qualify as recycling. In recent years, however, these technologies have been reframed as "advanced recycling" processes to produce feedstocks for new plastics, even in the absence of evidence that this can be accom-plished at scale. This term of art was created by the plastics industry and, while it has been used widely in ad-vertisements and other promotional materials, it does not have a single, uniform definition. As a result, technical experts typically continue to favor the term chemical recycling.

1 *See generally* Center for Climate Integrity, The Fraud of Plastic Recycling: How Big Oil and the Plastics Industry Deceived the Public for Decades and Caused the Plastic Waste Crisis (Feb. 2024), https://climateintegrity.org/uploads/media/Fraud-of-Plastic-Recycling-2024.pdf.

Plastics producers have used the false promise of plastic recycling to exponentially increase virgin plastic production and impose significant costs on communities that are left to pay for the consequences of plastic waste and pollution.

In recent years, however, the illusion of recycling as a solution to the plastic waste crisis has begun to fall apart. China's decision to stop accepting large amounts of plastic waste from western countries, along with increased public awareness of ocean plastics and microplastics, has placed an unprecedented level of attention on the problem of plastic pollution. This scrutiny has, in turn, placed renewed pressure on plastics producers to make recycling work, or, as Bain & Company put it in 2022, "risk facing more stringent regulation and more pressure from customers."[2]

Advanced recycling is the plastics industry's response to public pressure to reduce plastic waste. Industry advertisements acknowledge concerns about plastic pollution and frame advanced recycling as the only viable strategy to combat the crisis. "Breakthrough technologies are already starting to slow the leakage of plastics reaching our ocean, natural areas, and communities," according to Dow;[3] ExxonMobil says it is "helping to address the plastic waste challenge through advanced recycling";[4] and Eastman asserts that "[t]hrough innovation and collaboration, we can collectively make plastic waste a relic of the past."[5]
The Plastics Industry Association (PLASTICS) claims that "[a]dvanced recycling is a necessary and essential complement to mechanical recycling to ensure that plastics stay out of the environment";[6] the American Fuel and Petrochemical Manufacturers (AFPM) contends that its "members are working with a variety of industries to explore the myriad ways advanced recycling can help address plastic waste";[7] and "[a]dvanced recycling is keeping used plastic out of the environment and in the economy," in the words of an ad for the American Chemistry Council (ACC).[8]

> **"[T]he concerns of industry critics are, in many cases, justified."**
>
> Silke Einschuetz, AMI Consulting, 2023

Advanced recycling frequently appears in plastics industry advertisements and public messaging as a synonym for chemical recycling. A technical term for an area of active, ongoing research going back to the 1970s and earlier, chemical recycling encompasses various classes of technologies, each of which "deconstructs plastic into molecular intermediates,"[9] or its chemical building blocks.

The technologies under this umbrella offer different ways to break down plastics into distinct forms, which then have the potential to be turned into something else — exactly what, and how, and how much varies widely depending upon the particular process, types of plastics, and a variety of other factors.

2 Sabine Atieh et al., *Improving Sustainability and Circularity in Plastics*, Bain & Co.: Energy & Nat. Res. Rep. (June 14, 2022), https://www.bain.com/insights/improving-sustainability-and-circularity-in-plastics-enr-report-2022/.

3 Dow Chem. Co., Science and Technology Can Solve the Plastic Waste Problem, Nat. Geo. 6 (Feb. 1, 2020), Media Radar (accessed June 21, 2024).

4 ExxonMobil, Expanding the Plastics Lifecycle (Jan. 8, 2024), https://corporate.exxonmobil.com/sustainability-and-reports/sustainability/creating-sustainable-solutions/expanding-the-plastics-life-cycle#Strengtheningcircularitywithadvancedrecycling.

5 Eastman, A Better Circle: 2023 Sustainability Report 20 (2023), https://www.eastman.com/content/dam/eastman/corporate/en/media-center/resources/eastman-sustainability-report-2023.pdf.

6 Plastics Industry Ass'n, Advanced Recycling: Reducing Plastic Waste, Cutting Emissions, Growing Economies, ThisIsPlastics.com (2023) (on file with CCI #5505.1).

7 Am. Fuel & Petrochem. Mfrs., Commitment to a Sustainable Future: 2024 Sustainability Report 38 (2024), https://afpm.org/system/files/attachments/3993_AFPM_2024_Sustainability_Report_FINAL_v2.pdf.

8 America's Plastic Makers, Advanced Recycling, The Denver Post (May 3, 2022), Media Radar (accessed July 23, 2024).

9 Taylor Uekert et al., *Technical, Economic, and Environmental Comparison of Closed-Loop Recycling Technologies for Common Plastics*, 11 ACS Sustainable Chem. Eng. 965, 965 (2023), https://pubs.acs.org/doi/pdf/10.1021/acssuschemeng.2c05497.

The plastics industry falsely portrays advanced recycling as a solution.

Company	Deceptive Claim
DOW	"Breakthrough technologies are already starting to slow the leakage of plastics reaching our ocean, natural areas, and communities."[3]
ExxonMobil	"[Exxon is] helping to address the plastic waste challenge through advanced recycling."[4]
EASTMAN	"[T]hrough innovation and collaboration, we can collectively make plastic waste a relic of the past."[5]
PLASTICS INDUSTRY ASSOCIATION	"[A]dvanced recycling is a necessary and essential complement to mechanical recycling to ensure that plastics stay out of the environment."[6]
AFPM	"[M]embers are working with a variety of industries to explore the myriad ways advanced recycling can help address plastic waste."[7]
American Chemistry Council	"[A]dvanced recycling is keeping used plastic out of the environment and in the economy."[8]

But while chemical recycling has typically been framed as an option-of-last-resort in the waste management hierarchy, a tool for extracting energy content from waste plastics, the plastics industry's recent promotion of advanced recycling positions it as a solution for all the problems that have long plagued plastic recycling.

The term "advanced recycling" serves as an amalgamation of different chemical recycling technologies and their qualities, both real and theoretical. It is marketed to represent every imaginable advantage of each distinct chemical recycling technology with none of their respective downsides, providing the industry with the cover of a technological solution that demands no changes in the way we use plastics.

Indeed, the false promise of advanced recycling is the industry's justification for ever-increasing production of new plastics on the grounds that whatever waste is produced today will simply be fed back into a circular system. The reality that no such system exists — that there is not even a remotely plausible plan to make such a system exist — does not matter to the plastics industry.

The plastics industry's promotion of advanced recycling follows the same playbook it used decades ago to sell the public on mechanical recycling. In the 1980s and 1990s, the plastics industry convinced policymakers and the public that recycling could address plastic waste issues and represented a viable alternative to other steps to reduce plastic pollution, including regulations and product bans. The fraud was not in the claim that plastic recycling exists; chemical and mechanical recycling each offer potential solutions for select, limited portions of the plastic waste stream. Rather, the fraud — decades ago and today — is in the industry's promotion of recycling as the answer to the plastic waste crisis. The industry's statements to this effect are deceptive.

> **"I think a lot of it is greenwashing … If you put the name 'recycling' on anything, people assume that it's green and it's good for the environment."**
>
> Brittany Martin, Wood Mackenzie, 2024

Experts have pointed out that there is a significant gap between the version of advanced recycling portrayed in plastics industry advertisements and the technical realities of chemical recycling processes. "I think a lot of it is greenwashing," Wood Mackenzie market analyst Brittany Martin told *Texas Monthly* about chemical recycling.[10] "If you put the name 'recycling' on anything, people assume that it's green and it's good for the environment."[11]

According to a recent lawsuit filed by the State of California (*California v. ExxonMobil*), ExxonMobil has validated this idea internally, noting that "[r]esearch shows that the public is increasingly aware of plastics issues but favorably receptive to advanced recycling messages."[12] But for all of its theoretical appeal, the reality of chemical recycling is a far cry from the plastics industry's advanced recycling promises. These claims begin to crumble under the weight of even modest scrutiny — as the industry understands well.

10 Mark Dent, *Plastic Has Overrun the Planet. Does "Advanced" Recycling Offer a Solution?*, Texas Monthly (Feb. 14, 2024), http://archive.today/6PJUv.

11 *Id*.

12 Complaint at 77, *California v. ExxonMobil Corp.*, No. CGC24618323 (Cal. Super. Ct. filed Sept. 23, 2024) [hereinafter California Complaint], https://oag.ca.gov/system/files/attachments/press-docs/Complaint_People%20v.%20Exxon%20Mobil%20et%20al.pdf.

Big Oil and the plastics industry make five key claims in support of advanced recycling in advertisements and other public statements — each of them deceptive:

1. The plastics industry **presents advanced recycling as new and groundbreaking**, despite the industry's decades-long failed efforts to make chemical recycling work at scale.
2. The plastics industry **promises that advanced recycling is scaling up** and will soon be sufficiently developed to address the plastic waste crisis, despite its knowledge that the economic and technical limitations that have plagued chemical recycling for decades have not been resolved.
3. The plastics industry **argues that advanced recycling can address hard-to-recycle mixed plastics** — specifically the more than 90 percent of plastics that are not recycled through mechanical recycling — despite clear technical limitations.
4. The plastics industry **positions advanced recycling as an environmentally-friendly solution for plastic waste,** despite the fact that chemical recycling processes produce a host of hazardous pollutants, are extremely energy-intensive, and serve to perpetuate the extraction of ever-greater amounts of fossil fuels.
5. The plastics industry **defines advanced recycling as "circular,"** even though these processes do not keep plastic in the production cycle and do not reduce or offset the production of virgin plastic made from fossil fuels.

This report examines each of these claims in detail, providing examples of the claims, context for why they are important, and evidence for why they are deceptive. The analysis relies on the perspectives of the people and organizations that understand the chemical recycling industry best: chemical engineering experts, industry consultants, trade associations, and plastics producers themselves. The report highlights disparities between the plastics industry's public claims and the conclusions drawn by these experts, examining the public relations tool presented to the public as *advanced recycling,* the technical realities of *chemical recycling*, and the enormous divide between the two.

Photo credit: iStock

Photo credit: Killari Hotaru/Unsplash

Advanced recycling is not a new or groundbreaking technology.

The plastics industry presents advanced recycling as new and groundbreaking, despite the industry's decades-long efforts to make chemical recycling work at scale.

Plastics producers describe advanced recycling as a technical breakthrough that can overcome the problems of mechanical recycling.

The idea that advanced recycling constitutes a fundamental breakthrough in plastic recycling technology is an essential part of its positioning as a solution to the plastic waste crisis. A video produced by Chevron Phillips Chemical told viewers that "advanced recycling is a revolutionary innovation that can turn a used piece of plastic into a new material, again and again and again,"[13] and an American Chemistry Council (ACC) ad equated the term with "[n]ew ways to recycle more plastic."[14] Dow claimed that "[n]ew inventions and technologies are making it possible for plastic to be reused, repurposed, and reimagined to tap its value many times over" in sponsored content that appeared in *Fast Company* in 2023.[15] The year before, ExxonMobil CEO Darren Woods explicitly called advanced recycling "brand new technology" in an interview with CNBC.[16]

13 Chevron Phillips Chem., What is Advanced Recycling?, at 1:53, Vimeo (Oct. 7, 2020), https://vimeo.com/465979058.

14 America's Plastic Makers, That's Advanced Recycling, Dexerto (Dec. 28, 2023), Media Radar (accessed July 23, 2024).

15 Fastco Works, Tapping into Recycled Plastics' Value is the Future of Sustainability, Fast Company (Apr. 5, 2023), https://web.archive.org/web/20230504095000/https://www.fastcompany.com/90833806/innovation-in-recycling.

16 CNBC, How ExxonMobil Will Survive In The New Climate Reality, at 43:35, YouTube (June 24, 2022), https://www.youtube.com/watch?v=gTZK94-5yjU&t=2614s.

Sponsored content published in *Fast Company* in 2023 on behalf of Dow touted the plastic producer's partnership with advanced recycling company Mura Technology.


04-05-2023 | DOW

Tapping into recycled plastics' value is the future of sustainability

Recycling innovations are helping companies reuse far more plastic and repurpose it for good

BY FASTCO WORKS 3 MINUTE READ

America's Plastic Makers represents some of the American Chemistry Council's largest member companies, including ExxonMobil, Chevron Phillips, and LyondellBasell.

The alleged newness of the technology is important because it positions advanced recycling as an answer to the increasingly well-known failures of mechanical recycling to address the plastic waste crisis. In 2019, during a House Committee on Natural Resources hearing about plastic waste in the environment, then President and CEO of the Plastics Industry Association (PLASTICS) Tony Radoszewski explained that "[c]hemical recycling helps us overcome the limits of traditional recycling."[17]

Chevron Phillips' messaging hits a similar note, highlighting that advanced recycling "changes everything," helping us overcome the "limitations" of "today's recycling options."[18] An Eastman ad from 2023 made this connection even more explicit: "New chemical recycling technologies are creating an infinite loop for the plastic ecosystem, addressing waste streams that currently lack suitable recycling processes."[19]

The plastics industry has pursued chemical recycling since the 1970s with little success.

The industry's enthusiasm for chemical recycling as a solution for plastic waste — and an answer to public backlash about plastic pollution — goes back as far as the 1970s. Processes for the chemical recycling of plastics were patented as early as the 1950s,[20] and by the 1970s, the industry was presenting these processes as a solution for the looming plastic waste issue. An informational booklet published by the Society of the Plastics Industry (SPI) in 1977 explained that, given the economic challenges of mechanical recycling, the industry believed "that the more logical approach is to recover the energy and basic feedstocks that are locked inside the plastic rather than recover the plastics material itself."[21] That recovery process would be accomplished through chemical recycling: "Using the technique of pyrolysis, for example, mixtures of plastics ... are broken down into gases that can be recovered and then recycled into feedstocks that can be used again to make new plastics"[22] — language that closely resembles industry proposals today.

17 A Sea of Problems: Impact of Plastic Pollution on Oceans and Wildlife: Oversight Hearing Before the S. Comm. on Water, Oceans & Wildlife of the H. Comm. on Nat. Res., 116th Cong. 43 (Oct. 29, 2019) [hereinafter Oversight Hearing], https://www.govinfo.gov/content/pkg/CHRG-116hhrg38565/pdf/CHRG-116hhrg38565.pdf.

18 Chevron Phillips Chem., *supra* note 13, at 0:54 and 0:43.

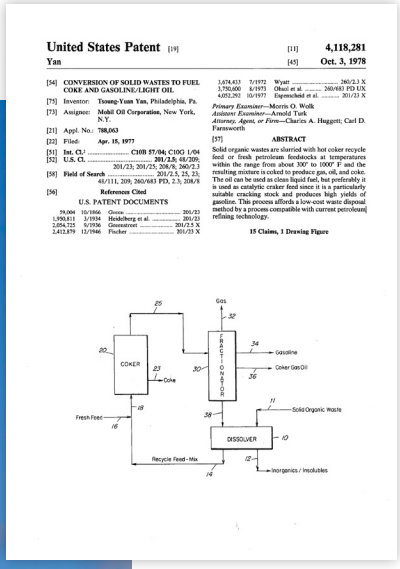
19 Mark J. Costa, Eastman, Infinite Plastic Recycling: The Technology is Ready, but What About Legislation?, Politico (June 28, 2023), https://archive.ph/2024.12.10-215220/https://www.politico.eu/sponsored-content/infinite-plastic-recycling-the-technology-is-ready-but-what-about-legislation/.

20 *See* Bryan D. Vogt et al., *Why is Recycling of Postconsumer Plastics So Challenging?*, 3 ACS Applied Polymer Materials 4325, 4333 (2021), https://pubs.acs.org/doi/10.1021/acsapm.1c00648.

21 Joel Frados, The Soc'y of the Plastics Indus., Inc., The Story of the Plastics Industry 13 (1977) (on file with CCI #5149.15).

22 *Id.*

Photo credit: JHVEPhoto/iStock



United States Patent [19]
Yan
[11] 4,118,281
[45] Oct. 3, 1978

[54] CONVERSION OF SOLID WASTES TO FUEL COKE AND GASOLINE/LIGHT OIL

[75] Inventor: Tsoung-Yuan Yan, Philadelphia, Pa.

[73] Assignee: Mobil Oil Corporation, New York, N.Y.

[21] Appl. No.: 708,063

[22] Filed: Apr. 15, 1977

[51] Int. Cl.² C10B 57/04; C10G 1/04

[52] U.S. Cl. 201/2.5; 44/20; 201/23; 201/25; 208/8; 260/2.3

[58] Field of Search ..... 201/2.5, 25, 23; 44/111, 209; 260/683 PD, 2.3; 208/8

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4,052,292	10/1977	Espenscheid et al.	201/23 X

Primary Examiner—Morris O. Wolk
Assistant Examiner—Arnold Turk
Attorney, Agent, or Firm—Charles A. Huggett; Carl D. Farnsworth

[57] ABSTRACT

Solid organic wastes are slurried with hot coker recycle feed or fresh petroleum feedstocks at temperatures within the range from about 300° to 1000° F and the resulting mixture is coked to produce gas, oil, and coke. The oil can be used as clean liquid fuel, but preferably it is used as catalytic cracker feed since it is a particularly suitable cracking stock and produces high yields of gasoline. This process affords a low-cost waste disposal method by a process compatible with current petroleum refining technology.

15 Claims, 1 Drawing Figure

Mobil patented a chemical recycling process intended to convert plastic waste into fuel or feedstocks for new plastics in 1978.

Along the same lines, Mobil received a patent for using existing petrochemical infrastructure to process plastic waste in 1978.[23] According to the complaint in *California v. ExxonMobil*, the company (now ExxonMobil) describes virtually the same process used at its advanced recycling facility in Baytown, Texas, today.[24] The 1978 patent described the impetus for the invention in much the same way that the plastics industry currently explains the need for advanced recycling: "Given the proliferation of ... plastic and paper packaging materials, one-way plastic and paper containers, by-product and substandard polymers, and solid organic wastes generally, improved methods of recovering the hydrocarbon values contained therein are needed, particularly in view of the increasing scarcity of oil and natural gas." The patent went on to explain that the "potentially valuable hydrocarbons in such materials would be better utilized if an economically attractive method could be devised for transforming them into useful liquid, solid, and/or gaseous hydrocarbon products having utility as fuel or as petrochemical raw materials."[25]

The plastics industry again promoted chemical recycling in the 1990s, but found that it was not viable.

When the industry faced renewed pressure to address plastic waste in the late 1980s and early 1990s, they again turned to chemical recycling. The Partnership for Plastics Progress, an industry front group, publicly promoted hydrolysis, methanolysis, and pyrolysis as "Technology That's Good for Ecology."[26] The organization also viewed pyrolysis, the most widespread chemical recycling process in use today,[27] as one of its high-priority, long-term "advocacy priorities," according to an internal strategy document from 1992.[28] Commentators also used strikingly similar language to the way that the plastics industry describes chemical recycling today. A 1992 article in *Automotive*

23 U.S. Patent No. 4,118,281 (filed Oct. 3, 1978), https://patentimages.storage.googleapis.com/58/bb/c2/77e7a4b5e456c9/US4118281.pdf.

24 California Complaint, *supra* note 12, at 75-77.

25 U.S. Patent No. 4,118,281, *supra* note 23, at col. 2, l. 25-36.

26 P'ship for Plastics Progress, Green Wheels: Automotive Plastics and the Environment (Draft Brochure) 8-9 (Aug. 19, 1991) (on file with CCI #244.193).

27 As of March 2024, 19 of the 33 announced or operating chemical recycling facilities in the United States used pyrolysis. Email from Anthony Schiavo, Senior Director and Principal Analyst, Lux Research to Davis Allen (Feb. 10, 2025) (on file with CCI #5508.1).

28 P'ship for Plastics Progress, Product Stewardship Taskforce, Budget v. Audience: Advocacy Priorities 3 (Jul. 29, 1992) (on file with CCI #224.29).

Photo credit: Brian Yurasits/Unsplash

Pepsi and Coke to Offer Recycled-Plastic Bottles

By BARNABY J. FEDER

Coke and Pepsi took their long rivalry to the environmental arena yesterday, with each company saying it would be the first to sell soft drinks in plastic bottles made with materials recycled from used bottles.

The recycling programs are set to begin next year and if successful might eventually reduce the amount of the plastic that ends up in the nation's landfills. They might also encourage more communities to set up recycling programs, by putting more cash in the pockets of companies that collect recyclable material. Both companies said recycling would not affect the cost of their products.

The Coca-Cola Company and its supplier, Hoechst Celanese Fibers Inc., have already applied to the Food and Drug Administration for approval of their new bottle, which will have about 25 percent recycled material. Goodyear Tire and Rubber, the supplier of the recycled material in the Pepsi bottle, said it expected to meet with the Federal agency in the spring to seek approval. Both companies said they would test-market the bottles once they had approval before trying to use them nationwide.

Consumer Enthusiasm

Even if consumers are enthusiastic or at least neutral when it comes to buying recycled bottles, the programs may never account for a large percentage of the companies' output unless consumers become more reliable about returning the bottles after they have slaked their thirst.

Polyethylene terephthalate, or PET, the material used in the bottles, is already recycled by a number of manufacturers into products ranging from park benches and piping to carpet and bedding. They are using everything they can get their hands on — the equivalent of 1.2 billion two-liter bottles, or 28 percent of PET output last year, according to estimates.

Unless Coke, Pepsi and the chemical companies working with them can substantially lift the number of bottles being recycled, they will simply be competing with the existing recyclers for the currently limited pool. And some experts say they will find that extremely costly.

'Public Relations Exercise'

"I think this must be a public relations exercise," said Thomas M. Duff, president and chief executive of Wellman Inc., the nation's largest independent plastics recycler. "They've lost track of the economics." Mr. Duff said products like carpets were more valuable than bottles, so that soft-drink companies would be outbid for the used PET if supplies were limited. The soft-drink companies argue that their recycling programs are more environmentally sound because reusing the material from bottles to make bottles — known as "closing the loop" — keeps the PET out of landfills indefinitely.

Nevertheless, they are trying to avoid a confrontation with other recyclers by encouraging a surge in supplies. Their preferred approach is to sharply expand curbside recycling.

DO NOT FORGET THE NEEDIEST!

Coca-Cola and Pepsi's attempts to chemically recycle plastic bottles were dismissed as "a public relations exercise" by a recycling executive in the December 5, 1990 issue of the *New York Times*.

Engineering explained that companies were working on "recycling programs that break a polymer down into its chemical building blocks,"[29] and a 1991 report published by a market research firm noted that Coca-Cola and Pepsi had developed processes which "will enable the companies to effectively close the loop in the PET bottle recycling process" — while also noting that the "economics of these processes have not been demonstrated."[30]

These concerns about the economic viability of chemical recycling were ultimately borne out, as companies such as DuPont, Coke, and Pepsi deemed their investments financially unsustainable. DuPont's chemical recycling facility, which recycled polyester, closed in 1998, just three years after it opened.

A representative explained that the company did not "feel market conditions allow us to operate the facility."[31] *Plastics News* reported that Coke and Pepsi likewise blamed the expenses associated with the processes when they abandoned their efforts to chemically recycle PET bottles by the mid-1990s.[32] Regardless of the specific circumstances, efforts to implement chemical recycling of plastics consistently ran up against the same issues. As an Exxon Chemical employee told staffers at the American Plastics Council (APC) during a 1994 meeting, pyrolysis is a "fundamentally uneconomical process."[33]

29 Recycling and the Automobile, Auto. Eng'g, Oct. 1992, at 41, 50 (on file with CCI #42.88).

30 Anthony M. Montrone et al., Decision Resources, Inc., Trends and Opportunities in Plastics Recycling 4 (1991), Box 4, Jack Milgrom Papers, Special Collections Research Center, Syracuse University Libraries (on file with CCI #784.14).

31 *Dupont Ends Recycling Experiment*, Plastics News (Nov. 2, 1998), https://www.plasticsnews.com/article/19981102/NEWS/311029985/dupont-ends-recycling-experiment.

32 Sarah S. Smith, *Coke & Pepsi Go Flat on Recycled Content*, Plastics News (March 8, 1999) (on file with CCI #511.1-2).

33 Bailey Condrey, Am. Plastics Council, ART Meeting—Houston, Notes 27 (Jan. 26, 1994) (on file with CCI #79.27).

Advanced recycling is not scaling up in line with industry commitments.

The plastics industry presents advanced recycling as new and groundbreaking, despite the industry's decades-long efforts to make chemical recycling work at scale.

ExxonMobil has committed to process 1 billion pounds of plastic waste annually at its advanced recycling facilities by the end of 2026, but has *cumulatively* processed just 70 million pounds since it began operations at its Baytown, Texas, facility in December 2022 — an average of just 28 million pounds per year.

Plastics producers have made bold commitments to use advanced recycling to process large amounts of waste within the next decade.

Plastics industry advertising and recycling targets announced by petrochemical companies and trade associations would have the public believe that advanced recycling facilities are rapidly scaling up capacity and will meaningfully address the proliferation of plastic waste soon. A sustainability director at Dow captured the promise in a 2022 interview, explaining that chemical recycling would succeed where mechanical recycling has not: "Mechanical recycling is an important component, but it doesn't allow you to recycle these plastics at scale. That's what advanced recycling does."[34]

Numerous petrochemical companies have made commitments to chemically recycle varying amounts of plastic waste within the next decade. Eastman has stated that it will chemically recycle 250 million pounds by 2025 and more than 500 million pounds by 2030,[35] and Dow has announced that it plans to add 600 kilotons, or roughly 1.3 million pounds, of annual recycling capacity by 2030 using advanced recycling technologies.[36]

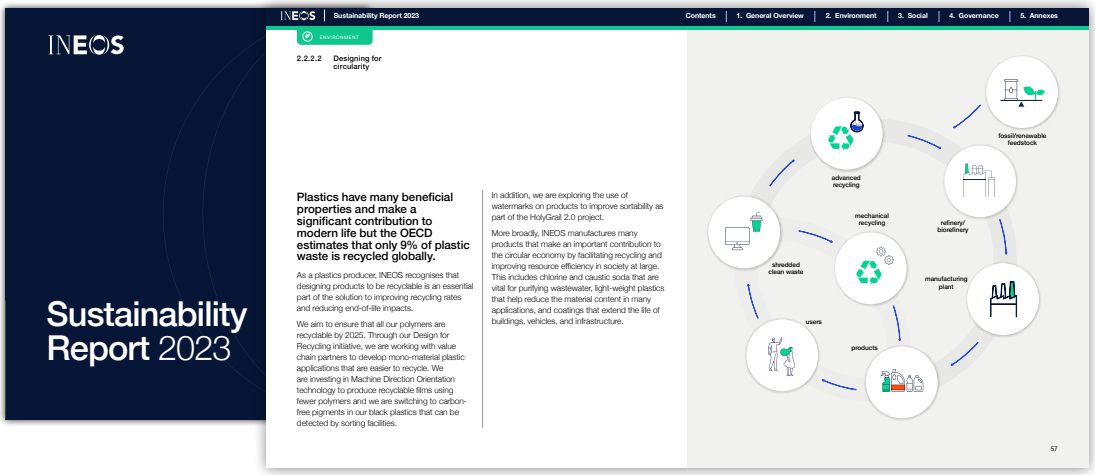
ExxonMobil has placed significant emphasis on its commitment to process 1 billion pounds of plastic waste annually at its advanced recycling facilities by the end of 2026,[37] but acknowledged in January 2025 that its only active advanced recycling facility, located in Baytown, Texas, has *cumulatively* processed just 70 million pounds of plastic

34 Megan Quinn, *Chemical Recycling Aims to Scale Fast in Effort to Manage Plastic Waste, Even as Questions Remain*, Waste Dive (Oct. 9, 2023), https://www.wastedive.com/news/chemical-recycling-plastic-waste-acc-exxonmobil-dow-eastman/651168/.

35 Eastman, *supra* note 5, at 17.

36 Dow Inc., 2022 Intersections Progress Report on Advancing our Ambitions 4 (2023), https://corporate.dow.com/content/dam/corp/documents/about/066-00432-01-2022-progress-report.pdf.

37 ExxonMobil, 2022 Sustainability Report 41 (2022), https://corporate.exxonmobil.com/-/media/global/files/sustainability-report/publication/exxonmobil-sustainability-report.pdf.



INEOS ackowledged the limitations of mechanical recycling in its 2023 sustainability report and presented advanced recycling as a viable, scalable alternative.

in the three years since it began operating.[38] Shell set an even more ambitious goal, claiming that it would use pyrolysis to process 1 million metric tons (over 2 billion pounds) of plastic waste by 2025 — until the company quietly retreated from that goal,[39] which it had deemed "unfeasible."[40]

Other companies, such as Chevron Phillips, Total, BASF, and LyondellBasell, have announced commitments to produce a certain amount of plastic from chemically recycled polymers. Chevron Phillips announced that it is aiming to produce 1 billion pounds of its polyethylene resin made with chemically-recycled material annually by 2030,[41] and Total has claimed that 30 percent of its polymers will be "circular" by 2030.[42] BASF has stated that it intends to replace 250,000 metric tons of virgin material, or around 500 million pounds, with "recycled and waste-based raw materials" per year by 2025, and says that chemical recycling represents a "focal point" for those efforts,[43] while LyondellBasell is aiming to "produce and market 2 million metric tons of recycled and renewable-based polymers annually" by 2030.[44]

Energy consulting firm Wood Mackenzie has noted that this would represent an increase of 1,500 percent compared to LyondellBasell's 2023 production figures.[45] Petrochemical companies support these proposed advanced recycling targets with public assertions of their commercial viability. The American Fuel & Petrochemical Manufacturers (AFPM), an industry trade group, touted Chevron Phillips' advanced recycling process in a 2020 post on its website, explaining that "[t]his isn't just done on a small scale in a lab; [Chevron Phillips] also announced that this can be done on a large scale making it commercially viable."[46]

38 Complaint at 22, *ExxonMobil Corp. v. Bonta*, No. 1:25-cv-00011 (E.D. Tex. filed Jan. 6, 2025) [hereinafter ExxonMobil Complaint].

39 Dharna Noor, *Shell Quietly Backs Away from Pledge to Increase 'Advanced Recycling' of Plastics*, The Guardian (Jul. 14, 2024), https://www.theguardian.com/business/article/2024/jul/17/shell-recycling-plastic-pledge.

40 Shell, Sustainability Report 2023 41 (2024), https://reports.shell.com/sustainability-report/2023/_assets/downloads/shell-sustainability-report-2023.pdf.

41 Chevron Phillips Chem., Chevron Phillips Chemical Deepens Collaboration with Nexus Circular, Securing Contracted Long-Term Supply of Advanced Recycled Plastic Feedstocks from New Facility (Feb. 7, 2023), https://archive.ph/2024.12.10-195638/https://www.cpchem.com/media-events/news/news-release/chevron-phillips-chemical-deepens-collaboration-with-nexus-circular.

42 TotalEnergies, Plastic Recycling: TotalEnergies and New Hope Energy Partner on U.S. Advanced Recycling Project (May 18, 2022), http://archive.today/2024.09.17-125610/https://polymers.totalenergies.com/latest-news/plastic-recycling-totalenergies-and-new-hope-energy-partner-us-advanced-recycling.

43 BASF, 2023 Combined Management's Report on Environmental, Social, Governance 124 (2023), https://report.basf.com/2023/en/_assets/downloads/esg-environment-social-governance-basf-ar23.pdf.

44 LyondellBasell, Responsible Consumption and Production (archived Sep. 19, 2024), http://archive.today/2024.09.19-204101/https://www.lyondellbasell.com/en/sustainability/un-sustainable-development-goals/responsible-consumption-and-production/.

45 Guy Bailey and Husam Taha, Wood Mackenzie, Waste to Wealth: Unlocking Circular Value Chains (2024), https://www.woodmac.com/horizons/unlocking-circular-value-chains/.

46 Robert Benedict, Am. Fuel & Petrochem. Mfrs., Addressing Plastic Waste Challenges: A Q&A with AFPM's Senior Director of Petrochemicals (Dec. 20, 2020), https://archive.ph/2024.12.10-200615/https://afpm.org/newsroom/blog/addressing-plastic-waste-challenges-qa-afpms-senior-director-petrochemicals#selection-1175.0-1175.88.

ExxonMobil,[47] Eastman,[48] and INEOS[49] have likewise claimed that their operations are or soon will be operating at a commercial scale. Several companies have even presented advanced recycling as a profitable venture. Eastman explained in their 2023 sustainability report that advanced recycling "could contribute approximately $500 million to $1 billion of new business revenue in the coming years."[50] A global sustainability officer at Dow pointed to the company's partnership with chemical recycling firm Mura Technology to illustrate that sustainability measures could be profitable: "Sustainability represents one of the biggest market opportunities we've seen in quite some time. It's a [significant] market opportunity for us to move from a linear model to a circular low-carbon solution."[51]

Industry experts project that chemical recycling is unlikely to scale up at the pace promised by plastics producers.

The plastics industry's claims that advanced recycling is being scaled up rapidly and can solve the plastic waste crisis ignore the substantial challenges that have limited chemical recycling capacity in the past, as well as the obstacles that continue to stand in the way of widespread implementation today. For as long as the companies have promoted "advanced recycling" as a concept, consulting and market intelligence firms advising the plastics industry have pointed to factors that limit scalability.

A 2017 report from consulting firm Accenture and the European Chemical Industry Council (Cefic)[52] concluded that — despite the industry's public claims of the readiness of the technology decades before — chemical recycling was "still fairly theoretical," noting

> **"[T]he ability to perform the process at industrial scale is still a technological challenge — and currently not economically feasible."**
>
> Accenture & European Chemical Industry Council, 2017

that while a "range of technologies are available, … the ability to perform the process at industrial scale is still a technological challenge—and currently not economically feasible."[53]

The same year, consulting firm Deloitte published a report with industry trade organization Plastics Recyclers Europe (PRE) evaluating the feasibility of sustainability goals for 2025, but excluded chemical recycling, noting that it was "still at early stages of development."[54] In a report published the following year, KPMG pointed out that there was some truth to the companies' claims to expertise in the area of chemical recycling, explaining that the challenges faced in mechanical recycling were "less an issue in chemical recycling, which primarily falls under the domain of large petrochemical companies."[55] But the consultants cautioned that "these companies tend to have … limited expertise with waste management and, as indicated by delays in previously promised recycling programs, relatively slow decision-making processes."[56]

Additional reports have continued to cast doubt on the viability of chemical recycling, even as the petrochemical companies publicized their huge targets and commitments. In 2020, McKinsey noted that

47 *See* ExxonMobil, *supra* note 4.

48 *See* Eastman, *supra* note 5, at 90.

49 *See* INEOS, Sustainability Report 2023 65 (2024), https://www.ineos.com/globalassets/sustainability/sustainability-reports/ineos_sustainabilityreport_2023_240430.pdf.

50 Eastman, *supra* note 5, at 90.

51 Fastco Works, *supra* note 15.

52 Eur. Chem. Indus. Council (Cefic), Studies (last visited Feb. 27, 2025), https://cefic.org/thought-leadership/studies/.

53 Accenture, Taking the European Chemical Industry into the Circular Economy 35, 39 (2017), https://cefic.org/app/uploads/2019/02/Accenture-Cefic-circular-economy-brochure.pdf.

54 Deloitte Sustainability, Blueprint for Plastics Packaging Waste: Quality Sorting & Recycling 24 (2017), http://www.plasticsrecyclers.eu/wp-content/uploads/2022/10/pre-blueprint-packaging-waste-2017.pdf.

55 Tom Hesselink, KPMG and Minderoo Found., From Waste to Commodity: Delivering on the EU's Vision of a Circular Plastics Economy 34 (2022), https://assets.kpmg.com/content/dam/kpmg/nl/pdf/2022/sectoren/from-waste-to-commodity.pdf.

56 *Id.*

A slide from an industry consultant's presentation at a 2023 chemical recycling conference pointed out that the process of scaling up operations across the industry remained in its "infancy."

"chemical-recycling technologies are still nascent and have only recently been pursued at commercial scale."[57] Accenture likewise explained in a 2020 report written with support from Cefic that, while there had been an "ever-increasing number of initiatives being announced by the chemical industry," these were "aimed at closing the loops for plastic waste where today no economic or technological solution exists."[58] Bain & Company cautioned that companies seeking to "achieve their 2030 targets" should not rely on chemical recycling given that it "won't be available on a large scale by the end of this decade."[59] An analyst at AMI Consulting similarly pointed out that "a significant degree of uncertainty regarding industry development remains" in a presentation at an industry conference sponsored by the American Chemistry Council (ACC) in 2023.[60] The analyst referred to the chemical recycling industry as "immature"[61] and pointed out that the "assessment of long-term economic viability" of chemical recycling operating at scale was made challenging by a "lack of information about investment & operating costs, input-output ratios, output quality and pricing."[62]

Even those experts who are relatively optimistic about the prospects of chemical recycling frequently acknowledge its extensive limitations and have cautioned against setting high expectations in the near-to medium-term. Wood Mackenzie, which "believe[s] pyrolysis will play a big role,"[63] predicts that the technology will handle just 7 percent of polyolefin plastic waste by 2050.[64] Regarding "the maturity and readiness of the technology [pyrolysis] and its infrastructure/logistics," a representative of the energy consulting firm explained that the "volumes we forecast will be available by 2030 are still way smaller than market demand, and this is due to operational and logistical issues that most players continue to suffer from."[65] Consulting and accounting firm EY similarly explained in 2023 that the

57 Mikhail Kirilyuk et al., McKinsey & Co., The European Recycling Landscape—the Quiet Before the Storm? (Aug. 13, 2020), https://archive.ph/2024.12.10-203135/https://www.mckinsey.com/industries/chemicals/our-insights/the-european-recycling-landscape-the-quiet-before-the-storm%23/.

58 Accenture, Winning in a Circular Economy: Practical Steps for the European Chemical Industry 2 (2020), https://cefic.org/app/uploads/2020/04/Accenture-Winning-In-A-Circular-Economy-Executive-Summary.pdf. This report was written with support from Cefic. Cefic, *supra* note 52.

59 Bain & Co., Paper & Packaging Report 2023: Unpack the Power of Sustainable Packaging 52 (2023), https://www.bain.com/globalassets/noindex/2023/bain_report_paper-and-packaging-report-2023.pdf.

60 Silke Einschuetz, AMI Consulting, Presentation at AMI Events: Chemical Recycling, Chemical Recycling in North America - Capacities, Players & Trends 7 (Mar. 20-22, 2023) (on file with CCI #5225.23).

61 *Id.*

62 *Id.*, at 18 (CCI #5225.34).

63 E-mail from Husam Taha, Principal Analyst - Plastics Sustainability, Wood Mackenzie, to Davis Allen (Sept. 23, 2024) (on file with CCI #5248.3).

64 Husam Taha et al., Wood Mackenzie, Webinar: Recycled Polyolefins: Pyrolysis Supply Chain - Where to Next? (Sept. 2024) (on file with CCI #5246.4). One analysis found that current operations, even if they were operating at their announced capacity, can process less than 1.3% of the plastic waste generated annually in the U.S. Lee Bell, Beyond Plastics and IPEN, Chemical Recycling: A Dangerous Deception 39 (Oct. 2023), https://www.beyondplastics.org/publications/chemical-recycling (citing U.S. Env't Prot. Agency, Advancing Sustainable Materials Management: 2018 Tables and Figures, Table 8 (Nov. 2020). https://www.epa.gov/sites/default/files/2021-01/documents/2018_tables_and_figures_dec_2020_fnl_508.pdf) (finding that, as of September 2023, the 11 operating plants in total have a rated capacity to process only 459,280 tons of the 35.7 million tons generated per 2018 data).

65 E-mail from Husam Taha, *supra* note 63.

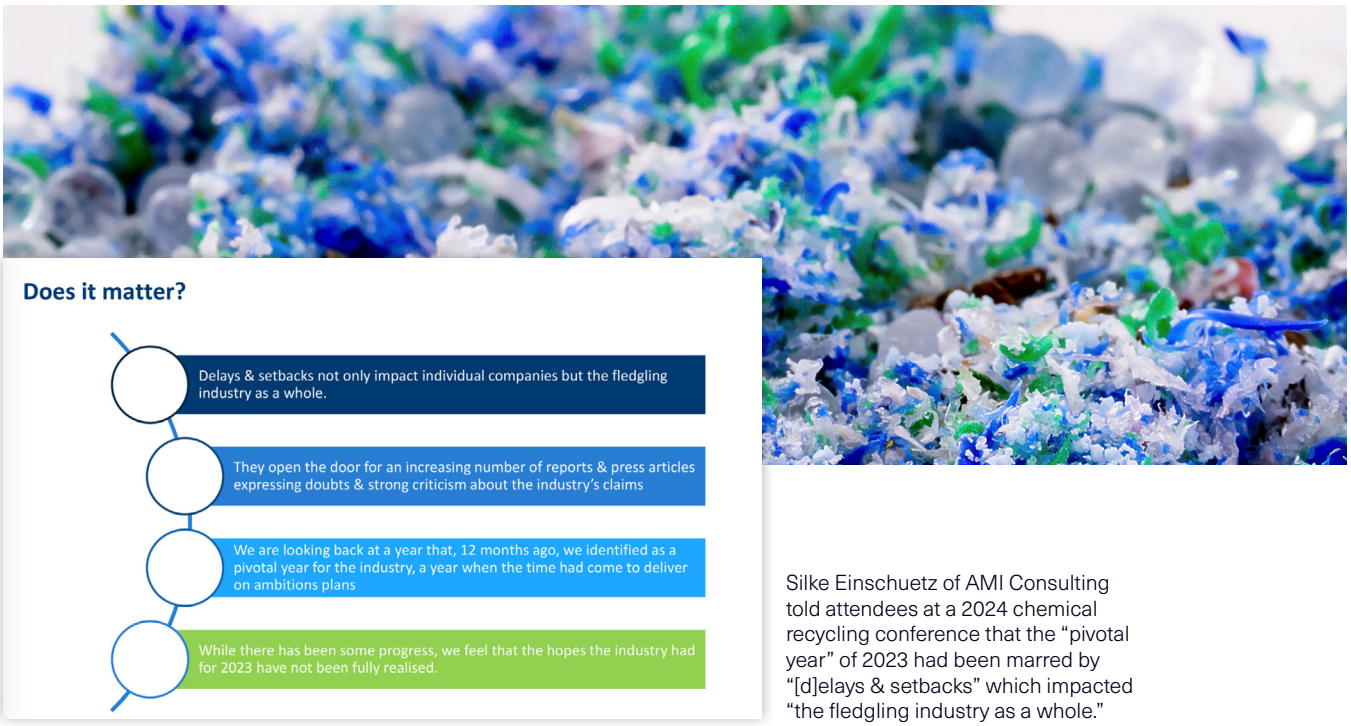


Photo credit: iStock

Silke Einschuetz of AMI Consulting told attendees at a 2024 chemical recycling conference that the "pivotal year" of 2023 had been marred by "[d]elays & setbacks" which impacted "the fledgling industry as a whole."

"chemical recycling market is at an early stage of development"[66] and that the technology was "operationally nascent."[67]

EY noted that mechanical recycling, even with its substantial limitations, dwarfed chemical recycling in terms of the amount of plastic waste it could handle, with 60 times the capacity.[68] The firm made a point to highlight the implications of these limitations for companies' publicized goals, encouraging them to be "realistic": "While there is growing momentum supporting various technologies, even the most economically feasible options will simply not be able to provide enough recycled plastic feedstock to meet brand owners' recycled content goals."[69]

Industry organizations recognize the substantial obstacles that will prevent chemical recycling from scaling up in the near future.

Industry organizations have reached similar conclusions about the readiness of chemical recycling to address plastic waste at a meaningful scale. The Flexible Packaging Association (FPA) — a plastics trade organization whose current members include companies such as ExxonMobil, Chevron Phillips, Shell, Dow, and LyondellBasell — noted in 2018 that "chemical recycling has not been widely used in the plastics and packaging industry due to economics and other processing challenges."[70] A few years later, the group explained that, despite investment from the industry, chemical recycling "likely will not be a major driver for recycling until the 2040 timeframe."[71]

66 Jim Doucette et al., EY, How Can Packaging Keep Things Fresh Without Listing a Lifetime? (Nov. 9, 2023), https://archive.ph/2024.12.10-204623/https://www.ey.com/en_us/insights/consumer-products/sustainable-flexible-plastic-packaging-strategy.

67 EY, If it's Broken, Fix it: How Chemical Recycling Can Fix the Broken Plastics Cycle 5 (2023), https://www.ey.com/content/dam/ey-unified-site/ey-com/en-us/insights/chemicals/documents/ey-if-its-broken-fix-it-v1.pdf.

68 *Id.* at 9.

69 *Id.*

70 Todd Bukowski and Michael Richmond, Flexible Packaging Ass'n, A Holistic View of the Role of Flexible Packaging in a Sustainable World 64 (2018), https://www.flexpack.org/publication/RG93bmxvYWQ6Mzc=/download.

71 PTIS, LLC and Priority Metrics Group, LLC, Flexible Packaging Ass'n, A Flexible Packaging Path to a Circular Economy Flexible Packaging Sustainability Roadmap 102 (2020), https://www.flexpack.org/publication/RG93bmxvYWQ6NDU4/download.

In 2023, the Recycled Materials Association (ReMA, then known as the Institute for Scrap Recycling Industries) submitted comments on a chemical recycling bill to the Kansas state legislature, arguing that while "chemical recycling technologies that seek to break down plastics to their molecular-level … have been utilized in laboratories and subsidized factories for years … challenges remain for many of the emerging chemical processes used for some hard-to-recycle plastics."[72] The Sustainable Packaging Coalition (SPC) — whose members include ExxonMobil, Eastman, Dow, and various other petrochemical and chemical recycling firms[73] — has noted similar issues. SPC points out that "important disadvantages [of chemical recycling] include elevated investment and production costs, despite expectations of reduction when scale is gained."[74]

As recently as 2024, a report prepared by environmental consultants Eunomia for the Association of Plastic Recyclers (APR) acknowledged that "[c]hemical recycling technologies are in the early stages of development and commercialization."[75] APR CEO Steve Alexander pointed out in the report's foreword that many of the same factors that have limited the effectiveness of mechanical recycling apply to chemical recycling as well: "To date, much of the information promoting chemical recycling technologies overlooks the necessary design, collection, sortation, and end markets that need to be in place for any type of recycling to scale."[76] A study by researchers at the Center for Plastics Innovation at the University of Delaware drew similar conclusions. The authors explained that "high cost[s], present in both mechanical and chemical recycling, [are] the result of multiple factors, including waste collection, sorting, and total energy consumption" — and that "[t]hese recycling costs are rarely recovered in the value of recycled materials."[77]

> **"To date, much of the information promoting chemical recycling technologies overlooks the necessary design, collection, sortation, and end markets that need to be in place for any type of recycling to scale."**
>
> Steve Alexander, Association of Plastic Recyclers, 2024

Chemical recycling operations are often cost prohibitive, making them unattractive to companies long term.

The economic viability of chemical recycling — like its mechanical counterpart — is severely hampered by the cheapness of the virgin resins produced by the very petrochemical companies promoting advanced recycling as a solution. As the industry-affiliated research center Chemical Upcycling of Waste Plastics (CUWP) notes, "small scale pyrolysis plants are typically not economically competitive when compared to chemical plants producing virgin products from fossil fuels."[78]

In 2023, consulting firm Oliver Wyman expanded on this point, highlighting the reality that the "capital investment required to get chemical recycling to commercial scale is steep, and initially selling recycled plastic would compete with the chemicals industry's virgin plastics

72 Inst. of Scrap Recycling Indus., Statement on Kan. S.B 114 (Feb. 20, 2023), https://www.kslegislature.gov/li_2024/b2023_24/committees/ctte_h_cmrce_lbr_1/documents/testimony/20230320_04.pdf.

73 Sustainable Packaging Coal., Our Members (archived Feb. 24, 2025), https://archive.ph/2025.02.24-153446/https://sustainablepackaging.org/membership-directory/.

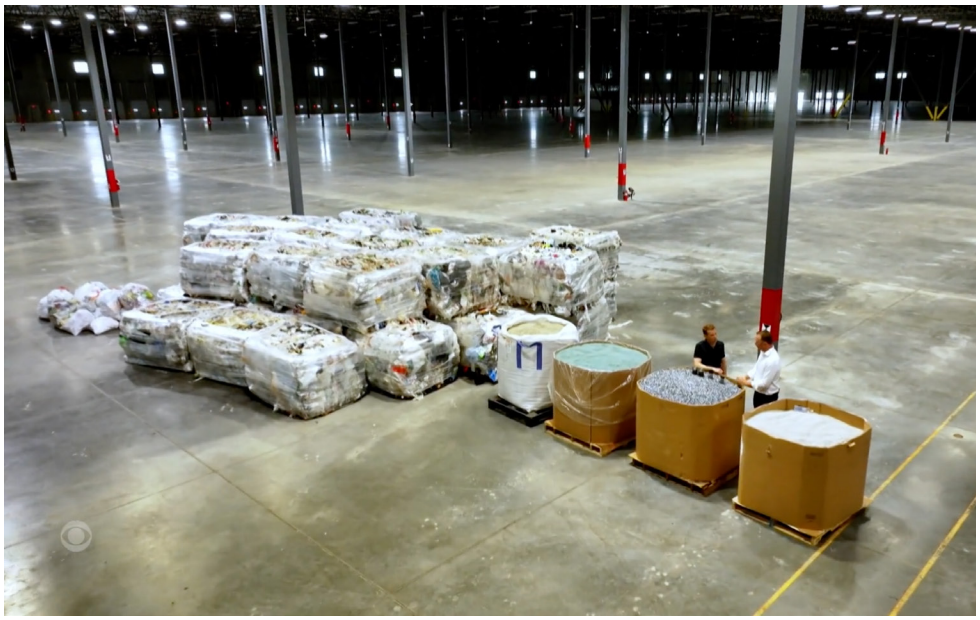
74 Paula Leardini and Olga Kachook, Sustainable Packaging Coal., Chemical Recycling Questions & Answers 6 (June 2024), https://sustainablepackaging.org/wp-content/uploads/2024/06/SPC-Chemical-Recycling-Q_A.pdf.

75 Ass'n of Plastic Recyclers, How to Scale the Recycling of Flexible Film Packaging: Modeling Pyrolysis' Role in Collection, Quantity and Costs of a Comprehensive Solution 20 (2024), https://web.archive.org/web/20240331130418/https://plasticsrecycling.org/images/library/Pyrolysis-Role-in-_FFP-Recycling-Report.pdf.

76 *Id.* at 4.

77 Tianwei Yan et al., *Circularity in Polymers: Addressing Performance and Sustainability Challenges Using Dynamic Covalent Chemistries*, 20 Chem. Sci. 5243, 5244 (2024), https://pubs.rsc.org/en/content/articlelanding/2023/sc/d3sc00551h.

78 Jiayang Wu et al., Chemical Upcycling of Waste Plastics, *Pyrolysis of Plastic Waste: Recycling Hard-to-Recycle Plastics* 7 (2023), https://cuwp.org/wp-content/uploads/2024/01/2_PYROLYSIS_112023.pdf.



ExxonMobil touted its advanced recycling process in CBS Reports' "Advanced Recycling: Does it Really Work?"

Industry investments to increase the production of new plastic far outweigh investments in advanced recycling.

For example, ExxonMobil recently announced that it would be investing an additional $200 million on advanced recycling, but this amount pales in comparison to the $8.6 billion the company is preparing to spend on a single new plastic production facility.

revenue."[79] Consultants at IHS Markit (now S&P Global) pointed out similar issues in 2019, explaining that "[c]ost and complexity are major negative factors: a chemical recycling plant has a much higher CAPEX than a comparable mechanical recycling operation."[80]

It is entirely possible that governments and society at large could decide that these projects are worth pursuing, whether profitable or not, but history has shown us that the petrochemical industry will not indefinitely subsidize practices that are not financially sustainable, regardless of their value for public and government relations. "For plastics recycling to be financially attractive," IHS Markit explained, "there must be a workable margin for everyone in the recycling chain — including municipalities, sorters, processors, and mechanical and chemical recyclers."[81]

As Emma Lewis, a senior vice president at Shell, explained to attendees at the World Chemical Forum in September 2023, "Ultimately, decarbonization, sustainability has to be profitable for all of us. We have shareholders, and we have to deliver returns."[82]

This dynamic is currently playing out at ExxonMobil's Baytown advanced recycling facility. According to the complaint in *California v. ExxonMobil*, the company did not expect to meet its goal to process 1 billion pounds of plastic waste by 2026 or that its advanced recycling endeavors would be profitable.[83] California alleges that the company has pursued its Baytown project anyway because of its public relations value to the company based on ExxonMobil's acknowledgment that "the public perception benefits received will be invaluable … even if it proves to not be financially sustainable."[84] At the same time, profitability limits how much the company will be willing to invest going forward — and

79 Iris Hermann and Hendrick Flock, Oliver Wynman, The Industry That Created Plastic May Fix Its Waste Problem (archived Dec. 10, 2024), https://archive.ph/2024.12.10-212907/https://www.oliverwyman.com/our-expertise/journals/energy-and-natural-resources-journal-volume-7/the-industry-that-created-plastic-may-fix-its-waste-problem.html.

80 Kaushik Mitra and Mark Morgan, Is Chemical Recycling a Game Changer?, Gulf Petrochem. & Chem. Ass'n (Aug. 4, 2019), https://archive.ph/2024.12.16-210224/https://www.gpca.org.ae/2019/08/04/is-chemical-recycling-a-game-changer/#selection-1887.3-1887.16.

81 *Id.*

82 Alexander H. Tullo, *Fallow Days Loom for Petrochemical Firms*, Chem. & Eng'g News (Oct. 30, 2023), https://archive.ph/2023.11.02-013524/https://cen.acs.org/business/petrochemicals/Fallow-days-loom-petrochemical-firms/101/i36#selection-2421.6-2421.46.

83 California Complaint, *supra* note 12, at 103-04.

84 *Id.* at 77.

Exxon's advanced recycling program is extremely costly. Internal ExxonMobil documents projected that the company's advanced recycling projects would lose upward of $100 million in 2023, which has led the company to consider a "decompression" of its advanced recycling timeline and caused it to refrain from "plac[ing] bets on" larger projects or facilities.[85] In April 2024, Exxon announced the closure[86] of one of the two facilities that it previously said would support its advanced recycling targets,[87] citing poor economics and over 500 million euros in losses since 2018.[88]

Recent history suggests that petrochemical companies are unlikely to meet their advanced recycling pledges.

ExxonMobil's predicament is familiar. The concerns about the viability of chemical recycling have played out much as anticipated by those with the most knowledge of the industry — if not worse. Attempts to scale up chemical recycling operations have been plagued by setbacks, and the last 10 years have been defined by announced facilities that never materialize,[89] operations

> **"[W]e've had a few successes and a ton of failures; capacity has not developed as major projects have been delayed or cancelled."**
>
> Anthony Schiavo, Lux Research, 2024

that fail to meet their production goals,[90] and short-lived ventures that end with abandoned projects[91] — all of this despite investment from the largest petrochemical companies and hundreds of millions of dollars of public funds.[92] The failure of the technology to meaningfully scale up has left the industry with an "[u]rgent need for success stories," Silke Einschuetz, a senior recycling and sustainability consultant at AMI Consulting, told attendees at a March 2024 chemical recycling conference.[93] "Delays & setbacks not only impact individual

85 *Id.* at 101.

86 Nel Weddle, *ExxonMobil to Close Gravenchon, France Cracker and Related Derivative Units in 2024*, Indep. Commodity Intel. Serv. (Apr. 11, 2024), https://archive.ph/2024.12.10-213302/https://www.icis.com/explore/resources/news/2024/04/11/10989084/exxonmobil-to-close-gravenchon-france-cracker-and-related-derivative-units-in-2024/#selection-1261.0-1261.89.

87 Exxon Mobil, Current Report (Form 8-K) (Oct. 29, 2021), https://ir.exxonmobil.com/node/33506/html.

88 Weddle, *supra* note 86.

89 *See, e.g.*, Renew One, Renew Phoenix is Working on a Plastics Renewal Project in Phoenix (last visited Feb. 20, 2025), https://renewone.co/phoenix/ (aiming to "complet[e] construction for the project by the end of 2022"); James Bruggers, *Fulcrum Bioenergy, Aiming to Produce 'Net-Zero' Jet Fuel From Plastic Waste, Hits Heavy Turbulence*, Inside Climate News (Nov 20, 2023), https://insideclimatenews.org/news/20112023/fulcrum-gary-indiana-net-zero-jet-fuel/ (noting Fulcrum Bioenergy's proposed Gary, Indiana plant that was supposed to have begun construction in 2020 and be completed within two years); Rachel Austin, *Braven No Longer Coming*, The Farmville Herald (Jan. 7, 2022), https://www.farmvilleherald.com/2022/01/braven-no-longer-coming/ (noting that Braven Environmental would not be building its operation to "process plastic waste with a low carbon impact and the potential to create a circular system for plastic"); Valerie Volcovici, *Brightmark, Georgia County Cancel $680 Mln Plastic-to-fuel Project*, Reuters (Apr. 12, 2022), https://www.reuters.com/world/us/brightmark-georgia-county-cancel-680-mln-plastic-to-fuel-project-2022-04-11/ (reporting that Brightmark Energy "scrapped plans to build 'the world's largest' facility to turn plastic waste into fuel" after missing a deadline to deliver "end product" to customers at a similar facility in Indiana).

90 *See, e.g.*, James Bruggers, *Inside Indiana's 'Advanced' Plastics Recycling Plant: Dangerous Vapors, Oil Spills and Life-Threatening Fires*, Inside Climate News (June 16, 2023), https://insideclimatenews.org/news/16062023/indiana-advanced-plastics-recycling-vapors-spills-fires/ (finding that Brightmark's pyrolysis facility "can't get past the production phase" and is "struggling to fulfill its promise of operating 'the world's largest plastics renewal facility' on a commercial scale").

91 *See, e.g.*, Jacob Wallace, *Fulcrum BioEnergy Shutters Nevada Waste-to-SAF facility, CEO Departs*, Waste Dive (June 5, 2024), https://www.wastedive.com/news/fulcrum-bioenergy-sierra-biofuels-reno-nevada-shutdown-eric-pryor/717916/#:~:text=Fulcrum%20BioEnergy%27s%20waste%2Dto%2Djet,also%20appears%20to%20have%20departed (reporting that Fulcrum BioEnergy's waste-to-sustainable-aviation-fuel plant in Nevada shut down after defaulting on bonds); Jim Johnson, *Oregon Plant that Converts Waste Plastic to Oil Shuts Down*, Plastics News (Aug. 6, 2014), https://www.plasticsnews.com/article/20140806/NEWS/140809959/oregon-plant-that-converts-waste-plastic-to-oil-shuts-down (reporting the shutdown of a plastic-to-oil plant in Oregon operated by Agilyx Corp. and owned by Waste Management); Joe Brock et al., *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/ (noting the failure of Renewology's advanced recycling operations in Boise, Idaho, and finding that 30 projects by two dozen companies were all "operating on a modest scale or [had] closed down" with more than half being "years behind schedule on previously announced commercial plans").

92 *See* Ivy Schlegel, Greenpeace, Deception by the Numbers: American Chemistry Council Claims About Chemical Recycling Investments Fail to Hold up to Scrutiny 9 (Sept. 9, 2020), https://storage.googleapis.com/planet4-usa-stateless/2024/12/fd0433ac-gp_deception-by-the-numbers-3.pdf (finding that at least $506 million of public funds had been spent on chemical recycling projects since 2017, including over $270 million on projects considered "questionable or unlikely to be built").

93 Silke Einschuetz, AMI Consulting, Presentation at AMI Events: Chemical Recycling, Chemical Recycling - Slow Progress in a Pivotal Year 4 (March 12-13, 2024) (on file with CCI #5226.35).

Photo credit: Mark Dixon/Flickr CC BY 2.0

companies but the fledgling industry as a whole" and "open the door for an increasing number of reports & press articles expressing doubt & strong criticism about the industry's claims," her presentation explained.[94]

In May 2024, Anthony Schiavo of Lux Research, which consults on sustainability issues for the chemicals industry, summarized the state of chemical recycling, explaining that the problem is twofold: capacity is lagging well behind announced figures *and* the few facilities that are operating are doing so well below their announced capacity.[95] Combined, these factors mean that far less waste plastic is being chemically recycled than public pronouncements about its viability would have us believe. As Schiavo stated, "we've had a few successes and a ton of failures; capacity has not developed as major projects have been delayed or cancelled."[96]

This has led Schiavo and Lux to conclude that their already-conservative 2030 projections for chemical recycling are unlikely to be met: "From where I sit, things look grim: The fact that we don't have a really successful case study at this point makes me think it's going to be all uphill to make pyrolysis work."[97]

94 *Id.* at 3 (CCI #5226.34).

95 Anthony Schiavo, Lux Research, 2024 is the Year the Pyrolysis Bubble Bursts (May 29, 2024), https://archive.ph/2024.12.10-213742/https://luxresearchinc.com/blog/2024-is-the-year-the-pyrolysis-bubble-bursts/#selection-751.0-751.44.

96 *Id.*

97 *Id.*

Photo credit: Brian Yurasits/Unsplash

Advanced recycling does not address the problem of hard-to-recycle mixed plastics.

The plastics industry argues that advanced recycling can address hard-to-recycle mixed plastics — specifically the more than 90 percent of plastics that are not recycled through mechanical recycling — despite clear technical limitations.

The plastics industry presents advanced recycling as a solution to the problem of post-consumer mixed plastic waste, which mechanical recycling has been unable to address.

The concept of advanced recycling arose out of the petrochemical industry's need to present the public with answers to the plastic waste crisis. This is reflected in industry messaging emphasizing the range of plastics that advanced recycling can purportedly address, including frequent references to post-consumer plastic waste. In a 2023 advertisement, America's Plastic Makers, which represents plastic-producing members of the American Chemistry Council (ACC), claimed that advanced recycling company Alterra is using plastic waste "from U.S. households," which it can then "convert into new plastics."[98] Similarly, in a 2023 video describing the advanced recycling process, Shell highlighted how "a special heating process called pyrolysis" can process plastics like those "used in many places like homes, hospitals, transportation, construction, agriculture and electronics."[99] INEOS also

98 America's Plastic Makers, Advanced Recycling Takes Hard-to-Recycle Plastics and Turns Them into New Plastics, at 0:07, YouTube (Apr. 6, 2023), Media Radar (accessed July 23, 2024).

99 Shell, Circular Process of Recycling Plastic Waste, at 1:01-20, YouTube (Sept. 8, 2023), https://www.youtube.com/watch?v=GxXFlQjlMO4&t=3s.

emphasized pyrolysis specifically, explaining that the "advantage is that [pyrolysis] can process a wide range of post-consumer mixed plastic waste that could not otherwise be recycled and would end up in landfill or be burnt."[100]

These kinds of claims are meant to highlight the contrast between advanced and mechanical recycling processes. With the public increasingly aware that only a select few plastic products have any chance of being recycled, petrochemical companies have presented advanced recycling as a tool to supplement the existing mechanical recycling infrastructure and recycle those plastic products that traditional processes have been unable to handle. As an ACC ad from 2022 explained, "90% of plastic isn't recycled today. Advanced recycling is changing that."[101] Importantly, advanced recycling is presented as a complement to mechanical recycling rather than a replacement, leaving a few particular items for mechanical systems while accepting those plastics that would otherwise end up landfilled, incinerated, or in the environment — and thus "ensur[ing] more packaging gets recycled," as Dow puts it.[102] ACC specifies that advanced recycling allows "more types of used plastics (3-7's) to be recaptured and remanufactured into new plastics and products."[103]

Eastman summarized this logic in sponsored content that appeared in *Politico*, explaining that "[c]urrent mechanical recycling processes work well for a portion of the waste stream — mainly clear bottles that are well sorted — however even with this stream of material, mechanical recycling output degrades over several cycles."[104] Another limitation of mechanical recycling, as explained by Dow in 2022, is that "careful sorting is necessary and the process does not work for all

Ads like this one from Dow, which appeared on Twitter in 2022, present advanced recycling as a solution for plastics that are not frequently recycled mechanically.

America's Plastic Makers has acknowledged the limitations of mechanical recycling in its advertising while ignoring the reality that advanced recycling is subject to many of the same constraints and limitations.

100 INEOS, *supra* note 46, at 65.

101 Am. Chem. Council, Inc., 90% of Plastic Isn't Recycled, Los Angeles Daily News (May 25, 2022), Media Radar (accessed July 23, 2024).

102 Marco Ten Bruggencate, *How the EU Can Enable a Circular Economy in Plastics Packaging*, Politico (Dec. 1, 2022), https://archive.ph/2024.12.10-214716/https://www.politico.eu/sponsored-content/how-the-eu-can-enable-a-circular-economy-in-plastics-packaging/.

103 Am. Chem. Council, Advanced Recycling (archived Sept. 18, 2024), https://archive.ph/2024.09.18-113642/https://www.americanchemistry.com/better-policy-regulation/plastics/advanced-recycling.

104 Mark J. Costa, *supra* note 19.

plastics."[105] But advanced recycling "changes this calculus" and "works for plastics that can't currently be recycled mechanically," according to Dow.[106] Eastman claims that chemical recycling can "[address] several waste streams that don't have a suitable recycling process today, creating an infinite loop for the plastic ecosystem."[107] Chevron Phillips likewise explains that "[a]dvanced recycling is a promising technology that complements mechanical recycling by processing items that are difficult-to-recycle and not suitable for mechanical methods."[108] ACC,[109] ExxonMobil,[110] Shell,[111] Total,[112] Chevron Phillips,[113] LyondellBasell,[114] and Eastman[115] have all used this same language, repeating that advanced recycling is capable of addressing "hard-to-recycle" or "difficult-to-recycle" plastics. Included in this category are items such as "flexible plastics,"[116] "multi-layered food packaging,"[117] "colored and opaque PET,"[118] and "landfill-bound films,"[119] according to Dow, Chevron Phillips, Eastman, and LyondellBasell, respectively. ExxonMobil provided additional examples in its complaint in *ExxonMobil v. Bonta*, explaining that "[a]dvanced recycling allows a wider variety of plastics to be recycled, including hard-to-recycle chip bags, motor oil bottles, and artificial turf."[120]

The essential argument behind these claims is that advanced recycling makes it possible to overcome one of the primary problems with mechanical plastic recycling: the need for clean, uniform feedstock. Because of advanced recycling's purported tolerance for high levels of contamination and mixed plastic waste, including types of plastic products that are not mechanically recyclable, Dow claims that it makes possible "recycling the unrecyclable."[121] Eastman asserts that its process "can recycle almost any kind of plastic."[122] A representative of Agilyx told *CBS Mornings* that "the level of contamination doesn't affect our process,"[123] Chevron Phillips lists "[m]ore tolerant of contamination" among the advantages of advanced recycling,[124] and ExxonMobil explains that it is able "to convert even complex blends containing a range of impurities or contaminants" into new plastics.[125]

105 Dow Chem. Co., The Coming Plastics Revolution, New Scientist (UK) (Sept. 17, 2022), Media Radar (accessed June 14, 2024).

106 *Id.*

107 Mark J. Costa, *supra* note 19.

108 Chevron Phillips Chem., Positioned to Perform: 2022 Sustainability Report 57 (2023), https://www.cpchem.com/sites/default/files/2023-07/CPChem-2022-Sustainability-Report.pdf.

109 *See, e.g.* America's Plastic Makers, Did You Know that Advanced Recycling Can Help Us Reuse Hard-to-Recycle Plastics?, The Guardian (July 6, 2022), Media Radar (accessed July 23, 2024).

110 *See, e.g.* ExxonMobil, *supra* note 4 ("With advanced recycling, difficult-to-recycle plastic waste from a wide range of sources is broken down at a molecular level, enabling us to convert even complex blends containing a range of impurities or contaminants into valuable raw materials that can be used to make products essential to modern life.").

111 *See, e.g.* Shell, *supra* note 99 ("Shell is transforming hard-to-recycle plastic waste into circular chemicals.").

112 *See, e.g.* TotalEnergies, Circular Solutions, Advanced Recycling (archived Sept. 17, 2024), https://archive.ph/2024.09.17-125157/https://polymers.totalenergies.com/circular-solutions/advanced-recycling ("TotalEnergies is at the forefront of the development of advanced recycling by pyrolysis. This technology allows to process hard-to-recycle waste that would otherwise be destined for landfill or incineration.").

113 *See, e.g.* Chevron Phillips Chem., *supra* note 13 ("It works for a variety of plastics, even hard-to-recycle items like plastic films and complex packaging.").

114 *See, e.g.* Peter Vanacker, Opinion: What it takes to solve plastic pollution, Sustainable Plastics (Oct. 28, 2024), https://archive.ph/2024.12.11-170220/https:/www.sustainableplastics.com/news/lyondellbasell-ceo-weighs-what-it-takes-solve-plastic-pollution (LyondellBasell's first commercial-scale chemical recycling unit in Germany "will have the potential to convert the hard-to-recycle plastic waste of 1.2 million German citizens each year into valuable raw materials to make new products.").

115 Eastman, *supra* note 5, at 24 ("Mechanical recycling is efficient but limited to certain types and forms of plastics, while molecular recycling like Eastman's polyester renewal technology (PRT) can handle hard-to-recycle polyesters like carpet, textiles, pots and trays, and colored and opaque PET.").

116 Dow Chem. Co., Helping Keep Flexible Plastics from Packaging out of Landfills and the Environment, Twitter (Feb. 23, 2022), Media Radar (accessed June 14, 2024).

117 Chevron Phillips Chem., Stepping Up for People, for the Planet, and for Circularity: Sustainability Report 79 (2023), https://sustainability-report.cpchem.com/2023/_assets/downloads/entire-cpchem-sr23.pdf?h=N7DS2xP3.

118 Eastman, *supra* note 5, at 24.

119 LyondellBasell, LyondellBasell Secures Advanced Recycled Feedstock with Nexus Circular (Feb. 22, 2023), https://web.archive.org/web/20230724064527/https://www.3blmedia.com/news/lyondellbasell-secures-advanced-recycled-feedstock-nexus-circular.

120 ExxonMobil Complaint, *supra* note 38, at 22.

121 Dow Chem. Co., *supra* note 116.

122 Eastman, *supra* note 5, at 20.

123 CBS Mornings, Chemical Recycling Could be an Industry Game Changer, at 1:24-26, YouTube (Apr. 3, 2019), https://www.youtube.com/watch?v=5K-ZvtgRz9o.

124 Chevron Phillips Chem., *supra* note 108, at 57.

125 ExxonMobil, Expanding the Plastics Lifecycle (archived Oct. 31, 2024), https://archive.ph/54BdI#.

Summing up the industry's presentation of advanced recycling's tolerance for contamination, the Plastics Industry Association (PLASTICS) claims that the quality of chemical recycling outputs are "nearly independent of the quality of the input stream."[126]

Post-consumer mixed plastic waste streams pose significant challenges for chemical recyclers.

Each individual chemical recycling process is only suitable for specific kinds of plastics. As a result, chemical recycling is typically limited to processing clean, uniform streams of post-industrial or post-commercial scrap plastics rather than mixed post-consumer plastic waste that has been collected for recycling. Eastman acknowledged this practice in an appendix to its 2023 sustainability report, noting that "[p]ostindustrial and pre-consumer scrap also feeds into the process."[127] Most chemical recycling facilities to-date have relied upon this kind of pre-consumer waste for feedstock. As Steve Alexander, president of the Association of Plastic Recyclers (APR), explained in 2021, chemical recycling "feedstock has essentially come from internal, post-industrial plant scrap, not something that's been out in the consumer world."[128]

Chemical recycling facilities have relied on these pre-consumer feedstocks because of their limited capacity to accept contamination and mixed plastics. This creates a stark contrast between companies' public statements and the technical realities of chemical recycling operations. California's complaint in *California v. ExxonMobil* alleges that Cyclyx — a plastic sorting joint-venture between Exxon, LyondellBasell, and Agilyx — sent a proposed press release to ExxonMobil for approval that included explicit

> **"[C]hemical recycling requires additional sorting and decontamination, and scaling will take a considerable amount of time to attain production costs that are comparable to the cost of creating new plastics from fossil fuels."**
>
> EY, 2023

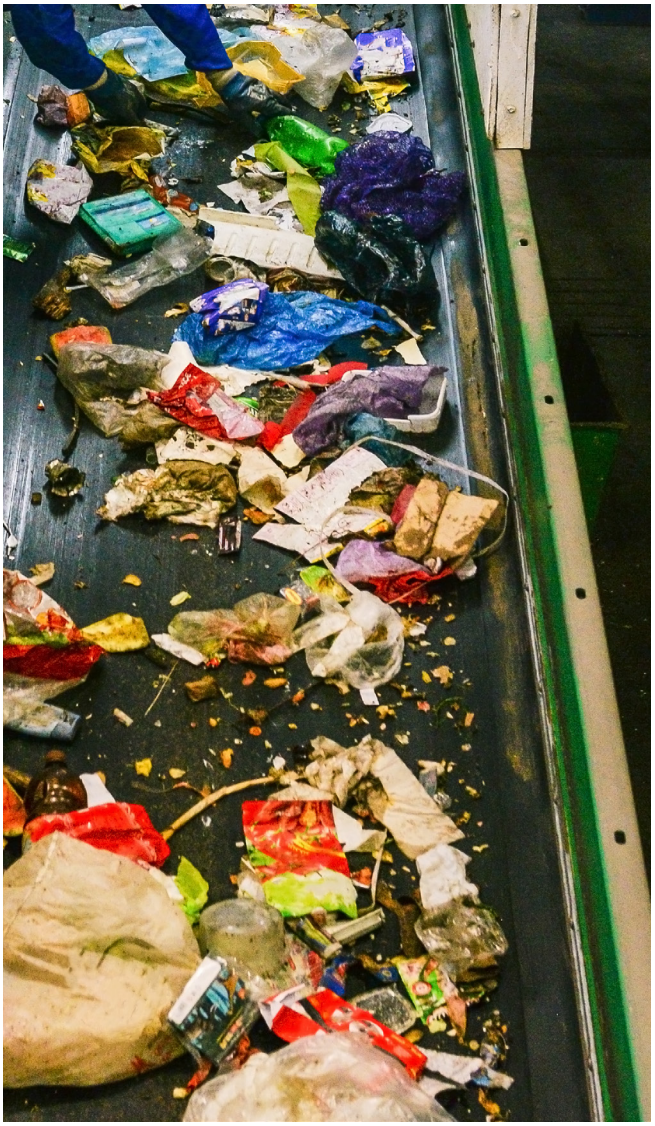


Photo credit: iStock

126 Perc Pineda, PLASTICS Research Working Group: Finding Meaning in the Literature, Plastics Indus. Ass'n (Sept. 10, 2021), https://archive.ph/2024.09.25-203227/https://www.plasticsindustry.org/blog/plastics-research-working-group-finding-meaning-literature/.

127 Eastman, *supra* note 5, at 90.

128 Steve Toloken, *APR Wants Chemical Recycling Limited to Plastics-to-Plastics*, Plastics News (June 1, 2021), https://web.archive.org/web/20210601142314/https://www.plasticsnews.com/news/apr-wants-chemical-recycling-limited-plastics-plastics.

acknowledgement of its use of plastic waste from "*existing commercial and industrial sources.*"[129] This was consistent with ExxonMobil's agreement with Cyclyx, which called for the collection of pre-consumer material and specified that polystyrene should be avoided.[130] But the original language was rejected by Exxon's vice president for sustainability, who explained that it "seems a bit restrictive regarding feed sources (i.e. one 'existing commercial and industrial') and could be interpreted as not collaborative with existing municipal waste."[131]

The Exxon executive explained that they had "changed the language to something a bit more aspirational and collaborative."[132] The public version of the press release excluded any mention of commercial or industrial sources to better conform to Exxon's established way of describing advanced recycling: "Cyclyx will source post-use mixed waste plastic for [its circularity center] via a range of existing sources and is continuing to expand its collaboration with companies from across the value chain to develop circular solutions for difficult-to-recycle plastic waste."[133]

Sourcing plastic for chemical recycling operations from post-consumer waste streams is expensive in practice, greatly impeding its viability. As Eric Hartz of Nexus Circular, an advanced recycling company, explained to *Chemical & Engineering News*, "If you want garbage, then you're going to have to set up a very, very expensive process before you can even use it."[134] EY reiterated this idea in 2023: "chemical recycling requires additional sorting and decontamination, and scaling will take a considerable amount of time to attain production costs that are comparable to the cost of creating new plastics from fossil fuels."[135]

An industry consultant's presentation at a 2023 conference sponsored by the American Chemistry Council noted that contaminated feedstock constitutes "a key bottleneck" for chemical recycling operations, despite the "misconception" otherwise.

This was the experience of plastic recycler Ultra-Poly Corporation, which discontinued its pyrolysis operation in 2016 after just three years.[136] In a presentation at a 2024 chemical recycling conference — attended by representatives from companies including ExxonMobil, Chevron Phillips Chemical, Shell, LyondellBasell, BASF, and BP[137] — a representative for Ultra-Poly explained that "[f]eedstock costs are higher than most potential investors assume" because of "[c]ontamination [r]emoval" and "[y]ield [l]oss," among other factors.[138] Even the largest operations are subject to this constraint. According to California's complaint, ExxonMobil is currently paying a price for post-consumer feedstock that is significantly higher than its internal "breakeven" requirements, suggesting that its current processes will not be financially sustainable.[139]

129 California Complaint, *supra* note 12, at 84, 102.

130 *Id.* at 84.

131 *Id.*

132 *Id.*

133 *Id.*

134 Alexander H. Tullo, *Amid Controversy, Industry Goes All in on Plastics Pyrolysis*, Chem. & Eng'g News (Oct. 10, 2022), https://archive.ph/2023.02.26-150528/https://cen.acs.org/environment/recycling/Amid-controversy-industry-goes-plastics-pyrolysis/100/i36.

135 Jim Doucette et al., *supra* note 66.

136 Nicholas LaFiura, Ultra-Poly Corp., Presentation at AMI Events: Chemical Recycling, Practical Realities for Evaluating Raw Material Preparation Costs 5 (Mar. 12-13, 2024) (on file with CCI #5229.182).

137 Attendees List, AMI Events: Chemical Recycling (Mar. 2024) (on file with CCI #5228).

138 Nicholas LaFiura, *supra* note 136, at 11 (CCI #5229.188).

139 California Complaint, *supra* note 12, at 101.

Contaminated feedstocks negatively impact the quality of chemical recycling outputs.

The industry's insistence on promoting advanced recycling as a solution for contaminated waste streams creates a host of new obstacles, in large part because processing contaminated streams of post-consumer plastic reduces the quality of chemical recycling outputs — something that is widely recognized by groups funded by or affiliated with the plastics industry.

The Sustainable Packaging Coalition (SPC) noted that, "Although chemical recycling has the potential to accept a wider range of plastic waste, like most manufacturing processes, the quality of the input affects the quality of the output product."[140] In other words, "contaminants generally result in lower process yields and affect the quality of the product," according to SPC.[141]

Chemical Upcycling of Waste Plastics (CUWP), a research center affiliated with several plastics producers, specifically recognized that, in addition to contamination with other kinds of plastics, feedstocks that are "contaminated with food and dirt tend to produce high levels of char and ash"[142] and that "[a]dditives in plastics can also cause issues during pyrolysis" since they "can end up in both the char and the oil."[143]

As the Alliance to End Plastic Waste (AEPW) — a group created by public relations firm Weber Shandwick for ACC[144] — summarized in a 2022 report published with Eunomia Research & Consulting, contaminants "cause undesirable effects including lowered process yield, reduced output quality, and wear on equipment, which all add cost burdens."[145]

Photo credit: iStock

140 Paula Leardini and Olga Kachook, *supra* note 74, at 4.

141 *Id.*

142 Jiayang Wu et al., *supra* note 78, at 2.

143 *Id.* at 6.

144 *See* Brian Probus, The Alliance to End Plastic Waste (archived Feb. 23, 2023), https://archive.ph/2023.02.23-171926/https://www.probusdesign.com/alliance-to-end-plastic-waste/.

145 Eunomia, Feedstock Quality Guidelines for Pyrolysis of Plastic Waste: Report for the Alliance to End Plastic Waste 17 (Aug. 2022), https://www.endplasticwaste.org/insights/reports/feedstock-for-pyrolysis.

Despite these known limitations of chemical recycling processes, "where thermal cracking technologies [such as pyrolysis] are concerned, there is often still the misconception that they can generate high-quality outputs from highly contaminated feedstocks," according to a presentation given by Silke Einschuetz of AMI Consulting.[146] "While it is possible to process contaminated feedstocks, yields will be lower and purification steps are required to prepare the resulting outputs for use in steam crackers," Einscheutz explained in 2023.[147]

ExxonMobil has not been immune to these realities of chemical recycling, internally identifying "[a]ccess to quality feed" as a "key" factor in the "scale up of Advanced Recycling," according to allegations in the California complaint.[148]

ExxonMobil recognized in internal documents that "[c]ontaminant mgmt. requires tailoring of accessible feed."[149] But Exxon has found acquisition of the required feedstock to be a substantial problem. One attempt to secure appropriately-sorted plastic waste failed when Exxon's proposal to a company called FCC Environmental Services was rejected in October 2023.[150] FCC cited Exxon's restrictive specifications for its decision, explaining that the proposal did "not make economical sense."[151] These challenges have led ExxonMobil to conclude that management of contaminants represents the "Biggest Challenge" of utilizing mixed plastic wastes in its advanced recycling facilities,[152] despite its public claims about its capacity to process these hard-to-recycle plastics.

> **"[W]here thermal cracking technologies [such as pyrolysis] are concerned, there is often still the misconception that they can generate high-quality outputs from highly contaminated feedstocks."**
>
> Silke Einschuetz,
> AMI Consulting, 2023

Chemical recycling faces many of the same obstacles as mechanical recycling, making the processes competitive rather than complementary.

Rather than complementing mechanical recycling, the chemical recycling push has created competition with mechanical recycling facilities for limited amounts of suitable feedstocks — fundamentally undermining one of the plastics industry's selling points for the technology. The Recycled Materials Association (ReMA) expressed concern in 2023 that a state-level advanced recycling law "is incentivizing chemical processing through special call-out definitions that create unique oversight, including preferred oversight of material feedstock held for or sent to chemical recycling facilities."[153] SPC noted this concern as well, explaining that it "discourages chemical recyclers from using feedstock that is currently used by mechanical recyclers to avoid competition between the technologies," although it does not provide any solutions for how to avoid that outcome.[154] As noted by Silke Einschuetz of AMI Consulting at a 2023 industry conference sponsored by ACC, "despite claims to the contrary, significant feedstock competition is emerging."[155]

This tension is magnified because chemical recycling faces many of the same challenges as mechanical

146 Silke Einschuetz, *supra* note 60, at 11 (on file with CCI #5225.27).

147 *Id.*

148 California Complaint, *supra* note 12, at 98.

149 *Id.* at 83.

150 *Id.* at 98.

151 *Id.*

152 *Id.* at 83.

153 Inst. of Scrap Recycling Indus., *supra* note 72, at 3.

154 Paula Leardini and Olga Kachook, *supra* note 74, at 5.

155 Silke Einschuetz, *supra* note 60, at 15-16 (on file with CCI #5225.31-32).

recycling when it comes to feedstock acquisition. An executive at Closed Loop Partners — which works closely with companies like Chevron Phillips, LyondellBasell, and Dow — noted in 2019 that the "challenges of accessing quality feedstock, reducing contamination and getting the volumes they need are all the same challenges that we see in existing mechanical recycling."[156] Similarly, the Flexible Packaging Association (FPA) — whose members include ExxonMobil, Shell, Chevron Phillips, Dow, and LyondellBasell — warned in 2020 that feedstock contamination presented a significant barrier to the development of chemical recycling, much as it did for mechanical recycling: "the process requires plastic material that is of suitable quality, with low levels of contamination and at sufficient volume to meet demand. These are some of the same challenges facing the mechanical recycling infrastructure."[157]

The 2022 AEPW/Eunomia report noted the problem as well: "To create quality outputs that are suitable for direct integration into the plastics production value chain, pyrolysis operators require well-sorted, clean, and largely homogenous feedstock … and suffer from contamination similarly to mechanical recyclers."[158] Both forms of recycling "require consistent streams of feedstock with minimal contamination," the report continued, "and while advanced recycling should be viewed as a recycling outlet for a different range of materials, it should not be viewed as a recycling outlet for contaminated materials or unsorted materials."[159]

These issues with using chemical recycling technologies to address hard-to-recycle plastics have not been resolved. As Dr. Marcian Lee of Lux Consulting noted in January 2025, "the current plastic recycling value chain is not prepared to support either the feedstock demands or outputs" of chemical recycling

> **"[W]hile advanced recycling should be viewed as a recycling outlet for a different range of materials, it should not be viewed as a recycling outlet for contaminated materials or unsorted materials."**
>
> Alliance to End Plastic Waste and Eunomia, 2022

technologies.[160] Based on interviews with a variety of industry stakeholders, Lee concluded that "the mismatch between what the waste supply chain is familiar with and the type of feedstocks that advanced plastic recyclers require leads to bottlenecks in feedstock supply."[161]

The plastics industry's claims that advanced recycling can address the problem of mixed plastic waste left behind by the existing mechanical recycling infrastructure are not supported. Specific chemical recycling processes are only suitable for specific kinds of plastics, and no technology exists that can overcome these limitations. Advanced recycling, insofar as it is presented as an amalgamation of those processes that can handle all the waste plastics producers create, does not exist. Further, no chemical recycling process can address the underlying issues that have prevented mechanical recyclers from acquiring suitable feedstock for decades. As alleged in California's complaint, ExxonMobil has recognized internally that "[n]ot all post-use plastics are appropriate for chemical recycling" and "[n]ot all post-use plastics are appropriate as feedstock for all chemical recycling product pathways."[162]

156 Lauren Phipps, The 5 Things You Need to Know About Chemical Recycling, Trellis (Apr. 15, 2019), https://archive.ph/2024.12.11-205015/https://trellis.net/article/5-things-you-need-know-about-chemical-recycling/.

157 PTIS, LLC & Priority Metrics Group, LLC, *supra* note 71, at 73.

158 Eunomia, *supra* note 145, at 6.

159 *Id.* at 9.

160 Marcian Lee, Lux Research, Voice of Industry: Value Chain Dynamics in Advanced Plastic Recycling (Jan. 27, 2025), https://luxresearchinc.com/blog/voice-of-industry-value-chain-dynamics-in-advanced-plastic-recycling/.

161 *Id.*

162 California Complaint, *supra* note 12, at 83.

Photo credit: Mark Dixon/Flickr CC BY 2.0

Advanced recycling is not environmentally friendly.

The plastics industry positions advanced recycling as an environmentally-friendly solution for plastic waste despite the fact that chemical recycling processes produce a host of hazardous pollutants, are extremely energy-intensive, and serve to perpetuate the extraction of ever-greater amounts of fossil fuels.

The plastics industry acknowledges the public's concerns about the environmental impacts of plastics and presents advanced recycling as a way to resolve those issues.

Somewhat counterintuitively, given their role in the plastic waste crisis, the petrochemical industry regularly references the negative environmental impact of plastics in advertising and public statements. The function of this messaging is to shift the blame away from the companies themselves and onto society at large. The narrator of a 2021 BASF video advertisement proclaims that "plastic needs to change. And you're helping to make that change happen" over imagery of recycling bins.[163] It then continues: "But the responsibility isn't yours alone. It's ours too. … Solving the plastic challenge is a journey we're all on together."[164] An ad from the American Chemistry Council (ACC)

163 BASF, Our Plastics Journey, BBC (Oct. 31, 2021), at 0:01-0:04, Media Radar (accessed July 26, 2024).

164 *Id.* at 0:10-0:26.

likewise promises to explain "[h]ow collective effort can help solve the plastics problem."[165]

In a video about circularity, Shell too suggests that we all bear equal responsibility for the production of plastic waste, explaining that "disposing of plastic … is a global problem and it needs global solutions."[166] Chevron Phillips gets more specific in a 2021 video about chemical recycling, explaining that "we all have to stop thinking of plastic as disposable" because "unmanaged plastic waste is not acceptable and must be addressed."[167] Tellingly, Eastman — like the rest of the industry — identifies a solution to this problem: advanced recycling. The company's 2023 sustainability report explains that "we need a wider range of technologies capable of recycling these plastic feedstocks and waste streams."[168] ACC runs online ads presenting chemical recycling as "a win for the environment,"[169] and BASF has claimed that the company's "solutions and technologies" such as chemical recycling allowed it to "achieve positive effects on biodiversity."[170]

Petrochemical companies and industry trade organizations regularly highlight emissions reductions as a key benefit of chemical recycling. Ads for Dow sponsored content in *Politico* told readers that a "circular economy is critical to achieve the net zero climate target in 2050."[171] In different formats, Eastman variously claims that chemical recycling reduces the greenhouse gas emissions of plastic production by either 20-50 percent or 40-80 percent compared to fossil fuel feedstocks.[172]

The American Fuel and Petrochemical Manufacturers (AFPM) used sponsored content to highlight LyondellBasell's sustainability director, who explains that the "work we are doing drives meaningful progress toward reducing plastic waste in the environment, helping to mitigate climate change and contributing to a thriving society."[173] An ACC employee even counterintuitively told attendees at a chemical recycling conference that "using advanced recycling" could "[r]educe CO2 emissions by more than 100% compared to alternative end-of-life processes."[174]

Experts' concerns about the environmental impacts of chemical recycling have been largely ignored by the industry.

Despite the industry's assurances of safety and sustainability, the science on the environmental impacts of chemical recycling is inconclusive at best. In 2017, as the term "advanced recycling" was just coming into use, the Ellen MacArthur Foundation (EMF) noted the risk of pollution being magnified by chemical recycling: "Experts indicate there is a risk regarding substances of concern (e.g. pyrolysis produces filtrates containing a range of substances), even though perceived lower than for incineration."[175] EMF expressed the need for "further detailed research,"[176] but the industry has done little to assuage concerns about pollution in the years since. The Plastic Pollution Working Group at Duke University, which includes plastic researchers from various departments across the university, commented on chemical recycling in 2023.[177] It noted that "there

165 Am. Chem. Council, Inc., How Collective Effort Can Help Solve the Plastics Problem, Fortune (Nov. 20, 2021), Media Radar (accessed July 24, 2024).

166 Shell, *supra* note 99.

167 Chevron Phillips Chem., *supra* note 13.

168 Eastman, *supra* note 5, at 24.

169 America's Plastic Makers, Did You Know Advanced Recycling is a Win for the Environment?, NJ.com (May 25, 2022), Media Radar (accessed July 23, 2024).

170 BASF, Combined Management's Report - Environmental, Social and Governance 116 (2023), https://report.basf.com/2023/en/_assets/downloads/esg-environment-social-governance-basf-ar23.pdf.

171 Dow Chem. Co., How the EU Can Enable a Circular Economy in Plastics Packaging, Politico (Germany) (Dec. 18, 2022), Media Radar (accessed June 21, 2024).

172 Eastman, *supra* note 5, at 35; Mark J. Costa, *supra* note 19.

173 Am. Fuel & Petrochem. Mfrs., The Manufacturers Revolutionizing Plastic Recycling, Politico (Oct. 22, 2021), https://archive.ph/2024.12.11-221407/https://www.politico.com/sponsored-content/2021/10/the-manufacturers-revolutionizing-plastic-recycling.

174 Craig Cookson, Am. Chem. Council, Plastics Division, Presentation at AMI Events: Chemical Recycling, That's Advanced: Policy and Environmental Drivers to Achieve a Circular Economy 10 (Mar. 20-22, 2023) (on file with CCI #5225.51).

175 Ellen Macarthur Foundation, The New Plastics Economy: Catalysing Action 58 n.25 (2017), https://content.ellenmacarthurfoundation.org/m/78d6bbcaadecd796/original/The-New-Plastics-Economy-Catalysing-action.pdf.

176 *Id*.

177 Duke University Plastic Pollution Working Group, Comments on *EPA's Draft National Strategy to Prevent Plastic Pollution* (June 19, 2023), https://law.duke.edu/sites/default/files/news/publications/Duke_PPWG_Comments_for_EPA.pdf.

are concerns about the development and use of these chemicals, many of which are identified as toxic" and that "the chemical reactions involved in [the] process may produce byproducts (e.g., volatile organic compounds) as well as hazardous waste."[178] Given chemical recycling's "sizable energy inputs" and that it "poses significant threats of harm to already overburdened communities," the group called for "caution in evaluating the industry's claims" and "independent research in evaluating the technology's impacts."[179]

With the enormous variety of both types of plastics and chemical recycling processes, there is currently "a substantial range of variability in climate change impacts" for these technologies, in the words of a 2024 survey of the scientific literature that appeared in the journal *Sustainable Production and Consumption*.[180] This uncertainty has been acknowledged within the industry, despite companies' public proclamations of its environmental benefits. As Silke Einschuetz of AMI Consulting explained in a presentation at a 2023 chemical recycling conference sponsored by ACC, "[e]nvironmental impacts/externalities — need to be taken seriously"[181] but "[c]oncerns about potential externalities remain largely unaddressed."[182] She called for recognition within the industry "that the concerns of industry critics are, in many cases, justified and that a greater level of transparency is required to fully realise the industry's potential."[183] Further, she noted that "there is a lack of clear guidelines to assess potential environmental, health and economic impacts of chemical recycling technologies & facilities."[184]

> **"Chemical recycling processes (especially pyrolysis) are energy-intensive [and] generate substantial greenhouse gas (GHG) emissions."**
>
> Roland Berger, 2024

Chemical recycling has significant energy demands, limiting any promised climate benefits.

Despite this uncertainty about specific health and environmental impacts, it is clear that chemical recycling is extremely energy intensive. Chevron Phillips Chemical acknowledged as much in its 2022 sustainability report, stating that "[i]ncreased energy required" represented one of the limitations of advanced recycling.[185] This is a challenge inherent to the chemical recycling of these materials. "Plastics are largely very stable materials, so they generally need a good deal of energy to break them down, by using thermochemical processes, hydrolysis, or solvolysis," as the Flexible Packaging Association (FPA) explained in 2020.[186] Or, as vice president of chemicals consulting at Wood Mackenzie Steve Jenkins told *CleanTechnica*, it is very, very, very, very difficult" to break down plastic using pyrolysis because the "laws of nature and the laws of physics are trying to stop you."[187]

178 *Id.* at 15.

179 *Id.*

180 Cheng-Yoo Zhang and Jun Nakatani, *Implications of Chemical Recycling of Plastic Waste for Climate Change Impacts: A Critical Review*, 48 Sustainable Prod. & Consumption 301, 301 (2024), https://doi.org/10.1016/j.spc.2024.05.016 .

181 Silke Einschuetz, *supra* note 60, at 18 (CCI #5225.34).

182 *Id.* at 7 (CCI #5225.23).

183 *Id.* at 21 (CCI #5225.37).

184 *Id.*

185 Chevron Phillips Chem., *supra* note 108, at 57.

186 PTIS, LLC and Priority Metrics Group, LLC, *supra* note 71, at 72.

187 Steve Hanley, *Pyrolysis is the Latest Climate-Killing Plastics Scam from ExxonMobil*, CleanTechnia (June 20, 2024), https://web.archive.org/web/20240716171355/https://cleantechnica.com/2024/06/20/pyrolysis-is-the-latest-climate-killing-plastics-scam-from-exxonmobil/.

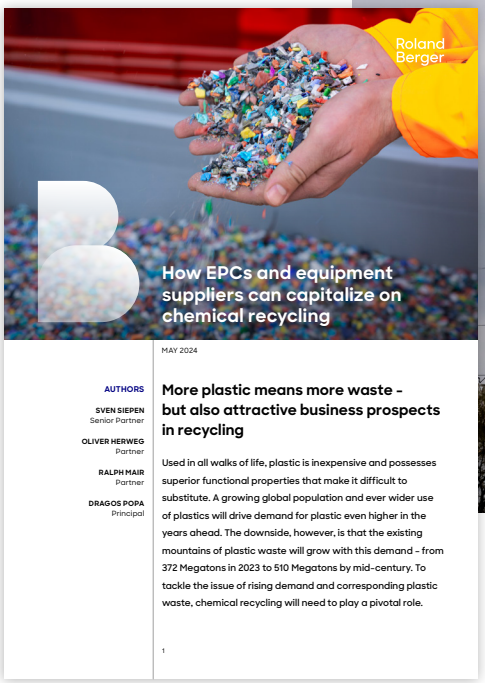


Photo credit: Alex Potemkin/iStock

Even industry insiders with relatively optimistic perspectives on the outlook of chemical recycling, like consulting firm Roland Berger, ackowledge that these processes cannot address the ever-growing amounts of plastic being produced today.

Those energy requirements translate directly to significant emissions potential: "Chemical recycling processes (especially pyrolysis) are energy-intensive [and] generate substantial greenhouse gas (GHG) emissions," explained a 2024 Roland Berger report.[188] In other words, as consultants at IHS Markit (now S&P Global) succinctly put it in 2019, chemical recycling "has an adverse carbon lifecycle assessment (LCA) footprint."[189] Concerns about the environmental impacts of chemical recycling are validated in the academic literature. A 2023 study published in the journal *Science of The Total Environment* concluded that "[s]ome of the major challenges responsible for the slow development and transition of plastic waste pyrolysis plants from small- to large-scale include … excessive energy needed to achieve a complete plastic waste conversion [and] … greenhouse gas emissions and other toxic pollutants."[190]

The problem is only magnified by the often-overlooked steps required to address plastic waste beyond the technical processes themselves. As explained by the Roland Berger report, "the need to transport waste feedstock over larger distances to ensure the necessary plant input volumes adds to the overall GHG footprint of this technology."[191] When properly accounting for the myriad stages in the chemical recycling process and focusing on the specific technologies preferred by the petrochemical companies, the data appears damning.

According to a 2023 peer-reviewed synthesis of chemical recycling research, the "economic and environmental metrics of pyrolysis and gasification are currently 10-100 times higher than virgin polymers due to low yields of monomers suitable for repolymerization … and high energy requirements for the conversion and subsequent upgrading processes."[192]

188 Sven Siepen et al., Roland Berger, How EPCs and Equipment Suppliers can Capitalize on Chemical Recycling 3 (2024), https://www.rolandberger.com/en/Insights/Publications/How-EPCs-and-equipment-suppliers-can-capitalize-on-chemical-recycling.html.

189 Kaushik Mitra and Mark Morgan, *supra* note 80.

190 Siu Hua Chang, *Plastic Waste as Pyrolysis Feedstock for Plastic Oil Production: A Review*, 877 Sci. Total Env't 162719, 3 (2023), https://doi.org/10.1016/j.scitotenv.2023.162719.

191 Sven Siepen et al., *supra* note 188, at 3.

192 Taylor Uekert et al., *supra* note 9, at 969 (emphasis added).

Claims that chemical recycling has environmental benefits frequently depend on misleading comparisons or assumptions.

To overcome these challenges and achieve results that can justify the expansion of chemical recycling infrastructure, industry-affiliated environmental analyses frequently frame the issue in such a way as to make these technologies seem less harmful to the environment than they are. Most commonly, this involves comparing chemical recycling to incineration, which — despite being an industry-favorite solution for plastic waste going back to the 1970s — is notoriously bad for the environment. A 2022 study in the journal *Green Chemistry* provides a good illustration of this method.[193] Its survey of various life cycle analyses (LCAs) shows that "[c]hemical recycling technologies tend to have high acidification potential."[194] But, it points out that these LCAs help to negate those findings by comparing those outcomes to incineration, explaining that "after accounting for credit to avoid incineration of plastic waste, the acidification potential of chemical recycling options is lower than the acidification potential of producing virgin plastic from fossil fuel."[195] The industry frequently compares advanced recycling to incineration in public communications as well.

Dow, for example, claimed in sponsored content that ran in the *New Scientist* in 2022 that "[s]witching to circular feedstocks lowers this carbon footprint by reducing the CO2 released when waste plastic is incinerated."[196] Similarly, ACC claimed that "advanced recycling reduces greenhouse gas emissions 43 percent relative to waste-to-energy incineration of plastic films made from virgin-resources."[197]

> **"[T]he environmental footprint of certain chemical recycling processes … is significantly higher than that of mechanical recycling."**
>
> KPMG, 2021

When compared to other end-of-life outcomes for plastic waste, however, the picture painted by the industry becomes less clear. For example, the available research suggests that mechanical recycling, even with its significant obstacles and downsides, has a substantially lower environmental impact than chemical recycling. KPMG stated in 2021 that chemical recycling "is and will remain much more costly (energy consuming) than mechanical recycling,"[198] and reiterated the point the following year, explaining that the "environmental footprint of certain chemical recycling processes — particularly pyrolysis and gasification — is significantly higher than that of mechanical recycling.[199] Consultancy Roland Berger has also emphasized this point, stating in 2022 that "converting plastics waste back into its building blocks is not cheap, and the energy needed to do so is much more than for mechanical recycling."[200] As Silke Einschuetz of AMI Consulting explained at an industry conference, "mechanical recycling should have precedence over chemical recycling" where possible since it has "[f]ewer environmental externalities," "[c]omparatively lower cost," and a "[l]ower carbon footprint."[201]

193 Houqian Li et al., *Expanding Plastics Recycling Technologies: Chemical Aspects, Technology Status and Challenges*, 24 Green Chemistry 8899 (2022), https://pubs.rsc.org/en/content/articlelanding/2022/gc/d2gc02588d.

194 *Id.* at 8909.

195 *Id.*

196 Dow Chem. Co., *supra* note 105.

197 Brian Taylor, *ACC Says New Recycling Techniques Not Incineration*, Recycling Today (May 4, 2022), http://archive.today/2024.12.12-214225/https://www.recyclingtoday.com/news/acc-plastic-chemical-recycling-epa-clean-air-act/.

198 Tom Hesselink & Emiel van Duuren, KPMG, The Green Deal 18 (2021), https://assets.kpmg.com/content/dam/kpmg/nl/pdf/2021/sectoren/green-deal-plastic-recycling.pdf.

199 Tom Hesselink, *supra* note 55, at 36.

200 Erwin Douma et al., Roland Berger, The Plastics Balancing Act: Driving the Transition and Seizing its Opportunities 11 (2022), https://www.rolandberger.com/publications/publication_pdf/ONLINE_Roland-Berger-Report-The-Plastics-Balancing-Act-v09092022.pdf.

201 Einschuetz, *supra* note 60, at 15 (CCI #5225.31).

Photo credit: Aaron Yoder/iStock

Beyond selectively comparing environmental outcomes against particularly negative alternatives, claims to environmental benefits of chemical recycling are typically based on the creation of new plastics. But this is misleading as well, since fuels are produced at a far higher rate with chemical recycling processes than are feedstocks for new plastics. As Taylor Uekert, a circular economy research analyst at the National Renewable Energy Laboratory (NREL), explained in 2023, "If you're turning plastic back into oil for fuel … you need to be comparing it to the environmental impacts of creating that fuel from fossil sources."[202] When chemical recycling is placed in its appropriate context in the waste management hierarchy, the comparison looks far less appealing. According to Uekert, "In general, you're getting higher greenhouse gas emissions from pyrolysis than you would from conventional drilling."[203] Given these emissions, chemical recycling cannot be considered a viable climate solution.

> **"[C]onverting plastics waste back into its building blocks is not cheap, and the energy needed to do so is much more than for mechanical recycling."**
>
> Roland Berger, 2022

202 Judith Lewis Mernit, As Plastics Keep Piling Up, Can 'Advanced' Recycling Cut the Waste?, YaleEnvironment360 (June 1, 2023), https://e360.yale.edu/features/advanced-plastics-recycling-pyrolysis.

203 *Id.*

Photo credit: Sigmund/Unsplash

Advanced recycling does not enable a circular economy.

The plastics industry defines advanced recycling as "circular" even though these processes do not keep plastic in the production cycle and do not reduce or offset the production of virgin plastic made from fossil fuels.

The plastics industry contends that advanced recycling will enable a circular economy for plastics.

In Eastman's 2023 sustainability report, the resin producer identifies a core problem at the heart of plastics production: "Modern society is built on a linear economy where we extract nonrenewable resources, make products and then discard them. Obviously, this isn't sustainable."[204] As for solutions, the report contends that "reduce and reuse can only go so far,"[205] but acknowledged that "little [plastic] gets recycled."[206] What is actually needed, according to the company, is a new system that would allow us to "significantly expand the types of plastics that can be recycled and brought back into the circular economy."[207]

The concept of a circular economy, in which the extraction of raw materials is minimized through the repurposing of waste, holds enormous appeal in a world beset by a plastic waste crisis; it is also fundamentally at odds with the business model of the world's largest producers of plastics. But that hasn't stopped the companies from claiming the term for themselves and using it as a way to sell the public and decision-makers on advanced recycling. The American Chemistry

204 Eastman, *supra* note 5, at 5.

205 *Id.* at 25.

206 *Id.* at 20.

207 *Id.* at 24.

Council (ACC) tells the public that they have "a plan to move the US towards a sustainable, circular economy for plastic;"[208] Shell vows that they "are working to close the loop: helping to transform the plastic value chain from linear to circular;"[209] Dow claims to be "working towards a day when every piece of plastic is created and re-created in a closed, renewable loop;"[210] and Eastman pledges that "the goal is to show the world what's possible and transition from a linear economy, where waste plastics end up in landfills, incinerators, or the environment, to a truly circular economy where waste is infinitely recycled and reused."[211]

Circularity, the industry insists, is the promise of advanced recycling; the president of Alterra has called the company "a plastic circularity enabler"[212] and the president of Nexus Circular told Congress that advanced recycling makes possible "a true circular plastics economy."[213] This is because "[a]dvanced recycling technologies … produce fully circular outputs," according to the Plastics Industry Association (PLASTICS).[214] Petrochemical companies argue that this notion of full circularity means turning post-consumer plastic waste into new plastic products repeatedly. Shell claims that the "circular chemicals" they produce "are used by our customers to make thousands of final products we see every day, including plastics."[215] Chevron Phillips likewise contends that their "fully circular" resin offerings, which are "[m]ade with waste plastics," can be recycled into "many products we use every day."[216] Or, as America's Plastic Makers told Facebook users in 2022, "#AdvancedRecycling can help address the 90% of plastics that aren't being recycled" because the "technology will allow manufacturers to used [sic] old plastics to create new products!"[217]

This vision is most clearly articulated in a video ad produced by America's Plastic Makers, which represents members of ACC's plastic division such as ExxonMobil, Chevron Phillips, Shell, Dow, BASF, LyondellBasell, and Eastman.[218] Part of a $30 million campaign to convince consumers that the world's largest petrochemical firms are committed to circularity,[219] the ad explains that the plastics industry is investing in "new recycling technologies for sustainable change."[220] As visuals of crumpled, monochromatic plastic containers springing into new, colorful versions of different plastic products play across the screen, narration invites viewers to "imagine a future where plastic is not wasted, but instead, remade over and over into the things that keep our food fresher, our families safer, and our planet cleaner."[221]

Until recently, chemical recycling technologies have primarily been promoted by the plastics industry as plastic-to-fuel processes.

The fundamental appeal of advanced recycling is supposed to be that it makes it possible to turn waste plastics into new plastic products — in other words, that it is a form of recycling. But this positioning itself is relatively new. Until recently, these processes had typically been described, more accurately, as a way to

208 Am. Chemistry Council, Inc., Introducing a Plan, Politico (Mar. 5, 2022), Media Radar (accessed July 23, 2024).

209 Shell, *supra* note 99, at 0:31-0:38.

210 Dow Chem. Co., *supra* note 3.

211 Mark J. Costa, *supra* note 19.

212 Am. Chemistry Council, Inc., Plastic Circularity Enabler, Sustainably Speaking (Apr. 24, 2024), Media Radar (accessed July 9, 2024).

213 Examining the Impact of Plastic Use and Identifying Solutions for Reducing Plastic Waste: Hearing Before the Subcomm. on Chem. Safety, Waste Mgmt., Env'l Just., & Regul. Oversight of the Comm. on Env't & Pub. Works, 117th Cong. (2022) (statement of Eric Hartz, Co-Founder & President, Nexus Circular), https://www.govinfo.gov/content/pkg/CHRG-117shrg52125/html/CHRG-117shrg52125.htm.

214 Position Statement, Plastics Indus. Ass'n, Advanced Recycling (Oct. 2021), https://s3.amazonaws.com/bizzabo.users.files/164636/370762/7519547/PLASTICS%20Position%20on%20Advanced%20Recycling_Adopted%20by%20PLASTICS%20Board_10.9.21.pdf.

215 Shell, *supra* note 99, at 1:50-1:55.

216 Chevron Phillips Chem., 2023 Sustainability Report: Stepping Up For People, For the Planet and For Circularity 79 (2023), https://sustainability-report.cpchem.com/2023/_assets/downloads/entire-cpchem-sr23.pdf?h=N7DS2xP3.

217 America's Plastic Makers, 90% of Plastics Aren't Recycled Today, Facebook (June 8, 2022), Media Radar (accessed July 23, 2024).

218 America's Plastic Makers, Our Members (last visited Feb. 12, 2025), https://plasticmakers.org/who-we-are/members/.

219 Arielle Samuelson, *The Plastic Industry's $30 Million Lie*, HEATED (July 25, 2024), https://heated.world/p/the-plastic-industrys-30-million.

220 America's Plastic Makers, Dominoes (30s), at 0:21-0:24, YouTube (Feb. 22, 2024), https://youtu.be/rewRKYlRew4?feature=shared.

221 *Id.* at 0:03-0:15.

produce fuels rather than new plastics. A 1972 report published by the U.S. Environmental Protection Agency based on information from industry sources — including Dow, Gulf Oil (now Chevron), the Flexible Packaging Association (FPA), and the Society of the Plastics Industry (SPI) — provided a typical description, explaining that "plastics can be pyrolyzed to yield non-plastic materials such as oils, waxes, or greases, or they can be burned as fuel."[222] This kind of language persisted for decades. In fact, ACC's chemical recycling group was previously known as the "Plastics-to-Oil Technologies Alliance" and the "Plastics-to-Fuel and Petrochemistry Alliance"[223] before becoming the "Chemical Recycling Alliance" in 2019[224] and adopting its current name, the "Advanced Recycling Alliance for Plastics," in 2020.[225] ACC was also using "plastics-to-fuel" as an alternate name for pyrolysis as recently as 2015 (in a video that remains on its YouTube channel).[226] A report published by the Ocean Conservancy and the McKinsey Center for Business and Environment in 2015 — which was funded by ACC, Dow, and Coca-Cola — also presented chemical recycling technologies as processes to produce fuels.[227] The report, which was later retracted by the Ocean Conservancy,[228] explained that "[l]arge-scale deployment of waste-to-energy technology (such as gasification, pyrolysis, or incineration with energy

The shifting names of the American Chemistry Council's chemical recycling group over the last decade reflect the industry's evolving marketing around the technologies.

222 Jack Milgrom, U.S. Env't Prot. Agency, Incentives for Recycling and Reuse of Plastics xviii (1972), Box 3, Jack Milgrom Papers, Special Collections Research Center, Syracuse University Libraries (on file with CCI #776.18).

223 Plastics Recycling Update, Plastics-to-Fuel Group Adds Member, Changes Name (last updated Nov. 23, 2016), https://archive.ph/2024.12.13-160607/https://resource-recycling.com/plastics/2015/10/07/plastics-to-fuel-group-adds-member-changes-name/.

224 American Recycler, The Chemical Recycling Alliance Grows (June 2019), https://archive.ph/2024.12.13-160948/https://americanrecycler.com/the-chemical-recycling-alliance-grows/.

225 Clare Goldsberry, *Chemical Recycling Alliance is Now the Advanced Recycling Alliance for Plastics*, Plastics Today (May 2, 2020), https://archive.ph/2024.12.13-161735/https://www.plasticstoday.com/packaging/chemical-recycling-alliance-is-now-the-advanced-recycling-alliance-for-plastics.

226 Am. Chem. Council, Plastics-to-Fuel: Creating Energy from Non-Recycled Plastics, YouTube (May 21, 2015), https://www.youtube.com/watch?v=1YUMHAtzuJY.

227 *See generally* Ocean Conservancy and McKinsey Ctr. for Bus. & Env't, Stemming the Tide: Land-Based Strategies for a Plastic-Free Ocean (Sept. 2015) (on file with CCI # 5506.1).

228 *See* Ocean Conservancy, Stemming the Tide Statement of Accountability (July 10, 2022), https://oceanconservancy.org/trash-free-seas/take-deep-dive/stemming-the-tide-statement-of-accountability/.

recovery), for example, may help solve the pollution problem associated with today's plastics, but if not done thoughtfully, it may also hinder the development of plastics that offer higher-residual-value uses at the end of their life cycle."[229]

This was typical even in the years since the term advanced recycling came into use. In 2019, the president of PLASTICS lauded the technology in testimony before Congress for its ability to produce fuels without any mention of creating new plastics: "Pyrolysis, sometimes called 'plastics to fuel,' turns non-recycled plastics from municipal solid waste (garbage) into a synthetic crude oil that can be refined into diesel fuel, gasoline, heating oil or waxes"[230] — language that remained on PLASTICS' website as recently as September 2024 but has since been removed.[231] Similar language was also reflected in a 2019 Deloitte report that defined pyrolysis as a process which "helps turn non-recycled plastics from municipal solid waste into synthetic crude oil that could be in turn refined into gasoline, diesel, or heating oil."[232]

Only in the last few years has advanced recycling been recast to mean plastic-to-plastic chemical recycling, and industry groups — including the Association of Plastic Recyclers (APR),[233] PLASTICS,[234] the Recycled Materials Association (ReMA),[235] Closed Loop Partners,[236] the Sustainable Packaging Coalition (SPC),[237] and the National Recycling Coalition (NRC) [238] — have gone on record opposing the use of the term "recycling" to refer to plastic-to-fuel conversion. ReMA expressed concerns about the inclusion of plastic-to-fuel in a state-level recycling bill in 2023, explaining that the law "allows for using the fuel generated from old plastic — which is not recycling. This fuel, fuel ingredients, and fuel substitutes generated from chemical processes certainly may be better than landfill, but it is not recycling and should not be in statute as recycling."[239] This would, according to ReMA, expand "the term 'recycling' into a realm beyond production of new material as raw product substitution for manufacturing" — beyond, in other words, "the fundamental soul of recycling."[240]

229 Ocean Conservancy, *supra* note 227, at 4 (CCI #5506.4).

230 Oversight Hearing, *supra* note 17, at 43.

231 Plastics Indus. Ass'n, Recycling 101: Energy Recovery Technologies (archived Sept. 20, 2024), https://archive.ph/2024.09.20-205752/https://thisisplastics.com/environment/recycling-101-energy-recovery-technologies/.

232 Deloitte, The Changing Plastics Landscape: Is the Chemical Industry Prepared? 8 (2019), https://www2.deloitte.com/content/dam/Deloitte/us/Documents/energy-resources/us-the-changing-single-use-plastics-landscape.pdf.

233 *See* Ass'n Plastics Recyclers, Chemical Recycling, APR Position (May 2021), https://plasticsrecycling.org/wp-content/uploads/2024/09/APR-Position-Chemical-Recycling.pdf ("Chemical recycling should only include processes converting resin feedstock to resin. Feedstock to fuel or energy should not be considered recycling.").

234 *See* Plastics Indus. Ass'n, Plastics Industry Association Position on Advanced Recycling (Oct. 2021), https://s3.amazonaws.com/bizzabo.users.files/164636/370762/7519547/PLASTICS%20Position%20on%20Advanced%20Recycling_Adopted%20by%20PLASTICS%20Board_10.9.21.pdf ("PLASTICS supports the EPA definition of processes used to generate heat, electricity, or fuel as a mechanism for energy recovery, not recycling.").

235 *See* ReMA, Position on Chemical Recycling (July 2022), https://www.isri.org/docs/default-source/policy-position-statements/rema%27s-position-on-chemical-recycling.pdf?sfvrsn=258f7e12_2 ("Non-mechanical processes that convert plastics at the end of life into petrochemical products that are fuels or used to make fuels do not meet ReMA's above definition of plastics recycling and thus cannot be properly considered recycling.").

236 *See* Paula Luu, Closed Loop Partners, What is Chemical Recycling, Why Does it Have So Many Names, and Why Does it Matter? (Aug. 15, 2023), https://archive.ph/2024.12.13-164248/https://www.closedlooppartners.com/what-is-chemical-recycling/ ("Converting plastics to fuel is not recycling or circular.").

237 *See* Ruth Maust, Sustainable Packaging Coal., Introduction to Chemical Recycling 5 (2023), https://sustainablepackaging.org/wp-content/uploads/2023/08/SPC-101_Introduction-to-Chemical-Recycling.pdf ("Fuels derived from conversion processes, while preferable to new fossil fuel extraction, cannot be considered recycled material.")

238 *See* Nat'l Recycling Coal., What We Do 4 (2024), https://nrcrecycles.org/mobius/wp-content/uploads/2024/07/NRC-What-We-Do-Statement-2024.pdf (acknowledging the "organization's 2023 stance on chemical recycling (which is fuel production and not recycling)").

239 Letter from Danielle F. Waterfield, Chief Policy Officer, ISRI, to Rep. Sean Tarwater, Chair of the House Committee on Commerce, Labor & Economic Development, Kansas Legislature, Statement on SB 114 by the Institute of Scrap Recycling Industries (ISRI) 2 (Feb. 20, 2023), https://www.kslegislature.gov/li_2024/b2023_24/committees/ctte_h_cmrce_lbr_1/documents/testimony/20230320_04.pdf.

240 *Id.* at 3.

Photo credit: iStock

Even ACC, which has supported that bill and others like it around the country[241] — and is now trying to accomplish similar goals at the federal level through their support[242] of the Accelerating a Circular Economy for Plastics and Recycling Innovation Act of 2024[243] — has publicly agreed and, for some time at least, advocated for the use of the term "advanced recovery" for the production of fuels using chemical recycling technologies.[244]

Material loss and the production of fuels make chemical recycling processes unsuitable for circularity.

A very small percentage of the waste material inputs that are processed via chemical recycling are capable of being turned into new plastics, undercutting any claims of "circularity." An analysis by researchers at the National Renewable Energy Laboratory (NREL) found that only 1-14 percent of plastic waste processed via pyrolysis or gasification could become new plastic feedstocks[245] — a figure that aligns with the State of California's allegation, based on internal company documents, that only 8 percent of the plastic inputs at ExxonMobil's Baytown advanced recycling facility become new plastic resins.[246]

241 *See* Kansas SB 114, Oral Testimony of Marcus Branstad, Am. Chem. Council (2024), https://www.kslegislature.gov/li_2024/b2023_24/committees/ctte_s_cmrce_1/documents/testimony/20230201_01.pdf.

242 *See* Am. Chem. Council, Comprehensive Bipartisan Plastics Recycling Bill Tackles Plastics Pollution in U.S. (Sep. 19, 2024), http://archive.today/2024.12.13-165148/https://www.americanchemistry.com/chemistry-in-america/news-trends/press-release/2024/comprehensive-bipartisan-plastics-recycling-bill-tackles-plastics-pollution-in-us.

243 Accelerating a Circular Economy for Plastics and Recycling Innovation Act of 2024, H.R. 9676, 118th Cong. (2024), http://archive.today/2024.12.13-165550/https://www.congress.gov/bill/118th-congress/house-bill/9676/text.

244 *See* Craig Cookson, Am. Chem. Council, America Needs Modern Regulations for Modern Technologies, (Nov. 11, 2021), https://archive.ph/2024.10.25-162003/https://www.americanchemistry.com/chemistry-in-america/news-trends/blog-post/2021/america-needs-modern-regulations-for-modern-technologies.

245 Taylor Uekert et al., *supra* note 9, at 969. The plastic-to-plastic potential of chemical recycling technologies has improved only marginally since the 1990s. A report entitled "Aspects of Plastic Packaging Waste Management," produced by Warren Spring Laboratory in the UK in 1993, explained that "it could well be argued that 'chemical recycling' is nothing more than a preliminary stage of energy recovery bearing in mind that roughly 96% of oil use is for heat and power generation and only 4% is used for the manufacture of plastics." S.M. Ogilvie, Aspects of Plastic Packaging Waste Management 57 (1993), Box 8, Jack Milgrom Papers, Special Collections Research Center, Syracuse University Libraries (on file with CCI #803.53).

246 California Complaint, *supra* note 12, at 79.

Interestingly, Exxon inadvertently confirms this material loss in its promotion of advanced recycling when the company tries to frame it as a benefit. The company notes that, "for every ton of certified-circular plastics sold, *more than* a ton of plastic waste avoids ending up in other end-of-life dispositions (e.g., landfill, incineration)."[247] Left unsaid is how the majority of that waste is avoiding landfilling and incineration — or what actually happens to it.

Chemical recycling processes are inherently not circular since only a small percentage of their output can be used to produce new plastics; a large percentage of the rest of the material is typically consumed as part of the process or turned into fuels. As SPC has explained, "fuels may be co-produced with recycled materials in the same [chemical recycling] process,"[248] and much of the material that goes into a process to create plastics is actually turned into fuels. "Conversion processes typically have low yields, especially when discounting the portion of materials going to fuels," according to SPC.[249] Pyrolysis, IHS Markit (now S&P Global) explained in 2019, "generat[es] an off-gas for use as fuel, a solid 'char' for fuel use, and a core product of mixed liquid hydrocarbons that is composed similar to naphtha" — meaning only a portion of the waste plastics fed into the process even have the potential to be recycled.[250]

This is a direct result of the feedstock limitations of chemical recycling technologies discussed in a previous section. As Silke Einschuetz of AMI Consulting explained in a conference presentation, "fairly clean and homogenous feedstock is required to achieve high yields and outputs suitable for uses *other than fuels*."[251] Chemical Upcycling of Waste Plastics (CUWP), a research center which has Dow, PLASTICS, and SABIC on its industrial advisory board,[252] has tried to reframe this as an economic and environmental benefit, noting that the "fuels generated by pyrolysis can be reused in the production process to reduce the use of purchased fossil fuels."[253] But it is in fact a serious obstacle to circularity. A 2022 Roland Berger report reiterated this point, explaining that "advanced recycling output is also frequently used in fuel applications, instead of in the reproduction of plastics," which "does not help close the plastics loop."[254]

> **"[A]dvanced recycling output is also frequently used in fuel applications, instead of in the reproduction of plastics … [which] does not help close the plastics loop."**
>
> Roland Berger, 2022

Mass balance accounting deceptively creates an appearance of circularity by overstating recycled content.

The plastics industry has attempted to hide this reality with the mass balance accounting method, a way to deceptively claim recycled content where it does not exist. Petrochemical companies including

247 ExxonMobil, supra note 4 (emphasis added).

248 Sustainable Packaging Coal., Position Statement, Chemical Reycling (2023), https://sustainablepackaging.org/wp-content/uploads/2023/06/SPC-Position-Statement_Chemical-Recycling.pdf

249 Paula Leardini and Olga Kachook, Sustainable Packaging Coal., Chemical Recycling Q&A 6, https://sustainablepackaging.org/wp-content/uploads/2024/06/SPC-Chemical-Recycling-Q_A.pdf.

250 Kaushik Mitra and Mark Morgan, *supra* note 80.

251 Silke Einschuetz, *supra* note 60, at 11 (emphasis added) (CCI #5225.27).

252 CUWP, Leadership (archived Feb. 20, 2025), https://archive.ph/2025.02.20-150503/https://cuwp.org/leadership/.

253 Jiayang Wu et al., *supra* note 78, at 2.

254 Erwin Douma et al, *supra* note 200, at 11.

ExxonMobil,[255] Chevron Phillips,[256] Shell,[257] Total,[258] Dow,[259] BASF,[260] INEOS,[261] and Eastman[262] have all pointed to mass balance as a vital tool to prove the circularity of advanced recycling. APR expressed measured support for mass balance in 2021,[263] but by 2023, the group had adjusted its view, noting in comments to the FTC that mass balance provided "little to no physical traceability to prove that there is any physical recycled content in the actual product."[264] ExxonMobil admits as much in its 2023 sustainability report, explaining that its circularity claims are based on adherence to an industry-supported standard rather than any actual recycled content: "The certificate we provide our customers is not a claim that our certified-circular polymers contain any 'recycled content' or carry GHG benefits. Rather, it represents an assurance that we followed a rigorous mass balance attribution system that is certified by a third-party."[265]

At a more fundamental level, the need for mass balance accounting at all is premised on deception. The companies claim that they are unable to track recycled content given the complexity of chemical recycling operations,[266] but allegations made in the State of California's complaint against ExxonMobil suggest that the company is able to accurately track the plastic waste it uses as inputs at its Baytown facility.[267]

> **"The certificate we provide our customers is not a claim that our certified-circular polymers contain any 'recycled content' or carry GHG benefits."**
>
> ExxonMobil, 2024

The plastics industry promotes mass balance anyway because it allows them to preserve the illusion that a meaningful percentage of plastic waste being fed into chemical recycling facilities is turning into new plastic products — and that those recycled plastics are displacing virgin materials. Anthony Schiavo of Lux Research notes that "free-attribution mass-balance plastics," the industry's preferred material accounting method, "may only be 2% – 5% recycled content by mass."[268] As a result, adoption of mass balance accounting "would increase the effective yield of recycled plastics from plastic pyrolysis by more than 10× compared to a strict proportional allocation."[269] Although this would obviously suit petrochemical firms desperate to create the perception that advanced recycling is a solution to plastic waste, Schiavo explains that the

255 *See* ExxonMobil, Exxtend Technology for Advanced Recycling and the Role Mass Balance Attribution Can Play in Supporting a More Circular Economy for Plastics (archived Dec. 13, 2024), http://archive.today/2024.12.13-194359/https://www.exxonmobilchemical.com/en/exxonmobil-chemical/sustainability/advanced-recycling-technology/mass-balance-attribution%20.

256 *See* Chevron Philips Chem., *supra* note 108, at 58.

257 *See* Shell, Mass Balance 101 (archived Oct. 31, 2024), https://archive.ph/2024.10.31-203917/https://www.shell.com/business-customers/chemicals/resources/mass-balance-101.html.

258 *See* TotalEnergies, *supra* note 112.

259 *See* Dow, Advanced Recycling (archived Oct. 14, 2024), https://web.archive.org/web/20241014232309/https://www.dow.com/en-us/materials-ecosystem/advanced-recycling.html ("If we want to tackle the plastics problem effectively, mass balance accounting is an essential piece of the puzzle.").

260 *See* BASF, Environmental, Social and Governance Report 124 (2023), https://report.basf.com/2023/en/_assets/downloads/esg-environment-social-governance-basf-ar23.pdf.

261 *See* INEOS, supra note 49, at 54.

262 *See* Mark J. Costa, *supra* note 19 ("[M]ass balance for material-to-material technologies is essential to allowing the circular economy to scale up.").

263 *See* Position Statement, Ass'n Plastic Recyclers, Mass Balance for Post-Consumer Resin (PCR) (May 2021), https://plasticsrecycling.org/wp-content/uploads/2024/09/APR-Position-Mass-Balance.pdf.

264 Megan Quinn and Maria Rachal, *Recycling, Packaging Groups Urge FTC to Modernize Green Guides*, Waste Dive (April 26, 2023), https://archive.ph/2024.12.13-195628/https://www.wastedive.com/news/ftc-green-guides-recycling-plastic-marketing/648645/#selection-605.17-605.79.

265 ExxonMobil, *supra* note 4.

266 *See, e.g.*, ExxonMobil, *supra* note 255 ("Because plastic waste derived raw materials are mixed with fossil-derived raw materials in the same system, there is no way to identify which molecules in those raw materials are derived from plastic and which are derived from crude-based feedstock.").

267 California Complaint, *supra* note 12, at 96.

268 Anthony Schiavo, Three Things Wrong — and One Right — With the New House Bill Legalizing Mass Balance, LinkedIn (Oct. 29, 2024), https://archive.ph/2024.12.13-195911/https://www.linkedin.com/pulse/three-things-wrong-one-right-new-house-bill-mass-balance-schiavo-wglye/?trackingId=OL3We%2BLFjMItTJoEw%2BDcbA%3D%3D.

269 *Id.*

Photo credit: Teslariu Mihai/Unsplash

system "creates a perverse incentive for low levels of blending of pyrolysis oil (where free attribution is maximally valuable) and dramatically reduces the amount of total waste treatment needed to achieve the content targets."[270]

Petrochemical companies use the language of circularity but oppose its principle of minimizing the extraction of virgin resources.

In reality, genuine circularity would be a threat to the companies' business models. In *California v. ExxonMobil*, the state has alleged that Exxon has promoted advanced recycling, at least in part, "to avoid the 'negative' impacts/consequences of the looming implementation/adoption of the circular economy way of thinking," in the words of internal documents.[271] Closed Loop Partners, an investment firm with ties to petrochemical companies like Chevron Phillips, Dow, and LyondellBasell,[272] noted in 2021 that to realize positive impacts, companies would need to use chemical recycling technologies to shift away from using virgin resources: "Molecular recycling can help mitigate climate change *when it displaces the use of virgin plastics*. The transition towards a circular future will rely upon the petrochemical industry shifting a significant proportion of their investment to solutions that address plastic waste, like molecular recycling, and *shifting away from oil exploration and new extraction infrastructure*."[273]

The incompatibility between this vision of circularity and the plastics industry's mandate for production growth explain why the companies have tried to co-opt the concept of a circular economy and mold it into something that is aligned with their business model. But no available chemical recycling technologies can overcome the technical constraints associated with plastic recycling. As ExxonMobil's own chemical engineers have noted internally, "there will continue to be a growing need for virgin resin even as recycle rates are anticipated to increase."[274] BASF employee Jasmin Beckenbach, a lead on the company's ChemCycling project, was equally direct in a 2022 interview: "From a technical point of view, there will be limitations. You cannot have a 100 percent closed loop, you always will need to have some fossil resources."[275]

270 *Id.*

271 California Complaint, *supra* note 12, at 77.

272 Closed Loop Partners, Closed Loop Partners' Circular Plastics Fund Announces New Investors, Catalyzing Capital Toward a Circular Economy (Mar. 14, 2023), https://archive.ph/2025.02.20-170304/https://www.closedlooppartners.com/closed-loop-partners-circular-plastics-fund-new-investors/.

273 Paula Luu, Closed Loop Partners, Transitioning to a Circular System for Plastics 14 (2021) (emphasis added), https://www.closedlooppartners.com/wp-content/uploads/2021/11/AR-report-V23_final7.pdf.

274 California Complaint, *supra* note 12, at 89.

275 DW Planet A, How to Recycle the Unrecyclable, at 8:15-8:25, YouTube (Feb. 11, 2022), https://www.youtube.com/watch?v=cPEDdrGDGrs&t=482s.

Photo credit: iStock

Conclusion

Big Oil and the plastics industry created the concept of "advanced recycling" as part of an effort to address a specific problem: the rapidly growing concern from policymakers and the public about the plastic waste crisis, which if left unaddressed could present an existential threat to the petrochemical companies' business model of ever-increasing plastic production. The plastics industry makes the claims about advanced recycling that it does — despite knowing them to be false — because those false claims allow the industry to present the public with a seemingly acceptable solution to the plastic waste crisis that does not entail placing limits on plastics production.

The plastics industry seeks to advance this goal with each of the false claims about advanced recycling discussed in this report:

1. The false claim that advanced recycling is new and ground-breaking seeks to prey on our impulse toward a technological fix to complex problems and provides a built-in excuse when advanced recycling fails to accomplish what the industry claims it will.

2. The false claim that meaningful solutions are imminent seeks to preserve the illusion that advanced recycling could solve the plastic waste crisis without more fundamental changes to the ways we produce and use plastics.

> **"From where I sit, things look grim: The fact that we don't have a really successful case study at this point makes me think it's going to be all uphill to make pyrolysis work."**
>
> Anthony Schiavo,
> Lux Research, 2024

3. The false claim that advanced recycling will address the problem of hard-to-recycle plastics seeks to deflect attention from the fact that the technology is subject to many of the same shortcomings that make mechanical recycling fundamentally unable to address the plastic waste crisis.

4. The false claim that advanced recycling is environmentally friendly and good for the climate seeks to promote solutions that fit into existing petrochemical infrastructure rather than genuine engagement with the environmental implications of plastic production and disposal.

5. The false claim that advanced recycling is compatible with a circular economy seeks to present plastics as materials that can be endlessly remade and the technology as a tool to reduce consumption of fossil fuels, despite chemical recycling technologies primarily producing fuels and circularity being fundamentally at odds with the goals of plastics producers.

Faced with the enormity of the plastic waste crisis, the idea of a straightforward solution is appealing for the public, policymakers, and plastics producers alike. The plastics industry's large-scale disinformation campaign is intended to present advanced recycling as that solution. But — especially given the plastics industry's long history of deceptively promoting recycling as a way to relieve public pressure to address the waste they produce[276] — policymakers cannot ignore the overwhelming evidence that the promotion of advanced recycling does not reflect the technical or economic realities of chemical recycling technologies.

Rather, it is simply the latest attempt by Big Oil and the plastics industry to deflect attention from the myriad problems with plastics and to continue producing ever-greater amounts of plastic, regardless of the consequences. The petrochemical companies responsible for this coordinated campaign of deception should be held accountable.

276 *See generally* Center for Climate Integrity, *supra* note 1.

Suggested Reading

The following resources provide additional insight into the plastics industry's deceptive promotion of advanced recycling. They document the technical obstacles that limit chemical recycling's viability, the repeated failures to scale up its use, and the role of greenwashing in perpetuating the industry's social license to operate.

Lee Bell and Jenny Gitlitz, Beyond Plastics and IPEN, Chemical Recycling: A Dangerous Deception (October 2023), https://www.beyondplastics.org/publications/chemical-recycling.

Jacqueline Ebner, Kathy Hipple and Irina Spector, Ohio River Valley Institute, Chemical Recycling: A False Promise for the Ohio River Valley (July 2024), https://ohiorivervalleyinstitute.org/chemical-recycling-a-false-promise-for-the-ohio-river-valley/.

Alice Mah, *Future-Proofing Capitalism: The Paradox of the Circular Economy for Plastics*, Global Environmental Politics (May 2021), https://doi.org/10.1162/glep_a_00594.

Denise Patel et al., Global Alliance for Incinerator Alternatives, All Talk and No Recycling: An Investigation of the U.S. "Chemical Recycling" Industry (2020), https://www.no-burn.org/wp-content/uploads/All-Talk-and-No-Recycling_July-28.pdf.

Jane Patton, et al., Center for Int'l Env't Law, Beyond Recycling: Reckoning with Plastics in a Circular Economy (2023), https://www.ciel.org/wp-content/uploads/2023/03/Beyond-Recycling-Reckoning-with-Plastics-in-a-Circular-Economy.pdf.

Andrew Rollinson, Zero Waste Europe, Leaky loop "recycling": A technical correction on the quality of pyrolysis oil made from plastic waste (October 2023), https://zerowasteeurope.eu/library/leaky-loop-recycling-a-technical-correction-on-the-quality-of-pyrolysis-oil-made-from-plastic-waste/.

Andrew Rollinson and Jumoke Oladejo, Global Alliance for Incinerator Alternatives, Chemical Recycling: Status, Sustainability, and Environmental Impacts (2020), https://www.no-burn.org/wp-content/uploads/2021/11/CR-Technical-Assessment_June-2020_for-printing-1.pdf.

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Renee Sharp, et al., NRDC, More Recycling Lies: What the Plastics Industry Isn't Telling You About "Chemical Recycling" (March 2025), https://www.nrdc.org/sites/default/files/2025-03/More_Recycling_Lies_IB_25-02-A_07_locked.pdf.

Renee Sharp and Veena Singla, NRDC, The Plastics Industry's Latest Deception: "Mass Balance" (September 2024), https://www.nrdc.org/bio/renee-sharp/plastics-industrys-latest-deception-mass-balance.

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Lisa Song, *The Delusion of 'Advanced' Plastic Recycling*, ProPublica (June 2024), https://www.propublica.org/article/delusion-advanced-chemical-plastic-recycling-pyrolysis.

Joachim Peter Tilsted et al., *Petrochemical Transition Narratives: Selling Fossil Fuel Solutions in a Decarbonizing World*, Energy Research & Social Science (December 2022), https://doi.org/10.1016/j.erss.2022.102880.

Lauriane Veilard, Zero Waste Europe, Fifty years: chemical recycling's fading promise (November 2024), https://zerowasteeurope.eu/library/fifty-years-chemical-recyclings-fading-promise/.

Joseph Winters and Emily Sanders, *'Plastics are awesome': Inside the Energy Department's partnership with the plastics industry*, Grist (February 2025), https://grist.org/accountability/energy-department-american-chemistry-council-chemical-recycling/.

Center for
Climate
Integrity