



Once Seen as Industry Savior, Petrochemicals Losing Financial Appeal

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Executive Summary

The oil and gas industry and its petrochemical counterpart generate millions of tons of plastic waste and millions of tons of greenhouse gases (GHGs). The industries are at the crosshairs of international criticism. The future that now confronts the industry is fraught with risk from a short-, medium- and long-term profit squeeze driven by unprecedented, powerful market and political forces. Investors must play a more effective role in moving corporations to a sustainable business model.

International appeals to limit the use of fossil fuels, based on scientific evidence, warn us of consequences if those admonitions are ignored. Markets for the major component commodities are oversupplied and being reshaped by unprecedented competition. The problems have also created burgeoning investment opportunities to transform the economy, yet, as this report demonstrates, most of these companies remain overly dependent on fossil fuels. They are wedded to financial models that possess neither the technological nor business essentials needed to chart a growth-oriented path to a sustainable future. Instead, they are adding more single-use plastics production facilities—the principal source of ocean pollution—despite warnings.

The complex dynamics that affect ethylene, polypropylene and polyethylene markets—the basic raw materials of single use plastics—have broad implications. The growth rates for these products have been robust historically, resulting in substantial quantities of single use plastics produced and deposited into the world's waterways. The underlying production dynamics and margin spreads have been positive, as plastics producers have a multiplicity of raw product outlets.

What is developing now is a series of structural chokepoints that over time is having the effect of reversing those positive dynamics. The market outlook for virgin plastics is turning negative.

Standard and Poor's, Fitch and Moody's have issued various credit warnings. Fossil fuel producers, the linchpin of plastics production, face impending downgrades due to their failure to prepare for market and policy changes. Petrochemical hubs are increasingly viewed as credit negative. Public concern has become a potent regulatory and political risk that echoes the changing policy and market forces challenging the oil, gas and petrochemicals industries' creditworthiness. The stock market shows that oil and gas majors, as well as some petrochemical producers, have experienced unstable short-term gains linked to underlying vulnerabilities, not market strength. Their financial performance has lagged the market for many years, and they are likely to continue on that path.

This report analyzes nine of the major companies that have a profound impact on how solutions to the problem of plastic pollution can become part of a company's business model. IEEFA reviewed six integrated oil and gas companies (ExxonMobil, TotalEnergies, Eni, Chevron Phillips Chemical, Repsol, Shell) and three petrochemical companies (LyondellBasell, Westlake, and Dow) regarding the issue of sustainability in the petrochemical and plastics industries, specifically the production, use

and disposal of single-use plastics. They are substantial producers and consumers of resins used to make single-use plastics.¹

IEEFA's research highlights a critical component of the sustainability equation—the industry's response to the pollution impacts of plastics, particularly single-use plastics. The following facts about the companies under study indicate they are making major investments that are going in the wrong direction by increasing the production and supply of fossil-based plastics.

The report finds:

- Eight of the nine companies identified in this study are actively sponsoring projects and investments collectively worth more than \$70 billion on ethylene, polyethylene and other assets that support the expansion of single-use plastics. The projects enter the market at a time of oversupply, slowing economic growth and rising competition. These long-term investments—choices made by corporate decision makers—run contrary to market forces, environmental/regulatory priorities and climate imperatives.
- ExxonMobil is sponsoring major ethylene, polypropylene and polyethylene facilities in the United States and China. Three investments are estimated at more than \$20 billion.
- TotalEnergies' sustainability plans support a substantial expansion of single-use plastics. Expanding its market share in the United States, its joint venture with BASF is adding a 1-million-ton ethylene cracker in Texas, as well as more polyethylene capacity.
- Eni has embarked on development of chemical recycling initiatives that rely on unproven technical and waste management techniques. It plans to spend upward of \$9 billion annually to increase its natural gas holdings, including its recently announced project to expand natural gas production in Australia, a move tied to a plan for a major increase in risky petrochemical production.
- Repsol has been criticized for using green bond proceeds to support a corporate structure overly reliant on fossil fuels.
- Shell invested more than \$6 billion in a petrochemical hub (ethylene, polyethylene) in western Pennsylvania that has caused pollution problems, lacks transparency and has opened to a weak market.
- Chevron Phillips Chemical has announced \$14.5 billion in investments that expand ethylene and polyethylene capacity in the United States and Middle East.
- LyondellBasell is helping to support a 1.5-million-ton annual polypropylene buildout in South Korea and Thailand.
- Dow Chemical is moving forward with a \$9 billion integrated cracker plant in Canada that would produce 1.8 million tons of ethylene and polyethylene every year. The project plans to

¹ Minderero Foundation. [Plastic Waste-Makers Index](#). 2023.

use natural gas as a feedstock and rely on unproven carbon capture and sequestration (CCS) technology.

Billions of dollars are being deployed on business-as-usual investments that will fail to achieve climate and pollution reduction goals, maintain profitability and encourage investor confidence.

Some of the companies identified in this report are making impressive attempts to support positive solutions. Efforts to replace fossil fuels with feedstock alternatives in the production of plastics; replacement of fossil fuels with biofuel products to make aviation and other transportation modes sustainable; advancing the use of wind and solar power; and new efficiency measures to replace coal and natural gas all offer promises of reducing emissions from the manufacturing of plastics and other forms of petrochemical production. Some already show strong results, with investable business models.

The sustainability options that are promising are also often mixed with problematic ones. Some initiatives reduce the amount of fossil fuels in the plastic production process. This will enable plastics expansion that continues to undermine efforts to reduce ocean pollution.

Even with new fossil fuel replacements, technologies, and research experiments, substantial work must be done. No uniform accounting mechanism is in place to monitor emissions. Core measuring tools are lacking that would specify and quantify changes—such as the emissions that are eliminated or transferred, the aspects of the economic chain that are measurable, and the evaluation of a complex web of chemical products and co-products in industrial processes.

Some countries have cast a wide net to better define these questions in the form of systematic taxonomies, as well as support for circularity and sustainable economics. The European Union has advanced a comprehensive model with the greatest clarity and far-reaching implications for the future of both fossil fuels and sustainability. Measuring the reuse potential, recycling viability and product lifecycles of single-use plastics, for example, is a major first step in understanding the policy and market ramifications of incentives to decarbonize or eliminate products.

A few companies are already attempting to apply these sustainability standards to their own business operations, with important results. TotalEnergies, for example, analyzed its capital expenditure portfolio regarding GHG emission concerns and found that despite its goals, the company's capital expenses support only 17% of initiatives oriented toward Paris-aligned goals. The company's disclosure reveals the distance this one company must go. Yet most companies have not come even this far.

Our review also finds a troubling corporate consensus emerging on some initiatives that actually serve to undermine, rather than support, the twin goals of producing fewer single-use plastics that pollute waterways and fewer emissions.

Most notably, a widely shared industry premise contends that using natural gas is a viable climate solution because it creates fewer emissions than coal. But gas is not a climate solution—it's a serious

climate *problem*. Given the speed of transition needed to forestall a global climate crisis, ramping up gas consumption for energy or feedstock is counterproductive.

Other efforts seek to partially or completely replace fossil fuels (including natural gas) as feedstock with biofuels, mechanical and chemical recycling. This approach is often explicitly designed to provide license to increase the supply of single-use plastics, based on the argument that climate goals have been advanced. These approaches are important, but often result in more products that will still find their way into the world's oceans and streams.

Non-gas alternatives that also address waste issues are generally better, cheaper and more climate friendly. Calls for investments in these areas tend to fall on deaf ears because they require detailed technical analysis. But analyzing such system supports as feedstock substitutes, energy storage, improved transmission systems, reusable products, and energy demand management can help to deal with the new questions and policy tradeoffs that are part of the evolution of a sustainable economy.

Most of the companies are investing in some form of carbon capture and storage (CCS), often proclaiming that its industrial adaptability can address production processes across a spectrum including ethane and naphtha, plastics, hydrogen, steelmaking, oil and gas extraction, and power generation. CCS is a technological process that has been used historically to provide CO₂ for use in enhanced oil extraction or as a coal emissions control technology. The technology has been presented as a strategy to control carbon emissions in a wide variety of power, petrochemical and industrial applications. The current level and type of support comes despite decades of audited results exposing technical failures, weak performance and a consensus that the business models supporting the technology are not commercially viable without permanent subsidization.

This report is a research tool that asks questions about the work of petrochemical companies, including integrated oil and gas majors, in the arena of sustainability in plastics production. The companies that were chosen are industry and market leaders.

The report also suggests other stakeholders have a role to play.

Investors, for example, are not powerless in this process. Many investors see an industry that has declined in market share, plagued the economy with disruptive actions and offered weak plans. Some are demanding greater disclosure about initiatives companies propose to address sustainability. Some investors have initiated shareholder resolutions and engagement dialogues at dozens of companies (see Section: Policy Responses) to establish and extend that language and metrics. This trend is likely to continue.

The evolution of sustainable economics is complex. The details must be disclosed and discussed to ensure systemic economic change is accompanied by sound corporate strategy, and obstacles are identified early and addressed effectively. In addition, investors need a common language and set of metrics that target the critical benchmarks needed to integrate climate, environmental and profitability goals.

Table 1: Pipeline of New Single-Use Plastics Assets by Company (2023)

Company	Project Name	Location	Cost	Polypropylene	Ethylene	Polyethylene	Start-Up
ExxonMobil	Corpus Christi	Texas, United States	\$10 billion		x	x	2022
ExxonMobil	Baton Rouge	Louisiana, United States	\$0.5 billion	x			2023
ExxonMobil	China Petroleum Complex	Guangdong Province, China	\$10 billion	x			2026
Total Energies	Payport/Port Arthur	Texas, United States	\$2 billion (partial)		x	x	2023
ENI	Evan Shoals Gas Field	Australia	Failure to disclose		x		n/a
CP Chem	Ras Laffan Petrochemical Complex	Saudi Arabia	\$ 6 billion		x	x	2026
CP Chem	Golden Triangle Polymers Company	Texas, United States	\$8.5 billion		x	x	2026
Shell	Pennsylvania Petrochemical Hub	Pennsylvania, United States	\$6 billion		x	x	2022
LyondellBasell	Thailand-Parnets-HMC Polymers	Thailand	N/A	x			2022
LyondellBasell	Ulsan PP/Poly Mirae	South Korea	\$0.42 million	x			2021
Dow	Alberta Ethylene Cracker	Canada	\$10 billion	x	x		2027
Repsol	Reciclex	Ongoing series of new businesses	\$11 billion		x	x	

Fatih Birol, executive director of the International Energy Agency (IEA), recently warned:

“New Large-scale fossil fuel projects not only carry major climate risks, but also business and financial risks for the companies and their investors.

“When I talk with the oil companies, both international and national oil companies, some of them are saying that we have been underinvesting in oil and gas. But companies and investors should be very careful about this claim, bearing in mind the demand trajectories we are seeing. It could lead them into taking very unhealthy, unwise economic and climate risks.”²

The IEA’s analysis of demand trajectories referenced by Birol suggests consumers are interested in products that have substantially reduced or eliminated fossil fuels from design, production and disposal practices. The fossil fuel industry faces stiff competition across its traditional end user groups. Transportation, power generation and petrochemical sectors today all face strong competition from companies that do not rely principally on fossil fuels.

There is no clearer indication of the industry’s weak transition planning than in the production of single-use plastics. The companies identified in this study are dominant players in the ethylene, polyethylene (PE), (high-density polyethylene (HDPE), linear low-density polyethylene (LLDPE), low-density polyethylene (LDPE) and polypropylene (PP) markets. Of particular concern are single-use plastics, which make up the largest component of the 24 million to 34 million metric tons of plastic that end up in waterways every year. The producers of single-use plastics face declining market share as replacements are sought to curb the escalating problem of ocean pollution and GHG emissions. This problem has reached international attention, with the United Nations supporting development of a major legally binding reform initiative.³ Yet the large companies in the integrated oil and gas and petrochemical business continue to plan for the expansion of the industry. This is unlikely to succeed because the basic financial assumptions being used are outmoded. The demand for single use plastics is likely to decline. If expansion proceeds but demand declines, the result is oversupply—which impairs profitability.

² The Guardian. [New fossil fuel projects ‘very unwise economic risk’ says global energy chief](#). September 14, 2023.

³ See: United Nations. [Climate Action](#). Last visited November 24, 2023.

The factors undermining the business model of these companies—increasing market share of electric vehicles, wind and solar power, and bio-based petrochemical substitutes—are all examples of technologies reducing the market share of the coal, oil, and gas industries. The loss of market share has been long in the making and stark in its results. The loss can be summarized using several financial indicators:

- The oil and gas sector claimed 28% of the stock market in 1980. Today, its share is 4.5%.⁴ In October 2020, the industry hit a bottom of 2% of the stock market.⁵
- In eight of the ten years before the Ukraine invasion, the oil and gas industry lagged the market. In five of those years, the industry was in last place.⁶
- Oil and gas companies enjoyed record profits in 2022, stemming from the price spike that accompanied the Ukraine invasion.⁷ But from January through August 2023, the industry bounced around near the bottom of the stock market. Despite a strong third quarter, the industry ended second to last for 2023.⁸
- The MSCI index without fossil fuels has outpaced its companion index with fossil fuels since 2014.⁹

The faltering performance of the oil and gas sector has caused some to argue that the oil and gas industry must pivot toward petrochemicals, including single-use plastics.¹⁰ The compound annual growth rate (CAGR) for both basic and specialty chemicals has historically exceeded global gross domestic product (GDP).¹¹ This assumption has been the cornerstone of the petrochemical and plastics industry's financial rationale. Integrated oil and gas companies (TotalEnergies, ExxonMobil, Shell, Chevron) play a leading role in the petrochemical sector, next to petrochemical standalone companies such as Dow and LyondellBasell.

Fundamental economic forces lie at the root of the issues facing the oil and gas and petrochemicals industries. The industry's investment thesis rests on macroeconomic logic that the energy sectors growth is inextricably linked to economic growth and that plastic demand exceeds economic growth rates. Oil sector growth, however, is becoming decoupled from broader economic growth. During the 10 years before the Ukraine invasion disrupted the market, the industry had lost market share as the economy generally, and the stock market specifically, had grown. This dynamic is likely to resume. Fitch has recently characterized the issue:

⁴ Standard and Poor's. [S&P 500 Index](#). October 31, 2023.

⁵ Sibillis Research. S&P Sector and Weightings, 1979 to present, (Proprietary database). "Sibillis Weighted"

⁶ Novel Investor. [Annual S&P Sector Performance](#). October 6, 2023.

⁷ Sibillis Weighted.

⁸ Yardeni. [S & P 500 Sectors Performance](#). December 29, 2023.

⁹ MSCI. [MSCI ACWI ex Fossil Fuels Index](#). November 30, 2023.

¹⁰ Wall Street Journal. [Big Oil flashes the Plastic](#). July 28, 2019.

¹¹ ExxonMobil. [2022 Investor Day Presentation](#). March 2022.

While current trade tensions represent disruption to energy, commodity and technology value chains, we believe in the long term this should not be detrimental to low-carbon transition and long-run assumptions around deployment of low-carbon technologies on the basis of falling costs.¹²

The largest player in the market globally is China, but its growth trajectories are expected to slow in coming years.¹³

Petrochemical and single-use producers confront not only a declining macroeconomic reality but also policy interventions that restrain traditional growth trajectories. Fossil fuels are used in a vast array of common plastic products, adding to global climate and environmental concerns. Ocean pollution from discarded plastic bottles and containers has become an international problem. Air, land and water pollution from industrial processes that use fossil fuels are a cause for concern, especially in communities that often host clusters of petrochemical plants.¹⁴

I. Policy Responses to Plastic Pollution and Policy Interventions to Spur Energy Transition

The public policy response to the problem of plastics as a source of ocean pollution is global. The United Nations is currently sponsoring treaty deliberations to address the plastics issue. Many countries, including the European Union, are engaged in large-scale planning efforts, classifying economic activity using taxonomy models and concepts of economic circularity to chart the regulatory course toward sustainable business models that are more efficient, profitable and environmentally safe.¹⁵ Local governments around the world are banning or restricting plastics production and distribution. Along with these changes comes the potential for new markets to form.

Although these policy interventions are bringing about considerable change, often the policy initiatives are launched with inadequate implementation infrastructure. The measures for a climate solution are evolving.¹⁶ Fundamental questions are emerging (but remain contentious) regarding: What should be counted; the boundaries of what gets measured along the economic value chain; and the relevant accounting practices to monitor co-products generated during often complicated technological processes.

¹² Fitch Ratings. [Climate Vulnerability in Corporate Ratings – Discussion Paper, Special Report](#). February 15, 2023.

¹³ See discussion of China's growth in Section III Commodity Risk Analysis - Polyethylene.

¹⁴ Oil and Gas Watch. [Plastics Boom brings flood of new ethylene cracker chemical plants despite frequent environmental violations](#). September 2022.

¹⁵ IEEFA. [Fact Sheet: Green Taxonomies Explained](#). August 2022.

¹⁶ S & P Global. [The Right Measure](#). March 2023.

Recently, third-party organizations have assembled panels of experts capable of drawing up scientifically sound, investable plans for companies to evaluate and integrate into their own plans. One such plan has been developed with the support of The Pew Charitable Trusts.¹⁷

Breaking the Plastic Wave: A Comprehensive Assessment of Pathways Towards Stopping Ocean Plastic Pollution is a global analysis of pathways to stop plastic pollution of the ocean. Pew Charitable Trusts and Systemiq produced and released the report in July 2020, in collaboration with expert advisers from the University of Oxford, University of Leeds, Ellen MacArthur Foundation and Common Seas.

The report found that if conditions remain on the current “business-as-usual” trajectory, annual flows of plastic into the ocean could almost triple by 2040. The analysis pointed to such issues as cheap virgin plastics leading to greater per capita consumption and the growing use of plastics in areas lacking adequate collection or recycling systems. It determined that existing commitments by industry and government to control plastic pollution would result only in a 7% reduction in annual plastic ocean pollution flow rates.

Breaking the Plastic Wave utilized stochastic modeling, often used to help make investment decisions, which examines the probability of various outcomes under a range and diversity of conditions. The resulting integrated systems change model identified an economically attractive and practical pathway to cut plastic waste pollution. The analysis included upstream and downstream options and established a criteria-based comparison of solutions.

The report proposed a system of better plastic design, robust reuse, improved recycling and stronger incentives for plastic waste collection. It concluded such a concerted effort could cut annual flows of plastic into the ocean by about 80% in the next 20 years.

The recommendations of the report would have significant implications for companies that use fossil fuels in the production of plastics and other petrochemical products. The ability of companies to adapt to a market that demands less virgin plastic and supports a wide range of alternatives is at the core of the questions raised.

The recommended solutions include:

- Cut almost one-third of projected plastic waste generation through elimination, reuse and new delivery modes (this initiative has the most far-reaching and effective impact).
- Replace one-sixth of plastic waste by substituting paper and compostable materials.

¹⁷ The Pew Charitable Trusts and Systemiq. [Breaking the Plastic Wave](#). July 2020. Also see: Science.org. [Evaluating scenarios toward zero plastic pollution](#). July 2020.

- Expand waste collection rates in middle and low-income countries to 90% in urban areas and 50% in rural areas. Support the informal collection sector, and double mechanical recycling capacity globally to 86 million metric tons per year (mmtpa).
- Build facilities (landfills, incinerators or plastic-to-fuel technologies) to dispose of the 23% of plastic waste that can't be recycled economically, as a transitional measure.
- Cut plastic waste exports by 90% to countries with low collection and high leakage rates.
- Address four microplastic (<5mm) sources—tires, textiles, personal care products and production pellets—to cut annual microplastic leakage by 1.8 mmtpa.
- Provide incentives to shift investment from conventional virgin plastics to new delivery models, plastic substitutes, recycling facilities and collection infrastructure.

The report warns that downstream plastic waste management systems, advocated by the plastics industry as overarching solutions, have limited potential. The report questions the practicality and effectiveness of so-called “advanced recycling” (predominantly pyrolysis and gasification), which is plagued by high costs, significant chemical use, emissions of carbon and other pollutants, and the potential for non-circular plastic-to-fuel pathways. It sees only a limited role for bio-based plastics—which may be chemically identical to fossil-fuel based plastics or may lack appropriate composting infrastructure.

The recommended strategies, in contrast, would provide consumers with the same services that plastic delivers today, at a lower cost to society. The total global cost to implement the System Change Scenario proposed by the Pew report is estimated to be \$600 billion in present value, compared to the \$670 billion price tag to manage a high leakage scenario such as we face today. It also results in a 6% increase in net employment (roughly 700,000 jobs) with almost all the jobs occurring in middle-income and low-income countries.

There is now significant pressure on these petrochemical producers from their downstream customers—global brands such as Coca-Cola, Nestle, PepsiCo, Unilever, and Walmart—to produce fewer plastics. Those brands are members of the Business Coalition for a Global Plastics Treaty, which has stated that the top priority of a plastics treaty should be “reduction of plastic production and use,” focusing on plastics with high leakage rates, short lives, and made using fossil-based virgin resources.¹⁸

A recent report by Fitch made clear they are changing their methodology to rate companies across the entire fossil fuel value chain.¹⁹ The new methods are placing renewed scrutiny on oil and gas producers and the banks that are involved in the financing of various traditional and sustainability

¹⁸ Business Coalition for a Global Plastics Treaty. [No Time to Waste](#).

¹⁹ Fitch Ratings. [Climate Vulnerability in Corporate Ratings – Discussion Paper, Special Report](#). February 15, 2023.

initiatives. If Fitch's standards were applied today, many companies that currently are investment grade with stable or better outlooks would be downgraded.²⁰

Fitch's attempt to adopt a comprehensive strategy advances the discussion on climate change that has been evolving at Moody's and Standard and Poor's over the last three years.^{21,22,23} Unlike the mortgage market meltdown, when credit agencies failed to warn the markets about the industry's deterioration,²⁴ the credit agencies are stepping up warnings about the full range of fossil fuel production, including petrochemicals. The question is, are the producer companies and their financial investors responding?

Investors have begun to press the large petrochemical producers. The Pew report served as the basis for shareholder resolutions filed at Dow, Phillips 66, and ExxonMobil, asking the companies to assess the impact on future business of a significant cut in virgin plastic demand as set forth in Pew's System Change Scenario. The proposals were filed by As You Sow, a California-based shareholder advocacy group. Votes for these resolutions were substantial, including a majority vote at Phillips 66 in 2022, demonstrating strong investor interest in the topic.

II. Company Outlines

This section identifies selected financial data and sustainability plans for nine leading companies in the petrochemical sector. It reviews six integrated oil majors—ExxonMobil, TotalEnergies, Eni, Repsol, ChevronPhillips Chemical, and Shell—as well as three independent petrochemical companies—Dow, LyondellBasell and Westlake.

Oil and gas majors are involved in the entire oil and gas value chain: Exploration and production, transport (via truck, rail and pipeline), refinery, petrochemical production and service stations. The independent petrochemical standalone companies are usually engaged in the production of petrochemicals through various refining and technological processes. Also, they are often involved with the buying and selling of raw, intermediate or end products to manufacturers or brand distributors. They typically buy feedstock (ethylene) from major oil and gas companies.

IEEFA anticipates that the market breadth of oil and gas producers will decline over time.²⁵ Competitive market alternatives in the power generation, transportation and petrochemical sectors are reducing consumption of fossil fuels in the production process. These market forces are being intensified by public policy interventions and support for sustainable investments. The trajectory has

²⁰ Fitch Ratings. [Over half of corporates facing climate related downgrades by 2035 are investment grade](#). October 24, 2023.

²¹ Moody's Investor Services. Shifting environmental agendas raise long term credit risk for natural gas investments. September 30, 2020 (Proprietary).

²² S&P Global Ratings. Ratings on Formosa Plastics Corp. And Three Associated companies Affirmed at 'BBB+' on Low Debt Leverage; Outlook Stable. October 7, 2021 (available at: Formosa Petrochemical Corporation. [Financials: Credit Ratings](#), accessed December 29, 2023) (hereafter, [S&P Global's October 2021 credit rating on Formosa](#)).

²³ IEEFA. [Rating stability at risk from looming climate downgrades](#). August 2023.

²⁴ New York Times. [Debt Watchdogs: Tamed or Caught Napping?](#) December 7, 2008.

²⁵ International Energy Agency. [Net Zero – 2050](#). May 2021.

ramifications for each company identified in this report. How a company allocates capital today tells us where they want to be tomorrow.

The oil and gas majors have a history of working toward an overarching goal of reserve replacement.²⁶ The basic thesis is that in each year, each oil and gas company must replace their individual reserves depleted roughly by their annual sales volume with new reserves. Companies could justify this strategy to shareholders with confidence because as the economy grew, so did the need for oil and gas. The link between oil and gas sector growth and economic growth was at the center of the investment hypothesis. For the most part, financial markets rewarded this strategic natural resource management strategy.²⁷

In 2021, The New York Times published an article documenting the growing division among oil and gas companies' strategies. It found U.S. producers remaining largely wedded to oil and gas drilling, with only a limited research and development agenda on energy transition. Meanwhile, European companies were moving faster toward renewable energy operations and emphasizing the future of electrification.²⁸ The article noted the collective power of these private companies contained sufficient scientific and technological resources to make a significant contribution to climate solutions.

McKinsey noted that in 2022, 90% of the world's largest chemical companies had announced net-zero or decarbonization plans, up from 50% the previous year.²⁹ Despite these announcements, recent reports show the oil and gas sector, including the large state-run operations, are actively opposing pressure in the latest round of climate change discussions to curb pollution. And the discussions, such as those associated with the UN Treaty on Plastics,³⁰ center squarely on petrochemicals. The future of single-use plastics is front and center of this dialogue.³¹

The remainder of this report probes the approaches being taken by nine companies that purport to manage the energy transition with a host of new products, technologies, services and business lines. This report covers the range of sustainability initiatives adopted by these companies—including with regard to plastics—because the purported solutions being offered often cut across corporate silos and use technologies that have implications for the range of fossil fuel companies from extraction to waste management. Notwithstanding the flurry of public debate, what companies are doing to address changes in the new era of sustainability marks the difference between a company that will succeed and a company that will fail as the transition progresses.

²⁶ For a discussion of how this overarching goal was the cornerstone of the oil and gas sector and its individual companies see: Steve Coll. *Private Empire ExxonMobil and American Power*. New York: Penguin Press, 2012, pp. 49-57.

²⁷ The companies identified in this report and the industry in general have credit ratings that are investment grade. See Appendix I: Credit Ratings.

²⁸ The New York Times. [U.S. and European Oil Giants Go Different Ways on Climate Change](#). September 21, 2021. This discussion of the private corporate interests does not address the role of large state-owned competitors in the field.

²⁹ McKinsey. [Petrochemicals in 2022: A return to normalcy with uncertainty ahead](#). February 17, 2023.

³⁰ Plastics News. [Mixed signs of agreement, warnings mark end of latest treaty talks](#). November 20, 2023.

³¹ Scientific American. [Fossil fuel interests try to weaken global plastics treaty](#). June 2023.

A. Large Integrated Oil Majors

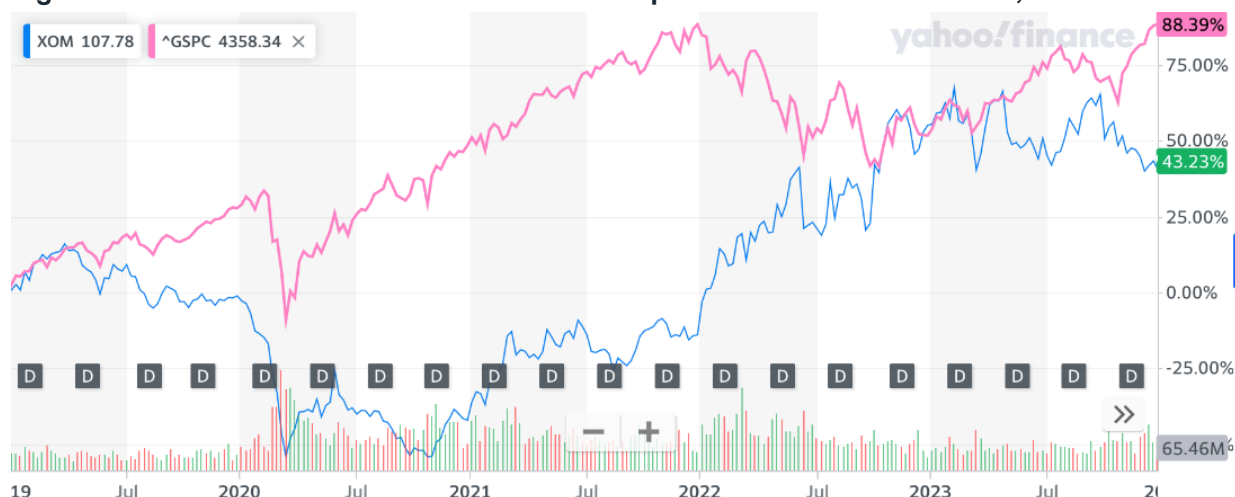
ExxonMobil (XOM)

Background

ExxonMobil is an integrated oil and gas major with offices in Houston, Texas. Its revenues in 2022 totaled \$398.7 billion, and its market capitalization is \$448.6 billion.³² Although known for its prodigious oil and gas extraction initiatives and execution capability, the company is also a leader in the petrochemical sector.

The company announced a reorganization in 2022 that changed some of its reporting units. The new plan maintained its upstream operations, but renamed its refinery unit to Energy Products and appears to have subdivided its chemicals unit into Chemical Products and Specialty Product units.³³

Figure 1: ExxonMobil Stock Performance in Comparison With S&P 500 Index, 2019-Present³⁴



Source: Yahoo Finance.

As Figure 1 shows, ExxonMobil's stock has lagged the S&P 500 over the last five years. This is despite the noticeable improvement in its stock value at the end of the pandemic and then rapid rise after February 2022 (the Ukraine invasion). Over the past five years, ExxonMobil's stock value grew by 31.7%, but the market rose by 57.5%. During the five years prior to the invasion (from February 2017 to February 2022), Exxon's stock had dropped by 6.5% but the S&P 500 increased by 98.8%.

³² ExxonMobil. [2022 Form 10-K](#). February 22, 2023 (hereafter, [ExxonMobil 2022 Form 10-K](#)), pp. 77 and p. 81.

³³ See: Hydrocarbonengineering.com. [ExxonMobil to streamline its business structure](#). January 2, 2022. Notwithstanding ExxonMobil's press statements regarding the shape of its organization restructuring, the financial reporting units used in the company's 10-K are Upstream, Energy Products, Chemical Products and Specialty Products. See [ExxonMobil 2022 Form 10-K](#), p. 35.

³⁴ YahooFinance, [ExxonMobil January 7, 2018 through January 7, 2023](#).

In 2023 coming off a banner year the company's stock lost 9.4% while the market increased by 23.5%.³⁵

ExxonMobil is the leader of the energy sector, which as a whole has lagged the S&P 500 for the last decade. After a strong 2022 due to the Ukraine invasion's impact on oil prices, the sector placed next to last in the stock market for 2023. The integrated oil and gas subsector is the poorest performing component of the energy sector.³⁶

The company is a top 10 producer of ethylene, polyethylene, polypropylene and propylene. In 2022, ExxonMobil posted record profits of \$55.7 billion (with upstream activities making up 65% of the amount) but profits in its Chemical unit decreased from \$7 billion in 2021 to \$3.5 billion.³⁷

ExxonMobil attributed the weak performance to "bottom-of-cycle" conditions and new industrial capacity added.³⁸ The company is referring to a build-out cycle occurring in the petrochemical sector.³⁹ During such periods, the market is oversupplied, which causes prices of some petrochemical commodities to fall while decreasing the profits for companies that produce and sell them.

ExxonMobil's long-term strategy is to grow new businesses centered around low-carbon solutions. By 2050, the company anticipates these businesses will be its largest cash flow producer, replacing traditional oil and gas extraction. The company anticipates its Chemical/Specialty unit will contribute revenues at about the same level as it has in 2023.⁴⁰

Capex and Single-Use Plastics Expansion

In the immediate term, the company has maintained a heavy emphasis on its traditional business model. ExxonMobil's capex in 2022 was \$22.7 billion. Of that amount, \$17 billion was for upstream oil and gas exploration (77% of its capital expenditures). The remainder was invested into Energy (\$2.4 billion), Chemicals (\$3.0 billion) and Specialty Products (\$0.3 billion).⁴¹ The company has dedicated approximately \$17 billion to fund lower-carbon emission projects over the next five years.⁴² The recent acquisition of Pioneer Natural Resources, for \$60 billion,⁴³ would add a total of 2.4 billion barrels to ExxonMobil's December 2022 total of 17.7 billion barrels.^{44,45}

³⁵ Yahoo Finance. [ExxonMobil January 1, 2023 through December 31, 2023](#). Last visited January 6, 2023.

³⁶ See: Yardeni. [S&P 500 Sector Performance](#). Accessed November 20, 2023.

³⁷ [ExxonMobil 2022 Form 10-K](#), p. 35.

³⁸ [ExxonMobil 2022 Form 10-K](#), p. 56.

³⁹ ICIS. [Global oversupply of petrochemicals to hit 218m tonnes in 2023— the highest in any year since 1990](#). March 2023.

⁴⁰ ExxonMobil. [Advancing Climate Solutions Progress Report: 2023](#). December 2022 (hereafter, [Exxon Solutions](#)), p. 31.

⁴¹ [ExxonMobil 2022 Form 10-K](#), p. 67.

⁴² [Exxon Solutions](#), p. 57. If the company allocates \$25 billion annually to capital expenditures, this represents approximately 14% of overall capital spending. The company discusses carbon capture and sequestration, hydrogen and low-emissions fuels such as renewable diesel.

⁴³ ExxonMobil. [ExxonMobil announces merger with Pioneer Natural Resources in an All-Stock Transaction](#). October 11, 2023.

⁴⁴ [Pioneer Natural Resources 2022 Form 10-K](#), p. 39.

⁴⁵ [ExxonMobil 2022 Form 10-K](#), p. 7.

ExxonMobil is the world's leading company in the production of polyethylene.⁴⁶ It currently is involved in three substantial investments to expand polyethylene and polypropylene production. The projects produce both durable and single-use plastics as well as various liquids (see Section III Commodity Risk discussion on market trajectories for these commodities). The three projects include:

- Corpus Christi: A 1,300-kilotons-per-year (KTA) Polyethylene and 1,100-KTA Ethylene Glycol facility that is currently operating.^{47,48} The announced total cost was \$7 billion, which included construction of an ethane cracker.⁴⁹ ExxonMobil has a 50% interest in the plant.⁵⁰
- China Huizhou Chemical Complex: Located at Dayawan Petrochemical Industrial Park, the project in Guangdong Province is slated for completion in 2026. It is slated to cost \$10 billion.⁵¹ The facility is designed to produce 1,600 KTA of ethylene, 1,650 KTA of polyethylene and 850 KTA of polypropylene.⁵²
- Baton Rouge polypropylene plant: An investment of more than \$500 million is expected to produce 450 KTA of polypropylene from the plant, which opened in 2023.⁵³

Taken together, IEEFA estimates these three projects are expected to produce 25% of the profits for ExxonMobil's new chemical investments.⁵⁴ The China project, for example, is expected to earn \$1.4 billion to \$1.8 billion per year. ExxonMobil's petrochemical business model is tied to expected GDP, resting on the assumption that as growth occurs, the demand for petrochemicals (particularly plastics) grows with it. In the 2016-18 period, when ExxonMobil was planning the facility, China's economy was growing in the high 6% range. Today, the rate of growth is around 3%, with the International Monetary Fund projecting it at 5% and other longer-term estimates at the 3% to 4% range of growth. It's important to note that a small change in growth rates can mean the difference between success and failure to meet profit targets.

Other trends are also pointing in the wrong direction for Chinese demand for polyethylene. Analysts point to the aging population, oversupply of the market and changing consumer behavior to suggest that margins are likely to be tight.⁵⁵ How these trends play out over the long term is uncertain, but the

⁴⁶ ExxonMobil. [Product Solutions Spotlight](#). September 20, 2023 (hereafter, [ExxonMobil Spotlight](#)), Presentation, p. 36.

⁴⁷ ExxonMobil. [ExxonMobil and Sabic reach mechanical completion for Gulf Coast Growth ventures derivatives](#). July 26, 2021.

⁴⁸ ExxonMobil. [ExxonMobil and Sabic start operations at Gulf Coast manufacturing facility](#). January 20, 2022.

⁴⁹ Corpus Christi Caller Times. [Gulf Coast Growth Ventures marks 'successful startup' of ExxonMobil facility near Gregory](#). March 24, 2022.

⁵⁰ [ExxonMobil 2022 Form 10-K](#), p. 27.

⁵¹ China News Daily. [ExxonMobil Huizhou Ethylene project makes great headway](#). February 2023. Also see: Reuters. [Exxon Mobil announces FID for mega China petchem project](#). November 9, 2021.

⁵² [ExxonMobil Spotlight](#), Presentation, p. 36. EChem.com. [ExxonMobil Huizhou ethylene project LDPE plant started](#). August 29, 2022.

⁵³ ExxonMobil. [ExxonMobil Doubles Propylene Production at Baton Rouge](#). December 6, 2022. Also see: Louisiana Economic Development. [Exxon Mobil's polypropylene growth project begins operations in Baton Rouge](#). January 19, 2023.

⁵⁴ See [ExxonMobil Spotlight](#), p. 36.

⁵⁵ ICIS. [Collective wishful thinking could be behind the global polyethylene crisis](#). February 2023.

first few years of these facilities are likely to experience lower operating rates and thus are unlikely to meet profit targets.⁵⁶

The trend of supply exceeding demand at levels that are increasing is global. The longer term through 2030 is likely to confront producers with an oversupplied market, as slower growth in general and various policy interventions limit how much of the oversupply can be absorbed.⁵⁷

Sustainability Program

ExxonMobil's sustainability program is designed as an integrated series of investments that are applied to the new organizational design—Upstream, Energy, Chemical and Specialty Products.

This report focuses on climate solutions discussed in the company's Chemical and Specialty Products section.⁵⁸ Since ExxonMobil is integrated, its Upstream and Energy operations are also integral to the petrochemical segment.

The company concentrates its sustainability efforts on a broad program of emissions reduction strategies that includes fuel switching (natural gas to blue hydrogen), product redesign, CCS (applied in various ways across all business segments), renewable energy, energy efficiency and refinery conversions. These general techniques are applied across the new enterprise structure, including various chemical and specialty product processes to reduce emissions.

The company's basic chemicals and specialty products climate solutions program relies heavily on new lower-carbon products across plastic resin and specialty production modalities.⁵⁹ Broadly, those applications are intended to result in cleaning up (lowering the carbon content) of existing product lines using fewer fossil fuels or improving the characteristics of end products. This approach focuses innovation on historically higher carbon content products and lowering the carbon content (lubricants for example); reducing fuel use in the production process (reducing per unit emissions); extending the useful life of products due to changes in weight (lighter automobiles from plastics); and improving product design (e.g., strengthening plastic to use less in final products).

These product goals are supported by increasing attention to sustainability in the production process. As part of various chemical production processes (e.g., ethylene cracking), the company envisions broad use of renewable energy to power facilities and specific applications of CCS and use of hydrogen (e.g., to replace natural gas; see discussion on CCS in Dow Profile and natural gas in the TotalEnergies profile). The intended net result is to lower carbon content of the products and co-products created during the cracking process (e.g., ethylene). Lower-carbon feedstock (one end

⁵⁶ *Ibid.*

⁵⁷ ICIS. [Global PE capacity may have to be 23m tonnes/year lower in 2023-2030 to end the downturn](#). August 2023.

⁵⁸ [Exxon Solutions](#).

⁵⁹ *Ibid.*, pp. 19 and 20.

product of cracking) is then blended using other low- or no-carbon compounds and technologies to reduce the carbon content of final products even more.

As noted above, these pronouncements about future expected performance by the company are belied by its large-scale investments in new single-use plastics facilities. Polyethylene, ethylene and polypropylene growth ensures the continued reliance on fossil fuels (oil and natural gas) in the plastics production process. Such plants last typically between 20 and 30 years. It is anticipated that policy interventions and market forces are likely to reshape the market over the next two decades.⁶⁰ These risks are known, and ExxonMobil is the oil and gas major with the greatest carbon exposure.⁶¹ The fact that the company projects flat prospects for chemicals,⁶² in IEEFA's view, is a tacit acknowledgement of the weak position of the petrochemical component in the company's enterprise plans and a strong reason for investors to question the profitability of the large petrochemical facilities being planned.

The company's sustainability plan emphasizes a rather dramatic shift from exploration and production (upstream) to low-carbon solutions. The company's current capex spending and the strong message sent regarding the Pioneer acquisition, however, suggest the company is moving forward with a plan to maintain oil and gas extraction as its core enterprise.

In its presentations, the company cites third-party modeling reports and company testing results to support its various decarbonization claims.⁶³ Nevertheless, ExxonMobil's record on climate change and sustainability has been the subject of critical commentaries, congressional investigations, shareholder actions and litigation for almost 20 years.^{64,65} The crux of the criticism has been assertions that the company was well aware of the risks that GHGs posed to the global climate and that the company suppressed much of the information.⁶⁶ Other criticisms highlighted the company's efforts to oppose climate solutions and the efforts of people seeking to hold the company to account on the matter.⁶⁷ Company officials have made statements that the company, though supportive of climate change solutions, expects to double down on traditional oil and gas investments at least in the short and medium term.⁶⁸

⁶⁰ ICIS. [The China and global PP downturns mean CEOs should be asked some tough questions](#). October 2023.

⁶¹ Moody's. Exxon Mobil: Strong cash flow fuels robust shareholder cash returns. June 30, 2023 (Proprietary).

⁶² [Exxon Solutions](#), p.31.

⁶³ [Exxon Solutions](#). For example, the company contracted with Sphera, an environmental, social and governance (ESG) consulting company, to assess its conclusion that advanced recycling reduces emissions in comparison to processing the same amount of fossil-fuel-based feedstock. See Exxon. Exxon shares carbon footprint assessment of proprietary advanced recycling technology. Accessed January 4, 2024.

⁶⁴ Committee on Oversight and Accountability (Democrats). [Oversight committee releases new documents showing big oil's greenwashing campaign and failure to reduce emissions](#). December 2022.

⁶⁵ The Washington Post. [The fight for the soul and future of Exxon](#). May 27, 2021.

⁶⁶ For example, Inside Climate News won a 2016 Pulitzer Prize for its coverage of ExxonMobil's handling of the climate issue as far back as the 1970s. See: Inside Climate News. [Exxon: The Road Not Taken](#). Accessed January 4, 2024.

⁶⁷ National Public Radio. How decades of corporate disinformation halted U.S. Climate Policy. October 2021. Also see: Coll, Private Empire.

⁶⁸ The Associated Press. [ExxonMobil doubles down on fossil fuels with \\$59.5 billion deal for Pioneer Natural as prices surge](#). October 11, 2023. Also see: Wall Street Journal. [Exxon CEO says fossil fuel demand isn't peaking](#). December 7, 2022.

Investors should have easy access to information that would allow them to monitor ongoing results related to the company's sustainability program. The company's investors would benefit from a transparent discussion of how ExxonMobil gets from its current cash flow mix and capital allocation practices (77% of capital expenditures in 2022 went for upstream activities) that rely heavily on oil and gas extraction to the 2050 mix outlined in its Climate Solutions report.⁶⁹

ExxonMobil's plans to move forward with its expansion of its single-use plastics capacity reflect the company's broader strategy to double down on traditional oil and gas production, and to support the continued maximum use of fossil fuels in the transport, petrochemical and power sectors. The company is expanding in this sector despite market signals,⁷⁰ policy warnings,⁷¹ and credit agency admonitions relevant to the petrochemical industry.⁷² These investments are likely value-losing propositions and are equally likely to keep ExxonMobil on its course as the leader of the slowest-growing subsector in the energy sector, a sector that in 2023 was a lagging market performer.

TotalEnergies (TTE)

Background

TotalEnergies is an integrated global oil and gas company that also includes some renewable energy and other transition-related business strategies. The company is headquartered in Courbevoie, France.

In 2022, the company amassed \$281 billion in revenue with a \$21 billion net income.⁷³

Table 2: Selected 2022 Financial Data by Business Segment⁷⁴

	External Sales	Net Income	Capital Employed
Integrated Gas, Renewables Power	48.7	9.6	49.9
Exploration and Production	9.9	5.1	65.8
Refining and Chemicals	121.6	6.6	9.5
Marketing and Services	100.7	1.6	8.0
Corporate		(.6)	(1.9)
Total	280.9	2.3	131.3

Source: IEEFA/TotalEnergies.

TotalEnergies' refining and chemicals segment, along with the marketing and service units, produced the most gross revenue. The company's integrated gas, renewables and power segment, however,

⁶⁹ See, e.g.: Reuters, [Exxon CEO says technology advances could double its shale output](#), June 1, 2023. Also see: Grist.org, [Exxon Reports record profits, doubles down on fossil fuels](#), February 1, 2023.

⁷⁰ ICIS, [The China and global PP downturns mean CEOs should be asked some tough questions](#), October 2023.

⁷¹ The Hill, [Popular push to cut plastics runs into fossil fuel opposition at UN conference](#), November 15, 2023.

⁷² [S&P Global's October 2021 credit rating on Formosa](#).

⁷³ TotalEnergies, [2022 Form 20-F](#), March 2023 (hereafter, [TotalEnergies 2022 Form 20-F](#)), p. 4. Unless specified, the data used to profile TotalEnergies is taken from the company's 2022 Form 20-F.

⁷⁴ See [TotalEnergies 2022 Form 20-F](#), pp. 10-14 and F-25.

provided most of the net income. High oil and gas prices stemming from the Ukraine invasion increased gross revenue and net income for the gas and oil units.

The company's petrochemical operations support both basic and specialty chemicals, including polypropylene, propylene, polyethylene, benzene, ethylbenzene, polystyrene, toluene and others.

Figure 2: TotalEnergies Stock Performance in Comparison With S&P 500, 2019-Present



Source: Yahoo Finance.

Absent the spike caused by the invasion of Ukraine, TotalEnergies—like ExxonMobil—has continued to lag the market over the last five years.

The company's capex (net investments) was \$16.3 billion in 2022 through 2030, the company anticipates spending between \$14 billion and \$18 billion per year in capital expenditures, and 45% of those expenditures will be in the oil and gas sector to support extraction and distribution. One-third will be used to support low-carbon initiatives such as the development of biofuels, biogas, synthetic fuel, hydrogen and polymer recycling. The company anticipates directing 20% of its investments to natural gas, primarily in the form of liquefied natural gas (LNG).^{75,76} Over time, the company's production is likely to be a blend of various fossil fuels and alternatives.

Capex and Single-Use Plastics Expansion

The company recently completed a joint venture with BASF to expand the company's production of ethylene and polyethylene, the critical components of single-use plastics. The project included construction of a \$2-billion ethane cracker with a capacity of 1 million tons that opened in Port

⁷⁵ TotalEnergies. [Universal Registration Document, 2022, Chapter 1: Presentation of the Company](#), p. 34-35. Excerpts from this document, including the cited information, are incorporated into the company's Form 20-F. The company's gross investments in 2022 totaled 19.8 billion. [TotalEnergies 2022 Form 20-F](#), pp. 17, F-35 and 209-210.

⁷⁶ The investments to support oil and gas extraction and distribution include controversial projects in Uganda and other countries. See: LeMonde. [Lawsuits mount at TotalEnergies over role in climate change](#). December 8, 2022.

Arthur, Texas, in 2022. It also included a \$1.4-billion new HDPE unit with a capacity of 625,000 mmtpa that opened in Bayport, Texas in 2023.^{77,78} The project will expand the company's position in the U.S. plastics market.

TotalEnergies has been criticized by environmentalists over air emissions and pollution at the Port Arthur site.⁷⁹ In 2023, TotalEnergies settled a complaint brought by the State of Texas alleging emissions of pollution from the Port Arthur facility.⁸⁰ In September 2023, The Port Arthur facility experienced a fire that caused the collapse of a pyrolysis tower.⁸¹ Also, like the ExxonMobil and Shell petrochemical projects discussed in this report, the facility opened into a weak market that is oversupplied.⁸²

Sustainable Investing

TotalEnergies works from the assumption that fossil fuels are the core of the energy structure today and electrification will be the core of sustainability in the future.⁸³ The company assumes that oil and gas can be used in the present and steps can be taken now to reduce emissions, but it asserts that, in the long term, "we must drastically reduce our consumption of fossil fuels (coal, oil, gas) and make the world energy system evolve by building the new low-carbon energy system at a much faster pace,"⁸⁴ to achieve net-zero GHG emissions by 2050. It concludes that two strategies are needed: Supporting electrification through the development of renewable energy, and supporting low-carbon investments in biofuels, biogas, clean hydrogen and synfuels.

TotalEnergies' renewable energy strategy focuses on merchant power arrangements in under-regulated markets to enable greater flexibility to meet a 10% return scenario.⁸⁵

The company currently views renewable energy and natural gas as complementary strategies, particularly with regard to LNG. The company's support for LNG rests upon an assumption that natural gas is a beneficial transition fuel to reduce coal consumption.⁸⁶ TotalEnergies also sees a long-term role for LNG to support countries moving forward with renewable energy, describing it as, "a perfect partner for intermittent renewable energies" and asserting that "flexible, controllable

⁷⁷ TotalEnergies. [Port Arthur Platform](#). Accessed December 29, 2023.

⁷⁸ TotalEnergies. [TotalEnergies and Borealis start Baystar JV polyethylene](#). October 3, 2023. Also see: Plasteurope.com. [Baystar: Borealis. TotalEnergies JV starts major US HDPE plant / Facility marks final step of integrated petchem project](#). October 6, 2023.

⁷⁹ Beaumont Enterprise. [Port Arthur refinery averaged double EPA benzene limit last year](#). May 12, 2022. Also see: Washington Post. [EPA promised to help communities with toxic air. They're still waiting](#). December 21, 2023.

⁸⁰ [Agreed Final Judgment and Permanent Injunction, State of Texas v. TotalEnergies Petrochemicals and Refining, Inc.](#), Cause No. D-1-GN-22-007073, District Court of Travis County, Texas, filed March 14, 2023.

⁸¹ Port Arthur News. [Fire contained, BASF TotalEnergies reports. Port Arthur blaze leads collapsed tower, evacuation of employees](#). September 5, 2023. Plasticnews.com. [Texas and BASF TotalEnergies site remains closed following fire](#). September 14, 2023.

⁸² PtonLine.com. [Bayport polymers starts up commercial olefin operations](#). July 2022.

⁸³ Electrification is the replacement of fossil fuel technologies with other technologies. See: International Energy Agency. [Electrification](#). Accessed January 4, 2024.

⁸⁴ [TotalEnergies 2022 Form 20-F](#), p. 189 (Universal Registration Document. 2022, Ch. 1, pp. 14-15).

⁸⁵ *Ibid.*

⁸⁶ IEEFA has compiled a body of reports on the global LNG sector. See Appendix II: LNG Analytics and Data for 13 reports on topics related to LNG.

CCGT plants ensure a secure electricity supply in the face of unforeseen weather events and fluctuations in demand.”⁸⁷

The company’s management argues that LNG allows countries that are coal-dependent to reduce consumption, which it asserts can make a relatively quick contribution to climate change. In this sense, the company sees natural gas combined cycle generation as an important climate transition solution.⁸⁸

The argument that natural gas is a valid transition fuel rests on weak assumptions. Natural gas extraction and transport leaks methane, which taken alone can erase most, if not all, of the emissions savings expected to be gained by switching from coal.⁸⁹ Also, marketing LNG internationally does not necessarily mean the receiving country will use it to burn less coal. China is not substituting natural gas for coal; it is burning both more coal and more natural gas.⁹⁰

Support for natural gas as a transition fuel is often based on reliability concerns, but conditions are changing. New storage and transmission grid investments can improve the reliability of renewable energy.⁹¹ Also, closer scrutiny of fossil fuel reliability is needed. For example, more than 100,000 megawatts of coal- and gas-fired generation failed to start or were forced offline during the Arctic blast that hit the central and eastern U.S. in December 2022. The failure stressed utilities across the Eastern Interconnection and forced unprecedented rolling blackouts at two major utilities.⁹²

The concerns of opponents of natural gas that investments “lock in” carbon are valid.⁹³ Power plants are long-term capital investments. There is nothing temporary about them. In 2007, the United States decided to build 150 new coal plants.⁹⁴ Billions in financial decisions were made to finance them, but the plans were dead by 2017.⁹⁵ Innovation in renewable energy and natural gas (fracking) replaced them. The impact on energy finance in the United States was revolutionary. Now, only long-term, low-cost power plants could be built. Low-cost natural gas and no-fuel-cost renewables have reshaped the market. Meanwhile, natural gas prices cannot remain low forever. It is a commodity with significant volatility. Market economics will require the selection of the low-cost, long-term **stable** choice. In the power sector, the long-term bet is renewable energy.

In the broader application of natural gas in the industrial sector, innovation to replace natural gas is robust. The financing rationale for new natural gas is a high-risk proposition in any of its applications.

⁸⁷ [TotalEnergies 2022 Form 20-F](#), p. 189 ([Universal Registration Document, 2022, Chapter 1](#), pp. 14-15).

⁸⁸ [TotalEnergies 2022 Form 20-F](#), p. 443 ([Universal Registration Document, 2022, Chapter 1](#), pp. 282-283).

⁸⁹ Science. [Natural gas could warm planet much more than coal in the short term](#). June 21, 2018. Also see: R. Alvarez, *et al.* [Assessment of methane emissions from the U.S. oil and gas supply chain](#). *Science* 361(6398):186-188. June 21, 2019.

⁹⁰ Power. [Group says China will add 70 GW coal and gas fired generation in 2023](#). January 21, 2023.

⁹¹ McKinsey. [Upgrade the grid: Speed is of the essence in the energy transition](#). February 1, 2022.

⁹² IEEFA. [Fossil Fuels Fail Reliability Test](#). March 2023.

⁹³ Fatih Birol’s statement at the beginning of this paper gets right at the point. Fossil fuel investments are now a significant business and financial risk.

⁹⁴ New York Times. [Cleaner coal is attracting some doubts](#). February 21, 2007.

⁹⁵ Science. [Coal plants are victims of their own economics](#). February 18, 2013. Also see: Scientific American. [Will the U.S. ever build another big coal plant?](#) August 21, 2017. Also see: U.S. Energy Information Administration. [Most coal plants in the United States were built before 1990](#). April 17, 2017.

This is particularly true for a company such as TotalEnergies, which is opening new single-use plastics facilities in the United States to take advantage of low-cost natural gas. As noted above, crackers and other production facilities for plastics production are long-term investments. The risk of facility underutilization in the face of declining demand for single-use plastics must be considered when the company is making decisions about deploying capital. Yet, the company's emphasis on plastics facilities calls into question the extent to which it is considering that risk.

The IEA, which has been monitoring oil and gas dynamics as they relate to climate change goals, has made clear that there is no need for new oil and gas wells, and its warnings are becoming more intense.⁹⁶ (See statement of IEA executive director Fatih Birol in Background section of this report).

TotalEnergies is supporting a battery of new investments to reduce methane emissions, meet zero-flaring goals, improve energy efficiency, improve carbon capture technology and develop hydrogen projects. In IEEFA's view, some of these are workable solutions; some are not.

It is also investing in various projects to improve feedstock options to replace its current product line of oil-based items. The company supports three plants—two in France and one in Thailand. The facilities use biofuels to produce polyethylene, polystyrene and polypropylene.⁹⁷

In addition, the company supports the production of biofuels from oil and animal fat, and food waste and residues, rather than planting crops for biofuel purposes (using scarce agricultural land and wasting water). The company is looking to invest in processing facilities to increase the supply of feedstocks for biofuel expansion.

Another component of the company's sustainability agenda is evaluating how the accounting system can better align with the climate crisis. In 2020-21, the company took an impairment on its books based on a standard that it would consider oil and gas reserves having more than a 20-year life and a high production cost as stranded assets. It identified fields in Canada's oil sands as falling within that category. The company reduced its value by \$5.5 billion.

The company has, however, expanded traditional integrated investments, including one with Saudi Arabia. The project is an \$11 billion petrochemical hub with an ethylene cracker, two polyethylene plants and a butadiene extraction unit.⁹⁸ The facility, like the ones being built in China (see Ethylene Commodity Risk discussion) will be added to an already oversupplied market. It is also unclear how this project is integrated into the sustainability program of the company.

Like ExxonMobil and other fossil fuel companies, TotalEnergies has received criticism for its alleged effort to suppress information it had regarding the dangers of GHGs.⁹⁹ The company also faces

⁹⁶ IEA. [Emissions from Oil and Gas Operations in Net Zero Transitions](#). May 2023. Also see: IEA. [Net Zero by 2050: A Roadmap for the Global Energy Sector](#). May 2021, p. 21.

⁹⁷ TotalEnergies. [Feedstock](#). Accessed December 30, 2023.

⁹⁸ Businesswire.com. [Aramco and TotalEnergies to Build a Giant Petrochemical complex in Saudi Arabia](#). December 15, 2022. Also see: TotalEnergies. [Amiral, a petrochemical complex integrated with the SATORP refinery](#). Accessed December 30, 2023.

⁹⁹ BBC. [TotalEnergies accused of downplaying climate risks](#). October 2022.

continued challenges from environmental groups over its reporting on GHG emissions.¹⁰⁰ TotalEnergies has been sued by environmental organizations over the company's assertions regarding GHG emissions,¹⁰¹ and has initiated litigation against an environmental organization regarding its research challenging the company's GHG reporting.¹⁰²

The company's sustainability investments are a mix of approaches. As it evolves, investors would benefit from examination of the specific initiatives it is undertaking. For example, its Port Arthur, Texas, expansion plans to increase capacity in an already oversupplied market, and its location along the storm-ridden U.S. Gulf Coast makes the possibility high for value loss.

Eni S.p.A (ENI)

Background

Eni is an oil, gas, and power company based in Italy with a €48 billion market capitalization. It is deemed a government-related issuer for credit purposes because of its close ties to the Italian government.¹⁰³

The company reports in four units (excluding Corporate and other activities):

- **Exploration and Production (E&P):** This segment includes development and production of oil and gas, forestry projects, and carbon capture and storage or utilization.
- **Global Gas and LNG Portfolio (GGP):** This segment supplies and sells natural gas via pipeline and LNG. It also conducts gas trading. The company has 6.2 billion barrels in oil and gas reserves.
- **Refining and Chemicals:** This segment, which is part of the Energy Evolution department, includes the processing, supply, marketing and destruction of traditional biofuels and chemicals.
- **Power:** This segment, also part of Energy Evolution, includes retail gas sales, electricity production and wholesale sales from thermoelectric and renewable plants. It also manages the company's hedged investments used to protect against losses.

¹⁰⁰ Greenpeace. [Greenpeace finds TotalEnergies emissions almost 4 times higher than reported](#). November 3, 2022.

¹⁰¹ Reuters. [Environmental groups sue TotalEnergies over climate marketing claims](#). March 2, 2022. Also see: [Greenpeace France and Others v. TotalEnergies SE and TotalEnergies Electricite et Gaz France](#), filed 2022, in Sabin Center for Climate Change Law: Climate Case Chart. Also see: [Deutsche Umwelthilfe v. TotalEnergies Warme & Kraftstoff Deutschland GmbH](#), Dusseldorf Regional Court, April 5, 2023, in Sabin Center for Climate Change Law: Climate Case Chart (TotalEnergies is no longer allowed to advertise its heating oil as "CO2 compensated").

¹⁰² Cadwalader.com. [TotalEnergies sues Greenpeace over greenwashing allegations](#). May 19, 2023. Also see: Reuters. [TotalEnergies sues Greenpeace over emissions report](#). May 3, 2023.

¹⁰³ The Italian government has a substantial say in the activities of the company. The Italian government has a 32.4% stake in ENI; the company's downstream operations is concentrated in Italy; and the government has the right to submit slates of candidates for the board. Six of current nine-member board come from slates provided by the Ministry of Economy and Finance. See Moody's. Update to credit analysis. September 29, 2023 (Proprietary – Available upon request).

Like most oil and gas companies, Eni had a strong 2022 year, amassing €132.5 billion in revenues.¹⁰⁴

The company's 2022 revenues were driven by its refining and marketing operations (€59.2 billion), followed by exploration and production (€31.2), global gas (€48.6 billion), and power (€20.8 billion).¹⁰⁵

Eni's net profits, however, show a different picture. In 2022, the company's earnings workhorse was exploration and production, followed by global gas, refining, power and chemicals.¹⁰⁶

The company's current oil-to-gas well ratio is 83% oil to 17% gas (8,200 wells).¹⁰⁷ It plans to reduce its oil holdings and increase its gas holdings to 90% of its oil-to-gas well ratio by 2050.¹⁰⁸ Toward this end, the company's strategic plan from 2023-2026 assumes a capital expenditure of €37 billion.¹⁰⁹ The company's growth agenda will be supported both by acquisitions and organic development.

Figure 3: Eni Stock Performance in Comparison With S&P 500, 2017-Present



Source: Yahoo Finance.

Eni's five-year stock performance has lagged the S&P 500 even with a significant cash bounce related to Russia's invasion of Ukraine. The long-term inability of companies that rely on oil and gas to provide stable, long-term growth is an issue at the center of Eni's expansion plans.

¹⁰⁴ Eni, [2022 Annual Report](#), January 26, 2023 (hereafter, [Eni 2022 Annual Report](#)), p. 14. Unless noted otherwise, all references to company financial data come from the [Eni 2022 Annual Report](#).

¹⁰⁵ [Eni 2022 Annual Report](#), p. 104. The total amount of revenue for each of the business units exceeds €132.5 billion. The formal revenue accounting includes a €29.4 billion consolidated adjustment that does not specify how each business unit's total revenues are aggregated.

¹⁰⁶ [Eni 2022 Annual Report](#), p. 104.

¹⁰⁷ [Eni 2022 Annual Report](#), p. 56.

¹⁰⁸ ENI, [Sustainability Linked Financing Framework](#), May 2022, p. 5. Also see: ENI [2022: A Just Transition](#), May 2023, p. 39.

¹⁰⁹ ENI, [ENI Strategic Plan 2023-2026](#) - Press Release, February 2023.

The company is attempting to reposition its refining business, largely based in Europe, which is faced with structural weaknesses that include excess capacity,¹¹⁰ declining consumption^{111,112} and volatile margins. The company has converted refineries in Venice and Gela to biorefineries, and is looking to increase its biofuel capacity to 5 million tons (Mt) by 2030.¹¹³ The company is investing in Ecofining technology, a proposed fossil fuel feedstock replacement using animal fats and oils.¹¹⁴

Capex, Single-Use Plastics Expansion and Plan for Gas Field Development

Eni subsidiary Versalis, which declares a commitment to a sustainable and circular chemical industry, is undertaking initiatives that will expand the number of plastics coming onto the market. The company has relied on mechanical recycling but recognizes it has limits. To address these issues, it is pursuing a chemical recycling process that relies on pyrolysis technology.¹¹⁵ Pyrolysis oil itself cannot substitute for naphtha.¹¹⁶ Additional processes are required to reshape the molecular structure needed to serve as a substitute. These processes have generated substantial controversy related to energy consumption, emissions issues, offtaker issues and questions of scale.¹¹⁷ Companies such as Eni and most other large-scale fossil fuel producers are continuing to pursue chemical recycling. To date, the technology has not proven itself to be commercially scalable.¹¹⁸

Eni has also announced plans for development of a new gas field off the coast of Australia which the company states has a capacity of 11 trillion cubic feet (tcf) of gas.¹¹⁹ The Verus project, previously called the Evans Shoals field, has raised significant questions since its development is at odds with the company's net-zero commitment, the IEA's advice against the production of any new oil and gas fields, and Australia's Safeguard Mechanism.¹²⁰ The company's use of sustainability bonds for general corporate purposes,¹²¹ moreover, indicates weaknesses in the accountability and transparency of this new market mechanism. Eni has provided very limited details on the project, with no cost estimate and no completion date. The project would include use of CCS technology, as part of a plan to develop a petrochemical hub in Australia's Northern Territory,¹²² a large project that

¹¹⁰ See [Eni 2022 Annual Report](#), p. 128-129, for discussion of the convergence of slowing economy and uncertainty of producer reactions leading to oversupply.

¹¹¹ See discussion on declining demand page 28 [Eni 2022 Annual Report](#).

¹¹² See CEO Stakeholder Letter to investors in [Eni 2022 Annual Report](#).

¹¹³ [Eni 2022 Annual Report](#), pp. 11 and 18.

¹¹⁴ Ecofining is a technology patented by the Honeywell company. See: [Honeywell.com. Ecofining](#). Accessed January 4, 2024. For a discussion of the technology, also see: [Energy.gov. Environmental Assessment for Department of Energy Loan Guarantee to Diamond Green Diesel, LLC for construction of the Diamond Green Diesel Facility in Norco](#). April 2011, p. 18.

¹¹⁵ Versalis. [Versalis for 2022: A Just Transition](#). July 20, 2023, pp. 3-4 and 57. Also see: [Eni 2022 Annual Report](#), p. 84.

¹¹⁶ [Mdpi.com. Can Pyrolysis Oil Be Used as a Feedstock to Close the Gap in the Circular Economy of Polyolefins?](#), January 2023.

¹¹⁷ [Greenpeace.org. Deception by the numbers](#). September 2020.

¹¹⁸ [Chemical & Engineering News. Amid controversy, industry goes all in on plastics pyrolysis](#). October 2022.

¹¹⁹ Eni. [Ordinary and Extraordinary Shareholders Meeting of Eni S.p.A.](#) May 2023, pp. 14-15. Also see: [ABC Rural. Italian energy company Eni to develop Evans Shoal gas field described as 'carbon bomb'](#). May 10, 2023.

¹²⁰ [IEEFA. Eni's Verus not so true on net zero](#). June 2023 (hereafter, [Verus](#)). The Safeguard Mechanism is Australia's policy to monitor, limit and enforce emissions for large industrial plants. See: [DCCEEW.gov. Emissions Reporting: National Greenhouse and Energy Reporting Scheme](#). Last visited December 30, 2023.

¹²¹ Eni, [ENI launches the first sustainability linked convertible bond issue in its sector. September 2023](#). See also: [Verus](#).

¹²² [Verus](#), pp. 20-21. Also see: [Sidney Morning Herald. Italian Firm pushes carbon bomb gas export project in the territory](#). May 8, 2023.

IEEFA has criticized with regard to practical feasibility and financial viability.¹²³ Eni is unlikely to bring this project to development, as it is financially unviable, in IEEFA's view, and would undermine both Eni's commitment to net zero and Australia's climate plans.

The company's power units plan to develop 7 gigawatts (GW) of renewable energy by 2026, and 15 GW by 2030.¹²⁴

Sustainability

Eni's carbon transition strategy is centered on its target to achieve carbon neutrality (for Scopes 1, 2 and 3) by 2050. The plan rests on five strategic initiatives:

- Increase share of gas in upstream portfolio through 2030.
- Convert European refineries into biorefineries.
- Undertake carbon sink forestry projects.
- Expand renewables.
- Increase share of carbon-free products.

To achieve these goals, Eni is increasing its capex to 9 billion per year. This will enable the company to keep its commitments to expand renewables and invest in biorefineries, carbon sinks and new low-carbon products.¹²⁵

Eni's sustainability plan contains several potentially positive steps related to renewable energy and improving feedstocks. The sustainability plan and subsequent updates nevertheless assume continued reliance on natural gas investments despite the IEA warnings against it. The company anticipates substantial improvement in CCS technology despite strong concerns arising about its efficiency and cost-effectiveness (see discussion in section on Dow). As noted above, the success of the company's chemical recycling production processes remains to be seen.

As the company proceeds with its plans to replace fossil fuel feedstock with biofuels, it still faces the problem of production of single-use plastics and ocean dumping.¹²⁶ Eni, like others considering the benefits of biofuels in plastics, is also challenged with issues related to the end of the useful life of the product. The tradeoffs between carbon in the atmosphere and landfill or ocean dumping confront the company.

¹²³ IEEFA. [Middle Arm Gas and Petrochemicals Hub: Combination of problems makes it unprofitable for business and a red flag to the public](#). June 2023.

¹²⁴ Eni 2022 Annual Report, p. 22.

¹²⁵ Eni. [Capital Markets Update](#). February 2023.

¹²⁶ The Guardian. [Garbage in, energy out: creating biofuel from plastic waste](#). June 2016.

Greenpeace and ReCommon have sued Eni, along with the Italian Ministry of Economy and Finance and Cassa Depositi e Prestiti S.p.A., for contributing to climate change. The organizations assert that Eni's plans to increase its oil and gas production are not in line with the goals of the Paris Agreement.¹²⁷ This suit has ramifications for the Italian government, since it is a major shareholder of the company. The suit not only seeks corrective actions by Eni but also asks for judicial orders directing the Italian government to adopt policies consistent with the Paris Agreement and asks the court to hold the all the defendants jointly and severally liable for past and future damages.¹²⁸

Eni plans to use carbon offsets and carbon sink investments to help it achieve its goals.¹²⁹ These methods use accounting techniques (See Dow discussion) to compensate for the inability of the combination of fuels and technologies to meet carbon targets.

The company's current outlook on sustainability and the program it has offered requires careful and consistent monitoring. Although Eni has initiated several sustainability initiatives, it also seeks to advance expansions in fossil fuel development, such as the Verus project.

Repsol (REP)

Background

Repsol is an energy company located in Madrid, Spain, with facilities across the globe. The company has a market capitalization of €19.7 billion. Its business segments include Upstream activities, which holds 1.9 billion barrels of oil and oil-equivalent predominantly in the United States, Peru, Africa and the Americas; its Commercial and Renewables unit, which supports 4,600 customer retail stations and 8,734 gigawatt-hours (GWh) of wind, solar, and hydroelectric renewables; and its industrial portfolio, which supports refineries with a total capacity of 1 million barrels per day.¹³⁰

The industrial portfolio also includes 2.4 billion tons of petrochemicals. Those petrochemical products include benzene, butadiene, styrene, ethylene, ethylene vinyl acetate/ethylene butyl acrylate (EVA/EBA), propylene glycol, propylene oxide, polyethylene, polyols, polypropylene, propylene and rubber.¹³¹

The company owns facilities in Spain, Portugal, Mexico and China.¹³²

¹²⁷ Reuters. [Environmental groups take Italy's Eni to court over climate change](#). May 9, 2023. See [Greenpeace Italy et. Al. v. Eni S.p.A., the Italian Ministry of Economy and Finance and Cassa Depositi e Prestiti S.p.A.](#), Civil Court of Rome, complaint filed May 9, 2023, in Sabin Center for Climate Change Law: Climate Case Chart. Cassa Depositi e Prestiti S.p.a. is a bank in which the Italian Ministry for the Economy and Finance, is a major public shareholder, and also has private shareholders. International Forum of Sovereign Wealth Funds. [CDP Equity SpA](#). Accessed December 30, 2023.

¹²⁸ Ecowatch, [Italy's First Climate Lawsuit Targets Major Oil Company Eni](#). May 2023.

¹²⁹ [Eni 2022 Annual Report](#), pp. 6-7 and 234.

¹³⁰ Repsol. [Integrated Management Report](#). 2022 (hereafter, [Repsol 2022 Integrated Management Report](#), p. 11. Unless otherwise noted company financial and sustainability data is taken from this Repsol report.

¹³¹ [Repsol 2022 Integrated Management Report](#), pp. 11 and 39.

¹³² [Ibid.](#), pp. 14-15 and 39.

Repsol reported a generally financially positive year in 2022. The company amassed €74.8 billion and adjusted net income of €6.7 billion—a five-year high for both indicators.¹³³

Revenues in billions for 2022 reflect the high price of oil and gas driven by the Ukraine invasion.

1. Crude €4.3
2. Gas €7.3
3. Oil Products €57.9
4. Petrochemicals €3.3
5. Electricity €2.0
6. Service Provision €0.3134

Figure 4: Repsol Stock Performance in Comparison with S&P 500, 2018-Present



Source: Yahoo Finance.

Repsol's stock performance has lagged the S&P 500 for the last five years. Like most companies that rely on revenues from oil and gas extraction and distribution, Repsol's stock performance has failed to impress. The expansion plans it is considering in 2023 are not only a matter of climate-related transition strategy, but also are likely intended to bolster the company's ability to adopt a new value proposition for investors.

¹³³ Repsol 2022 Integrated Management Report, p. 8.

¹³⁴ Repsol 2022 Consolidated Financial Statements, p. 54.

The company's capex in 2022 was €28 billion.¹³⁵ In 2022, the company allocated €12.3 billion to the Upstream segment, €11.1 billion to the Industrials segment and €4.6 billion to renewable and commercial investments.¹³⁶ The company's 2022 revenues and capex allocations are heavily weighted to fossil fuels.

Capex and Single-Use Plastics Expansion

The company's approach to sustainability is to reduce fossil fuel usage but to expand the supply of petrochemical products, including plastics. The company's strategies embrace both mechanical and chemical recycling. While several of the company's initiatives seek to replace fossil fuels as part of the chemicals production process, however, most of the new sustainability initiatives seek to manage the use of fossil fuels. Climate Bonds Initiative, a non-governmental organization (NGO), expressed concern in 2017 when Repsol announced it had issued a green bond devoted to improve energy efficiency in its chemical and refinery facilities in Spain and Portugal. Although the NGO praised Repsol's transparency and monitoring commitments with regard to the bond, it cautioned that the company's overall CO₂ emissions had risen in the previous year by 1.8 million tonnes, while the bond project would avoid only an estimated 1.2 million tonnes over the next three years. It recommended Repsol's business strategy should drive "incremental change."¹³⁷

The dilemma requires both bond and stock investors to pay careful attention not only to specific initiatives but also to the overall integration of specific projects into the environmental and financial direction of the company.

Sustainability

Repsol's sustainability plan commits to net-zero emissions by 2050 (measured in carbon intensity indicators). The plan covers six priority areas: Climate change, environment, innovation and technology, safe and secure operation, people, and ethics and transparency. In 2022, the company added commitments to renewable hydrogen, as well as the reduction of absolute CO₂ and methane emissions.¹³⁸

By 2030, the company plans to reduce carbon intensity by 28%; Scope 1 and 2 absolute emissions by 55%; and Scope 1, 2, and 3 emissions by 30%. The company also has set a series of interim goals that include a 50% flaring reduction by 2025 and recycling the equivalent of 20% of total polyolefin production by 2030.¹³⁹

¹³⁵ [Repsol 2022 Integrated Management Report](#), p.11 and 130.

¹³⁶ Repsol. [Repsol's Factbook 2022](#) (6th spreadsheet page: Capital Employed).

¹³⁷ Climate Bonds Initiative. [An oil & gas bond we knew would come eventually: Repsol: Good on GBPs, not so sure on green credentials](#). May 23, 2017.

¹³⁸ Repsol. [2023 Global Sustainability Plan](#). 2023 (hereafter, [Repsol 2023 Global Sustainability Plan](#)), pp. 51.

¹³⁹ *Ibid.*, pp. 51 and 56.

At the core of Repsol's transition strategy is a decrease in its hydrocarbon production through 2050, with a significant decline after 2030. The company's refinery production will be driven by the European Union's plans to reduce fossil fuels and improve capacity for biofuel integration.

The petrochemical strategy employs a combination of mechanical and chemical recycling to provide resins in a wide variety of sectors.¹⁴⁰ The company is also involved in the production of first-, second-, third- and fourth-generation biofuels.¹⁴¹

Overall, the company plans to focus annual capital spending on low-carbon businesses through 2050. By 2030, the company anticipates it will deploy 40% to 45% of its annual capital spending in low-carbon businesses and hit an upper limit of 85% by 2050.¹⁴²

The single most important risk facing Repsol's transition strategy is whether the company can find sufficient types of new low-carbon businesses to develop and acquire at a value and rate that replace its fossil fuel holdings (the company's principal revenue driver).¹⁴³ The company is involved in a wide array of new sustainable ventures. They include a full portfolio of biofuels (biojet), renewable hydrogen, next-stage photovoltaics, synthetic fuel production and geothermal.

The company highlights the recent sale of a 25% interest in its oil and gas portfolio (€4.8 billion payment) to EIG as an initial accomplishment in its transition plan.¹⁴⁴ The transaction provides Repsol with liquidity needed to launch its low-carbon initiatives. The asset sales are designed to decrease the company's carbon footprint and augment annual cash needs.

EIG, on the other hand, sees the transaction as an investment in oil and gas assets that will provide strong cash flow and opportunities for shareholder payments. Breakwater Energy (a joint venture between EIG and Repsol, which maintains a 75% stake) is a recently created entity established to manage the new business. Although both companies are committed to emissions reduction, the transaction has not provided a clearly articulated plan to accomplish it.¹⁴⁵

The company has also been involved in oil spill controversies. Most notably, it was criticized for the pace of its response to an oil spill off the Peruvian coast.¹⁴⁶ Repsol has also been involved in a recent controversy that reflects on how the energy transition is altering the terms of public dialogue on progress. An independent watchdog criticized the company for offering what the watchdog deemed to be a misleading impression about the business.¹⁴⁷ In its advertising, the company has

¹⁴⁰ Repsol. [Circular Economy: A key driver of Repsol Chemicals](#). Accessed December 30, 2023.

¹⁴¹ Repsol. [Emissions Reduction/Biofuels](#). Accessed December 30, 2023.

¹⁴² IEEFA estimates that at 40% spending levels and a \$28 billion annual capex outlay, the company would be spending approximately \$11 billion.

¹⁴³ See: Moody's. Repsol: Focus on shareholder returns tempers credit-positive effects of strong Q1 results. May 2023. (Proprietary)

¹⁴⁴ EIG is an institutional investor that services the financial needs of the energy sector. It was established in 1982 and has invested in over 400 projects with committed capital of \$46 billion.

¹⁴⁵ See: Columbia Center for Sustainable Investment and Sabin Center for Climate Change Laws. [Transferred Emissions are Still Emissions: Why Fossil Fuel Asset Sales Need Enhanced Transparency and Carbon Accounting](#). May 2023.

¹⁴⁶ Reuters. [Repsol says it will finish cleaning up Peru oil spill in late March](#). March 2022.

¹⁴⁷ MSN.com. [Repsol renewables ad banned over large scale oil and gas interests omission](#). Oct. 17, 2023.

been stressing its commitment to hydrogen and other sustainable initiatives in which it is involved. A complaint was filed that the company's current business is principally oil and gas extraction, refining and distribution, not sustainability. The Advertising Standards Authority determined that the ad, which appeared in the Financial Times, must be removed and not be aired again, and the news website complied. Repsol stated it disagreed with the ruling.¹⁴⁸

The company's low-carbon plan relies heavily on the growth of renewable energy, including wind, solar and hydroelectric, with an as-yet unarticulated portfolio of low-carbon businesses.¹⁴⁹

The company's deployment of its capital over the next few years will determine whether it can successfully meet its sustainability goals. As it stands, the historical allocation of capital by the company favors oil and gas extraction and refining.

Repsol's premise to grow a series of low-carbon businesses is risky financially. It is predicated on a high degree of speculation and rests on an assumption of continued value that can be received from oil and gas assets. Also, a greater degree of analysis will be required to determine the extent to which the businesses involved are low carbon.

Chevron Phillips Chemical (CPChem)

Background

Chevron Phillips Chemical LLC (CPChem) is a global, private joint venture of Chevron Corporation and Phillips 66. The company headquarters is in The Woodlands, Texas. It has an asset value of \$18.7 billion. Last year's revenues were \$14.2 billion, and the company reported \$1.7 billion in net income.¹⁵⁰ It spent \$1.5 billion on capex in 2022.

CPChem has 28 manufacturing facilities around the world, including projects in Belgium, Colombia, Qatar, Saudi Arabia, Singapore and the United States. The major joint ventures of the company are shown in Table 3.

¹⁴⁸ *Ibid.*

¹⁴⁹ Repsol. [Stepping up the transition: Building a fast growth Renewable Generation Business 2021-2025](#). Accessed December 30, 2023.

¹⁵⁰ CPChem. [Financials](#). Accessed December 30, 2023. CPChem does not publish a 10-K since it is a limited liability company. It publishes selected financial data on its website. It does not provide its financial statements to the public. All financial data is taken directly from website or from the company's [2022 Sustainability Report](#) and [Climate Risk Report](#).

Table 3: CPChem Major Joint Ventures

Country	Name	Products	Partner
Qatar*	Ras Laffan Petrochem Cplx	Ethylene/polyethylene	Qatar Energy
United States *	Golden Triangle Polymer	Ethylene/polyethylene	Qatar Energy
Saudi Arabia	Jubail Saudi Arabia (S-Chem)	Benzene	Saudi Investment Group
Qatar (2004)	Qatar Chemical Company	Ethylene/polyethylene/hexene	Qatar Chemical
Saudi Arabia	Saud Polymers Company	Ethylene/polyethylene/polypropylene	National Petrochem. Co.
United States (2008)	Americas Styrenics	Styrenics	Trinseo
Saudi Arabia	Jubails Chevron Phillips Co.	Styrene	Saudi Arabia Investment Grp.
Qatar (2010)	Qatar Chemical Company	Ethylene/polyethylene. Hexene	Qatar Chemical

Source: Moody's/IEEFA.

Note: * denotes projects that are announced or in development.

Capex and Single-Use Plastic Expansion

CPChem has announced plans to build two large petrochemical complexes.¹⁵¹ The first project is the \$6 billion Ras Laffan Petrochemical Complex joint venture with Qatar Energy, in which CPChem will own a 30% share, slated for operations in 2026. The facility, including a 2 million ton-per-year cracker and two polyethylene trains, is expected to yield 1.7 million tons per year in polyethylene resins.¹⁵² The second project is Golden Triangle Polymers, an \$8.5 billion joint venture project with Qatar Energy in which CPChem will own a 51% share. The project will include a 2.1 million ton per year cracker and two polyethylene units with combined capacity to produce 2 million tons per year in HDPE resins. It is slated to begin operations in 2026.¹⁵³ These projects are large petrochemical hubs that will produce and export basic chemicals and plastic resins. CPChem's production is largely in the United States, but its growth portfolio with the two new Qatar projects may change its geographic profile. The company is also completing expansion of its facility in Beringen, Belgium, to be opened in 2024, doubling its capacity to 120,000 tonnes per year.¹⁵⁴

CPChem's portfolio covers a variety of basic and specialty chemical products (see Table 4). The company holds a leading position in many of the markets.

¹⁵¹ Moody's. ChevronPhillips Chemical LLC. January 1, 2023.

¹⁵² CPChem. [Ras Laffan Petrochemical Project](#). Accessed December 30, 2023. Also see: Saudi Gulf Projects. [6bn: QatarEnergy and Chevron Phillips Chemical to build one of the world's largest ethylene plants](#). January 8, 2023.

¹⁵³ CPChem. [Chevron Phillips Chemical and QatarEnergy to construct integrated polymers facility on U.S. Gulf Coast](#). November 16, 2022. Also see: [Golden Triangle Polymers](#). Accessed December 30, 2023.

¹⁵⁴ CHEManager. [New PAO plant for CPChem in Belgium](#). June 14 2022. Also see: CPChem. [Chevron Phillips breaks ground on polyalphaolefin expansion in Beringen, Belgium](#). November 14, 2022.

Table 4: CPChem Production (millions of pounds per year)

Product	United States	Worldwide
Ethylene	11,900	14,430
Propylene	2,675	3,180
High-density polyethylene	5,305	7,470
Low-density polyethylene	620	620
Linear low-density polyethylene	1,815	1,815
Polypropylene	-	310
Normal alpha olefins	2,335	2,850
Polyalphaolefins	125	255
Polyethylene Pipe	500	500
Benzene	1,600	2,530
Cyclohexane	1,060	1,455
Styrene	1,050	1,875
Polystyrene	835	915
Specialty chemicals	440	575
Total	30,270	38,780

Source: Phillips66 2023 10-K.

Note: Capacities include CPChem's share in equity affiliates and excludes CPChem's NGL fractionation capacity.

Sustainability

The company's long-term plan is to achieve net-zero emissions. Its short-term goal is a 15% reduction of emissions by 2030.¹⁵⁵

Like other companies with their headquarters and major facilities on the Gulf Coast of the United States, CPChem has identified its location as presenting an ongoing physical risk from climate change. CPChem notes that its high-value assets are located on the Gulf of Mexico coast and that weather events can result in significant damages.¹⁵⁶

CPChem is planning to achieve emissions goals through a series of initiatives: Sourcing production with renewable energy (an approach that is in use), fuel switching (natural gas to hydrogen), efficiency improvements, electrification of crackers, CCS technology, enhanced flaring controls and capture of hydrogen to be reinjected into the production process. With the exception of renewable energy, these approaches are mostly in the planning stage. Future projects are to be built to specifications that lower emissions. The company is relying on an internal tool, Marginal Abatement Cost Curve (MACC), to assess emission reduction opportunities on an enterprise wide, asset-by-

¹⁵⁵ CPChem. [Positioned to Perform: 2022 Sustainability Report](#). July 18, 2023 (hereafter, [CPChem 2022 Sustainability Report](#)), p. 5.

¹⁵⁶ CPChem. [Enabling a Lower Carbon Future: 2022 Climate Risk Report](#). December 8, 2022 (hereafter, [CPChem 2022 Climate Risk Report](#)), p. 19.

asset level.¹⁵⁷ In 2022, the company also instituted a new accounting and monitoring system to monitor the emissions challenge it faces more closely.¹⁵⁸

To further reduce emissions, the company is looking to invest in both mechanical and chemical recycling to reduce the amount of fossil fuels it needs in the production process and to decrease the contribution to the global waste stream.¹⁵⁹ The company maintains that its low-cost ethane supply of feedstock from Middle Eastern and U.S. suppliers also creates a lower emissions profile than producers who rely on a mix of naphtha and ethane.¹⁶⁰ The company appears confident that the combination of renewable energy sourcing and energy efficiency measures will allow it to meet its goals.

CPChem faces significant challenges to achieving its goals. For the most part the components of the plan to reduce emissions based upon actions taken by the company are in the planning stage. The challenges are increased due to the lack of transparency in its financial reporting. Increased transparency is an imperative for a successful business in the current investment environment. As a limited liability company and subsidiary of Chevron and Phillips66, it does not file a Form 10-K annual report, severely limiting basic financial information readily available to investors regarding this significant stakeholder in the industry.

CPChem's limited reporting hinders the work of analysts and interested parties regarding the financial implications of any climate investment.¹⁶¹ For example, the company is undertaking two substantial petrochemical projects in Qatar, as described in the preceding subsection of this report. The projects will add significant product to the market for plastic resins. The cash outlay has a potential to strain the company's balance sheets and oversupply the market. It is also uncertain how these projects will contribute, if at all, to the sustainability plans discussed in the company's planning documents.

The company's climate change report states that new assets will be built to standards that reduce emissions compared to existing facilities. As an example, it predicts that its new Golden Triangle Polymers plant will achieve emissions 25% lower than comparable existing facilities.¹⁶² Absent a comprehensive financial reporting mechanism, however, sustainability reports that do not carry any discussion of detailed financial integration or financial risk for these or any other new projects are the principal source of readily available information regarding the company's sustainability measures and strategies.

¹⁵⁷ [CPChem 2022 Sustainability Report](#), p. 43. The company's cracker process currently produces hydrogen that is reused in the production process. This is true for most crackers. *Ibid.*, p. 48. It is unclear that the company will develop its capacity regarding hydrogen.

¹⁵⁸ [CPChem 2022 Climate Risk Report](#), p. 21.

¹⁵⁹ [CPChem 2022 Sustainability Report](#), pp. 56-57.

¹⁶⁰ [CPChem 2022 Climate Risk Report](#), p. 15.

¹⁶¹ CPChem is one of the top 50 chemical companies in the world. See: Chemical and Engineering News. [CEN's Global Top 50 2022](#). July 2022.

¹⁶² [CPChem 2022 Climate Risk Report](#), p. 22.

Similarly, the reporting on CPChem in the formal reporting by Chevron and Phillips66 is limited to that of a subsidiary.^{163,164} Financial information is in short supply.

Other emissions-related issues also need to be considered. The company was required to pay approximately \$118 million in fines due to violations of the Clean Air Act at three Texas facilities—in Port Arthur, Cedar Bayou and Sweeney.¹⁶⁵ In 2021, Reuters reported the company had failed to notify United States regulators that it was importing 18 toxic chemicals.¹⁶⁶

The company reports it has a “Critical Assessment of Project Pipeline Strategy,” which seeks to ensure the company has a clear picture of its upcoming projects, “including climate-related opportunities and investments.”¹⁶⁷ The strategy and any related reports, however, are not available publicly. Such a report, including its sustainability review, is crucial for investors to obtain a clear idea of the company’s future. The planning document—accompanied by specific budgetary information—would also shed light on whether the company can meet its climate goals, as well as how likely it is that profitability targets will be met.

In IEEFA’s view, the company’s two proposed petrochemical complexes run contrary to the company’s pledges and to the objectives of the Paris Agreement. These projects face all the market risks identified in this report—overdependence on fossil fuels, oversupplied markets, and a failure to disclose even basic information.¹⁶⁸ Both Chevron and Phillips face risk if they continue moving forward through the energy transition by lending their brands and resources to projects that undermine sustainability.

¹⁶³ Chevron. [Form 10-K](#), February 23, 2023.

¹⁶⁴ Phillips66. [Form 10-K](#), February 22, 2023.

¹⁶⁵ [Consent Decree, United States of America v. Chevron Phillips Chemical Co., LP](#), No. 4: 22-cv-00737 (order entering consent decree filed June 2, 2022). Also see: CNN. [Chevron Phillips will pay nearly \\$120 million to clean up 3 chemical plants after allegations it violated Clean Air Act](#), March 9, 2022.

¹⁶⁶ Reuters. [Chevron Phillips Chemical failed to report imports of 18 toxic chemicals, letters show](#), July 26, 2021. A Chevron Phillips Chemical spokesperson, according to the article, told Reuters the company had since fixed the data in its reporting to the Environmental Protection Agency.

¹⁶⁷ [CPChem 2022 Climate Risk Report](#), p. 13.

¹⁶⁸ It is generally understood that the changes brought about by climate change require an increased level of transparency if markets are to run smoothly. See, for example: Harvard Law School Forum on Corporate Governance, [Transparency paces the road to net zero](#), May 30, 2022

Shell (SHEL)

Background

Shell Plc is an international energy company with operations that include exploration, production, refining, and marketing of oil and natural gas, as well as the production and marketing of chemicals. In more than 70 countries, Shell invests in various power sources, including renewables such as wind and solar energy, and in electric vehicle-charging infrastructure and low-carbon transportation fuels, such as advanced biofuels and hydrogen.¹⁶⁹

In 2022, the company sold 66 mmtpa of LNG and more than 240 terawatt-hours (TWh) of power. Shell serves more than 32 million customers across more than 46,000 retail stations daily.¹⁷⁰ It has more than 40,000 public EV charge points.¹⁷¹

In fiscal year 2022, Shell recorded a total revenue of US\$381.3 billion,¹⁷² with the acquisition of Europe's top renewable natural gas producer, Nature Energy, adding to its revenue growth. The company's market capitalization is \$216 billion.¹⁷³

In 2022, Shell's Chemicals unit produced \$144 billion in revenue.¹⁷⁴ The company has almost 70 chemical products that encompass a cross-section of basic, intermediate and specialty products. The company's chemical profile includes acetone, aromatics (benzene, toluene), ethylene oxide and glycols, gas-to-liquids, drilling fluids, surfactants, olefins, polyethylene, phenols, polyols, propylene oxide, solvents and styrene monomers.¹⁷⁵ Shell has leading market positions in many of these markets.

Business Segments

The company operates through six reportable business segments (see Table 5):

- The **Integrated Gas** segment involves exploration and extraction of natural gas and liquids; the management of upstream and midstream infrastructure required to transport gas and liquids to the market; and the marketing, trading, and optimization of LNG.
- The **Upstream** segment is involved in exploration and extraction of crude oil, natural gas, and natural gas liquids. Also, it manages the marketing and transportation of oil and gas and oversees the essential infrastructure required for their delivery to the market.

¹⁶⁹ Unless otherwise noted, the information used to discuss Shell can be found in Shell. [Annual Report and Accounts for the year ended December 31, 2022](#). March 9, 2023 (hereafter, [Shell 2022 Annual Report](#)).

¹⁷⁰ Shell. [Shell at a Glance](#). Accessed December 30, 2023.

¹⁷¹ Shell. [Electric vehicle charging](#). Accessed December 30, 2023.

¹⁷² [Shell 2022 Annual Report](#), p. 266.

¹⁷³ Yahoo Finance, Shell Market Capitalization, (January 6, 2023)

¹⁷⁴ [Shell 2022 Annual Report](#).

¹⁷⁵ Shell. [Our products](#). Accessed December 30, 2023.

- The **Marketing** segment consists of three core businesses: Mobility, Lubricants, and Sectors & Decarbonisation.
- The **Chemicals and Products** segment encompasses chemical manufacturing facilities with their distribution networks, as well as refineries that transform crude oil and various feedstocks into a diverse range of oil products.
- The **Renewables and Energy Solutions** segment encompasses Shell's Integrated Power operations, which involve generating electricity; marketing and trading power and pipeline gas; and offering digitally enhanced customer solutions.
- The **Corporate** segment encompasses non-operational functions that provide support to Shell.

Table 5: Shell Financial Data by Segment on a Current Cost of Supplies (CCS) Basis in 2022¹⁷⁶

Information by segment on a current cost of supplies basis is as follows:

							\$ million
2022							
	Integrated Gas	Upstream	Marketing	Chemicals and Products	Renewables and Energy Solutions	Corporate	Total
Revenue:							
Third-party	54,751	8,352	120,638	144,342	53,190	41	381,314 [A]
Inter-segment	18,412	52,285	606	2,684	6,791	–	80,778
Share of profit/(loss) of joint ventures and associates (CCS basis)	1,219	2,111	237	374	(7)	(4)	3,930
Interest and other income, of which:	(714)	726	(104)	244	57	706	915
Interest income	43	22	–	24	(2)	959	1,046
Net gains on sale and revaluation of non-current assets and businesses	101	437	(186)	282	8	–	642
Other	(858) [B]	267	82	(62)	51	(253)	(773)
Third-party and inter-segment purchases (CCS basis)	37,785	10,666	108,012	127,521	57,024	(28)	340,980
Production and manufacturing expenses	4,907	9,676	810	7,583	2,520	22	25,518
Selling, distribution and administrative expenses	218	233	7,351	3,592	972	517	12,883
Research and development expenses	112	456	222	187	98	–	1,075
Exploration expenses	240	1,472	–	–	–	–	1,712
Depreciation, depletion and amortisation charge, of which:	2,211	10,334	1,900	3,289	777	18	18,529
Impairment losses	115	950	480	356	412	–	2,313 [C]
Impairment reversals	(3,449)	(2,504)	(151)	(73)	–	–	(6,177) [D]
Interest expense	84	345	46	22	2	2,682	3,181
Taxation charge/(credit) (CCS basis)	5,899	14,070	903	935	(303)	(7)	21,497
CCS earnings	22,212	16,222	2,133	4,515	(1,059)	(2,461)	41,562

[A] Includes \$11,708 million of revenue from sources other than from contracts with customers, which mainly comprises the impact of fair value accounting of commodity derivatives. This amount includes both the reversal of prior losses of \$9,815 million related to sales contracts and prior gains of \$7,201 million related to purchase contracts that were previously recognised and where physical settlement has taken place during 2022.

[B] Includes the full write-down of the Nord Stream 2 loan amounting to \$1,126 million. (See Note 6).

[C] Impairment losses comprise Property, plant and equipment (\$1,799 million, see Note 12), Goodwill (\$361 million) and Other intangible assets (\$153 million).

[D] Impairment reversals fully comprise Property, plant and equipment. (See Note 12).

Source: Shell Annual Report 2022.

¹⁷⁶ Shell 2022 Annual Report, p. 266.

Shell had a strong revenue producing year in 2022. Chemicals ranked high in revenue volume (\$144 billion) but failed to lead the company on net earnings (\$4.5 billion). High costs in the sector drove down its financial performance. Standard fossil fuel extraction provided strong returns (\$16.2 billion or 40% of earnings) based on spiking oil prices from the Ukraine invasion. The company's renewables portfolio posted a \$1 billion loss for 2022.

Capital Expenditure Overview

In the 2022 fiscal year, the company's capital expenditure stood at \$22.6 billion, compared to \$19.0 billion in fiscal year 2021.¹⁷⁷ The company's 2022 capital plan remained tied to fossil fuels with Integrated Gas, Upstream, Marketing and Chemicals and Products. In IEEFA's view, the company needs to specify how it plans to transition from a capital expenditures platform with significant fossil fuel investment to an asset base that supports sustainable economic activities and their revenues.

Table 6: Shell Cash Capital Expenditure, 2020-2023¹⁷⁸ (millions of dollars)

Cash Capital Expenditure	2022	2021	2020
Integrated Gas	4,265	3,502	3,566
Upstream	8,143	6,168	7,099
Marketing	4,831	2,273	1,774
Chemicals and Products	3,838	5,175	4,198
Renewables and Energy Solutions	3,469	2,359	928
Corporate	287	221	262
Total Cash Capital Expenditure	\$24,833	\$19,698	\$17,827

Source: Shell Annual Report 2022.

The company spent \$3.5 billion of its \$24.8 billion (14%) in capex on Renewable and Energy Solutions, a 47% increase from 2021.¹⁷⁹ The company's Upstream, Integrated Gas, Marketing and Chemicals Products account for the remaining 86%.

¹⁷⁷ Shell 2022 Annual Report, p. 364.

¹⁷⁸ *Ibid.*

¹⁷⁹ For an earlier review of Shell's renewable energy investments see: IEEFA. [Despite talk, Shell and Total are still investing much more in fossil fuels than renewables](#). July 2020.

Capex and Single-Use Plastics Expansion

In late 2021 Shell opened a petrochemical plant in western Pennsylvania. The plant cost a reported \$6 billion with cracker capacity (ethane-to-ethylene) and plastic resins.^{180,181} The plant has proven to be controversial since the company has offered very little information to the public and its launch has been hampered by violations of Pennsylvania's clean air statutes (see below).

Sustainability

The company supports a wide range of activities designed to lower the company's emission portfolio that cross the value chain, including biofuels; chemical and mechanical recycling designed to reduce the use of fossil fuels in the production process; use of renewable energy; carbon capture and sequestration, and hydrogen production; energy efficiency measures; divestments of assets; and carbon credits.¹⁸²

The company is facing significant public criticism for its climate policies and practices. In 2021, the company stated that it expected its oil production to decline at a rate of 1% to 2% annually.¹⁸³ In 2023, the company changed its position and told investors that production would remain flat going forward (and that it would be growing its natural gas business).¹⁸⁴ The June 2023 investor presentation was followed by comments from Shell's CEO that it would be "dangerous and irresponsible" to reduce oil and gas production.¹⁸⁵

The company's apparent retreat from its pledges has created a fundamental challenge to the company's climate efforts. Additional issues regarding its sustainability effort include:

- First, environmental law firm ClientEarth reports that Shell's sustainability targets are primarily based on its "Net Carbon Footprint" metric. This approach focuses Shell's Scope 3 net-zero goal on its energy products, leaving the emissions from the company's production of more than 17 million tonnes per year of chemicals unreported.^{186,187,188} Shell acknowledges that non-energy products such as chemicals, lubricants and bitumen are not included in its net carbon intensity target, stating: "This is because their end-use is not combustion, and so they are not consumed as energy in the way that fuels like liquified natural gas (LNG), petrol

¹⁸⁰ The \$6 billion figure has been reported in various news articles. See Reuters. [Trump promises more big energy projects at Pennsylvania plant](#). August 13, 2019. Also see: Pittsburgh Post-Gazette. [Shell cracker is a harbinger of things to come, drawing in President Trump and protesters](#). August 23, 2019. Also see: Pittsburgh Business Journal. [Shell's workforce, construction drastically cut at Beaver County site](#). March 25, 2020.

¹⁸¹ To IEEFA's knowledge, the \$6 billion cost figure has not been confirmed by Shell. See TimesOnline, [Shell CEO: Cracker plant project ahead of schedule, within budget](#). September 25, 2018.

¹⁸² See [Shell 2022 Annual Report](#), pp. 11, 14, 70, 73 and 76.

¹⁸³ Shell. [Shell accelerates drive for net zero emissions with customer-first strategy](#). February 11, 2021.

¹⁸⁴ Euronews.com. [Shell joins BP and Total in U-turning on climate pledges 'to reward shareholders'](#). June 15, 2023.

¹⁸⁵ The Associated Press. [Shell CEO calls it 'irresponsible' to cut oil production now](#). July 6, 2023.

¹⁸⁶ ClientEarth. [Greenwashing Files: Shell](#). March 25, 2021.

¹⁸⁷ For a description of Shell's Net Carbon Footprint methodology, see: Shell Global Solutions (UK). [Shell's Net Carbon Footprint: Methodology](#). February 2023.

¹⁸⁸ For Shell's chemical production, see Shell. [Shell Chemicals](#). Accessed December 30, 2023.

or diesel are consumed.”¹⁸⁹ In this sense, the company is failing to recognize GHGs that are linked to fossil fuel-related emissions from the production of petrochemicals.

- Second, investors have taken the company to court and received an order in 2021 requiring the company to reduce emissions by 45% by 2030.¹⁹⁰ The court’s intervention stems from recognition of the lack of adequate action being taken by Shell.^{191,192} Although the company has increased its renewable investments since 2020, which is critically important, the company’s capital spending, as noted above, still favors oil and gas extraction and related activities.¹⁹³
- Third, ClientEarth brought suit in the High Court of England and Wales asserting that the company’s sustainability effort is not in line with Paris goals and the company fails to show how its current capital allocation plans are going to achieve its goals. The court ruled that Shell’s board members are not personally liable for their failure to prepare for the energy transition,¹⁹⁴ and an attempt to appeal the case did not succeed.¹⁹⁵ Nevertheless, the issue is on the radar of climate advocacy organizations and may surface again in other forms or venues.
- Fourth, although the company has set forth broad goals to achieve 2050 net-zero targets, critical benchmarks along the way are missing. For example, the company discusses current activities but does not explain how its program will gradually meet the goal and how capex allocations will change to meet the goal.¹⁹⁶

In the United States, Shell’s credibility is at issue because of its construction of a petrochemical hub in Potter Township, Penn. Located in the western part of Pennsylvania, the relatively new plant produces ethylene and a supply of plastic resins and other chemicals. During the planning and construction phase, Shell provided very little information to the public or investors regarding the facility. As a 2020 IEEFA report noted, the company experienced considerable construction delays due to the impacts of the COVID-19 pandemic.¹⁹⁷

¹⁸⁹ Shell. [Our Climate Target: Frequently Asked Questions](#). Accessed December 30, 2023 (response to question: “What is not included in Shell’s net carbon intensity target?”)

¹⁹⁰ [Shell 2022 Annual Report](#), p. 16.

¹⁹¹ [Milieudéfensie, et al. v. Royal Dutch Shell PLC](#), Hague District Court, Decision of May 26, 2021.

¹⁹² Shell appealed the decision on July 20, 2022. See Sabin Center for Climate Change Law: Climate Case Chart. [Milieudéfensie, et al. v Royal Dutch Shell](#). Accessed December 30, 2023. Also see: Shell. [Frequently Asked Questions \(FAQ\) on Dutch District Court Legal Case](#). March 22, 2022.

¹⁹³ [Shell 2022 Annual Report](#), p. 32. Also see: IEEFA. [Despite the talk, Shell and Total are still investing much more in fossil fuels than renewables](#). July 23, 2020.

¹⁹⁴ [ClientEarth v. Shell Plc](#) [2023] EWCH 1897 (Ch).

¹⁹⁵ See: E&E News/ClimateWire. [London appeals court rejects Shell climate lawsuit](#). November 16, 2023. ClientEarth. [Court fails to engage with key climate risk arguments in Shell directors case dismissal](#). November 15, 2023. Also see: Fasken. [UK Court of Appeal declines to hear ClientEarth’s appeal in landmark climate case](#). December 4, 2023.

¹⁹⁶ See Shell PLC. [Responsible Energy: Sustainability Report 2022](#). March 28, 2023 (hereafter, [Shell 2022 Sustainability Report](#)).

Also see: Shell PLC. [Our Progress Toward Net Zero: Energy Transition Progress Report 2022](#). March 16, 2023.

¹⁹⁷ IEEFA. [Shell’s Pennsylvania Petrochemical Complex: Financial Risks and Weak Outlook](#). June 2020.

The Pennsylvania Department of Environmental Protection (DEP) issued multiple violations of the state's air quality laws that had occurred during the plant's construction and temporary operations.¹⁹⁸ After it opened the facility in November 2022,¹⁹⁹ the Pennsylvania DEP issued further violations for pollution problems at the plant. The company shut down part of the plant in late March 2023 for a period to make repairs.²⁰⁰ In May 2023, Shell agreed to pay a fine to settle the violations.²⁰¹ A lawsuit by environmental organizations calling for specific injunctive relief to redress past violations and prevent future violations remains before a U.S. District Court in Pennsylvania.²⁰² Despite the violations, the company was able to benefit from a tax credit that Pennsylvania granted in 2023,²⁰³ presumably for sales and transactions that occurred in 2022.²⁰⁴

Any attendant costs to Beaver County, the Borough of Monaca and Potter Township from the plant's disruptive pollution problems and plant closure are not known. Each benefit from continued annual Payments in Lieu of Taxes (PILOT) made by Shell. In 2022, Potter Township was given \$47,134, and Monaca received \$27,000 in PILOT payments.^{205,206}

The facility has opened to a tight market for polyethylene and its resins as the markets in the United States have been oversupplied.²⁰⁷ Since November 2022, the market price for polyethylene has been relatively low,²⁰⁸ and the initial finances for the project seem challenged with the disruption caused by the pollution issues.²⁰⁹ During Shell's Q3 2023 earnings call, its CEO revealed for the first time that the plant was facing a challenging market.²¹⁰

¹⁹⁸ Pennsylvania DEP. [Notice of Violation](#) (issued to Shell Chemical Appalachia LLC). December 14, 2022. Also see: PA Environment Digest. [DEP Issues Notice Of Violation To Shell Petrochemical Plant In Beaver County For Air Quality Violations In Sept. - Oct.](#) December 19, 2022.

¹⁹⁹ Shell. [Shell begins operations at polymers plant in Pennsylvania](#). November 15, 2022.

²⁰⁰ The (Beaver County) Times. [Shell: Expect 'continuous' flaring at cracker plant during maintenance](#). March 28, 2023. Also see: NBC News. [Months after residents sound the alarm, Pennsylvania 'cracks' down on Shell plant](#). May 25, 2023.

²⁰¹ [Consent Agreement, Matter of Shell Chemical Appalachia](#) (violations of Air Pollution Control Act and regulations), May 24, 2023. Also see: Pennsylvania DEP. [Shapiro administration secures \\$10 million payment from Shell, including \\$6.2 million for local community, to resolve air quality violations](#). May 24, 2023.

²⁰² [Complaint for Declaratory and Injunctive Relief, Clean Air Council v. Shell Chemical Appalachia](#), No. 2:05-mc-02025, U.S. District Court, Western District of Pennsylvania, filed May 11, 2023. Also see: The Associated Press. [Environmental groups sue Shell over air quality at massive new Pennsylvania petrochemical plant](#). May 11, 2023.

²⁰³ Pennsylvania Department of Revenue. [Pennsylvania Resource Manufacturing Tax Credit Report: Awarded Year 2023](#). Undated.

²⁰⁴ Pennsylvania Department of Revenue. Letter to Shell Chemical Appalachia, LLC, Pennsylvania Manufacturing Tax Credit and Notification. March 20, 2023 (Available upon request).

²⁰⁵ Potter Township. [2022 Potter Township Budget](#). April 2022. These payments from Shell to local governments are recorded as PILOT payments. We are unaware of any other agreements that the company has reached with the municipalities to pay additional amounts.

²⁰⁶ Borough of Monaca, 2023 Adopted Budget, (undated), p. 1 contains a reference to a budget item: In Lieu of Taxes for \$27,000.00 down from \$30,000.00 in the prior year. This item does not specifically attribute this to Shell. However, the [Beaver County Times](#) established that Shell had agreed to a PILOT payment in 2016 of \$44,000. See: The (Beaver County) Times. [Tax breaks given to Shell Chemicals 'essential' in attracting company to Beaver County](#). June 19, 2016.

²⁰⁷ Plastics Today. [PE, PP Resin Prices to Remain Under Pressure in 2023](#). January 3, 2023.

²⁰⁸ Although polyethylene prices have been under pressure this year due to a weak domestic market, they have managed some increase due to exports and cutbacks at some production facilities. See: Plastics Today. [Exports, production cuts help PE, PP Prices increases](#). October 2, 2023. (Proprietary)

²⁰⁹ IEEFA. [IEEFA report: Financial risks loom for Shell's Pennsylvania petrochemicals complex](#). June 4, 2020.

²¹⁰ Shell. [Q3 2023 Earnings Call Transcript](#). November 2, 2023.

In October 2023, Shell, which had been the lead applicant for a hydrogen project planned to be located in a western Pennsylvania hub, pulled out of the deal.²¹¹ While Shell continues to study the potential for hydrogen and decarbonizing the plant, its withdrawal from the western Pennsylvania project leaves the path to decarbonization of this cracker unclear.

Enhancing Sustainability Reporting

The litigation and subsequent discussions have produced a menu of items regarding sustainability. Left unaddressed, these issues will be cause for continued controversy:

- **Legal Compliance and Pollution Issues:** The fines and litigation stemming from Shell's environmental issues are an indication that management and the board need to carefully review and monitor Shell's compliance.
- **Stakeholder Engagement:** The company faces a number of challenges that go to its credibility on climate change issues. The company needs to create an enhanced stakeholder engagement and response plan to restore the loss of reputation.
- **Transparency and accountability:** The litigation discussed above raises issues of transparency regarding the company's climate policies.
- **Adaptation and Innovation:** Shell's sustainability program embraces a mixed bag of sustainable climate initiatives and efforts to expand its fossil fuel portfolio. Investors need to pay attention and hold the company to account.
- **Global Alignment:** Given the international nature of Shell's operations, aligning its sustainability efforts with global standards, such as those in the European Union, is essential.

Shell's Pennsylvania plant opened to an oversupplied market, environmental violations and significant community controversies. Shell has also been reluctant to disclose basic financial information, giving little baseline information to investors to help them judge the success or failure of an investment. It risks valuation loss if initial operating and market problems do not improve.

In addition, the litigation and environmental enforcement actions discussed above have exposed a management problem related to environmental and climate-related conduct and reporting. Shell, like all the fossil fuel companies covered in this paper, has shown lagging financial performance. A large portion of this matter is related to climate change and the company's response to it.

The problems may spur investors to exercise enhanced diligence to ensure that Shell is accurately disclosing its transition program and, particularly, its capital allocation plan going forward.

²¹¹ Pittsburgh Post-Gazette. [Once a player, Shell confirms it's not part of any regional hydrogen hub](#). October 12, 2023.

B. Individual, Independent Chemical Companies

Dow, Inc.

Background

Dow Inc. (NYSE: Dow) is a multinational chemical corporation located in Midland, Mich., with a diverse portfolio of operations spanning Asia Pacific, Europe, Middle East, Africa, India (EMEAI), Latin America, the United States and Canada. It produces a wide variety of feedstock and industrial products including additives, adhesives, elastomers, polymers, and specialty chemicals. The company's products also include packaging, infrastructure, mobility, and consumer applications.²¹²

The company operates through three operational segments: Packaging & Specialty Plastics; Industrial Intermediates and Infrastructure; and Performance Materials and Coatings. As of Dec. 31, 2022, the company had 104 manufacturing sites in 31 countries and a portfolio of approximately 3,700 active U.S. patents and 22,600 active foreign patents.²¹³

- **Packaging & Specialty Plastics:** The segment offers a comprehensive range of polyolefin products, backed by the company's proprietary catalysts and special manufacturing processes. It comprises two integrated global businesses: Hydrocarbons & Energy, and Packaging and Specialty Plastics. The business line caters to customers, brand owners, and consumers in markets such as food and specialty packaging, industrial and consumer packaging, health and hygiene, caps, closures, pipes, consumer durables, mobility and transportation, and infrastructure.
- **Industrial Intermediates & Infrastructure:** The segment comprises two globally oriented divisions: Industrial Solutions, and Polyurethanes & Construction Chemicals. These businesses focus on the creation of intermediate chemicals essential to certain manufacturing processes, as well as the development of specialized materials and formulations using advanced technologies. The company is a leader in production of ethylene oxide and propylene oxide. The intermediates cover a broad range of markets including appliances, coatings, electronics, cleaning agents and offer products that serve the needs of global infrastructure, oil and gas companies.
- **Performance Materials & Coatings:** The business segment is composed of two global enterprises: Coatings & Performance Monomers, and Consumer Solutions. These businesses employ the company's science and technology capacity in the field of acrylics, cellulose, and silicones. Its products meet the needs of architectural and industrial, home care and personal care, consumer electronics, mobility and transportation as well as building and infrastructure businesses. Each operational segment relies on a robust supply of raw materials that includes ethane, naphtha, natural gas, ethylene, hexene, methanol, and propane. The hydrocarbon-based materials feed the company's production of ethylene,

²¹² Dow Chemical. [2022 Form 10-K](#), 2023 (hereafter, [Dow 2022 Form 10-K](#)), p. 7. Unless otherwise noted, the background information on Dow, Inc., is from this document. Form 10-K is included in Dow's [2022 Annual Report](#).

²¹³ *Ibid.*, pp. 5 and 14.

polyethylene resins (HDPE, LLDPE and LDPE), propylene, benzene, butadiene, octene, and hexene.

In fiscal year 2022, Dow Inc. reported total revenue of \$56.9 billion, marking a year-over-year increase of 3.5%.²¹⁴ Net sales showed growth in every operational segment except Industrial Intermediates & Infrastructure, and across all geographical regions except EMEAI (Europe, Middle East, Africa and India).

Geographic Performance

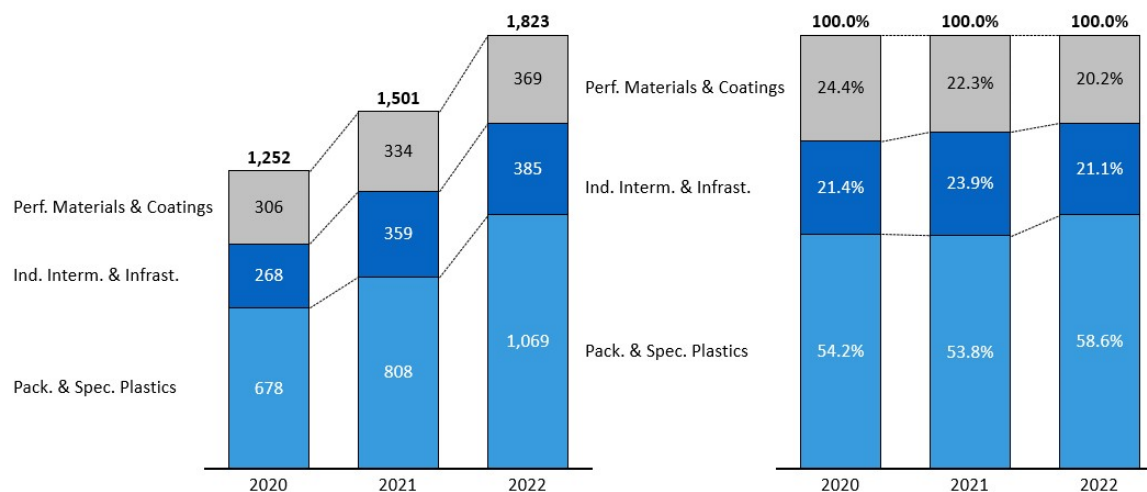
Except for EMEAI, revenues increased in each region.

- U.S. & Canada—Reported revenue of \$20.9 billion for FY22.
- EMEAI—Reported revenue of \$19.6 billion for FY22.
- Asia Pacific—Reported revenue of \$10.3 million for FY22.
- Latin America—Reported revenue of \$6.0 million for FY22.²¹⁵

Dow's Capital Expenditure Overview

In 2022, the company allocated \$1.8 billion for capital expenditures, an increase from the \$1.5 billion spent in 2021. For the year 2023, the company anticipates capital expenditures to reach approximately \$2.2 billion.²¹⁶

Figure 5: Dow Inc. 2022 Capital Expenditure Allocation by Business Segment



Source: Dow 10-K, IEEFA; chart by IEEFA.

²¹⁴ *Ibid.*, p. 32.

²¹⁵ *Ibid.*, p. 77.

²¹⁶ *Ibid.*, pp. 38 and 40.

The current strategic investments in Packaging and Specialty Plastics include joint ventures in Kuwait, Saudi Arabia and Thailand. The joint ventures manufacture and sell ethylene, polyethylene, Polyethylene Terephthalate (PET), Monoethylene glycol, propylene, propylene and ethylene oxide, styrene monomer and a host of derivative and specialty products.²¹⁷

The current projects in the Intermediate and Infrastructure unit include a series of projects in the U.S., Thailand, and Europe. These projects produce or enhance the production of polyurethane, methylene diphenyl isocyanate (MDI) distillation and polymers, alkoxylation and recycling.²¹⁸

Capex and Single-Use Plastic Expansion

The company is planning to build a new petrochemical facility in Saskatchewan, Canada to expand ethylene (1.8 mmtpa) and polyethylene production (3.2 mmtpa) by 2030. The cost of the project is estimated at \$9 billion. Its sustainability claims rest on hydrogen and CCS. The project will use natural gas feedstock (ethane).²¹⁹

Figure 6: Dow Inc. Stock Performance in Comparison With S&P 500 2019-Present



Source: Yahoo Finance.

Stock Analysis

Over the last five years, Dow has lagged the stock market, as well as the Materials Index. At a time when the market increased by 68.5%, Dow increased by 11.63%. Since company reorganization and

²¹⁷ Dow's 2022 Form 10-K identifies six joint ventures in which the company is engaged. *Ibid.*, p. 7.

²¹⁸ *Ibid.*, pp. 9-11.

²¹⁹ Dow. [Fort Saskatchewan Path2Zero](#). Accessed December 30, 2023. Also see: The Canadian Press. 'First of its kind': Dow invests \$9 billion on Alberta net-zero petrochemical project. November 29, 2023.

decoupling from DuPont in 2019,²²⁰ the stock price has remained flat. Dow's market capitalization of \$38 billion places it 10th in a list of top materials companies.²²¹

Like many of the companies in this report, Dow is following a growing consensus in the fossil-fuel and petrochemical industry about certain climate-related technologies and strategies that simply do not support the type and level of application that Dow currently envisions. The risks, particularly with regard to CCS, are very well known. Nevertheless, many in the industry are placing substantial sums behind it. Investors need to be wary and watch closely.

Overall, the Dow Chemicals business model continues to reflect a traditional petrochemical approach based on standard growth assumptions that are at high risk of failure. Dow's project in Canada could be the poster child for what not to do. It is being built to serve an oversupplied market, and it ties up significant capex and employs technology with a pattern of poor performance. The likelihood of value loss is high.

Sustainability Plans:

Dow's overall sustainability objectives include a goal of carbon neutrality in Scope 1, 2 and 3 emissions by 2050. Its interim goal is to reduce Scope 1 and 2 emissions by 5 million metric tons by 2030.²²²

Dow's history of environmental problems is global, and it has been subject to multiple enforcement actions related to pollution and health.²²³ The company's sustainability report identifies some of the priority challenges facing the company related to climate change (e.g., achieving feedstock replacement and biodegradable packaging).

Dow's sustainability plans have been developed over the last decade, and include:

- Development of alternative feedstock to replace natural gas and naphtha, with establishment of production plants.²²⁴
- Use of renewable energy and nuclear energy to decrease carbon content of feedstock and plastics production by changing energy source from natural gas to wind and solar. Improvements of wind and solar technologies.^{225, 226, 227}

²²⁰ Dow. [Dow completes separation from DowDuPont](#), April 1, 2019.

²²¹ Yahoo! Finance. [Basic Materials](#). Accessed December 30, 2023.

²²² [Dow 2022 Form 10-K](#), p. 16.

²²³ Corporate Research Project. [Dow Inc. \(formerly Dow Chemical\): Corporate Rap Sheet](#). August 1, 2020.

²²⁴ Dow. [Dow and New Energy Blue announce collaboration to develop renewable plastic materials from corn residue](#). May 25, 2023 (hereafter, [Dow announcement on renewable plastics from corn residue](#)).

²²⁵ Dow. [Dow partners with Qifan Cable to drive offshore wind power development](#). September 24, 2023.

²²⁶ Dow. [Dow signs four renewable power agreements to achieve 2025 Goal and lead petrochemical industry](#). Undated.

²²⁷ [Dow 2022 Form 10-K](#), p. 52.

- Development of e-cracker technology that would integrate renewable energy, CCS and hydrogen with ethane, propylene and other compounds.²²⁸
- Enhanced recycling of resins and products (e.g., mattresses, coated paper, difficult to recycle plastics²²⁹), employing waste collection and reuse.²³⁰
- Development of biodegradable and energy-efficient packaging.²³¹
- Emissions and fossil fuel reduction strategies for brand manufacturers and consumer products.²³²
- Saskatchewan Petrochemical Complex—The Path2Zero Project and CCS issues.

The long list includes a substantial plan to add a 1.9 mmtpa net-zero ethylene cracker to its petrochemical complex in Saskatchewan. The integrated cracker and polyethylene production capacity is expected to cost \$6.5 billion. Dow also plans to achieve net-zero emissions for the entire complex, at a cost of \$2 billion, by using CCS and converting cracker off-gas into hydrogen (to be used in the production process). It is expected to be online by 2027 and fully operational by 2030.²³³ Although Dow reportedly states the project, called Path2Zero, will decarbonize 20% of its global ethylene capacity, it will also grow its polyethylene production by about 15%, or 2 mmtpa,²³⁴ and one energy consultant estimates the project is expected to increase natural gas demand by 200 million cubic feet per day (cf/d) to 400 cf/d.²³⁵

A similar net-zero cracker plant is being proposed in Antwerp Belgium by INEOS.²³⁶ The company considered CCS as a potential technology to assist in achieving its carbon emissions goals. INEOS has cited three specific drawbacks: 1) No mature technology has been developed that can capture the low levels of CO₂ flue gases; 2) There is no guarantee for hydrogen or CO₂ off-taker customers or technologies and 3) The evolution in carbon prices under the EU Emission Trading System is not well aligned with project economics.²³⁷

Dow should reconsider its sustainability strategy in light of the cautions raised by INEOS about carbon capture. Potential applications of CCS technology to coal and natural gas plants, and broader

²²⁸ ICIS. [Dow advances EDH, e-cracking to lower carbon emissions – execs](#). May 20, 2021.

²²⁹ For example, see: Dow. [Dow's sustainable packaging solutions enable Mengniu to launch all polyethylene yogurt pouch designed for recyclability in China](#). August 4, 2023.

²³⁰ Dow. [Dow commits to accelerating the circular ecosystem by transforming waste and alternative feedstock to deliver 3 million metric tons per year of circular and renewable solutions by 2030](#), October 17, 2022.

²³¹ Dow. [Dow partners with P&G China to enable recyclability of air capsule e-commerce packaging](#). June 19, 2023.

²³² For example, see: [Dow announcement on renewable plastics from corn residue](#).

²³³ S&P Global. [Dow moving ahead with \\$6.5 billion net-zero ethylene, polyethylene project in Canada](#). November 28, 2023. Also see: Dow. [Dow's board of directors approves final investment decision for Path2Zero project](#). November 28, 2023.

²³⁴ Oil and Gas Journal. [Dow lets contracts for proposed Alberta net-zero petrochemicals complex](#). December 8, 2023.

²³⁵ The Financial Post. ['Staggering' — Dow plans major petrochemical expansion, shift to net-zero in Alberta](#). October 16, 2021.

²³⁶ IEEFA. [IEEFA Europe: Proposed INEOS cracker plan would oversupply ethylene market](#). December 21, 2021.

²³⁷ *Ibid.*

industrial uses, such as in the development of the hydrogen industry, are under discussion.²³⁸ But empirical studies of major projects with global recognition (including one with a 40-year history of operations) and other reviews show the technology has consistently failed to meet expectations.²³⁹ The U.S. Department of Energy, in its quest to establish hydrogen as a major strategy for its climate program, argues with optimism that “[t]he challenges of are real but solvable,”²⁴⁰ but the technology’s track record to date is not persuasive.

The application of carbon capture to coal-fired power plants in the U.S., in particular, has a history of extraordinary failure.²⁴¹ A 2008 Government Accountability Office (GAO) audit on CCS projects noted that few were underway at the time. With only a few demonstration projects on coal-fired power plants, it found that active commercial viability was still more than a decade away.²⁴² A December 2021 GAO audit chronicled a series of failed demonstration projects from a program portfolio of 11 projects. The audit concluded that projects continued to struggle to meet performance goals and lessons learned from past failures had not been applied. The report strongly cautioned against the use of more taxpayer dollars without recognition of the lessons learned.²⁴³ The practical problems that caused carbon capture projects at coal power plants to fail in the late 1990s and early 2000s have not been corrected.

The commercial-scale effectiveness of CCS in capturing emissions from the process of deriving hydrogen from natural gas also remains unproven. In addition to the limited levels of carbon capture efficiency seen in such applications, an important debate persists about the proper metrics to measure CCS success in the context of processes that use natural gas. Upstream methane leakage, for example, is excluded from the scope of emissions that can be captured, and little is known about leakage of captured carbon dioxide from downstream transport pipes or storage facilities. An IEEFA analysis concluded that hydrogen derived from natural gas would not meet the U.S. legal definition of “clean hydrogen,” even with the use of CCS.²⁴⁴ Studies that focus on standalone measures of the technology’s efficiency but do not include the full array of emissions that occur upstream or downstream are inadequate.

²³⁸ For example, see: Australia Department of Climate Change, Energy, the Environment and Water. [Australia’s National Hydrogen Strategy](#). September 27, 2023.

²³⁹ IEEFA. [Carbon capture landscape 2022 — still too early to confidently fulfil promises](#). July 7, 2022. Also see: IEEFA. [Carbon capture has a long history. Of failure.](#) September 2, 2022. Also see: IEEFA. [The ill-fated Petra Nova CCS project: NRG Energy throws in the towel](#). October 5, 2022. Also see: IEEFA. [Shute Creek – world’s largest carbon capture facility sells CO₂ for oil production but vents unsold](#). March 1, 2022. Also see: IEEFA. [Gorgon carbon capture and storage: The sting is in the tail](#). April 29, 2022.

²⁴⁰ U.S. Department of Energy. [Pathways to Commercial Liftoff: Carbon Management](#). April 2023, p. 3.

²⁴¹ IEEFA. [The Kemper IGCC Project: Cost and Schedule Risks](#). December 3, 2012. Also see: IEEFA. [Kemper Power Plant, a Debacle That Should Never Have Been](#). November 20, 2014.

²⁴² U.S. GAO. [Climate Change: Federal Actions Will Greatly Affect the Viability of Carbon Capture and Storage As a Key Mitigation Option](#). September 30, 2008, p. 34.

²⁴³ U.S. Government Accountability Office. [Carbon Capture and Storage: Actions Needed to Improve DOE Management of Demonstration Projects](#). December 2021.

²⁴⁴ IEEFA. [Blue Hydrogen: Not clean, not low carbon, not a solution](#). September 2023 (hereafter, [IEEFA 2023 Blue Hydrogen Analysis of Impacts](#)). Also see: IEEFA. [Infographic: Carbon capture’s methane problem](#). August 11, 2022.

One extensive analysis makes clear that the private sector is unlikely to be willing to absorb all the costs of a CCS system. The costs now and even perhaps into the future are too great.²⁴⁵

CCS is likely to require permanent, ongoing subsidization to be more broadly implemented as a viable climate solution. These conclusions suggest that the standard joint venture partnership model to share risk among private parties will not work, absent long-term public subsidization.

INEOS has opted to buy carbon offsets as a method to comply with European standards; the company can only make claims to net-zero status because of that accounting artifice. But INEOS estimates it will take another decade before its carbon capture offset strategy will be viable.²⁴⁶

LyondellBasell Industries N.V. (LYB)

Background

LyondellBasell Industries N.V. (LYB) is a global, independent chemical company incorporated under Dutch law. Its headquarters are in Houston, Texas. The company works across the petrochemical value chain and is an industry leader in many of its product lines. The production processes are typified by large processing plants that convert liquid and gaseous fossil fuel feedstocks into plastic resins and other chemicals. LYB's products serve as critical components of other finished end products such as food packaging, home furnishings, automotive parts, and paints and coatings. LYB's sole refinery is in Houston. It processes crude oil into gasoline and other distillates and is expected to close at the end of 2025.²⁴⁷

LYB's revenues hit \$50.5 billion in 2022, representing a substantial increase from its 2020 five-year low of \$27.8 billion. The low was driven by slumping sales during the COVID-19 pandemic. In 2022, revenues hit a five-year high, but net income was a modest \$3.9 billion.²⁴⁸ The company's 2022 long-term debt levels totaled \$10.5 billion,²⁴⁹ and LYB carries a BBB rating from Fitch and a Moody's rating of Baa2/Stable.^{250,251} The company has a market capitalization of approximately \$31 billion.²⁵²

The company divides its business activities into six segments:

- Olefins and Polyolefins-Americas (O&P-Americas) produces olefins and co-products, polyethylene and polypropylene.

²⁴⁵ M. Bui, et. al. [Carbon Capture and Storage \(CCS\): The way forward](#). *Energy and Environmental Science*, Issue 5, 2018, pp. 1137 and 1141.

²⁴⁶ INEOS. Environmental Impact Assessment, Conclusion, Section 14.5.4, Section 1 Concise Description. 2021, pp. 36-40. (English Translation Proprietary)

²⁴⁷ Reuters. [LyondellBasell delays refining business exit 2025](#). May 31, 2023.

²⁴⁸ [LyondellBasell 2022 Form 10-K](#), p. 62.

²⁴⁹ *Ibid.*, p. 65.

²⁵⁰ Fitch Ratings. [LyondellBasell Industries N.V.](#) June 22, 2023.

²⁵¹ Moody's. Moody's Assigns Baa2 rating to LyondellBasell's green bond; outlook stable, October 31, 2023. (Proprietary)

²⁵² MarketWatch. [LyondellBasell](#). Accessed January 2, 2024.

- Olefins and Polyolefins-Europe, Asia, International (O&P-EAI).
- Intermediates and Derivatives (I&D) produces propylene oxide and derivatives such as oxyfuels, and intermediate chemicals such as styrene, acetyl, ethylene oxide and ethylene glycol.
- Advanced Polymer Solutions (APS) produces polypropylene solutions, engineered plastics, advanced polymers and polybutene-1.
- Refining processes specializes in heavy, high-sulfur crude oil; and
- Technology develops and licenses chemical and polyolefin process technologies and manufactures and sells polyolefin catalysts.²⁵³

Company revenues are diversified across a broad set of products (Table 7). LYB holds a leading position in Europe and the United States in polyethylene and polypropylene.²⁵⁴ This leadership position places the company among the top producers of single-use plastics, particularly in the United States. Fifty percent of company revenues are from the United States (\$24.8 billion). Germany ranks second with \$3.6 billion.²⁵⁵

The company produces base chemicals, intermediates and polymers. The company's top base chemical portfolio products are ethylene, propylene and methanol. In the intermediates sector, its primary products are propylene oxide, styrene and ethyl tert-butyl ether (ETBE). Its polymers consist of polypropylene and polyethylene resins.

Table 7: LyondellBasell Revenues by Product Lines 2020-2022 (millions of dollars)

Sales and Other Operating Revenues	2022	2021	2020
Olefins & Co-Products	4,782	5,008	2,432
Polyethylene	9,608	10,134	5,842
Polypropylene	6,514	7,994	4,525
Propylene oxide and derivatives	3,097	2,885	1,714
Oxyfuels and related products	5,482	3,587	2,278
Intermediate Chemicals	4,012	3,415	2,080
Compounding and solutions	4,197	4,132	3,223
Advanced polymers	1,030	1,001	680
Refined Products	10,975	7,178	4,346
Other	754	839	633
Total	\$50,451	\$46,173	\$27,753

Source: LyondellBasell 10-K, 2022.

LYB's top earner is polyethylene. The company plays a significant role in each of the principal submarkets—high-density polyethylene, low-density polyethylene and linear low-density polyethylene.

²⁵³ LyondellBasell 2022 Form 10-K, p. 4.

²⁵⁴ LyondellBasell, [Olefins and Polyolefins](#). Accessed January 6, 2024.

²⁵⁵ LyondellBasell 2022 Form 10-K, p. 80.

The company's portfolio is diversified, supporting a broad range of end products and markets. This provides stability to the company's financial condition.

The company is in the top 10 of producers in propylene,²⁵⁶ ethylene,²⁵⁷ methanol,²⁵⁸ propylene oxide,²⁵⁹ ETBE,²⁶⁰ polypropylene,²⁶¹ and polyethylene.²⁶²

LYB's capex has averaged more than \$2 billion annually over the last five years. In 2022, the company spent \$1.9 billion, devoting 50% to Intermediates and Derivatives (\$375 million and \$344 million to O&P Americas and O&P EAI). It spent an additional \$98 million on Technology.²⁶³

Overall capex expenditures range annually from \$1.9 billion to \$2.0 billion. The capex strategy is expected to lower emissions and help ensure environmental compliance with potential climate legislation. The company anticipates that 15% of total capital expenditures will be deployed over the next two years to support climate and environmental goals.²⁶⁴

The company has adopted standards to evaluate and prioritize GHG emissions investments based on a rate of return standard per project.²⁶⁵

Historically, the company's capex spending has been heavily concentrated in the I&D, O&P-America, and O&P-Europe segments.

²⁵⁶ GlobalData. [Propylene Market](#). July 1, 2023.

²⁵⁷ Procurement Resources. [Leading Ethylene Producers in the World](#). June 28, 2023.

²⁵⁸ Imarc Group. [Top Players in the Methanol Market](#). 2022.

²⁵⁹ ChemAnalyst. [Decoding the Future of Propylene Oxide](#). August 2023.

²⁶⁰ Acumen Research and Consulting. [Ethyl Tertiary Butyl Ether Market Size - Global Industry, Share, Analysis, Trends and Forecast 2023 - 2032](#). April 2023.

²⁶¹ Yahoo Finance. [LyondellBasell Industries NV \(LYB\): A Comprehensive Analysis of Its Fair Valuation](#). September 19, 2023.

²⁶² Indexbox. [World - Polyethylene in Primary Forms - Market Analysis, Forecast, Size, Trends And Insights \(Insights: Largest Polyethylene Producers\)](#). January 1, 2024..

²⁶³ [LyondellBasell 2022 Form 10-K](#), p. 127.

²⁶⁴ LYB. [LyondellBasell Industries N.V. —Climate Change 2023](#), p. 16. Also see: [LyondellBasell 2022 Form 10-K](#), p. 14.

²⁶⁵ [LyondellBasell 2022 Form 10-K](#), p. 14.

Table 8: LyondellBasell Capex Spending

Project	Primary Product	Location	Size (mt/y)	Completion	Partners
Bayport/Channelview Complex	Propylene Oxide-butyl alcohol (PO/TBA)	Bayport, Texas	470,000	2023	
Ningbo ZRCC Lyondell Chemical Co.	Propylene Oxide-styrene monomer (POSM)	Ningbo, Mainland China	1,980,000	2023	Sinopec (73%)
Thailand JV Parnets/HMC Polymers	Polypropylene (PP)	Thailand	1,060,000	2022	PT TGC
JV/PdyMirae	Polypropylene	South Korea	400,000	2021	Daelim, SK Advanced
JV/ AFA Nord	Recycling Polyethylene	Germany	26,000	2025	AFA Nord

Source: *BIC magazine*; LyondellBasell news releases.

The current pipeline of projects reflects the company's strategic decision to concentrate its investment in its leading revenue base in the United States by building a new PO/TBA propylene oxide/tert butyl alcohol (PO/TBA) facility at two sites in Texas and a new propylene oxide styrene monomer (POSM) facility in China to boost its presence in the Asian market. LYB reports: "Approximately 50% and 60% of our capital expenditures in 2022 and 2021, respectively, was for profit-generating growth projects, primarily our PO/TBA plant, with the remaining expenditures supporting sustaining maintenance."²⁶⁶ The company announced in 2023 that a German recycling plant is slated to commence operations in 2025.²⁶⁷

Capex and Single-Use Plastics Expansion

The company's buildout of its polypropylene capacity in Thailand and South Korea adds 1.5 million tons per year to its profile and to the market. The company is experiencing lower demand across its portfolio, however, particularly with polypropylene and polyethylene.²⁶⁸ Some credit rating agencies have raised concerns about the investments specifically and more generalized issues of oversupply on an industry-wide basis.^{269,270}

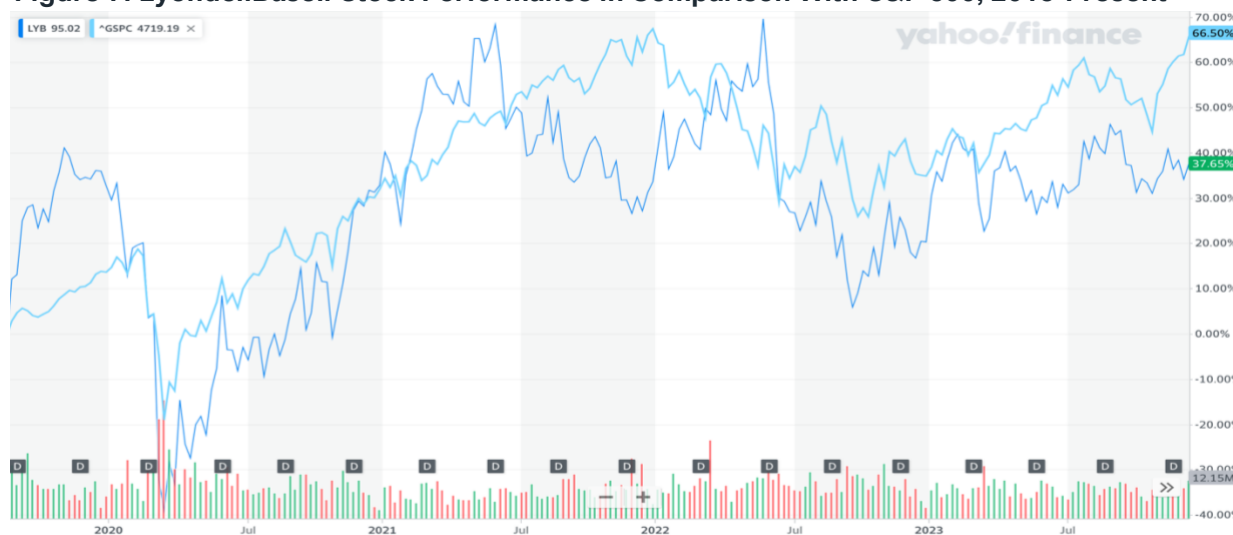
²⁶⁶ *Ibid.*, p. 46.

²⁶⁷ LYB 2022 Annual Report, p. 3.

²⁶⁸ ICIS. *LyondellBasell sees weaker demand, lower operating rates*. September 14, 2022.

²⁶⁹ Fitch Ratings. *Fitch Rates HMC Polymers' Proposed Debentures 'A-(tha)'*. August 24, 2023.

²⁷⁰ ICIS. *The China and global PP downturns mean CEOs should be asked tough questions*. October 2023.

Figure 7: LyondellBasell Stock Performance in Comparison With S&P 500, 2018-Present

Source: Yahoo Finance.

The company has lagged the stock market for most of the last five years. The company faces macroeconomic factors that have created uncertainty about its viability as an investment. Costs are tied to the erratic performance of the energy markets, and demand for its products is not strong. The company's market fundamentals appear sound, but the weak stock market performance suggests an underlying skittishness that IEEFA attributes to the broader challenges stemming from the energy transition.

Sustainability

LYB's sustainability goals focus on three areas: Ending plastic waste, addressing climate change and advancing a thriving society.²⁷¹

The company seeks to produce and market 2 million tons of recycled and renewable-based polymers by 2030 (which equals roughly 20% of the 2022 global sales of polyethylene and polypropylene). The company's climate goals establish a 42% reduction of Scope 1 and 2 emissions by 2030, using a 2020 baseline. The company anticipates that its 2 million tons of recycling will help reduce Scope 3 emissions by 30% by 2030.²⁷² The company estimates that 1 million metric tons in reductions of Scope 3 emissions will result from its circularity initiatives and reduce plastics waste at landfills and ocean dumping.²⁷³

²⁷¹ LYB. [Unlocking Possibilities: 2022 Sustainability Report](#), April 2023 (hereafter [LYB Sustainability 2022](#)), pp. 4-5. Unless otherwise noted, sustainability information on the company is taken from LYB Sustainability 2022.

²⁷² *Ibid.*, p. 5.

²⁷³ [LyondellBasell 2022 Form 10-K](#), p. 13.

LYB's sustainability agenda includes:

- Closing its Houston refinery by December 2025;²⁷⁴ and
- Phasing out coal in Germany, which is expected to yield Scope 1 reductions.²⁷⁵
- The 2030 operational goals are part of the company's larger goal to achieve net-zero emissions by 2050 and include at least 50% renewable energy by 2030 using purchase power agreements.²⁷⁶

As part of its sustainability strategy, the company has:

- Launched its Circulen family of recycled (through chemical and mechanical recycling) and renewable-based polymers in 2021. Circulen allows brand owners to meet their sustainability goals using recycled products in production.
- Achieved production, beginning in 2021, of polypropylene and polyethylene through thermal conversion of plastic waste to create ethylene and propylene feedstock.²⁷⁷
- Started an industrial pilot plant based on a new technology that produces monomers reused in polymer production. The plant is in Ferrara, Italy. The plant has the capacity to process about five to 10 kilograms of plastic waste per hour.²⁷⁸

LYB's sustainability program overall rests on several risky assumptions unlikely to materialize. For example, its Sustainability report projects how each sustainability area will contribute to its Scope 1 and 2 GHG emissions goals by 2030. Almost 40 percent of the initiatives rely upon CCS, divestments and unspecified low-carbon initiatives.²⁷⁹ These assumptions are weak (see discussion on CCS in Dow subsection above) and the unspecified nature of the other steps are unsupported. As discussed, CCS and divestment are unlikely to produce the kind of results projected by the company. A deeper discussion of the issues involved with both strategies would make it clear how they expect the operational investments will meet their goals.

In addition to the climate risks, the company has also faced several challenges related to air pollution in France, Iowa and Texas.^{280,281}

²⁷⁴ LYB. [LyondellBasell announces delay in refining business exit](#). May 31, 2023. Also see: Reuters. [LyondellBasell delays Houston oil refining business to 2025](#). May 31, 2023.

²⁷⁵ [LyondellBasell Industries N.V. —Climate Change 2023](#), p. 11. Also see: [LYB Sustainability 2022](#), p. 30.

²⁷⁶ [LYB Sustainability 2022](#), p. 32.

²⁷⁷ LYB. [LyondellBasell starts commercial production of polymers using raw material derived from plastic waste](#). May 6, 2021. Also see: Recycling Today. [LyondellBasell to produce virgin-like polymers using plastic scrap](#). May 6, 2021.

²⁷⁸ LYB. [LyondellBasell successfully starts up new pilot molecular recycling facility](#). September 8, 2020. Also see [LYB Sustainability 2022](#), p. 19 (project expanded in 2021).

²⁷⁹ [LYB Sustainability 2022](#), p. 29.

²⁸⁰ Public Health Watch. [In a small French town where Houston-based LyondellBasell is a fixture, residents complain of unending pollution](#). September 5, 2023.

²⁸¹ U.S. Department of Justice. [LyondellBasell companies agree reduce harmful air pollution at six U.S. chemical plants](#). October 14, 2021.

One analyst has urged that the CEOs of all companies manufacturing polypropylene should face tough questions about excess capacity and lower-than-expected import demand from China.²⁸² LyondellBasel is one of the world's largest polypropylene producers.²⁸³ The underlying market trends and conditions spell slow growth, oversupply and regulatory moves that do not favor fossil-based products. The likelihood of losses is high.

It is unclear how the company will meet its climate pledge, given its current portfolio and priorities for investment.

Westlake Corporation (WLK)

Westlake Corporation is based in Houston, Texas, and produces ethylene, polyethylene plastics, polyvinyl chloride (PVC) plastics, styrene, caustic soda and building supplies. The company operates through two main segments: 1) Performance and Essential Materials, which houses the ethylene (oxide and glycol), polyethylene (LDPE and LLDPE), chlor alkali, polyvinylchloride, styrene and epoxy product lines; and 2) Housing Infrastructure Products, which includes an array of commercial and residential building products, PVC pipes and fittings, vinyl and other building products.²⁸⁴ The company's principal place of business is the United States, but it has facilities in Germany, South Korea, Spain, Netherlands, China, Taiwan and Vietnam.²⁸⁵

Westlake produces much of its own feedstock—ethylene—through low-cost ethane purchased in the United States. The company acquires benzene and hexene for polyethylene and styrene manufacturing through contracts, with rail and pipeline transport. The end uses of the company's product span a wide cross-section of the economy: Electrification, automotive innovation, health care, clean and fresh water and energy-efficient durable housing.²⁸⁶

The company changed its name in 2022, removing the word "Chemical" to reflect its growing emphasis on building products.²⁸⁷ Given the growing awareness that chemical production has become an activity with increasing amounts of regulatory and political risk,²⁸⁸ the name change may be beneficial from a public relations perspective.

The company's 2022 revenues were \$15.8 billion.²⁸⁹ The company produced 43.4 billion pounds of product.²⁹⁰

²⁸² ICIS. [The China and Global PP downturns mean CEOs should be asked some tough questions](#). October 2023.

²⁸³ Verified Market Research.com, [Top Polypropylene compound manufacturers](#), June 2023.

²⁸⁴ Westlake. [2022 Form 10-K](#). February 22, 2023 (hereafter, [Westlake 2022 Form 10-K](#)), pp. 1-2 and 28. Unless otherwise noted all background information on Westlake can be found in this document.

²⁸⁵ Westlake. [Environmental Social and Governance Report 2022](#). October 31, 2023 (hereafter, [Westlake 2022 ESG Report](#)), p. 7.

²⁸⁶ [Westlake 2022 Form 10-K](#), pp. 2, 6 and 65.

²⁸⁷ Westlake.com, [Westlake Chemical Corporation to Change Name to Westlake Corporation](#), February 18, 2022.

²⁸⁸ For example, see: S&P Global Ratings. [Ratings On Formosa Plastics Corp. And Three Associated Companies Affirmed At 'BBB+' On Low Debt Leverage; Outlook Stable](#). October 7, 2021.

²⁸⁹ [Westlake 2022 Form 10-K](#), p. 38.

²⁹⁰ [Ibid.](#), p. 2.

Westlake's revenue for 2022 broken out by business segment includes net sales of its Performance Materials (PVC, polyethylene and epoxy) at \$7 billion; Essential Materials (caustic soda, styrene and related derivatives) at \$4 billion; and Housing and Infrastructure products (pipe, fittings, roofs, windows, PC+VC compounds and external sale for non-residential pipes and compounds) at \$4.8 billion.²⁹¹

The company's 2022 capex was \$1.1 billion, and long-term debt (net) amounts to \$4.9 billion.²⁹² The company has a BBB rating at Fitch and Standard and Poor's, and Baa2 at Moody's.²⁹³

Figure 8: Westlake Stock Performance in Comparison With S&P 500, 2018-Present



Source: Yahoo Finance.

The company's stock performance over the last five years has largely lagged the market. Its recent stock performance, however, reflects overall improvement in the housing industry,²⁹⁴ related to the recovery after the Covid-19 pandemic and the recent rebound from the early 2022 drop in housing.

Many larger companies with petrochemical interests—such as ExxonMobil, TotalEnergies, Eni and Repsol—have integrated operations with large oil and gas reserves, exploration and production portfolios. Those companies, as noted in this report, have consistently underperformed the stock market since they are exposed to the broad risks discussed throughout this paper.

Westlake's business model, which focuses on controlling costs through procurement policies, has eliminated the company's relative exposure to the growing volatility of the fossil fuel extraction.

²⁹¹ *Ibid.*, p. 38.

²⁹² *Ibid.*, pp. 45 and 60.

²⁹³ Fitch. [Fitch revises Westlake Corporation's outlook to stable: affirms IDR at 'BBB'](#). December 11, 2023. Also see: [S&P Global Ratings affirms Westlake Corporation at 'BBB' \(local currency credit rating\): outlook positive](#). October 19, 2023. Also see: Yahoo Finance. [Rating Action: Moody's affirms Westlake's Baa2 ratings; revises outlook to stable from negative](#). March 2, 2021.

²⁹⁴ St. Louis Federal Reserve Bank. [Total Construction Spending: Residential in the United States, 2002-Present](#). Accessed January 4, 2024.

Overall, the company is well positioned to finance the needed investments to step up its transition readiness.

Sustainability

Westlake, like many in the chemicals industry, faces challenges related to greenhouse gas emissions and circularity. It relies on strategies such as incorporating lower-carbon, bio-based or renewable feedstocks and post-consumer and post-industrial recycled content into the products it sells, as well as increasing its use of energy from renewable power sources to reduce its carbon footprint. In particular, it reports that the CO₂ savings of its GreenVin bio-attributed PVC is about 90% compared to its conventionally produced PVC, based on a cradle-to-gate product carbon footprint analysis. The company announced in its 2022 ESG report that it has achieved an 18% reduction in Scope 1 and 2 emissions from a 2016 baseline, and that it targets reaching a 20% reduction by 2030. The company is pledging to commit capital to proven and emerging technologies.²⁹⁵

To further cut emissions to reach its net-zero goal by 2050, the company is interested in investing in several technologies it would deem “economically feasible,” including the following “possible opportunities”:

- Increase electrification to generate heat in units currently heated by fossil fuel.
- Further increase the use of hydrogen, which Westlake terms “a less carbon-intensive fuel gas.” Westlake notes hydrogen is a byproduct of some of its manufacturing processes—the company both uses and sells it. Westlake hopes to reduce its own emissions by increasing use of hydrogen as an internal fuel source.
- Use solar, wind and other lower-carbon electricity options.

Two items on this list, carbon capture and hydrogen, present significant issues. Carbon capture, as discussed in the Dow subsection of this report, has an unsatisfactory performance record to date. Also, hydrogen’s climate impacts must be acknowledged and scrutinized.²⁹⁶

The company relies principally on renewable energy in the production process to reduce the carbon footprint of many of its products. It is also investing in recycling to reduce pollution and facilitate mechanical recycling outtake development.²⁹⁷ Like ExxonMobil and many of the other companies profiled in this report, Westlake is a member of the Alliance to End Plastic Waste.

Westlake’s sustainability profile could be enhanced considerably with a more complete articulation of the ways that its sustainable product claims comply with or exceed standards regarding fossil fuel

²⁹⁵ Westlake. [2022 Environment, Social and Governance Report](#). October 31, 2023 (Hereafter, [Westlake 2022 ESG Report](#)), p. 72.

Also see: Westlake. [UBS Chemical Conference](#). September 6, 2023, p. 16.

²⁹⁶ See: [IEEFA 2023 Blue Hydrogen Analysis of Impacts](#), p. 23-25.

²⁹⁷ Westlake. [Westlake BMO Chemical Conference](#). June 2022.

content, energy content, absolute and relative emissions, and other metrics related to the EU's taxonomy and other industry standards.

Similarly, the company's 2022 ESG report promises an allocation of capital that supports its sustainability roadmap, but does not specify the amount.²⁹⁸ Again, greater specification regarding the type and size of investments in company processes, acquisitions or other methods designed to achieve sustainability goals would be an improvement.

Westlake has offered a series of promises regarding a sustainability roadmap. Because the company has a very limited portfolio of successful initiatives, it should disclose greater detail, timeframes and budget allocations as well as impact analysis. Absent more details, the plan is weak.

III. Commodity Risk Analysis

In a recent blog post, ICIS Asian commodity analyst John Richardson provides an insight that cuts to the financial core of the future of single-use plastics: "Global ethylene operating rates are forecast to average 80% in 2022-2030 and propylene 72%. This would compare with ethylene at 88% in 2000-2021 and propylene at 81%."²⁹⁹

A change of this magnitude alters the economics of plastic production, with the revenue projections of existing and new plants being materially reduced.³⁰⁰ The lower capacity factor sends market signals that there is lower demand. It represents a market that is not conducive to investment in new cracker facilities.

Citing the long-term decline in Chinese economic growth and regulatory realignment that is occurring particularly in Europe, the ICIS analysis strongly suggests that traditional economic patterns in the plastics industry are undergoing a transformation.³⁰¹

Each of the three commodities discussed below are part of the basic chemical components of the largest segment of ocean polluting and waste-producing plastics known commonly as single-use plastics. These are the commodities targeted by environmentalists most often because they are a major contributor to pollution and are brutally symbolic of a throwaway culture that fuels wasteful consumption. The flip side of the industry, however, was on display during the pandemic, when single-use plastic medical supplies—face masks, shields, sheets, gowns, and packaging—were

²⁹⁸ [Westlake 2022 ESG Report](#), p. 70.

²⁹⁹ ICIS. [A fundamental shift in thinking on petrochemical plant closures](#). November 2023 (hereafter, [ISIS analysis regarding petrochemical plant closures](#)).

³⁰⁰ U.S. Department of Energy. [Ethane: Market Issues and Opportunities](#). September 2022. For a discussion of the relationship between capacity factors, revenue and plant profitability see: IEEFA, [IEEFA report: Financial risks loom for Shell's Pennsylvania petrochemicals complex](#), June 2020. For a discussion of revenues, capacity factors and profitability in the European context see: IEEFA, [IEEFA Europe: Proposed INEOS cracker plant would oversupply ethylene market](#), December 2021.

³⁰¹ See: [ISIS analysis regarding petrochemical plant closures](#).

lifesaving tools. The public became aware that the availability of such products, often in short supply during the pandemic, was a matter of life and death.

The traditional supply and demand cycles that have governed each commodity market, as shown in the analysis below, face changes from the growth of the sustainability sector. Although policy interventions to curb plastics are growing, the industry response through innovation also is robust.³⁰² The norm is that periods of oversupply are followed by periods of slack capacity growth, tightening supply, rising prices and improved margins. This convergence sends market signals for producers to increase capacity again. The move toward sustainability is spurring a series of innovations designed to limit the use of fossil fuels in plastics and chemicals. Through science and technology, new products are designed. This process, taken cumulatively, is placing downward pressure on demand for fossil fuel as a power source and feedstock. The disruption to the traditional market is under way. Now, periods of oversupply will either take longer to be absorbed or result in ultimate value impairments.³⁰³

The companies outlined above are all participants in these markets. Their climate solutions look to reduce or eliminate the feedstock necessary to make plastics—replacing the components of the products to allow for the production of “green” plastics. Other initiatives look to reduce the amount of fossil fuels consumed as energy to reduce emissions in both intermediate and final steps in the value chain. Still other proposals seek to recycle products, cutting down on future demand for ethylene, polypropylene and polyethylene.

The investment decisions to move forward with facilities that produce greater amounts of ethylene and polyethylene based on traditional marketplace models are increasingly risky. The rate of economic growth, particularly in China; declining demand from policy interventions; and consumer behavior are factors that point to longer periods of oversupply. Although it is hard to predict which new ethylene cracker plant is the source of oversupply, Richardson points out the other impact: Lower capacity factors for all cracker facilities, and declining profitability as a result.³⁰⁴

Standard and Poor’s has offered an important warning to investors and companies looking to expand petrochemical capacity. The ratings agency, in an opinion related to a petrochemical hub supported by Formosa, said that the hub was unlikely to be approved because of pressure from regulators concerned with carbon emissions and responding to “protests from local environmental groups.”³⁰⁵

Its opinion did not limit the analysis to the individual petrochemical hub but extended the discussion to a global perspective on petrochemical hub investment generally, stating:

³⁰² For example, *Plastic News*, a trade publication established under the Crain’s Communication masthead in 1989, decided in 2020 to publish a companion, *Sustainable Plastics*.

³⁰³ Some analysts are now looking at 13.4% CAGR over the next several years: See: Globenewswire. [Global Sustainable Plastic Market Size to Reach USD 1,128.53 Billion in 2032](#). August 23, 2023.

³⁰⁴ See: ICIS. [A fundamental shift in thinking on petrochemical plant closures](#). November 2023.

³⁰⁵ S&P Global. [Ratings on Formosa Plastics Corporations](#). October 7, 2021.

“We believe the four companies will find it increasingly challenging to pursue mega expansion projects in the commodity chemical field because of surging global pressure to reduce carbon emissions as well as chemical and plastic pollution worldwide, just as Formosa Petrochemical has already experienced in the U.S.”³⁰⁶

Standard and Poor’s strongly suggested that Formosa’s credit rating would decline if it moved forward with the project and that its credit rating would improve if it sought out investments that supported the development of electric cars, for example. The credit rating agency concluded Formosa benefitted from the delay in the Louisiana project in the short term, as it did not tie up cash or take on more debt, stating:

“Strong cash flow, **the prolonged suspension of its U.S.-based chemical complex project**, and faster reduction in the companies’ guarantee on its Vietnam steel mill will **enable the group to lower its debt** by more than we previously assumed for the next two years.”³⁰⁷

The agency noted cash that could accumulate over the delay period would improve the company’s position should it ever go forward with any unspecified facility expansion in the United States, stating, “This will increase their financial buffer against industry volatility and the likely resumption of its expansion plans in the U.S.”³⁰⁸

Standard and Poor’s points out that the company would borrow less and therefore carry less debt into the future “if the Louisiana project does not materialize.”³⁰⁹ The credit opinion then states that further delay, if not cancellation, “gives the four companies more time to strengthen the financial buffer for the ratings.” Further to the point, although cancellation of the project would eliminate a potential opportunity to diversify the company’s assets and markets, the credit opinion observed that cancellation “could prevent deterioration in the group’s debt leverage during what would have been the construction period.”³¹⁰

All things considered, Standard and Poor’s concludes:

“The four companies are likely to shift their focus to specialty products, particularly electronic materials for emerging applications such as electric vehicles. This could help smooth their capex cycles without sharp swings in their free operating cash flow and debt levels.”

This October 2021 warning came after Moody’s offered a very similar view on the risks of fossil fuel infrastructure in September 2020.³¹¹

³⁰⁶ *Ibid.*

³⁰⁷ *Ibid.*, p. 2.

³⁰⁸ *Ibid.*

³⁰⁹ *Ibid.*

³¹⁰ *Ibid.*, p. 3.

³¹¹ Moody’s. Shifting Environmental Agendas. September 2020. (Proprietary)

Ethylene

Ethylene is the feedstock for the plastics segment of the petrochemical industry. The dominant use of ethylene (68%) is to produce plastic resins (HDPE and LLDPE). These plastics make up the dominant portions of the food packaging and medical plastics. The importance of ethylene and single-use plastics was demonstrated during the pandemic when global Gross Domestic Product fell 3.4% while ethylene demand jumped by 3.5%.³¹²

Most of ethylene feedstock is derived from naphtha and ethane, which are fossil fuel-based raw materials. The top ethylene suppliers are in China, North America, the Middle East and western Europe. Specifically, the top 10 producers of ethylene in the world are Reliance Industries, China Petroleum and Chemical, ExxonMobil, Shell, LyondellBasell, SABIC, Borealis AG, Braskem SA, Chevron Phillips Chemical and INEOS Group AG.³¹³ Some of the internal composition of market share is expected to shift as India ramps up its capacity.

The ethylene market was 172.4 mmtpa in 2022,³¹⁴ with a total production capacity of 224 mmtpa.³¹⁵ Supply typically exceeds demand, keeping industry assets at a utilization rate approaching 90%, but between 2019 and 2023 the utilization rate dropped to 82%.³¹⁶

In both a short- and long-term sense, the industry is oversupplied.³¹⁷ Despite the global glut, China is adding new cracker capacity.³¹⁸ Middle Eastern and U.S. producers are using their low-cost advantage with inexpensive natural gas reserves to participate in production.³¹⁹ They too have contributed to the oversupply.³²⁰ Europe faces rising feedstock prices as oil and gas producers are benefiting from high oil and gas prices. Imports are likely to increase.³²¹

³¹² OECD. [Global Plastics Outlook: Economic Drivers, Environmental Impacts and Policy Options: The effects of the COVID-19 pandemic on plastics use and waste](#). February 22, 2022.

³¹³ Procurement Resource. [Leading Ethylene Producers in the World](#). June 28, 2023.

³¹⁴ DataHorizon Research. [Ethylene Market by Feedstock \(Naphtha, Ethane, Propane, Butane, Others\), Application \(HDPE, LDPE, Ethylene Oxide, Ethyl Benzene, Others\), End Use \(Building and Construction, Automotive, Textiles, Packaging, Others\), by Region, Market Size, Share and Trends: Forecasts 2022-2032](#) (excerpts). November 30, 2023.

³¹⁵ GlobalData. [Ethylene Market Outlook](#) (excerpts). April 27, 2023.

³¹⁶ Wood Mackenzie. [Big Oil's opportunity for M&A in the petrochemicals shutdown](#). November 30, 2023.

³¹⁷ ICIS. [Chemical market overcapacity and weakening: A perfect storm](#). Accessed January 4, 2024.

³¹⁸ ChemAnalyst. [PetroChina Launches Construction of Massive \\$3 Billion Petrochemical Plant in Xinjiang](#). September 29, 2023.

³¹⁹ Gulf Petrochemicals & Chemicals Association (GPCA). [Harnessing opportunities in the Middle East petrochemical industry amidst global ethylene economics shift](#). September 25, 2023.

³²⁰ ICIS. [2023 Global Market Outlook](#), Accessed January 3, 2024.

³²¹ S&P Global Commodity Insights. [Commodities 2023: Europe set for greater ethylene import attention amid energy volatility](#). December 5, 2022.

Table 9: Project Pipeline for Ethylene Crackers With Start-up Dates 2025 and Beyond

Project Name	Location	Investors	Ethylene Capacity (mmtpa)	Start-up
Golden Triangle Polymers	US	CP Chem and Qatar Energy	2.08	2026
Fort Saskatchewan Path 2Zero expansion project	Canada	Dow Chemical	1.8	2027
Project One	Belgium	INEOS	1.45	2026
Ras Laffan	Qatar	Qatar Energy and CP Chem	2.1	2026
Amiral	Saudi Arabia	Saudi Aramco and Total Energies	1.65	2027
Gulei II	China	Sinopec and Saudi Aramco	1.5	2025
Shaheen	South Korea	S-Oil (a subsidiary of Saudi Aramco)	1.8	2026

Source: [ICIS](#), January 2023. Table reformatted by IEEFA.

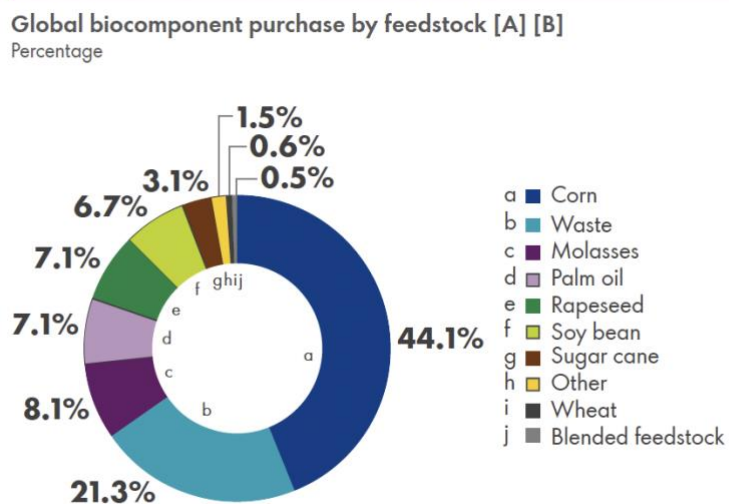
Over the long term, it is likely that the U.S. and China's capacity growth will flatten. Other countries seeking greater self-sufficiency, such as Russia and India, have plans to increase investments.^{322,323}

The industry faces a series of long-term risks that are likely to decrease annual growth rates. The principal drivers likely to reduce growth are: 1) Recycling and adoption of lower-carbon intensive products; 2) new laws and regulations reshaping the marketplace; 3) significant efficiency improvements in key industries such as automobiles that increase the viability of electric vehicles; 4) a generalized adoption of new technologies that decrease and in some cases eliminate ethylene; 5) a slowing Chinese economy and 6) the long term-changes to the market caused by the Ukraine invasion.³²⁴

³²² HSF Notes. [Russian Petrochemical Industry gets the roadmap and achieves its first milestone](#). December 29, 2020.

³²³ Oil & Gas Journal. [Indian Oil lets contract for new petrochemical expansion projects at Panipat refinery](#). July 31, 2023.

³²⁴ This factor cannot be predicted with much certainty, although it is likely that Russia's plans to expand its petrochemical assets face challenges assuming continued sanctions restrict gas supply to Europe.

Figure 9: Global Biocomponent Purchase by Feedstock³²⁵

[A] Does not include purchases by Raízen.
[B] Percentage may not add up to 100% because of rounding.

Source: Shell.

Figure 9 offers a glimpse of the way in which market competition is likely to reduce the demand for ethylene as a feedstock for chemicals and use in textiles, plastics, durable plastics and liquids/solvents. The substitution of one of these bio-based alternatives is unlikely to have a material impact on ethylene demand. However, this figure implies that venture and startup capital is likely to be invested across the board in the coming years. Some of these markets will grow and some will not, but the very likely outcome is a diminution of ethylene and other fossil fuel feedstock for petrochemical products.

Traditional market analysis suggests that the current oversupply will tighten over time due to rising GDP and rising demand for ethylene. The risks cited above, however, raise a high degree of uncertainty that future markets will perform as they have in the past. Companies looking to expand ethylene capacity face growing direct and indirect regulatory constraints and volatile margins. In places like Europe, new facilities will face significant financial stresses without some steps toward market rationalization.

As the energy transition progresses, cracker production is likely to be shaped by initiatives that reduce and/or eliminate the use of fossil fuels as feedstock; improve heat capture; and increase use of renewable energy.

³²⁵ Shell 2022 Sustainability Report, p. 34.

A. Polyethylene Markets on the Decline

The polyethylene market is dominated by HDPE, LDPE, and LLDPE. The market consumes 60% of ethylene for feedstock, producing a wide array of single-use plastics such as bags, bottles and medical supplies.

The collective market size, amounting to 110 million tons per year,³²⁶ supports worldwide production and marketing efforts by industry leaders ExxonMobil, Dow, LyondellBasell, CPC, SABIC, Reliance Industries Limited, INEOS, China National Petroleum Corporation, Ducor, Formosa, Braskem and Sinopec.³²⁷ According to ExxonMobil, plastics commodity growth (polyethylene, polypropylene) is expected to exceed GDP growth through 2025.³²⁸

B. Short Term

Producers face lower prices, soft demand and an oversupply. In the U.S., the industry faces oversupply at a time when Shell, for example, opened a large petrochemical complex in Pennsylvania in late 2022. Slower growth in China is tamping down market growth, sending all important price signals well below the amount necessary for greater investment.

C. Long Term

The long-term financial position of polyethylene was summarized by ICIS's John Richardson in an August 2023 ICIS base case analysis. He observed:

Average annual capacity exceeding demand was 10m tonnes in 2000-2022 with the average annual operating rate across the three grades at 86%. But average annual capacity exceeding demand is forecast to be 26m tonnes in 2023-2030 with the operating rate at 80%.³²⁹

The ICIS analysis reflects two critical trends. First, the analysis projects demand growth for polyethylene in China to be 3.3% in 2023-2030, rather than in the range of 6% to 8%, which the analysis notes was the consensus projection just three years ago for long-term chemicals and polymers growth. Second, ICIS sees a substantial decrease in polyethylene growth through 2030 in mature economies due to the steady integration of sustainability measures.

Most companies involved in the market are planning growth strategies shaped at least to some extent by attention to the energy transition. The pursuit of new patents across the polymer recycling landscape is robust.³³⁰ But in the field of bioplastics—a field that has the potential of replacing fossil

³²⁶ Statista. [Market volume of polyethylene worldwide from 2015 to 2022, with a forecast for 2023 to 2030](#). July 11, 2023.

³²⁷ Procurement Resource. [Leading Polyethylene Producers in the World](#). August 24, 2023.

³²⁸ ExxonMobil. [Investor Day \(Presentation\)](#). March 2022, p. 38.

³²⁹ ICIS. [Global PE capacity may have to be 23m tonnes/year lower in 2023-2030 to end the downturn](#). August 25, 2023.

³³⁰ Pradeep Shirodkar. [Preliminary Survey Plastics Recycling Patent Publications](#). Accessed January 4, 2024.

fuels—none of the top 10 polyethylene producers³³¹ were among the top companies filing international patent family (IPF) applications in the packaging, cosmetics and detergents fields as of late 2021.³³²

Polyethylene stakeholders across the value chain also face continued critiques related to the variety of pollution issues associated with single-use plastics. Nonprofit organizations such as Planet Tracker have offered credible analyses that link poor disclosure of plastics pollution risks by companies to long-term financial risks.³³³

D. Polypropylene Market

Polypropylene is a lightweight polymer that resists most chemicals and possesses a high rigidity and melting point. It has varied end uses, including medical face masks, water pipes, food packaging, automotive parts, carpets, and toys. It is used in the production of 100% polypropylene products and compounded with other thermoplastics. It competes with polyethylene and polyethylene terephthalate in many uses. Polypropylene, which is recyclable, is also competitive in the aluminum, glass, paper, cardboard and wood markets.³³⁴

Propylene is produced in three ways: 1) A core product from on-purpose technologies like propane dehydrogenation; 2) a byproduct from crude oil/gasoline refineries, and 3) as a co-product of steam crackers that primarily produce ethylene. With changes taking place that will result in greater use of natural gas in the cracking process (with less naphtha, there is less propylene byproduct), and less demand for gasoline, investment is moving into on-purpose production of propylene that relies on propane (another fossil fuel with rising demand).^{335,336,337}

Polypropylene has taken its place among leading contributors to plastics ocean pollution,³³⁸ and this status is a factor that clouds its continued market viability. Sinopec, LyondellBasell, CNPC, Saudi Aramco, Reliance Industries and ExxonMobil are the largest producers of polypropylene. The polypropylene market in 2022 was 96 million tons. The average growth rate globally has been more than 4%.

³³¹ Procurement Resources. [Largest Polyethylene Producers in the World](#). Accessed January 7, 2024.

³³² European Patent Office. [Patents for Tomorrow's Plastics](#). October 2021. p. 45.

³³³ Planet Tracker. [Exposing Plastic Risk: What plastic companies really think of plastic-related risk](#). August 2023. Also see: [Plastics News. Report urges public companies to say more on plastics risks](#). August 3, 2023. Also see: Planet Tracker. [Plastic Risk: Measuring Investors' risk in the plastic sector](#). June 2023.

³³⁴ See Omnexus. [Comprehensive guide on polypropylene \(PP\)](#). Accessed January 4, 2024.

³³⁵ For a discussion of how shale gas altered polypropylene production in the United States, see: [Plastics Engineering. How shale gas is changing propylene](#). February 20, 2013.

³³⁶ For a discussion of the declining global demand for gasoline, see IEA. [Oil 2023](#). July 24, 2023, pp. 17-21.

³³⁷ For a discussion of the growth of on-purpose propylene production see: Digital Refining, [On Purpose Propylene Production](#). February 2019.

³³⁸ Montero, *et al.* [Impact of polypropylene microplastics and chemical pollutants on European sea bass \(*Dicentrarchus labrax*\) gut microbiota and health](#). *The Science of the Total Environment*, 805:150402. January 20, 2022.

The fundamental picture of oversupply, however, confronts the industry and is likely to persist for several years unless and until this capacity is absorbed,³³⁹ but the gap between demand and capacity has been growing. Between 2000 and 2019, the gap between demand and capacity averaged 7 mmtpa, and the annual operating rate of production plants was 87%.³⁴⁰ But in 2023, the gap between demand and capacity had tripled, to 21 mmtpa, and the annual operating rate of production plants had dropped to 79%, while the projections for 2023-2025 similarly averaged 21 mmtpa in excess demand with an 80% annual operating rate.³⁴¹

In the short and medium term, the propylene market is likely to be relatively healthy, benefiting from the higher capacity rates. In the longer term, however, the ability of the industry to grow is likely to be slowed by an increase in the number of countries and local jurisdictions regulating ocean dumping.

Several options are being pursued (and some mandated) to reduce plastics pollution.³⁴² The restrictions placed on plastics pollution increase the possibility that growth rates of polypropylene will not follow past patterns. The risk here is that demand for polypropylene will decline, sending prices lower and making margin spreads uninvestable.³⁴³ This is likely to occur while the industry also faces an upper limit in the propane industry supply. As noted above, the industry has lost two production processes upon which it relied to provide supply of propylene, due to changes in marketplace demand for gasoline.³⁴⁴ Demand for propane is rising rapidly and is expected to continue to increase. If the supply of propane decreases, this will place an upward pressure on propylene costs, likely resulting in higher prices for plastics and a stronger interest in finding alternatives.

The complex dynamics that affect ethylene, polypropylene and polyethylene markets have broad implications for the basic raw materials that support single-use plastics growth. The growth rates have been historically high, resulting in substantial quantities of single-use plastics produced and then disposed of into the world's waterways. The underlying production dynamics have been positive, as plastics producers have a multiplicity of raw product options. What is developing, however, is a series of structural chokepoints that over time is resulting in positive dynamics being reversed. The market outlook for virgin plastics is turning negative.

³³⁹ ICIS. [New capacities and weak demand to cause global supply glut of PE/PP in 2023](#). Accessed January 3, 2024.

³⁴⁰ ISIS. [Global PP crisis: Why capacity may need to be 18m tonnes/year lower in 2024-2030](#). August 1, 2023,

³⁴¹ ICIS. [A flood of PP no matter what the 2023-2025 demand growth](#). February 8, 2023.

³⁴² ICIS. [Why PP producers need to shift from maximising volumes to adding value through sustainability](#). May 9, 2023.

³⁴³ John Richardson. [LinkedIn Post](#). September 2023.

³⁴⁴ ICIS. [China will create petrochemical deflation with the only question being how](#). May 16, 2021.

Conclusion

The largest producers of the components and end products from single use plastic products face significant challenges. They are the subject of policy campaigns that seek to end, or substantially decrease, the amount of single use plastics dumped in the world's waterways. IEEFA's analysis finds that most of the companies have announced plans for new products, business lines and production processes as responses to environmental and climate policy concerns. Nevertheless, the report also reveals plans for a substantial buildout of new single use plastics facilities in the coming years. The companies' plans use shareholder dollars in a manner that runs counter to the policy-driven programs that have been announced.

The new investments in single use plastics face market challenges that raise serious issues about their long-term profitability. The three credit rating agencies have issued warnings—warnings that are likely to intensify. The climate-driven need to decrease the use of fossil fuels in plastics production is a factor that should spur questions about corporate plans for polyethylene expansion. New policy initiatives around the world are reducing demand for single use plastics and the fossil fuel infrastructure that has supported its growth. The industry can no longer rely on historical growth patterns to absorb the current oversupply conditions.

At the same time, market forces are driving the creation of increasingly low-cost sustainable technologies that are shifting market share. The shifting market share changes the revenue growth patterns of these companies.

Most of the companies involved in the fossil fuel and petrochemical area are market laggards, which suggests a challenging financial outlook to match the risks from ongoing disposal of single use plastic waste. This report offers an outline of the questions that CEOs, boards of directors and stakeholders need to answer about the future of companies now engaged as the single largest producers of ocean pollution facing the world.

Appendix I: Credit Ratings of Companies Identified in This Report

Company	S&P	Moody's	Fitch
LyondellBasell	BBB	Baa2	BBB
Westlake	BBB	WR	BBB
Dow	BBB	Baa1	BBB+
Repsol	BBB+	Baa1	BBB+
Eni	A-	Baa1	A-
Chevron Phillips Chemical	A-	A2	NA
Total	A+	A1	AA
Shell	A+	Aa2	AA-
ExxonMobil	AA-	Aa2	WD

Source: Compiled by IEEFA.

Appendix II: IEEFA LNG Markets Analytics and Data Reports

The Institute for Energy Economics and Financial Analysis provides broad market analysis of the fossil fuel and sustainable sectors and has devoted considerable resources to the analysis of the status of LNG markets.

- IEEFA. [Europe's LNG capacity buildout outpaces demand](#). October 31, 2023.
- IEEFA. [Calcasieu Pass LNG: Unreliable operations result in excessive pollution and profits](#). October 25, 2023.
- IEEFA. [San Miguel Global Power: Fossil fuel-oriented growth strategy raises financial red flags](#). September 18, 2023.
- IEEFA. [Seesawing gas market dominated by fear and volatility](#). September 6, 2023.
- IEEFA. [Is Italy unknowingly importing Russian LNG via Spain and other routes?](#) July 13, 2023.
- IEEFA. [Building LNG terminal close to rocket launches could prove costly](#). June 20, 2023.
- IEEFA. [Rio Grande LNG project could raise U.S. gas prices—and add to a looming global glut](#). June 15, 2023.
- IEEFA. [LNG exports may spell trouble on horizon for U.S. consumers](#). April 24, 2023.
- IEEFA. [Asia's LNG demand continues to slide in first quarter](#). April 17, 2023.
- IEEFA. [Contracting debacles underscore long-term LNG risks in the Philippines](#). April 11, 2023.
- IEEFA. [IEEFA comments on Mexico Pacific Limited application to expand LNG operations](#). March 29, 2023.
- IEEFA. [Over half of Europe's LNG infrastructure assets could be left unused by 2030](#). March 21, 2023.
- IEEFA. [IEEFA FERC comments on LNG projects](#). March 17, 2023.
- IEEFA. [Global LNG Outlook 2023-27](#). February 15, 2023.
- IEEFA. [IEEFA: Turmoil in global LNG markets is curbing long-term demand growth](#). February 15, 2023.
- IEEFA. [IEEFA Comments: Environmental assessment for proposed Louisiana LNG project](#). February 6, 2023.
- IEEFA. [British Columbia LNG project costs rising again](#). February 1, 2023.
- IEEFA. [Asia's lower LNG demand in 2022 highlights challenges for industry growth](#). January 11, 2023.
- IEEFA. [As Europe tries to cut Russian ties, dependence on imported LNG deepens](#). January 10, 2023.

About IEEFA

The Institute for Energy Economics and Financial Analysis (IEEFA) examines issues related to energy markets, trends and policies. The Institute's mission is to accelerate the transition to a diverse, sustainable and profitable energy economy. www.ieefa.org

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