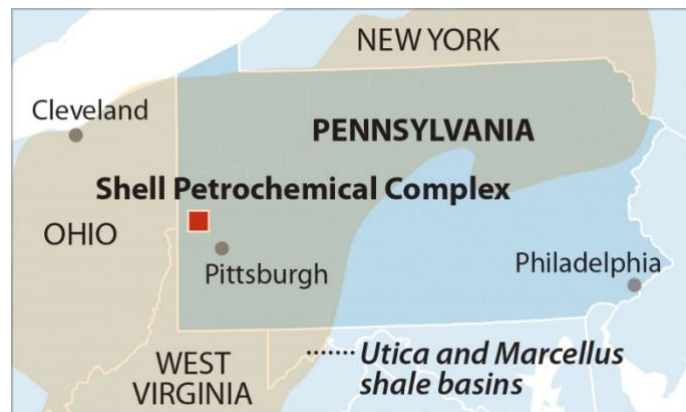


Shell's Pennsylvania Petrochemical Complex: Financial Risks and a Weak Outlook

Executive Summary

Royal Dutch Shell owes a more complete explanation to shareholders and the people of Pennsylvania of how it is managing risk. Shell remains optimistic regarding the prospects for its Pennsylvania Petrochemical Complex in Beaver County, Penn. The complex, which is expected to open in 2021 or 2022, is part of a larger planned buildout of plastics capacity in the Ohio River Valley and the U.S. IEEFA concludes that the current risk profile indicates the complex will open to market conditions that are more challenging than when the project was planned. The complex is likely to be less profitable than expected and face an extended period of financial distress.



In response to concerns raised about the viability of the larger plan and another similar petrochemical complex planned for Ohio, Shell has stated it takes a long-term view and that current risks should not affect the plans for its Pennsylvania facility. The risks outlined in this paper, however, predate the coronavirus pandemic. They have been merely exacerbated by the business disruption stemming from the pandemic. These risks will remain major factors that Shell must address beyond the short-term financial impacts from the pandemic.

These risks include the following:

- The revenue from the complex will be substantially lower than anticipated because the price of plastics has declined precipitously over the past several years. The Shell complex is designed to manufacture and sell plastic resin pellets. When the project was being planned circa 2010-2012, the price of plastic resin pellets was approximately \$1 per pound. Today, according to conservative estimates, the price is 60 cents per pound or lower—and some indexes are reporting prices in the 40 cents-per-pound range. Futures prices through 2021 are in the middle 20 cents-per-pound range.
- The U.S. plastics buildout has oversupplied the market. The glut has placed downward pressure on prices. Analysts now see this oversupply as placing

pressure on some companies to cancel projects and others to rethink profit expectations.

- Shell has a presence in the U.S. petrochemical market but is a new entrant in the plastic resins space. It will enter the market amidst a plastics price war among formidable corporations with existing client bases that are reducing prices to maintain their position in a constricted market. This factor will pose further price and revenue risks to Shell's profitability for the first few years of operations.
- The Shell complex relies on low ethane and natural gas prices as critical cost inputs to its manufacturing process and financial bottom line. It is expected that low natural gas prices will continue, but the market supplying ethane, the low-cost feedstock, is unsustainable. The outlook for shale gas production is one of financial stress and bankruptcies. Shell's petrochemical project is dependent on these unstable partners. It also may have to absorb additional unplanned outlays to protect its low-cost feedstock. The recent collapse of oil prices also poses risks to ethane's cost advantage as low-cost, naphtha-based plastics present a competitive challenge.
- Although Shell recently told *Inside Climate News* that the industry-wide downturn should have no impact on the Pennsylvania complex, troubling economic growth forecasts predate the coronavirus and recent crash in oil prices.¹ Plastic sales have generally been robust when annual GDP growth has exceeded 3% globally and 2% in the U.S. At the time the decision was made in 2016, Shell projected a comfortable scenario of U.S. domestic GDP rising at 2.4% and plastics demand in the 3% to 4% range. Slower long-term economic growth forecasts, however, don't bode well for Shell's plastics market. Those projections placed U.S. GDP growth below 2% annually for the foreseeable future, making it unlikely that Shell would see an expected 3% to 4% growth in plastics sales. The projections occurred before the coronavirus and recent crash in oil prices. Recent estimates of GDP since the pandemic suggest that stability may return in 2022, but the degree to which the plastics market will rebound to pre-disruption conditions is uncertain and even then, the outlook would still need to improve if conditions were to meet Shell's expectations.
- Over the long-term, Shell expects demand for virgin plastics will rise. Plastics demand is likely to rise, but the demand for virgin plastics will

**The price of plastics
has declined
precipitously over
the past several years.**

¹ Inside Climate News. [Market Headwinds Buffet Appalachia's Future as a Center for Petrochemicals](#). March 21, 2020.

flatten or decline in favor of recycled products. Policy-driven bans on single-use plastic products also present a risk to demand growth.

The profitability of the complex is weakened not by one or two negative events, but by a cumulative set of missed revenue and profit targets, unpredictable costs, lost market share, diminished growth and increased competition. These risks are analytically distinct, but taken together, they pose significant red flags that the complex will not be as profitable as originally planned. Recent analyst warnings, credit concerns and poor stock performance provide the 'all-things-considered' judgments that summarize the negative impacts of this combination of risks. The financial and managerial problems described in this paper—and already experienced by Sasol at a similar complex in Lake Charles, LA—underscore the fact that the complex is unlikely to be as profitable as originally thought.

Methodological Considerations:

The research for this paper would have been enhanced if IHS Markit, Shale Crescent USA, professors at Robert Morris University and Shell had allowed two studies related to the Shell Petrochemical Plant in Beaver County, Penn., to be publicly released.

One study—entitled *Benefits, Risks, and Estimated Project Cash Flows: Ethylene Project Located in the Shale Crescent USA versus the US Gulf Coast*—was commissioned by Shale Crescent USA and prepared by IHS Markit. Although the report has been cited widely by government, corporate, business associations and media, only the executive summary has been publicly released.²

IHS Markit withheld the full March 2018 report from IEEFA on the grounds that it only released the full study to entities with a commercial interest.³

The IHS Markit executive summary identifies the construction cost for the 'ethylene/plastics' units at \$3 billion. As is demonstrated throughout this report, however, an integrated 'ethylene/plastics' complex, in the current market, can cost more than \$10 billion. In fact, in May 2018, IHS Markit posted on its website that the Shell Petrochemical Complex is likely to cost \$10 billion.⁴

**The IHS Markit/Shale
Crescent profitability
measures may
be misleading.**

The IHS Markit/Shale Crescent USA executive summary identifies various profitability measures, but given that the full report has never been released to the public, these measures may also be misleading. The difference between a \$3 billion

² Shale Crescent USA. [Executive Summary](#). March 2018.

³ Email confirmation of this rationale for the failure to supply the full report to IEEFA was sent by Anthony Palmer of IHS Markit on March 16, 2020.

⁴ IHS Markit. [Petrochemical Cluster a Bright Future for the Tristate Region](#). May 2018.

capital expenditure and a \$10 billion capital expenditure, for example, has significant implications for the profit estimates in the report.

ICIS, a leading petrochemical industry analyst, recently warned that an oversupply of capacity threatens new cracker plant viability, including the Shell complex.^{5 6}

A second report, commissioned and funded by Shell and prepared by professors at Robert Morris University in December 2014, reportedly put the cost of plant construction at \$6 billion.⁷ Shell has never confirmed the estimate.

The company has decided not to disclose basic information about its project.

(The company has told IEEFA that the report is not “externally available.”)

The \$6 billion estimate, however, has been cited by numerous independent media sources since 2014.^{8 9 10 11} The figure, quoted in press accounts in August 2019 when President Trump attended an event in Beaver County to celebrate the petrochemical complex, reportedly was supported by Shell management.^{12 13} It was also cited by Pennsylvania Gov. Tom Wolf, who later agreed to a generous tax credit package for Shell, on his November 2016 visit to the plant.¹⁴

Only the *Beaver County Times* has pointed out that this \$6 billion figure was never confirmed by Shell.¹⁵

The company has clearly decided not to disclose basic information about its project—not even how much the plant will cost. In contrast, other similarly situated cracker projects have reported costs on an ongoing basis to their shareholders (See:

⁵ ICIS. [Global chemicals must prepare for extended economic downturn lower-for-longer oil](#). March 31, 2020.

⁶ Kallanish Energy. [Market conditions threatens U.S. petchem projects](#). March 25, 2020.

⁷ Pittsburgh Quarterly. [What Will the Shell Cracker Bring with It?](#) July 21, 2017. Also: (Beaver County, Penn.) TimesOnline. [Shell CEO: Cracker plant project ahead of schedule, within budget](#). September 25, 2019. The report allegedly uses IMPLAN, an economic development software program that is commonly used in economic development planning to estimate jobs, taxes and economic impacts of large development investments. [IMPLAN website](#).

⁸ Reuters.com. [Trump promises more big energy projects at Pennsylvania plant](#). August 13, 2019.

⁹ Pittsburgh Post-Gazette. [Shell cracker is a harbinger of things to come, drawing in President Trump and protesters](#). August 23, 2019.

¹⁰ Pittsburgh Business Journal. [Shell's workforce, construction drastically cut at Beaver County site](#). March 25, 2020.

¹¹ Inside Climate News. [Plastics: The New Coal in Appalachia?](#) February 25, 2019.

¹² Pennsylvania Capital-Star. [President Trump is visiting Pennsylvania's cracker plant. Here's what you need to know about the project](#). August 13, 2019.

¹³ Time.com. [Shell Union Workers Had to Choose Between Attending President Trump's Speech or Losing Pay: Reports](#). August 18, 2019.

¹⁴ Pennsylvania Department of Community and Economic Development. [Governor Wolf Tours Shell Plant Site in Beaver County, Commends Company's Continued Progress and Job Creation](#). November 14, 2016.

¹⁵ (Beaver County, Penn.) TimesOnline, [Shell CEO: Cracker plant project ahead of schedule, within budget](#), September 25, 2019.

Appendix 1: Sasol and Lake Charles Chemical Program). Given that the company has sought and obtained abundant support from the State of Pennsylvania and host communities, its lack of transparency is disturbing.

Despite a lack of access to these key studies, the findings of this report are supported by Shell's limited disclosures, and by those of its contractors and project proponents. The report also relies upon independent market analysis, government documents, and Shell's formal filings with State of Pennsylvania and local governments. Its conclusions raise serious questions about the viability of Shell's Pennsylvania Petrochemical Complex.

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Background

Project Description: Petrochemical Complex

Royal Dutch Shell ("Shell") is building the Shell Chemical Appalachia Petrochemical Complex ("Petrochemical Complex") in the Potter Township of Beaver County, in the State of Pennsylvania. Shell's subsidiary company for the project is Shell Chemical Appalachia, LLC.¹⁶

The complex is an integrated ethane/ethylene cracker and plastic pellet manufacturing plant.

The complex is slated to produce 1.6 million metric tons per annum ("MTPA") of polyethylene plastic resin pellets. An estimated 1.1 million MTPA will be Lower Linear Density Polyethylene (LLDPE) and 500,000 MTPA will be High-Density Polyethylene (HDPE).¹⁷

The complex will utilize 3.9 million barrels of ethane per year to produce 1.7 million MTPA of ethylene as the manufacturing feedstock for the plastic pellets.¹⁸ The ethane will be secured from natural gas liquids (NGLs) produced principally from the Marcellus and Utica shale basins.

**Ethane will come
from NGLs principally
from the Marcellus and
Utica shale basins.**

The complex will house seven ethane cracker units, one HDPE and two LLDPE manufacturing units, a natural gas-fired combustion turbine, four emergency diesel generators, multiple fuel and storage tanks, multiple flaring units and an incinerator.¹⁹

The plastic pellets will be sold to companies that typically produce plastic bags, film, food packaging, diapers, toys, crates and bottles. It is anticipated that most of the pellets will be sold within the Ohio River Valley Petrochemical business cluster, an

¹⁶ Shell. [2019 Form 20 F](#). March 14, 2019.

¹⁷ State of Pennsylvania, Department of Environmental Protection. [Plan Approval](#), December 30, 2016, p. 23. The project production numbers are expressed on the Shell website as 3.5 billion pounds of product from three polyethylene units. Also: Shell. [About the Appalachian Petrochemical Project](#). April 17, 2020. Also: American Chemistry Council. [2017 Elements of the Business of Chemistry](#). 2017, p. 93. ACC uses 2204.06 pounds per 1 metric ton.

¹⁸ Shell Pipeline Company, L.P. [Information Memorandum and Binding Open Season Notice for Falcon Ethane Pipeline Report](#). October 17, 2016. The Memorandum states that the pipeline capacity is 107,000 barrels per day. The memo does not state that the 107,000 barrels per day will be delivered exclusively to the Shell Petrochemical Complex in Beaver County.

¹⁹ State of Pennsylvania, Department of Environmental Protection. [Plan Approval](#). December 30, 2016, pp. 5-7.

area within a 300-mile radius from Pittsburgh.²⁰ It is anticipated that most of the sales from the plant will be to the domestic market.²¹

The complex received Shell's final investment decision in June 2016, and construction commenced in November 2017.²² The project is slated to open in 2021. Shell states on its website that the project will produce 6,000 construction jobs and 600 permanent jobs.²³ The company's permit application to the State of Pennsylvania in April 2016, however, estimated the creation of only 400 permanent jobs.²⁴

Petrochemical Hub in the Ohio River Valley

The Ohio River Valley (ORV), which incorporates southeastern Ohio, western Pennsylvania, eastern Kentucky and West Virginia, is host to a petrochemical business cluster. The area includes an extensive network of upstream oil and gas production, as well as downstream chemical and plastics manufacturing facilities.²⁵ Its current network of processing infrastructure, pipelines, ports, storage, fractionation plants, cracker plants and manufacturing (including resin production) facilities, however, is insufficient to support the prolific production of the Marcellus-Utica shale plays.

**The objective is
to transform the ORV
from a business cluster
to a petrochemical hub.**

The Shell complex and a number of other prospective infrastructure projects are an attempt to capitalize strategically on the location of the shale plays (inexpensive feedstock) and proximity to the network of petrochemical businesses in the region (lower transport costs).²⁶ The objective is to transform the ORV from a business cluster to a petrochemical hub similar to the Mont Belvieu hub that serves Gulf

²⁰ U.S. Department of Energy. [Ethane Storage and Distribution Hub in the U.S.](#) November 2018, p. 13.

²¹ Petrochemical Update. [Location and tax breaks key to Shell's Pennsylvania cracker plant approval.](#) July 8, 2016.

²² Shell. [Shell starts main construction on Pennsylvania petrochemicals complex in USA.](#) November 7, 2016.

²³ Ibid.

²⁴ State of Pennsylvania, Department of Environmental Protection. [Shell Chemical Appalachia LLC, Petrochemicals Complex, Application for Authorization to Modify Plan Approval, 1.0 General Information.](#) April 2016, p.1.

²⁵ U.S. Department of Energy. [Ethane Storage and Distribution Hub in the U.S.](#) November 2018.

²⁶ IEEFA. [Proposed PTTGC Petrochemical Complex in Ohio Faces Significant Risks.](#) March 2020. Also: IEEFA.org. [IEEFA Ohio: Mountaineer NGL storage project loses its environmental permit.](#) March 10, 2020.

Coast oil, gas and petrochemical markets.²⁷

The Market Potential for Plastics Manufacturing Expansion (1997-2016)

Plastic resin sales in the U.S. grew annually for most of the decade from 1997 to 2007.²⁸ The annual increases were interrupted by the 2008 market downturn but had picked up again by 2010. Demand for plastics was anticipated to continue rising, as profit margins in Gulf Coast petrochemical and plastics were high and operating rates were high. With low natural gas prices in Appalachia, companies like Shell saw the advantage of both buying shale assets and expanding plastics investment.^{29 30} The Shell complex was seen as the first major new cracker investment in the U.S. since 2005.³¹

The current relatively positive position of petrochemicals from Shell's perspective must be seen in context, against the backdrop of underperforming oil and gas assets within the industry. Historically, petrochemical investments complemented the core business of companies like Shell but were significantly less profitable. The recent turn to petrochemical projects was recently characterized by the *Wall Street Journal*: "Resigned to more pedestrian returns, integrated oil companies see a strong case for investing in a business that was once a sideshow."³²

The price environment for plastic resin pellets during the first half of the previous decade was also promising. Market prices for plastic resins that had peaked at \$1.02 per pound in 2008 quickly recovered from the downturn and bounced back, from a low of 54 cents per pound in 2009 to 89 cents per pound in 2010. From 2010-16, the price never went below 75 cents per pound and peaked at \$1.07 pound in 2014 (See Table 1).

The price environment for plastic resin pellets used to be promising.

Shell Corporation's Participation

Shell, like all the other oil majors, has struggled in the last decade to maintain its leadership status.³³ The company's total market capitalization in the 2010-2020 period was \$270 billion. Today it stands around \$145 billion.³⁴ The company has

²⁷ U.S. Department of Energy. [Ethane Storage and Distribution Hub in the U.S.](#) November 2018. Also: IHS Markit, [Prospects to Enhance Pennsylvania's Opportunities in Petrochemical Manufacturing](#). March 2017.

²⁸ American Chemistry Council. [The Resin Review—2019](#). 2019, p. 16.

²⁹ IHS Markit. [North American Resin Market Trends](#). January 7, 2014.

³⁰ New York Times. [Shell Buys U.S. Shale Gas Assets for \\$4.7 billion](#). May 28, 2010.

³¹ ICIS. [Shell's new ethylene cracker in Appalachia may be the first of several](#). August 26, 2011.

³² Wall Street Journal. [Big Oil Flashes the Plastic](#). July 28, 2019.

³³ IEEFA. [IEEFA Update: Oil and gas stocks place dead last in 2019 again, despite 30 percent price rise](#). January 9, 2020.

³⁴ MacroTrends. [Royal Dutch Shell Market Cap 2006-2020](#). (Last checked May 1, 2020).

assets in Europe, Asia, the Middle East, Russia, Africa, South America and North America, including natural gas assets in Appalachia.³⁵

When the company was making its final investment decision in 2016, the Chemicals Unit was making a substantial contribution to the company's earnings. For the period 2015-2017, the unit averaged 18.26% of company earnings. Today it is below 10%.

Shell produced \$345 billion in revenue in 2019, down from \$388 billion in 2018.³⁶ The company spent \$29 billion on capital expenditures ("capex") in 2019. With the onset of the coronavirus and severe decline of oil prices and natural gas prices, the company has announced a cutback in both capex and dividend payments in 2020.³⁷

The company has written off more than \$33 billion in asset losses since 2013 (see Appendix 3), with approximately one-third of the write-offs related to company's shale assets in North America.³⁸

The reduction in the number of Shell employees in North America illustrates enterprise-wide decline.

The global average number of Shell employees has declined by 18,000 over the past decade, dropping from 101,000 in 2009 to 83,000 last year.³⁹ The bulk of the losses—approximately 17,000 global staff—has occurred since 2015, resulting in a 22 percent reduction in its cost of employment worldwide.⁴⁰ The reduction in Shell's global workforce accelerated in 2016, when it averaged 95,000 employees.⁴¹ The firm began a staff reduction that year, due to low oil prices, announcing plans to lay off 12,500 workers by the end of 2016.⁴² That same year, the company also departed One Shell Plaza, its 50-floor office building in downtown Houston.⁴³ The reduction in the number of Shell employees in North America illustrates this enterprise-wide decline. Shell reported 29,000 North American employees in 2016 but only 21,000 in 2019, a 38 percent decline.⁴⁴

³⁵ Shell. [2019 Form 20 F](#). March 14, 2019, p. 30-32.

³⁶ *Ibid.*, p. 8.

³⁷ Moody's Investor Service. [Royal Dutch Shell, Plc. Credit Opinion](#), April 7, 2020.

³⁸ See Exhibit III.

³⁹ Shell. [2009 20F](#). 2009. Also: Shell. [2019 20F](#). 2019.

⁴⁰ Shell. [2019 Investor presentations](#). May 2019, slide 20.

⁴¹ Shell. [2018 20F](#). 2018.

⁴² Bloomberg. [Shell layoffs to hit 12,500 by end of 2016 – equal to Facebook's entire workforce](#). May 25, 2016.

⁴³ Houston Chronicle. [Namesake tenant departing One Shell Plaza](#). September 20, 2016.

⁴⁴ Shell. [2019 20F](#), p. 103. In 2019, Shell had an average of 83,000 employees, with 21,000 employees in North America. The year-on-year increase in global employees was driven by growth in the IT hub in Bangalore, India. The company's annual filings record average employees each year, with a breakdown by division and by region. Since 2011, Shell has reported the

Shell's chemical unit is projected to spend \$3 billion and \$4 billion in annual capex.⁴⁵ It is expected to contribute between \$2 billion and \$3 billion annually in free cash flow from its facilities in China, Iraq and the U.S.⁴⁶ Shell also owns approximately 800,000 acres of dry gas assets in Appalachia.⁴⁷ The chemical unit has a 15% targeted rate of return.⁴⁸

IEEFA estimates that the complex will produce between \$1.8 billion and \$2.2 billion in revenue after a few years, or less than 1% of the company's annual worldwide revenue. IEEFA estimates the plant will cost between \$10 billion and \$12 billion to build, with construction taking four years. This amounts to approximately \$2.5 billion annually, or 8.6% of 2019 annual capital expenditures.

Economic and Financial Risks

Project construction started in the fourth quarter 2017.⁴⁹ The onset of the coronavirus resulted in Gov. Wolf's shutting construction down on March 18, 2020, but according to published reports, construction has resumed.^{50 51} Shell has stated the plant is on schedule to open in the early 2020s.⁵²

The complex will face significant financial risks when it enters the market.

The complex will face significant financial risks as it completes construction and enters the market. The risks outlined in this report are presented individually for analytical purposes, but should be viewed cumulatively. These risks include pricing issues, oversupply, competition, slow economic growth, concerns regarding reliability of the supply of low-cost feedstock, and the impact of recycling and other demand-side reductions.

Price Risk

Under current and expected market conditions, the complex is likely to face plastic prices that are significantly lower than when the project was originally planned.

number of employees in North America. Prior to that date, the company had recorded a separate number for US employees.

⁴⁵ Shell. [2019 Investor Presentation – Management Day](#). June 2019, p. 72.

⁴⁶ Ibid.

⁴⁷ Shell. [Appalachia](#). Last visited April 23, 2020.

⁴⁸ Shell. [2019 Form 20 F](#). March 14, 2019, p. 68.

⁴⁹ The Beaver County Times, [Shell officially starts construction on \\$6 billion ethane cracker plant](#). November 8, 2017.

⁵⁰ S&P Global. [Shell suspends construction on Pennsylvania petchem complex on coronavirus concerns](#). March 19, 2020.

⁵¹ Observer-Reporter. [Some cracker plant workers return; local shop selling online](#). April 19, 2020.

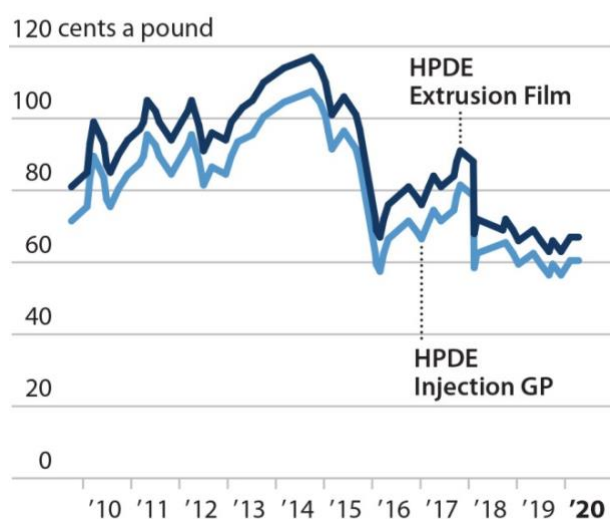
⁵² Business Journal Daily. [Shell Suspends Construction at PA cracker plant](#). March 18, 2020.

Plastics prices today are 40% below those that existed in the 2010-2013 period when the project was first developed. Futures prices through 2021 are weak. Such weak prices will drive profit margins that will undermine Shell's investment targets.

Figure 1 shows the price history for two of the more common HDPE products produced by plastics manufacturers.⁵³ During the 2010-13 period, market prices for these two HDPE products hovered around \$1 per pound. In September 2014, the price for HDPE Injection General Purpose (GP) hit a 20-year high of \$1.07 per pound.

Figure 1: Commodity Price History: HDPE-Injection GP (1997-2020)

**Resin Prices for HDPE
(High-Density Polyethylene)**



Source: *Plastics News*.

Since 2015, prices have been substantially below the \$1-per-pound price environment that prevailed during the planning stages of the Shell complex. Since 2016, prices dropped from 81 cents per pound to a low of 56.5 cents per pound in December 2019.

According to *Plastics News*, current prices are in the 60 cents-per-pound range. *Plastics Exchange*, which tracks spot prices in the plastics market, put HDPE GP Injection sales spot market prices at 34 to 42 cents per pound as of April 20, 2020.⁵⁴

CME's HDPE forward price curves are at 25 cents per pound through 2021.⁵⁵

In the current environment, it is difficult to project price changes. Broader fundamental factors like GDP growth and oil prices suggest short- and medium-term

⁵³ *Plastics News*. [Plastics Resin Pricing—Commodity Thermoplastics](#). March 17, 2020.

⁵⁴ The Plastics Exchange. [Weekly Review](#), May 8, 2020. Also: The Plastics Exchange. [Weekly Review](#). April 22, 2020.

⁵⁵ CME Group. [HDPE High Density Polyethylene \(PCW\) Financial Futures Quotes](#). April 22, 2020.

prices will remain low. How patterns of demand for plastic resin pellets change—and how supply capacity logistics and investment may be reorganized—are open questions.

Risk of Oversupply

Oversupply from a global industry-wide plastics buildout is likely to drive prices and revenues down.

The petrochemical buildout in the U.S. has oversupplied the market. Lower operating rates of cracker plants from new capacity additions have placed downward pressure on operating rates and resin sales prices. The supply/demand imbalances are likely to last through 2026.

**The petrochemical
buildout in the U.S. has
oversupplied the market.**

Between 2010 and 2013, industry analysts emphasized that no new cracker capacity had been added since 2005, resulting in operating rates above 95% and consistent demand growth.⁵⁶ With declining feedstock prices created by rising production from unconventional drilling, market signals encouraged a plastics buildout in North America.

Supporting arguments for expanded production, however, also came with warnings that substantial increased capacity could lead to margin declines and increased competition, domestically and globally.⁵⁷

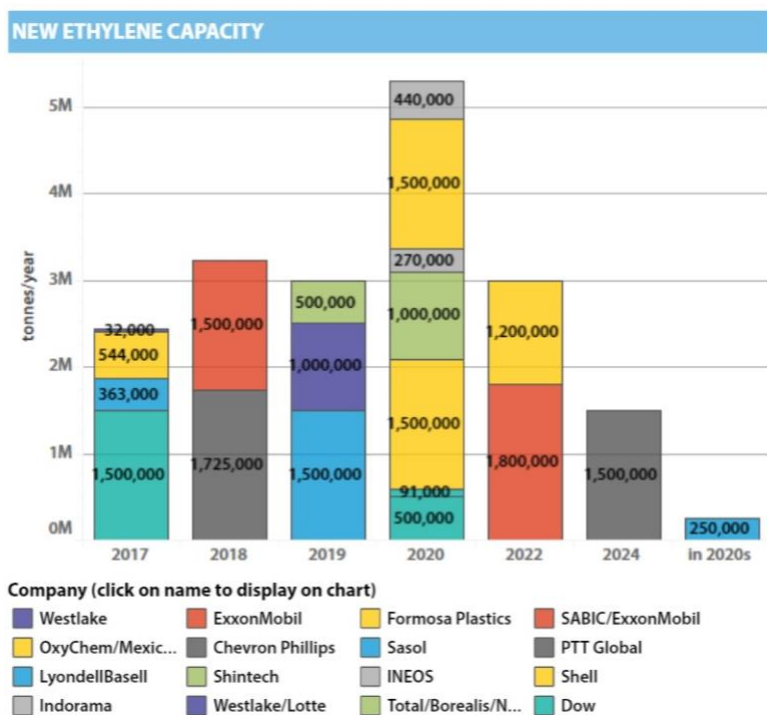
Figure 2 shows the number of new cracker facilities that have been added since 2017, and potential new facilities that are planned to be built through 2026.⁵⁸

⁵⁶ IHS Markit. *North American Resin Market Trends*. January 2014.

⁵⁷ *Ibid.*

⁵⁸ ICIS. *Long term down cycle will transform global petrochemicals creating new winners and losers*. December 6, 2019.

Figure 2: Recently Added and New Cracker Capacity



Source: ICIS.

In late 2019, as new capacity was being added in the U.S. and around the world, plastics prices remained depressed. Although new capacity was being added, demand was not growing at a rate sufficient to absorb the new facilities. Persistent oversupply is likely to continue at least through 2021.⁵⁹

Plastics News has reported on projected lower operating rates through 2023:

*"In the U.S., the wave of new capacity fueled by shale gas 'is cresting' this year, with additions from Sasol, Formosa Plastics, ExxonMobil and LyondellBasell. Global PE operating rates also are expected to peak in 2019 before declining through 2023. At that point, linear low-density PE will be in the greatest oversupply."*⁶⁰

Continued conditions of oversupply will maintain downward pressure on prices. Some analysts see that the pressure will be on U.S. project cancellations.⁶¹ Global capacity additions are expected to continue through 2026.⁶²

⁵⁹ IHS Markit. [Chemicals and Resins Outlook](#). September 25, 2019.

⁶⁰ Plastics News. [Global PE Market faces 'most formidable set of issues,' PP keeps rolling](#). July 23, 2019.

⁶¹ ICIS. [Asian polyethylene shutdowns? Once again, good luck with that idea](#). November 2019.

⁶² GlobalData. [China and US lead global ethylene capacity additions by 2026, says GlobalData](#). January 11, 2019.

The pandemic and oil price crash are likely to slow the rate at which the new capacity is absorbed by growth.

Risks From Competition

Shell faces stiff competition in a constricted market that may depress prices.

Shell's Pennsylvania complex will enter the plastics market in the U.S. during a time of intense competition from existing producers and suppliers.⁶³ Slower economic growth projections by the International Monetary Fund (IMF) for the U.S. suggest a slowdown in the growth rate of plastics that may have a negative impact on both volume and prices of Shell's plastic products made in Pennsylvania.

With lower prices, margins are down for current polyethylene producers generally.⁶⁴ Thus, Shell will enter the market when its key competitors are pursuing strategies to recover from the current down cycle. The down cycle in the short-term is likely to be exacerbated by the coronavirus. Prices that are already depressed by oversupply are likely to be depressed further due to competitive pricing.⁶⁵

Shell faces competition from a formidable array of companies that already dominate U.S. market share and have strong domestic market relationships.⁶⁶ Those companies include: Baystar, Chevron Phillips Chemical Company, Dow Chemical Company, ExxonMobil Chemical Canada, ExxonMobil Chemical Company, Formosa Plastics Corporation, INEOS Olefins & Polymers, LyondellBasell Industries, NOVA Chemicals, Ltd., and Sasol Chemicals North America.

Competitive pressures, moreover, are not limited to the U.S. Analysts are now identifying a lower growth scenario for the global economy—and increased competition in the global plastics sector.⁶⁷

Risk to Low-Cost Feedstock

Shell's low-cost advantage from cheap natural gas and low ethane prices is at risk from the market instability of local producers, additional outlays to secure reliable feedstock assets, low and rising price scenarios, and a lack of feedstock flexibility as markets change.

Having an abundant supply of ethane, with a predictably low price, has been offered by Shell and project proponents as the linchpin to the value proposition for Shell's complex.

⁶³ ICIS. [Global PE Price war begins as supply grows and demand fades](#). September 11, 2019.

⁶⁴ ICIS. [Insight: US PE margins remain pressured amid ongoing supply additions](#). January 21, 2020.

⁶⁵ IHS Markit. [Prospects to Enhance Pennsylvania's Opportunities in Petrochemical Manufacturing](#). March 21, 2017.

⁶⁶ American Chemistry Council. [The Resin Review—2019](#). (Proprietary Report – available upon request).

⁶⁷ ICIS. [Surge in US polyethylene exports occurs as China growth slows, Asian margins turn negative](#). October 2019.

Appalachian oil and gas producers are financially unstable.

More than 200 shale producers have filed for bankruptcy protection since 2015, representing nearly \$130 billion in debt restructuring.⁶⁸ Since 2015, at least 11 of these were shale-gas operations focused on Appalachia.⁶⁹ In the past two months, two more have sought restructuring advisors.⁷⁰

Large oil and gas companies have taken multibillion-dollar write-offs on their Appalachian shale assets. Losers include Chevron, which recorded a \$6 billion impairment during the fourth quarter of 2019, writing down its 780,000 acres in Marcellus-Utica.^{71 72} Shell also has written off almost \$10 billion on its shale assets since 2013.⁷³

**More than 200 shale
producers have filed
for bankruptcy protection
since 2015.**

The eight largest publicly traded Appalachian-focused frackers have recorded negative cash flows for a decade. These companies also face significant debt loads, signaling distress.^{74 75} At the end of 2019, these eight companies faced \$29.4 billion in long-term debt, yet their combined market capitalization, as of March 23, 2020, was just \$10.5 billion.^{76 77}

Appalachian oil and gas producers are seeking federal credit enhancements to avoid bankruptcy. Weak and unstable conditions facing the industry have led small independent oil and gas producers, many concentrated in Appalachia, to lead a federal lobbying effort to obtain relief from debt incurred over the last decade. The Independent Petroleum Producers of America (IPPA) has asked the Federal Reserve to allow oil and gas producers to use new credit enhancements to refinance legacy debt.⁷⁸

⁶⁸ Haynes and Boone, LLP. [Oil Patch Bankruptcy Monitor](#). April 6, 2020.

⁶⁹ The 11 shale producers focused on Appalachia that filed for bankruptcy between 2015 and 2019 are: Magnum Hunter (2015); Warren Resources, Penn Virginia, Stone Energy, and Ultra Petroleum (2016); Ascent Resources, Rex Energy, EV Energy Partners, and EXCO (2018); and EdgeMarc, Arsenal Resources (2018), based on an several reports in Marcellus Drilling between 2105 and 2019.

⁷⁰ Marcellus Drilling News, [Chesapeake Energy](#) and [Gulfport Energy](#) have each sought restructuring advisors.

⁷¹ Chevron. [Fourth Quarter 2019 results press release](#), January 31, 2020.

⁷² Chevron. [Chevron in Appalachia](#).

⁷³ Shell. [Annual Reports Download Centre & Archive](#), 2013-2019.

⁷⁴ These eight shale gas producers with primary operations in Appalachia are: Antero Resources, Cabot Oil and Gas, Chesapeake Energy, CNX Resources, EQT, Gulfport Energy, Range Resources, and Southwestern Energy. None has filed for bankruptcy.

⁷⁵ S&P Global. [Bond market signals distress for Appalachian gas drillers](#). February 5, 2020.

⁷⁶ IEEFA. [Bankruptcies in Fracking Sector Mount in 2019](#). January 2020.

⁷⁷ IEEFA. [In Extremis: Crisis mounts for Appalachian Shale Producers](#). April 2020.

⁷⁸ Reuters. [U.S. energy industry steps up lobbying for Fed's emergency aid: letters](#). April 20, 2020.

Recent congressional actions to support businesses disrupted by the pandemic targeted companies with short-term liquidity concerns.⁷⁹ Congress planned to support those businesses that are going concerns. The intention was not to relieve long-term debt obligations that stem from unviable businesses.

To maintain its access to a reliable supply of cheap natural gas and ethane, Shell may be compelled to make additional, unanticipated cash outlays that will place further downward pressure on the rate of return produced by the complex.

Although independent oil producers have requested credit support from the federal government, large oil and gas interests have opposed this kind of government intervention. Support for free market policies in today's oil and gas market generally assumes that significant sales of distressed assets and bankruptcies will occur as the natural course of the business cycle plays out.^{80 81} To those proponents, this value destruction is preferable to any governmental intervention. The assumption is that larger oil and gas companies, like Shell, will buy out distressed assets controlled by small producers.

Shell, however, faces a particular risk in this area. If the company opts to acquire more shale assets in the Marcellus-Utica region as a defensive move to protect its supply of cheap natural gas for its petrochemical complex, it must increase its capital outlay. This would be an unintended, additional increase to the capital cost of the investment. An increase of capital for the complex will lower its return, all other things being equal.⁸² By acquiring such interests, moreover, Shell also takes on risks that have caused distress for the independent producers and have even led Shell to sell its own Appalachian dry gas assets at distressed prices.⁸³

Low natural gas and ethane prices are unsustainable for oil and gas producers, yet rising prices for natural gas and ethane pose risks to the complex's profitability from weak plastics prices and low oil prices.

Low prices for ethane and natural gas result in lower profits for oil and gas producers and increasing market disruption. One outgrowth of this market disruption for the Shell complex is that ethane may become too expensive to extract, especially if oil prices remain very low. Unlike other natural gas liquids (NGLs), recovery of ethane from the gas stream is uneconomical under conditions of low oil

⁷⁹ IEEFA. [IEEFA Update: Loan program for coronavirus-impacted businesses excludes oil and gas companies. Or does it?](#) March 31, 2020. Also: IEEFA. [Federal Lending to the oil and gas sector would be a complete waste of money.](#) April 27, 2020.

⁸⁰ Morning Consult. [Public More Receptive to Oil and Gas Bailout Than the Industry Itself.](#) March 12, 2020.

⁸¹ CNBC. [Pioneer Natural Resources CEO warns independent oil companies could go bankrupt if production continues amid coronavirus.](#) March 26, 2020.

⁸² For an analysis of how these key elements combine to determine the elements of final investment decision see: Honfleur, LLC., [Honfleur Ethane Cracker Part I](#), June 2016; Honfleur, LLC., [Honfleur Ethane Cracker Part II](#), March 2016 and Honfleur, LLC, [Ethane Cracker Part III](#), March 2016.

⁸³ Shell, [Shell sells U.S. Appalachia assets to National Fuel](#), May 4, 2020.

prices.⁸⁴ Potential ethane scarcity could place upward pressure on prices. This would raise the feedstock costs to the Shell complex and restrict profit margins.

Rising ethane prices in a slow growth environment where plastics prices also remain low create another risk for Shell, as costs begin to rise but product prices remain stagnant or fall.

Recently, the collapse in world oil prices has undermined ethane's low-cost advantage.⁸⁵ As both oil and gas interests are looking to higher forward prices, Shell and its investors will need to monitor whether the low-cost advantage remains.

The collapse in world oil prices has undermined ethane's low-cost advantage.

Slower Growth

Slower economic growth projections in the U.S. suggest a slowdown in the growth rate of plastics that may depress the volume and prices of Shell's plastic products made in Pennsylvania.

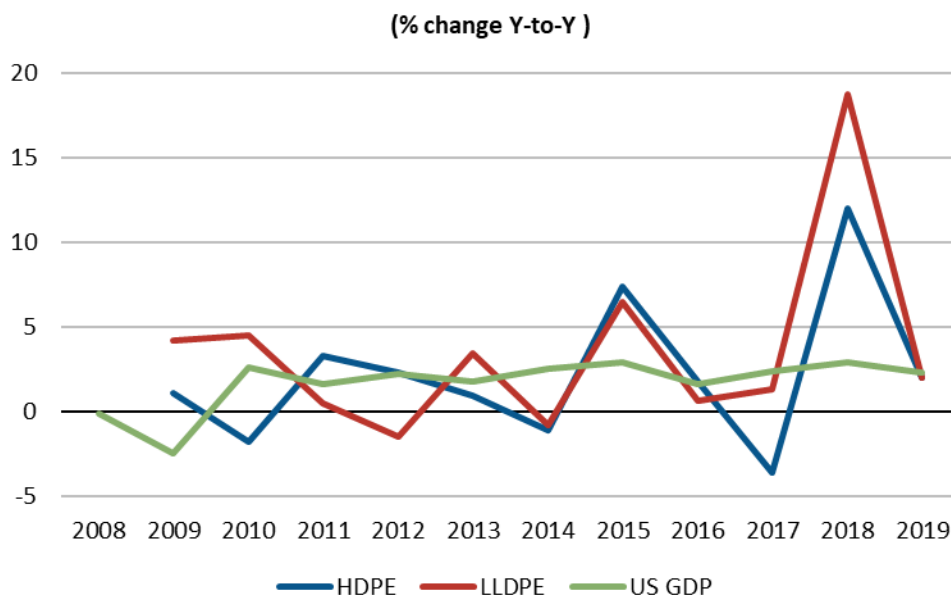
While GDP growth is not the sole determinant of the rise or decline of polyethylene sales, the plastics markets have generally done better when global GDP growth exceeds 3% and when U.S. GDP growth exceeds 2%. In any given year, as GDP rises, the plastics market tends to improve, and as the GDP growth rate declines, rates of plastics growth follow suit. Some companies assume as part of their business model that plastics sales grow at a rate of 1.4x GDP.⁸⁶

⁸⁴ See the explanation for the economics of processing ethane from the natural gas stream in BIC.com. [The ethane price premium to natural gas has nearly tripled over the past three months.](#) August 31, 2018. See also: American Chemistry Council. [The Resin Review—2019](#), p. 13.

⁸⁵ S&P Global. [Factbox: US contract ethylene settles at all-time low.](#) April 2, 2020.

⁸⁶ Sasol. [Investor Presentation.](#) March 2017, p. 22.

Figure 3: HDPE, LLDPE and U.S. GDP Growth 2008 to 2019



Source: American Chemistry Council, International Monetary Fund.

In its January 2020 outlook, prior to the pandemic, the IMF had lowered its global growth projections.⁸⁷ While growth projections globally remained above 3%, slower growth in China's baseline economy was expected. The IMF predicted U.S. growth of 2% for 2020 and declining through 2021.

The IMF's April 2020 assessment of world economic growth assumes a high degree of uncertainty, estimating U.S. domestic growth declining by 5.9% in 2020 and then growing at above-typical growth levels at 4.7% in 2021.⁸⁸

Shell projected a comfortable scenario with U.S. GDP rising at 2.4% annually.

When Shell made its final investment decision to proceed with the Pennsylvania Complex in 2016, it projected a comfortable scenario would be achieved with U.S. domestic GDP rising at 2.4% annually and plastics demand increasing in the 3% to 4% range.⁸⁹ The Shell scenario assumed a certain level of oversupply in the market that would be absorbed by the time the complex opened in 2021.⁹⁰

Prior to the pandemic, the IMF had lower expectations of U.S. GDP growth than what was expected by Shell. The pandemic has disrupted the usual flow of business and

⁸⁷ International Monetary Fund. [World Economic Outlook Update](#). January 2020.

⁸⁸ International Monetary Fund. [World Economic Outlook Update](#). April 2020.

⁸⁹ Petrochemical Update. [Location and tax breaks key to Shell's Pennsylvania cracker plant approval](#). July 8, 2016.

⁹⁰ *Ibid.*

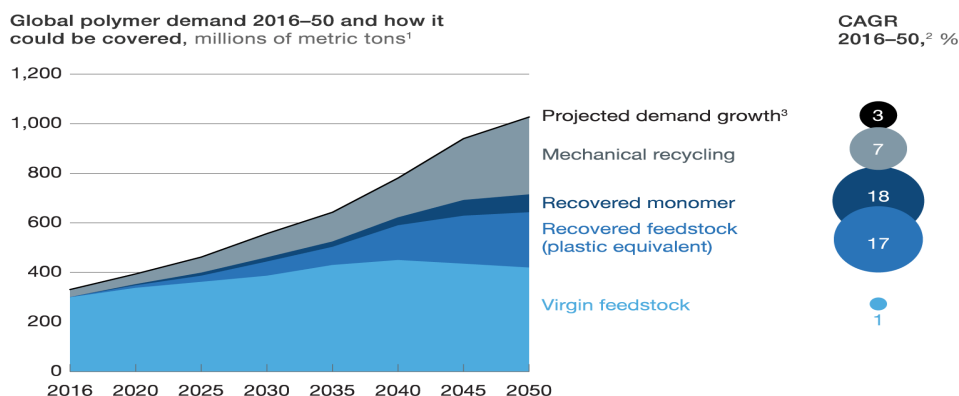
markets, adding a high degree of uncertainty. Although oil futures markets expect the price of oil to remain below \$45 per barrel (bbl) through 2026, the degree to which the larger economy rebounds is uncertain, and, with it, the expectations for plastics demand.⁹¹

Recycling and Long-Term Profitability

Demand for plastics is expected to increase, based on most long-term projections. Demand for virgin plastics, however, is likely to level off as it cedes increasing amounts of market share to recycled materials. Rates of growth are also expected to be tempered by plastic bans and plastic content laws.

Figure 4: McKinsey Plastics and Recycling Growth Rates through 2050⁹²

By 2050, nearly 60 percent of plastics production could be based on plastics reuse and recycling.



¹Scenario based on a multi-stakeholder push to boost recycling, regulatory measures to encourage recycling, consistent progress on technologies, and \$75-per-barrel oil price.
²Compound annual growth rate. Mechanical recycling limited by downcycling and applicable materials, monomerization limited by applicability to condensation polymers only, pyrolysis limited by likely rise in input costs.
³After demand reduction, assuming annual global GDP growth of 3.1%.

Source: McKinsey & Company.

The annual long-term demand for plastics is expected to climb between 3% (see Figure 4– CAGR) and 4%.⁹³ According to McKinsey, nearly 60% of plastics demand between 2020 and 2050 will be satisfied by recycled plastics. Analysts expect Chinese initiatives in this area to drive progress.⁹⁴ The expectation is that virgin plastic utilization will flatten out and perhaps decline. In the short term, some absorption of oversupplied plastics capacity may be absorbed. Looking forward, however, the buildout of supply capacity of virgin plastics is likely to increasingly

⁹¹ CME Group. [Crude Oil Futures Quotes](#). May 2, 2020.

⁹² McKinsey, [How plastics waste recycling could transform the chemical industry](#), Exhibit 4, December 12, 2018.

⁹³ IHS Markit. [Plastics Demand Rising](#).

⁹⁴ ICIS. [China Plastics Recycling To Lead The World As Virgin Resin Demand Declines](#). May 30, 2018.

exceed demand due to recycling and other initiatives to reduce plastics consumption.^{95 96}

Cumulative Risk Analysis

Low prices for ethane and the petrochemical complex's proximity to a significant customer base is critical to profitability, but a constellation of factors that are largely outside of Shell's control create a negative outlook.

What once looked like a promising investment with returns that met investment targets is now a more speculative proposition. The petrochemical complex would open to weaker-than-anticipated prices and revenues, an oversupplied market with lower-than-projected economic growth expectations to absorb it, a highly competitive operating environment, a distressed feedstock, and lower returns and longer-term risks from downward pressure on demand by recycling and plastics legislation.

**Reports on the Shell
complex's financial strength
have not been subjected
to independent review.**

The perception of the Shell complex's financial strength as presented in a series of third-party reports that are not publicly available and have not been subjected to any independent review has contributed to an overly optimistic outlook.

Assumptions of the Consultant Studies

In March 2018, IHS Markit released an executive summary of a report, "*Benefits, Risks, and Estimated Cash Flows: Ethylene Project Located in the Shale Crescent USA versus the US Gulf Coast*," on the prospects for petrochemical investment in Appalachia. The summary was misleading in several respects and no longer accurately depicts the financial and market conditions faced by Shell and the proponents of the complex. It contained the following three critical points about the financing of such a facility:

- "Would a nearly \$3 billion investment in an ethylene/polyethylene plant in the Shale Crescent USA earn higher or lower returns than a comparable investment in the U.S. Gulf Coast over a 20-year timeframe?" The executive summary concluded that such a facility would achieve a higher return than a similarly situated Gulf Coast facility.

⁹⁵ Petroleum Economist. [Downstream slumbers as plastics backlash grows](#). December 2019.

⁹⁶ [Bloomberg Technology](#).

- “The analysis conducted by IHS Markit highlights the economic opportunities for the Shale Crescent USA region based on predicted volumes and prices of natural gas and NGL production in the Marcellus and Utica shale plays; the estimated capital and operating costs to convert ethane (the primary raw material) into its derivative products (ethylene and then polyethylene); and the cost to distribute polyethylene to a mix of domestic and international customers.”
- “Without considering the time value of money, the pre-tax cash flow of the Shale Crescent USA project from 2020 to 2040 amounts to \$11.5 billion, compared to \$7.9 billion for a similar Gulf Coast project, a pre-tax cash flow advantage of \$3.6 billion.”

The IHS Markit summary is misleading.

First, the study states it is reviewing a hypothetical complex in Pennsylvania and comparing it to a hypothetical complex in the Gulf Coast. IHS Markit and Shale Crescent USA, however, have marketed the findings in this study as if it were the actual Shell complex. IHS Markit's website combines its two studies on the region under the banner that a bright future awaits plastic manufacturing in Appalachia.⁹⁷ It mentions the Shell complex twice in its website article. It is plainly misleading to conflate the two investment scenarios. The illustrative model used to support the investment concept and Shell's investment prospectus for the complex also are not available to the public.

Second, the executive summary describes the cost basis of the construction estimate of its model as if it were an integrated complex, an “ethylene/polyethylene” plant. IHS Markit then estimates the construction cost at \$3 billion. The Shell facility, for example, is a petrochemical complex. It is an integrated model that contains an ethylene cracker, several ethylene/polyethylene units, and a number of other infrastructure items related to power generation and flaring. The \$3 billion figure might be an estimate for a stand-alone cracker plant, but for an integrated complex, such an estimate is far below what it has actually cost other facilities, such as the Sasol Lake Charles Project. Also, IHS Markit ascribed a \$10 billion construction figure to the Shell complex just months after it released its March 2018 report.

Third, the IHS Markit study executive summary estimates that the facility will produce \$11.5 billion in pre-tax cash flow over the 20-year period, or \$575 million annually. The IHS Markit summary does not disclose its assumptions regarding the price of plastics, debt/equity ratio of the project, ethane costs, interest rates on any financing, annual operating expenses and operating rates. IHS Markit withheld the full report from IEEFA researchers.⁹⁸

⁹⁷ IHS Markit, [Petrochemical Cluster: A bright future for the Tri-state region](#), May 25, 2018.

⁹⁸ For an analysis of how these key elements combine to determine the elements of final investment decision see: Honfleur, LLC., [Honfleur Ethane Cracker Part I](#), June 2016; Honfleur, LLC., [Honfleur Ethane Cracker Part II](#), March 2016 and Honfleur, LLC, [Ethane Cracker Part 3](#), March 2016.

IEEFA assumes that the cost of the complex will be far in excess of \$3 billion and likely closer to \$10 billion to \$12 billion, which is typical of a construction project of this size and complexity (See Appendix 2). IEEFA assumes that plastic prices are unlikely to exceed 60 cents per pound for a number of years (and perhaps remain as low as 40 cents per pound for long periods), reflecting the oversupplied market and weak GDP growth estimates. Even assuming long-term low and unsustainable ethane prices, it is unlikely that the project will achieve its \$575 million free cash flow target.

The Sasol complex, a facility with similar design and which commenced construction in Louisiana shortly before Shell (See Appendix 1), reflects both market increases and management issues. The company is lowering its internal rate of return (IRR) for the project to the 6.0% to 6.5% range.⁹⁹ This is far below Sasol's own hurdle rate of 10.6%. Shell's assumption that its petrochemical projects will return 15%, consistent with the IRR for projects in its petrochemical unit and IHS Markit's similar assumption in its March 2018 executive summary, both seem implausible.¹⁰⁰ In response to a query from *Inside Climate News*, Shell stated that it did not see any of the market changes taking place now as having any impact on the complex.¹⁰¹

Upon the release of an IEEFA report in March 2020 on the PTTGC project, IHS Markit explained that it had removed PTTGC from its long-range forecast because of fundamental financial problems unrelated to the coronavirus.¹⁰² The PTTGC complex is similar to the Shell complex in its plan to produce significant amounts of plastic resin pellets. *Inside Climate News* reported the facts surrounding the PTTGC facility and interviewed IHSMarkit representatives regarding their current view of the market:

IHS Markit had removed the proposed \$5.7 billion ethane plant in Belmont County, Ohio, from its long-range plastics supply forecast even before the coronavirus pandemic seized the global economy, said Nick Vafiadis, manager of IHS's global plastics practice. The project is a collaboration between Thailand's PTT Global Chemical America and South Korea's Daelim Industrial.

There has been an oversupply of polyethylene, the product the Ohio plant would make. And IHS sees that overage continuing for at least three more years. Plastics demand will continue to rise, but at a slower rate, Vafiadis said. Coronavirus will take its own additional bite out of global plastics demand.

"The economics that would support approval of a final investment decision of the (Ohio) project are less compelling today than they have been the entire

⁹⁹ To understand the relationship between capital costs and declining profitability, see the discussion in Honfluer, op cit, Parts 1, 2 and 3.

¹⁰⁰ When asked by IEEFA if Shell agreed with the conclusions of the IHS Markit study, the company replied in an email on March 11, 2020, "We do not comment on the correctness of research published by another source."

¹⁰¹ *Inside Climate News*. [Market Headwinds Buffet Appalachia's Future as a Center for Petrochemicals](#). March 21, 2020.

¹⁰² IEEFA. [Proposed PTTGC Petrochemical Complex in Ohio Faces Significant Risks](#). March 2020.

*time it has been under consideration," he said.*¹⁰³

Within a week of the publication of the *Inside Climate News* article, the Global Editor for ICIS Chemical, Joseph Chang, published a piece suggesting that the plastics buildout in general was facing a slowdown due to an oversupply and severely declining oil and gas prices.¹⁰⁴ ¹⁰⁵ The ICIS article confirmed the insights regarding the PTTGC Complex and the outlook for Shell's complex in Pennsylvania, and broadened the matter to the entire plastics buildout worldwide.

Conclusion

This report identifies a series of financial risks facing the Shell Petrochemical Complex in Beaver County, Penn., which is slated for opening in 2021 or 2022. Taken alone, some of these risks are formidable. Taken together, they strongly suggest the complex will be far less profitable than Shell's expected return. The financial risks have significant implications for Shell's investors, local and state governments in Pennsylvania, and, of course, the people of Pennsylvania.

**The financial risks suggest
the complex will be
far less profitable than
Shell's expected return.**

Shell is benefiting from significant tax breaks offered at the state and local level for the complex.¹⁰⁶ ¹⁰⁷ These public benefits and many other accommodations are sufficient reasons for the company to provide timely and relevant information to the public.

Shell also has an obligation to its shareholders to report market changes that have an impact on the project's potential profit. Recent warnings by top oil and gas industry experts suggest the operating environment for the complex has been altered by a series of short- and long-term events with negative implications for the project's profitability. These conclusions were drawn prior to the pandemic, and the ensuing economic shutdown has only amplified the need for greater disclosure.

Shell owes both its public and private partners greater accountability.

¹⁰³ Inside Climate News. [Market Headwinds Buffet Appalachia's Future as a Center for Petrochemicals](#), March 21, 2020.

¹⁰⁴ Hydrocarbon Processing. [Chemical and oil companies to slash capex, slowing investment wave](#). March 30, 2020.

¹⁰⁵ Inside Climate News. [Market Headwinds Buffet Appalachia's Future as a Center for Petrochemicals](#). March 21, 2020.

¹⁰⁶ Petchem Update, [Location and tax breaks key to Shell's Pennsylvania cracker plant approval](#), July 8, 2016.

¹⁰⁷ Ellwood City Ledger, [Commissioners approve tax-exempt zone for Shell](#), August 9, 2013.

Appendix 1: Sasol, Lake Charles Chemical Projects

Background

Sasol South Africa Limited (“Sasol”) has substantially completed construction on a 1.77 MTPA chemical project in Lake Charles, La. (Lake Charles Chemical Project, or LCCP).¹⁰⁸ The project started construction in March 2015. It is slated to produce 900 KTPA of polyethylene (Low Linear Density Polyethylene and Low-Density Polyethylene), 380 KTPA of ethylene oxide products, 330 KTPA of ethylene, and 160 KTPA of alcohol and alumina.

The project rationale sought to capitalize on low ethane prices in the U.S. and Lake Charles’ transportation access to global markets. Sasol has holdings and a customer base in the U.S., South Africa, Nigeria, Gabon, Egypt, Europe, Russia, Oman, United Arab Emirates (UAE), Malaysia, China, and Japan.¹⁰⁹ Strategically, the company seeks to expand its polyethylene and differentiated chemical market share in the U.S. and globally as it transitions from an energy company to a chemical company.¹¹⁰

The financial outlook assumed that polyethylene growth rates would be 1.4x GDP in the future, U.S. operating rates would rise from 87% in 2010 to 92% by 2020 (and be tighter than the rest of the world), and Sasol’s U.S. position could be expanded.¹¹¹

Project execution has been weakened by management issues and market factors, resulting in higher-than-expected construction costs and lower-than-expected returns from the project.

Deterioration of Project and Corporate Finances

Construction Cost Increases

The earliest public construction cost estimates were \$8.1 billion in October 2014.¹¹² Five years later, plant costs had increased to \$12.9 billion, or 59%.¹¹³

¹⁰⁸ Sasol. [2019 Annual Financial Statement](#), June 30, 2019.

¹⁰⁹ Sasol. [Investor Presentation](#). March 24, 2017, p. 9.

¹¹⁰ Sasol. [Investor Presentation](#). March 24, 2017.

¹¹¹ *Ibid.*, p. 22.

¹¹² Plastics News. [Sasol to build \\$8.1 billion petrochemical complex in Louisiana](#). October 2014.

¹¹³ Sasol. [Update on the Lake Charles Chemicals Project \(“LCCP”\)](#). May 2019. See also: Moody’s. [Moody’s downgrades Sasol’s CFR to Ba2 from Ba1 ratings placed PR](#). March 31, 2020.

Table 1: LCCP Cost of Construction and updates (2014-2019) (\$ billions)

	Amount
Prior to October 2014	\$8.10
14-Oct	\$8.90
16-Aug	\$11.00
19-Feb	\$11.80
19-May	\$12.90

Source: Sasol company filings.

Sasol has released several updated project reports to investors. Those updates included project progress as well as the results of internal reviews and investigations to determine the reasons for rising costs. The largest drivers of construction cost increases were due to the site, the Engineering Procurement Construction (EPC) contractor, labor, the scope of work, defective work, weather delays and declining productivity.¹¹⁴

Selected Financial Impacts

Poor project execution and market factors caused the construction price to rise. These factors combined with several others to cause critical financial metrics to deteriorate during the course of construction.

Debt

By 2016, the project’s cost was estimated at \$11 billion. Sasol estimated that \$7 billion would come from a combination of project and corporate financing, and \$4 billion from an equity contribution by the company.¹¹⁵ It was expected that the debt required for the project would be quickly repaid upon construction completion and that debt levels would subside as the plants became fully operational.¹¹⁶ On March 31, 2020, Moody’s downgraded Sasol in part due to rising debt levels driven by the LCCP cost increases, and to a slower-than-anticipated start of the project. The ratings agency also cited price deterioration in the markets to be served as a factor in the downgrade.¹¹⁷

Internal Rate of Return

The deterioration in project finances caused Sasol to reassess the expected internal rate of return once the complex is operational. The project was established with a hurdle rate of 10.4%.¹¹⁸ By August 2016, the rate was adjusted to 8%, and the analysis accompanying the adjustment informed investors that for every \$500 million spent above \$11 billion, the IRR would drop by 0.3%. By May 2019, management expressed extreme disappointment with the rise in construction costs

¹¹⁴ Sasol. [Lake Charles Chemicals Project—Fact Sheet](#). February 2019. Also: Sasol. [Investor Fact Sheet—Lake Charles Project](#). August 23, 2016, p.1.

¹¹⁵ Sasol. [Investor Fact Sheet—Lake Charles Project](#). August 23, 2016.

¹¹⁶ Sasol. [Investor Presentation](#). March 24, 2017, p. 58.

¹¹⁷ Moody’s. [Moody’s downgrades Sasol’s CFR to Ba2 from Ba1 ratings placed PR](#). March 31, 2020.

¹¹⁸ Sasol. [Investor Fact Sheet—Lake Charles Project](#). August 2016, p. 13.

to \$12.9 billion.¹¹⁹ Sasol again revised the internal rate of return to between 6.0% and 6.5%. The construction cost problem was also compounded by negative changes in the short- and medium-term pricing outlook.¹²⁰

EBITDA

Sasol's estimates of project EBITDA has remained relatively stable at a full-run rate of \$1.3 billion to \$1.4 billion annually. On an enterprise-wide level, Sasol's actual EBITDA has dropped by 50% since 2015.¹²¹

Significant Project-Related Financial Disclosures

Ethane Futures Prices (Feedstock Costs)

In August 2016, Sasol published its outlook on future ethane prices.¹²² The company anticipated prices from 2017-2021 ranging from 30 to 40 cents per gallon; rising to 35 to 60 cents per gallon from 2022-2026; and climbing further from 2027-37, between 50 and 75 cents per gallon.

Costs of Operation

Sasol projected a cost of operation (minus feedstock costs) between \$350 million and \$380 million during years one to three, \$450 million to \$480 million in years four to seven, and \$510 million to \$530 million in years eight to 20.¹²³

Loss Assumptions

In August 2016, Sasol published several disclosures that quantified the costs of problems encountered on the project.¹²⁴ The disclosures were also to be used to help investors understand how Sasol would quantify any additional problems experienced with the project. The company said any adjustments to future project costs would be based on the following: a) Every 10 cents-per-gallon movement in ethane price from the base assumption has an impact on IRR of approximately 1 percent; b) Every \$500 million increase in capex above \$11 billion has an impact on IRR of approximately 0.3%; and c) Every three-month schedule delay has an impact on IRR of approximately 0.2%.

Current Status

Moody's reports that as of January 2020, the construction was 99% complete.¹²⁵ The LLDPE unit opened in February 2019 but was closed due to an explosion in January 2020. The EO units were opened during 2019 and early 2020, and the alcohol units

¹¹⁹ Sasol. [Update on the Lake Charles Chemicals Project \("LCCP"\)](#). May 2019.

¹²⁰ *Ibid.*

¹²¹ Moody's Investor Service, [Sasol Limited: Updated Credit Analysis Following downgrade to Ba1, Stable](#), Credit Opinion, March 10, 2020, p. 8.

¹²² Sasol. [Investor Fact Sheet Lake Charles Project](#). August 23, 2016, p. 10.

¹²³ *Ibid.*, p. 12.

¹²⁴ *Ibid.*, p. 13.

¹²⁵ Moody's Investor Service. [Sasol Limited: Updated Credit Analysis Following downgrade to Ba1, Stable](#). March 10, 2020, p. 4.

are expected to be fully operational in mid-2020. Moody's has recently downgraded Sasol and their review is continuing, with potential for further downgrades.¹²⁶

Class action litigation has commenced, charging Sasol with failure to adequately inform its shareholders about the deterioration of project finances. The complaint alleges that defendants misled investors by misrepresenting and failing to disclose that Sasol conducted insufficient due diligence into multiple issues with Sasol's Lake Charles chemical plant, as well as its true cost; construction and operation of the plant was plagued by control weaknesses, delays, rising costs and technical issues; and Sasol's top management exacerbated issues by engaging in improper and unethical behavior concerning financial reporting.¹²⁷

In the wake of the market downturn and problems at Lake Charles, the company is looking to sell a stake in the Lake Charles Plant to another investor.¹²⁸

¹²⁶ Moody's. [Moody's downgrades Sasol's CFR to Ba2 from Ba1 ratings placed PR](#). March 31, 2020.

¹²⁷ Hagens Berman. [Hagens Berman National Trial Attorneys Alerts Sasol Limited \(SSL\) Investors: Application Deadline Today, Investors with Losses Should Contact its Attorneys Now](#). April 5, 2020.

¹²⁸ Bloomberg. [Sasol Starts Stake Sale in \\$13 Billion U.S. Chemical Plant](#). April 21, 2020.

Appendix 2: Background on IEEFA's Estimate of Cost of Construction

IEEFA's Estimate of Plant Costs

For purposes of this study, IEEFA estimates the cost of the Shell Petrochemical Complex in Beaver County, Penn., will be at least \$10 billion. Shell has not confirmed any specific construction price, although it funded a report in 2014 that reportedly estimated the cost at \$6 billion. IEEFA has reviewed related consultant studies and cost opinions, industry construction escalation data, and recent construction costs from Sasol's LCCP (a similarly situated petrochemical complex in Louisiana) to arrive at its estimate. This report also takes note of a March 2019 disclosure by IHS Markit that placed the cost at \$10 billion.

The cost of construction has particular relevance for the Shell complex because so little has been publicly disclosed about the finances of the plant. Shell has a target of 15% for its petrochemical investments.¹²⁹ As seen in the LCCP case (Appendix 1), when capital costs rise and there is simultaneous downward pressure on the expected sales price for the plastics and petchem products being produced, company return targets are challenged.

Consultant Estimates of Shell Complex and Related Reports

The Shell Petrochemical Complex allegedly will cost \$6 billion to build. This number has been reported widely in the press. The \$6 billion figure, however, has not been publicly disclosed by Royal Dutch Shell or any of its subsidiaries. The company has not disclosed how much it has actually spent or plans to spend on the plant. The \$6 billion figure appears to come from a report written by professors at Robert Morris University (RMU) in 2014.¹³⁰ The report appears to have been paid for by the Shell Corp.¹³¹

The report is unavailable to the public. IEEFA has requested the report from the library at Robert Morris University, which contacted each of the study's four authors and the Shell Corp. The report has not been forthcoming from any of these sources.

Two additional related reports have been prepared by IHS Markit. The first was prepared for the Pennsylvania Foundation.¹³² This report outlines the specific benefits of locating new petrochemical facilities in southwestern Pennsylvania, such as the Shell plant. It outlines higher costs of Gulf Coast versus Northeastern U.S. locations for the industry. It also offers a number of cautions about an oversupplied

¹²⁹ Shell. 2019 Investor Presentation—Management Day. June 2019. p. 72.

¹³⁰ Beaver County (Penn.) TimesOnline. Shell CEO: Cracker plant project ahead of schedule, within budget. September 25, 2018.

¹³¹ Pittsburgh Quarterly. What Will Shell Cracker Bring Along with It? July 21, 2017. According to published reports, that report used a well-known economic modelling program called IMPLAN.

¹³² IHS Markit. Prospects to Enhance PA's Opportunities in Petrochemical Manufacturing. March 2017.

plastics market and competition from existing market players.

A second report was prepared by IHS Markit at the request of Shale Crescent USA. The executive summary of this report emphasizes low-cost feedstock and transportation advantages of locating a petrochemical facility in southwestern Pennsylvania.¹³³ The full report, like the Robert Morris University study, is not available to the general public.

The executive summary presents the questions that are covered in the report and provides some quantification of the report's claims. For example, it poses the question: "Would a nearly \$3 billion investment in an ethylene/polyethylene plant in the Shale Crescent USA earn higher or lower returns than a comparable investment in the U.S. Gulf Coast over a 20-year timeframe?" This statement is misleading. It seems to imply that an 'ethylene/polyethylene' plant would be built with an investment of \$3 billion. An integrated facility, like the Shell complex, would require a far greater investment than \$3 billion. If the IHS Markit study assumed \$3 billion was the total capital outlay for the entire facility, the profit picture would be highly distorted.

The report also states: "Without considering the time value of money, the pre-tax cash flow of the Shale Crescent USA project from 2020 to 2040 amounts to \$11.5 billion, compared to \$7.9 billion for a similar Gulf Coast project, a pre-tax cash flow advantage of \$3.6 billion." The report appears to say that the annual average pretax cash flow is \$575 million. Without additional examination of the debt service, ethane and operational costs, it is impossible to derive a clear understanding of how IHS Markit arrived at its conclusion.

IHS Markit posted a blog item in May 2018 that summarized both studies and stated that the Shell petrochemicals plant currently under construction in Pennsylvania would cost \$10 billion.¹³⁴ The estimate did not provide any data to support the estimate.

Petrochemical Update Construction Cost Escalation

Petrochemical Update publishes regular updates on cracker construction costs on the Gulf Coast and Northeast region.^{135 136}

Over time, the *Petchem Update* offers a series of cost estimates for U.S. cracker plants. The updates from January 2018 through 2020 show price escalations based on the following schedules:

¹³³ IHS Markit. [Shale Crescent USA IHS Executive Summary](#), March 2018.

¹³⁴ IHS Markit. [Petrochemical Cluster: A bright future for the Tri-state region](#). May 25, 2018.

¹³⁵ Petrochemical Update. [Petchem-update](#). April 21, 2015.

¹³⁶ Petrochemical Update. [U.S. Ethylene Complex Construction Costs Data 2018-2020](#). January 2018. Also: Petrochemical Update. [Costs for ethylene projects in the U.S. on the rise: study](#). December 4, 2019. Also: Petrochemical Update. [U.S. Northeast crackers offer market advantages but higher capex](#). January 26, 2018.

Table 2: Construction Cost Escalation Ethylene Complex Construction Data (through 2020)

Cost Escalation Period	Amount Increase
From 2012 through 2017 ¹³⁷	40.00%
2018 ¹³⁸	4.25%
2019	4.00%
2020	3.20%

Source: *Petrochemical Update*.

Using these escalation assumptions, a petrochemical complex priced at \$6 billion in 2014 would result in a 2020 cost of approximately \$9.4 billion.

Lake Charles Chemical Plant

Sasol's LCCP project saw an increase from an initial estimate of \$8.1 billion in 2015 to a near-final construction cost of \$12.9 billion—an increase of 59%. The size of the increase in this case resulted from market factors and significant mismanagement. Other projects similar to the LCCP were finished on time and within their budget.¹³⁹

¹³⁷ Ibid.

¹³⁸ Petrochemical Update. [U.S. Ethylene Complex Construction Costs Data 2018-2020](#). January 2018.

¹³⁹ Business Live. [Sasol: investors dump portfolio stalwart](#), August 22, 2018.

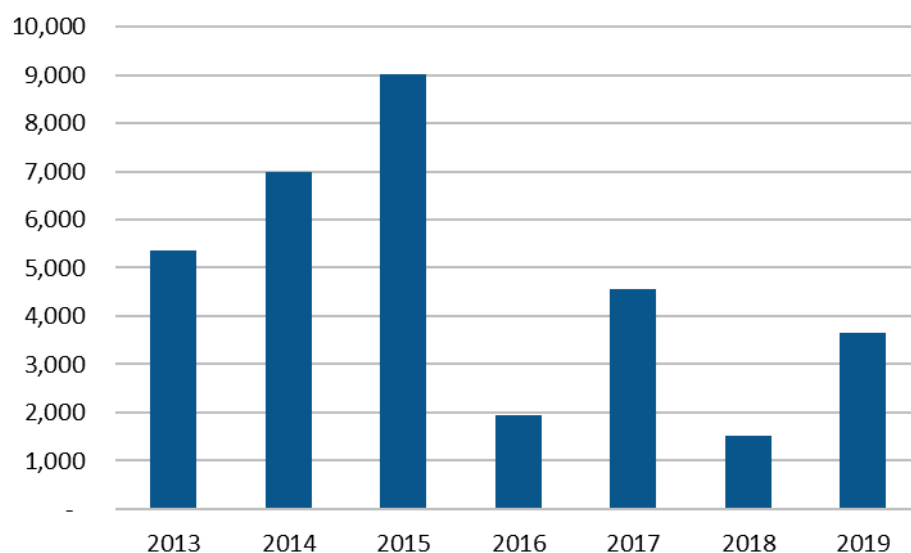
Appendix 3: Shell Impairments

Shell Write-Offs, Selected Data from Years 2013-2019

During the past seven years, Shell has taken write-offs totalling more than \$33 billion. Impairment charges are noted in the company's quarterly and annual filings, along with brief descriptions. The company conducts annual tests for impairment on some assets, while others are tested "whenever events or changes in circumstances indicated that the carrying amounts for those assets may not be recoverable."¹⁴⁰

Impairments related to shale assets in the U.S. comprise a significant share of the company's write-offs. Between 2013 and 2019, shale-related impairments accounted for charges of more than \$9 billion, even after a \$1.27 billion impairment reversal in 2018.

Figure 5: Shell Impairments: 2013-2019 (in millions)



Source: Company filings, 2013-2019.

The following partial list of the company's write-offs is listed by year:

2013

\$5.365 billion, broken down as follows: Exploration & Production \$4.528 billion; Manufacturing, Supply & Distribution \$.305 billion; and Other \$.532 billion.¹⁴¹ The 2013 impairment charge includes \$2.071 billion, mostly related to "liquids-rich

¹⁴⁰ Shell. 2019 20F. Note 2A. "Significant accounting policies, judgments and estimates." 2019. Also: Shell. *Annual Report 2019*, Impairment is reported in notes to the financial statements under the heading of "Significant accounting policies, judgments and estimates," p. 201.

¹⁴¹ Shell. 2015 20F, Note 5. 2015, p. 133.

shale properties in North America."^{142 143}

2014

\$6.983 billion, broken down as follows: Upstream \$3.495 billion; Downstream \$3.396 billion; Integrated Gas \$.092 billion.¹⁴⁴ The \$2.9 billion in Q1 mostly related to refineries in Asia and Europe, and the \$2.406 billion in Q2 mostly related to "tight-gas shale properties in the USA."^{145 146 147 148}

2015

\$9.3 billion, which represented more than 4 percent of the company's market value.¹⁴⁹ These write-offs were primarily related to \$2.3 billion North American shale gas properties and two projects that were halted or cancelled: The Alaskan Arctic, and Canadian oil sands (Carmon Creek).¹⁵⁰ The breakdown was: Upstream \$8.536 billion; Downstream \$.556 billion, and Integrated Gas \$.21 billion.¹⁵¹

2016

\$1.931 billion, as follows: Upstream \$1.274 billion; Downstream \$.588 billion and .072 Integrated Gas, largely related to redundancy and restructuring.^{152 153}

2017

\$4.572 billion, as follows: Exploration & Production \$4.186 billion; Manufacturing, Supply & Distribution \$.376 billion.¹⁵⁴ The largest share of the E&P impairment was the \$2.6 billion "mainly related to divestments of oil sands interests in Canada, offshore in Gabon, and interest in the Corrib gas project in Ireland, and a charge of

¹⁴² Shell. [Q2 2013 Quarterly results](#). 2013, p. 6. Also: Financial Times. [Shell takes impairment on North America as profit slides](#). August 21, 2013.

¹⁴³ Bloomberg. [Shell Begins Sale of U.S. Shale Assets Following Charge](#). September 30, 2013.

¹⁴⁴ Shell. [2016 20F. Consolidated Financial Statements](#). 2015, p. 130.

¹⁴⁵ Shell. [2014 20F. Downstream earnings](#). 2014. Also: CNBC. [Shell earnings fall on refineries impairments](#). April 30, 2014.

¹⁴⁶ Shell. [2014 20F](#). 2014.

¹⁴⁷ [Ibid.](#)

¹⁴⁸ In response to changes to future capital expenditure plans, an impairment review of tight-gas properties in North America was carried out in 2014, resulting in impairment charges of \$2.7 billion in upstream for a number of US properties. Shell. [2015 Annual Report](#). 2015, p.133. There was also an impairment reversal in 2014 of \$0.351 billion, consisting of \$0.1 billion in upstream charges and \$0.251 billion in downstream charges. Shell. [2016 20F](#). 2016. Also: Shell. [2016 Annual Report, Note 5—Segment Information](#). 2016, p. 132.

¹⁴⁹ Shell. [2017 Annual Report](#). 2017, p. 150.

¹⁵⁰ Shell. [Q2 2015 Quarterly Results. 2017 Annual Report](#). 2017, p. 152. Also: Reuters. [Shell's profits hit by big Arctic, Canadian write-offs](#). October 29, 2015. Also: New York Times. [Low Oil Prices Take a Toll on Royal Dutch Shell](#). October 29, 2015

¹⁵¹ Shell. [2016 20F. Consolidated Financial Statements](#). 2016, p. 129.

¹⁵² [Ibid.](#), p. 128. Also: Shell. [2018 Annual Report](#). 2018, p. 187.

¹⁵³ Shell. [2018 20F](#). 2018.

¹⁵⁴ Shell. [2019 20F. Consolidated Financial Statements](#). 2019.

\$1.1 billion related to US tax reform.”¹⁵⁵ There was an impairment reversal of \$.615 billion.¹⁵⁶

2018

\$1.515 billion, as follows: \$1.066 billion Exploration & Production; \$0.441 billion Manufacturing, Supply & Distribution and a number of smaller assets. There was a significant impairment reversal in 2018 of \$1.265 billion, primarily related to assets in North America.¹⁵⁷

2019

\$3.792 billion, as follows: Upstream \$2.586 billion; Downstream \$0.627 billion; Integrated Gas \$0.579 billion.¹⁵⁸ In December 2019, the company announced it expected impairments between \$1.7 billion and \$2.3 billion during the fourth quarter, “based on the macro outlook.”¹⁵⁹ For FY 2019, the largest portion of the write-off was \$1.93 billion, “related to impairments primarily in the U.S. Appalachia unconventional gas assets and a drilling rig joint venture.”¹⁶⁰

¹⁵⁵ Shell. 2018 20F. 2018.

¹⁵⁶ The impairment reversal in 2017 was \$.615 billion, related to Exploration and Production Shell. Annual Report 2019. 2019, p. 216, under the impairment table. Also: 2018 Annual Report. 2018, p. 187.

¹⁵⁷ Shell. 2019 20F. Consolidated Financial Statements, Note 4—Segment Information. 2019. Also: Shell. 2019 20F, Consolidated Financial Statements, Note 8—PPE and Impairments. 2019.

¹⁵⁸ Ibid. Also: Shell. Annual Report 2019. 2019, p. 210.

¹⁵⁹ Shell. Shell fourth quarter 2019 update note. December 20, 2019.

¹⁶⁰ Shell. 2019 20F. 2019.

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