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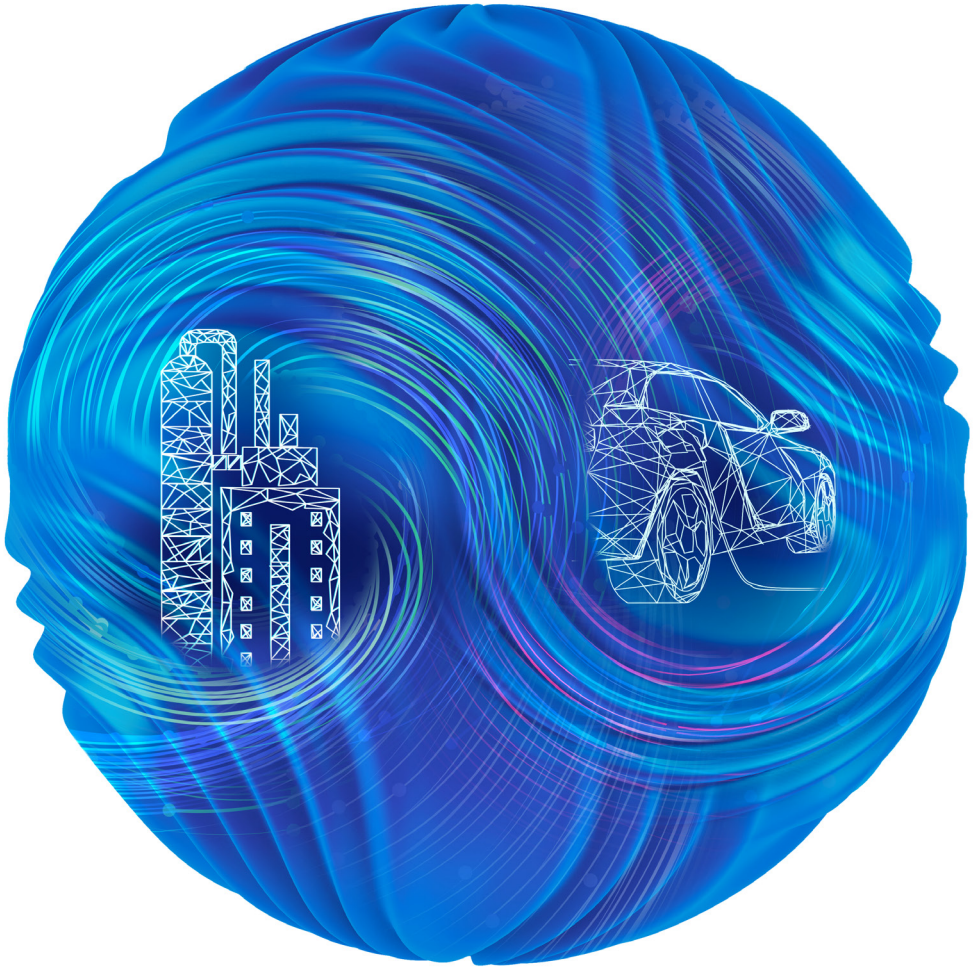


Crossing the chasm to convergence

Achieving a stronger petrochemical-minded business model

MAKING AN IMPACT THAT MATTERS since 1845

Contents

New drivers of downstream convergence

The convergence of the petrochemical and refining industries has often been a successful strategic option for refiners who have grappled with increased globalization, price volatility of feedstocks, and uncertain demand. Further, projections of refined product demand have softened due to growing electric vehicle sales, tightening fuel efficiency standards on passenger vehicles, and the introduction of commercial vehicle fuel efficiency standards in many economies. As a result, convergence between refining and petrochemicals has created optionality to respond to major market pivots.

This trend was particularly evident during COVID-19–as demand for transportation fuels plummeted, demand for intermediates such as isopropyl alcohol (IPA), ethanol, and plastics such as polyethylene and polypropylene skyrocketed.[1] Many of the pure-play refiners felt the harsh impact of COVID-19 with the standstill of the transportation sector due to the lockdowns. In contrast, integrated refiners and petrochemical manufacturers could offset some of the lost revenues due to the demand drop in the transportation sector with the increased demand for personal care and hygiene products (gloves, masks, and hand sanitizers). Companies who had invested in plastics and resins found these businesses provided an effective hedge to collapsing transportation fuel demand. This convergence bolstered the revenue streams and earnings of many international and national oil companies with a chemicals business as upstream revenues declined.

But longer term, moving to petrochemicals may not be the silver bullet for refiners. First, there is a fundamental difference between the refining and petrochemicals businesses: refiners sell into markets, but petrochemical companies sell to customers.

Thus, refiners who are considering moving into petrochemicals should craft a new way to go to market with "decommodified" products. The ability to anticipate and meet changing customer needs is a crucial requirement in the petrochemicals business as companies are closer to the end markets and customers. Embracing customer-centricity involves understanding where buyers are in the marketplace and providing customers with a high-quality buying experience.

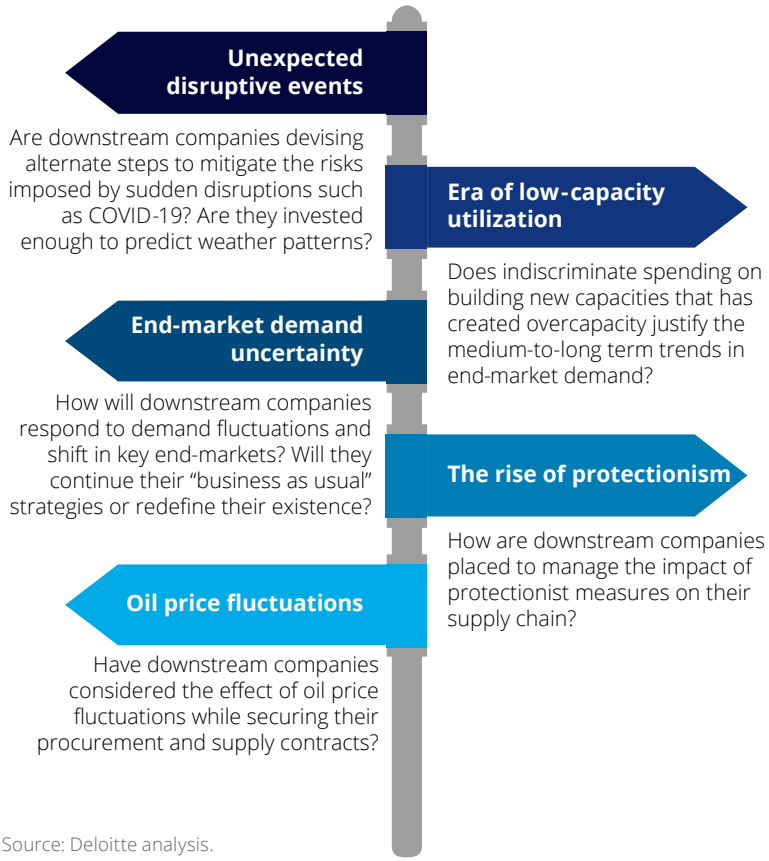
Second, the petrochemicals business often comprises a large and complex product portfolio compared to refining. A typical refinery produces and sells just a few petroleum products: naphtha, gasoline, diesel fuel, asphalt base, heating oil, kerosene, liquefied petroleum gas, jet fuel, and fuel oils. In contrast, petrochemicals represents a larger slate of chemicals used for a variety of commercial purposes. They are usually found in products as diverse as plastics, soaps and detergents, solvents, drugs, fertilizers, pesticides, explosives, synthetic fibers and rubbers, paints, epoxy resins, and flooring and insulating materials. Petrochemical customers consider changing suppliers and materials relatively quickly if their needs are not met. The willingness to switch suppliers makes the petrochemicals business somewhat riskier due to the higher possibility of customer attrition.

Third, there is overcapacity in refining compared to petrochemical capacity, so there may not be room for everyone to compete in that market. Fourth, petrochemical companies face challenges such as evolving end-market demand and new areas of innovation—for instance, crude oil-to-chemicals (COTC).

And these drivers have been accelerated by the events of 2020 (figure 1) particularly in terms of evolving consumer demand and increased focus on sustainability. Though the refining industry has faced challenges previously, the impact of these drivers presents a more complex picture for these companies as they contemplate greater exposure to the petrochemicals markets.

For pure play refining companies to become competitive in the petrochemical business, they should consider ways to differentiate themselves, such as building customer-centricity, honing business-to-business (B2B) and business-to-customer (B2C) strategies, de-commodifying their products to appeal to evolving customer preferences, and recognizing the growing focus on sustainability. Accelerated innovation will likely be critical in building these new capabilities and enhancing product quality through advanced technologies such as data analytics and edge computing.

Figure 1. Growing need for managing risks in uncertain times



Source: Deloitte analysis.

Overcapacity increasing competition

Pure play refining companies contemplating a move into the petrochemical market must address the fact of current overcapacity in the refining industry.[2] This global refining overcapacity is likely to prevail for the rest of this decade, although it is expected to fall from more than 3.5 million barrels per day (MBPD) in 2021 to around 1.5 MBPD by 2030.[3] Even in Asia there is overcapacity that could last another three to five years.[4] For example, China has added around 2.7 MBPD of refining capacity in the last five years, with up to another 1.7 MBPD due to come online by 2025.[5] These expansions have outstripped growth in domestic transport fuel demand and sent more oil products into export markets. Weaker margins will leave over 500,000 barrels per day of regional capacity at the risk of closure, mainly in Australia, New Zealand, and the Philippines.[6] Consequently, most downstream expansions in China are now geared primarily to meeting demand from the petrochemical sector, and capacity additions elsewhere in Asia are likely to mirror this trend.

Global installed capacity for major petrochemicals is estimated to be ~750-850 million tons per year, and the demand ranges between 550-650 million tons annually, which is only a fraction of the current global refining capacity.[7] In other words, ~13 percent (~12-13 MBPD) of current oil refining capacity and ~ 8% (~320-325 billion cubic meters or BCM) of natural gas could power global demand for major petrochemicals, suggesting some future rationalization may be coming in the industry.[8]

This rationalization may hit the older, smaller refineries harder[9] as they will find it harder to compete with the larger, more technologically advanced facilities.

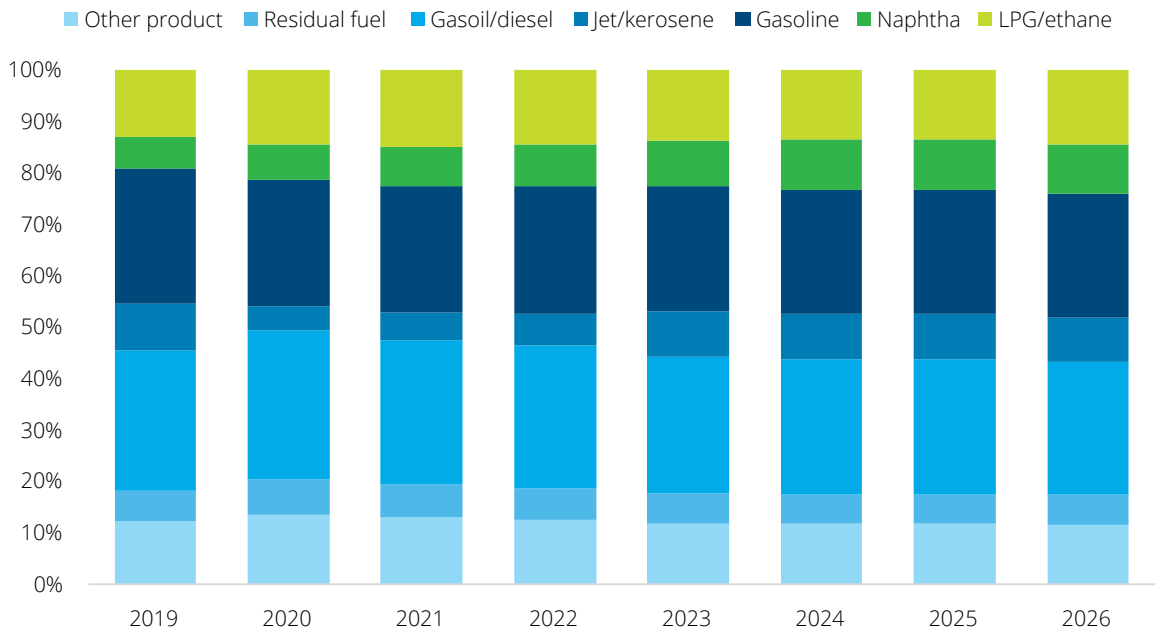
Furthermore, first movers in the petrochemical industry and those with scale are already taking significant market share globally–especially those companies that have an overall refining capacity nearing or exceeding one MBPD.[10] These facilities with close integration of refining and petrochemicals located close to growing demand centers in Asia have a potential competitive advantage. The additional innovation of crude-oil-to-chemicals can make this an even more daunting picture for companies who are still considering their competitive strategy.

Volatile end-market demand

The COVID-19 pandemic showed how rapidly consumer demand could adapt to changing market conditions as consumers focused suddenly on health and safety concerns and changed their purchasing habits substantially. Demand for plastics soared, as curbside pickup became the norm at restaurants and home delivery of consumer goods and groceries—nearly all wrapped in plastic—predominated. Demand for crude oil also shifted rapidly in 2020, as gasoline demand and aviation fuel demand declined due to lockdowns across various regions (figure 2).

Meanwhile, demand for personal protective equipment (PPE)—masks and gloves—soared. To meet the growing demand for PPE due to the pandemic, the industry needed to scale up production by 40% globally in 2020.[11] The global PPE demand is expected to return to close to its precrisis mix after 2021 and keep rising at a CAGR of 6-9% between 2022 and 2025.[12]

Figure 2. Crude oil demand by major products (2019-2026)



Source: Deloitte analysis based on data from IEA's Oil 2021 report.

Another area of evolving market shift is electric vehicles (EVs), which also offer new markets for petrochemical products. Favorable policies, corporate investments, and growing environmental concerns among consumers are expected to drive US EV sales to reach 5.3 million in 2025 from 1.8 million in 2020.[13] Globally, the IEA Stated Policies Scenario forecasts EV penetration could reach just over 20% percent of vehicle sales by 2030. In the Sustainable Development Scenario, penetration as percentage of sales increases to over 35% by 2030.[14] Automakers are planning to increase the mix of EVs in vehicle production, creating new opportunities for battery systems, but less for under-the-hood plastic.

While the decline in internal combustion engine (ICE) vehicle sales and growth in EV sales can lead to lower demand for some petrochemical products (such as fuel additives), it opens new segments around battery materials and high-performance polymers. Figure 3 shows a high-level view of how the future of mobility could affect various materials' classes. In general, the chemical industry can be optimistic about materials that play a role in reducing weight or enabling autonomy. In contrast, materials that are integral to the complexity of the internal combustion engine and its related gearing and powertrain systems will likely be under pressure.

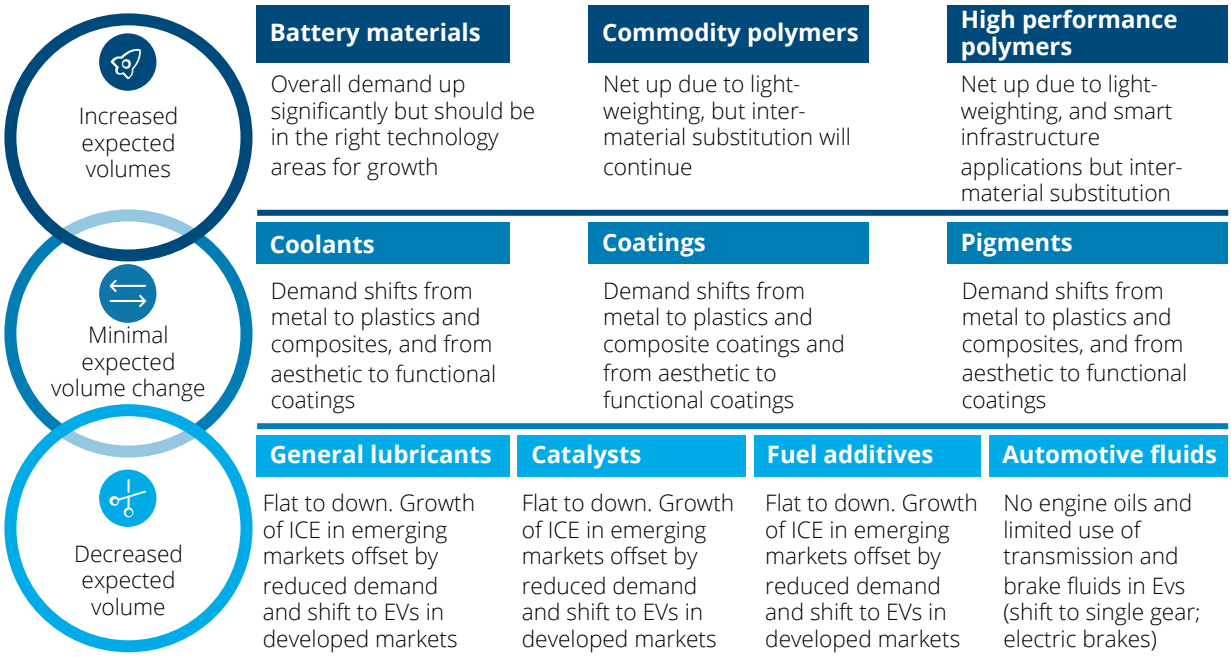
Biofuels offer a potential solution to longer-term structural challenges

Among the many challenges refiners are facing, the most prominent include declining fuel demand, rising carbon constraints, competition from EVs, and growth of alternative fuels such as biodiesel. The near-to-medium-term threat to traditional downstream players is likely limited, but alternative fuel production is growing rapidly from a small base. Today, US renewable diesel consumption is less than 40,000 BPD, much less than the 3.5 MBPD of distillate consumed domestically. By 2030, it could plausibly double.[15] Additionally, almost 1 MBPD of ethanol is sold for blending and used as a transport fuel.[16] While historically most gasoline sold contains up to 10% ethanol, changes in regulations aimed at reducing fossil fuel consumption could lead to increased availability of higher ethanol content fuel.

Biofuels will not likely displace fossil fuel demand in the short term as it represents only a small fraction of the current fuel market. However, the increase in access to EVs and alternate fuel sources will likely incrementally reduce refined product demand growth in the short-to-medium term and could displace it in the longer term.

Slowing demand growth and therefore lower refinery throughput, combined with fixed operating costs, mean companies should increase margins and find new outlets for their products. Therefore, one of the steps that can help conserve capital while meeting demand is assessing the viability of converting refineries into biofuels production plants–an option that should be on the table to protect margins throughout the commodity price cycle.

Figure 3. The impact of EVs on chemicals and materials usage



Source: Deloitte analysis.

End market demand is also showing a trend of bifurcation between wealthier nations and emerging economies. Consumers in wealthier nations with disposable income are often willing to pay more for sustainable solutions like electric vehicles and recycled plastics. Those in developing nations have limited ability to pay for premium-priced products and services. As the differing rates of demand growth between wealthier nations and emerging economies become more pronounced, companies could experience multibillion-dollar market shifts.

In wealthier countries, the 2020s are likely to be characterized by initial high costs to manufacture the sustainable products consumers increasingly seek, such as low-carbon transport fuels and environmentally benign plastic products.

But as companies progress along their maturity cycle, costs will likely come down and demand will rise. For developing economies, the 2020s will likely see increased demand for traditional transportation fuels and plastics.[17] Gradually, as more environmentally beneficial versions of those products are produced for the same or lower costs, emerging economies may well shift to low-carbon transport fuels and plastics derived from biomass and other non-fossil feedstocks.

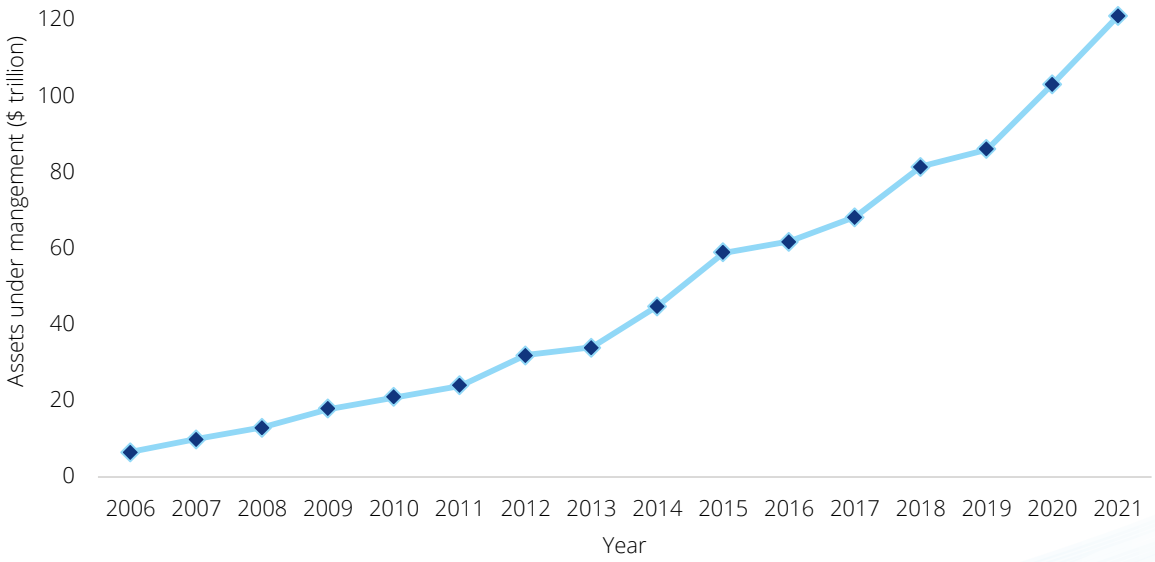
Focus on climate change driving sustainability investments

The growing focus on climate change and emissions abatement is having an impact on capital availability. Investors are increasingly routing funds to perceived low or no-carbon projects and industries. Renewable energy has become a target investment area, even for investors outside of the energy industry. For example, of the estimated 2021 capital expenditure of $254 billion in renewables, nearly 40% is expected to come from pension funds and other financial investors.[18] The rise of environmental, social, and governance (ESG) investing (figure 4) is encouraging change in corporate boardrooms. Oil and gas companies are responding to this investor focus in several ways.

First, in a recent Deloitte survey on energy transition preparedness, 92% of oil and gas and 87% of chemical company executives surveyed responded that their company had an emissions reduction target in place or under development.[19] And of those, 56% indicated that these emissions targets were tied to compensation.[20] For instance, British Petroleum (BP), one of the world's seven oil and gas "supermajors" has a net-zero target which includes net-zero across Scope 1 and Scope 2 emissions,[21] net-zero on carbon in oil and gas production on an absolute basis, and a 50% cut in the carbon intensity of all products sold.[22]

Second, even during the depths of the pandemic, several oil company CEOs reiterated their commitments to reducing emissions, and in some cases, included Scope 3 emissions (emissions generated by the use of their products) in these targets.[23] Seven major oil and gas companies with revenues over $1 billion have disclosed their emission targets and included Scope 3 in their long-term energy transition targets.[24]

Figure 4. Investment dollars flowing into ESG funds



Source: Deloitte analysis based on data from the U.N. Principles for Responsible Investment (UNPRI), an investor initiative in partnership with UNEP Finance Initiative and UN Global Compact.

Evolving consumer preferences

Pure play refiners are used to selling into markets, and so have not had to rapidly pivot their product offerings to capture changing consumer preferences. Refiners considering increased exposure to the petrochemicals business should build capacity to anticipate and adjust to these changes. Consumer preference in the longer term will likely increasingly be driven by product differentiation, convenience, and consumer perception of sustainability impacts of a product or company.

One of the trends most accelerated by the events of 2020 has been a consumer focus on sustainability, and some chemical companies have been quick to respond. Recyclable packaging and circular products have been a growing area of consumer focus with concern for reduced land fill waste and containment of plastic waste found in the oceans. About 40% of today's global plastic waste ends up in the environment in the form of ocean leakage, open burning, and terrestrial leakage.[25] Single-use plastics are the main culprit, and with the onset of COVID-19, the growing use of PPE has only added to plastic waste. The plastic waste crisis will likely outlive COVID-19, and consumer focus on this issue is expected to continue, potentially affecting purchasing behavior. Innovation is needed to solve the single-use plastics issue, and chemical companies are building the agility to respond accordingly.

For example, some chemical companies are differentiating themselves amid this consumer concern. LyondellBasell is developing its proprietary chemical recycling technology and expanding the types of mechanically recycled resin it offers. The company plans to produce and market two million metric tons of recycled and renewable-based polymers per year by 2030. The company has implemented a three-prong approach to advance the circular economy, which helps reduce plastic waste using recycled content, including mechanical recycling, molecular recycling, and renewable feedstocks.[26]

BASF is providing information on the carbon content of its products, including all product-related greenhouse gas emissions for its entire product portfolio. The data includes product-related greenhouse gas emissions that occur until the company's product leaves the factory gate for the customer—from the purchased raw material to the use of energy in the production process. The calculation is based on substantial data from the collection of emissions in its production process and high-quality average data for purchased raw materials and purchased energy. This data helps the company's customers to better measure and reduce their own CO_2 footprint of their activities and end products.[27]

Honing B2B and B2C capabilities

B2B business strategies are evolving in the downstream sector as companies realize they no longer want to position themselves as participants in a commodity market. Instead they should differentiate their products, in terms of convenience, quality, or by their sustainability credentials. And in fact, B2C is becoming a key competitive point, as consumers demand more convenient and "contactless" ways to interact with suppliers. Chemical industry customers are expecting a simplified ordering process and buyers expect better digital experiences and e-commerce solutions, such as live chat.

Advances in digital technology also build success from a customer perspective. For example, application of the smart factory concept to transport, with delivery tracking, customer notifications, and other improvements allows the customer more control. The level of control and the seamless delivery experience also differentiate the product in mind of the customer.

Even as the industry has been slow to move sales online, US downstream sales will likely gain a further foothold in e-commerce in the next few years. Nearly 30% of chemical executives in a recent Deloitte poll indicate that more than 20% of total US chemical sales will be driven by B2B e-commerce in 2021 and beyond.[28]

By leveraging digital tools, downstream companies can become more agile, responsive, and efficient. Digital adoption will likely create more intimate relationships among companies, their customers, and end markets by accelerating products to market through data and insight sharing and meeting customer demand using analytics for demand planning.

Driving innovation and advanced technologies

One of the primary drivers of sustainable growth in the downstream industry continues to be innovation. But the industry's age-old approach to innovation and the status quo might no longer be an option. This is because a staggering amount of change has occurred in the industry, and there could be more to come. So, what has changed? The answer lies in the rise of digital technologies and open digital platforms—which have the capability to accumulate vast amounts of knowledge from varied sources into a single, reliable, searchable format, and leverage machine learning algorithms to develop new innovations quickly and efficiently.

In responding to the changing demand due to COVID-19 pandemic, innovative digital technologies can help rapidly re-engineer products to reduce costs considering changing supply chains. Extended simulations and experiments can now be run on computers that digitally model the product or process outcome and help companies decide on the best combination of design, product, and process attributes that can make a solution highly functional. A few large petrochemical companies are heavily invested in such digital capabilities, allowing them to perform simulations costing a fraction of what actual experiments entail. Such simulations tend to help companies reduce failures during the product development phase and make physical laboratory tests more robust.

With a host of cost-effective digital R&D tools at their disposal, these companies can acquire, amalgamate, and nurture the best combination of systems, products, and processes. Moreover, many new digital capabilities are already in place or underway, which could help build a more intimate relationship with customers and end-markets. These include:

- Leveraging open innovation by collaborating with academic institutes, emerging startups, and technology companies for new ideas and technologies.
- Using advanced analytics to generate actionable and deep insights on first, second, and third-party data to inform operational decisions.
- Building AI-based real-time demand sensing models to leverage market forecasts and shift application portfolio.

Harnessing crude-to-chemicals technology

Electrification of mobility, a significant increase in renewables, and regulation is changing the paradigm and structurally reshaping fuels demand for the future. Refineries, therefore, are increasingly looking for chemical opportunities. Several options ranging from well-known and understood options to emerging opportunities present themselves for current refineries—from conventional opportunities such as expanding propylene from the fluidized catalytic cracking (FCC) unit to non-traditional opportunities such as utilizing vacuum gas oil (VGO) as a cracker feed.

Among these, COTC has high potential because of its large chemicals yields. COTC enables direct production of chemicals from crude oil with yields of over 40 percent.[29] Many such COTC complexes are coming up in China and the Middle East. These COTC projects are mostly pursued by large, integrated oil-and-gas companies hoping to make a dent in the petrochemicals industry. For example, a single COTC complex coming up in the Middle East could produce about 10 million tons of chemicals per year once it becomes operational.[30] Thus, for the first time in history, petrochemical production is being expanded to a refinery scale. Companies could strategically respond by cooperating with integrated oil and gas players pursuing COTC or venturing further downstream in the chemicals value chain i.e., producing intermediate or specialty chemicals. They can also independently pursue COTC technology by tying up with process technology companies.

However, conventional petrochemical producers would likely lose their market position due to COTC's immense petrochemical volume. For instance, any needed global annual capacity additions for ethylene and propylene could nearly be supplied from two large-scale 200,000 barrel-per-day COTC complexes, instead of four conventional state-of-the-art naphtha-cracking light olefins plants.[31]

Growing carbon capture technologies

Today's innovations should facilitate the march to a lower carbon future. For example, there is growing focus on leveraging CO_2 emissions to create brand-new business models by manufacturing CO_2-based chemicals through carbon capture and utilization (CCU) technologies.

CCU technologies use carbon from industrial emissions as a feedstock to produce liquid transportation fuels (such as ethanol and methanol) and chemicals (including building blocks such as formic acid, acetic acid, polyols, and acetone). These processes, which are becoming more prevalent driven by advances in fields such as electrolysis, reduce the amount of CO_2 that would otherwise be emitted to the atmosphere.

Similarly, it is expected that carbon capture and sequestration (CCS) technology will increasingly be used to lower the carbon footprint of facilities using fossil fuel-based feedstocks. Combining CCS with steam methane reforming (SMR) to produce low-carbon hydrogen (blue hydrogen) for process heat marks further innovation towards lower carbon operations. However, this process is still not economically attractive, as the cost of this blue hydrogen can be near $3.00 per kg, which compares approximately with $17 per MMBTU for natural gas.[32] There is room for further pilot projects and innovation to reduce these costs and speed commercialization of this technology.

In 2020, the global carbon capture capacity was approximately 40 million tonnes per year (MTPA).[33] Of this, over 60% of the capacity (or about 25 MTPA) is present in the US, which is likely to increase in the future with various incentives offered by the government to promote CCS.[34] The global installed capacity for carbon capture is less than 1% of the total energy-related CO2 emissions, which was approximately 31.5 billion tons in 2020,[35] even after the impact of COVID-19. To achieve the emissions target, more capacity of CCS needs to come on board.

Successful downstream convergence requires a deliberate strategy

Convergence between refining and petrochemicals remains a sound strategy, but pure-play refiners who are increasing exposure to the petrochemical industry should develop a customer focus, potentially with a more extensive product portfolio, as well as more direct exposure to changing consumer preferences. The three drivers of changing end-market demand, increased focus on sustainability, and innovations such as COTC will likely make competing successfully in the petrochemical market even more of a challenge for pure play refiners entering the market. Furthermore, the smaller size of the petrochemical market compared to the current refined product market will likely make it even more highly competitive, possibly favoring companies with scope located near growing end markets. The ability to differentiate products and build customer relationships can separate the winners from losers. Moreover, the commercialization of new technologies, ranging from crude to chemicals to carbon capture, can also lend a critical competitive advantage to companies that can leverage them.

Companies in the petrochemical industry, both new entrants and established market participants, will need to focus on three areas to differentiate themselves and "de-commodify" their products: planning for volatile end market demand, anticipating consumer preferences for seamless delivery and sustainable products, and capitalizing on innovation. Increasingly these last two elements, consumer preference and technology innovation will be driven by the need to recognize sustainability in the product portfolio, including renewable energy, renewable fuels and carbon capture, sequestration, and storage.

Contacts

Authors

Amy Chronis
Vice Chair – US Oil, Gas & Chemicals Leader
Deloitte LLP
achronis@deloitte.com

Kate Hardin
Executive Director
Deloitte Research Center for Energy & Industrials
Deloitte Services LP
khardin@deloitte.com

Aijaz Hussain
Senior Manager
Deloitte Research Center for Energy & Industrials
Deloitte Services LP
aihussain@deloitte.com

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Global contacts

Rajeev Chopra
Global Leader – Energy, Resources & Industrials
Deloitte Touche Tohmatsu Limited
rchopra@deloitte.co.uk

John England
Global Sector Leader – Oil, Gas & Chemicals
Deloitte Touche Tohmatsu Limited
jengland@deloitte.com

Country contacts

Argentina

Ricardo Cesar Ruiz
Oil, Gas & Chemicals Leader
Deloitte Argentina
riruiz@deloitte.com

Asia Pacific

Mike Lynn
Oil, Gas & Chemicals Leader
Deloitte Asia Pacific
mlynn@deloitte.com.au

Australia

Bernadette Cullinane
Oil, Gas & Chemicals Leader
Deloitte Australia
bernadettecullinane@deloitte.com.au

Brazil

Eduardo Raffaini
Oil, Gas & Chemicals Leader
Deloitte Brazil
eraffaini@deloitte.com

Canada

Andrew Botterill
Oil, Gas & Chemicals Leader
Deloitte Canada
abotterill@deloitte.ca

China

Paul Siu
Oil, Gas & Chemicals Leader
Deloitte Asia Pacific: China
pausiu@deloitte.com.cn

Commonwealth of Independent States

Gennady Kamyshnikov
Oil, Gas & Chemicals Leader
Deloitte Russia
gkamyshnikov@deloitte.ru

France

Olivier Perrin
Oil, Gas & Chemicals Leader
Deloitte Central Europe: France
operrin@deloitte.fr

Germany

Stefan van Thienen
Oil, Gas & Chemicals Leader
Deloitte Central Europe: Germany
stvanthienen@deloitte.de

India

Ashwin Jacob
Oil, Gas & Chemicals Leader
Deloitte Southeast Asia: India
ashwinjacob@deloitte.com

Italy

Paola Rolli
Oil, Gas & Chemicals Leader
Deloitte North South Europe: Italy
prolli@deloitte.it

Japan

Dai Yamamoto
Oil, Gas & Chemicals Leader
Deloitte Asia Pacific: Japan
dai.yamamoto@tohmatsu.co.jp

Mexico

Valeria Vazquez
Oil, Gas & Chemicals Leader
Deloitte Mexico
vavazquez@deloittemx.com

Middle East

Bart Cornelissen
Oil, Gas & Chemicals Leader
Deloitte North South Europe: Middle East
bpcornelissen@deloitte.com

Netherlands

Willem Vaessen
Oil, Gas & Chemicals Leader
Deloitte North South Europe: Netherlands
wilvaessen@deloitte.nl

Nordic

Johannes Wiik
Oil, Gas & Chemicals Leader
Deloitte North South Europe: Norway
jwiik@deloitte.no

South Africa

Jenny Erskine
Oil, Gas & Chemicals Leader
Deloitte Africa
jerskine@deloitte.com

Spain

Felipe Requejo Siguenza
Oil, Gas & Chemicals Leader
Deloitte Spain
frequejo@deloitte.es

Turkey

Gökay Özdemir
Oil, Gas & Chemicals Leader
Deloitte Central Europe: Turkey
gozdemir@deloitte.com

United States

Amy Chronis
Oil, Gas & Chemicals Leader
Deloitte US
achronis@deloitte.com

United Kingdom

Oliver Holder
Oil, Gas & Chemicals Leader
Deloitte North South Europe: UK
oholder@deloitte.co.uk

Endnotes

1. Kumpf Robert, Yankovitz David, Hardin Kate, "The shifting landscape of chemicals and materials", Deloitte, October 2020, https://www2.deloitte.com/us/en/insights/industry/oil-and-gas/covid-19-chemicals-industry-impact.html.
2. According to IEA's Oil Report 2021, about 60 to 65% of the average barrel of crude is processed to yield transport fuels. The remaining demand for refined crude oil and gas is largely from petrochemicals, base oils, and lubricants.
3. Foster Kevin, "Argus Live: Petchem demand drives Asia refining plans", Argus, January 2021, https://www.argusmedia.com/en/news/2181324-argus-live-petchem-demand-drives-asia-refining-plans.
4. Ibid.
5. Ibid.
6. Ibid.
7. Deloitte analysis based on the data from IEA's, "The Future of Petrochemicals: Towards more sustainable plastics and fertilizers", Deloitte analysis based on the data from IEA's, October 2018, https://iea.blob.core.windows.net/assets/bee4ef3a-8876-4566-98cf-7a130c013805/The_Future_of_Petrochemicals.pdf.
8. Ibid.
9. AFPM Communications, "The refining and petrochemical industries: 170 years of innovation", AFPM, October 2020, https://www.afpm.org/newsroom/blog/refining-and-petrochemical-industries-170-years-innovation.
10. Dickson Duane, Yankovitz David, Hussain Aijaz, "Building resilience in petrochemicals", Deloitte, October 2020, https://www2.deloitte.com/us/en/insights/industry/oil-and-gas/building-resilience-petrochemical-market.html.
11. Chaib Fadela, "Shortage of personal protective equipment endangering health workers worldwide", World Health Organization, March 2020, https://www.who.int/news/item/03-03-2020-shortage-of-personal-protective-equipment-endangering-health-workers-worldwide.
12. International Finance Corporation, "Covid-19 – PPE demand & supply perspectives", March 2021, https://www.ifc.org/wps/wcm/connect/1d32e536-76cc-4023-9430-1333d6b92cc6/210402_FCDO_GlobalPPE_Final+report_v14updated_gja.pdf?MOD=AJPERES&CVID=nyiUnTU.
13. Dickson Duane, Yankovitz David, Hussain Aijaz, "Building resilience in petrochemicals", Deloitte, October 2020, https://www2.deloitte.com/us/en/insights/industry/oil-and-gas/building-resilience-petrochemical-market.html.
14. IEA, "Global EV Outlook 2021", IEA, April 2021, https://iea.blob.core.windows.net/assets/ed5f4484-f556-4110-8c5c-4ede8bcba637/GlobalEVOutlook2021.pdf.
15. Rebecca Elliott, "US oil refiners accelerate shift to renewables in downturn," Wall Street Journal, August 2020, https://www.wsj.com/articles/u-s-refiners-embrace-greener-fuels-11597251600.
16. EIA, "Weekly ethanol plant production," September 2021.
17. Kah Marianne, Fulton Lew, Jaffe Amy Myers, Schwartz Mark, Finley Mark, "Will COVID Drive an Early Peak in Transportation Activity and Oil Demand?", Columbia Center on Global Energy Policy, June 2021, https://www.energypolicy.columbia.edu/research/report/will-covid-drive-early-peak-transportation-activity-and-oil-demand.
18. Deloitte, "The Global Energy Transition", Deloitte, June 2021, https://www2.deloitte.com/global/en/pages/energy-and-resources/events/global-energy-trasition-reuters-events.html.
19. Porter Stanley, Hardin Kate, "Navigating the Energy Transition from Disruption to Growth", Deloitte, May 2020, https://www2.deloitte.com/us/en/insights/industry/power-and-utilities/future-of-energy-us-energy-transition.html.
20. Ibid.
21. Emissions are classified into three categories, namely, Scope 1 (direct emissions from combustion of fuel and consumption of raw materials), Scope 2 (indirect emissions such as the third party generated electricity purchased from utilities), and Scope 3 (indirect emissions created when a company's products are used).
22. BP, "BP sets ambition for net zero by 2050, fundamentally changing organisation to deliver", BP, February 2020, https://www.bp.com/en/global/corporate/news-and-insights/press-releases/bernard-looney-announces-new-ambition-for-bp.html.

23. Geck Marshall, "Seven major companies that committed to net-zero emissions in 2020", Principles for Responsible Investment, December 2020, https://www.unpri.org/pri-blog/seven-major-companies-that-committed-to-net-zero-emissions-in-2020/6909.article.
24. Ibid.
25. The Pew Charitable Trusts and SYSTEMIQ, "Breaking the Plastic Wave", The Pew Charitable Trusts and SYSTEMIQ, July 2020, https://www.pewtrusts.org/-/media/assets/2020/07/breakingtheplasticwave_report.pdf.
26. De Luna Marcy, "How LyondellBasell's CEO hopes to tackle industry waste", Houston Chronicle, July 2021, https://www.houstonchronicle.com/business/energy/article/LyondellBasell-CEO-hopes-to-tackle-industry-s-16304887.php.
27. Haupt Christine, "BASF calculates CO2 footprint of all sales products", BASF, July 2020, https://www.basf.com/global/en/media/news-releases/2020/07/p-20-260.html.
28. Dickson Duane, "2021 chemical industry outlook", Deloitte, January 2021, https://www2.deloitte.com/content/dam/Deloitte/us/Documents/energy-resources/us-2021-chemical-industry-outlook.pdf.
29. Dickson Duane, Hussain Aijaz, Kumpf Bob, "The future of petrochemicals", Deloitte, March 2020, https://www2.deloitte.com/us/en/pages/energy-and-resources/articles/base-chemicals-transform-petrochemicals-industry.html.
30. Ibid.
31. Goldsberry Clare, "Crude oil-to-chemicals technology could be game changer for chemicals industry", Plastics Today, June 2018, https://www.plasticstoday.com/materials/crude-oil-chemicals-technology-could-be-game-changer-chemicals-industry.
32. US DOE, "Hydrogen Strategy: Enabling a low-carbon economy", Office of Fossil Energy US department of energy, July 2020, https://www.energy.gov/sites/prod/files/2020/07/f76/USDOE_FE_Hydrogen_Strategy_July2020.pdf.
33. Global CCS Institute, "Global Status of CCS 2020", Global CCS Institute, 2020, https://www.globalccsinstitute.com/wp-content/uploads/2021/03/Global-Status-of-CCS-Report-English.pdf.
34. Ibid.
35. Ibid.

Deloitte.

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