

A photograph of laboratory glassware, including an Erlenmeyer flask in the foreground and a beaker in the background, both containing liquid. The scene is lit with vibrant, out-of-focus colors like blue, green, and purple, creating a bokeh effect. The glassware is reflected on a surface below. The text is overlaid on the right side of the image.

# Growth and innovation in chemicals

A glass half empty or half full?

For decades, chemical industry growth has outpaced GDP growth, and innovation has been an important driver of that growth. Innovation has brought materials with new performance properties, new applications and new solutions to the industry's customers—and their customers' customers.

In short, innovation has always been closely linked to growth in the industry. But today, the need for innovation is greater than ever. Governments have set ambitious targets with ambitious timelines for moving toward sustainability, greenhouse gas (GHG) reduction and the circular economy. And the UN's Strategic Development Goals include a focus on areas such as climate change, clean water, green energy and responsible consumption.<sup>1</sup> At the same time, the industry's customers need to meet their own sustainability goals and pursue growth in areas such as electric vehicles, batteries and 3D printing. Altogether, these trends will require a range of innovative chemical products—creating a tremendous growth opportunity for the chemical industry.

The question is, will chemical companies be ready for that opportunity? To find out, Accenture researchers analyzed chemical companies' investments across six key levers related to growth and innovation: *patents, startups, corporate venturing, partnerships, mergers and acquisitions, and capital projects*. The answer, it turns out, is essentially “maybe.”



# Innovation, today and tomorrow

The analysis paints a mixed picture of the industry. Indeed, whether the “glass is half full” or “half empty” depends on one’s perspective and the timeframes involved.

On the one hand, the industry has well-established innovation capabilities and is pursuing a range of innovations—the glass is half full. It continues to provide a stream of products and solutions tailored to customers’ and end-consumers’ needs, such as materials with improved performance properties and others for batteries and 3D printing. It uses corporate venturing to tap into the innovations of new startups and helps commercialize ideas emerging from academic spin-offs and entrepreneurs. And as the “industry of industries,” it is in position to support its customers’ transition to carbon neutrality and efforts to meet sustainability goals. Indeed, the industry is already on its way to doing just that, having doubled the number of its capital-project announcements in recent years for recycling and plants that leverage new process innovations, such as methanol-to-chemicals technology.

On the other hand, the industry tends to focus on improving today’s products and processes, rather than creating new ones—the glass is half empty. Historically, breakthrough innovations such as polyurethane, nylon and vitamin synthesis drove growth in chemicals and led to the establishment of a new industry—but that was nearly a century ago.

Today, in-house research and development (R&D) is focused largely on incremental improvements to the properties of existing materials. Innovation in chemical processes to reduce GHG emissions, for example, is trailing material-related innovation

significantly. For chemical companies, basic and applied research typically represent higher risk and longer-term payouts, while incremental developments that focus largely on modifying existing products tend to offer faster, more certain returns—and are seen as the “safer bet.”

In the United States, that attitude is reflected in a 9 percentage-point decline in the basic and applied research share of the industry’s total R&D expenditures between 1990 and 2020, in favor of incremental development.<sup>2</sup> Furthermore, capital investment announcements for the classical chemical segments still account for the majority (68%) of published projects, while a similarly dominant share of merger and acquisition (M&A) investments (73%) target extensions to existing products or additional business in segments already served. Those traditional segments and products are highly likely to be left behind by shifts in demand due to customers’ GHG-reduction and circular-economy efforts.

At the same time, there has been tremendous growth in chemical-related startups, which shows that new entrants are working to fill the gaps opened by incumbents in the chemical industry. These startups may well disrupt the chemical industry using new technologies such as artificial intelligence (AI), computational chemistry and solutions for the circular economy and biotechnology.

# The stakes are rising

The industry's "more of the same" approach to innovation will need to change. Customer industries will require leading-edge breakthrough innovations that will enable them to deliver more new products and services, more quickly, to a changing world.

In the very near future, the need for all industries to reduce greenhouse gases will require a massive wave of innovation from chemical companies. And longer term, that requirement will only increase with the continuing focus on sustainability and circular economy solutions.

The chemical industry is at an inflection point where the need for rapid and disruptive innovation is increasing. Government mandates and evolving customer challenges are creating rapid shifts in demand that call for new products and services from the industry. In that world, chemical companies' incremental and narrowly focused approaches to innovation are likely to fall short—and if companies don't change, the demand for innovation will soon outpace their ability to deliver it. That will mean missed opportunity—and an increased potential for being disrupted by new industry players.

For chemical companies, success depends on understanding the six key levers of growth and innovation that are explained on the pages that follow.





# Patents

The research examined more than 100,000 priority patent filings from 100 leading chemical companies in three categories: *materials*, *processes* and *applications*. This was used to gauge the importance of various areas of innovation, while year-to-year changes in share were used to identify increases and decreases in a given category's patent activity. (Figure 1)

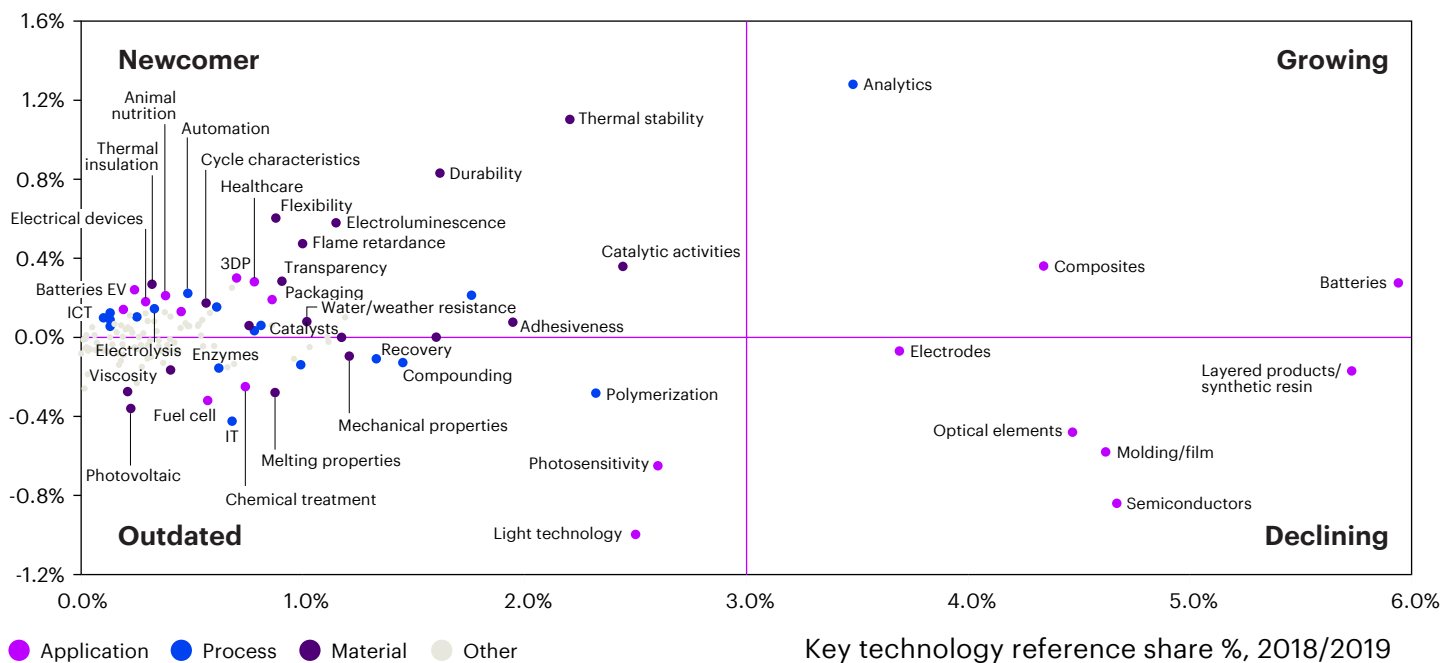
It is important to note that while patent-share analysis is a useful way to assess innovation, there are some caveats. For example, a patent grant requires novelty, usefulness and non-obviousness, which means that many valuable innovations, such as new business models, may not be patentable. In addition, patents require a company to disclose its innovations, prompting some to avoid filing them to keep their intellectual property confidential.

Typically, companies file more patents on products they intend to sell on the open marketplace (where competitors can scrutinize them) and less on production processes, which can be kept confidential and represent a greater intellectual property risk.

The research findings reflect this pattern, with the highest number of patents relating to materials, followed by those focused on applications and then processes. The number of priority patent filings for materials has increased 7% in recent years, slightly surpassing application-related patents, which have traditionally been the most common type of patent in the industry. However, many of these material patents cover incremental improvements of existing materials—rather than new materials—and focus on enhancing performance characteristics such as flexibility, durability, chemical resistance and electroluminescence.

**Figure 1: Patent filing activity**

Reference share, change in % points, 2015/2016 vs. 2018/2019



Source: See endnotes.

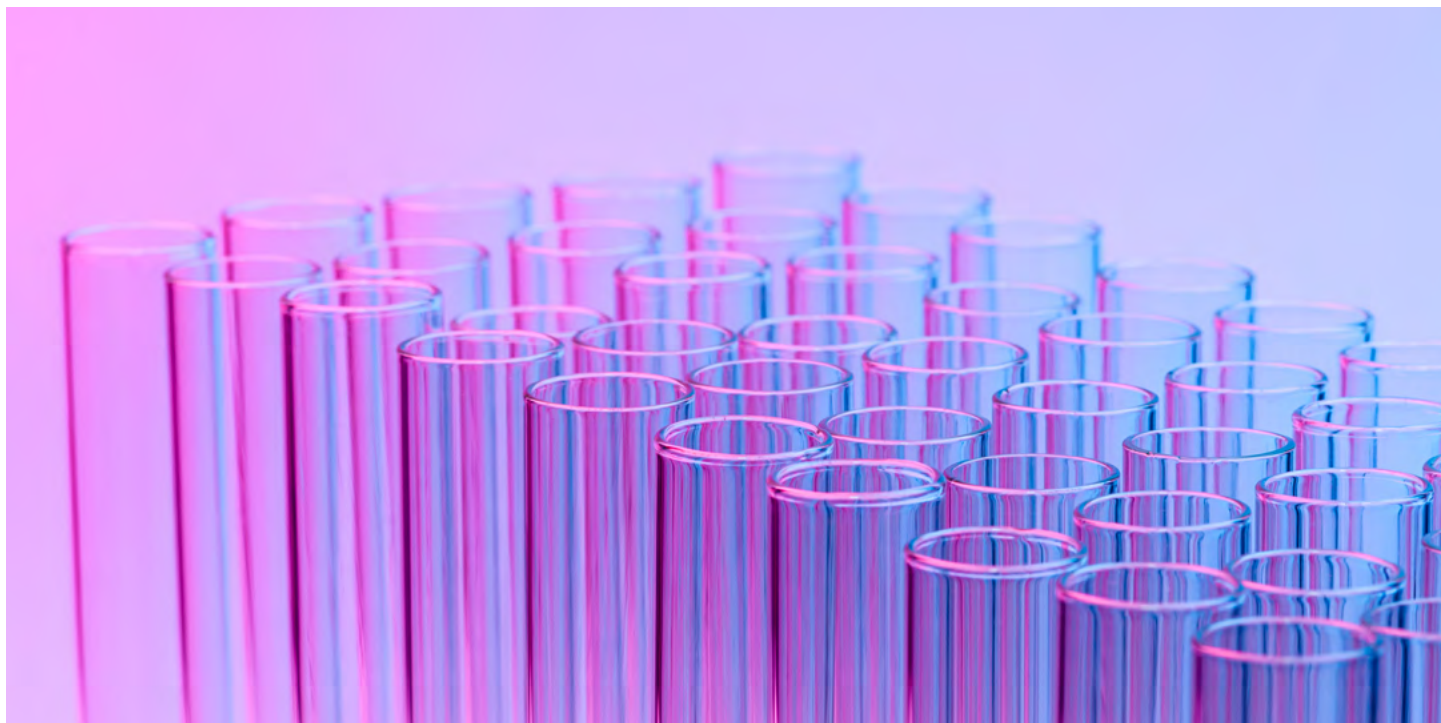
Meanwhile, growth in application patents has been led by layered products/composites, which are needed in applications in the automotive and aerospace industries where weight and strength are critical. Battery-related patents have also seen strong growth, based largely on their importance to the automotive and aerospace industries. The number of filings for applications related to electric vehicles is still small—there were less than 200 from 2015 to 2019—but they have increased enough that it now represents its own new, distinct share.

Process innovation has always been key to increasing yield and quality, and reducing costs in the industry. However, the number of patent references related to chemical processes was half the number related to materials and to applications. This may be due in part to a desire not to publicize process innovations, but it also suggests that the

industry may not be investing enough in the core processes that will be required to reduce carbon footprints and meet the growing demand for more sustainable products.

Among the filings that were made, there was a shift away from biotechnology processes and toward physical and digital technologies. The greatest growth was in patents involving analytics, which doubled in the past five years. Enzymatic process- and genetic engineering-related patents, on the other hand, showed the largest decline, with their share dropping by half over the past five years.

Overall, Accenture's analysis shows that the industry's patents tend to focus on current businesses—on improvements and modifications to existing offerings, rather than breakthrough developments.





# Startups

Looking at more than 1,900 chemical-related startups, the analysis found that this is an especially active area of innovation in the industry, and startups have seen dramatic growth in funding, which has totaled an estimated US\$28 billion in the last decade. In fact, the total 2020 investment in startups is equivalent to more than two-thirds of the total chemicals R&D spend in the United States, for example. Numbers for the first five months of 2021 indicate another year of strong growth. (Figure 2)

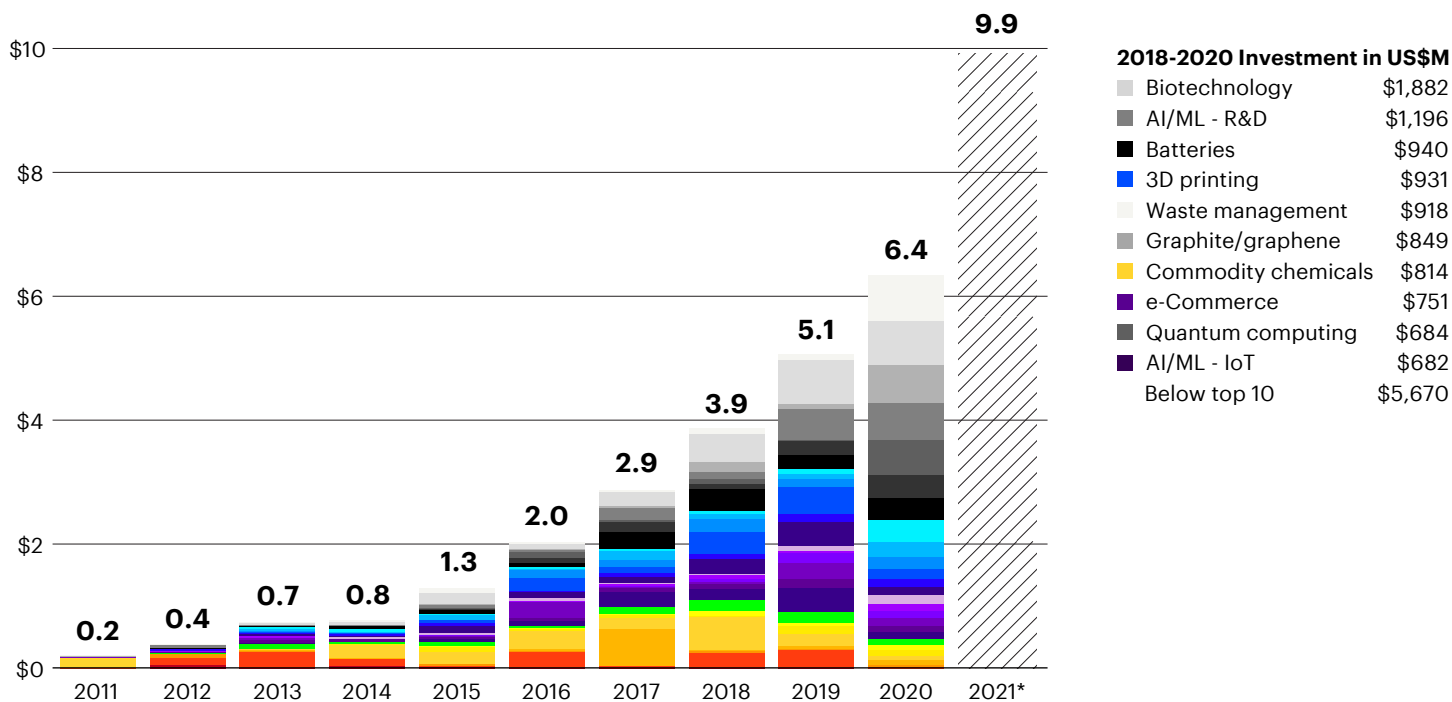
Startups are addressing a number of the industry's important growth and innovation areas, including building materials, waste management, additive manufacturing and machine learning (ML), which together represent about 30% of the total investment amount. Startups are exploring materials that support CO<sub>2</sub> reductions and the circular economy (such as graphene, hydrogen and biomaterials),

which together account for another 10% of investment share. And many support increasing digitalization and the growing use of displays, sensors and chips. Indeed, nearly 20% are investing in digital solutions such as AI/ML for molecule discovery and quantum computing for simulations, or activities in the fields of e-commerce and business-to-business interactions.

The differences between startups and corporate patenting and partnership efforts are striking in several key areas where startups show significantly higher levels of activity than their corporate in-house counterparts. These include platform-based biotechnology innovations and other technology-oriented fields such as AI, ML, Industry X, semiconductors and computational R&D. Startup investments are also going into new recycling processes, as the industry looks to produce more products based on recycled feedstock and materials.

**Figure 2: Funding growth in independent chemical-related startups**

Chemical-related startup investments since 2011 (US\$ Billion)



Source: See endnotes.



# Corporate venturing

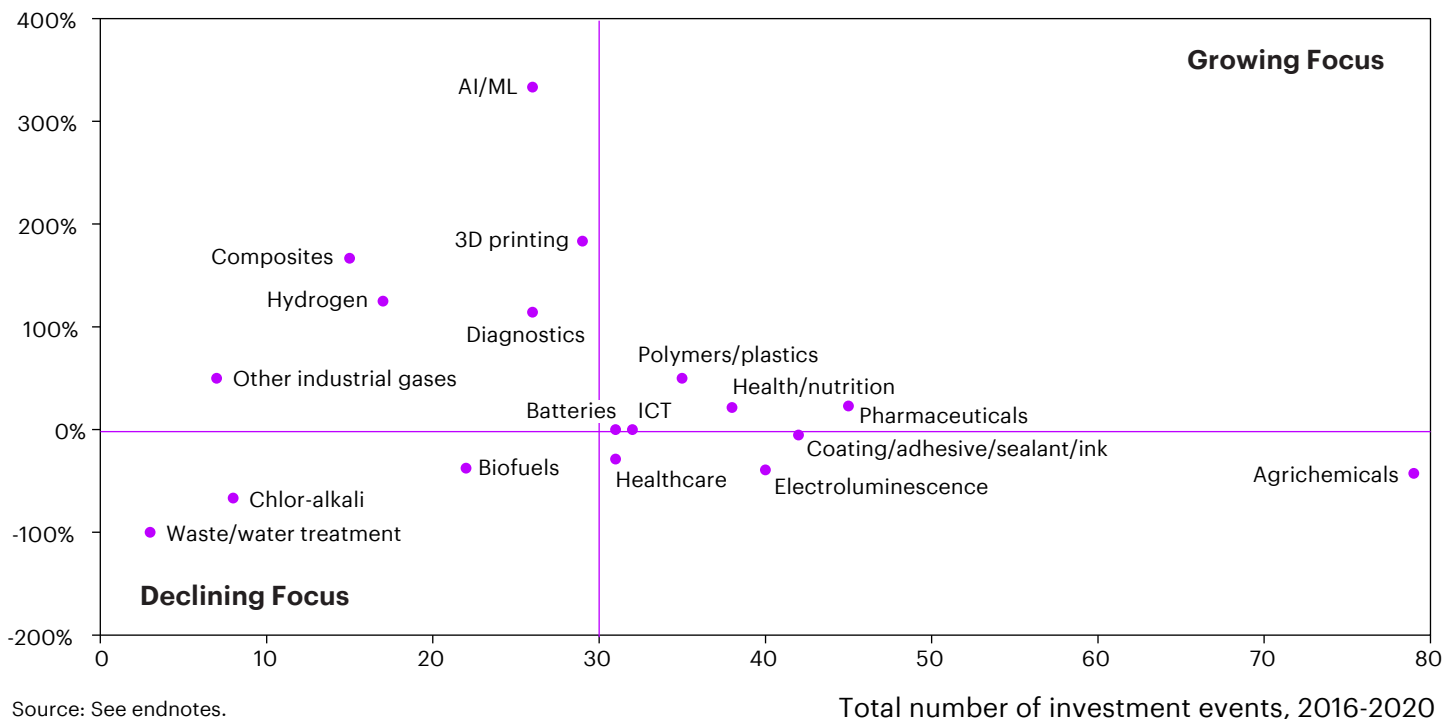
Looking at 100 large chemical companies, the analysis found that much of the industry’s corporate venturing activity—that is, the direct investment of corporate funds into other companies—continues to focus on existing product groups such as agrichemicals, paints and coatings, and food ingredients. (Figure 3)

Companies appear to view their corporate venturing activities as an extension of their in-house R&D efforts, rather than a way to explore uncharted territory. This is illustrated by the difference between corporate venturing activities and startup activities. And instead of seeking disruptive innovations for the market, they are primarily targeting improvements to their internal capabilities and looking for new applications for existing molecules.

However, the picture changes when considering the growth rate of technology-related investments. The number of venture capital investments in several technologies has increased significantly, including AI, 3D printing, hydrogen/fuel cells and analytics. These areas represent new frontiers for the industry, outside of the core business and the traditional, pure chemistry-related technologies—areas where companies presumably see potential for innovation.

**Figure 3: Corporate venture capital investments**

Growth, %, 2016/2017 to 2019/2020



Source: See endnotes.





# Partnerships

The analysis of 100 large chemical companies showed an increase in their use of partnering to enhance innovation, with the number of announced partnerships growing nearly 30% year-on-year for several years. A dominant focus of these partnerships is production, accounting for an average of 33% of announced partnerships. (Figure 4) This is not surprising, given the importance of integrated material flows, offtake agreements, stable supply and interlinked production methods in the industry.

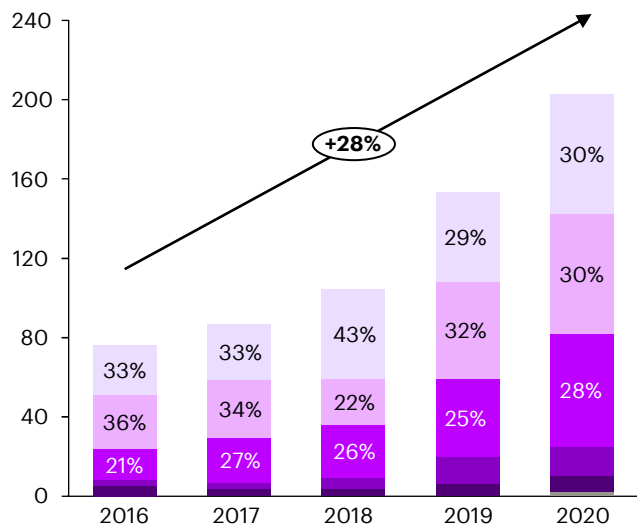
Getting close to the customer is a well-established credo in the industry. While partnerships with customers increased in 2020, averaged over five years they are still less frequent (26%) than chemical company-to-chemical company partnerships (33%). Looking forward, a number of the fields that are projected to show high demand growth—such as

3D printing and circular economy products and processes—will require close collaboration across industries and thus, a stronger focus on partnering with customers.

The chemical industry should also consider increasing its partnering efforts with technology providers. As an asset-intensive and data-rich industry, it has substantial potential to use AI, ML, analytics, Industry X, quantum computing and so forth to further improve operations and extract value from data and assets. Currently, however, there are only a few partnerships with digital technology providers, and these are being formed by just a few of the largest chemical companies. In an age of increasing digitalization, chemical companies should consider expanding and accelerating their partnering efforts in this arena.

**Figure 4: Partnerships by functional area and type**

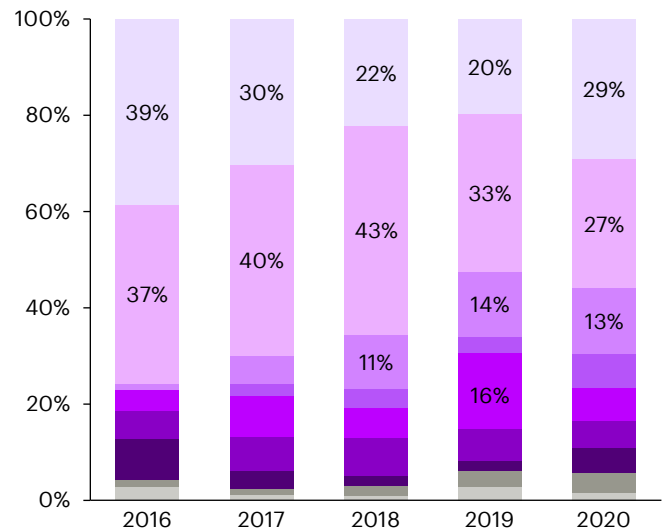
Partnership press announcements – by functional area



- Production
- R&D
- Market
- Process/Technology
- General
- Logistics

Note: Select data points shown.  
Source: See endnotes.

Partnership press announcements – by partner type\*



- Customers
- Chemical companies
- Suppliers
- Distributors/Logistics
- Others
- IT providers
- Academia
- Engineering firms
- Energy companies

\*Excludes partnerships with associations

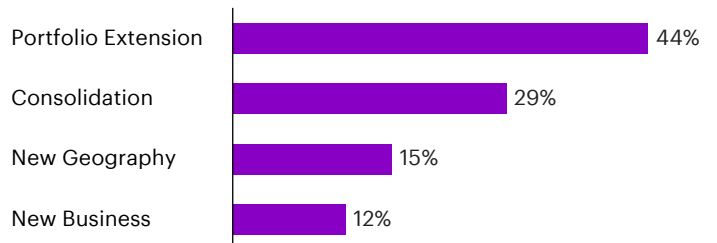


# Mergers and acquisitions

The analysis looked at more than 500 M&A transactions with a total value of more than US\$300 billion. Portfolio extension—the expansion of products and services complementary to what a company already offers—was the most common category, accounting for 44% of total transactions in the 2016 to 2020 period. That was followed by consolidation—the addition of businesses in segments that a company already services—at 29%. Entering new geographies accounted for 15%, while only 12% of transactions focused on moving into new businesses. (Figure 5)

**Figure 5: Mergers and acquisitions by category**

Share of transactions 2016-2020

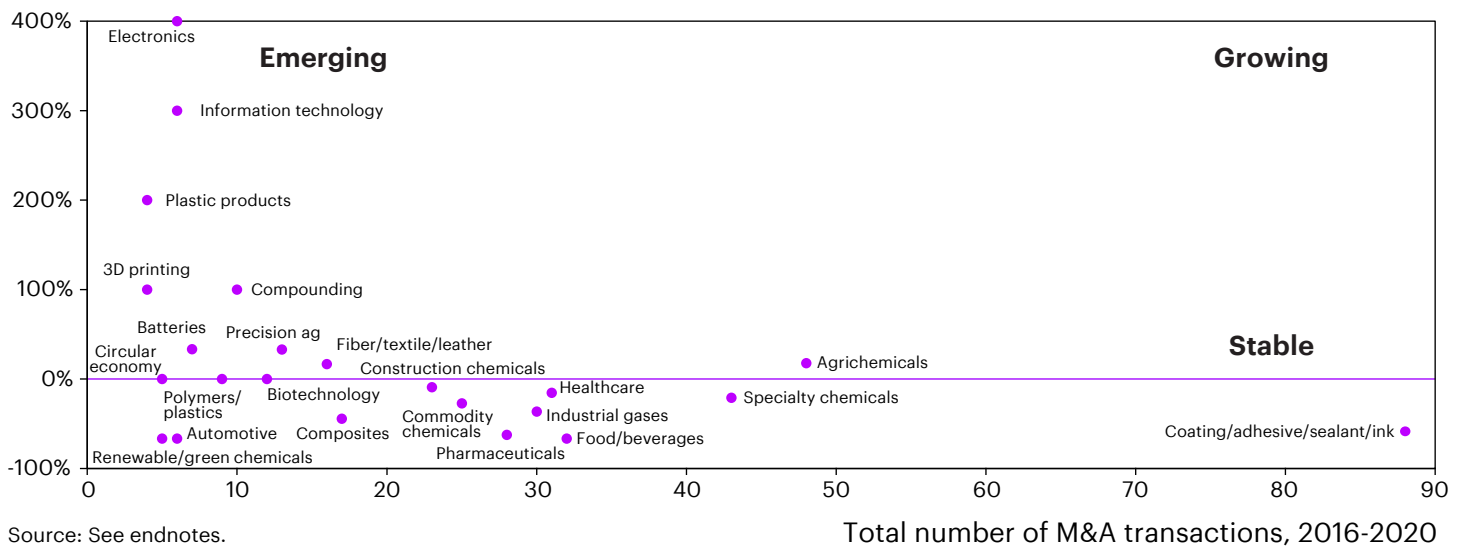


Source: See endnotes.

Looking at the products and offerings of M&A activities, the highest growth rates—involving up to four-fold increases—were for transactions that involved chemicals and solutions for electronics, information technology and plastics products. However, the majority of M&A deals took place in coatings, adhesives, sealants and inks, in agrichemicals or in “traditional” specialty chemicals. (Figure 6)

**Figure 6: Industry focus of merger and acquisition activities**

Growth, %, 2016/2017 to 2019/2020



Source: See endnotes.



# Capital projects

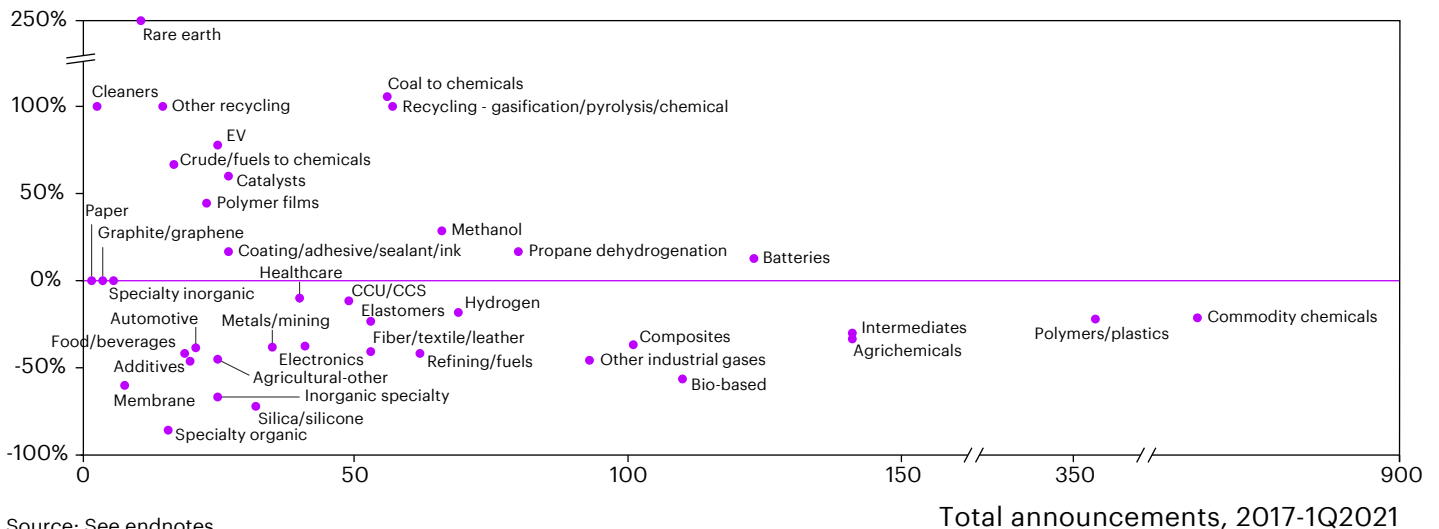
The analysis of more than 2,600 industry capital projects announced in the last four years showed some investing momentum in newer fields such as batteries, recycling and pyrolysis (Figure 7). However, a majority of investments (68%) are still going into traditional areas such as basic and intermediate chemicals, thermoplastics and fertilizers. In fact, even though these traditional areas have seen a decline in announced investments, they still outnumber battery and bio-based projects by a factor of 10, and recycling and pyrolysis projects by a factor of more than 30. The significant decline in bio-based raw material projects is also noteworthy, even though these still account for a significant portion of overall capital project investments.

Rare earth-related projects have had the highest growth rates, with a 250% increase (admittedly starting from a fairly small base). This has been fueled not only by increasing demand driven by everything from cell phones and computers to electric car batteries and satellites, but also by concerns over supply chain challenges and dependence on Chinese suppliers, which could impair future availability.

The analysis showed that the industry is seeing some companies shifting their capital project investments to new segments related to the circular economy and GHG reductions, but here again the numbers are still fairly small. This indicates that many are not pivoting quickly enough to meet increasing near-term demand growth in areas such as recycling and batteries, and may be “betting” too heavily on facilities for the production of conventional polymers and other products—which may be exposing them to the risk of not building the circular economy assets (e.g., chemical recycling plants) that will be needed in the future.

**Figure 7: Announcements of capital projects**

Growth, %, 2017/2018 to 2019/2020



Source: See endnotes.

# The growing risk of disruption

**For chemical companies, customers face a range of challenges that will soon lead to a rapidly growing need for lower-carbon, more sustainable and more circular products.**

That need is likely to expand as companies and nations work to meet ambitious GHG emissions and net-zero carbon goals by 2050. However, the current patterns of industry investment do not fit with that shift in demand. Indeed, they could tend to “lock in” resources to today’s technologies and processes, making it all the more difficult to accelerate innovation in the coming years.

If chemical companies fall behind in the race to deliver more innovation on more fronts, they run the very real risk of not being able to exploit the major growth opportunities that will be created by shifting demand. Even more troubling, they also run the risk of being disrupted by new industry entrants that can move more quickly along the innovation curve.

Today, there are a growing number of chemical-related startups that are essentially filling the innovation gaps opened by the industry’s traditional, limited approach. Many of them are pursuing leading-edge and potentially disruptive innovations. What’s more, many of these smaller, nimble companies are targeting key industry growth areas. For example, startups are far more involved than corporate venturing in exploring new approaches to recycling and inputs into circular-economy solutions. Indeed, corporate venturing appears to be focusing on a few selected areas, and essentially ignoring a number of innovation fields where startups are very active.

The relative size of chemical companies’ investments is also cause for concern for established companies. While the industry spends billions on R&D and venture capital, those investment levels have essentially stagnated.

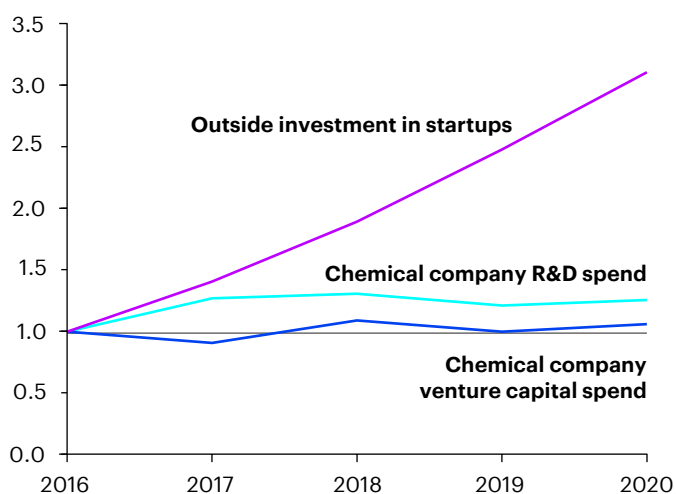
At the same time, investment in chemical-related startups—much of it coming from outside the industry—has seen strong growth over the past five years, with initial data for 2021 indicating that this growth is continuing (Figure 8).

These issues are complicated further by the emergence of computational chemistry and the increasing use of tools such as AI and ML in R&D. These technologies have the potential to not only make research faster and more predictive, but to also make it less asset-intensive, with greater reliance on virtual experimentation. As a result, they are likely to reduce the barriers to entry for new innovators in the industry, opening up yet another avenue of risk and disruption.

As these trends continue and startups gain more traction, chemical companies are likely to find themselves facing competition from the new products, processes and technologies being released by new players in the industry. They are, in a sense, ceding future innovation to the startups—and as a result, becoming increasingly vulnerable to disruption.

**Figure 8: Innovation—startups vs. chemical companies**

Chemical company R&D and venture capital spend vs. startup investment (Index 2016=1)



Source: See endnotes.

# Jump-starting innovation in the industry

Today's approaches to innovation will not be sufficient for tomorrow. To reduce the risk of disruption and take advantage of new growth opportunities, chemical companies will need to reshape their innovation efforts.

They will need new approaches to risk taking, new technology, agile R&D and technology teams, and innovation-centered KPIs for running the business. But more fundamentally, they will need to challenge established thinking, rebuild old line-management structures and move beyond the short-term profit focus that restricts innovation. They will need to change a mindset that has been in place for more than a century—and that makes the re-thinking of innovation a business imperative for the CEO.

Decarbonization, the circular economy, renewable energy and new technologies are creating new challenges for the chemical industry, but they are also driving demand for new offerings. There are tremendous opportunities for chemical companies in this changing world. But as the research shows, positioning them for growth will depend on recognizing these trends and realigning the focus of their investments. Chemical companies will need to keep improving the core business—but at the same time, they will need to enhance their innovation capabilities and cast a wider net that encompasses a broad and evolving range of new products, processes and services.

## About the research

The Accenture Study on Growth and Innovation in Chemicals defined and analyzed the innovation lifecycle in the chemical industry across six key levers: **patents, startups, corporate venturing, partnerships, mergers and acquisitions, and capital projects.** For each lever, clusters of primary data were created, and traditional as well as advanced analytics were applied to extract insights. The research encompassed the following:

**Patents:** More than 100,000 patents (filed 2015-2019, published by July 2021) from in-house R&D

**Startups:** Outside investment in more than 1,900 operating chemical-related startups since 2016, with the startups founded after 2010

**Corporate venturing:** More than 500 venture capital investments by chemical companies since 2016

**Partnerships:** More than 600 partnership announcements since 2016

**M&A:** More than 500 M&A transactions between 2016 and 2020

**Capital projects:** More than 2,500 capital outlay announcements since 2016

## References

All data points in this report are from the Accenture Study on Growth and Innovation in Chemicals except as indicated below.

<sup>1</sup> Sustainable Development Goals, United Nations website, accessed September 28, 2021, <https://www.un.org/sustainabledevelopment/sustainable-development-goals>.

<sup>2</sup> American Chemistry Council 2021 Guide to the Business of Chemistry, <https://www.americanchemistry.com/chemistry-in-america/data-industry-statistics/resources/2021-guide-to-the-business-of-chemistry>.

## Figure Sources

**Figure 1:** Accenture Research based on Derwent Innovation™ (Clarivate © 2021); analysis of more than 100,000 priority patents filed by 100 leading chemical companies; labeling includes only select high/low growth and high reference share IPC8 codes (group level) representing 62% of all filed patents; grey dots represent remaining fields.

**Figure 2:** Accenture Research based on Quid® analysis of 1,974 selected chemical-related startups since 2010 from © Capital IQ, total of US\$28bn; 2021 estimated based on data from first five months.

**Figure 3:** Accenture Research based on Quid® analysis of more than 500 corporate venture investments by 100 chemical companies from © 2021 Capital IQ, business focus of private and minority investment.

**Figure 4:** Accenture Research based on Quid® analysis of 621 “partnership” announcements of 100 chemical companies in the press.

**Figure 5:** Accenture Research based on Quid® analysis of 587 M&A transactions of 100 chemical companies from © 2021 Capital IQ.

**Figure 6:** Accenture Research based on Quid® analysis of 587 M&A transactions of 100 chemical companies from © 2021 Capital IQ.

**Figure 7:** Accenture Research analysis of 2,650 press announcements since 2017; Some projects link to multiple projects/topics; gasification/syngas/chemical recycling includes coal gasification, as well as waste gasification/pyrolysis. Some rare earth announcements may link to batteries as well.

**Figure 8:** © 2021 Capital IQ; Accenture Research based on Quid® analysis of 100 chemical companies.

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