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Innovation for a sustainable world

**Practical implications for
the chemical industry**





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EXECUTIVE SUMMARY

The world is decarbonizing. Plans to cut carbon emissions to meet commitments to the Paris Agreement on climate change and those made at COP26 are producing a flurry of corporate, national, and international initiatives aimed at eliminating net greenhouse gas emissions by mid-century. The EU projects that it will reach net zero by 2050 and aims to cut its emissions by half over the next decade. China has announced it will reach net zero by 2060; India by 2070. At the same time, customers and end-consumers are placing new demands on all industries to ensure that the products and the services they deliver are not adding to the problem.

This powerful trend places a particularly stringent set of demands on the chemical industry because it accounts for a large share of global emissions. It is an energy-intensive industry that relies on hydrocarbons for raw materials. And about 50% of its total emissions are Scope Three, i.e., the results of all activities of the organization or its assets along the value chain. Reducing these emissions will require huge investment. To further aggravate matters, as the International Energy Agency (IEA)¹ points out, the technologies for achieving 75% of the required emissions cuts by 2050 are not commercially available today. That uncertainty is apparent in three scenarios developed by the German Chemical Industry Association (VCI) that show the possible development of greenhouse gas (GHG) emissions over time (see *Exhibit 1, next page*).

But these challenges also present the chemical industry with a particularly powerful set of opportunities to position itself as a key partner in the sustainability-driven transformations of its customers' industries. Because they are essential participants in the manufacturing value chain, chemical companies that prepare early to comply with more rigorous environmental, social, and governance (ESG) standards will build an advantage. And their response to address ESG pain points will spur important innovation. Leading companies already report that their innovation portfolios are shaped to an increasing degree by such pressures.

However, few of these firms are taking advantage of the full suite of strategies available to them. And that's vital, because reaching net zero will require a root-and-branch transformation. This can only be achieved by unleashing far-reaching innovation within the chemical industry and its value chain, and by implementing ESG-driven innovation management. Recognizing the importance of the moment, last year, the IEA called for "urgent efforts to accelerate innovation."²

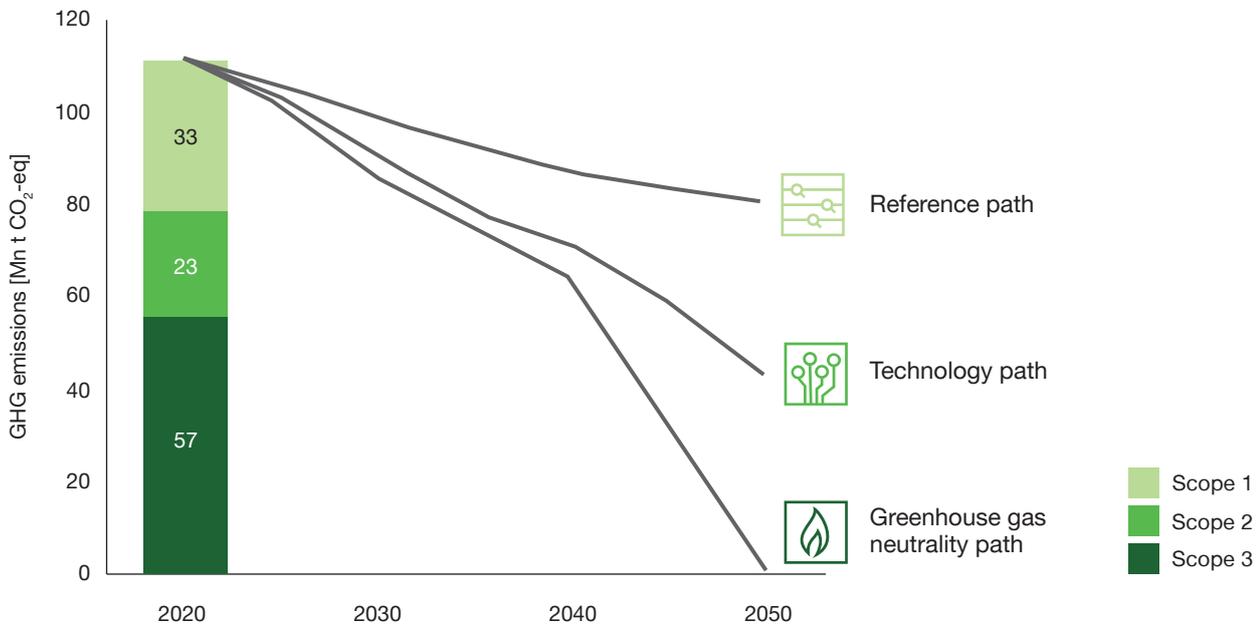
Many businesses appreciate that they must innovate and change but are unsure where to begin. In our daily work with clients and through interviews we conducted with key stakeholders, we have observed six distinct trends common to the most innovative companies in the chemical sector. Increasingly, ESG is central to all of them.

¹ Sarah George, "IEA: Most technologies needed to achieve net-zero aren't yet mature," Euractiv, July 7, 2020, <https://www.euractiv.com/section/energy/news/iea-most-technologies-needed-to-achieve-net-zero-arent-yet-mature>.

² IEA, IEA at COP26: Working together to accelerate clean energy technology innovation, Nov. 4, 2021, <https://www.iea.org/events/iea-cop26-working-together-to-accelerate-clean-energy-technology-innovation-2>.

EXHIBIT 1

Scope One, Scope Two, and Scope Three greenhouse gas emissions scenarios, today and in the future



Source: <https://www.vci.de/vci/downloads-vci/publikation/2019-10-09-studie-roadmap-chemie-2050-treibhausgasneutralitaet.pdf>

Six hypothesis for ESG-driven innovation

1. Innovating beyond regulatory requirements to respond to customer demands.
2. Aligning ESG-driven innovation with the authentic identity, or “true north,” of the business. This ensures that innovation strategies are purpose-driven and deliver the right value to stakeholders.
3. Adopting a hybrid corporate–business unit operating model for innovation that can respond quickly to changes in a highly dynamic environment.
4. Building an innovation ecosystem with external partners to gain access to complementary capabilities and increase the value pool.
5. Leveraging external funding opportunities for innovation to mitigate the costs and uncertain time horizons of ESG transformation.
6. Adopting innovation impact metrics that include new concepts such as value to society and the environment.

It is our belief that this holistic approach to innovation can both increase the value-creation potential of businesses and secure their future license to operate in a broader social and regulatory context. Below, we look at each of these trends in detail.

1. Innovating beyond regulatory requirements to respond to customer demands

Climate and environmental legislation is placing new demands on many industries. In China, for example, environmental action plans such as Air Ten, Water Ten, and Soil Ten outline heavy penalties for pollution by the chemical industry. Enforcement of these plans has resulted in the closure of many smaller manufacturers that were heavy polluters. In Europe, the EU already requires certain large companies to disclose information on the way they operate and manage social and environmental challenges.³ These reporting requirements are now being extended to all publicly listed companies and large unlisted groups, under a proposal for a Corporate Sustainability Reporting Directive.⁴

As key players in the manufacturing value chain, chemical companies stand to gain an advantage through early preparation to comply with more stringent ESG standards. Innovation that addresses ESG pain points is an important aspect of these efforts, and leading companies report that ESG-related ratings and frameworks increasingly play a role in shaping their innovation portfolios.

Many industrial customers are going beyond regulatory requirements and asking their suppliers to come up with sustainable solutions to meet their own ambitious ESG targets and those of their end-consumers. Our clients, for example, report that ESG considerations are more important than ever in guiding the decisions of purchasing departments, particularly in B2C industries.

These trends pose particular challenges for the chemical and materials industries, as they are both energy intensive and heavily dependent on hydrocarbons for their raw materials. At the same time, ESG-driven client demands create a real opportunity for chemical companies to leverage innovation and position themselves as key sustainability transformation partners.

³ European Commission, Corporate sustainability reporting, accessed Jan. 2022, https://ec.europa.eu/info/business-economy-euro/company-reporting-and-auditing/company-reporting/corporate-sustainability-reporting_en.

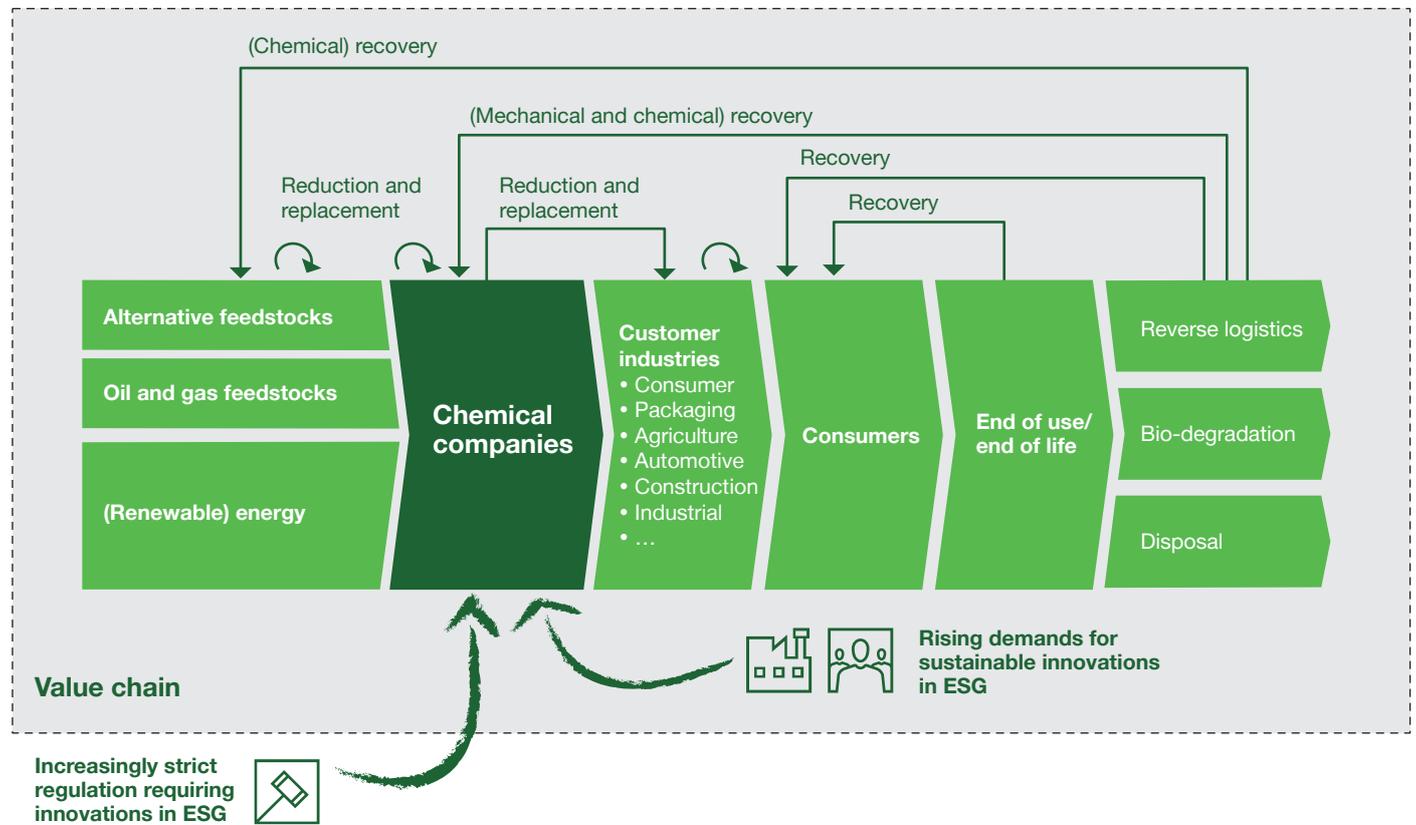
⁴ Financial Stability, Financial Services, and Capital Markets Union, European Commission, "Proposal for a Corporate Sustainability Reporting Directive (CSRD)," Sustainable finance package, Apr. 21, 2021, https://ec.europa.eu/info/publications/210421-sustainable-finance-communication_en#csrd.



An ESG-driven approach to innovation should involve assessment of a company's entire value chain and ecosystem. As key intermediaries in many industries, chemical companies must examine the opportunities for sustainable innovation in their own operations and across their value chains to respond to both regulatory and customer needs (see *Exhibit 2*).

EXHIBIT 2

Chemical companies are in a “sandwich” position between increasing requirements and rising customer and consumer demands



Source: Strategy& analysis

Due to the central position they occupy, chemical companies have an opportunity to influence ESG innovation across entire value chains. Potential interventions include innovations to reduce emissions and waste, the replacement of inputs with lower-carbon alternatives, and the recovery and recycling of materials and products at end-of-use or end-of-life. Innovation in products, processes, and business models can help value-chain players to comply with and, in some instances, even shape regulation (see *Exhibit 3*).

EXHIBIT 3
The three principal components of the innovation design space

	R eduction	R eplacement	R ecovery	R egulation
 Product innovation	<ul style="list-style-type: none"> • Reduce volume per consumption and increase performance • Reduce repurchase frequency and increase durability/extend product life 	<ul style="list-style-type: none"> • Replace traditional fuel based materials and feedstocks by alternative feedstocks • Replace traditional energy sources by renewables 	<ul style="list-style-type: none"> • Repair by end consumers • Reuse by end consumers • Extend product life by discovering second market 	<ul style="list-style-type: none"> • Comply with regulatory, standards and certifications • Integrate sustainability performance in reporting • Set industry trends and impact industry standards
 Process innovation	<ul style="list-style-type: none"> • Reduce material waste and increase material efficiency/yield • Reduce energy consumption and increase energy efficiency 	<ul style="list-style-type: none"> • Replace disposal product design by design for efficiency and recovery • Replace conventional production processes/ synthesis route by using environment friendly processes and solvents 	<ul style="list-style-type: none"> • Remanufacture by material processors (in process recycling) • Recycle mechanically • Recycle chemically • Recover energy from end-of-life products 	
 Business model innovation		<ul style="list-style-type: none"> • Replace delivery methods and logistics by considering carbon footprint 	<ul style="list-style-type: none"> • Reuse transportation aids 	

Source: Strategy& analysis



Leading practices

German chemical multinational BASF and German energy giant RWE have signed a cooperation agreement to develop a two gigawatt offshore wind farm. Green energy will power the world's largest integrated chemical complex, in Ludwigshafen, Germany, and enable the emissions-free production of hydrogen. The aim is to remove fossil fuels from the production processes for basic chemicals, utilizing CO₂-free technologies such as electrically heated steam cracker furnaces.

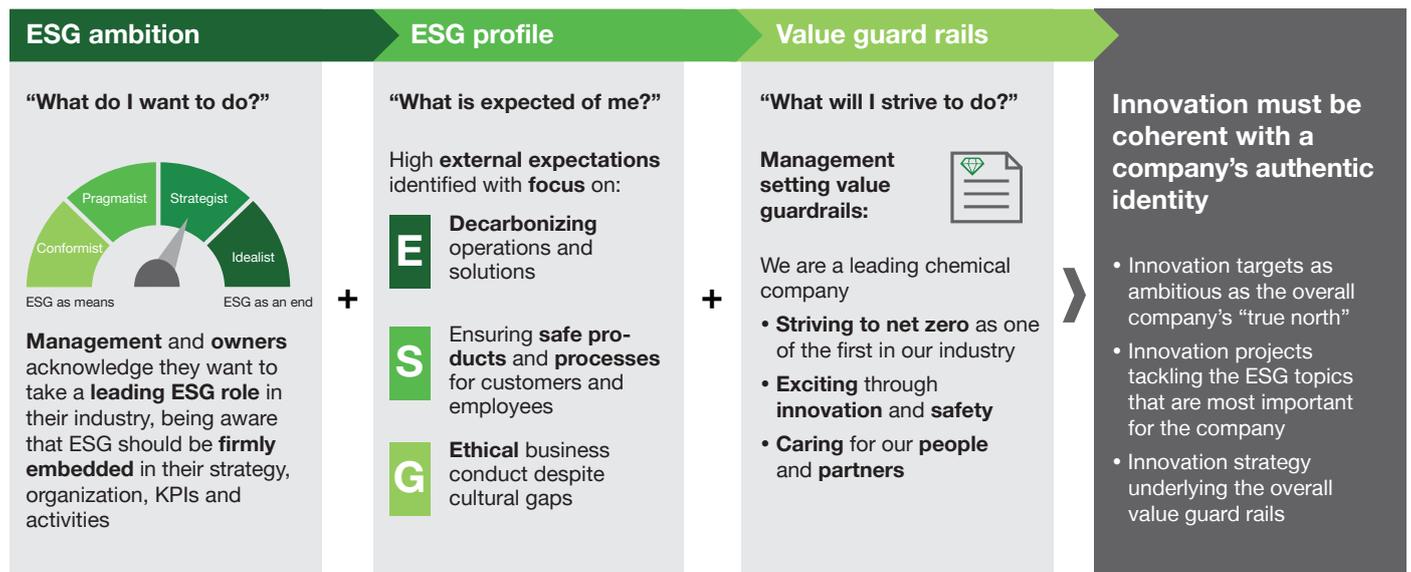
In response to demand from its clients, Belgian polymer specialist Solvay has invested in virtual testing software for materials to speed the development of new high-performance polymer and composite materials for the aerospace, automotive, and biotech industries, among others. The software is expected to accelerate time-to-market for new materials.

2. Aligning ESG-driven innovation with a company’s “true north”

To deliver the appropriate value to stakeholders, chemical companies should align their innovation strategies with their authentic identity or “true north.” Important elements to include in the framing of this authentic identity include a clear ESG ambition, a thorough understanding of the existing ESG profile, and a plan of action (see *Exhibit 4*).

A company’s “true north” must always be considered in the development and execution of an innovation strategy, especially when considering the innovation operating model and key performance indicators (KPIs). Decision committees should focus on selecting innovation projects that target the ESG topics identified as most critical. The targeted outcome of an innovation strategy should also be as ambitious as the company’s overall “true north.”

EXHIBIT 4
Aligning innovation to an authentic ESG identity (exemplary visualization)



Source: Strategy& analysis



Leading practices

DSM, a purpose-led Dutch multinational focusing on nutrition, health, and sustainable living, has aligned its strategy with the 2015 United Nations Sustainable Development Goals. It has introduced an initiative called Brighter Living Solutions, a range of products and services—such as advanced polymers to increase vehicle efficiency—that combine high performance with social and environmental benefits throughout their entire life cycle. Brighter Living Solutions now makes up a majority of DSM’s portfolio.

3. Adopting a hybrid operating model for innovation

Though hybrid operating models for innovation already exist in the chemical sector, they will need to be adjusted to deal with new ESG challenges. On the one hand, companies need to continue to develop incremental innovations, which deliver fast returns. On the other hand, companies need to think ahead to longer-term challenges, such as meeting net-zero targets. This will require setting aside research time and budgets to develop disruptive innovations that will likely be more costly, but that are crucial for achieving longer-term goals.

As a result, chemical players need to balance their teams. Regional business unit-based teams should continue to focus on the incremental innovations that best fulfill customer needs, while corporate innovation teams can engage with research into disruptive technologies. This research is usually driven by a senior group that also steers the strategic direction of R&D.

In our research for this report, we found that about two-thirds of the companies we interviewed allocate as much as 30% of research time to the pursuit of new ideas. One-third of our interviewees hive off future-oriented research into a discrete unit with a longer-term perspective.

We believe companies that adopt such a hybrid model are better positioned to exploit new business opportunities because they are both close to the customer and focused on disruptive innovations (see *Exhibit 5, next page*).

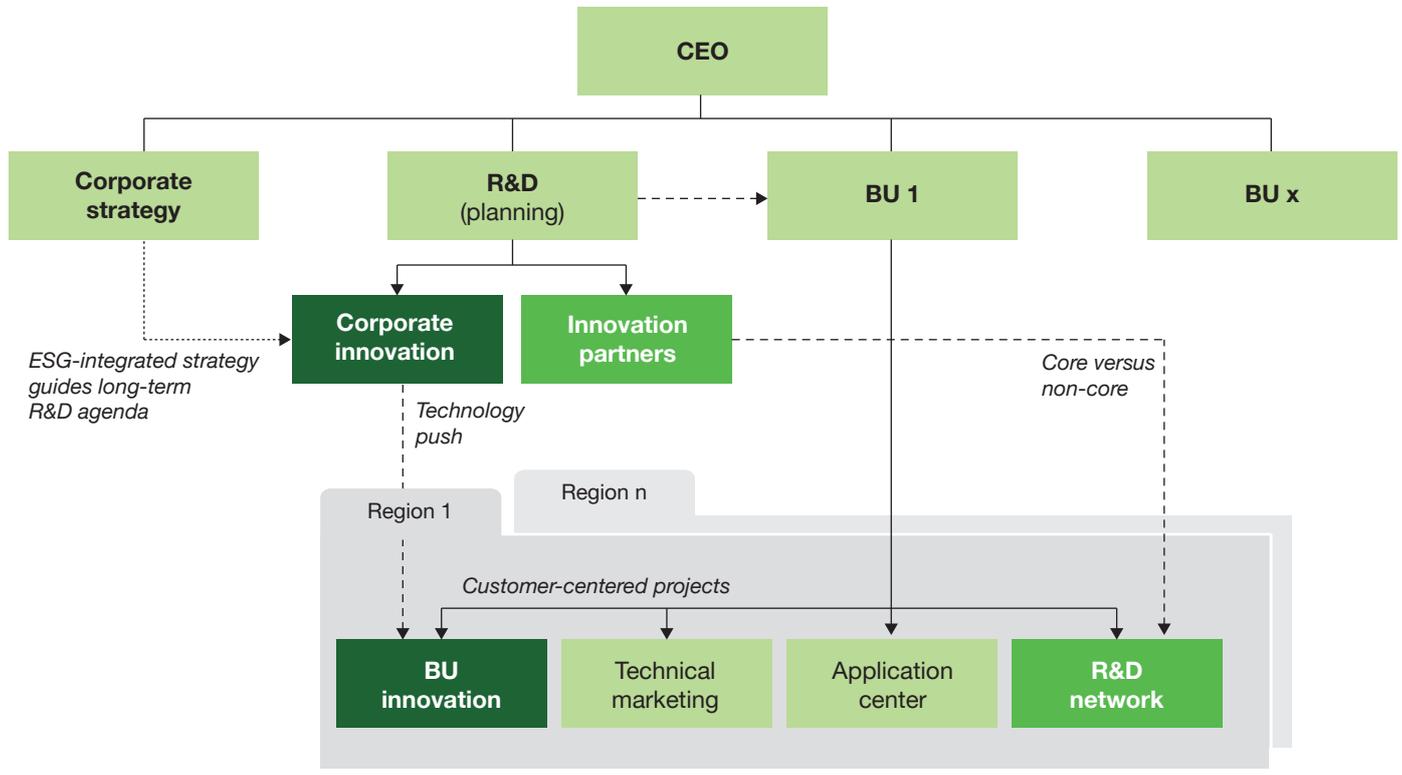


Chemical companies should adopt a hybrid operating model in innovation to be best positioned towards disruption and new customer requirements.”

**Dr. Volker Fitzner, Global Chemicals Leader,
Partner, PwC Germany**

EXHIBIT 5

A hybrid operating model for innovation balances immediate demands with long-term needs



Source: Strategy& analysis



Leading practices

The German chemical producers Evonik and BASF direct 80 to 85% of their innovation spending to a handful of core activities within their businesses and 15 to 20% to disruptive processes and technologies. At BASF, 19% of R&D spending in 2019 focused on strategically important long-term research areas.

4. Building an innovation ecosystem

Innovation today is increasingly about collaboration. The transition to a sustainable economy is so multifaceted that no single company can hope to possess every skill and resource required to address the challenges and opportunities of an ESG-driven future.

Historically, chemical enterprises have conducted most of their research in-house, collaborating within innovation ecosystems only when there was a need to share risk or access new markets. This is still a productive pathway for innovations related to a company's core businesses.

However, the approach to innovation is changing in response to the complexity of ESG challenges. It is becoming more open, and innovation ecosystems are growing larger and more versatile. Such an approach is important for ESG innovations that require significant investment, but for which returns are uncertain and may lie well in the future.

This is particularly true when specific capabilities cannot already be found within a company and are difficult to acquire in a timely and affordable manner. The challenges that come with some ESG requirements, such as cross-enterprise circularity or traceable supply chain monitoring, can be much better addressed when working in a diverse ecosystem. Success is sometimes predicated on venturing outside the company, and often outside the industry.

About two-thirds of our interviewees externalize part of their R&D. The most frequently mentioned reasons they give are: to find more powerful solutions for ESG-driven challenges, to better tailor core capabilities and skills, and to control innovation costs. These companies spent between 2 and 10% of their R&D budgets on external providers, with externalization costs averaging at about 5% of annual budgets.

More than 80% of interviewed companies employ dedicated teams to identify partners that are potentially a good fit for their ecosystem. They also contract out part of their fundamental research (see *Exhibit 6, next page*).

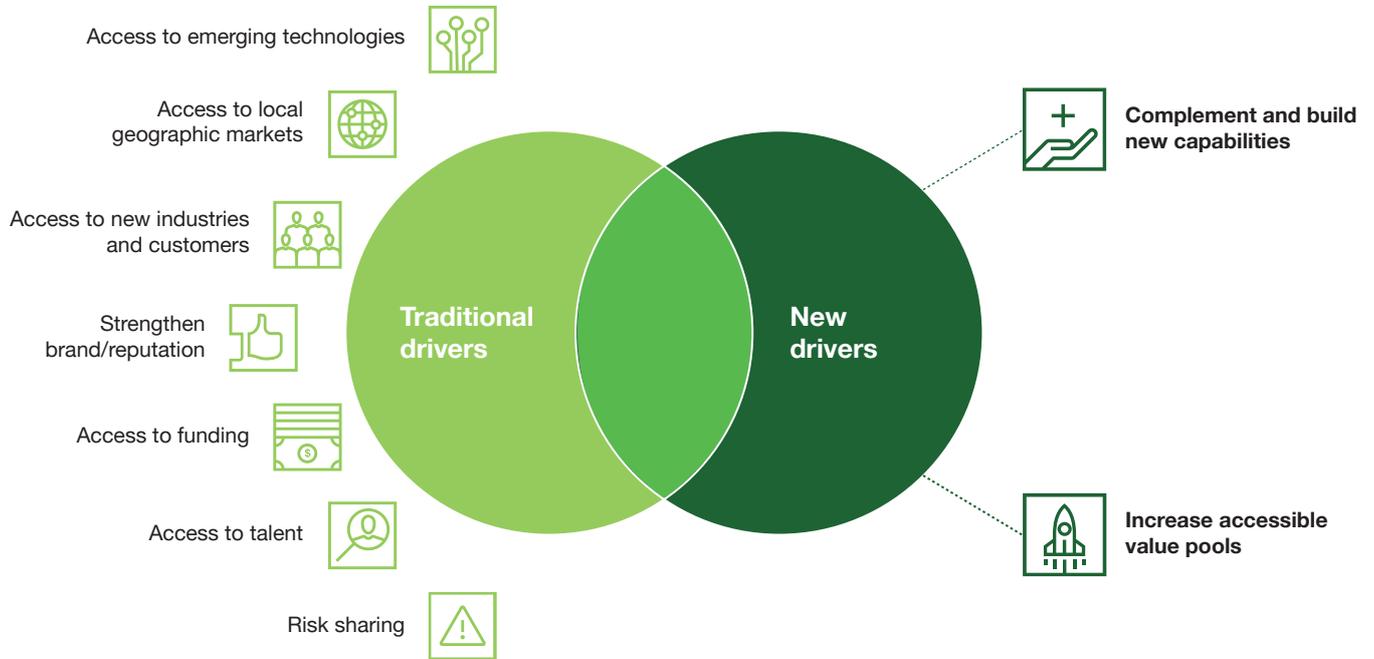


Participating in diverse ecosystems put chemical companies in a position to better cope with ESG requirements.”

Ruirui Zong-Rühe, Director, Strategy& Germany

EXHIBIT 6

Selected drivers of ecosystem interaction



Source: Strategy& analysis



Leading practices

The German materials company Covestro organizes public contests, offering awards and job opportunities to participants who solve specific problems; peers organize crowdsourcing R&D events, internal startup challenges, or university hackathons.

Battery materials supplier Umicore⁵ is collaborating with mining companies China Molybdenum Company (CMOC), Eurasian Resources Group (ERG), and Glencore to pilot Re|Source, a solution to track responsibly produced cobalt from the mine to electric car batteries.

5 Umicore, EV supply chain majors pilot Re|Source, a blockchain solution for end-to-end cobalt traceability, May 20, 2021, <https://www.umicore.com/en/newsroom/news/ev-supply-chain-majors-pilot-resource-a-blockchain-solution-for-end-to-end-cobalt-traceability>.

5. Leveraging funding for innovation

Though technologically feasible, full ESG compliance in all dimensions will come at a cost. According to a study for VCI⁶, German chemical companies will need to invest an additional €45bn between 2020 and 2050 to reduce their carbon footprint to zero.

Across the globe, governments are providing strong financial support at national and multi-national levels to assist industry in its ESG transformations. For example, the EU Green Deal has earmarked €1tn⁷ for the transition to net zero by 2050. Given the longer time horizons required for ESG investments to deliver sustainable returns, companies should increase their leverage in these external funding opportunities. This would help to lower costs and improve the chances of long-term innovation success. Leading companies lobby for new funding opportunities and are skilled at accessing public funding for their research projects.

Public grants must then be managed and audited for compliance purposes, which is best done by dedicated teams to lighten managerial demands on core innovation units.

Experience shows that innovation delivers better results when different kinds of funding are available. The most important sources include tax incentives, grants, loans, guarantees, and venture capital. (PwC's State of Climate Tech 2021 documents the amounts and destination of venture capital investment in vital fields.) Success in capturing these funding opportunities depends on having a good process in place—one that spots funding opportunities early on, efficiently prepares grant applications, and manages the funds well, in full compliance with legal frameworks and regulations.

⁶ Verband der Chemischen Industrie e.V. (VCI), Working towards a greenhouse gas neutral chemical industry in Germany (Summary of the DECHEMA and FutureCamp study for the VCI), Sep. 2019, <https://www.vci.de/langfassungen/langfassungen-pdf/vci-study-greenhouse-gas-neutrality-in-the-german-chemical-industry.pdf>

⁷ European Commission, The European Green Deal Investment Plan and Just Transition Mechanism explained, Jan. 14, 2020, https://ec.europa.eu/commission/presscorner/detail/en/qanda_20_24.



6. Adoption of new innovation impact metrics

The new world in which we operate calls for a new set of metrics. It is common for large chemical companies such as BASF to report the results of operations with a triple bottom line, using three distinct frameworks to assess performance. The chemical industry needs to adopt a similar approach when reporting on investment in ESG-driven innovation. Companies should be valued for their broader contribution to the three Ps—people, profit, and the planet—and given longer horizons for delivering returns.

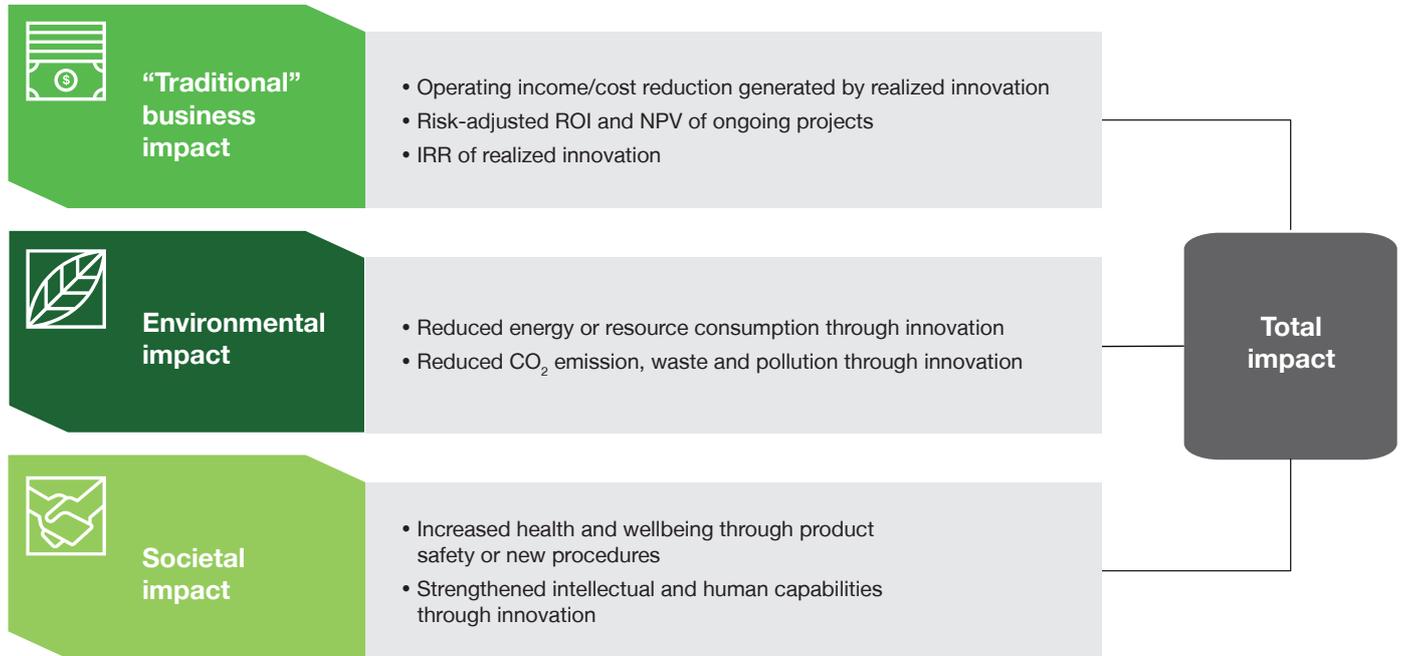
A “total impact” return on investment for innovation differs significantly from the way ROI has been assessed in the past (see *Exhibit 7, next page*). Lead times are considerably longer than the two to three years allowed for incremental product innovation. Positive and negative external impacts—such as innovations that reduce energy consumption or that contribute to public health by resulting in cleaner air or water—are entered into the calculations for total impact returns.

Many such external effects are not yet fully priced-in by markets, and the fact that they are not has acted as a deterrent to ESG-driven innovation. For example, some refineries continue to be counted as profitable assets only because their negative external impacts on society—on air and water quality, waste disposal, CO₂ emissions, and other metrics—are not included as a cost of operations. Undoubtedly, an ESG transformation has costs, particularly in the short term. However, if negative externalities arising from unsustainable legacy technologies are appropriately accounted for, the case for investing in sustainable technologies becomes much stronger.

A global price on carbon emissions, as discussed during COP26, would help level the innovation playing field for the chemical and materials industries. Currently, only national or regional prices exist. Companies should also consider the implicit costs of not taking action, given that failure to innovate could result in missed business opportunities. Additional risks include customers with growing ESG expectations rejecting old products and higher penalties for failure to comply with increasingly strict ESG regulations.

EXHIBIT 7

Measuring total innovation impact



Source: Strategy& analysis

Leading practices

Together with the OECD and various other organizations, including PwC, BASF has co-created a Value Balancing Alliance (VBA)⁸ that aims to use the expertise of commercial enterprises to introduce an industry-wide common accounting and reporting standard that incorporates ESG measurements. The aim is to develop a standardized methodology allowing companies to present their value contributions in an easily comparable way. As a first step, BASF has developed its Value to Society approach, which it applies to produce annual evaluations.

⁸ BASF SE, Sustainability: Value to society, accessed Jan. 2022, <https://www.basf.com/global/en/who-we-are/sustainability/we-drive-sustainable-solutions/quantifying-sustainability/value-to-society.html>.

CONCLUSION

To reach net zero within the next 30 years, the chemical industry will need to innovate across all value-chain segments. This means companies must think of reducing their own emissions (Scope One) by developing new processes. They need to reduce their Scope Two emissions by leveraging more sustainable energy sources. But most important, they need to reduce their Scope Three emissions, which means they should consider the upstream value chain segments by sourcing more sustainable raw materials.

This will need an ESG-driven innovation approach that is aligned with a company's authentic identity. Such an approach sets aside specific funding for disruptive technologies and is smart about leveraging public funding to lower R&D costs. Lastly, it thrives in an innovation ecosystem that includes its supply chain and other external partners. Throughout this transformation, companies should embrace new concepts to measure the broader impact of investment in innovation on people, profits, and the planet.

Looking forward, chemical companies should change their mindset and rethink their time horizons. They need to focus on engaging with their ecosystems and being open to new ways of collaboration. It has long been clear that chemical companies need to follow an innovation-push strategy to comply with increased environmental, social, and governmental pressures. Increasingly, they will also need to do so if they want to stay ahead of their competitors.



Reducing
emissions



ESG-driven
innovation



Changing
mindset

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