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Chemicals

Pathways to decarbonization

Sector landscape

Key enabling role of the chemical sector

The chemical sector contributes 3% of global carbon emissions^{1,2} and is one of the major industrial emitters of greenhouse gases (GHG). But it also plays a key role in the industrial value chain by providing critical products for many industries, such as automotive, construction, electrical and electronics, and consumer businesses.

With carbon-based products and partially high energy-intensive processes, it is one of the hard-to-abate (HTA) sectors on the path to net-zero. But in addition to its own target goal of becoming net-zero, the chemical industry is uniquely positioned to play a key role in driving sustainability knowledge, innovation, and demand across industries, and offering new sustainability-enabling processes, products, and services to its customers.

The successful transformation of the chemical industry toward net-zero is therefore a critical step on broader society's road to carbon neutrality.

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Pathways to decarbonization for the chemical sector

The chemical industry involves a variety of production processes that emit carbon dioxide and other GHGs. Some of the most common sources of carbon emissions are the use of fossil fuels and feedstocks. Others include process-related carbon emissions and end-of-life emissions from downstream products.

In contrast to other HTA sectors, there is no straightforward, uniform set-up in place to abate these emissions. Instead, chemical companies must apply different sets of technological measures depending on their region and type of chemical activity.

- **Increasing overall operational efficiency** is a long-standing endeavor and should continue to contribute to GHG reduction.
- **Switching to low-carbon electricity** is one option for replacing high-carbon electric consumption, subject to the availability of sufficient green electricity supply.
- **Bio-based feedstocks and the use of hydrogen** are not new to the industry. However, scale, application alignment, and penetration may reach new levels, and resource availability may therefore be the critical issue.
- **Carbon capture, utilization, and storage (CCS) technology** is being implemented at varying speeds, depending on the region and the level of discussions on suitable storage locations and costs. CCS is also being considered as a bridging technology to help reduce CO₂ output in the near- to mid-term, while carbon capture and utilization (CCU) and other technologies advance.
- **Advanced electrification** still faces limitations due to a lack of technological maturity but is nevertheless the subject of major ongoing effort (e.g., electrification of steam crackers).
- **Circularity** has a pronounced impact on end-of-life emissions and is being strongly pushed by many customers and legislators alike. Ongoing progress in collection and advanced recycling is beginning to help drive its expansion.

Geographical and policy aspects

As in other industries, the chemical industry is regulated by the jurisdictions in which its companies operate. With all major countries and regions committed to achieving carbon neutrality by 2050-2060, this is setting a binding framework for the industry (Figure 2).

Key insights

Regulatory landscapes setting out pathways to net-zero can differ not only in their timelines, but also in the effects they will have on the industry. Matters such as the impending tax-free environment by the EU are adding further challenges. Together with an ever-evolving regulatory environment (e.g., Carbon Border Adjustment Mechanism), the industry must find ways to drive investment and portfolio strategies in the face of uncertainty.

Figure 1: **2022 saw the first worldwide tightening of the overarching political framework for achieving the Nationally Determined Contributions (NDCs) of the Paris Agreement.**



Challenges

Transformation challenges

The chemical industry will inevitably face multiple challenges on the way to its net-zero transformation:

Low supply of green electricity

A significant short-term roadblock is the availability and the competition for green electricity/green hydrogen with other sectors, and the associated risk of insufficient and non-cost-competitive supply. Additionally, high returns remain in fossil-based value chains, which can complicate the business case for green investments.

Carbon leakage management

When it comes to carbon regulations, the global playing field is still rather uneven, and companies may choose to move production to a country with less stringent policies. One option is a carbon premium on the import price of products produced in countries with lower sustainability standards. However, the market in base and intermediate chemicals is typically very competitive and it can be hard to pass on additional energy costs, particularly when faced with less sustainable, low-priced competitor products.

End-market demand and valuation

Consumers in some applications are beginning to demand products with a low-carbon footprint, helping drive investments in sustainable consumer goods and innovation in the chemical industry to provide the supporting products. A market-based mechanism will help create a sustained focus on emission reductions, however the sole reliance on regulation-based transformation might not lead to a successful transition to low-carbon products.

Lack of transparency in carbon measurement and reporting

Sustainability policies, such as establishing standardized and consistent rules for measuring and reporting carbon emissions, do not yet exist—but are nevertheless, high on the industry's agenda.

Linear business models

Chemical waste continues to be a problem. Adopting new business models and perspectives to create a fully circular value chain could create new opportunities for value generation while allowing for full-scale chemical recycling.

Technology development and implementation

New technologies are also needed to help mitigate, abate, capture, and use emissions on a commercial scale. In this and other areas, the industry faces challenges from qualified suppliers' limited capacities, as well as a general shortage of skilled workers. The skills gap extends to green technology (e.g., electro-chemistry), digital, and artificial intelligence (AI).

The net-zero transformation challenges



Switching to green electricity



Carbon leakage management



End-market demand/valuation



Lack of transparency and disparities in carbon measurement and reporting



Linear business models and circularity realization



Technology development, maturation, scaling and implementation capacity of respective technologies

Key drivers of transformation for the chemical sector

When considering the chemical sector’s net-zero transformation, a wait-and-see approach—one that relies solely on regulation-mandated change—is increasingly risky.

Today, application industries are already faced with consumer requests for green products and are increasingly looking for suppliers that provide sustainable options in the form of low- or zero-carbon products and services.

This indicates that sufficient market demand for sustainable products already exists. A unified commitment to reduce emissions across the chemical lifecycle should make a net-zero transformation successful and help drive companies to integrate sustainability into their competitive DNA.

That’s not to say such integrations will come without challenges. Because assets have a lifetime of 20-plus years, it can be challenging for chemical companies to de-risk these investments in the absence of long-term regulatory certainty. One way to overcome this challenge is to adjust overall (portfolio) strategies, management and controlling systems—as well as key performance indicators—to reflect the new realities of sustainability and becoming net-zero.

In addition to its own activities, the chemical industry should understand the challenges faced by its suppliers. The availability of green electricity and green hydrogen may be crucial for the sector, but supplies could be limited until 2040, and there could be competing demand for green electricity from other sectors. Sustainable supply may remain a critical issue for years to come, potentially impacting the industry. Supplies of renewable and bio-based feedstocks are also limited and, at this stage, cannot replace raw materials altogether.

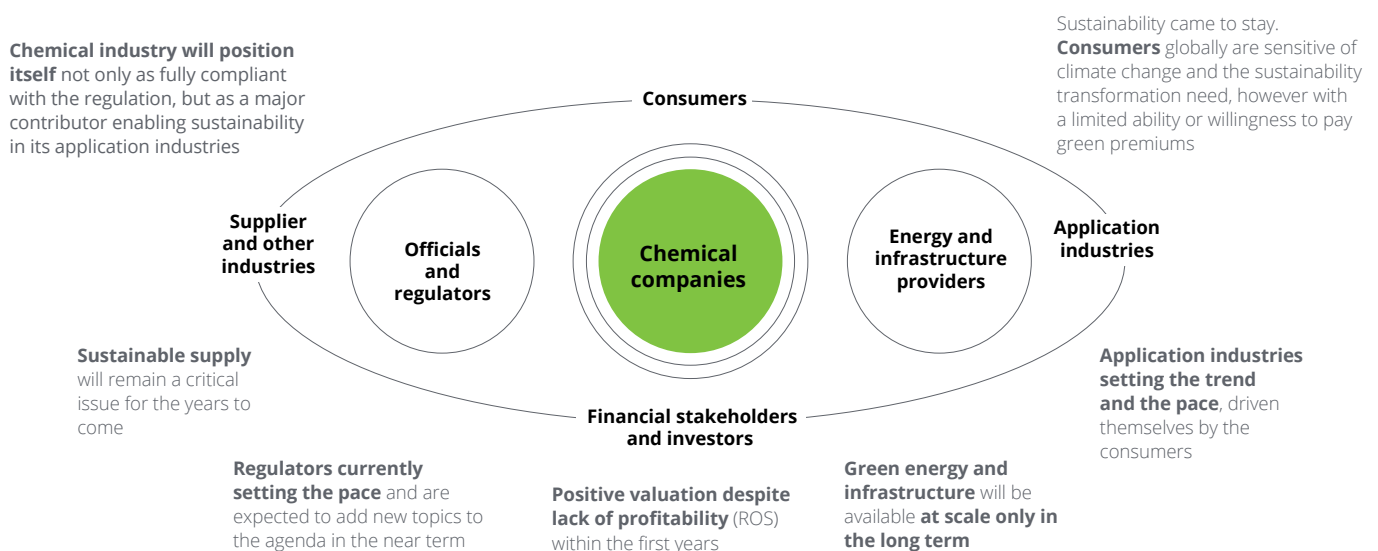
To close this gap, the chemical industry would be well-served to find ways to share development costs, foster more coordinated and sustained investment flows, and advocate for supportive policy moves that can catalyze early-stage technology development or create the regulatory or market incentives needed to accelerate progress.³

As the industry moves forward, chemical companies should take strides to:

- Create frameworks for proper CO₂ footprint reporting,
- Develop a clear net-zero strategy; and
- Forge relationships that allow for co-innovation.

These steps, and others, should allow companies to increase their ESG ratings, which may positively impact company value and ease access to capital markets.

Figure 2:
A variety of stakeholders will play key roles on the path to net-zero for the chemical industry



The path forward

Today, a growing number of consumers worldwide are demanding more sustainable product options from the businesses they support. Given the prominent role the chemical industry plays in many different industries, it has the potential to drive real change across the business realm.

Authors and contacts

This paper is part of a collection of insights on possible pathways to decarbonization for high-impact sectors. Each sector perspective offers a foundational starting point for leaders would like to better understand the landscape across these critical sectors. For additional sector papers and links to in-depth reports, please visit [Pathways to decarbonization](#) on Deloitte.com.

At Deloitte, we understand this is an incredibly complex endeavor—but one well worth the effort, both for the future of the chemical sector and the planet. Our Chemicals team is adept at helping companies identify and accelerate their path to decarbonization by facilitating private-public partnerships, creating customized decarbonization solutions, and providing in-depth expertise.

To learn more about how we can help your organization with your journey, contact us.



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Endnotes

- 1 International Energy Agency (IEA), [World Energy Outlook 2022](#), pp 63, October 2022
- 2 International Energy Agency (IEA), [Tracking report: Chemicals](#), September 2022
- 3 Deloitte, [Getting from hard-to-abate to a low carbon future](#), November 14, 2021



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