Sustainability Insights | Research

Decarbonizing Chemicals Part Two: The Credit Risks And Mitigants

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Drivers of decarbonization-related credit risks may gain greater influence in future, especially beyond 2030. Sector risks should be manageable until then, based on current information, policies, and regulations.

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This second part of our research into decarbonizing chemicals explores the challenges companies are facing on the path to net zero. We look to identify the credit risks that could arise from these challenges, the possible mitigants available to companies, and the potential influence on their credit quality. We focus on the U.S. and Europe, where about 80% of our rated chemical companies are based, where regulatory frameworks are better defined, and consumer pressure to decarbonize is more keenly felt. This research complements "Decarbonizing Chemicals Part One: Sector-Wide Challenges Will Intensify Beyond 2030," published Sept. 5, 2023, in which we look at companies' operational strategies, solutions for reducing greenhouse gas emissions, and how regulatory frameworks could influence cost structures and capital spending. We examined over 100 rated chemical companies with a primary focus on the highest greenhouse-gas-emitting chemicals, including base chemicals such as ammonia and petrochemicals. These represent the majority of the sectors' emissions and are emissions-intensive to produce.

Key Takeaways

- **There is no quick fix to decarbonize the chemical sector.** The sector's numerous (over 70,000) and heterogenous products, and dependence on carbon-based fuels and feedstock, create risks relating to decarbonization technology, costs, and regulations.
- **We assume that companies will benefit from the future technological evolution and development of decarbonization options, thereby mitigating some credit risks.** Decarbonization could create new markets and applications for some chemicals.
- While we see potential risks for chemical companies, in our view the sector's credit risks are currently manageable under existing regulatory policies.
- **We believe decarbonization-related credit risks won't hurt company credit standings at least until 2030.** After that, risks could mount especially at lower rated companies with limited flexibility to absorb decarbonization costs and capital outlays, and lower ability to avail of mitigants.

Decarbonization-related credit risks

Source: S&P Global Ratings.

Choices Chemical Companies Make Will Shape Credit Risk

A key factor, among many, influencing the level of credit risk companies face is the choices they make with regard to decarbonization solutions. Chemical companies have an array of components or technologies from which to forge a bespoke decarbonization route or solution. A company could possibly choose multiple decarbonization solutions, one for each manufacturing location. We illustrate, in chart 1 below, our views of the risks associated with the key decarbonization technologies that are most widely discussed (and presented in part one of our research; see table 2 in part one for a summary). Each technology in the chart below is itself an umbrella term that covers several subcomponents. With the exception of energy efficiency, we think all decarbonization technologies shown in the chart have high to moderate risks associated with their implementation. However, because they are viewed as being highly effective in their contribution to decarbonization, we believe they carry low risk related to their effectiveness. Energy efficiency, which refers to a variety of energy-saving measures, but not the substitution of high-carbon raw materials and energy sources with low-carbon materials and sources, is easier to implement and therefore important. However, we believe energy efficiency will be, relatively speaking, a low contributor to decarbonization and therefore less effective.

Chart 1

Risks of various decarbonization solutions

Decarbonization technologies	Ease of implementation	Development stage	Cost	Effectiveness
Energy efficiency	High	Adoption	Low	Low
Electric power	Low	Demonstration	Moderate to high	Potentially high
Low carbon fuel / feedstock	Low	Demonstration / R&D	Moderate to high	Potentially high
Carbon capture	Moderate	Demonstration	Moderate to high	Potentially high
Other innovation	Not known	R&D	Not known	Not known

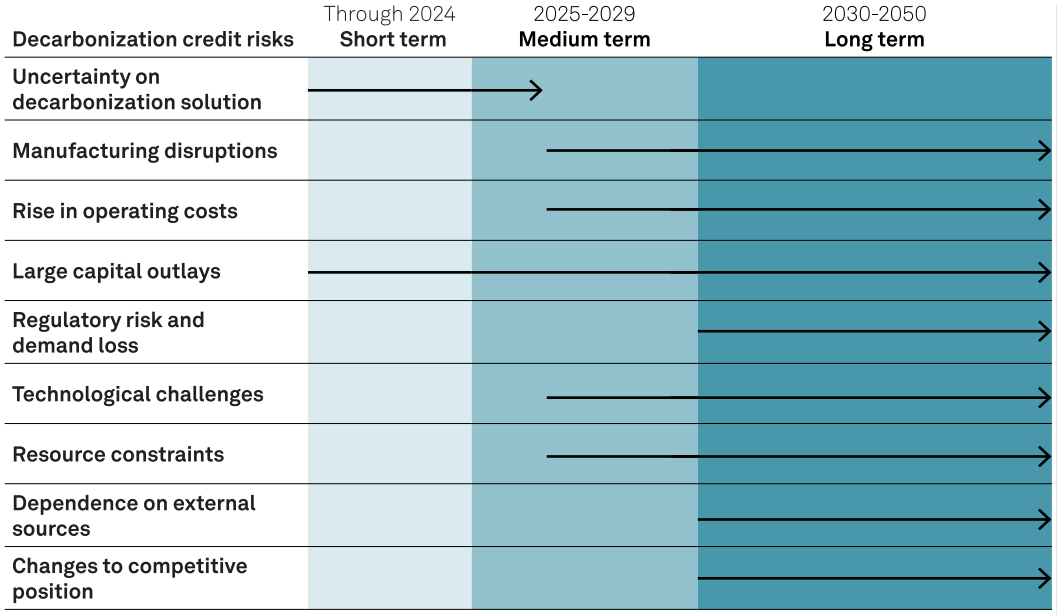
R&D--Research and development. Source: S&P Global Ratings.

What Are Decarbonization-Related Credit Risks, And How Could They Impact Credit Quality?

Based on our analysis of rated chemical companies, we identify nine top credit risks related to decarbonizing chemicals (see chart 2). These risks cover technology risk, cost and financial risks, and disruptions to markets. How these risks manifest, and which are most important for any given company, will depend on the decarbonization strategy they choose to deploy. The timeframes in which these risks could materialize also differ, and we categorize them as short-, medium-, and long-term. Below, we discuss each of the identified risks and why they could be relevant.

Chart 2

Chemical decarbonization-related credit risk drivers



Source: S&P Global Ratings.

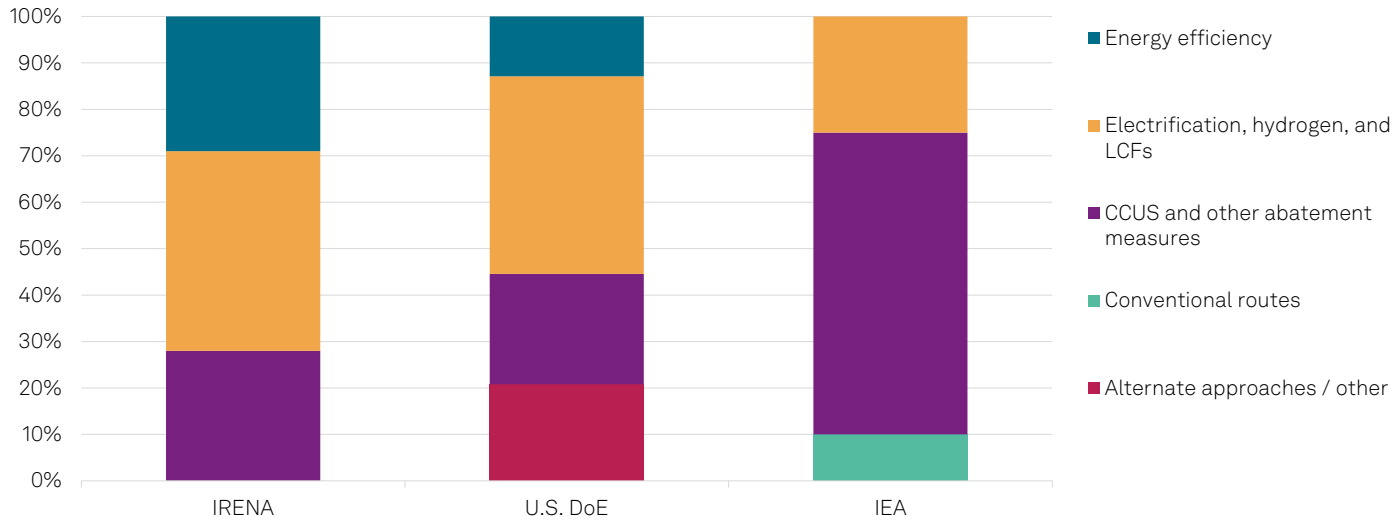
Uncertainty about decarbonization solutions

In our view, the absence of consensus on a clearly demonstrated decarbonization solution raises risks that companies might make suboptimal choices that slow their progress or raise their decarbonization costs. Industry players including credible external entities such as the U.S. Department of Energy (DoE), the International Energy Agency (IEA), and the International Renewable Energy Agency (IRENA) appear to have different ideas on the best way to decarbonize. Most published opinions and net-zero scenarios modeled on chemical decarbonization include several common decarbonization technologies, a combination of which forms a decarbonization solution.

But opinions differ on the level of contribution these technologies might provide (chart 1). For example, several rated companies have published decarbonization goals and plans, including LyondellBasell Industries N.V., Yara International ASA, and Nutrien Ltd., in high emitting subsectors such as petrochemicals and fertilizers. But we find that no company has published a detailed definitive plan, with specific components to achieve net zero across manufacturing locations and products. We believe this is because companies are still evaluating various solutions and their options. This uncertainty reflects the sector's complexity, the largely untested nature of some decarbonization technologies, and the early stage of the process. The diversity of opinions also reflects that policy and regulatory frameworks are still evolving.

Chart 3

Solutions to decarbonization for chemicals



Note: The vertical axis measures estimated decarbonization achieved. IRENA's value of energy efficiency includes assumption of demand declines. IEA's value of CCUS and other abatement measures includes the use of hydrogen. For all entities, percentage figures represent proportion of decarbonization using each component. The entities don't all use identical terms and we have interpreted and classified some of their categorization to fit into the common framework illustrated above. IEA suggests that 10% of chemical emissions cannot be decarbonized using developed technologies and expects that this proportion will use conventional routes. The DoE believes the figure is 21% but frames the issue differently, categorizing this proportion as getting to net zero using currently undeveloped or alternate routes. Sources: S&P Global Ratings and the agencies.

Manufacturing disruptions

We think that decarbonization toward net-zero targets could disrupt manufacturing, over the longer term.

Decarbonization will likely entail plant-specific changes to chemical manufacturing for companies that prioritize net-zero targets over the coming two-to-three decades. Large and complex ammonia and petrochemical plants, optimized over decades to run continuously at high utilization rates with minimum disruptions, may be hardest hit. Another disruptive force could be a move away from fossil feedstocks and fuels, after nearly a century of their use. All of these changes could also increase plant downtimes and at least temporarily reduce operating efficiency. Changes could include:

- Retrofitting existing plants or constructing new ones to accommodate new or unconventional feedstock, without impacting product characteristics. This could also require reconfiguring the entire supply chain.
- Introducing new methods, fuels, or energy sources to generate the high levels of heat required in many chemical manufacturing processes.
- Introducing processes and infrastructure to capture, process, transport, and/or store carbon.

Rise in operating costs

Changes to fuels or feedstock or to carbon-capture methods will add to operating costs. Power and electricity costs could rise if electricity providers decide to pass on any increased decarbonization costs to chemical companies. It remains to be seen if producers' profit margins will decline, or if they find they can pass costs on to consumers without hurting demand. The recent energy crisis in Europe and resulting power and gas price hikes suggest that some increases can be passed on, but maybe not all. We think chemical companies with more favorable cost and market positions should be better placed to navigate this risk.

Large capital outlays

The capital deployed in decarbonizing will likely be unprecedented. However, if spent prudently in a phased manner over nearly three decades, the sector-level outlay should be manageable. In the U.S., for example, we estimate decarbonization capital investments will likely exceed the $200 billion (source: the American Chemistry Council) invested in the sector over the past decade or so following the availability of shale gas. The U.S. chemical sector, which spent $33 billion in total capital in 2022, managed that decade-long $200 billion outlay without meaningful credit consequences.

At this point, we do not forecast a capital investment amount. Chemical companies have not yet decided on the components for decarbonization, and the costs and availability of related technology also remain uncertain. For example, extrapolating currently expensive equipment such as electrolyzers--critical in the production of hydrogen--over the next three decades results in unreasonably high capital cost estimates. It is plausible to suggest that electrolyzers will become cheaper as mass production begins; the IEA assumes a 65% decline through 2050. However, estimating future pricing requires another layer of assumptions. When exactly will demand increase, and by how much, remains unknown. This uncertainty creates more room for forecasting errors.

But we can learn something by looking at capital outlays in some of the sector's early movers. Dow Chemicals has announced that it expects to spend $1 billion annually on decarbonization. BASF expects to spend up to €4 billion (about US$4.3 billion at current rates) through 2030. These amounts are within the companies' recent annual capital spending ranges. Large fertilizer producers have made similar announcements with no suggestion of onerous burdens on cash flows. At this early stage there are some very high, and varied, third-party estimates for sectoral capital spending that in part reflect the uncertainties around decarbonization-related capital spending (table 1).

Table 1

Estimated capital investments for decarbonization through 2050

Subsector	Capital investment	Source
Global petrochemical	$750 billion	BloombergNEF
Global petrochemical	$2 trillion	McKinsey & Company
Global ammonia	$1 trillion	McKinsey & Company
European chemical industry	$1 trillion+	Accenture
European chemical industry	€17 billion-€27 billion per year	Cefic/DECHEMA

Sources: McKinsey & Company, DECHEMA.

Regulatory risk and demand loss

Companies may need to thread a needle in terms of their pace of decarbonization. Moving too slowly risks running afoul of regulations and evolving consumer preferences, but moving too quickly could expose companies to largely untested technology, processes, and inputs.

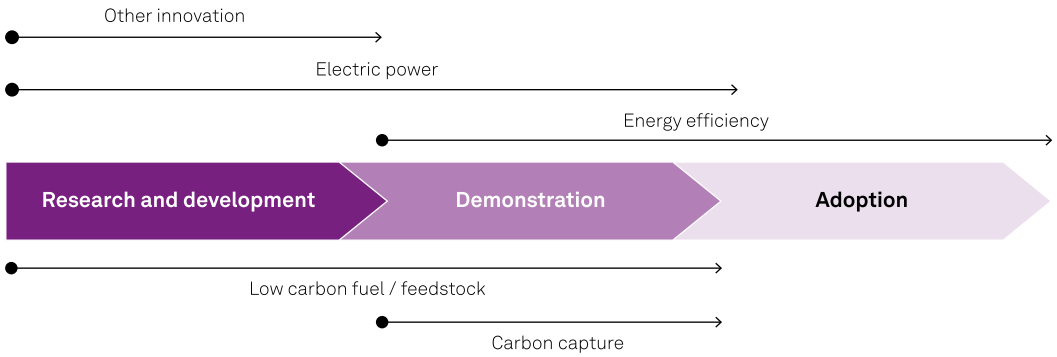
Not keeping up with regulatory timelines could mean potential penalties for companies, including taxes in some jurisdictions, and costs related to buying carbon credits or offsets. Changing consumer preferences may be harder to preempt. Companies face the prospect of demand-side decarbonization if chemical customers decarbonize their own operations by shunning chemicals from high greenhouse gas emitters. The recycling of plastics is an example. A meaningful increase in plastics recycling would lower plastics users' (for example beverage companies, consumer nondurables) lifecycle emissions for ethylene. But recycling could reduce demand for virgin polymers, hurting some chemical companies. This reduced demand could exacerbate risks created by periodic capacity build-ups in petrochemicals.

Technological challenges

Current technology allows some companies to decarbonize, but only up to a point. For example, the U.S. DoE believes that about 21% of decarbonization will be achieved by unconventional new technologies not actively in current use (see chart 3). The industry will need technology that is still in the R&D stage. Even among the technologies that are advanced or developed, not all are fully available yet for widespread commercial adoption. This creates uncertainty around costs, and the feasibility of decarbonization.

Chart 4

Technological maturity of decarbonization technologies



Source: S&P Global Ratings.

Resource constraints

Some of the most important components of decarbonization, including carbon capture use and storage (CCUS) and hydrogen solutions, need an infrastructure network. Key requirements include specialized dedicated pipelines to transport carbon dioxide, available sites to sequester carbon underground, and infrastructure to store and transport hydrogen. Chemical companies by themselves may be unable to build this infrastructure and so may depend on partnering with external agencies. We also anticipate that specialized labor, equipment, contractors, land for pipelines and other uses such as biomass, and geological areas suitable for sequestration will be among the variables in short supply as the chemical industry competes with other sectors to implement decarbonization solutions. The cost and availability of funding for decarbonization

projects could become a constraint, especially beyond highly rated players with strong balance sheets. While we will continue to monitor this potential risk, it has not yet been factored into our current credit ratings due to the uncertainties about the timing and quantum of funding needs.

There is a precedent of sorts for such constraints. The U.S. chemicals sector invested about $200 billion over a decade or so following the widespread availability of shale gas. Projects faced delays and rising costs caused by issues including shortages of engineering, procurement, and construction contractors; specialized professionals such as welders; and materials such as steel. Decarbonization is a much larger endeavor and therefore likely to face even greater constraints.

Dependence on external sources

Most chemical companies cannot directly control their scope 2 and downstream scope 3 emissions. The chemicals sector depends heavily on external electricity suppliers as the largest consumer among all the industrials. Although we expect electric grids in the U.S. and Europe to continue to decarbonize, the chemicals sector does not control the timing of this decarbonization. In our view, synchronizing the chemicals sector's own plans with those of electricity providers will be important. For example, the use of hydrogen as fuel without the decarbonization of the grid will actually increase emissions from the chemicals sector. It is only when the chemicals sector uses hydrogen produced by low-carbon electricity that hydrogen becomes an effective component of chemicals decarbonization. The sector also depends on a swathe of diverse customers and has little control over how its products are used. The chemicals sector sells into many different industries; in most instances its products are not sold directly to end-use consumers but instead to other industrial sectors. Developing relationships with energy, fuel, and feedstock providers, and with the post-sale value chain, will become key to chemical companies' decarbonization.

Changes to competitive position

Competitive advantages from the U.S.'s access to conventional low-cost hydrocarbon feedstock and fuel might fade as their usage diminishes. If this happens, replacing cheaper energy and fuel sources (for example, natural gas and natural gas liquids) with potentially costlier low-carbon alternatives could weaken a key competitive factor for the U.S. chemicals industry. U.S. producers will then have to find a way to produce low carbon fuels, or decarbonize in other ways that retain their cost-competitiveness. We will monitor projects such as The Dow Chemical Company's announced "net zero" project in Alberta, Canada, to track the effectiveness of this and other early large-scale attempts to decarbonize while retaining competitive advantages.

For Now, Mitigants Should Keep Credit Risks Manageable

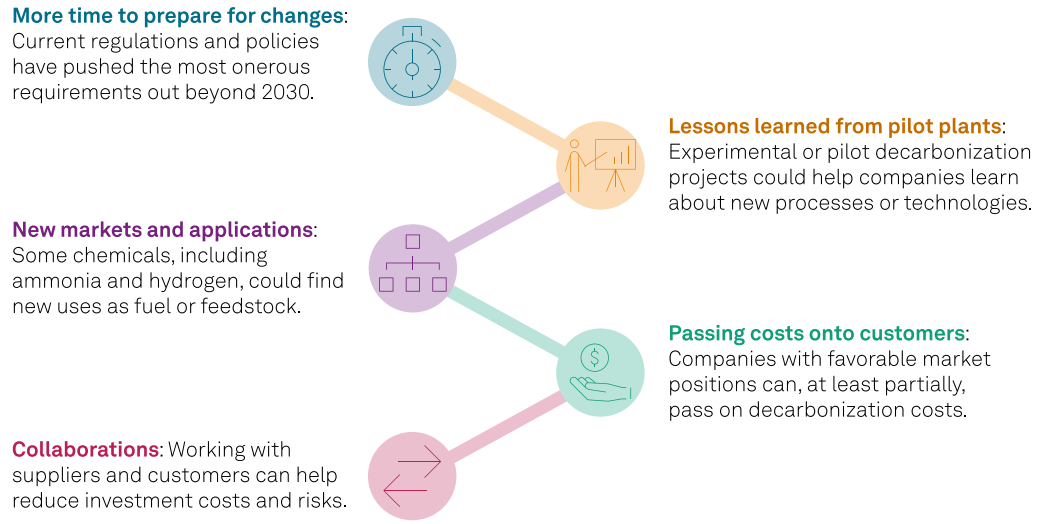
While we see potential risks for chemical companies, in our view the sector's credit risks are currently manageable under existing regulatory policies. New environmental policies and regulations are giving companies time to plan, evaluate options, and grapple with the risks that will peak mostly over the longer term. We also think decarbonization creates opportunities for new products, applications, and markets for some chemical companies. Below we identify key mitigants we think manage the potential risks, at least to 2030.

Given the familiarity of some chemical companies with certain decarbonization technologies and solutions (such as hydrogen) we think chemical companies might be relatively better placed to implement some mitigants compared to sectors less familiar with these solutions.

Five key mitigants are likely to keep credit risks manageable for chemical companies

Chart 5

Potential credit risk mitigants for chemical companies



Source: S&P Global Ratings.

More time to prepare for changes

The sector faces some medium-term changes, but we believe the more meaningful changes will be needed beyond 2030 because regulations push out the most onerous decarbonization requirements beyond that year. We base this view on current information and the current policies and regulations that are in place (as we discuss in part one of our research). This gives companies time to evaluate options and determine their decarbonization strategies.

Lessons learned from pilot plants

Knowledge gained from experimentation could reduce manufacturing disruptions and technology-related risks. For example, many ammonia producers, such as CF Industries Holdings Inc., have announced pilot projects for green ammonia, and some petrochemical companies are trying alternative fuel or heating methods for experimental ethylene crackers.

New markets and applications for chemicals

Ammonia appears on course to play an important new role as a carrier of hydrogen, opening up new applications for this chemical that is currently mainly used as fertilizer. Chemical companies such as Air Products And Chemicals Inc., Air Liquide S.A., and Linde PLC are already among the largest industrial hydrogen producers. These, and other chemical companies that produce hydrogen, are likely to benefit from hydrogen's future role. Similar new opportunities, applications, and markets will arise for other chemicals from industrial decarbonizing.

The ability to pass costs on to customers

Chemicals tend to form a very small percentage of consumer-facing end-products such as cars, textiles, food and beverage, pharmaceuticals, and electronics, among others. A rise in chemical prices would therefore have a limited effect on ultimate consumer prices. In our view, this should

support the sector's ability to pass on cost increases, although companies' market positions will ultimately determine the success of such efforts. Fertilizers have the additional advantage of being key to improving farm yields. Most rated ammonia and petrochemical companies tend to be among the larger players with likely better cost structures and greater pricing power than smaller players. All this results in our view that most rated ammonia and petrochemical companies with favorable market positions should be able to pass on at least some decarbonization-related costs to customers. One way they could do so is by charging a premium for a low-carbon substitute to an existing high-carbon product. This would be similar to current price premiums for recycled plastics over virgin plastic.

Collaborations cutting back risks and costs

Chemical companies can enter into collaborations with oil companies for the storage of carbon, while sharing decarbonization incentives or subsidies with their partners. We think innovative financing and operating structures could be created to share operating costs for hydrogen hubs, carbon pipelines, and similar infrastructure. Such structures could involve joint ventures or collaborations among chemical companies in a geographic region or between chemical companies and infrastructure providers. For example, natural gas providers could team up with ammonia producers to share costs (and incentives) for CCUS projects.

The chemical sector could mitigate the cost and technological risks of certain solutions better than some other sectors

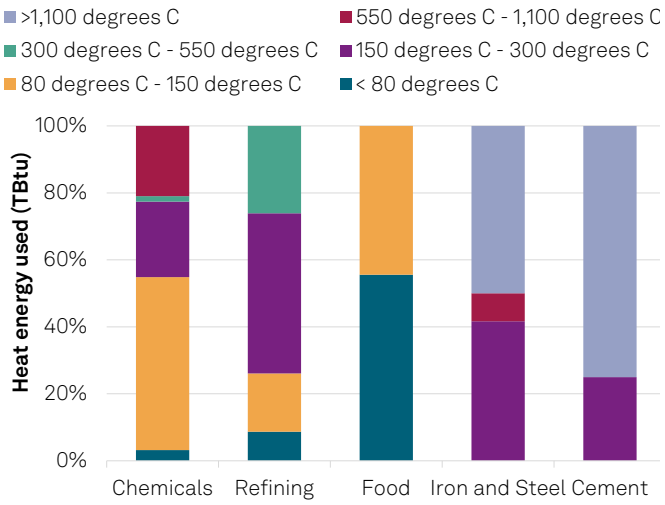
It may be easier for the chemical sector to adapt to some decarbonization technologies and solutions.

Some chemical processes lend themselves to decarbonization relatively easily, which may help contain risks for the sector or even present new opportunities, especially compared to other sectors:

- Some chemical production processes might be especially suitable for electrification. This could reduce technological challenges with the electrification of some chemical processes. The sector consumes more heat energy than other forms of industrial production. Unlike some other sectors, such as cement or steel, a large proportion of chemical process heat is at low temperatures (see chart 6). Nearly 60% of heat energy is for chemical processes that require less than 150 degrees Celsius, making these processes especially suitable for electrification. Higher temperatures can also be electrified but present greater challenges because commercially available technologies are relatively few.
- The chemical sector's familiarity with hydrogen should help partly offset risks related to its use. The sector is already the largest producer and consumer of hydrogen, accounting for over half the global demand for hydrogen (see chart 7). The sector mainly uses hydrogen as feedstock or part of the chemical process in ammonia and methanol production. This creates at least two avenues for decarbonization: the use of decarbonized hydrogen as feedstock, reducing carbon emissions at the highest greenhouse gas emitting plants in the sector, and the broader use of decarbonized hydrogen as energy/fuel. The sector's familiarity with hydrogen might explain why chemical companies are the among first movers in projects for low-carbon hydrogen.

Chart 6

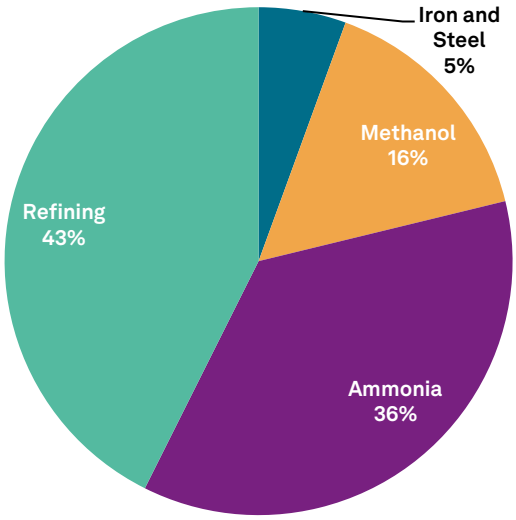
Temperature-wise use of heat energy in the chemical sector compared to other sectors



Source: IEA, S&P Global Ratings.

Chart 7

2021 global hydrogen demand by product



Source: IEA, S&P Global Ratings

How Decarbonization Could Impact Credit Quality

We believe the sector will manage decarbonization credit risks at least until 2030, in the current policy and regulatory landscape. As illustrated in chart 2, we expect the potential influence of chemical decarbonization-related credit-risk drivers will arise, or become more pronounced, from 2030, which is when decarbonization goals and requirements become more onerous, based on current policies and regulations. Supportive decarbonization policies, including those that lower the cost of decarbonization investment and infrastructure, will help companies manage their risks. Risk mitigants also play an important role in tamping down some risks. We factor climate transition risks--including decarbonization risks based on current information, policies and regulations--into our chemical industry risk scores; see "Methodology: Industry Risk," published Nov. 19, 2013. These remain unchanged at '2' (low risk) for specialty chemicals and '4' (moderately high risk) for commodity chemicals. We will continue to weigh these evolving risks against each company's specific abilities to manage them. Much depends on the choices individual companies make, including selecting from a slew of possible paths to decarbonization.

We believe decarbonization-related credit risks are more likely to impact credit quality at lower rated companies. Decarbonization will likely weigh more on the credit ratios of those that are lower rated. These companies typically have little flexibility in their current capital structures for disruption, cost increases, or extra capital outlays. This low flexibility, which we generally reflect in our ratings, might make it harder to access resources such as personnel or funding or to form risk-mitigating partnerships or collaborations. However, many lower-rated companies are relatively low emitters compared to their large bulk commodity counterparts, which could at least partially mitigate risks. To date, we have not taken any rating actions based on our view of decarbonization risks given our view that the sector's credit risks are currently manageable under

existing regulatory policies (see also "Why Climate Risks Are Changing So Few Corporate Ratings," published April 12, 2023, on RatingsDirect).

Regulatory Frameworks Could Influence Credit Quality

We believe two variables in particular will shape how decarbonization risks impact company-level credit quality. The first is companies' absolute greenhouse gas emissions and intensities. The second is the regulatory frameworks under which companies (and their assets) operate. This latter variable notably includes potential differences in policy priorities and goals and their implementation among various policymakers globally.

Chart 8

Regulatory frameworks could mitigate or exacerbate decarbonization risks

	Regulatory framework	
Relative GHG emission level	**Incentive based with subsidies (e.g. U.S.)**	**Stringent / punitive with penalties**
High (e.g. ammonia, petchem producers)	Moderate to high risk	Highest risk
Moderate (e.g. intermediate chemical producers)	Moderate risk	Moderate to high risk
Low (e.g. low energy consuming inorganic specialty chemical producers)	Lowest risk	Low to moderate risk

Source: S&P Global Ratings.

A supportive regulatory framework could have double-edged effects

We believe a supportive regulatory framework could mitigate some decarbonization credit risks; conversely, a less supportive framework might somewhat exacerbate risks. Other things being equal, we believe high emitters in particular will find decarbonization challenges less onerous for their operations in regions with a supportive framework versus emitters in a stringent or punitive framework.

For example, under a supportive regulatory framework such as the US Inflation Reduction Act (IRA) in its current form, high emitters could benefit from tax relief or similar benefits for their decarbonization investments, in our view. This could effectively lower the cost of company-decarbonization projects such as CCUS or green hydrogen, helping manage a key risk.

Companies could also benefit from lower costs for regional or national infrastructure projects such as pipelines or sequestration sites. Such incentives could spur technology, or R&D investments, essential to lowering costs and increasing the efficacy of decarbonization solutions. Other approaches like a carbon border adjustment mechanism (CBAM), which imposes a penalty on imports produced with a high carbon footprint in jurisdictions whose regulations are not similar to the importing regions' regulations, could protect domestic industry from overseas competition--but that same carbon tax may hurt competitive positions on exports.

Divergence in regulatory approaches between the U.S. and Europe

With the caveat that regulations will change and evolve, our preliminary view is that the subsidies available to chemical companies in the current U.S. regulatory frameworks benefit U.S.-based chemical producers relative to their European counterparts. Specifically, the U.S. framework, including the IRA, creates investment incentives via tax relief and other measures for investments in decarbonization. These provisions could lower chemical decarbonization capital and operating costs and encourage technology investments and infrastructure projects in the U.S. relative to Europe.

Legislation in Europe, including the European Climate Law and its supporting legislation (such as Fit for 55, which aims for a 55% reduction in greenhouse gas emissions by 2030 compared to 1990) seems to be adopting a different approach. The approach envisages support in different forms, including the development of infrastructure, but with a lower level of outright subsidies than in the U.S. The EU framework could impose costs on domestic producers, but does have supportive elements including mechanisms, such as the CBAM, that could protect regional industry from imports that don't incur comparable additional costs of complying with domestic regulations that are similar to EU regulations.

Looking Ahead

While we see potential risks for chemical companies, in our view the sector's credit risks are currently manageable under existing regulatory policies. Chemical companies that operate and sell their products across global markets will face current and potential future differences in policy priorities, goals, and implementation between jurisdictions. Challenges arising from these differences are amplified by the wide disparity in products, processes, and supply chains, which also makes regulations difficult to standardize.

Decarbonization is an important credit risk driver for the sector. But precisely how the process will play out and ultimately impact specific companies remains unclear. The credit risks and the mitigants, as well as the pace and significance of regulatory and policy frameworks, and technological and market developments, are the moving parts we are focusing on as the decarbonization process gathers steam. Our decarbonization-related credit views will continue to reflect decisions taken as companies start choosing their solutions, as technology evolves, and as the costs and benefits of various decarbonization technologies become clearer.

Related Research

- Decarbonizing Chemicals Part One: Sectorwide Challenges Will Intensify Beyond 2030, Sept. 5, 2023
- Decarbonizing cement: How EU cement-makers are reducing emissions while building business resilience, October 27, 2022
- Carbon Capture, Removal, And Credits Pose Challenges For Companies, June 8, 2023
- Why Climate Risks Are Changing So Few Corporate Ratings, April 12, 2023
- Carbon Pricing, In Various Forms, Is Likely To Spread In The Move To Net Zero, Aug. 9, 2022

External Research

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- Decarbonization of industrial sectors: the next frontier, McKinsey & Company, 2018
- Low carbon energy and feedstock for the European chemical industry, DECHEMA, 2016

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