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Sustainable1

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Sustainability Quarterly

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INTRODUCTION

Introduction

Welcome to the second edition of the S&P Global Sustainability Quarterly, featuring research authored by a cross-section of representatives from across S&P Global. We publish at a pivotal time for the sustainability world — hard on the heels of the U.N. Climate Change Conference in Sharm el-Sheikh, Egypt, known as COP27. The second part of the U.N.'s Convention on Biological Diversity, known as COP15, is underway in Montreal. As we head into 2023, it is increasingly clear that these two topics — nature and climate — are inextricably linked.

For example, mining exploration around the world is picking up as companies seek new deposits of elements like lithium and copper to support the energy transition. But research by S&P Global Sustainable1 finds that many existing mines and exploration sites overlap with some of the world's most important areas for **biodiversity**. Enabling the energy transition while managing the potential negative impacts on biodiversity is a complex challenge. It is also increasingly urgent, given that trillions of dollars of economic activity rely on nature.

While the challenges of climate change and nature loss are ubiquitous, their impact differs across geographies. Developing countries disproportionately face increasing costs and disruption from the physical impacts of climate change. Read on for a special report from S&P Global's Economics & Country Risk team exploring the impact of water issues and extreme weather events in Latin America. The research finds that **water scarcity** in Latin America is likely to intensify supply chain and operational disruptions, regulatory risks, and economics losses for businesses over the next decade.

The challenges also differ by sector. During COP27, we saw commitments from public and private sector alike, including ambitious carbon reduction initiatives from one sector that is a major contributor to global CO_2 emissions: cement. The EU is leading the way on decarbonizing the cement industry, and in the pages that follow, S&P Global Ratings analyzes the steps some European players are taking to decarbonize their operations and update their strategies to meet changing customer demands. The research also looks at the potential financial and operational implications for companies in light of the EU's goal to hasten emissions reduction and the challenges the industry faces, given the current nascent stage of **decarbonization** technology.

In the banking sector, there has been an increasing number of regulatory initiatives across the globe to accelerate the assessment of exposure to and management of climate risks, notably through **stress tests**. Research from S&P Global Ratings explores the approaches of regulators and prudential authorities and aims to identify the key challenges that remain.

With the acceleration of global ambition to tackle climate change, market participants increasingly need to better understand the greenhouse gas competitiveness, or the relative **greenhouse gas intensity**, between different sources of crude oil globally. A newly developed proprietary model helps do just that by modeling greenhouse gas emissions down to individual assets and the sources of emissions. Research by S&P Global Commodity Insights applies this model to the North Sea — one of the most significant oil- and gas-producing regions globally.

There is no one-size-fits-all solution to climate and nature challenges. In the research that follows, we seek to understand the sustainability challenges different parts of the world and the economy face — and the solutions to help address these challenges. ■

Richard Mattison
President, S&P Global Sustainable1

Rocks and hard places:

The complicated nexus of energy transition minerals and biodiversity

Minerals such as copper, lithium and cobalt are key to ramping up low-carbon technologies like electric vehicles and solar panel manufacturing. But the process of extracting them — from exploring potential sites to closing depleted mines — poses significant threats to the ecosystems and species that often coincide with potential mineral deposits. A new analysis by S&P Global Sustainable1 finds there is overlap between existing mines and exploration sites and some of the world's most important areas for biodiversity.

Published on November 22, 2022

Key takeaways

- Low-carbon energy transition pathways predict a massive expansion in the supply of rare minerals, and companies are exploring hundreds of new sites globally that have mining potential.
- More than 1,200 mining sites lie within Key Biodiversity Areas, and 29% of those sites are for energy transition minerals, according to a new analysis from S&P Global Sustainable1 based on data accessed through collaboration with UNEP-WCMC.
- Accessing more of these minerals to expand low-emissions technologies like electric vehicles, solar energy and batteries can create pressures on biodiversity, undermining the resilience of ecosystems and their role in addressing climate change.

▶ **Pathways to transition the global economy** away from fossil fuels predict a massive expansion of the supply of critical minerals, and mining exploration around the world is picking up as companies seek out new deposits of elements like cobalt, lithium and copper.

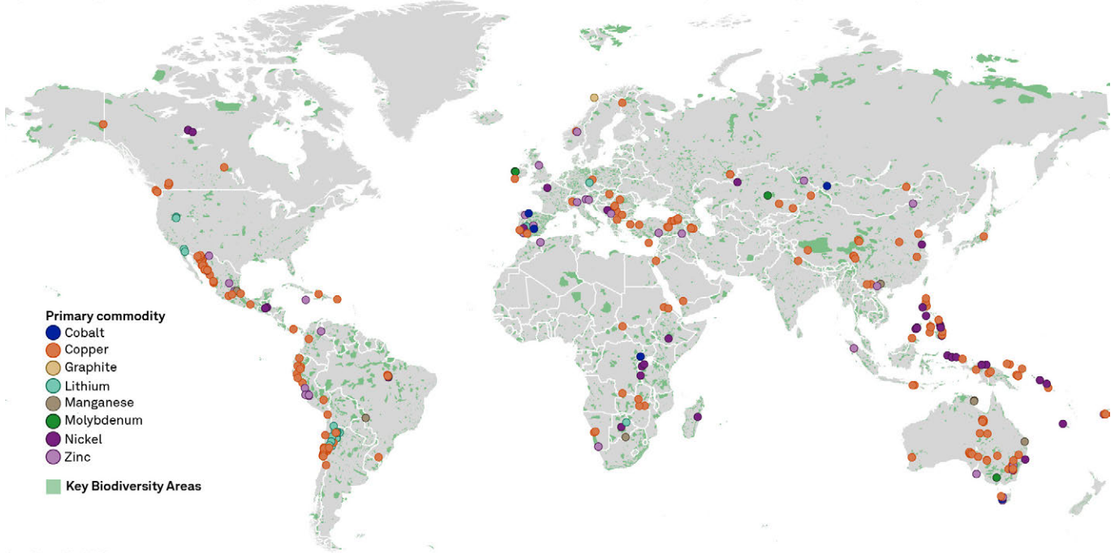
But while access to more of these minerals is key to ramping up low-carbon technologies like electric vehicles and solar panel manufacturing, the process of extracting them — from exploring potential sites to closing depleted mines — poses significant threats to the ecosystems and species that often coincide with potential mineral deposits. A new analysis from S&P Global Sustainable1 finds that many existing mines and exploration sites that could become mines overlap with some of the world's most important areas for biodiversity.

This presents a complicated problem: How does the world attain the mineral resources needed to enable the energy transition while managing the potential negative impacts on biodiversity? How do we minimize trade-offs arising between efforts to conserve nature and reduce emissions? These questions take on greater urgency as the world better understands that trillions of dollars of economic activity rely on biodiversity. Looming above this challenge is the basic fact that failing to lower greenhouse gas emissions will continue to cause dramatic losses to biodiversity in the coming decades.

About 5% of the more than 24,500 operational mines and exploration sites around the world are in Key Biodiversity Areas (KBAs), according to the analysis conducted by S&P Global Sustainable1 based on data accessed through collaboration with UNEP-WCMC, the UN Environment Programme World Conservation Monitoring

29% of all mines in Key Biodiversity Areas are for transition minerals

Operating, closed and exploration transition mineral mines that overlap with key biodiversity areas



As of Apr. 19, 2022.
Map credit: Ciaralou Agpalo Palicpic.
Mapping layer: UN Geospatial. The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.
Sources: S&P Global Sustainable1, S&P Global Market Intelligence. Key Biodiversity Area data downloaded March 2022 from the Integrated Biodiversity Assessment Tool (https://www.ibat-alliance.org). Provided by BirdLife International, Conservation International, International Union for Conservation of Nature and United Nations Environment Programme World Conservation Monitoring Centre.
Please contact ibat@ibat-alliance.org for further information.

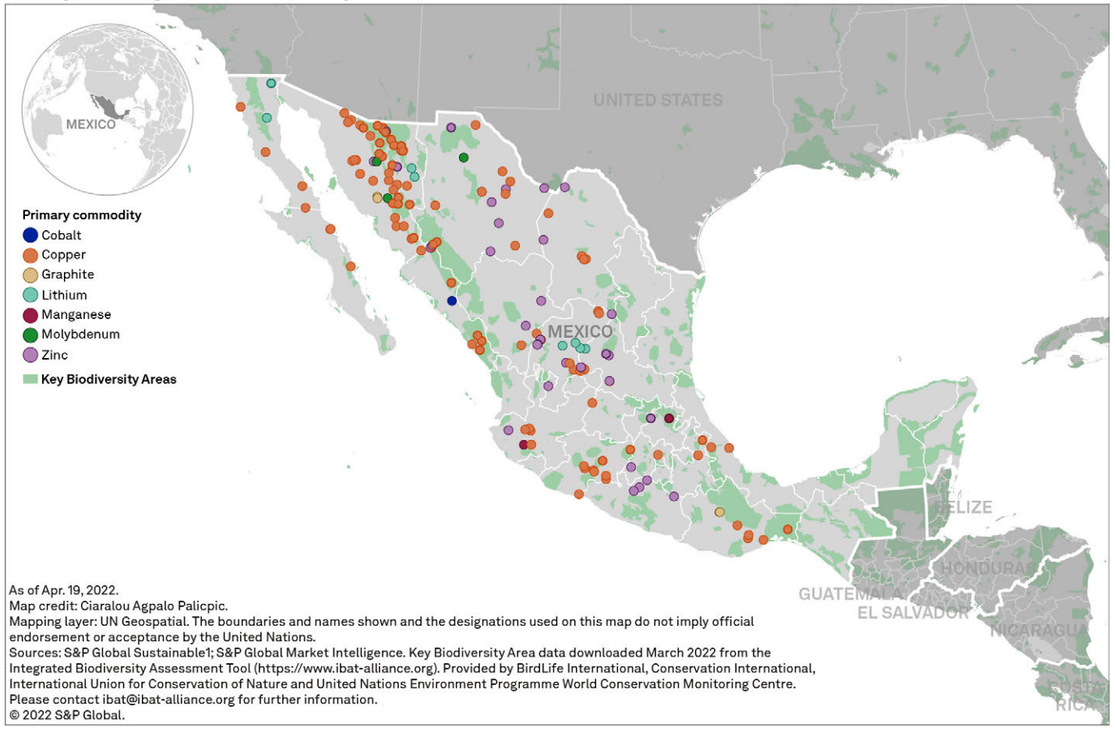
Transition mineral mines have significant overlap with KBAs around the world

Countries where 10% or more of transition mineral mining sites overlap with KBAs

Country	Total number of transition mine sites	Transition mine sites overlapping with KBAs	Percentage of transition mine sites overlapping with KBAs	Transition minerals (number of sites overlapping with KBAs)
Turkey	43	19	44%	Copper (17), zinc (2)
Ecuador	24	7	29%	Copper (7)
Philippines	105	30	29%	Copper (14), zinc (5)
Mexico	161	46	29%	Copper (37), lithium (1), manganese (2), zinc (6)
Papua New Guinea	34	9	26%	Copper (9)
Italy	17	4	24%	Copper (4)
Spain	36	8	22%	Cobalt (2), copper (2), lithium (1), zinc (3)
Bulgaria	10	2	20%	Copper (2)
Argentina	112	18	16%	Copper (10), lithium (10)
Indonesia	91	13	14%	Copper (5), nickel (7), zinc (1)
Portugal	18	2	11%	Copper (1), nickel (1)
Germany	19	2	11%	Copper (1), lithium (1)
Serbia	38	4	11%	Copper (2), nickel (1), zinc (1)
Botswana	30	3	10%	Lithium (1), manganese (2), nickel (1)

Data as of April 19, 2022.
Transition minerals include cobalt, copper, graphite, lithium, manganese, molybdenum, nickel and zinc.
Table includes countries that have at least 10 transition mineral mining sites and where 10% or more of transition mineral mining sites overlap with KBAs.
KBA = key biodiversity area
Source: S&P Global Sustainable1; S&P Global Market Intelligence; UNEP-WCMC. Key Biodiversity Area data downloaded March 2022 from the Integrated Biodiversity Assessment Tool. Provided by BirdLife International, Conservation International, IUCN and UNEP-WCMC.

All operating, closed and exploration transition mineral mines in Mexico



As of Apr. 19, 2022.
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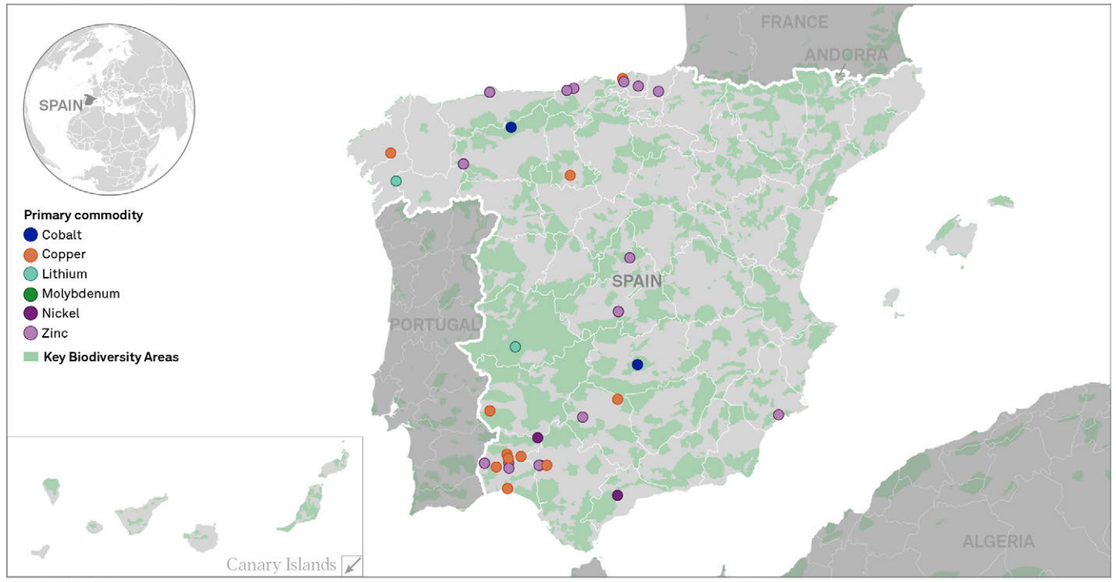
Centre. KBAs are sites deemed by the scientific community as contributing significantly to the global persistence of biodiversity. The KBA designation does not carry legal protection, but many KBAs overlap with protected areas such as national parks or wildlife reserves. As of September 2021, about 16,000 KBAs have been defined, and scientists may identify more in the future, including in areas where mines already exist.

Of the 1,276 mining sites that intersect with KBAs, 29% are for extracting minerals needed for the low-carbon energy transition. Moreover, of these transition mineral sites in KBAs, 67% are exploration sites, meaning they are being assessed for future development into operational mines to meet the demands of the energy transition.

Mining sites for transition minerals overlap with KBAs in 65 countries around the world. In some countries where mining development is more widespread, a significant portion of mining for transition minerals is taking place within KBAs. There are more than a dozen countries with at least 10 transition mineral mines and where 10% or more of those mining sites overlap with KBAs.

Take Mexico, for example, where about 29% of transition mineral mining sites overlap with KBAs. More than a dozen of those transition mineral mining sites intersect with KBAs in the massive Sierra Madre Occidental, or SMO, which consists of highland plateaus, mixed forests and deeply cut canyons. The SMO extends about 700 miles from northwestern Mexico near the U.S. border to the southeastern part of the country.

All operating, closed and exploration transition mineral mines in Spain



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Sources: S&P Global Sustainable1; S&P Global Market Intelligence. Key Biodiversity Area data downloaded March 2022 from the Integrated Biodiversity Assessment Tool (https://www.ibat-alliance.org). Provided by BirdLife International, Conservation International, International Union for Conservation of Nature and United Nations Environment Programme World Conservation Monitoring Centre.
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The SMO has some of the richest diversity of ecosystems and species in North America, according to a scientific study published in the journal Environmental Science. BirdLife International, a conservation group that helps identify KBAs, describes the canyon corridor of the SMO as a refuge for bird species including parrots, macaws and the golden eagle and for mammals such as the jaguar, ocelot and river otter. Companies are exploring four mining sites for copper and zinc in this KBA.

Countries with significant overlap exist around the world, including in regions that have made protecting biodiversity a priority. The EU has set out a biodiversity strategy with a 2030 target date that includes turning at least 30% of its land and sea area into protected areas. But in Spain, for example, 22% of transition mineral mines are in KBAs, a significant share of its contribution to supplying the energy transition with needed minerals. These locations are for a variety of transition minerals — cobalt, zinc, copper and lithium — and nearly all are in the exploration stage. These sites overlap with KBAs that are home to endangered species including the Iberian minnowcarp, which could be threatened by habitat destruction imposed by the exploration process and by potential water pollution.

Mining and the economic consequences of biodiversity loss

Global biodiversity is already in rapid decline due to human activity and climate change. The world has experienced an average decrease of 69% in the populations of mammals, birds, reptiles, amphibians and fish since 1970, according to the World Wildlife Fund. Hitting what the World Bank has called “ecological tipping

points" of damage to some natural services could hurt global GDP by $2.7 trillion annually by 2030.

Mining has the potential to degrade habitats and harm biodiversity both directly and indirectly, not only at a mining site itself but also through road and railway development in nearby areas. Building this infrastructure can increase access to remote, biologically diverse areas and lead to significantly higher human populations as well as hunting and other business activities that otherwise might not have occurred.

Another direct risk to biodiversity comes from a mining waste byproduct called tailings. Tailings are a liquid slurry of pulverized rock, water and leftover extraction chemicals that remain on-site and must be treated after the target minerals are separated from the ore.

Tailings are stored in dams that, if they fail, can pollute downstream waters and wreak havoc on ecosystems. Past major tailings dam failures have caused fatalities and catastrophic damage to local communities, economies and nature.

The S&P Global Corporate Sustainability Assessment (CSA) has collected data on mining companies' adherence to tailings management standards, and this data has become even more relevant in the aftermath of recent tailings failures that led the industry to publish international standards for tailings management in 2020. However, major dam collapses have occurred as recently as September 2022.

CSA data shows that a majority of assessed mining firms now report their active tailings sites, and an increasing number are conducting audits. However, little progress has been made on aspects of tailings management that are relevant to avoiding biodiversity impacts and maintaining dams into the future, such as decommissioning procedures and life-of-mine facility plans. Better tailings management could have a twofold benefit: lessening the impact of tailings dams on the local ecosystem and lowering the chance of failure, which can cost firms billions of dollars in cleanup costs and serious reputational damage in addition to harm to both people and biodiversity.

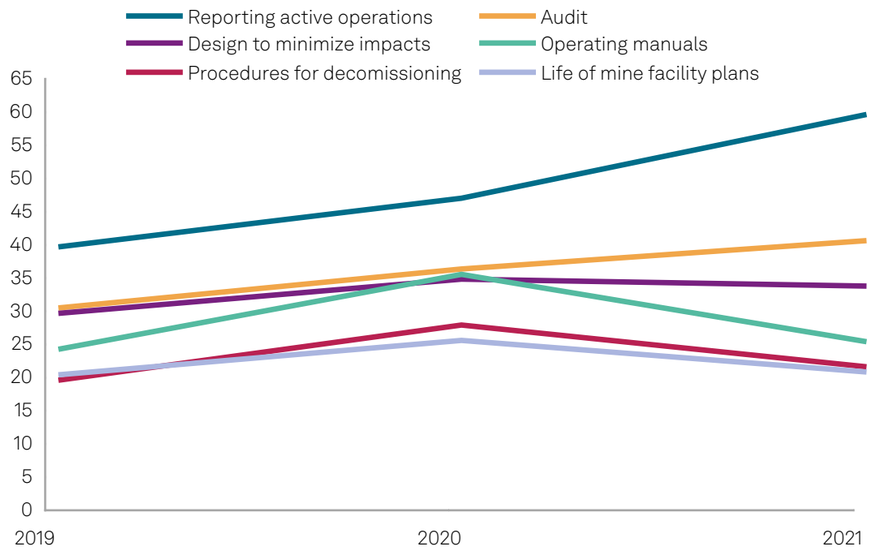
The energy transition's demand for minerals

Despite its potential harm to ecosystems, mining for energy transition minerals is a key part of transitioning to low-carbon energy and technologies. The world needs to act quickly to reduce greenhouse gas emissions to limit global warming and avoid potentially catastrophic impacts to society and nature alike.

The low-carbon transition will require a massive expansion of renewable generation, high-voltage power lines and electric vehicles, according to the International Energy Agency's "World Energy Outlook Special Report" released in May 2021. Many low-carbon technologies will require significantly larger amounts of certain minerals than their fossil-fuel based counterparts. For example, the IEA estimates that electric cars, which rely on lithium, nickel, cobalt, manganese and graphite for electric batteries — need about 6x the amount of minerals of a conventional combustion car.

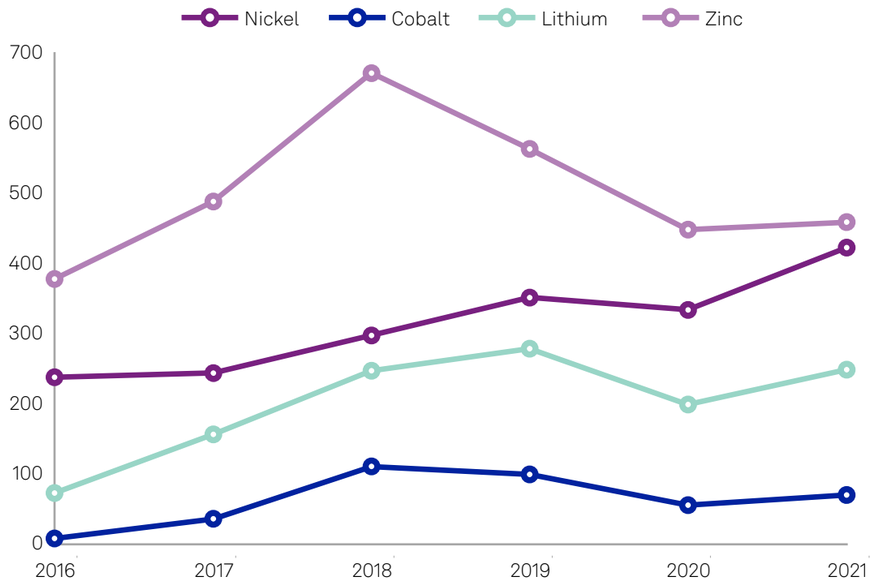
More companies are reporting active tailings sites, but few are implementing adequate tailings management

Percentage of companies providing evidence on different aspects of their tailings facility policy and management



Data as of May 2022.
Results based on responses from 136 companies in the Metals & Mining and Coal & Consumable Fuels industries that were assessed in the S&P Global Corporate Sustainability Assessment in each of the past three years.
Source: S&P Global Sustanable1.

Annual nickel, cobalt, lithium and zinc exploration budgets have climbed since 2016 ($M)

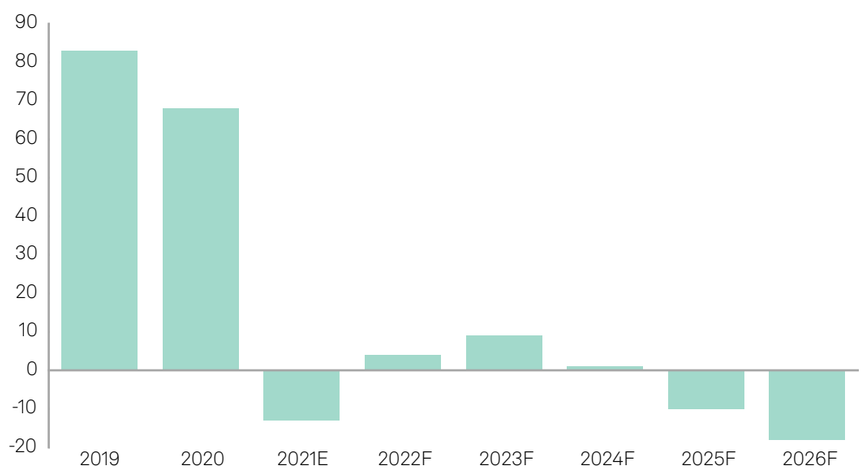


Data compiled Aug. 16, 2022.
Includes aggregate exploration budget by mining companies worldwide. Exploration budget data is estimated by S&P Global Market Intelligence when company data is unavailable.
Source: S&P Global Market Intelligence.

BIODIVERSITY

Lithium global supply may struggle to keep up with demand

Supply-demand balance in tonnes of LCE (000)



As of Jul. 25, 2022.
E = estimate; F = forecast; LCE = lithium carbonate equivalent.
Source: S&P Global Market Intelligence.

One indication of where companies are considering developing new mines or expanding existing ones is their exploration budgets. Companies use the exploration process to determine if there are sufficient minerals under the ground to warrant moving forward with development. Of the energy transition-related mining sites in KBAs around the world, 67% are exploration sites, our analysis finds.

Meanwhile, mining companies have collectively ramped up their exploration budgets for many of the minerals needed for technologies such as wind and solar power, utility-scale battery storage and electric vehicles.

From 2016 through 2021, the aggregate exploration budgets of mining companies worldwide increased for copper, nickel, lithium, cobalt, molybdenum and zinc, according to S&P Global Market Intelligence data. The biggest increase over that five-year period was for cobalt, which is a key component to electric vehicle batteries and battery storage. The global aggregate exploration budget for cobalt increased by 733% from 2016 through 2021, from $8.4 million to $70 million. Even so, cobalt's exploration budget is still far lower than many other transition minerals.

While exploration budgets are rising for transition minerals, global production may struggle to meet demand in the near term, which could affect the pace of the low-carbon transition. Exploration does not mean production is coming online quickly. If a company does decide to pursue an exploration site, obtaining development permits can take up to 10 years, depending on the country of jurisdiction.

Demand for some minerals is particularly durable. S&P Global Market Intelligence in its "World Exploration Trends 2022" report projected that "soaring demand for lithium as a major battery component will keep the market in deficit in the near and medium terms, as growth in supply will lag due to pandemic-related disruptions."

Meanwhile, demand for copper will double by 2035, creating a supply gap that could threaten climate goals and pose serious challenges to reaching net-zero emissions by 2050, according to research by S&P Global's Economics & Country Risk, Commodity Insights, and Mobility teams.

In the face of potential supply shortfalls, alternatives to mining for critical minerals are emerging. Some of those alternatives, such as minerals and metals recycling, could also reduce threats to biodiversity to the extent that they decrease the need for mining.

A 2022 study by researchers at Belgian university KU Leuven found that Europe faces critical shortfalls in transition minerals in the next 15 years, but those shortfalls could be reduced if Europe invests more in metals recycling. Up to 75% of Europe's clean energy metal needs could be met through local recycling by 2050 if Europe quickly ramps up investments in the circular economy, the study found.

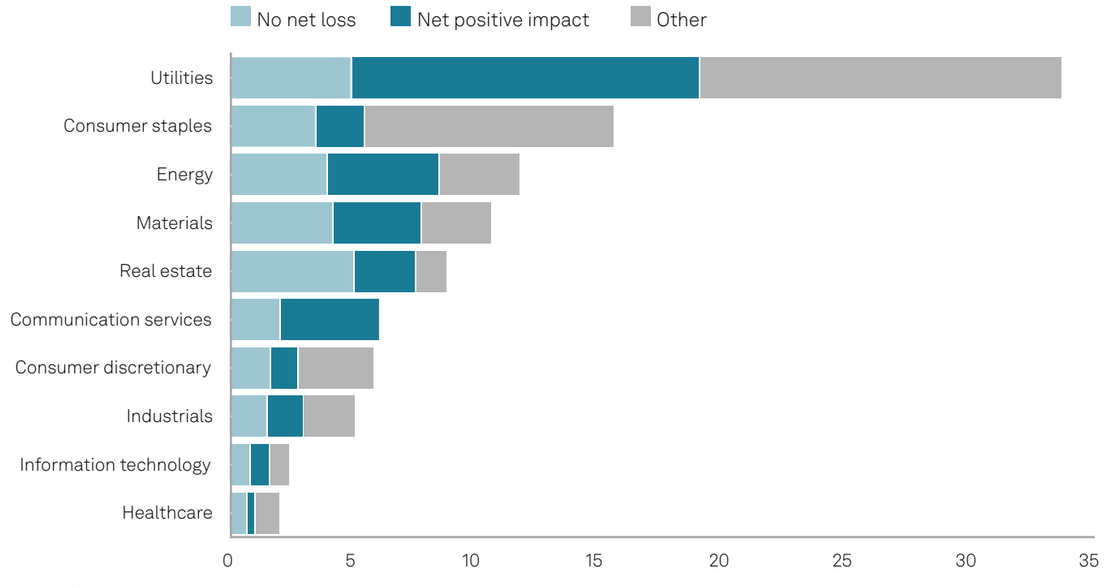
The IEA has also suggested a circular economy approach could help reduce primary supply requirements for minerals for electric vehicle batteries by about 10% by 2040.

Stakeholders paying closer attention to biodiversity

At the center of the tradeoff between supplying the energy transition with minerals and limiting the impact on biodiversity are the voluntary commitments to preserving nature that companies are willing to make.

Biodiversity commitments are uncommon outside the utilities sector

Percentage of companies by sector making nature-related commitments



Data as of November 2022.
No net loss means that damages linked ot business activity are offset by at least equivalent gains, avoiding a net loss of biodiversity and ecosystem services.
Net positive impact means that corporate actions on biodiversity, such as habitat protection, are greater than the impact from its business activity. A commitment to Net positive typically goes further than one to No net loss. Examples of "other" commitments include: No deforestation; no peat; no exploitation; the use of certified raw materials, etc.
Results based on responses from 3,753 companies assessed in the 2022 S&P Global Corporate Sustainability Assessment.
Source: S&P Global Sustainable1.

Corporate pledges to protect nature are increasing, but they remain rare. Research by S&P Global Sustainable1 has found wide variations in commitments to protecting biodiversity and ecosystem services. According to CSA findings, no assessed industry has a majority of companies making nature-related commitments. For the metals and mining industry, the share of companies with a nature-related pledge of any kind was 20%.

That could change if the regulatory landscape on biodiversity begins to shift. Governments from around the world will discuss an updated set of goals at the Conference of the Parties to the Convention on Biological Diversity, commonly known as COP15, in December 2022 in Montreal. The current draft framework proposes to conserve at least 30% of land and sea globally by 2030 and restore at least 20% of degraded freshwater, marine and terrestrial ecosystems by the same year

Meanwhile, other initiatives are underway to help financial institutions, companies and investors understand and manage biodiversity risks. The recently launched Taskforce on Nature-related Financial Disclosures, or TNFD, aims to create a framework of definitions, benchmarks and indicators that allow companies to measure, report and eventually address nature-related risks. The TNFD has released beta frameworks that some institutions are already pilot testing. S&P Global is a member of the TNFD.

For the mining sector, new voluntary standards and guidelines have been released or updated in recent years, including by the International Council on Mining and Metals (ICMM). In June 2022, the ICMM updated its mining principles on 10 issues including the human rights of workers and local communities impacted by mining and improving environmental performance metrics such as water usage.

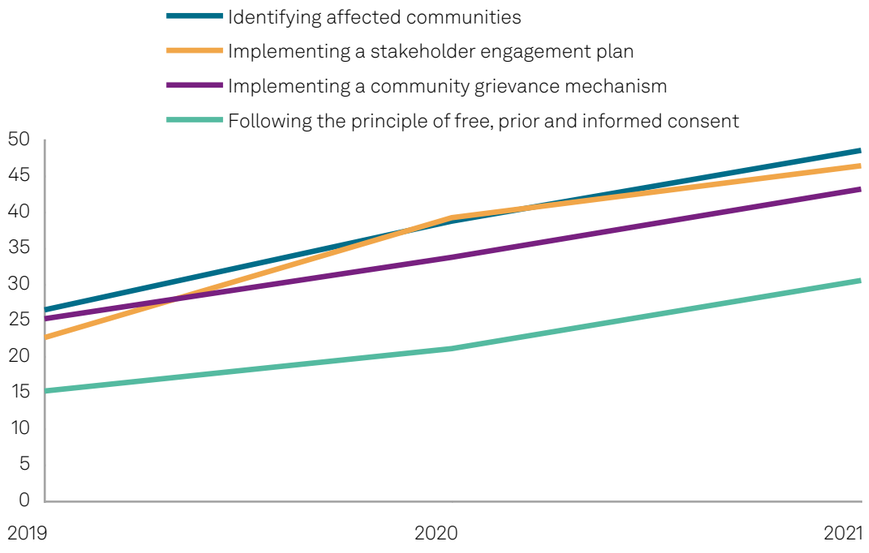
CSA data shows that mining companies have shown improvement in their engagement with local and Indigenous communities affected by mine development. In the 2021 CSA, more than 40% of assessed mining companies provided evidence that they identified affected communities, implemented a stakeholder engagement plan and put a community grievance mechanism in place. However, it remains uncommon for companies to follow the principle of free, prior and informed consent, a key aspect of respecting the rights of Indigenous peoples and local communities.

The ICMM's updated principles also include one dedicated specifically to protecting biodiversity. Principle 7 asks companies not to explore or mine in World Heritage Sites and respect "legally designated protected areas." It also sets "the ambition of achieving no-net-loss of biodiversity" for new projects and major expansions to existing projects.

While KBAs are identified by scientists, and the designation is unrelated to any legal status, they have informed the creation of protected areas in the past, and conservation groups expect KBAs will continue to do so. KBAs where mines currently operate or are being explored could evolve into protected areas over time, presenting another complication for mining firms.

Companies' engagement with local and indigenous peoples has improved but has further to go

Percentage of companies providing evidence of the following aspects of their engagement with local communities



Data as of July 2022.
Results based on responses from 186 companies in the Metals & Mining, Steel, Aluminum, Coal & Consumable Fuels and Steel industries that were assessed for each of the past 3 years.
Source: S&P Global Sustanable1.

There is no easy solution to balancing the conservation of species and ecosystems with the needs of the energy transition. The problem is global in scope yet local in impact and will require the entire mining sector to adopt a comprehensive approach to minimizing their impacts on biodiversity. However, some mining sites have greater potential for biodiversity harm than others, and companies and investors could prioritize their efforts on overseeing these mining sites to have the greatest impact on conservation. The UN Environment Programme Finance Initiative and the Natural Capital Finance Alliance found in 2021 that more than half of the mining sector's potential for reducing species extinction risk is concentrated in only 2% of mines worldwide. Better biodiversity management in just this small portion of mining sites as a starting point could have an outsized benefit on biodiversity. ■

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Water in Latin America: Operational challenges

Access to water is likely to become increasingly strategic and disruptive in Latin America over the coming decade. Climate scenario projections for the coming decades forecast that water stress and drought frequency will increase in many parts of Latin America, particularly in southern Argentina, northern Mexico and the Antofagasta region in northern Chile. Water scarcity is likely to be an ongoing constraint to the region's contribution to meeting global energy transition targets, affecting lithium extraction and green hydrogen.

Published on November 21, 2022

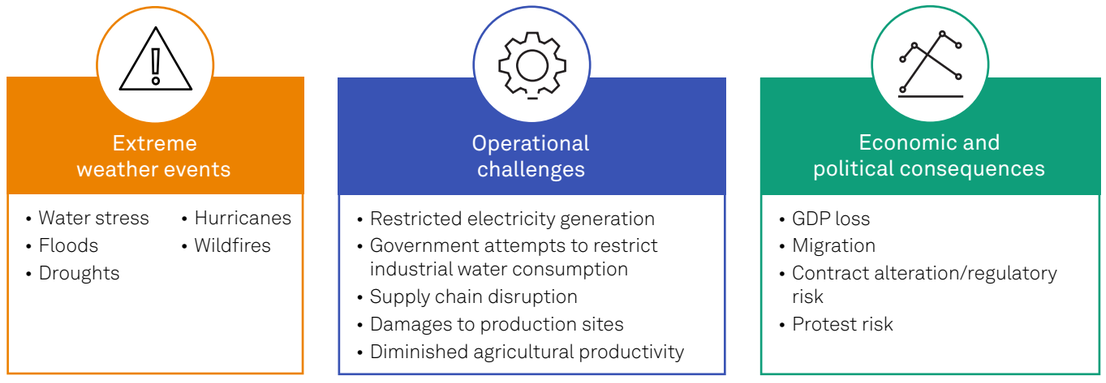
Key takeaways

- Access to water is likely to become increasingly strategic and disruptive in Latin America over the coming decade. Climate scenario projections for the coming decades by S&P Global Sustainable1 forecast that water stress and drought frequency will increase in many parts of Latin America, particularly in northern Chile, southern Argentina and the Antofagasta region in northern Chile.
- Water shortages and the resulting popular protests will increase the risk of government scrutiny into terms of water concessions, increased regulation and higher tariffs.
- Water stress and drought will also pose risks particularly to electricity generation (hydropower comprises 45% of Latin America's electricity matrix), manufacturing and agriculture.
- Delays to road cargo transportation are likely because of water disputes between local communities and governments, with fluvial supply chains also affected by delays and higher costs because of lower levels of water in rivers and canals.
- Water scarcity is likely to be an ongoing constraint to the region's contribution to meeting global energy transition targets, affecting lithium extraction and green hydrogen.

▶ **Water scarcity in Latin America is likely to** intensify supply chain and operational disruptions, regulatory risks and economics losses for businesses over the next decade. This special report reviews a selection of countries and sectors to assess the impact of water issues and extreme weather events in Latin America during the coming five years.

Extreme weather events such as water stress, floods and droughts have led to additional operational challenges in Latin America in recent years. Restricted electricity generation, supply chain disruption, damage to production sites and agricultural losses will continue generating detrimental economic and political effects.

Impact of water incidents in Latin America over the next decade



Source: S&P Global Market Intelligence.

Water stress exposure in the 2020s – middle of the road scenario (SSP2)

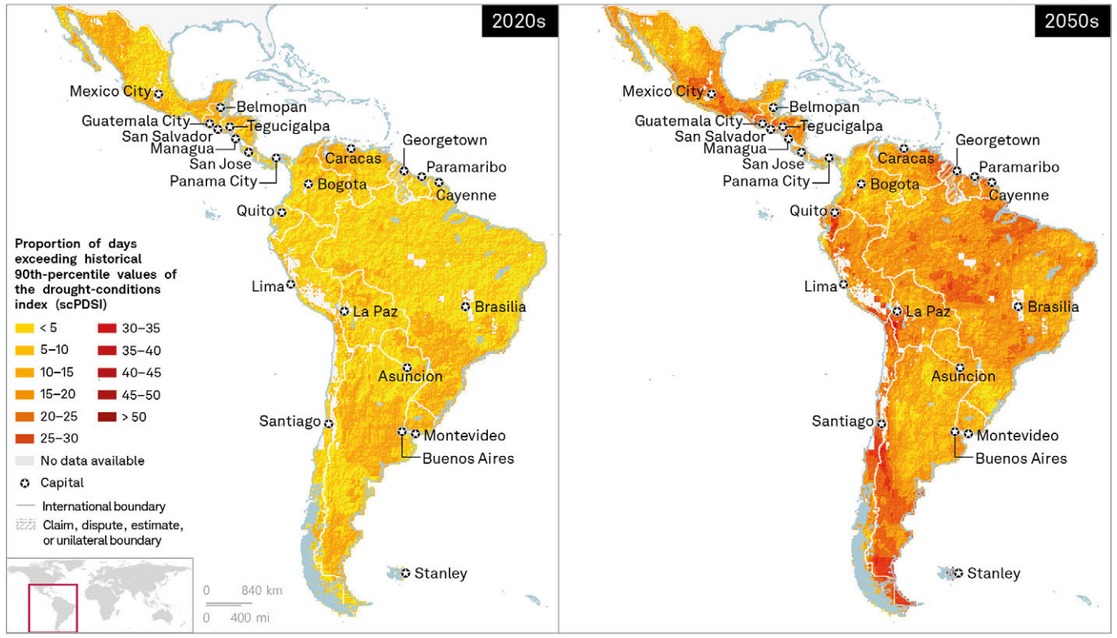
Data compiled: Dec. 06, 2022.
Sources: S&P Global Sustainable 1/ S&P Global Market Intelligence: 2008001

These include reducing income levels, increased migration, and rising contract alteration and protest risks. S&P Global Sustainable1 projects increased water-related stress across many parts of Latin America during the current decade. Simulations based on a middle-of-the-road climate scenario show that water stress in Latin America will be particularly pronounced in southern Argentina, northern Mexico and the Antofagasta region of northern Chile. Water basins in all these regions are estimated to have a water stress exposure score of above 90, out of a maximum of 100, for the current decade. The middle-of-the-road scenario assumes strong mitigation measures and total greenhouse gas emissions that stabilize at current levels until 2050 and then decline in the period to 2100.

Water stress coincides with drought risk in many parts of the continent, according to the same middle-of-the-road scenario. The drought conditions index is expected to be higher than the historic top 10% of index values for more than 10% of the period in northern Mexico, southern and central Argentina, and southern Brazil in the current decade to 2030. By the 2050s, the index is expected to be higher than the historic top 10% of daily readings on more than 15% of the daily measurements across almost all of Latin America and to surpass the levels for more than half a year in the Chile/Bolivia border region, in the Chile/Argentina border region, in southern Argentina and on the Falkland Islands. In this report, we review a selection of countries and sectors to assess the impact of water issues and extreme weather events in Latin America during the coming five years.

WATER SCARCITY

Drought hazard in 2020s and 2050s in Latin America – middle of the road scenario (SSP2)



Data compiled: Dec. 06, 2022.
Source: S&P Global Sustainable 1/ S&P Global Market Intelligence: 2008002

Manufacturing gross value added as a share of GDP in Mexico in 2022

Data compiled: Dec. 06, 2022.
Sources: Regional Explorer S&P Global Market Intelligence: 2008003

Energy

Latin America's vulnerability to extreme weather events poses risks for electricity generation, increasing production costs and the likelihood of shortages. A key example illustrating the region's vulnerability to extreme weather events is the risk that droughts and floods pose to electricity generation, increasing production costs and the likelihood of shortages in the five-year outlook. Hydropower is the main source of electricity generation in the region and comprises 45% of Latin America's electricity production. Low water levels due to changing rainfall patterns with prolonged dry periods increase the need for alternative energy sources and are likely to result in significantly higher electricity prices for businesses. Brazil for example, with 65% of its electricity matrix from hydropower, faced reservoir levels in 2021 at their lowest in over 20 years, with a state of emergency imposed in five states. The period of drought in June 2021 was followed by periods of extreme flooding in December 2021, which caused two dams to burst and endangered 10 others. Although such floods in Brazil did not directly affect electricity generation, flooding incidents in the region have previously severely affected dams. More frequent extreme weather events in the region are therefore highly likely to lead to a trend of rising corporate electricity costs in the five-year outlook.

Manufacturing

Water shortages are worsening operational disruption, protests, and contract revision risks for companies in the manufacturing sector. Conditions caused by water shortages in Latin America also increase the likelihood of operational disruption and contract revision risks for companies in the manufacturing sector. This has been the case in Mexico, which experienced some of the severest water shortages on record during 2022 because of low rainfall, population growth, and warmer temperatures in its north and northeastern states. The north of Mexico is particularly vulnerable to increased water stress and drought risk while being economically reliant on the manufacturing sector — up to 40% of GDP. Given shortages in Nuevo León state in July, particularly affecting Monterrey, the federal government intervened by initially requesting that industrial and manufacturing firms voluntarily return water to the main system. After failing to achieve an improvement in water supplies, Mexican President Andrés Manuel López Obrador issued a decree on July 29 allowing the government to exercise temporary control over existing water rights to redistribute them for public use as necessary. On Nov. 7, López Obrador stated that he requested preparations for a bill to amend the country's water legislative framework, focusing on restricting water-use permit allocation in areas facing high levels of water stress. He explicitly singled out the states of Nuevo León, Baja California, Coahuila and Durango as locations where the future bill would restrict the presence of water-intensive industries. Mexico's water shortages will be exacerbated in the one-year outlook as a result of the U.S. Interior Department's announcement in August 2022 that Mexico would need to reduce by 7% its water intake from Lake Mead, which feeds the Colorado River Basin, from 2023 because of its low water levels.

The north of Mexico is particularly vulnerable to increased water stress and drought risk

Agribusiness

Droughts and flooding events worsen the risk of lower crop yields and higher food prices. Higher temperatures and lower-than-average rainfall levels are likely to increase the risk of lower crop yields and consequently higher food prices in the five-year outlook. The weather extremes experienced during the 2021-22 crop season severely affected several major agribusiness-producing countries in Latin America. Argentina, the third-largest global soybean and maize producer, experienced $2.9 billion in total losses within its agribusiness sector. As drought remains an issue in Argentina, an estimated 15% of wheat production will be lost with significant delays to maize planting for the current season. Brazil's agricultural sector experienced $9 billion in losses in 2021 because of drought. According to the Brazilian Association of the Coffee Industry, drought and recent frosts destroyed the entire plantations of coffee in the state of Minas Gerais, where almost 50% of Brazil's coffee is produced. Although crop estimates indicate that crop yields are likely to recover during the 2022-23 season in Brazil, weather phenomena, including La Niña, are also likely to affect crops in the Parana River Basin during 2022, affecting Argentina as well, with growing risk of further extreme weather events affecting crops and raising costs for producers, exporters and consumers. As extreme weather events become more accentuated in the five-year outlook, crop yields are likely to become increasingly unreliable, leading to food shortages and lower agricultural revenues.

Sustained periods of droughts will encourage legislative efforts to limit companies' water use, increasing the regulatory burden for the agriculture sector. Chile currently faces a 13-year megadrought, with agriculture and livestock producers the most affected, particularly in the north and center of the country, with $1 billion estimated losses just in 2020, according to the Ministry of Agriculture. In April, a new water code was introduced in Chile after 11 years of legislative discussions. The agriculture sector, which uses more than 70% of available water, is likely to face stringent application of the new water code. It reinforces the character of water as a public good, prioritizing its use for consumption and sanitation. In Latin America, countries that face similarly acute and prolonged droughts as in Chile, government, legislative and public pressure is likely to be imposed on companies and sectors with high water usage, requiring them to donate or forgo water supplies to increase water availability for domestic use, with agriculture potentially most affected because of its high proportion of water use.

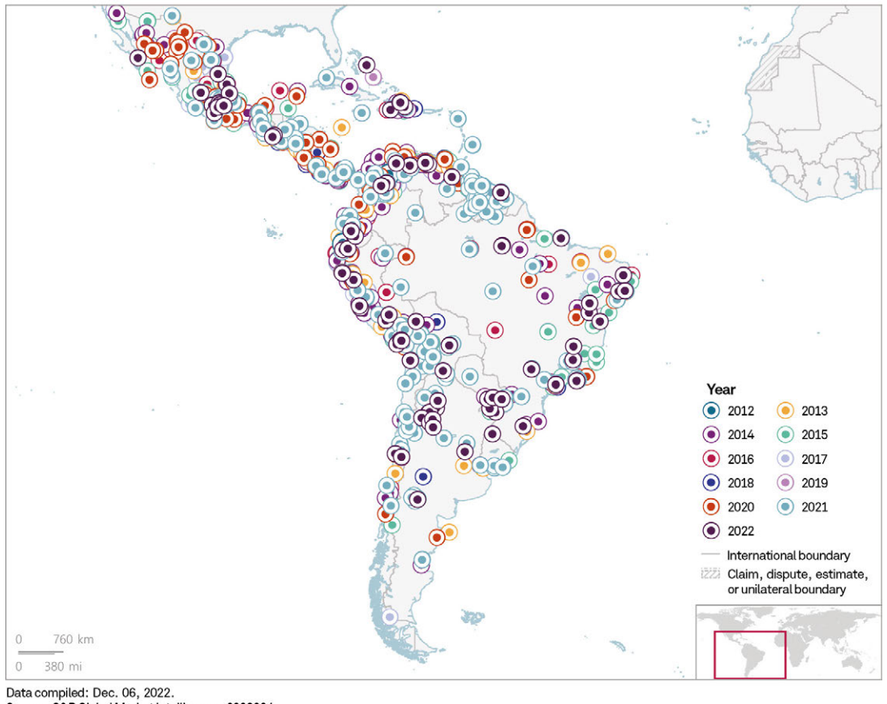
Supply chain

Water disputes are likely to increase disruption to road cargo, damaging supply chains. Disputes over water usage between communities and state governments, such as the recent protests in Mexico's Tamaulipas state demanding transfer of water from Nuevo León state, are likely to increase disruption to road cargo. Protests in 2020 over the federal Mexican government's decision to relocate water flows from La Boquilla Dam to comply with international obligations for water transfer led to $700 million in losses following road blockades during more than a one-month period. Further protests and roadblocks due to water concerns disrupting operations are likely, particularly in northern Mexico, where water stress is more acute and through which more than 80% of U.S.-bound exports are transported by land.

Our Economics and Country Risk open-source intelligence collection system data is highlighted in the infographics below.

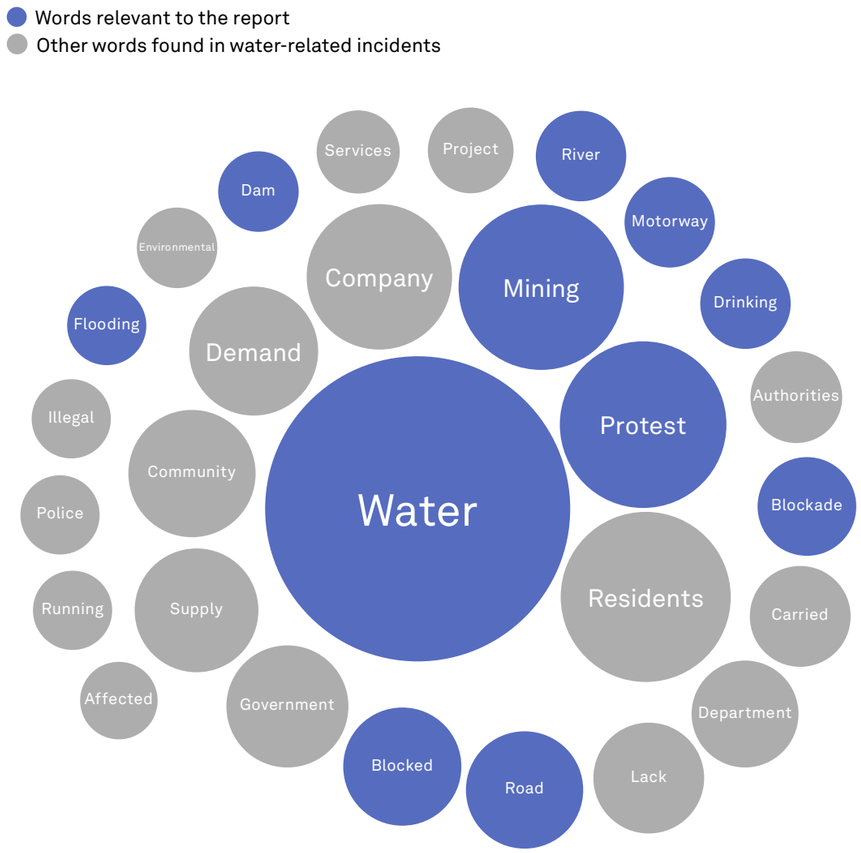
Changes in water levels will affect global supply chains relying on rivers and canals to move cargo. Rising temperatures and changing precipitation patterns are likely to reduce critical water levels in rivers and canals used for transportation by significant numbers of vessels, impacting supply chains at both the local and global levels in the five-year outlook. It is likely to apply in the Panama Canal Basin, where 13,000 vessels crossed in 2021 — 2.4% of global maritime trade. In 2020, the Panama Canal Authority (Autoridad del Canal de Panamá, or ACP) imposed a fee for water usage, after a 20% decline in precipitation levels during 2019 forced the imposition of lower maximum draft requirements for crossing. Disruptions derived from such

Incident events related to water stress



Data compiled: Dec. 06, 2022.
Source: S&P Global Market Intelligence: 2008004

Words most frequently found in water-related incident events in Latin America



Intelligence events collected by Economics and Country Risk between January 2012 and October 2022.
Source: S&P Global Market Intelligence.

temporary weight restrictions are likely to become increasingly common, leading to transportation delays and higher costs. Similarly affecting supply chains in South America, the Paraná River Basin is a principal route for the transportation of agribusiness products between Brazil and Argentina and forms part of the fourth-most transited waterway in Brazil. Soybeans and corn make up most of Paraná River cargo. However, during periods of drought, as in 2021, restrictions were applied to cargo on the waterway, given low water levels in the river basin, restricting vessels to 75% of their normal cargo capacity. More severe or longer lasting droughts worsen the risk of temporary bans on cargo, which would force reliance on road transport, leading to delays and higher costs.

Mining/extractives

Water stress will drive environmental activism, increasing protest and legal challenges for extractive companies. Water scarcity, pollution and the provision of permits will remain key drivers for environmental and community activism in Latin America. Opposition by Peruvian local communities, particularly farming groups, to the provision of water permits for the mining industry is likely to remain a trigger for popular protests, indicated by recent local protests against the granting of a water permit to a copper mining project in the Arequipa region. In Colombia, concerns about water usage and contamination have been a main driver behind the new left-wing Gustavo Petro administration's proposal to implement a national ban on fracking. A bill was submitted in August to ban fracking as part of the government's broader agenda to accelerate Colombia's energy transition away from fossil fuels. The bill, slated to be discussed in Congress soon, proposes the cancellation of existing fracking contracts. One reason for the firmer stance on fracking is the environmental concern about high volumes of water use and potential contamination of surrounding aquifers, with local communities holding frequent protests against fracking pilot projects in Puerto Wilches during 2022. In Chile, after growing pushback against mining projects, companies have increased the use of seawater to better manage water use in order to maintain relationships with communities and limit operational disruption caused by rationing; eight mining-related desalination plants are already in operation.

Water scarcity and its effects on the energy transition

Water scarcity is likely to be an ongoing constraint to Latin America's contribution to meeting global energy transition targets. Although the region is well positioned to become a key supplier of critical minerals such as lithium for batteries for electric vehicles (EVs), having around 60% of global lithium reserves, the intensive use of water to extract lithium by evaporating brine from salt flats will continue to be an issue in the five-year outlook. Protests over water usage related to lithium extraction have already occurred in Argentina's Jujuy region and in Chile's Atacama region. As global demand for lithium continues growing, the expansion of existing or new projects in the region, particularly in arid locations already facing water stress, is likely to face increased opposition from local communities. Water is also likely to be a constraint for green hydrogen – hydrogen generated using environmentally friendly energy sources – a key priority in Chile. However, green hydrogen projects' use of desalination plants using seawater as the main source of water should mitigate risks by limiting the need to use potable water. ■

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Decarbonizing cement:

How EU cement-makers are reducing emissions while building business resilience

European cement manufacturers have committed to reducing carbon emissions by 30% by 2030, which we view as achievable. However, if more stringent regulations are enacted to mandate emissions reduction, we believe that it will be challenging for the industry to achieve net-zero by 2050 without putting profitability under pressure.

Published on October 27, 2022

Key takeaways

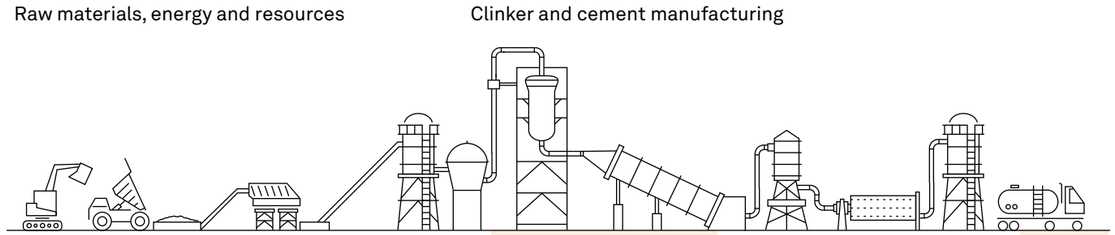
- The EU's largest cement manufacturers have committed to reducing their Scope 1 CO2 emissions per ton of cement by about 30% by 2030, from 1990, mostly via enhanced thermal-energy efficiency and fuel switching. We view this target as achievable and at reasonable cost.
- Beyond 2030, a significant drop in direct emissions can only be achieved via reduced demand (greater product efficiency) and accelerated carbon capture and storage. The required technologies are still in prototype or development, awaiting significant infrastructure investments to scale up. As such, it remains uncertain whether the sector can achieve carbon neutrality by 2050.
- The proposed EU regulation "Fit for 55," targeting a 55% carbon emissions reduction by 2030, could lead to a much lower supply of free carbon allowances for cement companies, significantly increasing their carbon-related costs if they cannot cut emissions.
- While sector decarbonization presents many challenges, we also consider a number of mitigating factors that may shield the most efficient players. Cement substitution alternatives are currently limited, meaning demand should remain structurally steady. These factors together could allow entities to pass higher costs on to customers, but pressure on profitability still looms, in our view.

▶ The EU is leading the way on decarbonizing the cement industry, with larger players taking steps to reduce emissions by 2030. In this research, we analyze the steps some European players are taking to decarbonize their operations and update their strategies to meet changing customer demands. We also look at the financial and operational implications for companies in light of the EU's goal to hasten emissions reduction and the challenges the industry faces, given the current nascent stage of decarbonizing technology. We also set out some mitigating factors, which largely reflect cement's limited substitution risk and still-high demand. In the second part of our research, "Companies could see pressure on ratings as the EU firms up carbon rules", we explore how producers are preparing for tighter European carbon regulation and how this might influence our credit rating analysis.

Cement is a main contributor to global CO_2 emissions

Cement production is responsible for about 7% of the world's direct CO_2 emissions, according to the Global Cement and Concrete Association. China and India are the largest producers at about 55% and 8% of global production, respectively, according to the International Energy Agency (IEA). Cement, chemicals and steel account for nearly 60% of all industrial energy consumption and about 70% of direct CO_2 emissions from the industrial sector. Cement production is highly concentrated in emerging markets and developing economies: about 70% of combined output. Concrete is the second-most consumed substance on earth after water, with half a ton of cement being used each year for every person on the planet (IEA, Energy Technology Perspectives 2020).

Chart 1: **Calcination and heating are the most carbon intensive stages of cement manufacturing**



	Quarry	Crusher	Transport*	Raw mill	Kiln and preheater/ precalcinator§		Cooler†	Cement mill	Logistics‡	Total
Energy (MJ/ton)	40	5	40	100	3,150		160	285	115	3,895
CO2 (KG/ton)	3	1	7	17	479 calcination process	319 fossil fuels	28	49	22	925

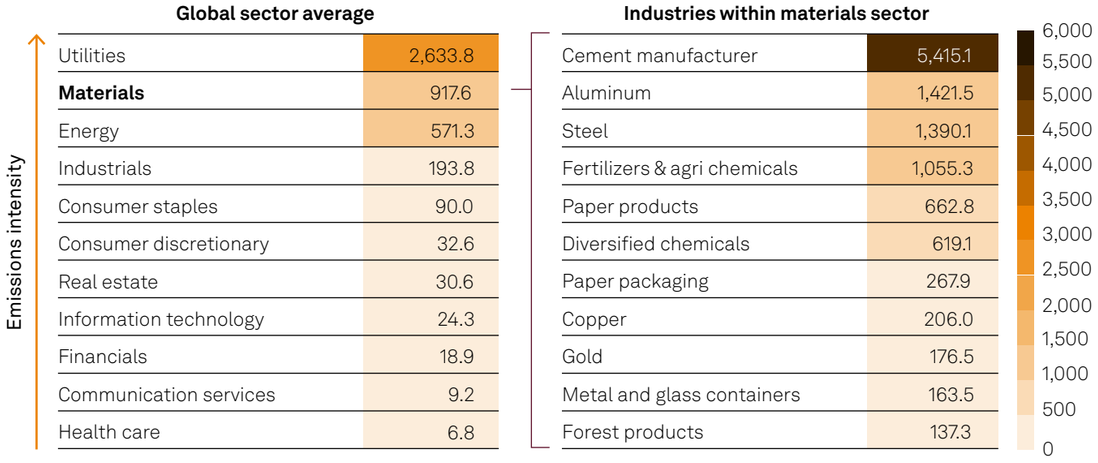
* Assumed 1kWh/tonne/100m.
§ Assumed global average, data from Global Cement and Concrete Association (2017).
† Assumed reciprocating grate cooler with 5kWh/tonne clinker.
‡ Assumed average truck transportation of 200 km.
Source: Mckinsey data.

Cement manufacturers' carbon intensity ratios are about 6x larger than the average for the materials sector and well above most other business sectors (see chart 2). Producing a ton of grey cement today generates about 0.6 metric tons of CO_2 on average but can vary widely from 0.5 to 0.8 metric tons (EIA data). Two-thirds of emissions are generated in the chemical process, or calcination, from carbon released from the raw materials used, particularly limestone, and are difficult to decarbonize. The other third stems from energy consumed as process heat. Fossil fuels, mostly coal plus some petroleum coke, account for 90% of thermal energy needs in cement production. White cement, which is higher quality but more energy intensive, emits more than grey cement, which is more common and cheaper to produce, at an industry average of 0.9 metric tons of CO_2 per ton of cement, reflecting both higher clinker ratios and lower use of alternative fuels to preserve its quality (IEA).

Carbon intensity ratios differ among large European cement manufacturers. Companies with lower emissions or greater diversification into other building products typically have lower carbon intensity. For example, CRH displays the lowest intensity ratio among European rated companies (see figure 3) because cement comprises only 15% of its total revenues, which compares with an average of 60% for the other cement manufacturers. Ready-mix concrete, aggregates and other building products, such as architectural and infrastructural, typically make up the balance of cement manufacturers' revenues.

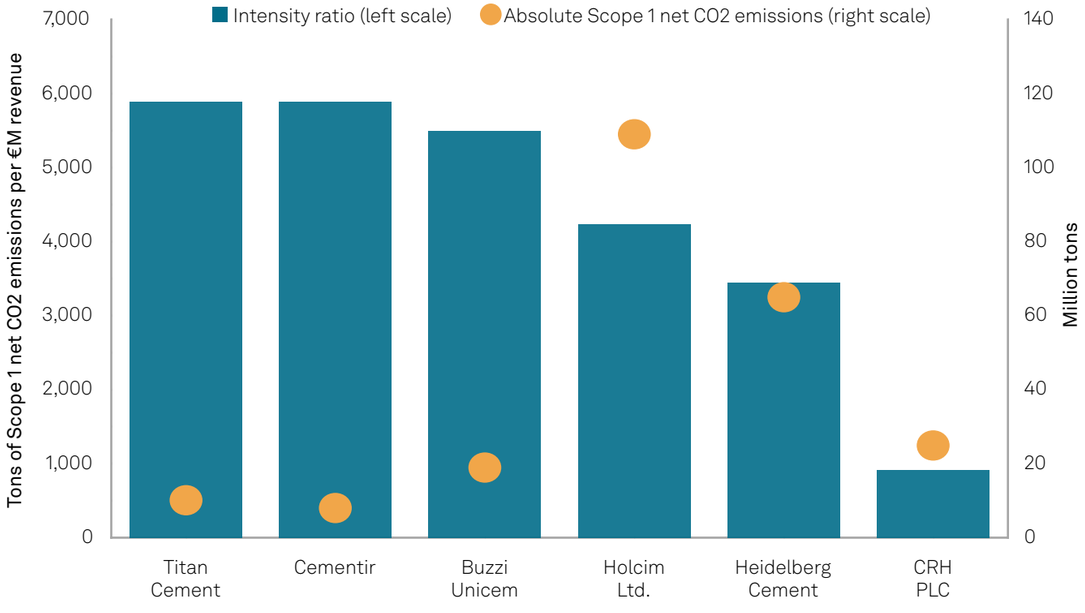
Chart 2: **Cement manufacturing is a highly carbon intensive process**

Emissions intensity by sector. Scope 1 CO2e per $1M of revenue (tonnes)



CO2e = carbon dioxide emissions.
Scope 1 revenue intensity is calculated as tons of Scope 1 gross emissions per $1 million of revenue. Calculation is based on 2019 and 2020 averages using GICS Industry Group data. The analysis is based on companies covered by S&P Trucost Ltd., a part of S&P Global Inc.
Source: S&P Global Inc.

Chart 3: **Intensity ratio and CO2 emissions, 2021**



CO2e = carbon dioxide emissions.
Scope 1 revenue intensity is calculated as tons of Scope 1 gross emissions per $1 million of revenue. Calculation is based on 2019 and 2020 averages using GICS Industry Group data. The analysis is based on companies covered by S&P Trucost Ltd., a part of S&P Global Inc.
Source: S&P Global Inc.

European cement companies are leading CO_2 reduction, but carbon neutrality by 2050 seems uncertain for the sector

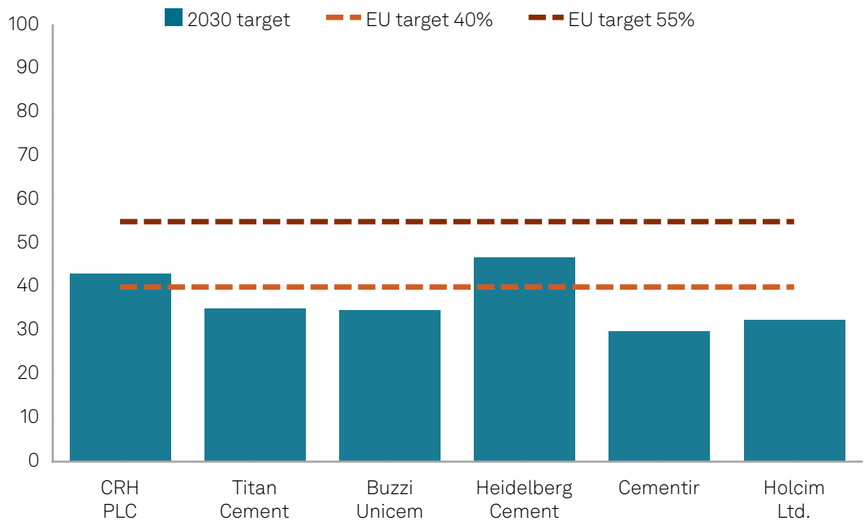
Europe's large cement companies have reduced CO_2 emissions substantially in the past few years. This is as a result of investments to improve plants' thermal efficiency and increase the use of alternative fuels, such as biomass. For example, according to its company reports, HeidelbergCement has cut carbon emissions per ton of cement by 23% since 1990 and Buzzi Unicem by 17% in the same period. Most of their investments have been driven by cost considerations, but more recently, the increase of carbon costs in the EU and their anticipation of more stringent EU environmental policies have become key drivers. European players represent a significant portion of the market in EMEA and North America; among manufacturers outside the EU, however, decarbonizing regulations for the industry remain nascent at best, and carbon pricing is either nonexistent or not constraining.

For EU companies, energy efficiency remains the most relevant factor for meeting 2030 emissions reductions targets. 2030 is the year most large companies have set as a target to cut Scope 1 carbon emissions to below 500 kilograms per ton (kg/t) of (grey) cement, compared with an average of 600 kg/t today. Holcim, for example, has set a target of 475 kg/t of cement for Scope 1 net carbon emissions by 2030, 14% lower than its 2020 emissions. Some companies have more work to do than others to reach their 2030 targets (charts 4 and 5). Cementir's emissions are currently well above those of Holcim or HeidelbergCement, largely reflecting its lower use of alternative fuels in Europe and higher share of white cement as a portion of total revenues. In May 2022, HeidelbergCement provided new decarbonization targets and now aims to cut Scope 1 net carbon emissions to 400 kg/t of cement by 2030, which is close to a 50% reduction compared to 1990 and compares with a former commitment to reduce emissions to 525 kg/t of cement by 2025. The new target is 15%-20% lower than the typical target of the largest European players. HeidelbergCement plans to reach this target by reducing the clinker content in its cement to below 68%, from 73% currently, and by increasing its use of alternative fuels to 45% from 26%. It is also aiming to capture a cumulative 10 million tons of CO_2 using carbon capture, utilization and storage (CCUS) technologies to reach its 2030 target, and it is the first company in the sector to include CCUS in its 2030 emissions strategy.

The cement industry as a whole, and some large European players in particular, could update their 2030 emissions targets over next few years. HeidelbergCement already has. This is because the proposed EU regulation "Fit for 55," which targets a 55% carbon emissions reduction by 2030 compared with 1990, will likely result in a much lower supply of free carbon allowances to companies. This will significantly increase the costs associated with carbon if companies cannot cut emissions. The investments needed to reach current 2030 reduction targets are not prohibitive, in our view; most companies have already woven such costs into their annual capital expenditure (capex) targets, and we, in turn, have factored them into our credit quality assessments. Investments relate to increasing the use of alternative fuels or biomass, decreasing clinker content and accelerating process innovation. HeidelbergCement has stated that its annual capex for conventional CO_2 reduction initiatives is about €100 million-€150 million, which it is already included in its total capex guidance. On average, we estimate that investments associated with reaching 2030 targets represent about 20% of large European cement companies' yearly maintenance capex.

Chart 4: **Cement companies' Scope 1 carbon reduction 2030 target vs. EU target**

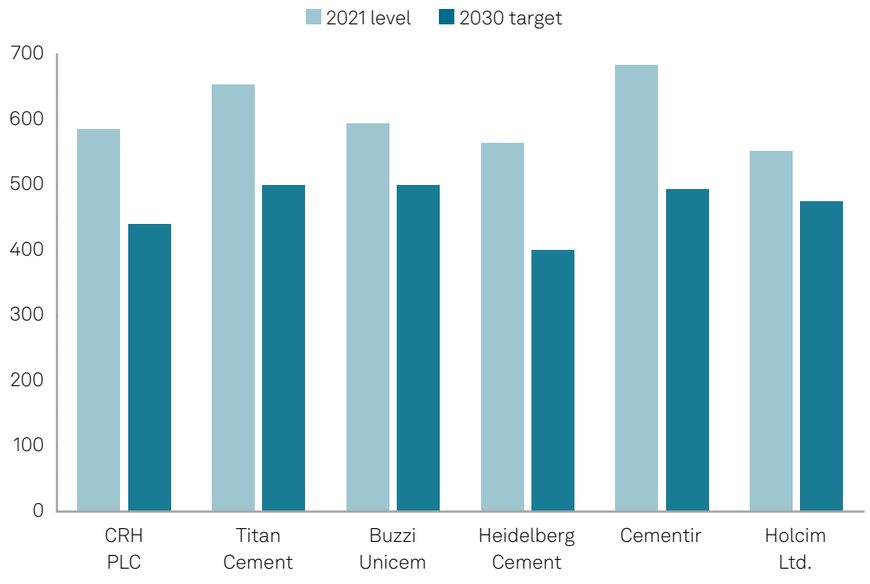
Percent reduction compared with 1990 figure



Source: Companies' 2021 sustainability reports.

Chart 5: **Cement companies' carbon reduction per ton of cement**

(net Kg CO2/ton of cementitious product)



CRH PLC target estimated, based on the company's target for absolute reduction in CO2 emissions.
Source: Companies' 2021 sustainability reports.

Whether cement companies can achieve carbon neutrality by 2050 is a more difficult call to make. Given current production technologies, a significant drop in emissions beyond 2030 can only be achieved by accelerating new technologies. CCUS as described below by S&P Global Commodity Insights, an S&P Global Ratings affiliated entity, potentially offers the most promising decarbonization solution for the sector but requires technologies that are still prototypes or under development and will need significant infrastructure investments to scale up as well as policy support to reduce the associated production costs. Currently, only the leading cement manufacturers are at the forefront of carbon capture and storage projects.

Summary of the current state of CCUS technologies

There are multiple ways to lower the carbon footprint of cement at different stages of development. CCUS is the only option to eliminate process CO_2 without changing cement's chemistry.

The integration of carbon capture in cement production could reduce emissions by up to 36%, according to the Global Cement and Concrete Association. This technology could capture the emissions generated during the calcination process and does not require fundamental modifications to the cement production process.

Cement currently accounts for 6% of global CCUS capture capacity in the pipeline. This is mainly from European manufacturer-led projects in Europe and the U.S. Most of the CCUS project additions capturing CO_2 from the cement industry are expected to be operational beyond 2025; currently, 5% of the pipeline of projects for the cement sector is under construction, while the rest is still in early development.

Five main technologies are being tested to capture CO_2: oxy-fuel, cryogenic, solid sorbent, membranes and amine scrubbing. Other technologies are also being tested on a smaller scale.

Multiple CCUS decarbonization options, pre- and post-combustion, exist at different stages of development with a variety of additional energy inputs.

Amine scrubbing
This leverages amine-based solutions to absorb CO_2 from the tail-end flue gas, usually coupled with steam generated from natural gas boilers or combined heat and power.

Calcium looping
Capture units apply reversible carbonation reaction ($CaO + CO_2 \leftrightarrow CaCO3$) burning additional coal as the thermal input. A steam cycle recovers electricity, reducing the overall electricity reliance on grid.

Membrane
Gas separation membranes are used in physical and/or chemical interactions with end-of-pipe flue gas from cement, usually requiring pressure powered by electricity.

Oxy-fuel combustion
CO_2-rich flue gas produced from combustion performed with oxidizer consists mainly of oxygen and can be easily captured using a simple carbon purification unit powered by electricity.

Solid sorbents
CO_2 from the flue gas can be adsorbed with sorbents and later released in a pressure swing adsorption process, which requires electricity and steam usually generated from natural gas boilers.

Post-combustion CCUS (solid sorbent, membrane, calcium looping and amine scrubbing) provides opportunities to decarbonize without compromising existing production but requires additional thermal input that is expensive and creates emissions.

Oxy-fuel could be a solution to decarbonize the industry; however, it is a less mature technology compared to CCUS and would require the modification of existing production processes. Its effects on product quality are also uncertain.

All technologies require sufficient infrastructure to transport and store or utilize the captured carbon, which could prove very expensive.

The potential for recycled and low-carbon products to decarbonize the cement industry is lower than that offered by CCUS technologies

Adding CCUS to cement production currently more than doubles the cost of cement; as a result, manufacturers globally are testing a wide range of capture technologies with the aim to reduce capture costs. Despite the cost reductions these new technologies could deliver, policy support will still be required.

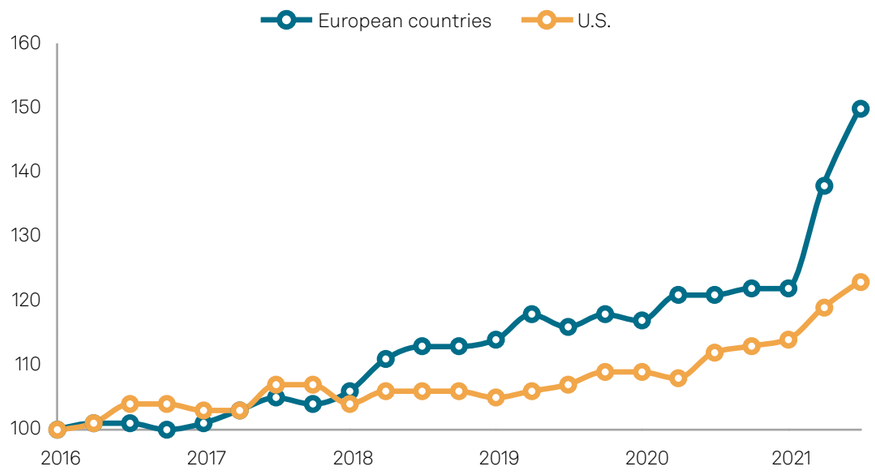
In Europe, adding CCUS currently increases the cost of cement by 125%–200% because of high fuel costs and offshore CO_2 infrastructure requirements.

Beyond carbon reduction of existing operations, rated EU cement companies are updating business strategies to mitigate regulatory risks

We observe that rated EU cement companies are updating their commercial strategies, given increasing customer demand for recycled and low-carbon cement products. HeidelbergCement has committed to doubling its revenue from low-carbon and circular products and solutions to 50% of group revenue by 2030. This would largely come from increased use of recycled aggregates and of supplementary cementitious material with a lower clinker ratio. Cementir in 2021 rolled out its FUTURECEM™ technology, in which about 40% of the energy-intensive clinker in cement can be replaced by limestone and calcined clay, leading to a 30% CO_2 emissions reduction. Cementir targets FUTURECEM volumes to reach 50% of total volumes sold by 2030. We believe that demand for low-carbon products in the building materials industry will surge in the next decade, boosted by intensifying regulatory and public pressure on builders to transition to green buildings and use materials with reduced negative impacts on human health and the environment. This could prove a game changer for the cement industry's competitive position over the medium term, which should support the larger and more sophisticated European players that can leverage on more advanced product offerings. Because of the trend toward low-carbon products, we could see the industry gradually diversifying away from standard cement only, with pricing premiums helping more advanced companies to protect their margins ahead of much higher carbon costs. Still, the much wider use of recycled materials or low-clinker products will require reshaping the construction value chain and greater end-user acceptance, which could prove a challenge in some countries. Therefore, we do not currently reflect this trend in our assessment of companies' business risk profiles. Furthermore, the potential for recycled and low-carbon products to decarbonize the cement industry is lower than that offered by CCUS technologies.

Chart 6: **Trend of cement price in the EU**

Cement Price Index* (Index: 2016=100)



The Cement Price Index is calculated as the average of the following European countries: Poland, Italy, Czech Republic, Germany and Luxembourg. Regions included in the average for the United States are the North East, the Midwest and the Southern States along the Mississippi River, Georgia, Alabama and Texas.
Source: Buzzi Unicem SpA.

Some companies are repositioning away from cement by switching to other building products, which is helping reduce their consolidated carbon intensity. The most tangible example is Holcim, whose growth strategy is focused on increasing its share of value-added products and strengthening its environmental credentials by refocusing away from the core cement business. As part of this portfolio transformation, in 2021 Holcim acquired Firestone Building Products for $3.40 billion and more recently Malarkey Roofing Products for $1.35 billion, both to strengthen Holcim's presence in the U.S. residential roofing market. Holcim also executed on its strategy to reduce exposure to cement in emerging markets, signing an agreement in September 2021 to divest its operations in Brazil for an enterprise value of $1.025 billion. In December 2021, it closed the sale of its 75% stake in its business in Zambia for $150 million. In May 2022, Holcim announced the divestment of its India businesses, Ambuja Cement and ACC, to Adani Group for net cash proceeds of CHF 6.4 billion. We believe that Holcim will reinvest these funds to accelerate the transformation of its portfolio to grow its solutions and products segment to the targeted 30% of group sales by 2025. We view the disposal and reinvestment plan for the proceeds as aligned with Holcim's strategy of increasing its presence in less asset-intensive building solutions and in mature markets, where cement and building materials products require more diversification and innovation.

Companies with high emissions and with a high portion of business in the EU could see significant profitability pressures post-2027

Limited substitutions for cement should enable companies to increase prices if CO_2 costs rise. Grey cement is used as a binder in concrete and is therefore an essential raw material for buildings, roads and infrastructure. Currently, few materials can replicate cement's characteristics, robustness and affordability, though increased design and construction efficiency could translate into reduced use of concrete. For now, however, all subsegments globally that rely on cement are showing good medium- and long-term growth potential.

In our view, grey cement's low substitution risk may lead cement manufacturers to increase prices ahead of rising carbon costs in the EU. Rising grey cement prices in most European countries in 2022, ahead of higher energy costs, indicate that for as long as demand stays resilient, companies can pass on higher costs to clients (see chart 6). If current growth potential persists, we believe that this is what cement companies will continue to do, and as such, we anticipate significant cement price increases in those regions with carbon taxes. Most companies have already started to show CO_2 cost components in their client invoices to improve transparency. This commercial strategy aims at shortening the time lag for pass through, ahead of the expectation that carbon costs will become a key driver of price increases in the next few years.

We believe that substitution risk can be higher for white cement, which is used for decorative purposes and represents a niche market. At the same time, white cement benefits from much higher margins and has different demand dynamics, which could support its market position.

Still, we see a risk that much higher cement prices may lead to structurally reduced demand in the construction industry, for example through the more efficient use of concrete in building construction. This could happen if most regions introduce or tighten carbon regulations, thereby increasing carbon costs.

A long road to full decarbonization, with potentially substantial pressure on profitability

Decarbonization challenges are significant for the sector, given the still-early stage and high costs of technological solutions and potentially much more stringent regulations coming particularly in Europe. Apart from cost pass-through capacity, the most efficient and proactive companies could also benefit from more rapidly adopting, and developing, new technologies to improve their competitive positions. This can come from high upfront investments. Gradually bringing new products into the business mix, such as recycled or low-carbon building solutions, may further mitigate risks, but we recognize that this is still a nascent trend. In the second part of our research, "European companies could see pressure on ratings as the EU firms up carbon rules," published Oct. 27, 2022, our scenario analysis shows annual carbon costs could reach 75% of EU cement companies' EBITDA on average, assuming a complete phase-out of allowances. We also find that companies with high emissions and with a high portion of business in the EU could see significant profitability pressures post-2027, particularly if weaker economic conditions challenge pass-through strategies, potentially weighing on our credit ratings on issuers. More supportive financial policies or other adaptive measures could mitigate such pressures. ■

Companies could see pressure on ratings as the EU firms up carbon rules

Key takeaways

- Our current credit ratings on European cement companies factor in significant uncertainties related to future climate-related technologies, market developments, and regulatory and policy initiatives.
- We see European cement companies' profits, competitive positions and cash flows as potentially the most vulnerable to the EU's aim to accelerate the reduction of greenhouse gas emissions by at least 55% by 2030 (from 1990). "Fit for 55" calls for reduced free carbon allowances and increased carbon costs in sectors with the highest emissions.
- Our scenario analysis found that annual carbon costs could reach 75% of EU cement companies' EBITDA on average, assuming a complete phase-out of allowances. We also found that cement companies with high emissions and with a high share of business in the EU could see significant profitability pressures post-2027.
- Geographic diversification, and having the time and capacity to adapt operationally and financially, could be credit supports for cement companies. We also believe that steady demand and limited cement substitutes should allow for significant cost pass-through, which could ease pressure on profitability.

▶ **This second part of our research into** decarbonizing cement explores the regulatory environment that the European sector could be facing in light of the EU's envisaged more stringent regionwide carbon legislation and how we can analyze this from a credit perspective. We leverage S&P Global Ratings' data on the industry to perform a scenario analysis of the potential implications of the regulations for our ratings on cement companies. This research complements the first part of our research, "Decarbonizing cement part one: EU makers are reducing emissions while building business resilience," published Oct. 27, 2022, in which we present our views on trends in the European cement industry's carbon footprint and manufacturers' decarbonization strategies.

Our ratings on European cement manufacturers reflect currently manageable decarbonization risks

The current regulation, phase four of the EU's Emissions Trading System, has only slightly increased carbon costs for cement companies, but the proposed ramp-up of emissions reductions to 55% by 2030 will likely increase pressure on credit ratios.

The EU Emissions Trading System (ETS) dates from the 2000s and covers the power and heavy industrial sectors, including cement, and more recently aviation. Under current regulations, cement manufacturers receive slightly fewer free emissions allowances from EU member states. These allowances, until now, have materially alleviated companies' carbon-price cost pressures. Annual allowance reductions have gathered pace, by 2.20%, under the current phase four, from 1.74% under phase three (2013-2020). The aim is to encourage faster decarbonization efforts.

Beyond 2024, if phase four continues, carbon costs will not likely top 10% of cement companies' EBITDA on average by 2030. This is why we have not yet taken any rating actions on entities in the European sector related to carbon-price risk. EU ETS reform will continue to evolve, and the implications for cement producers remain uncertain.

In 2019-2021, carbon costs represented 0%-3% of cement companies' EBITDA. Under phase four, we think that carbon costs will increase slightly but still comprise a modest share of total costs. More notably, we have not highlighted any material differences in competitive positions among European players based on their carbon intensity. This reflects that differing levels of carbon intensity have had little financial or business impact on the sector so far. The sector's ability to pass through these marginal cost increases is an important credit support and reflects sustained demand ahead of construction backlogs (see chart 1). Low carbon costs until recently mean most companies still benefit from a surplus of received allowances carried over from past years (see chart 2). This means companies' exposure to carbon costs is still broadly contained, even in today's higher carbon price environment.

Climate transition risk and the rating implications for cement-makers

Cement companies are high emitters of CO_2. They have among the highest carbon intensity of all sectors and, as such, are exposed to climate transition risk (see "Environmental, social, and governance principles in credit ratings," published Oct. 10, 2021). Carbon regulation and raising carbon costs is a key risk for cement manufacturers as their profitability can be undermined in the medium term. Production or product innovation could potentially reduce carbon emissions. But decarbonization can be very expensive, and some technologies to capture carbon are still in prototype.

Climate transition risk has so far had limited influence on our ratings on cement manufacturers. This is because the costs linked with high carbon emissions have been contained, reflecting limited (EU) or no carbon regulation (elsewhere). The EU ETS dates from the 2000s, but cement companies have received free allowances covering a large share of their carbon emissions. We also note that there are few cement alternatives at present, which should preserve steady volumes in the medium to long term and enable cement producers to pass through higher costs.

We factor climate transition risks into our ratings on cement companies when we assess a company's business risk and financial risk profiles. More specifically, we incorporate climate transition risks into our assessment of a company's competitive position and cash flow/leverage analysis. Among the key factors we consider for our competitive position assessment are:

- Effective local carbon regulation, which typically translates into monetary costs associated with carbon emissions, for instance, free allowances and/or carbon price/tax.
- How high an issuer's carbon emissions are, and its carbon intensity relative to the sector average.
- The issuer's commitment to cut emissions, how far advanced it is, and whether it has a track record of emissions reductions.
- Technologies adopted to reduce emissions and associated capital investments.

Carbon regulation and rising carbon costs are key risks for cement manufacturers as their profitability can be undermined in the medium term.

- Investments in research and development to develop innovative technologies to capture emissions.

- Risk of cement substitution with other products, and cement demand trends.

- Innovative product offerings such as low-carbon cement or concrete, or the use of recycled or new binder materials; significant price premium gained by using such products compared with standard cement products; share of innovative products in total revenues.

In our cash flow/leverage analysis, we incorporate the monetary costs associated with carbon emissions if present. We also reflect the capital spending linked to carbon reduction initiatives and greener production processes. Both can reduce a company's free operating cash flow.

The EU will likely accelerate decarbonization targets: Fit For 55 will up the ante for cement decarbonization

The EU is furthest along globally in cement industry regulation. Its emissions trading scheme currently covers about 4% of the world's cement production. In the U.S., only 13 states currently have a carbon pricing mechanism for power generation, and California is the only one that applies a carbon price to cement production. China's ETS only covers coal and gas power generation emissions at the moment, but the government has signaled its intent to include emissions from industries such as cement production. The EU-only scope of this research reflects that the other regulations are still evolving, which does not allow us to determine easily the assumptions for this research.

Still pending EU members' approval is a proposal to increase the 2030 target to a 55% reduction in carbon emissions, up from 40% currently. It would tighten annual caps and therefore reduce the supply of free carbon allowances, much more so than the current phase four. The linear reduction factor (LRF; the annual decrease of allowances) would almost double to 4.2% from 2.2% and be accompanied by a small one-off reduction.

Furthermore, the EU is proposing to gradually introduce a Carbon Border Adjustment Mechanism (CBAM) to impose fees on imports from neighboring countries based on emissions incurred in their production, and cement is included. We understand the policy intent is to both protect European manufacturers from unfair competition as well as to avoid a flight to production sites outside the EU ("carbon leakage"). However, the CBAM would be accompanied by a complete phase-out of free allowances in 10 years, from 2026 to 2035.

In June 2022, the European Parliament voted on ETS reform and the CBAM, agreeing that the latter would not start until 2027. The European Commission had initially posited 2025. The later starting date, however, comes with a much faster phase-out of free allowances, down to five years from 10 initially, between 2027 and 2032. This would accelerate carbon deficits for cement companies.

Reflecting the market's perception that regulatory pressure is increasing in Europe, the EU ETS price has soared since 2020, with a monthly average approaching €90 per metric tonne in January 2022 from below €10/tonne on average over the past decade. The gas crisis in Europe amid the Russia-Ukraine conflict and the resulting increased use of high-carbon-emitting coal sources has somewhat reduced ETS prices in 2022.

Chart 1: **EU ETS price has significantly increased in 2021-2022**

Historical price development (€ per tonne of CO2)
From Apr. 29, 2005, to Sep. 19, 2022

Source: Bloomberg.

A faster free allowances phase-out would be a risk for producers' profitability

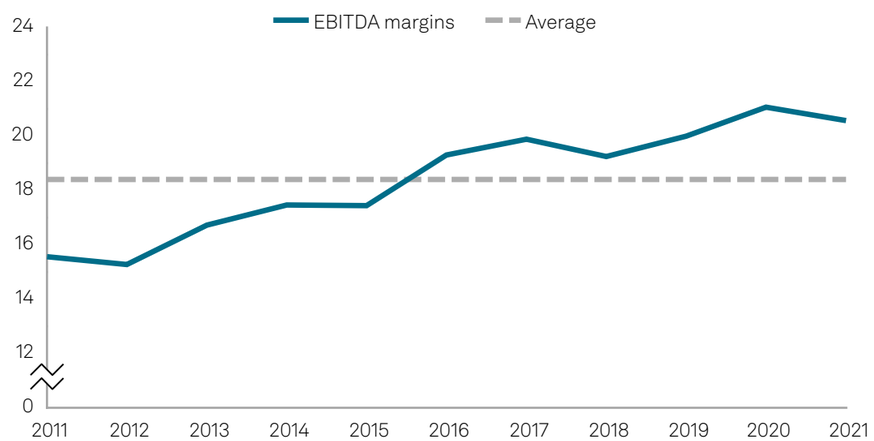
The European Parliament's step forward is not the final one for EU ETS reform. Details are lacking, but we understand the EU Parliament, the Council and the Commission are in negotiations. The reform has complex implications, which makes it difficult to fully grasp what it means for the European cement sector. We also recognize that under the current implementation timeline of 2027, sector players would still have time to adjust their operations and capital structures in the face of potential regulatory changes. Given the uncertainties, our ratings do not currently incorporate these potential evolutions; the direction and visibility of those climate-related factors could change rapidly. Therefore, our research focuses on assessing, with scenario analysis, how companies' profitability could be affected by new regulations (see section below: How companies' profitability could actually be impacted: Findings of our scenario analysis).

The so far limited effect of carbon costs on cement companies' profits and financial risk profiles could change under the proposed EU ETS reform. This is because most manufacturers would likely rapidly consume any stockpiled carbon allowances and start paying much higher carbon costs. Their ability to sustainably pass-through much higher costs to customers would be tested. We note that so far, amid rising energy prices in Europe, cement manufacturers have been able to increase cement prices, albeit with some time lag, largely preserving their EBITDA and sales volumes.

Under the proposed EU ETS reform, companies that are further along the decarbonization path, with lower carbon intensity, would be better off. Larger companies that have invested more to cut emissions or diversified in favor of circularity and low carbon products are in a

Chart 2: **EU-based rated cement companies' EBITDA margins currently average 19%-21%**

Average S&P Global Ratings-adjusted EBITDA margin (%)



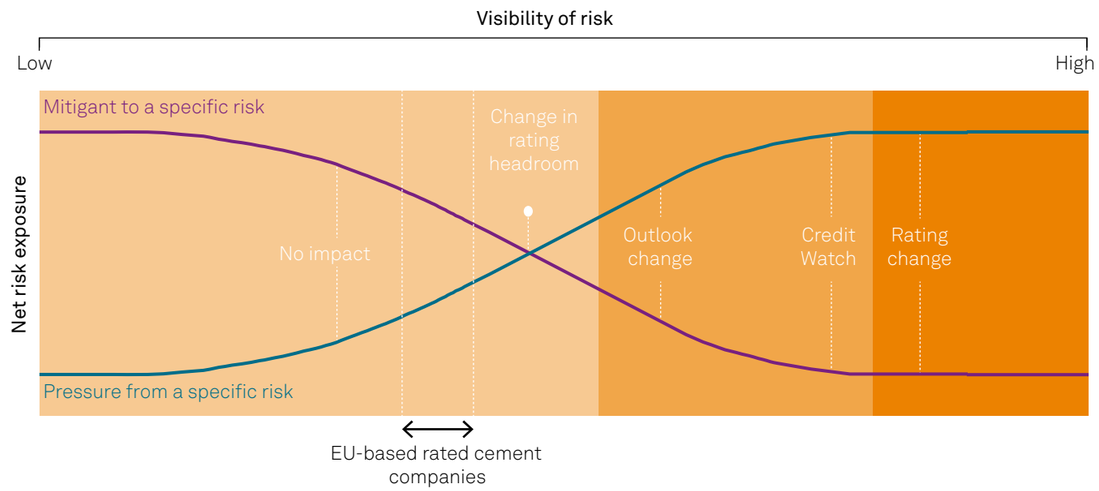
Average calculated on the following companies: Cementir, Titan Cement, Buzzi Unicem, Holcim, CRH and Heidelberg Cement.
Sources: Companies' reported data; S&P Global Ratings calculations.

comparatively stronger position. Smaller producers could risk a slump in profitability and cash flows, potentially leading to market exits. That said, most of our rated EU producers are regional or global, with lower-than-market-average carbon intensity. This means their competitive positions could even benefit from such market disruption. Larger issuers also generally benefit from geographic diversification outside the EU, with a meaningful share of revenues not subject to EU ETS rules.

If higher carbon costs lead an EU cement manufacturer to post a below-average S&P Global Ratings-adjusted EBITDA margin — that is, sustainably below 15% — we would revise down our business risk assessment. For context, the EU cement sector's EBITDA margin currently averages 19%-21% (see chart 2). Our business risk assessment also factors in an entity's ability to increase (pass through) prices when costs rise and its productive efficiency relative to peers. If lacking, we could revise down our assessment. This could lead to us taking negative rating actions, absent any remedial measures. We could consider downgrading companies that do not adjust their financial policies or cannot rapidly adapt their assets to mitigate rising carbon costs. Other considerations would be whether carbon capture technology became widely available and affordable; or if the lack of cement substitutions continued to allow cost pass-throughs; or if low-carbon cement products become widely available.

If future developments in technology, regulation, carbon pricing, demand or cost pass-through become more visible and influential to our analysis of creditworthiness, we will reflect them in our ratings. This could, for example, see us update the headroom for credit metrics currently available in our ratings, potentially leading to ratings actions (see chart 3).

Chart 3: **Visibility of risks: Impacts on ratings**



Source: S&P Global Inc.

How companies' profitability could potentially be impacted by the EU new proposals: Findings of our scenario analysis

We conducted two simulation exercises under our hypothetical scenario analysis to compare the two EU proposals and their potential implications for our ratings on cement companies. One scenario is under the July 2021 European Commission proposal. The second assumes EU members will pass the June 2022 EU parliamentary vote on ETS reform and the CBAM, with the later starting date of 2027 accompanying a much faster phase-out of free allowances, between 2027 and 2032. In both simulations, we assumed a more favorable and less favorable scenario, which reflects different business conditions and companies' ability to pass through carbon costs.
Our scenario analysis concludes that more geographically diverse cement companies and those with lower carbon costs would see a much smaller EBITDA decline.

We also anticipate that leaders in carbon emissions reductions would be better off than less-efficient companies because their marginal cost of cement production would be lower. This would increase their competitive edge in the sector. This is why we anticipate market consolidation with several small players being acquired by larger players or exiting the market. Most of the companies we rate in the EU are regional or global producers with lower-than-market-average carbon intensity and with geographic diversification outside the EU. Still, decarbonization paths differ within the EU; large companies such as HeidelbergCement are better positioned than purely regional players, reflecting their lower CO_2 emissions and their higher investments in projects to capture carbon. We would consider negative rating actions if we observed structurally weaker profitability due to higher carbon costs, leading to weaker credit metrics. We believe that financial policy — and the ability of a company to balance shareholder remuneration with managing credit metrics — will be a key rating driver.

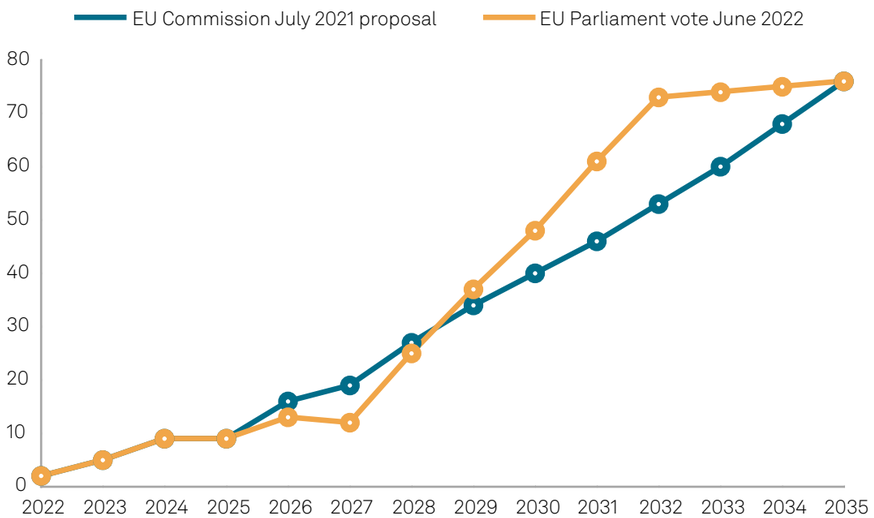
Table 1: **The key findings from our hypothetical scenario analysis**

	July 2021 European Commission proposal	June 2022 EU Parliament vote
More favorable scenario*	**Carbon cost trend** Annual carbon costs rising progressively, reaching about 40% of EBITDA on average in 2030 and about 75% in 2035, when the phase-out is complete. • **Companies more diversified** geographically and in business lines would likely see annual carbon costs not exceed 45% of their EBITDA by 2035. • **Smaller and less diversified companies** would likely see annual carbon costs exceed 100% of their EBITDA by 2035. **EBITDA trend** EBITDA decrease would likely be limited, reflecting companies' prolonged ability to pass through higher costs. By 2030, EBITDA would likely be about 10% lower than 2022 levels. • **Companies with lower emissions** would likely be able to largely pass through higher carbon costs to clients. • **Companies with higher emissions** could suffer from prolonged post-pass-through time-lags, which would likely constrain their profitability.	**Carbon cost trend** Annual carbon costs would be less pronounced until 2026 but would grow swiftly from 2027 when the phase-out of free allowances starts, reaching 75% of EBITDA on average by 2032 when the phase-out ends. **EBITDA trend** EBITDA decrease would likely be more pronounced, reflecting less-effective pass-through policies ahead of the accelerated phase-out of free allowances. In 2032, EBITDA would likely drop by 20% compared with 2022, on average. EBITDA would likely recover only partially thereafter. • **Companies with lower emissions** would likely be able to largely pass through higher carbon costs to clients and would likely see a limited and temporary profitability decline. • **Companies with higher emissions** would likely suffer longer time lags, and their EBITDA decline would likely exceed 30% by 2032 and would not recover, all else being equal. • The EBITDA spike in 2027 reflects that a few companies still have carbon credits and could therefore benefit from higher cement prices in Europe.
	Ratings impact • **For companies with lower emissions,** we anticipate a moderate weakening of credit metrics but likely with no change in ratings, all else being equal. • **For companies with higher emissions,** we anticipate a significant erosion of available ratings headroom. We would not rule out negative ratings actions, absent offsetting mitigants.	**Ratings impact** • **For companies with lower emissions,** a deterioration of credit metrics could be more pronounced during the five years of the allowances phase-out and could translate into negative rating actions, absent offsetting mitigants. • **For companies with higher emissions,** we believe that, compared with the June 2021 European Commission proposal, ratings headroom could erode faster, thereby increasing the likelihood of negative rating actions.

	July 2021 European Commission proposal	June 2022 EU Parliament vote
Less favorable scenario*	**Carbon cost trend** Same as more favorable scenario **EBITDA trend** EBITDA decline would likely be more marked across the sector because of less-effective pass-through strategies ahead of weaker business conditions. On average, the EBITDA drop would likely be about 20% by 2035 versus 2022. • **Companies with lower emissions** would likely be able to limit their profitability decline. • **Companies with higher emissions** would likely see prolonged and permanent reductions in EBITDA.	**Carbon cost trend** Same as more favorable scenario **EBITDA trend** EBITDA decline would be even more pronounced than under the July 2021 proposal. On average, EBITDA would likely decline by close to 25% by 2032 compared with 2022. • **Companies with lower emissions** would be able to limit their profitability decline. • **Companies with higher emissions** would likely see prolonged reductions in EBITDA of at least 35% by 2032.
	Ratings impact • **For companies with lower emissions,** tightened ratings headroom could translate into negative rating actions, absent offsetting mitigants. • **For companies with higher emissions,** negative rating actions are likely, especially for those with a high share of business in the EU.	**Ratings impact** • **For companies with lower emissions,** tightening ratings headroom could translate into negative actions, absent offsetting mitigants. • **For companies with higher emissions,** we believe that the likelihood of negative rating actions would further increase compared with the July 2021 proposal, especially for those with a high share of business in the EU.

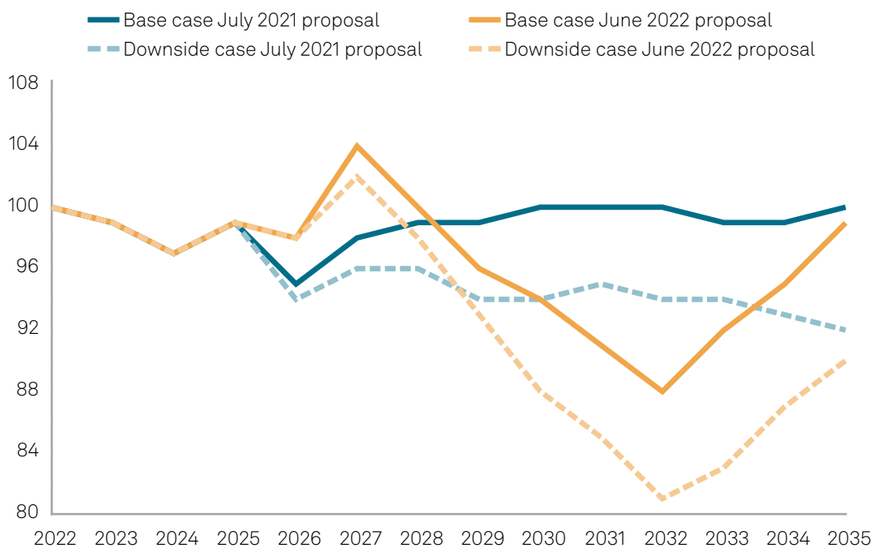
*See below on main assumptions underlying our scenario analysis for more details on more favorable and less favorable scenarios.

Chart 4: **EU-based rated cement companies' possible carbon costs trend in 2023-2035**
(% of EBITDA)



Source: S&P Global Ratings.

Chart 5: **EU-based rated cement companies' EBITDA trend in favorable and less-favorable scenarios**
Index: 2022=100



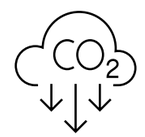
Source: S&P Global Ratings calculations and estimates.

There are some factors not included in our scenario analysis, which may change the outcome.

Our scenario analysis does not incorporate the potential benefits arising from the widespread adoption of CCUS technology at the end of this decade. For example, if HeidelbergCement's new 2030 carbon reduction target were to become the industry standard, carbon costs could be lower than we have assumed. Our scenarios also do not consider the effects of a widespread adoption of carbon regulations outside the EU, which would likely translate into higher carbon costs as well as accelerated investments to reduce emissions. We also do not factor in risks of structural decline in demand due to increased efficiencies and more readily available alternatives in the construction process.

The main assumptions underlying our scenario analysis:

- Constant cement volumes in both the EU and the outside EU.
- Revenue and EBITDA growth of 1% per year from 2022 (sector average).
- Our estimation of chargeable CO_2 emissions in the EU based on our discussions with rated companies.
- Reduction of CO_2 emissions in the EU, through to 2030, as per companies' public commitments or based on more detailed assumptions that companies have shared with us.
- Our estimation of carbon-free allowances received in 2021 and stocks of carbon credits carried over from previous years based on our discussions with rated companies.
- Free allowances will reduce, as per the European Commission's "Fit for 55" proposal of July 2021 (4.2% load factor and progressive phase-out of free allowances in 2026-2035) and as per the EU's June 2022 parliamentary vote on "Fit for 55": that is, a higher load factor and progressive phase-out of free allowances in 2027-2032.
- Companies would first utilize their available stocks of carried-over free allowances, when available, to cover their CO_2 deficits.
- Progressive increase in CO_2 prices from €100 in 2025 to €125 in 2030 and €150 in 2035, as per S&P Global Commodity Insights' published forecasts.
- No carbon leakage in the EU, prevented by the CBAM.
- In our more favorable scenario associated with stable operating conditions, we assume that cement companies with lower-than-average emissions would be able to largely pass higher carbon costs through to clients, albeit with a lag of six to nine months following the introduction of the CBAM. Higher-emitting companies would experience a longer lag before being able to pass on costs, which would weigh on their profitability. We assume a longer lag for cost pass-through if the EU phases out free allowances in five years, as per the parliamentary vote, given the significant drop in carbon allowances and the sudden increase in carbon deficits that would follow.
- In our less-favorable scenario, we assume that cement companies' pass-through strategies are less effective. This would largely reflect weaker operating conditions, for example due to prolonged business contraction, reduced demand or a decline in pricing discipline. In this scenario, the cost pass-through lag would widen compared with the more favorable scenario. ■



If HeidelbergCement's new 2030 carbon reduction target were to become the industry standard, carbon costs could be lower than we have assumed.

S&P Global Ratings related research

- Industry Top Trends Update: Building Materials EMEA, July 14, 2022
- Industry Top Trends 2022 Building Materials, Jan. 25, 2022
- ESG Credit Indicator Report Card: Building Materials, Nov. 19, 2021
- Environmental, Social, And Governance Principles In Credit Ratings, Oct. 10, 2021
- ESG Materiality Map: Building Materials, May 18, 2022
- Key trends that will drive the ESG agenda in 2022, Jan, 31, 2022

Other references

- GCCA 2050 Net Zero Roadmap Accelerator Program, Global Cement and Concrete Association
- Cement report, International Energy Agency, September 2022

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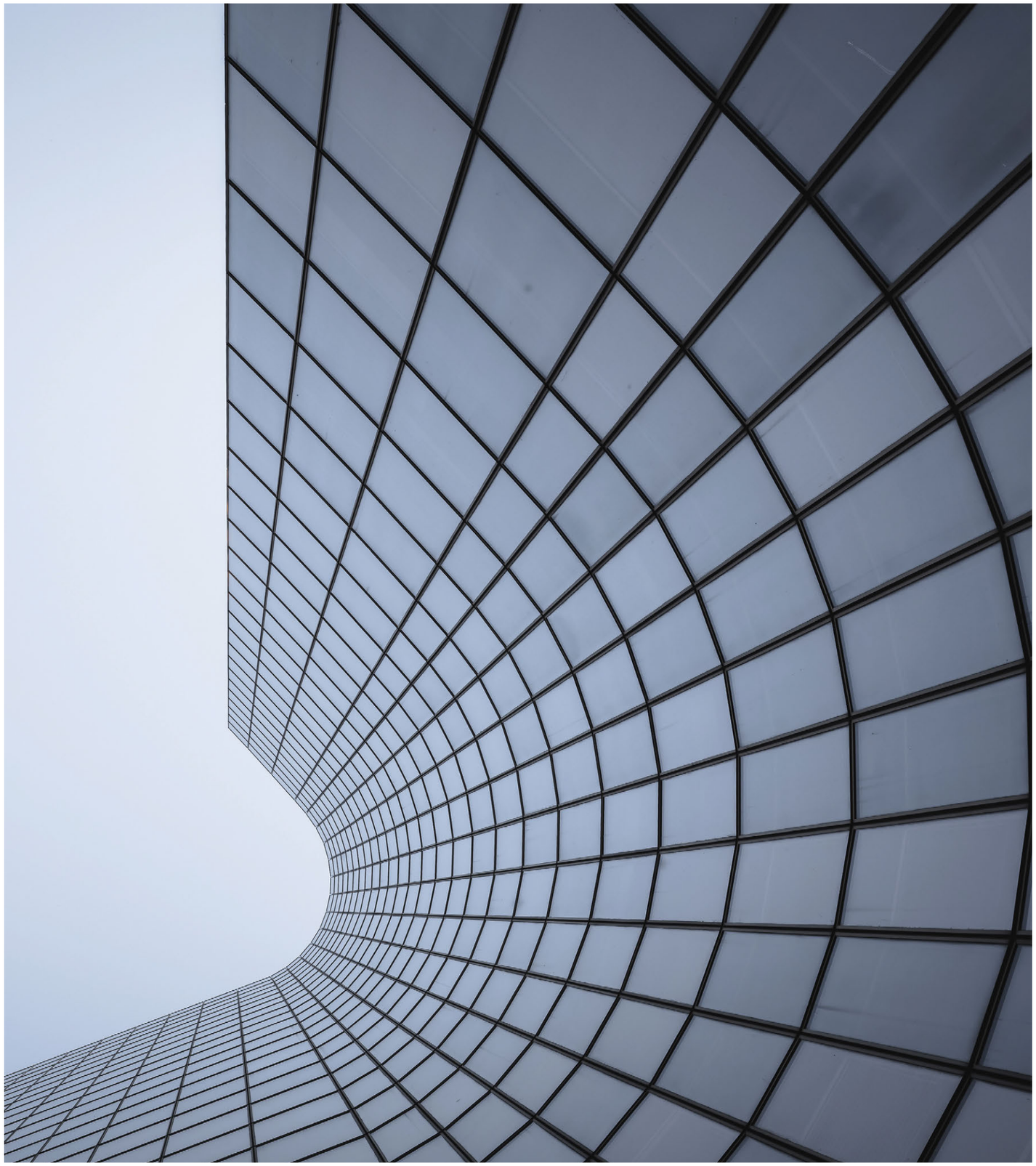


Bank regulation and disclosure to foster climate-related risk analysis

Climate-related risks are being considered in stress testing, prudential frameworks and disclosure standards to raise banks' awareness of and preparedness for such risks. Still, banks face many obstacles to the effective assessment and management of those risks.

Published on October 3, 2022.

Key takeaways

- There has been an increasing number of regulatory initiatives across the globe to accelerate the assessment of banks' exposures to and management of climate risks, notably through stress tests.
- Although they support the industry's preparedness, these regulatory exercises are being done at different paces and levels of detail.
- At the same time, banks face methodological challenges and data availability issues that continue to hinder progress in assessing their vulnerability to climate-related risks.
- Another hurdle for banks is navigating the numerous recommendations and standards to disclose climate risks, with different approaches to identifying issues to report on and some still under development.
- The real step-change would be globally agreed analytical approaches and disclosure standards to enable banks, regulators and investors to assess climate-related risks more consistently.

▶ **Numerous regulatory initiatives globally** are raising banks' awareness of and preparedness for assessing their exposure to climate-related risks, but differing approaches are limiting progress. This research compares and contrasts the approaches of regulators and prudential authorities and aims to identify the key challenges that remain. To this end, we reviewed the major regulatory exercises in several jurisdictions and the most relevant draft disclosure standards issued in 2021 and 2022.

Supervisory initiatives are helping banks analyze climate-related risks, although progress varies

Regulatory bodies globally are working on various initiatives to address climate-related risks for banks, including through the Network for Greening the Financial System (NGFS). Recently, the higher frequency of severe weather events is also pushing banks to prioritize climate-risk analysis.

In some jurisdictions, in Europe and Asia-Pacific for example, the analysis of climate-related risks is more advanced than in others. Some regulators have helped guide banks on how to better integrate environmental considerations into their risk management frameworks and business strategies. For instance, the European Central Bank's (ECB) guide on climate-related and environmental risks, released in November 2020, enhanced the banking industry's awareness and preparedness. However, this foundational exercise has not yet been completed in several countries.

The increasing role of climate stress testing is a key trend we identified earlier this year; see "Key trends that will drive the ESG agenda in 2022," published Jan. 31, 2022. Regulators' current focus is to assess banks' stages of development in climate stress testing and scenario analysis, aiming to uncover potential systemic risks. We found several common characteristics among climate stress tests (CSTs), including their exploratory nature and the disclosure of only aggregate results, instead of at the individual bank level (see table 1). To date, the main objective has been to assess the preparedness of management teams in understanding, managing and mitigating climate risks. Only some of these regulatory exercises, namely the CSTs in Europe and in some APAC countries, have disclosed the quantitative impact of climate-related risks on their banking sectors' creditworthiness. Most CSTs have based their assumptions on some NGFS scenarios. We find that most used relatively mild assumptions, and therefore quantitative results showing only a relatively limited impact on capital are likely underestimating potential future losses. In addition, supervisors have so far focused on assessing the drivers of climate risks through the lens of credit risk analysis and, to a much lesser extent, through other types of risk, such as reputational risk, business modeling, legal risk and strategic positioning. We anticipate that supervisors will fine-tune their stress tests over time, providing more detailed quantitative measures of the climate-related risks at system and individual bank levels.

Europe

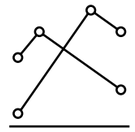
The ECB's CST is the most comprehensive and detailed climate stress test we have observed so far.

The quantitative part of this CST involved a subset of 41 European banks projecting potential losses they would incur under disorderly transition and physical risk scenarios. The banks estimated credit and market losses of about €70 billion on aggregate in the three-year disorderly transition and in the two one-year physical risk scenarios: flood, drought and heat. Based on these estimates, we think the banks could cover such losses via earnings — representing about 18% of 2021 pretax profits annually — without capitalization levels being threatened. This is consistent with the results the Bank of England (BoE) reported in May 2022 in its Climate Biennial Exploratory Scenario. The BoE estimated losses of 10%-15% of U.K. bank earnings, not enough to materially reduce capital levels; see "Bank of England stress test suggests the U.K.'s banks and insurers can absorb future climate risk," published May 25, 2022. That said, we view these estimates as likely understating the climate stress losses banks might face in practice. This is because of data limitations but also the macro assumptions, based on the NGFS scenarios, being relatively benign and the exercise covering only about one-third of total exposures of the 41 banks in the ECB's CST scope; see "ECB stress test: Eurozone banks need to do more to comprehend climate risk," published July 11, 2022. The CST results also reveal that banks would face lower losses in an orderly transition scenario than after delayed action, in line with the ECB's economywide top-down climate stress test concluded in 2021; see "Climate Risk Vulnerability: Europe's regulators turn up the heat on financial institutions," published Aug. 2, 2021.

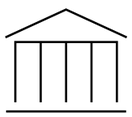
Asia-Pacific

The Financial Services Agency of Japan (JFSA) has encouraged banks to establish a governance framework for climate-related risks and factor these risks and opportunities into their business models and strategies.

In collaboration with the Bank of Japan (BoJ), the JFSA has developed a pilot exercise to test banks and insurers' assumptions and models to assess the impact of climate change on their business models and creditworthiness. The results reveal that the banks' estimated increase in annual credit losses was reasonably lower than their average annual net income. However, the report notes that the estimated results depend heavily on banks' analytical models and on banks' various additional assumptions. The JFSA and BoJ are committed to improving the comparability of this analysis and are encouraging the use of common assumptions and standard scenarios.



We find that most climate stress tests used relatively mild assumptions, and therefore quantitative results showing only a relatively limited impact on capital are likely underestimating potential future losses.



The Chinese central bank plans to incorporate climate risk stress testing into its macroprudential framework.

The Hong Kong Monetary Authority published the results of its pilot climate risk stress test to assess the potential financial impact of climate change on 27 banks.

This accounted for about 80% of the sector. Published in December 2021, the pilot covers a physical risk scenario, focused on typhoons and floods, and two climate transition scenarios (NGFS based). The results highlight that the one-year credit losses from residential mortgages are expected to increase 25x from an extremely low level under the physical risk scenario. The impact is also material under the disorderly transition scenario, where banks' projected annualized credit losses from exposures to high-emitting industries increase 3x compared to 2019. With higher credit costs and an increase in risk-weighted assets, domestic systemically important banks' capital adequacy ratios are expected to drop by 3 percentage points on average over the five-year disorderly transition scenario. Although the sector's resilience is well supported by banks' strong capital buffers, the potential impact of climate change on their profitability and capital could also be notable. As with similar exercises in other jurisdictions, the CST also revealed major challenges in data availability and assessment methodologies.

The Chinese central bank conducted its first climate stress test to assess the financial impact on 23 leading Chinese commercial banks.

The test assesses the impact of an increase in greenhouse gas emission costs on the repayment capacities of high-carbon industries — energy, steel and cement — and the consequences for banks' asset quality and capital adequacy ratios. The test results, published in November 2021, show that if enterprises in these sectors do not decarbonize, their default rates will increase significantly under stress scenarios. However, as Chinese banks do not have high loan-book exposures to these three industries, the central bank's estimated impact on banks' capitalization would be limited with capital adequacy ratios declining by only about 60 basis points to 14.3% by 2030 under the most adverse scenario. The central bank plans to incorporate climate risk stress testing into its macroprudential framework and develop mandatory disclosure requirements for megabanks and listed financial institutions on climate and carbon emissions information.

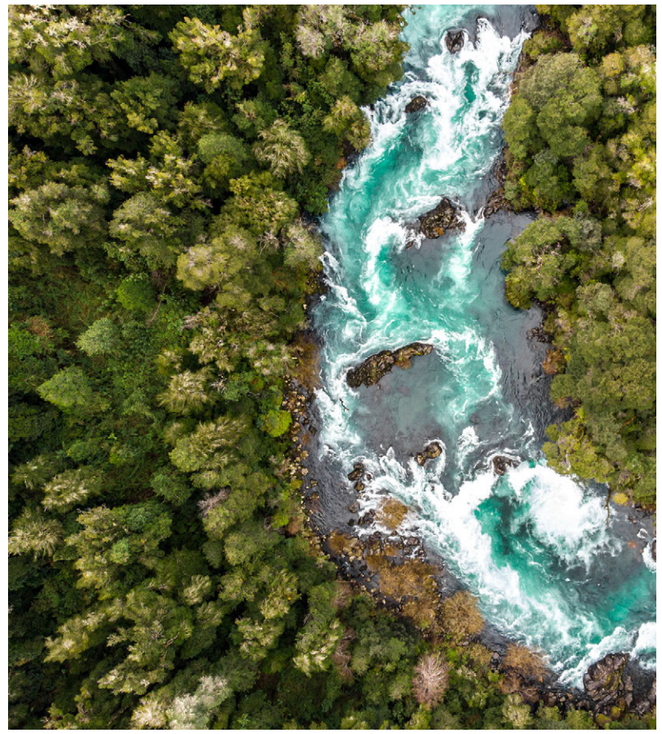
North America

A pilot exercise by the Bank of Canada and the Office of the Superintendent of Financial Institutions assessed financial institutions' understanding of climate-related risks.

Published in January 2022, the pilot assesses the vulnerability to climate transition risks of six Canadian federally regulated financial institutions. The analysis, which is built on four climate scenarios over a 30-year horizon from 2020 to 2050, aligns with those developed by the NGFS and focuses on credit and market risks, with top-down and bottom-up approaches. The exercise concludes that Canadian financial institutions are generally at the early stages of building climate-related risk assessment capabilities for transition risks, including through scenario analysis, and reveals differences in analytical tools, capacities and assumptions across institutions. A parallel survey of the six pilot participants assesses current risk management practices. It reveals that while most have incorporated climate-related risks into their risk appetite frameworks, they are yet to develop quantitative climate-related risk measures such as key risk indicators and risk limits and other more sophisticated tools to ultimately adjust their strategies and business decisions.

Regulatory oversight of U.S. banks' measurement and management of climate-related risks is accelerating.

Executive Order 14030 (May 2021) resulted in the Financial Stability Oversight Council (FSOC) issuing a report in October 2021 on how member regulatory agencies might assess the financial risks of climate change, improve related data and disclosures, integrate climate-related risks into existing supervisory frameworks or create new ones, and build expertise on climate-related issues. The guidance is nonbinding with no mention of timeline or concrete guidance on incorporating climate-related risks into stress testing or capital requirements. Certain U.S. bank regulatory agencies have responded to the FSOC guidance. For instance, in December 2021 the Office of the Comptroller of the Currency (OCC) released its draft "Principles for climate-related financial risk management for large banks." This provides the largest OCC-regulated national banks with a framework to measure, manage and mitigate both physical and transition risks, including through enhanced governance, strategic planning, reporting and scenario analysis. In September 2021, the research department of the New York Fed published a methodology that could be used to stress test banks for climate transition risk. The chair of the Fed has stated that scenario analysis will be a part of the guidance under development. Toward this goal, on Sept. 29, 2022, the Fed announced a pilot climate scenario analysis with participation by six of the United States' largest banks. The Fed expects to release findings of this pilot by year-end 2023, and these learnings are likely to help in the development of future supervisory stress-testing regimes for climate change.



Latin America

Some regulatory initiatives are more advanced than others in developing climate-related risks analysis for banks.

For instance, in the first half of 2022, Mexico's central bank performed a stress test to assess the impact of physical risk events — like cyclones, droughts, heat waves and floods — on commercial banks' balance sheets, with the results showing a moderate impact. The Central Bank of Brazil has introduced several resolutions since 1995 to support social and environmental responsibility, with a focus on agribusiness considering Brazil's exposure to the Amazon rainforest. In September 2020, the bank set out an environmental, social, and governance agenda and has said it will conduct its first climate risk stress test for Brazilian banks, expected to be published before the end of this year.

CLIMATE RISK & RESILIENCE

Table 1: **Climate-related risk regulatory initiatives in selected geographies**

Geography	Regulatory authority	Climate stress tests (Y/N) - Transition risk and/or physical risk?	NGFS scenarios (Y/N)	Coverage (no. of banks)	Time of publication	Other initiatives to address climate risk
Europe	European Central Bank	Y - Transition and physical risks	Y	104 significant institutions, but only 41 for the quantitative part of the exercise	July 2022	Final guidelines published in November 2020 to explain how the ECB expects banks to prudently manage and transparently disclose climate-related risks under current prudential rules.
U.S.	Primary U.S. Prudential bank regulators, members of the Financial Stability Oversight Council (FSOC)	N - But in September 2022, the Fed announced a pilot climate scenario analysis with participation by six of the United States' largest banks, the findings of which are to be released by year-end 2023	N/A	N/A	N/A	FSOC published in October 2021 a report that suggested ways member regulatory agencies might assess the financial risks of climate change, improve related data and disclosures, integrate climate-related risks into existing supervisory frameworks or create new ones, and build expertise on climate-related issues. The Office of the Comptroller of the Currency (OCC) released draft principles providing the largest OCC-regulated national banks with a framework to measure, manage and mitigate both physical and transition risks.
Canada	Bank of Canada and the Office of the Superintendent of Financial Institutions	N - But a pilot exercise was undertaken to assess the financial system's vulnerability to climate transition risks	Y	Six Canadian federally regulated financial institutions, including two banks and four life and nonlife insurance companies	January 2022	A survey conducted among the six pilot participants to assess current risk management practices.
China	People's Bank of China (PBOC; the central bank)	Y - To assess the impact of an increase in greenhouse gas emission costs on the repayment capacities of high-carbon industries, namely energy, steel and cement	Not available	23 leading Chinese commercial banks	November 2021	Mandatory disclosure requirements regarding climate and carbon emissions information for the megabanks and listed financial institutions are under development.
Japan	Financial Services Agency of Japan (JFSA) and Bank of Japan	N - But the JFSA and BOJ published a report on their pilot exercise to assess the financial system's vulnerability to climate transition risks	Y	Three largest banks and three major nonlife insurance groups	August 2022	JFSA published guidance to encourage banks to establish a governance framework for climate-related risks and factor these risks and opportunities into their business models and strategies.
Hong Kong	Hong Kong Monetary Authority	Y - Transition and physical risks	Y	20 major retail banks and seven branches of international banking groups, accounting for about 80% of the banking sector's total lending	December 2021	N/A
Taiwan		N - But the Financial Supervisory Commission plans to finalize a climate stress test scenario by end-2022 and start this exercise in 2023	N/A	N/A	N/A	N/A
Australia	Australian Prudential Regulation Authority (APRA)	N - But a Climate Vulnerability Assessment) was performed to assess banks' potential exposure to climate risk and to understand how banks could adjust their business models	Y	The five largest banks, accounting for about 75% of system assets	Expected release: end-2022	In April 2021, APRA released draft guidance for banks, insurers and superannuation trustees on managing the financial risks of climate change. An aspect of this guidance was the value of using scenario analysis to underpin the quantitative analysis of the potential impacts of different future climate scenarios.
New Zealand	Reserve Bank of New Zealand (RBNZ)	Y - Physical risks: droughts and storm events incorporated into banks' solvency stress tests since 2021	Y	The five largest banks, accounting for more than 90% of system assets	December 2021	In 2022, RBNZ plans to further develop climate change sensitivity analyses. The focus will be on coastal and river flooding effects on mortgage exposures and the impact of drought and emissions pricing on agricultural exposures. The outcomes will inform a full climate change stress test, which will be conducted at a later date.
Brazil	Central Bank of Brazil	N - But in September 2020, the central bank issued an ESG agenda and has stated its commitment to conduct its first climate risk stress test for Brazilian banks, which we expect it will publish by end-2022	N/A	N/A	N/A	Adoption of a green protocol in 1995 and, since then, several resolutions to support social and environmental responsibility, with a special focus on agribusiness, were introduced.
Mexico	Central Bank of Mexico	Y - Transition and physical risks	Y	Banks	June 2022	Banco de México is undertaking an analysis of the banking system's physical and transition risk exposures. It is currently developing a framework to assess climate-related macro financial risks with a forward-looking perspective, which is expected to be completed in 2022.
Peru	Supertintendencia de Banca y Seguros y AFP	N - But it is working to incorporate climate risk within the stress model	N/A	N/A	N/A	N/A
Chile	Comisiòn para el Mercado Financiero	N - But it approved the planning of the Climate Change Working Group for 2022-2023	N/A	N/A	N/A	N/A

NA = not applicable

Banks struggle to navigate the plethora of recommendations and disclosure standards

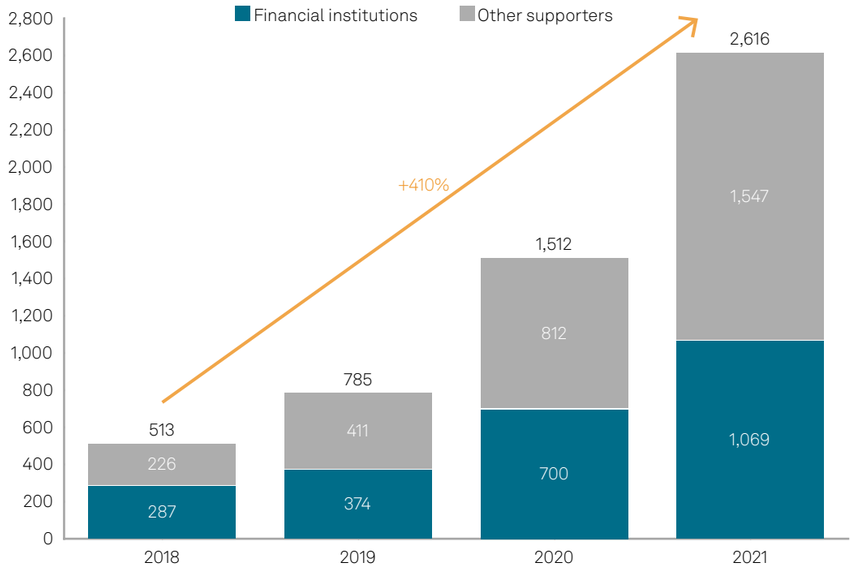
In our view, several jurisdictions' initiatives to improve sustainability disclosures will likely enhance the quality and the comparability of climate-related information. This is all the more supported by the fact that most of them refer to the recommendations of the Financial Stability Board's Task Force on Climate-related Financial Disclosures (TCFD) as an effort to align and harmonize definitions, processes or metrics related to climate-related risks. Yet, banks have to navigate numerous and various recommendations and disclosure standards, some still under development. Another hurdle for banks is getting access to climate-related information and data from the various economic sectors and companies to which they lend, or in which they invest, rendering data-availability issues even more pronounced.

In June 2017, the TCFD released its recommendations for a global framework for companies to develop more effective climate-related financial disclosures through their existing reporting processes. Since then, companies, including banks, have increasingly supported alignment with the TCFD recommendations (charts 1 and 2), and multiple initiatives have been launched to encourage better disclosure of climate-related information.

Europe appears furthest along to date in terms of setting up climate-related disclosure standards.

The European Commission released its proposed Corporate Sustainability Reporting Directive (CSRD) in April 2021. This was part of a broader sustainable finance policy package that was open for consultation until early August 2022. The CSRD requires all large and listed EU companies to report in line with mandatory

Chart 1: **Number of TFCD supporters is increasing fast**



TCFD = Task Force on Climate-related Financial Disclosures.
Source: TCFD 2021 Status Report.

EU sustainability reporting standards for fiscal years beginning on or after Jan. 1, 2023, while small and midsize listed enterprises get a further three years. The EU directive aims to improve the consistency and comparability of companies' sustainability reporting by requiring them to publicly disclose information about sustainability issues in compliance with EU regulations, including the EU Taxonomy, and according to the concept of "double materiality." This entails analysis of the risks they face ("financial materiality") as well as how their activities might affect the environment and people ("impact materiality"). A new set of sustainability reporting standards referring to the TCFD, being developed by the European Financial Reporting Advisory Group (EFRAG), is earmarked for the end of October 2022. The EFRAG's disclosure standards adopt the "double materiality" concept to determine significant sustainability issues on which banks should report. A second set of complementary sustainability information, including more sectoral considerations, will likely be adopted by the end of October 2023.

The U.S. Securities and Exchange Commission published in March 2022 a proposal to standardize climate change reporting in companies' annual reports and other public documents.

The SEC's proposal applies to publicly traded companies in the U.S. and, if implemented, would require these companies to, among other things, report on their climate-related governance practices and transition plans to achieve decarbonization targets. The SEC's proposal is mainly focused on financial materiality; it would require companies to disclose how climate change is affecting their business and financial results. Required climate-related information would include disclosing greenhouse gas emissions, a common metric for assessing a

The SEC's proposal is mainly focused on financial materiality; it would require companies to disclose how climate change is affecting their business and financial results

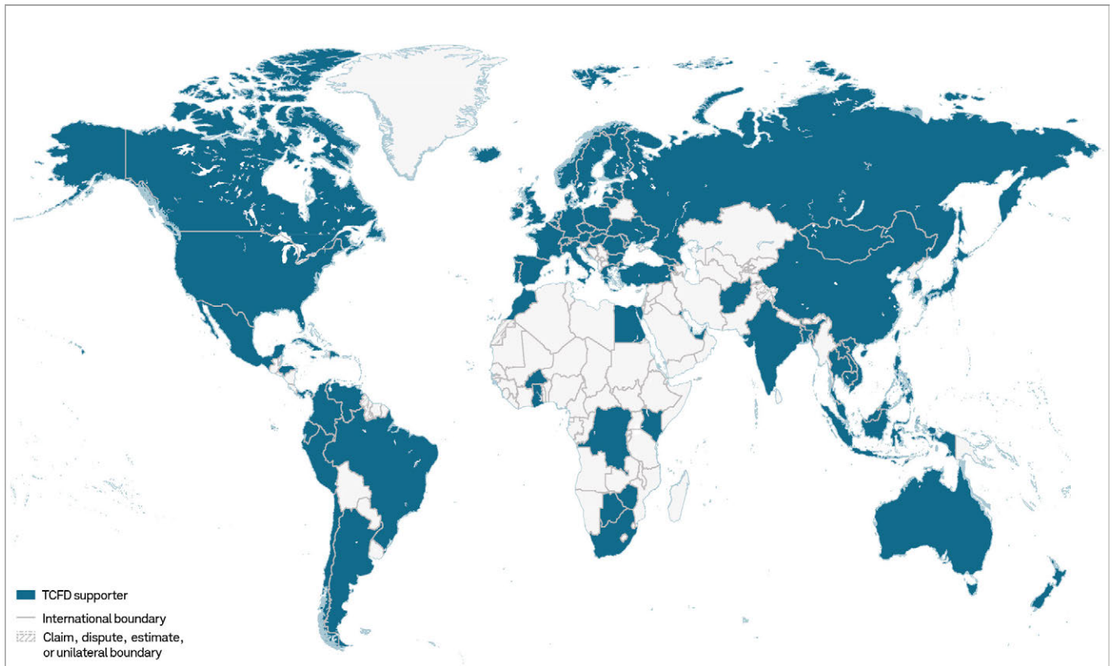
company's exposure to climate-related risks. In particular, all publicly traded companies would be asked to disclose their Scope 1 and Scope 2 emissions, while Scope 3 disclosure would be required only for companies that have either set a decarbonization target that includes Scope 3 emissions or have found Scope 3 emissions to be material to their operations and financial performance. Companies would also be required to explain how they have identified climate-related risks and their potential impact.

The International Sustainability Standards Board (ISSB) has developed a global sustainability disclosure standard.

The International Financial Reporting Standards (IFRS) Foundation set up the ISSB in November 2021 to establish IFRS Sustainability Disclosure Standards. In March 2022, the ISSB released two drafts for consultation. The first covers general requirements for disclosing sustainability-related financial information (IFRS S1). It requires companies to disclose, as part of their financial reporting, information about their significant sustainability-related risks and opportunities and how sustainability-related financial information is related to information in their financial statements.

TCFD supporters are widespread across the globe

3,000+ supporters across 114 countries



Note: Taskforce on Climate-Related Financial Disclosures (TCFD) supporter means that the organization believes the TCFD recommendations provide a useful framework to increase transparency on climate-related risks and opportunities within financial markets. Because many different types of organizations support the TCFD, there are no specific requirements for each type of supporter—however supporting organizations are expected to encourage TCFD implementation. For companies, support is a public commitment to work toward their own implementation of the TCFD recommendations.

Data compiled: Dec. 07, 2022.
Source: TCFD/S&P Global: 200815

The second relates to climate-related disclosures (IFRS S2). It incorporates the TCFD recommendations, including metrics tailored to industry classifications derived from the industry-based Sustainability Accounting Standards Board standards. It requires companies to disclose information about how they expect climate change to affect their business model, strategy and financial performance as well as the governance processes, controls and risk management practices they are using to monitor and manage climate-related risks and opportunities. The proposed disclosure requirements include not only Scope 1, Scope 2 and Scope 3 emissions but also companies' transition plans and business-strategy resilience in multiple climate-change scenarios.

The ISSB's focus is on the financial materiality of sustainability issues, including those related to climate. Having closed the consultation period at end-July 2022, the ISSB is now expected to issue its new standards by the end of the year. As the adoption of the ISSB's disclosure standards will not be mandatory, individual jurisdictional authorities will decide whether to require their application. We will need to wait and see the extent to which the ISSB standard is ultimately adopted by individual jurisdictional authorities to assess its impact on driving consistency of reporting on sustainability-related risks and opportunities including climate-related disclosures across regions.

CLIMATE RISK & RESILIENCE

The European Banking Authority (EBA) recently published its final draft technical standards for Pillar 3 disclosures of ESG risks.

Banks in Europe will be required to publish qualitative information about ESG risks and quantitative data about their exposure to climate transition and physical risks. These disclosures are to be aligned with the TCFD and the classifications specified in the EU's Taxonomy Regulation. Banks will also be asked to report their green asset and banking book taxonomy alignment ratios, indicating the extent to which their financing activities are associated with economic activities aligned with the Taxonomy Regulation and the Paris Agreement on climate change. Banks will also need to clearly show how they are mitigating climate transition and physical risks, including information about how they are engaging with clients in the process of adapting to climate change and the transition to a more sustainable economy.

These initiatives highlight an already heightened awareness as to how relevant for policymakers climate-related disclosure is to addressing climate risks.

They also represent important progress toward a standardized and reliable set of climate-related information. We believe that the creation of harmonized climate-related disclosure will help reduce information asymmetries, enhance transparency and improve comparative analysis of environmental data. But the real step-change would be globally agreed disclosure standards. These would enable banks, regulators and investors to assess climate-related risks more accurately. However, reaching global agreement is challenging and will take time; we can see this clearly in the ongoing efforts to converge U.S. GAAP and IFRS.

The incorporation of environmental risks into the Pillar 1 regulatory capital framework could help with the consistent addressing of global risks such as climate change.

The prudential treatment of environmental risks is a complex issue

The incorporation of environmental risks into the Pillar 1 regulatory capital framework could help with the consistent addressing of global risks such as climate change. According to the Basel Committee on Banking Supervision (BCBS) and the EBA, climate-related risks can be analyzed through the lens of traditional risk categories (credit, market, liquidity, operational, and reputational; see "Basel committee proposal highlights banking authorities' focus on climate-change risks," published Nov. 17, 2021). That said, the data availability in climate-related information disclosures as well as the analytical challenges of measuring the financial impact of climate change on banks' business and financial performance make it difficult for financial regulatory authorities to incorporate climate-related risks into their prudential frameworks; see "Capturing environmental risks in banks' capital frameworks is an ongoing discussion in Europe," published May 6, 2022).

A recent ECB publication discussed potential tools to embed climate-related risks into macroprudential measures for the banking sector. Some options, like introducing a sectoral systemic risk buffer or applying a concentration threshold or borrower-based measures, seem more feasible than others and could help banks increase their resilience to potential risks stemming from their exposures to sectors vulnerable to climate change, according to the ECB. Some also have the flexibility of not being capital-based measures. Some others, like concentration charges or the introduction of new sectoral risk weights or minimum loss given defaults, are more complex because they could materially raise capital requirements, thereby having potential negative side effects and, in some cases, might also overlap with microprudential requirements already in place (table 2), according to the ECB.

Table 2: **Some candidate tools the ECB has discussed for addressing climate-related risks in the banking sector**

Options	Goals	Selected helpful attributes	Selected drawbacks	Feasibility according to the ECB
(Sectoral) systemic risk buffer	• Increase resilience against materialization of risks from such exposures • Discourage exposure to certain geographical areas for physical risk and/or critical sectors for transition risk	• Very flexible	• Challenging calibration • Complex classification system of sectors/geographical areas exposed to climate risk • Currently applicable for domestic exposures only	More
Concentration threshold	• Non-capital-based measure limiting exposure to a certain geographical area for physical risk and to critical sectors for transition risk	• Targeted measures	• Challenging calibration • Complex classification system of sectors/geographical areas exposed to climate related risks	More
Borrower based measures	• Decrease vulnerability of households toward climate risks and change the pattern of demand toward more energy-efficient houses or houses located in geographical areas less prone to physical risks, if applied in mortgage markets	• Very flexible, no additional capital	• Gradual effect on resilience • Targeting only specific portfolios	More
Concentration charge	• A risk-weighted capital add-on that applies once exposures to a certain sector or geography particularly exposed to climate risk exceed a certain threshold	• Targeted measures	• Challenging calibration • Complex classification system of sectors/geographical areas exposed to climate risk	Less
Sectoral requirements (risk weights or minimum loss-given default)	• Higher risk weights or minimum loss given default to be applied to exposures vulnerable to high physical and/or transition risk	• Mandatory reciprocity • (limiting arbitrage)	• New complex tool • Challenging calibration • Impact on microprudential requirements	Less

Source: S&P Global Ratings on ECB/ESRB report (The macroprudential challenge of climate change, July 2022).

Amending Pillar 1 capital requirements would be the most difficult option

In a May 2022 discussion paper, the EBA appears unlikely to introduce brown and/or green factors into banks' Pillar 1 capital requirements, at least for now; see "Capturing environmental risks in banks' capital frameworks is an ongoing discussion in Europe," published May 6, 2022). While we understand certain banks' appetite for a discount on the capital requirement of green assets, which could encourage them to fund the green transition, we think that it is better to keep risk weights calibrated with the probability of default associated with these assets. It is currently difficult to find evidence that green assets carry a lower probability of default.

While the EBA explored some potential amendments within the Pillar 1 framework that could enhance the incorporation of environmental risks into existing risk factors, especially credit risk, we view as

unlikely any large near-term increases in capital requirements related to these risks. This is not only because of the difficulties in applying risk-differentiating factors but also because European banks could be perceived as riskier compared with international peers. Conversely, we anticipate that evidence of differences in the vulnerability of banks because of climate change might lead to some Pillar 2 add-ons — as has already happened to reflect deficiencies in risk management, high litigation risks, or other aspects of governance — which could ultimately influence banks' strategies over time.

Banks already disclose long-term climate commitments, but details and interim targets are usually missing

Over the past few years, an increasing number of banks have publicly disclosed their commitments to environmental sustainability. The most common commitment is to be net-zero in 2050. Most banks' public commitments to reduce their financed greenhouse gas emissions focus on the same high-emitting industries, especially the oil and gas and coal sectors. Their goals and commitments for some other economic sectors are less clear, in our view. These include real estate (residential or commercial), which often represents the majority of a bank's exposures — at least, but not only, in Europe — and is a material contributor to worldwide greenhouse gas emissions. As importantly, most of these commitments do not provide enough details, barely define interim targets, and mostly concern corporate lending and overlook capital market activities like bond or equity underwriting.

We also note that commitments to reduce financed emissions toward net-zero also depend on borrowers reducing their own emissions. At the same time, reducing absolute exposures is not an easy decision given that a reduction of financing facilities could affect some economic sectors, especially in economies that are largely dependent on fossil fuels. This is why we observe that some banks are increasingly engaging with companies on climate-related topics. While exclusion policies can help reduce the carbon footprints of lending or investment portfolios, this approach has its drawbacks, including breaking the relationship with revenues from these companies. Proponents of engagement therefore prefer to influence change by engaging with companies on the climate transition. Whether banks take the negative screening or engagement approach, they will remain under pressure to explain how they arrive at their decisions. They will also face pressure to credibly measure and disclose the concrete outcomes of their chosen approach.

Better disclosure of banks' climate-related risks will inform our credit rating analysis

We include the impact of environmental credit factors, such as climate transition risks, if we deem these material to our analysis of creditworthiness and if we have sufficient visibility on how those factors will evolve or manifest. Environmental factors currently have a limited impact on our bank credit ratings. For most rated banks, our environmental credit indicator — reflecting the influence of this factor on our credit rating analysis — is E-2, indicating a neutral influence on our credit rating analysis (on a 1-5 scale with 5 being very negative). We believe that significant business and sector diversification in banks' loan portfolios mitigates their vulnerability to climate transition and physical risks. There are exceptions, though. A country's economic structure could explain high exposure to these risks for some banks.

Despite environmental factors being generally a neutral consideration in our credit rating analysis on most rated banks, we think that such factors will likely become more negative considerations over time, mainly due to climate-related risks. Public policy changes to support the transition to a low-carbon economy and more frequent severe climate events will increase the materiality of these risks and opportunities as well as amplify the effects they might have on financial systems. As such, a bank's ability to measure and mitigate climate-related risks will likely become a more important factor that could affect its creditworthiness. For instance, our credit loss estimates at both system and individual bank levels could be impacted by this factor.

More harmonized and comparable disclosures of banks' exposures and vulnerabilities to climate and environmental risks would better inform our credit rating analysis and help us further differentiate among banks. As supervisors and banks provide greater transparency on the financial sector's vulnerability to these risks, this will likely increase the quality and the quantity of data we can leverage in our analysis.

A bank's ability to measure and mitigate climate-related risks will likely become a more important factor that could affect its creditworthiness.

Beyond climate change, nature-related risk analysis is gaining traction

Climate-related risks are in the spotlight, but the notion that nature-related financial risks, including biodiversity loss and ecosystem degradation, could have material implications for financial stability is only now gaining traction. In March 2022, the NGFS published a statement encouraging financial authorities to hone skills and increase their capacity to consider these risks more in their supervisory activities. It also announced the creation of a task force to strengthen the analysis of nature-related risks, which is less advanced than that of climate change.

Biodiversity loss and climate change are interconnected. Biodiversity loss can translate into physical and transition risks, and conversely, climate change can cause biodiversity loss. The potential consequences for financial institutions and ultimately for financial stability explain regulators and investors' increasing focus on nature-related risks.

That said, difficulties in measuring biodiversity loss and other nature-related risks make the assessment of their impacts even more challenging than climate change.

A few jurisdictions' initiatives highlight some financial authorities' efforts to address these risks. For example, in the Netherlands and France, the central banks tried to measure the extent to which their financial institutions are exposed to risks from biodiversity loss. They found that 36% and 42%, respectively, of their financial institutions' investments depend heavily on one or more ecosystems, concluding that the loss of biodiversity would substantially disrupt business processes and lead to financial losses.

We expect that the assessment of nature-related risks will gradually be incorporated into forward-looking scenario analysis, similarly to climate change. Progress on this front would require increased biodiversity-related data and disclosure, which is currently even less advanced than climate-related disclosure. ■

Related research and criteria

S&P Global Ratings related research

- ECB Stress Test: Eurozone Banks Need To Do More To Comprehend Climate Risk, July 11, 2022
- Bank of England Stress Test Suggests The U.K.'s Banks And Insurers Can Absorb Future Climate Risk, May 25, 2022
- Capturing Environmental Risks In Banks' Capital Frameworks Is An Ongoing Discussion In Europe, May 6, 2022
- The ECB's Climate Risk Stress Test: Raising The Bar For Banks, Feb. 3, 2022
- Key trends that will drive the ESG agenda In 2022, Jan. 31, 2022
- Basel Committee Proposal Highlights Banking Authorities' Focus On Climate-Change Risks, Nov. 17, 2021
- Climate Risk Vulnerability: Europe's Regulators Turn Up The Heat On Financial Institutions, Aug. 2, 2021

Related research (external)

- Japan Financial Services Agency and Bank of Japan, Pilot Scenario Analysis Exercise on Climate-Related Risks Based on Common Scenarios, Aug. 26, 2022
- European Central Bank, 2022 climate risk stress test, July 2022
- ECB/ESRB Project Team on climate risk monitoring, The macroprudential challenge of climate change, July 2022
- Basel Committee on Banking Supervision, Principles for the effective management and supervision of climate-related financial risks, June 2022
- Taskforce on Nature-related Financial Disclosures, second beta version of prototype risk management and opportunity disclosure framework, June 2022
- Hyeyoon Jung, Robert Engle, and Richard Berner, Federal Reserve Bank of New York Staff Report n°977: Climate Stress Testing, September 2021; revised June 2022
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- International Sustainability Standards Board, Draft IFRS S1 General Requirements for Disclosure of Sustainability-related Financial Information, March 2022
- Network for greening the Financial System, Statement on Nature-Related Financial Risks, March 24, 2022
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- International Sustainability Standards Board, Draft IFRS S2 Climate-related Disclosures, March 2022
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- APRA, Climate Vulnerability Assessment, Sept. 2021
- Financial Stability Oversight Council, Report on Climate-Related Financial Risk 2021
- Bank of Canada and Office of the Superintendent of Financial Institutions, Using Scenario Analysis to Assess Climate Transition Risk 2022, Final Report of the BoC-OSFI Climate Scenario Analysis Pilot

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Greenhouse gas intensity of the North Sea

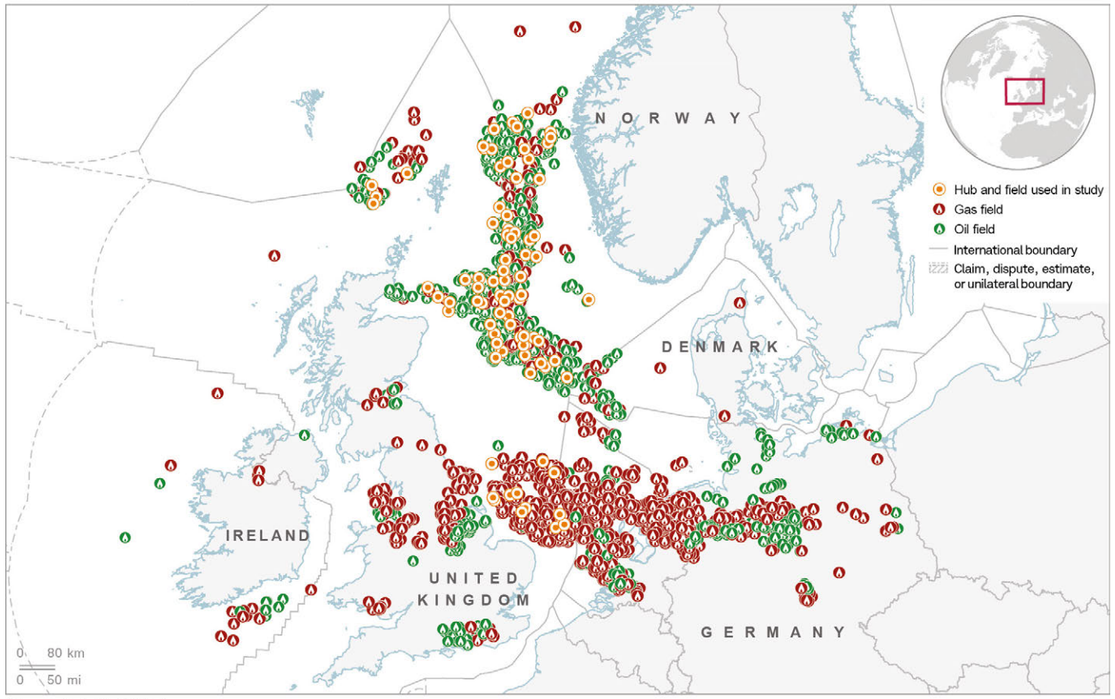
An examination of the U.K. and Norwegian North Sea, using a new and comprehensive approach to upstream oil and gas production emissions, finds that the average greenhouse gas intensity of production in 2021 was 12 kilograms of carbon dioxide equivalent per barrel of oil equivalent. Productivity, electrification and the extent of gas flaring all contribute to different levels of emissions for production operated by the U.K. and by Norway.

Published on November 8, 2022

Key takeaways

- **S&P Global Commodity Insights has developed an entirely new and comprehensive approach to estimating upstream oil and gas production emissions.** Internationally (outside North America, which uses a different approach), we are now capable of estimating the totality of an upstream oil and gas play's emissions and emissions intensity — from across the play, down to individual assets and the sources of emissions, such as the fuels, that underpin each operation.
- **An examination of the U.K. and Norwegian North Sea found that the average greenhouse gas intensity of production in 2021 was 12 kilograms of carbon dioxide equivalent per barrel of oil equivalent (kgCO2e/boe); however, considerable variation exists.** The study included 265 individual oil and gas fields and projects, consolidated into 84 key hubs or stand-alone projects. The greenhouse gas intensity across the study area ranged from less than 1 kgCO2e/boe to nearly 150 kgCO2e/boe. Nearly two-thirds of production was found to be beneath the basinwide average. Almost 80% of production occurring from only 20 assets accounted for just 50% of total emissions.
- **Productivity, electrification and flaring are key sources of emissions differentiation in the North Sea.** U.K. production was estimated to be, on average, about 2.5 times more greenhouse gas intensive than Norway. Younger, or less mature and more productive, assets principally located in the Norwegian offshore were, on average, lower intensity compared with the U.K. The greenhouse gas intensity of Norwegian operations benefited from electrification projects, which tied back to Norway's hydro-dominated power grid, as well as stricter controls on venting and flaring. On average, venting and flaring accounted for about 9% of total emissions from Norwegian operations compared with 28% in the U.K.

North Sea study area



Data compiled: Oct. 17, 2022.
Source: S&P Global Commodity Insights upstream E&P content (EDIN): 2008014

▶ **The North Sea is one of the most significant** oil- and gas–producing regions globally. Although its contribution has declined over the past 20 years, it still accounted for nearly 4% of global oil supply in 2021.[1] Since the initial fields were discovered in the 1960s, a complex network of offshore platforms, drilling operations, subsea recovery units, and pipelines has evolved. Most production comes from offshore facilities located in Norway and the U.K., with lower levels of activity in the Danish, Dutch and German offshore.

North Sea upstream operations are typically organized around larger gathering hubs that connect out to more remote fields accessed through subsea and surface production platforms. Some of these gathering stations connect back to shore, while others may transfer crude oil directly to oceangoing tankers. The scale and complexity of operations across the basin make it an interesting region to explore upstream greenhouse gas intensity. See Figure 1 for the location of North Sea oil and gas fields and the individual hubs and fields included in this study.

Modeling background/methodology

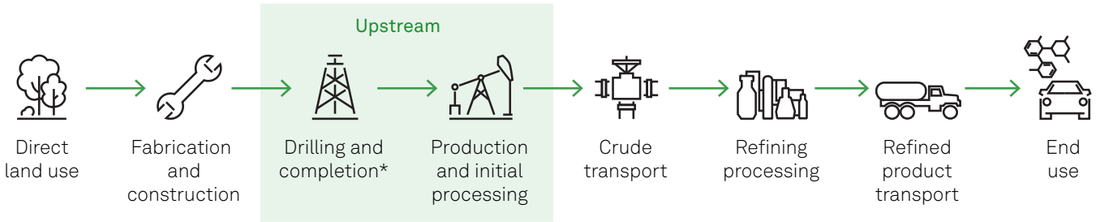
S&P Global Commodity Insights has developed a proprietary in-house upstream greenhouse gas emissions model built atop its deep upstream databases. Emerging data sources, such as reported emissions and satellite flaring data from the Earth Observation Group, are also captured to generate an unprecedented level of emissions data granularity and understanding. Greenhouse gas emission estimates go down to individual sources, including fuels, flaring, venting and fugitives. The emissions included in our international estimates, known as system boundaries, include all direct production and processing-related emissions to the point of offloading to shuttle tanker or export via pipeline (see Figure 2). Carbon dioxide, methane and nitrous oxide are the three main greenhouse gases that have been included as part of a carbon dioxide equivalent (CO_2e). Methane and nitrous oxide were converted to 25 CO_2e and 298 CO_2e, respectively, using global warming potentials from the U.N. Intergovernmental Panel on Climate Change's "Fourth Assessment Report." Estimates in the international emissions data set currently are based only on Scope 1 direct emissions but will soon include treatments to consider implications of Scope 2 emissions.

Emissions are quantified for each individual facility/asset. For this analysis, individual asset emissions have been allocated to their respective hub where applicable. This perspective allows the performance of the production, gathering, processing and transportation centers, and the fields/facilities tied into them, to be analyzed and compared across the region irrespective of ownership.

All major producing fields within the U.K. and Norwegian sectors of the North Sea have been included in this analysis, as well as those in the West of Shetlands. Stand-alone developments/fields are also included but maintain the preexisting development

[1] See the S&P Global Commodity Insights Scheduled Update "Global Crude Oil Markets Annual Strategic Workbook, 2022."

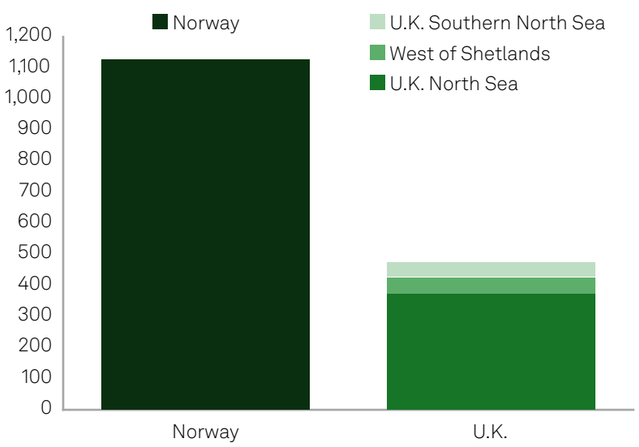
Figure 2: **Full product life cycle**



* Consistent with the guidance in the S&P Global Commodity Insights Strategic Report The Right Measure: A guidebook to crude oil life-cycle GHG emissions estimation, GHG emissions associated with drilling and completion were amortized over the estimated ultimate recovery.
Source: S&P Global Commodity Insights.

or field name. Hubs are defined as discrete production areas that are characterized by a central facility or field that handles production from two or more surrounding fields. Operators typically refer to key hubs as production or development areas, for example, the Sleipner Area, which includes production volumes from Sleipner East, Sleipner West, Gudrun, Gina Krog, Utgard, Gungne and Sigyn. Operator-designated hub names are applied where available. Hubs without defined names are allocated the central facility/field name. Through this approach, a total of 265 producing projects have been consolidated into 84 hubs and stand-alone projects, with 64 of these in the U.K. North Sea and the remaining 20 in the Norwegian North Sea. In terms of production volumes, 1,127 MMboe is accounted for by the Norwegian coverage and 492 MMboe for the U.K., of which 55 MMboe is from the West of Shetlands and 48 MMboe from the Southern North Sea gas basin (see Figure 3).

Figure 3: **Study area production total, 2021 (MMboe)**



Source: S&P Global Commodity Insights upstream E&P content (EDIN).

The greenhouse gas intensity of North Sea production

With the acceleration of global ambition to tackle climate change, there is increasing need by market participants to better understand the greenhouse gas competitiveness, or the relative greenhouse gas intensity between different sources of crude oil globally. This data is essential to help governments and investors understand the competitiveness of oil and gas assets, and for companies, as well as buyers and sellers of the potential carbon cost between different commodities.

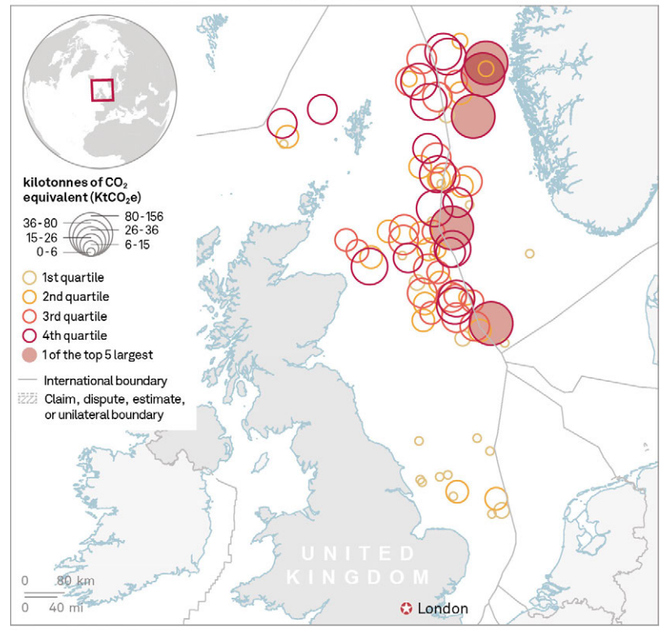
The hub and spoke system found the in the North Sea influences the greenhouse gas intensity of the resulting marketed products. Although each individual production operation may have its own unique greenhouse gas intensity, the intensity of some key transportation hubs or terminals can represent a compilation of various fields. S&P Global Commodity Insights modeled each production operation to estimate the greenhouse gas intensity of all major hubs and fields. From this, it is possible to complete a comprehensive analysis of the entire producing region.

The distribution of absolute emissions and emissions intensity across the study area are displayed in Figures 4 and 5. Some of the largest individual emitting hubs/fields in absolute terms were located in the Norwegian North Sea, whereas many of the largest emitters by intensity were located in the U.K. The five largest sources of absolute emissions in 2021 were located on the Norwegian Continental Shelf. However, four of the top five greenhouse gas intensity assets were in U.K. waters. The discrepancy between these two underscores production's role in a greenhouse gas intensity metric. Out of the 30 most intensive hubs, 29 were in the U.K., and out of the top 50, only seven were in Norway. In the U.K., the southern North Sea gas basin and West of Shetlands were advantaged in terms of emissions intensity.

As shown in Figure 6, when production volumes are plotted against emissions intensity for individual hubs, a distinctive hockey stick pattern emerges. Overall, the average greenhouse gas intensity of the upstream North Sea production in 2021 is estimated to be 12 $kgCO_2e/boe$, which includes both natural gas and liquids.

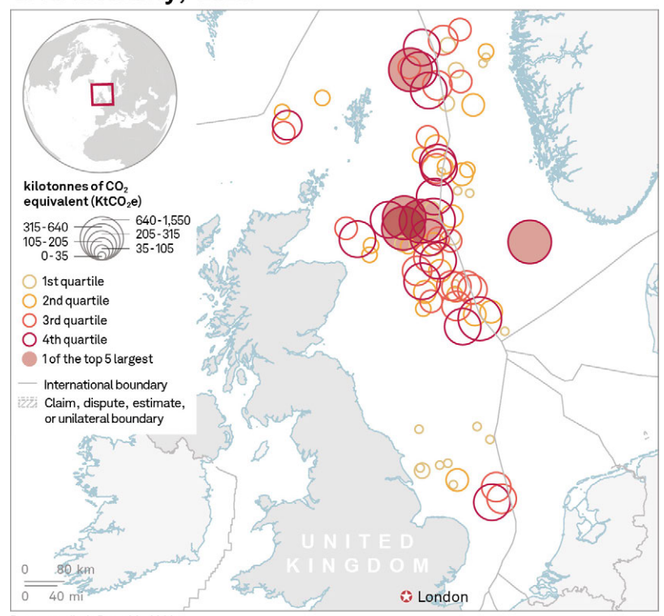
Similar to other basins globally, considerable variation in the greenhouse gas intensity exists, ranging from less than 1 $kgCO_2e/boe$ to nearly 150 $kgCO_2e/boe$. As Figure 5 shows, the most productive and efficient hubs and projects accounted for nearly two-thirds (62%) of output, with greenhouse gas intensity being below average. The more mature and/or geologically complex fields are more

Absolute GHG emissions, 2021



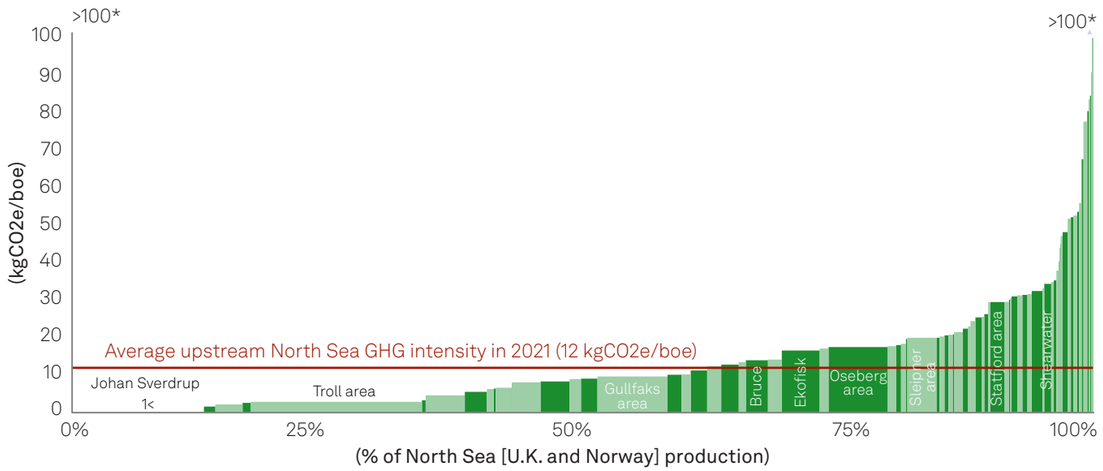
Data compiled: Dec. 06, 2022.
Source: The UK emissions data contains public sector information licensed under the Open Government Licence v3.0/ S&P Global Commodity Insights upstream E&P content (Vantage): 2008012

GHG intensity, 2021



Data compiled: Dec. 06, 2022.
Source: The UK emissions data contains public sector information licensed under the Open Government Licence v3.0/ S&P Global Commodity Insights upstream E&P content (Vantage): 2008012

Figure 6: **Greenhouse gas intensity of North Sea (UK and Norway) oil and gas production**
(2021 annual average)



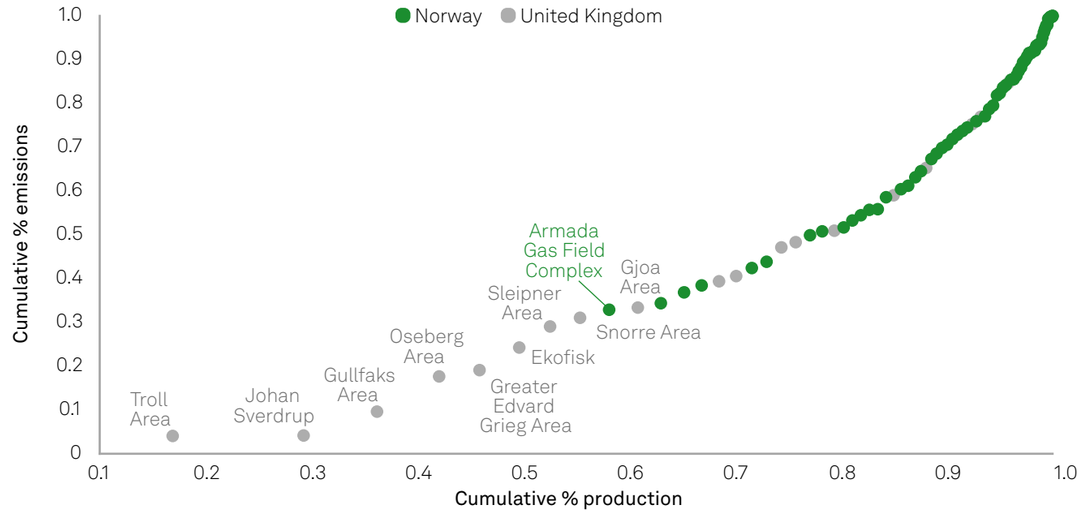
* The upper bound exceeds 100 kgCO2e/boe. For legibility, the full range was not included. CO2e includes our estimate of CO2, CH4, and N2O emissions.
Source: S&P Global Commodity Insights upstream E&P content (Vantage).

numerous, have lower productivity, and thus have higher greenhouse gas intensity. Greenhouse gas intensity, after all, is a simple ratio of emissions over productivity, so as productivity declines, emissions intensity tends to increase. This is a relationship that can be observed in numerous fields within the study area and globally. In addition to declining productivity, the implementation of energy-intensive enhanced recovery techniques, increased drilling to maintain productivity and aging technology may also put upward pressure on emissions intensity.

The lower bound of the greenhouse gas intensity of North Sea production is particularly illustrative of the importance of productivity in an intensity metric as well, with a total of four assets having an estimated greenhouse gas intensity of less than 1 $kgCO_2e$/boe, remarkably low the world over. Collectively, these four operations accounted for 13% of the study area's production in 2021. A significant contributor to the sub-1 $kgCO_2e$/boe intensity production club, 97% by 2021 production volume, is the giant Johan Sverdrup field in Norway, which reached this extraordinarily low value because of high productivity and electrification. In contrast, the top 10% of output on a greenhouse gas intensity basis was underpinned by 45 operations, with each having an individual greenhouse gas intensity of more than 25 $kgCO_2e$/boe.

When viewing emissions in an absolute sense, it is clear that the larger, more productive hubs and assets accounted for a smaller proportion of emissions (see Figure 7). The 20 largest assets by production volumes in 2021 accounted for almost 80% of production but only 50% of emissions. Of the 20 assets, 13 were in Norway and the remaining seven were in the U.K. The remaining 64 assets generated 50% of emissions and produced 20% of the total volumes in 2021, with 57 of these in the U.K. and seven in Norway.

Figure 7: **Study area cumulative production vs. cumulative absolute emissions, 2021**



Source: S&P Global Commodity Insights upstream E&P content (EDIN).

Greenhouse gas intensity of Norwegian versus U.K. production

Breaking apart the North Sea by Norwegian or U.K. production shows that, on average, U.K. production has roughly 2.5 times the greenhouse gas intensity of Norway. Norwegian production averaged about 8 $kgCO_2e$/boe in 2021 versus the U.K. at 23 $kgCO_2e$/boe (see Figure 8). Excluding the Southern North Sea and West of Shetlands pushes the U.K. North Sea up to 26 $kgCO_2e$/boe.

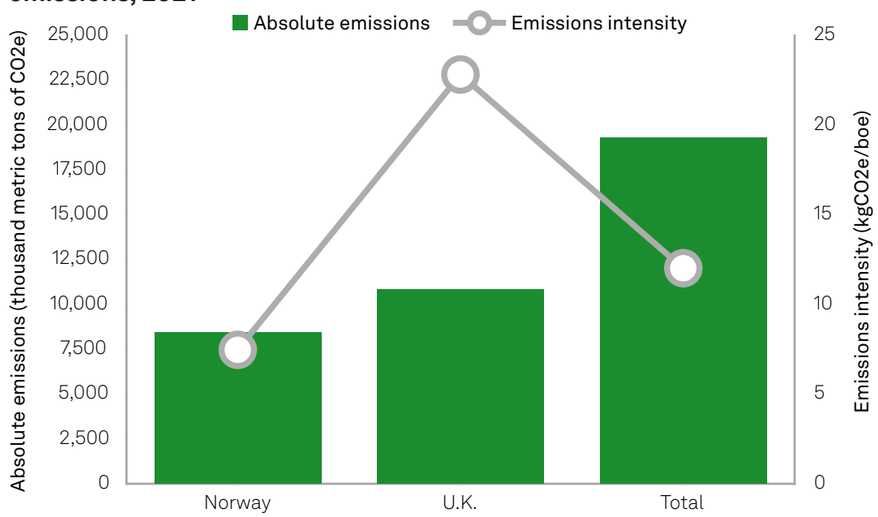
Norwegian operations were advantaged on a greenhouse gas intensity basis as, on average, fields tended to be less mature, with a greater share of output from larger, more productive and technologically advanced operations. Additionally, Norway benefited from electrification projects that tie back to Norway's relatively low-emission, hydro-dominated power grid. Carbon capture and sequestration has also been deployed at the Sleipner East field, lowering emissions.

U.K. output by comparison tended to be from smaller, more mature or more challenging fields as well as from fields with older infrastructure and technology, which resulted in lower productivity and, thus, higher greenhouse gas intensity.[2] In addition to this, operations in the U.K. were more flaring intensive, and unlike Norway, the U.K. had no power from shore projects to offset emissions from fuel combustion. However, it is notable that the gas-dominated Southern North Sea and relatively low emissions production from Quad 204 and Clair in the West of Shetlands made these two provinces significantly less intensive than the U.K. North Sea (see Figure 9).

When viewing the share of emissions by the underlying fuel or emissions source — i.e., fuel gas, diesel, flaring and venting — there is a clear distinction between Norway and the U.K. (see Figures 10 and 11). The intensity of all sources of emissions was higher for the U.K. The proportion of emissions by

[2] In 2019, S&P Global Commodity Insights estimated that the average U.K. field was about two-thirds (62%) through its life, whereas in Norway, it was about halfway (51%). Data was sourced from Vantage.

Figure 8: **Study area cumulative production vs. cumulative absolute emissions, 2021**



Source: S&P Global Commodity Insights upstream E&P content (Vantage).

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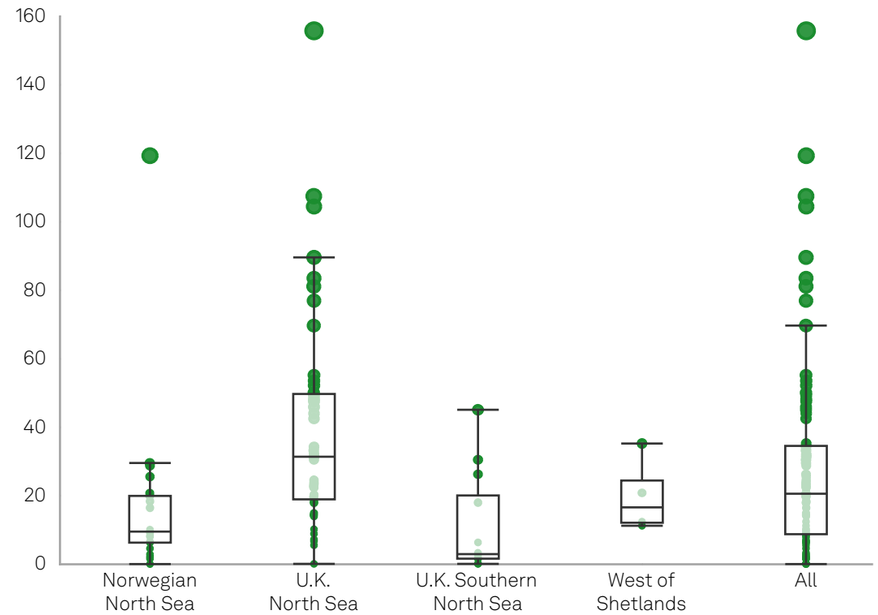
Figure 9: **Study area GHG intensity by province, 2021 (kgCO2e/boe)**



Nonproduction weighted values.
Source: S&P Global Commodity Insights upstream E&P content (Vantage).

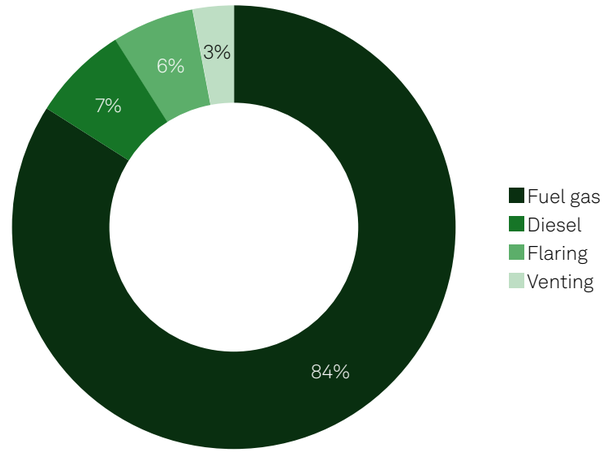
The UK emissions data contains public sector information licensed under the Open Government Licence v3.0.

source also differed between the nations. Strict controls on flaring and venting activity on the Norwegian Continental Shelf mean that these sources only took up 9% of emissions in the Norwegian sector of the study area. Yet in the U.K., where zero-routine flaring regulations are not currently in place, flaring and venting accounted for 28% of total emissions in 2021.

Concluding remarks

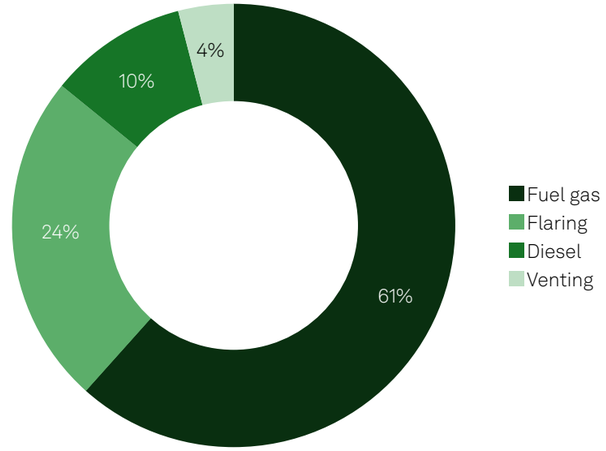
S&P Global Commodity Insights comprehensive upstream greenhouse gas estimation capability is shedding new light and understanding on the true nature of upstream greenhouse gas emissions. The ability to take a comprehensive view of an entire region or basin enables a complete statistical analysis of the weighted average from a range of emission intensities that, in this study, span nearly 150 $kgCO_2e$/boe. The detail available through this new modeling approach, which is only available from S&P Global Commodity Insights, allows for detailed exploration across the region and elsewhere globally, enabling an analysis of production at multiple scales, including national level and basin level, as well as providing data rich enough to drill down to individual assets, emission sources and greenhouse gases. This is the first in a series of analyses of a brand new upstream greenhouse gas data set from S&P Global Commodity Insights. ■

Figure 10: **GHG intensity of Norwegian North Sea production in 2021 (8 KgCO2e/boe of product)**



Source: S&P Global Commodity Insights upstream E&P content (Vantage).

Figure 11: **GHG intensity of UK North Sea production in 2021 (23 KgCO2e/boe of product)**



Source: S&P Global Commodity Insights upstream E&P content (Vantage).

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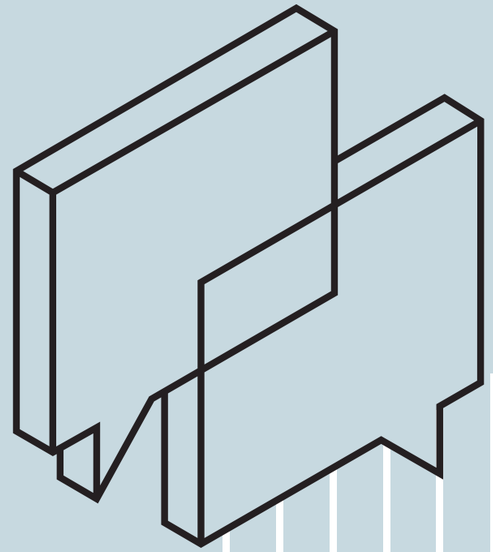

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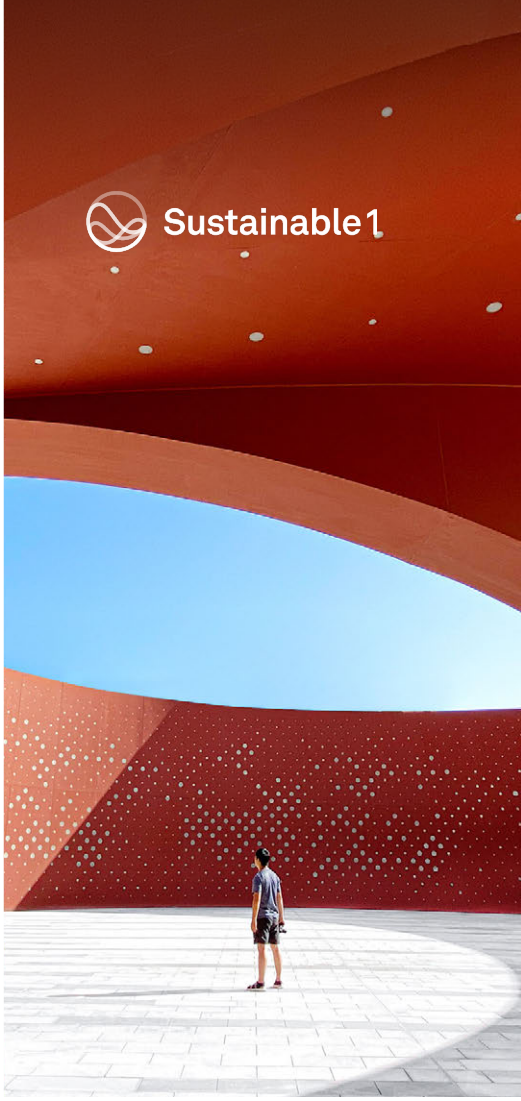

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