Carbon Capture, Removal, And Credits Pose Challenges For Companies

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Companies pursuing carbon capture, removal, or credits, could face potential financial costs, technical challenges, as well as risks relating to still evolving regulatory and voluntary guidance.

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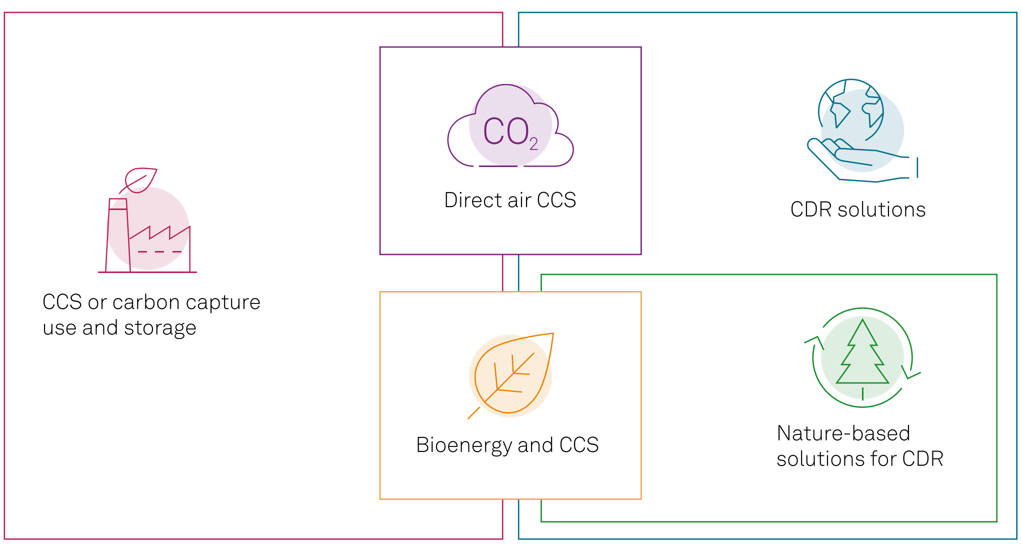
Companies that have made ambitious decarbonization commitments may need to rely on technologies such as carbon capture and storage (CCS), carbon dioxide removal (CDR), and the use of carbon credits. Studies by global stakeholders generally recognize that these solutions have a role to play in decarbonizing the economy. Such solutions also carry technological, financial, policy, and stakeholder perception risks.

In this research, we explore the risks of a variety of approaches for managing carbon emissions, including those that are more difficult to address (often referred to as hard to abate or residual). As part of this research, we include a case study on the oil and gas sector, using publicly available information from a sample of 25 companies from across the globe with combined revenue of US$3.8 trillion and capital expenditure of US$279 billion. We also examined a range of reports and guidance from industry stakeholders.

Key Takeaways

- Each potential solution carries its own risks, and companies that pursue CCS, CDR, or carbon credits could face considerable uncertainties about financial costs, as well as evolving regulations and voluntary guidance.
- Using the oil and gas sector as a case study, we find a mix of strategies under consideration. Overall, we see limited consideration or disclosure of the potential risks associated with CCS, CDR, or carbon credits, and the quality of disclosure varies, which restricts comparison of plans across our sample.
- We believe disclosure and transparency by companies about their chosen emissions-reduction solutions, and how they are planning for the associated risks, will better enable analysis of how companies might meet their decarbonization commitments.
- As solutions continue to evolve, companies that are able to understand and manage potential technical challenges are likely to be better placed to deliver the most efficient solutions, limiting financial costs and reputation risks.

Understanding the interaction between carbon capture and removal technologies can be challenging



CCS--Carbon capture and storage. CDR--Carbon dioxide removal. Source: S&P Global Ratings.

Decarbonization Calls For A Broad Range Of Solutions

More companies are setting decarbonization targets, but not all emissions will be easy to tackle. To avoid the most severe effects of climate change--as most recently set out in the Intergovernmental Panel on Climate Change's (IPCC's) Sixth Assessment Report (AR6)--global economic actors will need to take significant mitigating action (IPCC, 2021; 2023).

Whether driven by policy, financial risks, reputation risks, or stakeholders' concerns, more companies are taking steps to decarbonize each year. Those committing to the Science Based Targets initiative (SBTi) have roughly doubled in each of the past four years (SBTi, 2022). Companies looking to align with the Paris Agreement--to reduce the average global temperature rise to "well below" 2 degrees Celsius (2 C) compared with pre-industrial levels--have set specific targets for decarbonization, and many are investing in new technologies and facilities and/or different business models to operate in a future net-zero environment. Some companies have aspirational net-zero-by-2050 targets.

Some companies that have set ambitious decarbonization targets (such as net-zero commitments) face significant challenges to reduce all their emissions. While parts of many companies' emission footprints might have an identifiable pathway to decarbonization (for example, switching to renewables or hydrogen from fossil-fuel-based electricity), others face greater challenges, for example, emissions resulting from calcination during cement production. These are often referred to as hard-to-abate or residual emissions and will require their own solutions if such companies are to completely decarbonize.

CDR and CCS may play a role in efforts to reach decarbonization goals

A large body of research now shows ways to decarbonize. However, some climate scenarios suggest that CCS and CDR will be required to limit warming to 1.5 C or 2 C, including those of the IPCC (2021), the International Energy Agency (IEA, 2020; 2021; 2022), and the Network for Greening the Financial System (NGFS, 2022). These studies have differing views about the importance of each solution, but the message is consistent: Although significant emissions reductions come first, CDR and CCS are likely to play a role in efforts to achieve the most ambitious decarbonization scenarios, and the two approaches have some overlaps.

CDR is a group of both nature-based and technological solutions that remove carbon dioxide from the atmosphere and permanently store it in terrestrial, geological, or ocean reservoirs. The most prominent examples of nature-based solutions are afforestation and reforestation, but other approaches include improving soil quality, enhanced weathering, and the production of biochar (see table 1). Technological options include direct air carbon capture and storage (DACCS), which removes and stores carbon from ambient air, and bioenergy combined with CCS (BECCS). In most cases, CDR approaches are de-coupled from actual emissions sources or industrial processes, meaning their potential benefits are net in nature and do not directly reduce emissions. For technological CDR options, CCS forms a key part of solutions. The vast majority of the 2 gigatons per year of CDR achieved today comes from land management, with only a small amount from technological solutions, according to the State of Carbon Dioxide Removal (2023). The IPCC, however, concludes that CDR use--both natural and technological--will need to increase significantly to support all scenarios that limit warming to 2 C.

CCS is a group of technologies that separate carbon dioxide from other gases, then capture and store it in a permanent facility. It can be deployed in power generation and industry to capture carbon dioxide directly from processes and transport the gas in pipelines to long-term geological storage sites. Captured and stored carbon can also be used in the energy sector, for example for extracting oil and gas in depleted reservoirs. The Global CCS Institute (2022) reported that the operating capacity of CCS in 2021 was 37 million tons per annum (mtpa) with a pipeline of projects that could develop around 150 mtpa of capacity. This is a small fraction of the total that the IPCC, IEA, and NGFS anticipate would be needed (between 3 gigatons and 8 gigatons per year) in more ambitious decarbonization scenarios. IPCC (2022) notes that deployment is already behind where it would expect it to be to meet a 2 C scenario.

While CCS and CDR are expected to play a key role in decarbonization, the limitations of both have been documented in global studies. There are also technical, economic, and political barriers to overcome. Approaches using CCS are seen as having stronger permanence characteristics than nature-based solutions (NbS), meaning they are considered less vulnerable to the accidental release of carbon dioxide, provided they are well managed. With a CCS-based approach, it can also be easier to monitor and determine the amount of carbon stored compared to NbS. The technological readiness of CCS is, however, generally behind that of afforestation or reforestation, and costs are less certain, although there are some facilities operating in certain sectors such as oil and gas. Storage capacity is a major consideration; studies estimate that there is enough total storage capacity for CCS to cope with decades of emissions, whereas NbS could be constrained by available land but also could deliver a wider range of benefits to stakeholders if well planned. Technological CDR solutions, especially DACCS, are at much earlier stages of development, with technical and economic challenges still to be overcome.

Table 1

Overview of the most prominent CCS and CDR solutions

Solution	Description	Examples
CCS or carbon capture use and storage	Used in conjunction with industrial production to capture carbon dioxide emissions generated from a particular activity. The captured emissions can either be stored or used for another purpose.	Capture systems as part of power generation, cement production, and other industrial processes, placed in geological storage locations. Capture systems that subsequently use carbon dioxide for enhanced oil recovery, chemical products, or food production.
Carbon dioxide removal solutions		
Nature-based CDR (or nature-based solutions)	Interventions that use natural processes to remove carbon dioxide directly from the atmosphere and store it as carbon in organic materials.	Afforestation (or reforestation) where new vegetation absorbs and stores carbon. Efforts that improve soil quality and increase organic carbon, including peatland and wetland restoration. Production of biochar, a charcoal-like product made from biomass, which can then be used to improve soil quality. Enhanced weathering, the spreading of finely ground silicate rocks, which promotes fast carbonation.
Technology-based CDR	Using a chemical and mechanical process to remove carbon dioxide from ambient air and geologically store it, commonly referred to as direct air capture.	Systems that use a chemical solution to cause a reaction with carbon dioxide. Systems that use filters to absorb carbon dioxide, then store carbon in geological storage locations.
Special case: bioenergy and CCS	Where crops are grown to produce bioenergy (thereby absorbing carbon dioxide from the atmosphere) and then, when combusted, the emissions are captured through CCS and geologically stored.	Biomass or biofueled thermal power generation with integrated CCS facilities.

Source: S&P Global Ratings, IPCC (2021), S&P Commodity Insights. CCS--Carbon capture and storage. CDR--Carbon dioxide removal.

Carbon credits carry their own risks but could provide flexibility

Carbon credits are certificates that represent the reduction, avoidance, or removal of one ton of carbon by a specific activity. For example, a party develops an afforestation project that removes a ton of carbon from the atmosphere, generating a carbon credit, which the party can either use for itself to support a decarbonization claim or trade to another party like any other commodity.

Some stakeholders have expressed concerns about the role of carbon credits and whether they can deliver real reductions. Carbon credits are complex, with multiple actors involved (see "Voluntary carbon markets: how they work, how they're priced and who's involved," June 10, 2021). The World Resources Institute (2010) and the U.K. Climate Change Committee (2022) are among those that have identified specific considerations for companies when selecting projects that could offset emissions. The credibility of the underlying projects is crucial; potential issues can arise for carbon credits that are based on perceived benefits that can be difficult to substantiate or simply lead to adverse effects elsewhere. For example, credits based on avoided deforestation in one area would need to show that deforestation didn't simply occur somewhere else, which can be difficult to prove. Crediting schemes also require that the creation of carbon credits should be limited to reduction or removal projects that would not otherwise be economically viable without the additional source of revenue the credits provide. Transparent and credible verification and data are therefore key for increasing stakeholders' confidence that any given carbon credit represents a real benefit. Meanwhile, some companies' interest in carbon credits might only be to trade them, not necessarily using them to support their own decarbonization goals.

Despite this, momentum is growing for voluntary carbon markets (VCM), which could indicate some stakeholders believe carbon credits can support decarbonization claims. For example, the IEA's net-zero scenario notes that offsetting mechanisms could provide cost-efficient support to mitigate emissions. There are several existing schemes that promote VCM, managing the creation, offering, and retirement of carbon credits for buyers and sellers alike. Some sectors, such as the International Civil Aviation Organization's Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), allow participating companies to use carbon credits as a key part of their decarbonization approach.

The voluntary market could also support the development of new technologies. For example, methodologies are being increasingly developed that would allow DACCS projects to generate carbon credits, potentially making those projects more financially viable. The World Bank (2023) reports on a significant increase in VCM activity in the last five years, with 275 million voluntary credits issued in 2022. Ecosystem Marketplace (2021) estimated the market value of VCM at US$2 billion. Although this represents only a fraction of current global emissions, demand is expected to increase substantially.

Companies Face A Complex Set Of Challenges

While global studies recognize the potential role for CDR, CCS, and carbon credits, not all companies have identified the potential risks that could limit their effectiveness. Here, we use the oil and gas sector as a case study to illustrate how companies are approaching the available solutions.

Our Oil And Gas Sector Case Study Approach

- From across the globe, we selected a sample of 25 of the highest-revenue oil and gas companies, with combined revenue of US$3.8 trillion and aggregate capital expenditure of US$279 billion in their latest fiscal year. We see the sector as clearly exposed to climate transition risks given the significant emissions that are generated through the use of oil and gas, and we think our sample offers a representative view of how a key sector is approaching CCS, CDR, and carbon credits.
- We reviewed the companies' publicly available sustainability and financial disclosures for 2022 and their positions on using CDR, CCS, or carbon crediting schemes to achieve stated carbon targets. We also assessed how investment, as well as the understanding of technology and other sustainability risks, informs their plans.
- Our sample represents scopes 1 and 2 emissions of 687 million tons of carbon dioxide (MtCO2) covering about 31% of emissions from listed oil and gas companies, based on the universe of companies in our S&P Global Market Intelligence dataset. We note the majority of oil and gas sector emissions are scope 3 because fuels are burnt by users; in our sample, scope 3 accounted for 93% of total emissions.

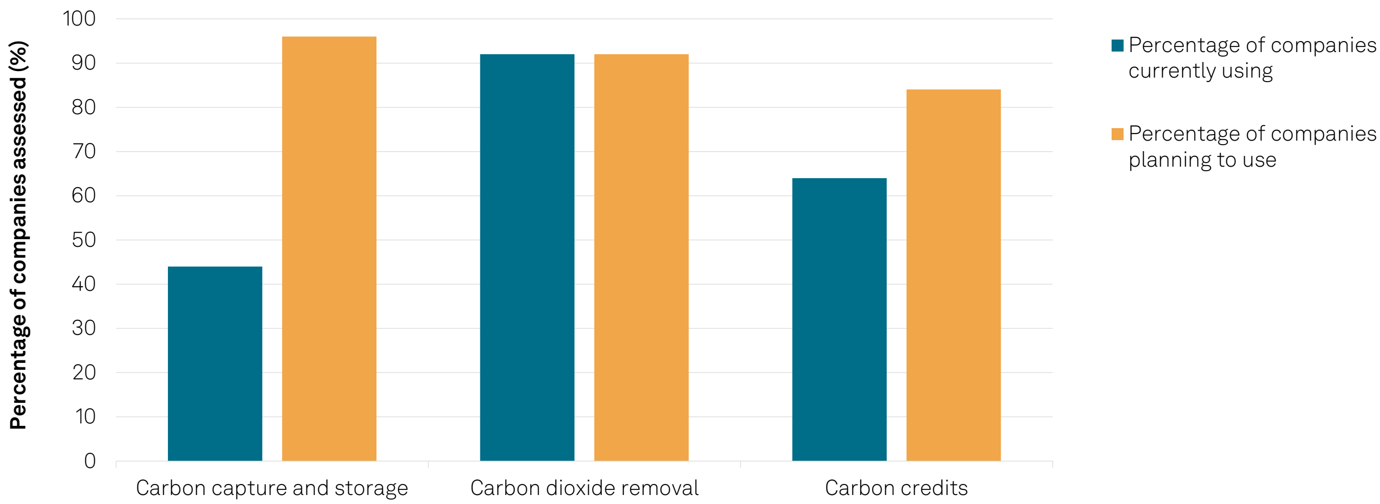
Oil and gas companies show a wide range of starting points and approaches to meeting emissions-reduction targets

Not all companies in our sample have set net-zero targets (see chart 1); this also applies to other sectors, but all have set targets to reduce emissions to some extent between 2030 and 2050. Of our sample, 76% are targeting net zero for scopes 1 and 2 emissions by 2050. Additionally, 64% of the companies have set a methane reduction target and 80% are signatories to the World Bank's Zero Routine Flaring by 2030 initiative. While 32% of companies have set targets to reach net zero, including scope 3 emissions, this only covers 20% of the scope 3 emissions in our sample. To put these figures into context, IPCC (2021) suggests that emissions from the combustion of fossil fuels--the main scope 3 emissions of oil companies--would need to decline by around 85% by 2050, compared to today, to meet the below 2 C scenario.

All the companies in our sample plan to use at least one of CCS, CDR, or carbon credits to meet their decarbonization goals, although strategies vary in the level of detail. Current CCS capacity in our sample in 2022 represented only 7% of the companies' reported scopes 1 and 2 emissions, with most activity from the U.S.- and Europe-based global majors. Plans for future deployment reported by companies in our sample would see capacity increase substantially (to around 325 million tons by 2030 from 50 million tons today). These CCS and CCUS capacities include plans for enhanced oil recovery and solutions to capture emissions from other companies. However, only 60% disclose their expected future capacity and only 56% identify the specific investment costs required, either explicitly or as part of a wider package of measures. When we looked at companies' aims, 24% mentioned they would use captured carbon for enhanced oil recovery, but often these aims are expressed in vague terms, which is important because emissions that result from the oil produced in this way could nullify the possible benefits of the captured carbon, potentially introducing reputation risks.

Chart 1

All oil and gas companies in our sample plan to use CCS, CDR, or carbon credits to achieve their decarbonization goals



Source: S&P Global Ratings.

In our sample, 92% of companies intend to use CDR, mainly through NbS, but implementation plans are not always clear. We have observed that the most common approach is to partner with others, although a high proportion of companies' disclosures lacks details. Most companies in our sample described projects that contribute to biodiversity initiatives, but they do not identify CDR as a potential additional benefit. In our analysis, companies' strategies focused on afforestation or reforestation solutions; none disclosed any involvement with other types of NbS. Reference to the use of DACCS (40%) and BECCS (28%) in our sample is also limited. Our finding is supported by the Global CCS Institute (2022) status report that found limited developments, and an estimate by S&P Global Market Intelligence that DACCS and BECCS represent only 2% of planned CCS deployment to 2030.

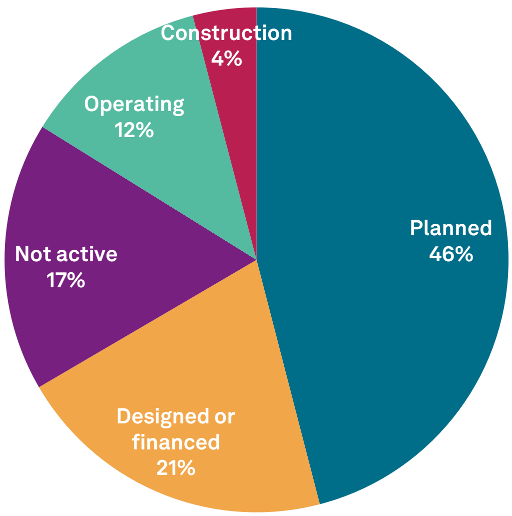
Among the oil and gas companies in our sample, 64% are already participating in the voluntary carbon credit market, but 84% suggest this will be part of their future strategy. Current total purchases were disclosed as 3% of 2022 scopes 1 and 2 emissions across our sample, including both removal- and reduction-based credits. From our sample, only five companies disclosed plans to limit the use of carbon credits to offset on average 10% of total greenhouse gas emissions by 2030. We note, however, an emphasis on coupling credits to sold fuel, for example marketing the fuel as carbon neutral or net zero to emphasize relevance for scope 3 emissions, as opposed to balancing scopes 1 and 2 emissions. Meanwhile, some oil and gas companies treat trading carbon credits as a business line, not exclusively as a way to support their own decarbonization claims. From our sample, 40% of companies have disclosed that carbon credits are part of their low carbon solutions for customers. Understanding how companies will use credits is difficult without a standardized reporting framework (Rosales et al., 2022).

All Options Will Add To Costs And Carry Considerable Technical Uncertainty

Some solutions are still evolving and are yet to be proven at commercial scale (see chart 2), making it difficult to gauge the potential impact on investment needs and costs. IPCC (2021) notes that while afforestation and reforestation are well understood, technological approaches (such as DACCS and BECCS) are less mature.

Chart 2

Six times more CCS projects are planned globally than already operational



Note: Of the projects monitored by S&P Global Market Intelligence, only 12% are operating as of 2023.
Source: S&P Global Market Intelligence. CCS--Carbon capture and storage.

In addition, some already-delivered CCS projects have not met their full potential, having experienced technical issues with both capture and storage as well as economic challenges in some geographies (Institute for Energy Economics and Financial Analysis, 2022). All options involve both capital and operating expenditure, where current estimates fall into wide ranges (see table 2).

The wide variation in estimates for life-cycle costs shows the state of technological readiness, the specific application, and the uncertainty involved in all the solutions. For example, the cost of CCS is related to the concentration of the carbon dioxide being captured. Where concentrations are high (for instance in some industrial processes) costs are likely to be lower, compared to DACCS where the carbon dioxide in ambient air is very diluted. However, geographic considerations are also relevant, such as the distance to storage sites. This can make estimating the potential financial costs of hypothetical developments difficult. In our sample, disclosure about investment in CCS, CDR, or carbon credits is mixed. In some cases, specific investment amounts are identified but, in many cases, they are not stated or set out clearly, or are expressed only as a future ambition. To illustrate the range of uncertainty, a company in our sample with median carbon emissions could expect costs of US$1.5 billion-US$2.5 billion per year to balance current scopes 1 and 2 emissions of 21 million tons through CCS or afforestation, assuming a future policy requirement for oil and gas companies to operate with net-zero emissions, and CCS and afforestation or reforestation costs of US$72-US$118 per ton. In this illustrative example, these costs would likely represent at least 10% of operating profit. Using only DACCS (which is still in early development) would cost considerably more because of higher expected operating costs.

Table 2

Estimated cost ranges for CCS and CDR solutions

Type	Solution	Cost range (US$/ton)
Technology-based solutions	Carbon capture and storage	15-130
	Direct air carbon capture and storage	100-345
	Bioenergy combined with carbon capture and storage	15-400
Nature-based solutions	Afforestation and reforestation	5-240
	Soil carbon sequestration	45-100
	Biochar	10-345
	Enhanced weathering	50-200

Note: Costs are expressed as life-cycle costs. Source: Based on a range of estimates from IPCC (2021), IEA (2020,2021).

Those that choose to rely on carbon credits could also face cost risks, particularly for higher-quality removal-based projects. There is considerable uncertainty about how the voluntary market for carbon credits will evolve. While prices appear lower for now on average across all carbon credit types--and therefore potentially more attractive than other options--Trove (2021) estimated that carbon credit prices could be between US$25/tCO2 and US$100/tCO2 by 2030. There could also be variations in cost between credit types. For example, in 2022, nature-based removal credits traded at a daily average price that was more than twice as high as that of avoidance-based credits, according to S&P Global Commodity Insights data. This wide range of costs introduces uncertainty for companies that might plan to use carbon credits as part of a long-term decarbonization strategy.

The total cost and return for companies can vary. Assessments of potential future carbon pricing obligations, regulatory incentives, and whether there is an ability to pass on costs to customers may be used as tools to estimate cost scenarios. For example, in the U.S., where there is no federal carbon tax, there is a current tax incentive of US$85 per ton from the Inflation Reduction Act that would partially offset costs associated with construction and operation for CSS. But that could change in the future. In regions with carbon taxes or emissions trading schemes (for example in the EU), companies may have more of an incentive to consider CCS or CDR to minimize regulatory costs, albeit costs and returns may again be uncertain and highly variable. For example, the price for allowances under the EU Emissions Trading System could reach €128 per tCO2 by 2030 (see "Carbon Pricing, In Various Forms, Is Likely to Spread In The Move To Net Zero," Aug. 9, 2022).

CCS And CDR Could Have Other Environmental Consequences

NbS and the deployment of carbon capture technologies could add pressure to ecosystems. IPCC (2020) and UNEP/ICUN (2021) have assessed the potential wider effects, both positive and negative, of NbS. For example, low-diversity tree plantations on naturally low-cover habitats, such as savannas, can increase water demand and nutrients, which in turn can put pressure on other forms of life that habit the ecosystem. NbS might also be susceptible to permanence risks such as climate hazards, say wildfires or drought, in the long term (Badgley et al., 2022). Meanwhile, CCS assets typically have high water requirements and could add pressure to water-scarce areas. In our sample, companies that plan to deploy NbS were generally better at disclosing environmental risks but lacked detail about how they would manage permanence risk, for example.

Aside from the potential cost of implementing NbS, companies face obstacles to securing enough land to manage it successfully. Given the scale of some companies' emissions, such as those in our sample, the requirements for land could be significant. Although we have found good examples that provided specific locations and timelines for such projects, details are broadly lacking. As an example of the potential scale, if we assume the median company in our sample (current scopes 1 and 2 emissions of 21 MtCO2 equivalent in 2022) chose to use NbS alone to balance its emissions, around 18,000 square kilometers of land could be required. The amount of land required would depend on the type of solution and, over time, this area would need to be increased as habitats reach maturity and to protect them from potential damage. While this is just an illustration, it highlights the challenges of implementing such a solution, implying that companies would either need to use a mix of options, or go further in their actual emissions reductions, if they were to meet such a target.

Table 3

Potential impact of CCS and CDR on other environmental factors

Approach	Land use competition	Increase in energy use	Air pollution	Water use	Water quality	Biodiversity	Vulnerability to climate hazards	High risk of reversibility
CCS and DACCS		•		•				•
BECCS	•		•	•		•		
Afforestation/ reforestation	•			•		•	•	•
Biochar	•		•			•		
Soil carbon sequestration					•		•	•
Enhanced weathering	•		•			•		
Peatland restoration	•						•	•

Note: The actual impact will depend on factors such as implementation and location. Reversibility refers to the potential re-emission of carbon that has previously been captured. In the case of situations where captured carbon is used to make new products (such as hydrogen) rather than stored, the risk of reversibility is considerably greater. Some risks may be upstream (for example enhanced weathering being potentially dependent on mining). In some cases, benefits could also be delivered where carefully managed, for example those related to biodiversity. DACCS--Direct air carbon capture and storage. BECCS--Bioenergy combined with carbon capture and storage. Source: IPCC AR6 (2021), Royal Society (2018).

Increased Transparency From Companies Could Help Communicate Risks

The policy landscape for CDR, CCS, and carbon credits will likely keep evolving

The economics of some solutions have given rise to incentives from governments to support companies' research and development (R&D) or offer financial help to deploy technologies such as CSS and CDR. Some authorities have already implemented policies supporting CCS and CDR R&D. For example, the U.S. Inflation Reduction Act of 2022 provides further incentives to develop CCS projects, which could strengthen deployment rates in the medium term. In the U.K., government support has been given to developers of new industrial hubs that have CCS as an integrated element. Similarly, the European Green Deal, the EU Innovation Fund, and Net Zero Industry Act increase support for CCS. We found examples in our sample of oil and gas companies of investments that are looking to take advantage of such financial support. Given that these solutions always represent some additional cost to the business activity involved, incentives are likely to drive deployment faster than in jurisdictions with more limited or different policy objectives.

The role of policy is a common theme in the energy transition and there are still some complex stakeholder issues to resolve. Article 6 of the Paris Agreement paves the way for potential international trading of mitigating actions to support national commitments, but the relationship between national budgets and companies is less clear. As of COP27, there are still many methodological and technical issues to resolve about the treatment of removals and who owns the right to use them to support their decarbonization claims, avoiding double-counting issues. Monitoring frameworks are also likely to develop. For example, in 2022, the European Commission published its draft regulation for the establishment of a centralized EU-wide CDR certification framework to support the EU in meeting its 2030 targets. The regulation aims to build trust in CDR and encourage finance by introducing a set of harmonized criteria covering quantification, additionality, permanence, and impact on other sustainability factors. Zhang et al. (2022) has also noted the need for more consistency in how CCS capacities are reported. Increased consistency as to how CDR, CCS, and carbon credits are measured and reported by companies will likely increase stakeholder confidence. Notwithstanding this, there may be some short-term risk as companies develop their strategies within evolving regulatory frameworks.

Guidance is varied and voluntary about the use of CDR, CCS, and carbon credits to support companies' decarbonization plans

Few specific regulations govern what requirements companies should or should not meet in order to make decarbonization claims. As a result, a wide range of voluntary guidance has emerged. It is not always aligned, however, and can be fragmented or complex to navigate (see table 4). Some of the guidance and frameworks have made efforts to define the role of CDR, CCS, and carbon credits in decarbonization to drive consistency (for example, the U.N. [2022], SBTi [2021]), and investors and other stakeholders often refer to some of these as standards.

Concerns about quality have led to the development of third-party review services that aim to assure the veracity of carbon credits. Separately, sector initiatives, such as the Integrity Council for the Voluntary Carbon Market, aim to harmonize rules for voluntary carbon credits by providing assurance about the veracity of carbon credits in response to criticisms of some standards, methodologies, and projects. There is growing consensus--such as by SBTi (2021) and The Oxford

Principles for Net Zero Aligned Carbon Offsetting (2020)--that generally views removal-based carbon credits as more robust than reduction or avoided-emission credits.

However, claims about climate performance are increasingly attracting the attention of advertising regulators on the back of stakeholder concerns. Specific attention has been given to the use of carbon credits, for example the U.S. Federal Trade Commission's Guides for the Use of Environmental Marketing Claims include a section specifically on carbon offsets. The U.K.'s Advertising Standards Agency also provides guidance on how companies should describe the role carbon credits might play in environmental claims, and also on the broader use of terms such as carbon neutral or net zero.

Disclosure proposals are likely to increase the onus on companies to provide more comprehensive information about their decarbonization strategies. The International Sustainability Standards Board and the EU's Corporate Sustainability Reporting Directive are among those developing reporting standards on climate-related issues, which could go some way to increasing visibility on how companies plan to deliver on their commitments.

Table 4

Summary of a sample of views from industry standards and guidelines on CDR, CCS, and carbon credits

Framework or guidance	Approach to CDR, CCS, and carbon credits
GRI (Global Reporting Initiative)	Requires reporting and disclosure on the use of offsets, including the type of scheme, number of credits involved, and reductions due to direct removals.
Greenhouse Gas Protocol Corporate Standard	Includes guidance about how to treat removals as part of a greenhouse gas inventory. Enhanced draft guidance published in September 2022 provides clarity about how removals and carbon credits should be treated and reported. Guidance is expected to be published in 2023.
International Capital Market Association (ICMA) Principles	Does not consider carbon offsetting within the Green Bond Principles' guidance, because ICMA does not consider it to represent carbon reduction.
Climate Bond Initiative	Allows for the use of CCS in certain sectors, such as cement and oil and gas, following specific criteria, and for carbon sequestration through its forestry criteria. Self-generated or purchased offsets (with exceptions) should not be taken into consideration.
MDB-IDFC (Principles for climate mitigation financing)	CCUS for enhanced oil recovery and carbon credits are not an eligible mitigation approach.
SBTi's latest Net Zero Standard (October 2021, version 1.0)	Requires companies to reduce actual emissions by 90%, with the remainder being balanced by removals ("neutralized" according to its definition). Market-based carbon credits in science-based targets are defined as activity that happens beyond the value chain of the company, meaning that companies can finance offset schemes but not use them to abate their emissions on their science-based target pathway.
Climate Action 100+	Stresses that both offsetting and removal should not be used in lieu of actual emission reductions. The Benchmark 2.0 framework update in 2023 expanded Disclosure Indicator 5 to include new metrics on offsets, negative emissions technologies, and abatement measures. With this expansion, it is not endorsing or promoting the use of offsets or negative emissions technologies in decarbonization strategies. Rather, it evaluates how comprehensive and robust companies are in terms of disclosure.
IIGCC Net Zero Standard for Oil and Gas	Requires the disclosure of the contribution of CCUS, BECCS, and DACCS as part of emissions targets, and requires companies to publish studies on the technological measures and investments planned to support the deployment of such solutions. It also requires companies to publish strategies regarding the use of carbon credits, including details on types, cost, storage, and providers.
Transition Plan Taskforce	Within the Transition Plan Taskforce Disclosure Framework draft, entities should state specifically whether they rely on the use of carbon credits to achieve their targets. It also suggests disclosing details of carbon credits, including the quality and their contribution to transition plans.
U.N. High-Level Expert Group on Net Zero Emissions Commitments of Non-State Entities	Non-state actors should prioritize emission reductions across their value chain. High-integrity carbon credits can be used for beyond-value-chain mitigation, but they should not be counted toward interim carbon targets. Residual emissions can be balanced with permanent greenhouse gas removals with independent verification.

Note: Some of the sources cited above use the term "offsets" interchangeably with carbon credits or to represent the action of using carbon credits to make decarbonization claims. Source: S&P Global Ratings.

Limited disclosure makes stakeholder scrutiny more difficult

Disclosure of CCS and CDR risks within our sample of oil of gas companies was limited. Most of the companies in our sample included a Task Force on Climate-related Financial Disclosures (TCFD) section (or similar) within their annual report or sustainability report, but the level of detail about CCS and CDR varied. For example, we found only eight instances (from 25 companies) of specific disclosures related to risks associated with CCS and CDR, such as technology readiness, cost, and access to storage locations. Most discussions framed risks around achieving specific targets, but we also found that in cautionary notes in annual reports there were more statements about limitations. Half the companies in our sample specifically mention risks relating to policy support, performance, or technology maturity, albeit in few words. This could reflect the current state of companies' TCFD reporting, but nonetheless makes it difficult for stakeholders to form a clear view about the deliverability of solutions in decarbonization plans.

The disclosure of risks about the use of carbon credits in our sample was also limited, with only five companies noting particular risks. Some of the companies have developed, or are in the process of developing, a carbon credit policy (mainly those that also act as brokers to others). We see this as a critical step in managing risks associated with stakeholder concerns about issues such as additionality, and whether the credits are to be used by companies themselves or sold to another party. Companies that plan to build up a significant portfolio of credits now, to use or trade in the future, could also be exposed to risks, since views about the quality of different carbon credit types might differ among stakeholders and could change over time. Our finding is similar to that of the Transition Pathway Initiative (2021), which found that oil and gas companies did not disclose sufficient detail about the contribution from offsets to their overall targets.

CCS, CDR, And Carbon Credits In Our Credit Analysis Of Oil And Gas Companies

Oil and gas companies are adopting different strategic responses to the energy transition; reducing, capturing, or offsetting emissions are a part of these. Companies with depleted hydrocarbon reservoirs may have a key asset for carbon dioxide storage activities, but this is not the only requirement for technical and commercial success. As shown in our sample and across the sector in general, large oil and gas companies are exploring different business models for carbon capture, which may include sequestering emissions from other companies' activities, not necessarily capturing their own emissions. Production of blue hydrogen--capturing the carbon dioxide formed by steam methane reforming and a water-gas shift reaction--is another use of carbon storage.

We view CCS investments as both prudent and affordable for large companies, but not transformational. Announced plans across the sector to date appear to be comfortably within most companies' capital investment guidance and financial frameworks. This moderate level of investment also signals that companies don't see CCS as a panacea, nor is it typically a mandatory requirement imposed by licenses or regulations. Our ratings do not assume any requirement for producers to offset their emissions, still less scope 3 emissions. This is just one area where a conceivable, disruptive change in regulations could increase costs and affect operations. S&P Global Ratings factored in the potential for these changes and other increasing challenges and uncertainties when it changed its industry risk assessment to moderately high, from intermediate, for oil and gas producers on Jan. 25, 2021. We note that net-zero targets set by companies are long-dated, typically for 2050 as shown in our sample.

As the energy transition proceeds, particularly for smaller producers, we may see some differentiation by investors and lenders between energy companies that produce fossil fuels but do so on a more sustainable basis and with credible operating metrics, and those that have not meaningfully addressed their scopes 1 and 2 emissions and are not demonstrably willing or able to do so. As shown in our sample, disclosure of potential risks varies across the sector, and investors may increasingly expect more transparency on companies' strategic approaches to CCS, CDR, and carbon credits. In the first instance, if more investors were to differentiate these risks, this could affect the cost of funding rather than access to funding. Nevertheless, particularly in a weak oil price environment, it could represent another potential hurdle for companies seeking funding or refinancing of debt.

Looking Ahead: All Options Add Complexity To Decarbonization Strategies

The global decarbonization pathways from the IPCC, IEA, and NGFS agree that solutions to manage hard-to-abate emissions will have to play a key part in limiting rising global temperatures. While these solutions might support the management of transition risks associated with broader decarbonization strategies, all of them carry risks and present significant hurdles to overcome. The options will take companies time to develop, plan, implement, and scale up, and will require investment of some kind even as relative costs change.

Over the coming decade, we expect to see more discussion and disclosure from major emitters across the economy about their decarbonization plans, including how they plan to tackle their hard-to-abate emissions. Along with other risks in the energy transition, companies that can understand and manage these risks are likely to be better placed to deliver the most efficient and effective solutions. National policies and financial support will evolve and could provide more clarity to companies about dealing with emissions.

For now, there is considerable uncertainty about the potential costs associated with all of these options for those that want to meet their own decarbonization targets or those that look to reduce their potential exposure to carbon taxes or costs associated with emissions trading schemes. However, as the policy landscape changes, we expect to see companies pursue a wide range of solutions. Given all these factors, we believe improved disclosure could enhance stakeholders' analysis of companies' strategies toward reaching their decarbonization goals.

Related Research

- Carbon Pricing, In Various Forms, Is Likely To Spread In The Move To Net Zero, Aug. 9, 2022
- Mind The Gap: Pledges At COP26 Give Hope But Significant Shortfall Still Exists, Nov. 18, 2021
- Fuel for Thought: Carbon offsetting goes mainstream as producers set sights on net-zero, May 18, 2021
- Voluntary carbon markets: how they work, how they're priced and who's involved, Jun. 10, 2021
- Too Late For Net-Zero Emissions By 2050? The Potential Of Forests And Soils, Jun. 4, 2020

External Research

- California's Forest Carbon Offsets Buffer Pool Is Severely Undercapitalized, Badgley G, Chay F, Chegwidden OS, Hamman JJ, Freeman J and Cullenward D, Frontiers in Forests and Global Change, Apr. 29, 2022
- Climate Action 100+ Net Zero Company Benchmark 2.0, March 2023
- Proposal For A Regulation Of The European Parliament And Of The Council Establishing A Union Certification Framework For Carbon Removals, European Commission, 2022
- The Global Status of CCS 2021, Global CCS Institute, 2022
- The Carbon Capture Crux, Institute for Energy Economics and Financial Analysis, 2022
- Technical Summary. In: Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, M. Pathak, R. Slade, P.R. Shukla, J. Skea, R. Pichs-Madruga, D. Ürge-Vorsatz, Cambridge University Press, 2022
- NGFS Scenarios For Central Banks And Supervisors, Network for Greening the Financial System, 2022
- Scaling Urgent Corporate Climate Action Worldwide: Science Based Targets Initiative Annual Progress Report, 2021, Science Based Targets Initiative, 2022
- Who Is Paying for Carbon Dioxide Removal? Designing Policy Instruments for Mobilizing Negative Emissions Technologies, Honegger M, Poralla M, Michaelowa A and Ahonen H-M, Frontiers in Climate, June 7, 2021
- State Of The Voluntary Carbon Markets 2021, Ecosystem Marketplace, 2021
- Is Carbon Capture Too Expensive?, IEA, 2021
- Carbon Performance Assessment Of Oil & Gas Producers: Note On Methodology, Transition Pathway Initiative, 2021
- Future Demand, Supply and Prices for Voluntary Carbon Credits – Keeping the Balance, Trove Research, 2021
- SBTi Net-Zero Criteria, October 2021. Version 1.0, Science Based Targets Initiative, 2021
- Special Report: Climate Change and Land, IPCC, 2020
- Energy Technology Perspectives 2020, IEA, 2020

- Nature-based solutions for climate change mitigation, Nairobi and Gland, United Nations Environment Programme and International Union for Conservation of Nature, 2021
- The Oxford Principles for Net Zero Aligned Carbon Offsetting, University of Oxford, 2020
- State And Trends Of Carbon Pricing, World Bank, 2023
- Bottom Line On Offsets, Goodward, J and Kelly, A, World Resource Institute, 2010
- What Makes A High Quality Carbon Credit, World Wildlife Fund (WWF-US), Environmental Defense Fund (EDF) and Oeko-Institut, 2020
- An Estimate of the Amount of Geological CO2 Storage over the Period of 1996–2020 (2022), Zhang Y, Jackson C and Krevor, S, Environ. Sci. Technol. Lett. 2022, 9, 8, 693–698
- Financial Accounting for Carbon Finance: A New Standard for a New Paradigm, Rosales R, Pelaez MA, Wang K, Elnahass M., 2022
- Greenhouse Gas Removal, Royal Society, 2018
- The State of Carbon Dioxide Removal, Smith, S. M., Geden, O., Nemet, G., Gidden, M., Lamb, W. F., Powis, C., Bellamy, R., Callaghan, M., Cowie, A., Cox, E., Fuss, S., Gasser, T., Grassi, G., Greene, J., Lück, S., Mohan, A., Müller-Hansen, F., Peters, G., Pratama, Y., Repke, T., Riahi, K., Schenuit, F., Steinhauser, J., Strefler, J., Valenzuela, J. M., and Minx, J. C., 2023
- Integrity Matters: Net Zero Commitments By Businesses, Financial Institutions, Cities And Regions, United Nations' High Level Expert Group, 2022IEA (2022), World Energy Outlook 2022, IEA, Paris https://www.iea.org/reports/world-energy-outlook-2022, License: CC BY 4.0 (report); CC BY NC SA 4.0 (Annex A)

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