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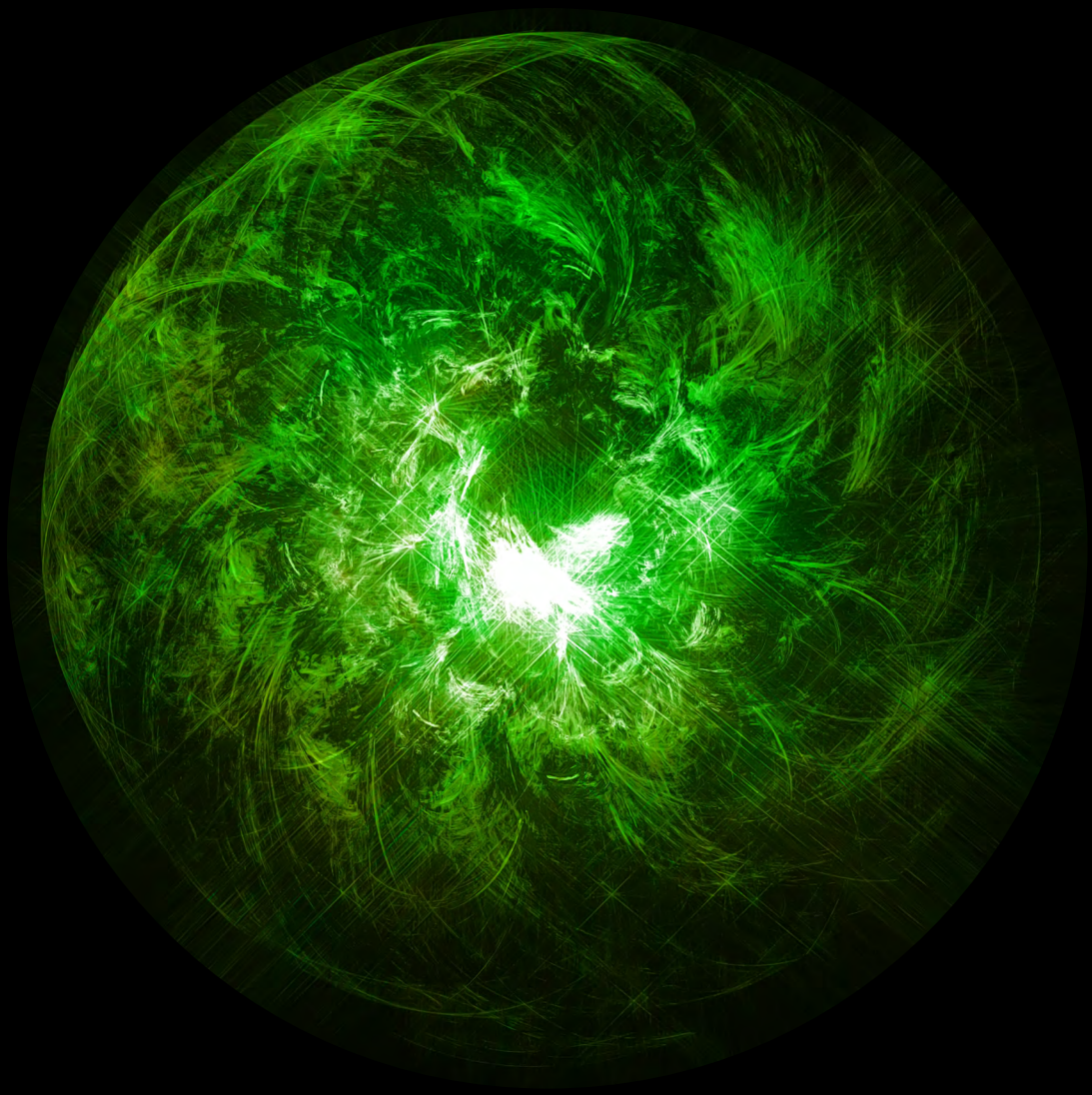


# Carbon management

## Views from across the value chain

# Contents







# Accelerating into 2023

In the six months following Deloitte's publication of The imperative for carbon management, the United States passed the Inflation Reduction Act (IRA) and world leaders met in Egypt for the 27th Conference of the Parties of the UNFCCC (COP27) to discuss how to tackle climate change globally. The IRA is expected to reduce US greenhouse gas (GHG) emissions to 40% below 2005 levels by 2030 by investing $369 billion to modernize energy infrastructure.[1] It includes several provisions aimed at increasing investment in carbon capture, storage, and utilization.

How are these new policy provisions expected to change the game for startups and companies investing in carbon capture? To begin pinpointing the key implications, we spoke with stakeholders regarding how the carbon management ecosystem is developing (especially in the United States), what challenges still exist, and how the future might progress. We conducted interviews across the landscape to gain perspectives from the startup community, academia, and established energy companies.

# Where we've been and where we're headed

Investment and project activity in carbon management (including carbon capture, utilization, storage, and removal) continued to increase in 2022. Operational carbon capture capacity increased from 14.1 MT to 43.7 MT between 2010 and 2021.[2] However, carbon capture capacity that is operational or under development rose by nearly 80 MT to 244 MT in 2022.[3] Still, it is expected that 10.4 GT of CO2 capture capacity will be needed by 2070 to reach net zero.[4]

Investment interest in carbon capture and storage has been through several cycles, with interest waxing and waning.[5] But many of the market participants we interviewed noted that this has begun to change. Several factors may have helped accelerate investment into carbon management projects. First, there has been increased climate change awareness from the publication of reports by the Intergovernmental Panel on Climate Change and the National Academies of Science, Engineering, and Medicine, as well as "in your backyard" evidence such as hurricanes, droughts, flooding, and record temperatures. Second, those we spoke with suggested that more mature technologies are driving corporations and investment funds toward clean energy. One interviewee proposed that more people and companies are beginning to understand the cost of inaction and want to find ways to contribute to the solution.

More recently, the IRA has increased attention to carbon management. One interviewee noted that the IRA has attracted more interest in carbon management not only with increased tax credits for some projects and clearer guidelines for project qualification but also by signaling the government's long-term commitment to cleaner energy. While the stakeholders interviewed all agreed that the IRA credits are not significant enough to make capturing all carbon dioxide (CO2) economic, the higher levels and broader application of the credits are expected to significantly improve many projects' economics. As a result, some of our interviewees noted a new wave of investment coming from multiple stakeholders, including private equity, depleted oil and gas reservoir operators looking to monetize their assets, and emitters exploring how much of their CO2 they can capture and at what cost. Much of this interest is focused on capture and sequestration, where project efficacy can be more easily tracked. But those interviewed predicted that interest would grow in utilization as end markets and infrastructure develop.





# Potential challenges

While encouraging progress has been made in growing investment in carbon management, many challenges still exist. Through our conversations, six factors emerged as critical to helping increase investment, decrease costs, and accelerate deployment.

### Consistent, supportive government policy

Several stakeholders emphasized that carbon management is still a policy-enabled industry. Many carbon management projects are still not economical. The industry will likely require consistent government support across the value chain until a market is fully formed. Policy action (such as the expansion of the 45Q tax credit for carbon capture, sequestration, or utilization in the IRA) improves the economics of carbon management,[6] although it may not be enough to reach climate goals alone.

### Clear, streamlined leasing and permitting processes

Several stakeholders noted that a timely, streamlined permitting process is likely essential for the widespread deployment of carbon management technologies. Permitting is required for essential CO2 infrastructure, such as pipelines and geological storage. When permitting processes are delayed, it can drive up project costs or even stall the project indefinitely. Additionally, the ability to obtain pore space for sequestration can also be critical. Subsurface rights differ by geography, but governments may need to be willing to make that space available for geological sequestration to be possible.

### More sophisticated carbon markets

Voluntary carbon markets (VCMs) have grown tremendously in the last few years, but these markets could need to mature to materially grow the carbon management ecosystem. VCMs still face vulnerabilities on three different levels: the project level (e.g., carbon credit quality, double counting, emissions reduction calculation accuracy, verification), the trading environment, and the overall communication about the use of carbon credits by buyers.[7] Carbon credit quality includes issues of additionality, permanency, and leakage. According to one interviewee, some large corporations have kick-started the market for high-quality carbon removal credits, with other corporations and government bodies beginning to adopt more rigorous carbon removal credit strategies. As more players enter the market, price curves for the high-quality credits will likely improve, opening the market to mainstream buyers that expect a reliable, low-cost solution.

### Stronger public education and support

Even if a project makes economic sense, it can be held up when the public is not supportive. While climate change awareness has increased, communicating the need for new or retrofitted infrastructure for CO2 transport and storage is still challenging. Environmental protection, public health, and safety issues may need to be addressed and communicated transparently to increase public confidence in carbon management projects.

### Scaled-up renewables to power carbon management projects

One often-overlooked challenge for carbon management (and other clean energy) projects is their energy intensity. Capturing carbon, transporting it, and utilizing it all require energy. Renewable energy sources will be needed to power these new carbon management projects to reduce life cycle GHG emissions. Not only will this require additional renewable energy capacity, but it will likely also require expanded infrastructure to deliver clean electricity where it is needed. Once again, streamlined permitting will likely be an important part of the timely deployment of clean energy solutions.

### Maturation of technologies and supply chain

At a facility level, there may still be challenges to capturing 100% of the CO2 emitted from a point source. Sources of CO2 at each facility can often diffuse, so installing carbon capture equipment at each source may become economically prohibitive. While lower-emission industrial hubs can help reduce the cost of carbon capture, utilization, and storage (CCUS) and clean hydrogen deployment by 20% to 95%,[8] some emitters could still be geographically isolated from storage or utilization solutions. In addition, emitters that find it most cost effective to sell to a company that can utilize the CO2 will likely be tied to the purchaser's daily CO2 requirements.

# The continued importance of partnerships

Through our interviews, there was widespread agreement that oil and gas companies could be part of the solution. They may be able to provide valuable infrastructure, capital, and technical "know-how" that can help enable carbon management projects to be successful. Leveraging the expertise and financial portfolios of oil and gas companies may be a key enabler to speed up the adoption of carbon management technologies. Their knowledge could be especially important once the CO2 is removed from the air.

Partnerships along the carbon management value chain—for example, large corporations and oilfield services companies partnering with emitters—could also increase the adoption of carbon management technologies. Creating an ecosystem in which all points in the carbon value chain are connected will likely be one key to limiting carbon emissions.

Outside the oil and gas sector, there are opportunities that other large corporations can capture. Some companies have created plans to reduce carbon emissions through carbon management measures.[9] Corporate involvement can attract more robust investment to the space (especially when partnering with startups), as they can sometimes more easily take on loans and calculate their internal rate of return based on multiple projects to spread the risk over a larger pool.

From a technology perspective, university labs have the potential to create and license novel CCUS inventions and processes. They could then partner with businesses, both small and large, to disrupt the carbon management market and, in turn, potentially help fuel the growth of this industry.





# The potential for CO2 utilization

Across the board, those we interviewed agreed that CO2 utilization technologies currently lag behind other parts of the carbon management ecosystem. In particular, the economics of utilization through conversion (in which CO2 is used as a feedstock to make added-value products such as chemicals, fuels, etc.) can be challenging. A company may have to replace an incumbent in the market that likely produces a cheaper product today. Consequently, new products using CO2 would need to provide additional value elements to customers to compete against cheaper incumbent technologies. Additionally, carbon accounting (or measuring the carbon reduction) for carbon conversion processes can be complicated. One interviewee revealed that most businesses he interacts with are focused on carbon dioxide removal since it has a more straightforward narrative to explain to investors, with CO2 captured and stored.

There are a few utilization applications that interviewees felt appeared promising, including building materials and sustainable aviation fuels (SAFs). For example, some building material products, like CO2-enhanced cement, were said to be attractive because the CO2 captured will not be re-emitted once it has been mineralized. Depending on how the CO2 is introduced into cement production, it can lower the overall carbon intensiveness of the process and/or improve product quality (e.g., strength and durability). Some government entities are prioritizing the purchase of low-carbon building materials to kick-start the industry, given that the cost of this cement remains higher than for traditional cement.[10] Similarly, SAFs are drawing interest because they reduce carbon intensity compared to fossil fuel-based alternatives.[11]

# The path forward

Our conversations engaged stakeholders across the value chain. Although they come from different backgrounds, they are all looking toward similar trends in the coming years:

1. The evolution and scale of governmental policy support;
2. The potential for increased scale of deployment to drive down costs; and:
3. An increasing public understanding of carbon management's role in curbing climate change.

There are a few inflection points in particular that our interviews indicated.

**Policy maturation.**
From a policy perspective, several stakeholders agreed that tax credits in the IRA would likely accelerate carbon management deployment but not be sufficient to make enough projects viable to meet climate targets. Some of the market participants we interviewed suggested that compliance markets or carbon taxes could be other tools to help stand up the industry. Additionally, streamlining these applications for startups seeking investment could accelerate deployment.

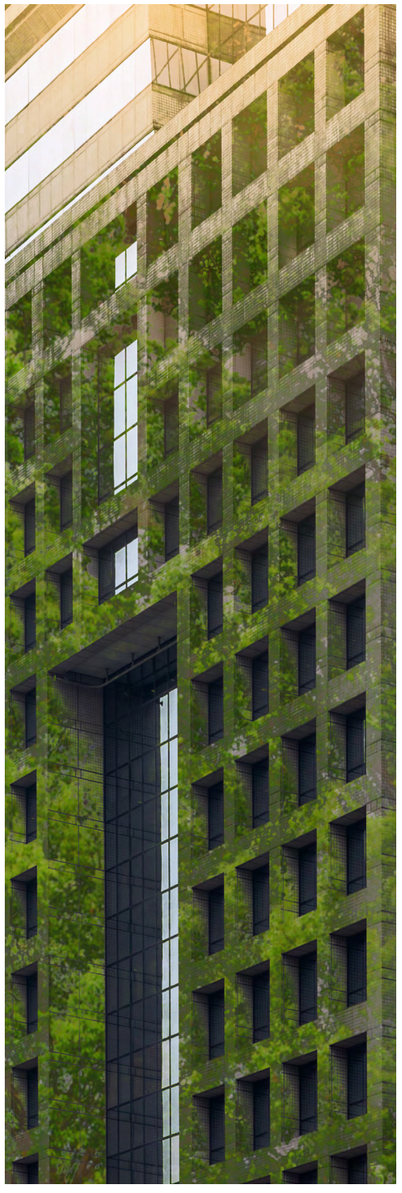
**Economies of scale.**
All our interlocutors agreed that creating economies of scale will be key to carbon management project viability. Low-emission hub projects could be important in demonstrating this opportunity and securing future investment for carbon management projects.

**Building out renewable infrastructure.**
In addition, many we spoke with felt that scaling renewable infrastructure is paramount to the success of carbon management projects. These projects should be powered by clean energy to achieve carbon neutrality (or negativity). Increasing renewable power could also reduce energy costs by replacing more expensive fossil fuels.

**Scaling transport infrastructure.**
Scaling up transportation infrastructure for renewable electricity and CO2 could also be important to drive the widespread adoption of carbon capture, utilization, storage, and removal technologies.

**Cross-sector partnerships.**
Establishing partnerships among companies capturing CO2 to create market signals through coalitions and industry associations could help to propel the CCUS industry forward. Aggregating demand to give project developers confidence could galvanize the market and decrease the risk for individual players.

A multi-pronged approach is likely essential to meeting climate change targets on time. Carbon management, along with other complementary strategies, can play an increasingly important role to scale up investment in and deployment of clean technologies.







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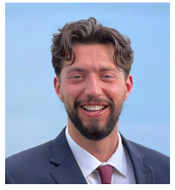

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# Endnotes

1. US Department of Energy Office of Policy, "The Inflation Reduction Act drives significant emissions reductions and positions America to reach our climate goals," August 2022.

   IEA (2021), "Carbon capture in 2021: Off and running or another false start?," IEA, Paris.

3. Alex Zapantis et al., *Global status of CCS in 2022*, Global CCS Institute, 2022, pp. 5–8.
4. IEA (2020), CCUS in Clean Energy Transitions, IEA, Paris.
5. Samantha McCulloch, "Carbon capture in 2021: Off and running or another false start?," IEA, November 24, 2021.
6. U.S. Government Publishing Office, Public Law 117-169 ("Inflation Reduction Act"), August 16, 2022.
7. Board of the International Organization of Securities Commissions (IOSCO), *Voluntary carbon markets: Discussion paper*, OICU-IOSCO, November 2022.
8. Deloitte, *Low carbon industrial hubs: Driving deep decarbonization for industry*, September 2022.
9. Cassandra Garrison, "Explainer: How industry is depending on carbon capture technology for climate goals," Reuters, August 29, 2022.

   The New York State Senate, Senate bill S542A, January 6, 2021.

11. Office of Energy Efficiency & Renewable Energy, "Sustainable aviation fuels," accessed December 12, 2022.

    nomic Forum, February 2, 2022.

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