COLUMBIA THREADNEEDLE INVESTMENTS

THEMATIC INSIGHTS

Carbon capture and storage: opportunities in a burgeoning market

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At a glance

- Carbon capture and storage (CCS) is key in helping the world achieve its ambitious net zero emissions targets
- There are three catalysts driving increased adoption: policy incentives, improving economics and new infrastructure
- While CCS is promising it does require significant investment. The IEA estimates $1 trillion is needed by 2030 and $3 trillion by 2050
- CCS offers a variety of investment opportunities to suit different risk tolerances, from oil majors that are leaders in the value chain to specialised companies working on next-generation technology

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Introduction

The transition to a low-carbon future is well underway[1]: countries representing more than 80% of global emissions have made net zero commitments, as well as more than 700 of the world's largest companies. Carbon capture and storage (CCS) has a key role to play in achieving this. CCS refers to a combination of technologies that can be used to capture and store carbon dioxide (CO2) from point-of-source emissions. CCS is made up of three processes:

1 **Capture**
This involves separating CO2 from other gasses produced in large industrial process facilities such as coal and natural gas power plants, steel mills and cement plants.

2 **Transport**
Compressing captured CO2 and transporting it to a suitable geological storage site.

3 **Storage**
CO2 is injected into deep underground rock formations.

Here we explain how CCS can make a difference, why investment is ramping up, and how investors can take advantage of burgeoning opportunities in this potentially transformative technology.

[1] Columbia Threadneedle Investments, The energy transition – transformative on a global scale, September 2023

How CCS can help

According to the International Energy Agency (IEA), in order to achieve net zero goals CCS is a necessity, not an option.[2] For heavy industries like cement, steel and petrochemicals that cannot utilise electrification or renewables to reduce emissions it is the only viable means of doing this, and is critical in helping to decarbonise the oil and gas sectors (Figure 1)

As such, the IEA's net zero roadmap estimates CCS could lead to a 15% reduction in greenhouse gas emissions.

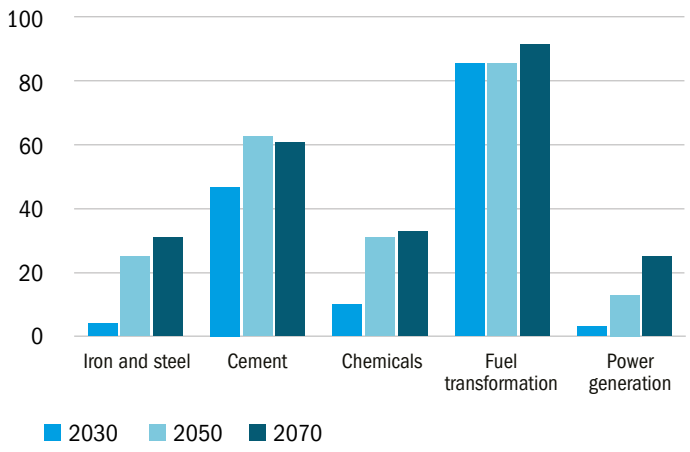
While CCS technologies have been around for some time, three catalysts are driving increased adoption: policy incentives, improving economics, and new infrastructure.

Policy On the policy side, the US Inflation Reduction Act (IRA) and Infrastructure Bill provide significant financial incentives and are spurring further development. The IRA increased tax credits for CCS by more than 70% to $85 per ton of CO2 captured (Figure 2). Because the act requires projects to be under construction by 2032 there is an incentive to act quickly.

Meanwhile, the Infrastructure Bill allocated $12 billion to the Department of Energy (DoE) for CCS[3], and this money is already flowing. For example, in August the DoE allocated $1.2 billion to develop direct air capture hubs in Louisiana and Texas, in conjunction with private sector companies including Occidental Petroleum, Climeworks Corporation, and Heirloom Carbon Technologies[4]. In October, meanwhile, the DoE announced $7 billion in funding for America's first clean hydrogen hubs. Of the seven hubs, four will generate blue hydrogen, which is hydrogen produced with natural gas, coupled with carbon capture and storage.[5]

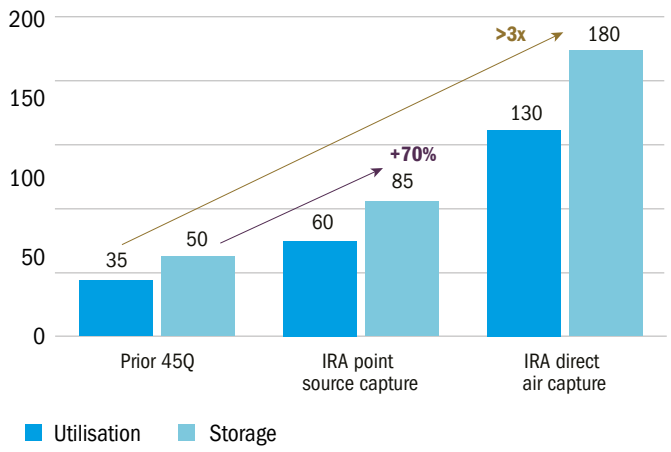
Three catalysts are driving increased CCS adoption: policy incentives, improving economics, and new infrastructure

Figure 1: CCS contribution to sector CO2 emission reductions



Source: Liberium, 2023

Figure 2: prior 45Q credits vs. new IRA credits



Source: Columbia Threadneedle Investments' analysis, November 2023

[2] IEA, CCUS in the transition to net-zero emissions, 2020
[3] Department of Energy, The Infrastructure Investment and Jobs Act: Opportunities to Accelerate Deployment in Fossil Energy and Carbon Management Activities, September 2022
[4] Energy.gov, Funding Notice: Bipartisan Infrastructure Law: Regional Direct Air Capture Hubs, August 2023
[5] The White House, Biden-Harris Administration Announces Regional Clean Hydrogen Hubs to Drive Clean Manufacturing and Jobs, 13 October 2023

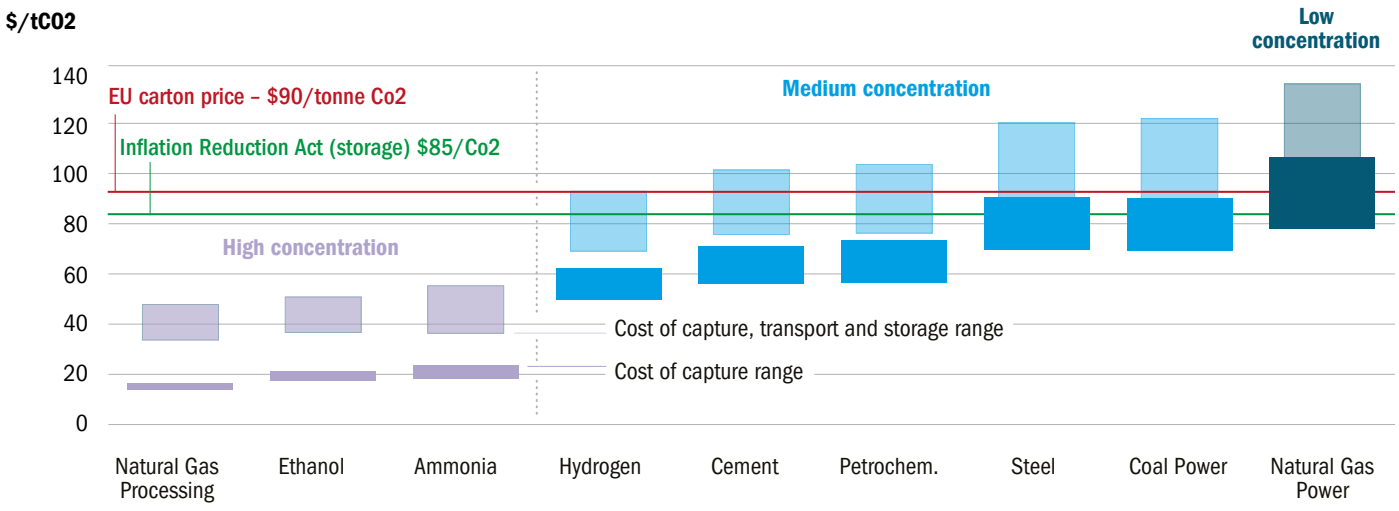
Costs are falling The cost of CCS depends on the industrial application. Those with higher CO2 concentrations are less expensive to capture, while access to transport and storage also factor into the overall cost. Thanks to IRA tax credits, CCS projects for highly concentrated CO2 streams such as those from natural gas, ethanol, and ammonia are now profitable. The economics are also vastly improved for less-concentrated industries such as cement and steel (Figure 3).

Technology will also play an important role in reducing the costs around CCS. But with most capture technologies still in the early stages, their bespoke nature means cost declines are likely to be gradual. As part of our ongoing research, we are continuously monitoring the space for both incremental and breakthrough improvements in technology.

The most commercialised type of carbon capture technology is chemical absorption with liquid solvents. Here, cost-reduction efforts are focused on developing solvents that can last longer at lower temperatures, and on re-engineering the absorber. Some private players estimate that these efforts could lead to a 30%-50% cost reduction in the next five years[6].

The most commercialised type of carbon capture technology is chemical absorption with liquid solvents

Figure 3: cost of CCS for different industries



Source: BNEF, Columbia Threadneedle Investments, Market Outlook 2023

[6] Svante and Carbon Clean Solutions, 2023

Infrastructure is ramping up Although infrastructure investment is increasing, there remains a chicken-and-egg challenge when it comes to developing CCS. To commit to building storage facilities, companies need to have confidence there will be sufficient capture and transport infrastructure in place. Despite this conundrum, there has been a significant increase in CO2 storage projects announced in the past year. If all of these come online the market will see a greater balance between capture and storage (Figure 4).

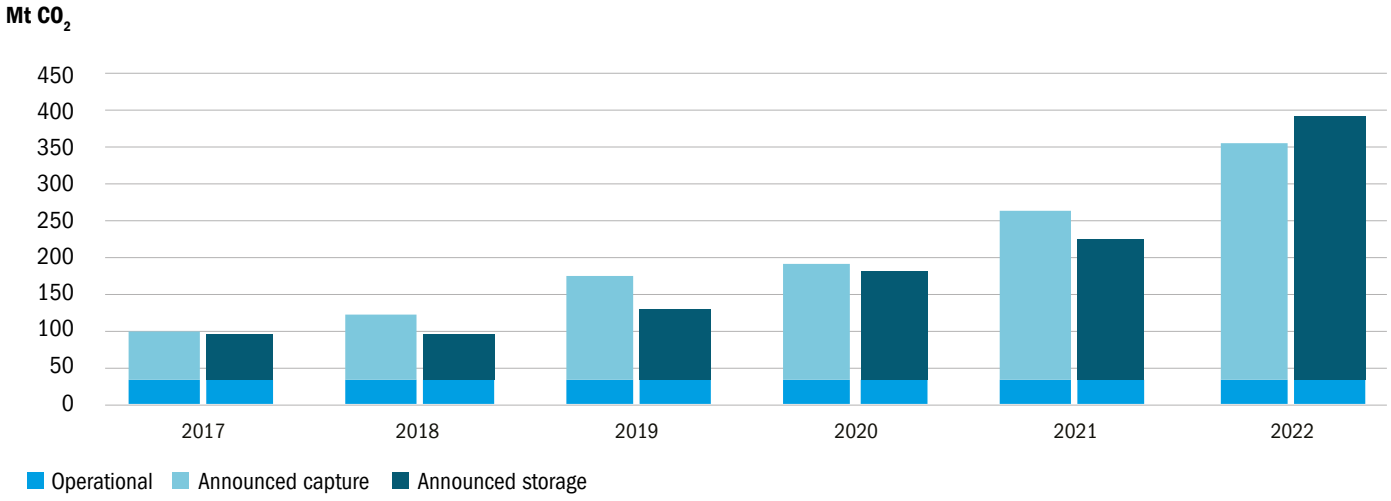
There has also been strong progress on transportation infrastructure in the US. Exxon's acquisition of carbon emissions solutions company Denby[7] in August 2023 gives it access to the largest CO2 pipeline in the US, spanning around 2,000 kilometers and 20 storage sites. The acquisition is viewed as a critical part of Exxon's plan to help develop a large-scale CCS hub in the Houston area. Elsewhere in the US, private infrastructure developers in the midwest are working on three projects across five states to develop CCS hubs for an ethanol production cluster.

Headwinds remain Perhaps the biggest headwinds to building CCS infrastructure are the permitting and development processes. This can take up to four years for pipelines and storage facilities, with opposition from local communities delaying or preventing some projects. Even when projects get the green light, they take many years given their complex nature.

While the pickup in transport and storage infrastructure is encouraging, we remain cautious on their ability to keep pace with the growth of the capture sector. For the CCS market to scale effectively, all three components need to grow in tandem.

Permitting and development processes can take up to four years for pipelines and storage facilities

Figure 4: Operational and announced capture and storage capacity



Source: IEA, 2023

[7] Mention of specific stock is not a recommendation to buy or sell

Significant investment required

While CCS is promising, it also requires significant investment. The IEA estimates $1 trillion in investment is needed by 2030 and $3 trillion by 2050.[8] The required scale opens up significant opportunities for investors, but there are economic and execution challenges. Figure 5 outlines the key challenges and catalysts.

Figure 5: challenges and catalysts

Execution

Challenges	Catalysts
1. **"The known unknown":** Lack of transport and storage infrastructure 2. **Slow licensing/permitting process key bottleneck (3/4 years):** federal and regional differences. Attaining state level permits over the next year appears to represent the key hurdle for project development 3. **Operational risk: Leakage concerns** Extensive knowledge of geology and storage location required, analysis of seismic data and monitoring is essential 4. **Completion risk: A CCS project may take a decade** to progress from concept to operation due to the amount of studies, assessment and complexities of negotiating commercial agreements with number of parties involved 5. **Local opposition: do not underestimate this challenge!** Early engagement/outreach programmes between developers and communities can reduce this risk 6. **Supply chain risk: materials, labour shortage** "the unknown unknown"	**Short-term:** ■ Reform EPA timelines for US Class VI injection wells permitting ■ Approval for state primacy for Louisiana, Texas: representing ~20% US total emissions **Near/medium-term:** ■ Completion of large-scale projects, expected in next 2-3 years

Economic

Challenges	Catalysts
1. **High and uncertain costs for most CCS applications** Many capture technologies still in demonstration phase Large capex requirements Energy and water intensity could drive high opex Demand uncertainty 2. **Project financing** 45Q clarity will likely be required to sign project-level financing Questions around project viability: those that are "chasing just credits" and which might be in the wrong place	**Short-term:** ■ IRA guidelines on implementation ■ Expansion CCS networks, clusters, corporates' partnerships ■ More Government funding, financial incentives by more countries ■ Development voluntary carbon market ■ Increase utilisation – demand of CO2 as a product

[8] IEA, Net Zero by 2050, May 2021

Opportunities are emerging

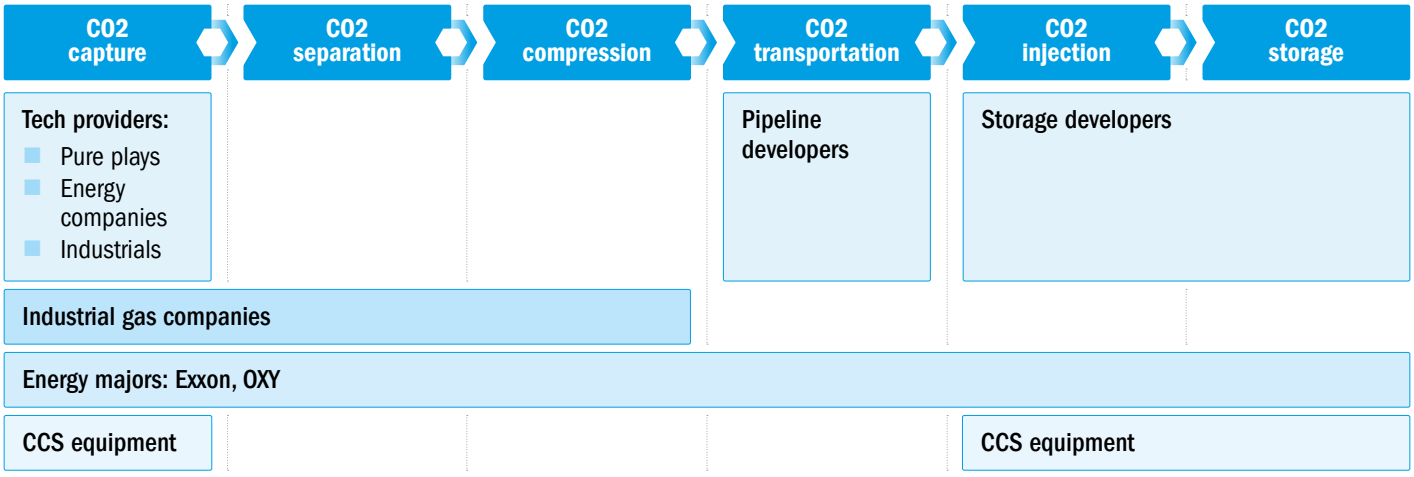
CCS is a multi-decade theme that provides investment opportunities across the value chain, from capture to transport to storage (Figure 6). The US offers the most supportive policy environment and the most attractive investment opportunities, in our view.

At present, spending on CCS is dominated by oil and gas majors like Exxon and Occidental Petroleum, and by industrial gas companies including Linde and Air Liquide. We believe such players are best positioned to capture future market growth.

However, there are many other potential beneficiaries and a variety of investment opportunities to suit different risk tolerances and return targets. Examples include pure-play companies working on the next generation of capture technology, pipeline developers repurposing existing infrastructure, and specialty providers focused on seismic data, design, monitoring and equipment manufacturing.

The US offers the most supportive policy environment and attractive investment opportunities

Figure 6: the CCS value chain



Source: Columbia Threadneedle Investments

Conclusion

CCS has the potential to play a major role in delivering ambitious emission-reduction targets. After many years of halting progress, we are encouraged by increased investment in CCS infrastructure on the back of supportive policy and improving economics. However, caution is warranted as bottlenecks remain. For those looking to invest in CCS opportunities, a deep understanding of the technologies, policies, projects and constraints should underpin selective investment decisions.

Get to know the author

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Natalia joined the Thematic Research team in 2020 and focuses on analysing the investment risks and opportunities coming from climate change and the energy transition across sectors and companies. She collaborates very closely with investment teams and engages with companies exposed to these themes. Previously, she worked as a credit analyst at Goldman Sachs. She also teaches sustainable finance at business schools.

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