Supercritical

Novel CDR

Q1 2025

Novel methods such as DACCS, BECCS, mineralization, and biomass storage are essential to achieving permanent carbon removal.

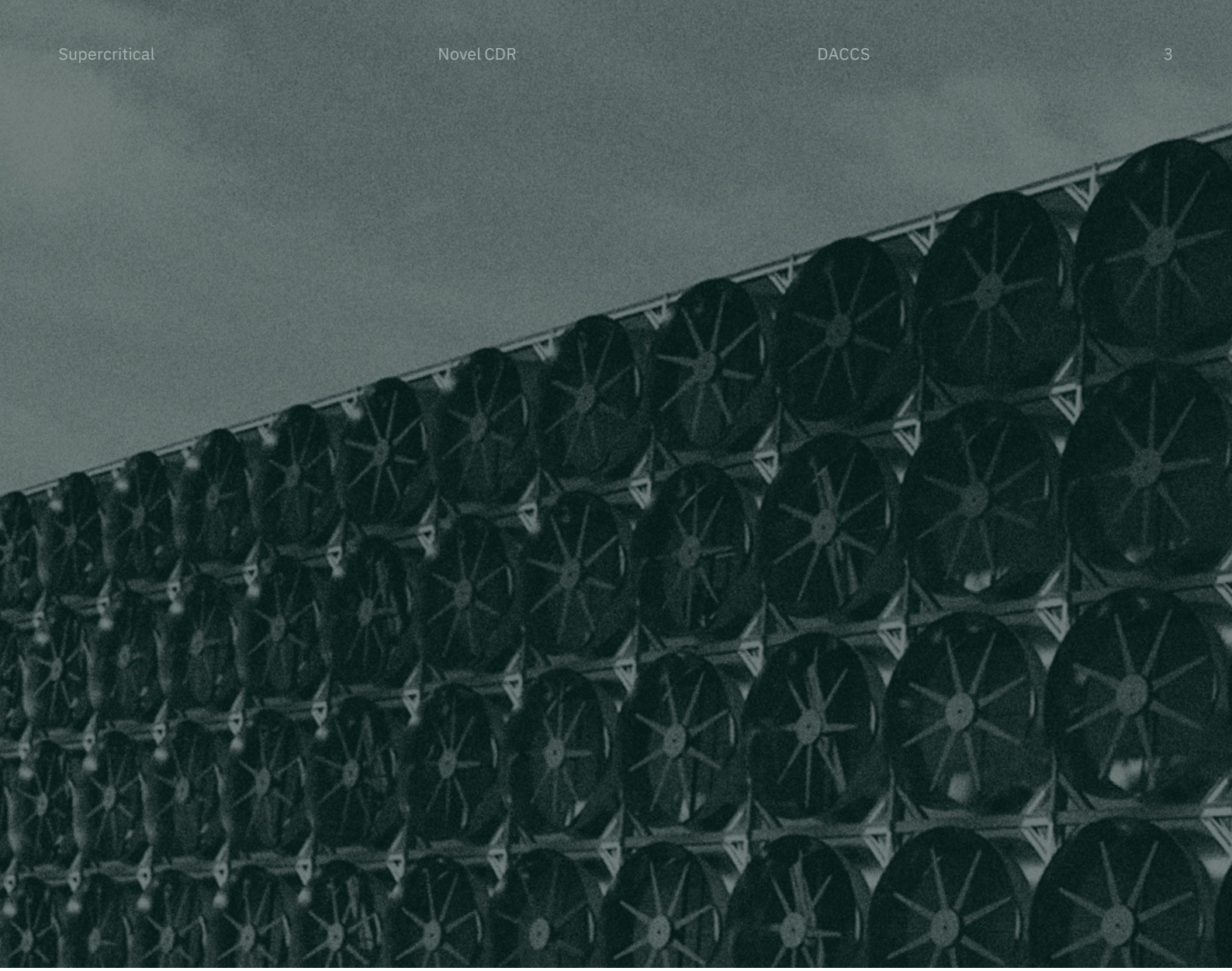
Introduction

Carbon dioxide removal (CDR) technologies are essential to achieving net zero by 2050. We need more than one method to scale in order to 14,000x the carbon removal market and get to the gigatonnes scale needed to reach net zero by 2050. To do this, we need to scale a few methods to the 1-2 gigatonne range, rather than relying on a single method to reach 10 gigatonnes.

Although biochar is leading the way in availability and scalability so far, emerging novel methods such as direct air carbon capture and storage (DACCS), bioenergy with carbon capture and storage (BECCS), mineralization, and biomass storage are essential to achieving permanent carbon removal. Major policy, guidance and standards, such as Science Based Targets Initiative (SBTi), are increasingly emphasizing the importance of permanent CO_2 storage. These methods are critical to the future of CDR and net-zero strategies. Despite their promise, these methods vary significantly in cost, scalability, technological readiness, and market adoption.

	DACCS	BECCS	Mineralization	Biomass storage
Average price*	$892/t	$406/t	$273/t	$230/t
Tonnes purchased to date**	2,189,257	10,767,640	162,329	360,134
Tonnes delivered**	156	10,000	3,090	10,270
Tonnes retired**	700	0	1,245	6,817
Number of active projects***	25	13	11	8
Number of pending projects***	139	9	15	5
Average number of transactions per month**	6.25	3.8	6.71	5.55
Average size of transaction (tonnes)**	6,889	201,621	709	1,927

* Based on research including data from Allied Offsets
** CDR.fyi
*** Supercritical defines an active/pending project as a project that has/has not displayed evidence of actively selling carbon credits, including recorded transactions (whether delivered, retired, or undelivered) and any evidence online of sales.



Direct air carbon capture and storage (DACCS)

DACCS captures CO_2 directly from the atmosphere using chemical solvents and sorbents. The captured CO_2 may then be stored in a variety of storage locations, including geological formations, deep saline aquifers, depleted oil and gas reservoirs, or mineralized into stable carbonates. While DACCS represents the most energy-intensive and high-cost method, it offers incredible CO_2 permanence.

$892/t

Average cost

“Buyers considering DACCS should prioritize offtake agreements to support infrastructure growth and secure future supply.”

Cost: DACCS is currently the most expensive method, with costs averaging $892/t in early 2025. However, companies like Climeworks and 1PointFive are scaling up, supported by long-term offtake agreements with companies like Microsoft and Stripe.

Market insights: Only 156 tonnes of DACCS credits have been delivered, highlighting its nascent stage in project development. However, DACCS sees significant interest, with an average transaction size of 6,889 tonnes, 25 active projects globally, and 139 pending projects. Although of these 139 pending projects, many will offer less than 100 tonnes/year, and others will convert CO_2 into fuels instead of providing CDR. Despite the high costs, the average number of transactions per month suggests steady demand growth, signaling that buyers are betting on DACCS’s scalability and permanence.

Strengths: DACCS offers high permanence and scalability, critical for addressing residual emissions, as well as ease of monitoring, reporting and verification (MRV) compared with other CDR methods. Co-location with renewable energy sources can reduce energy intensity.

Challenges: High upfront costs and energy requirements remain barriers. Additionally, DACCS’s effectiveness hinges on its integration with long-term carbon storage solutions. Regulatory and logistical hurdles for CO_2 transport and storage also persist.

Alongside these challenges, recent political developments in the US have created further uncertainty. With the current US administration announcing plans to suspend the Green New Deal and IRA funding, DACCS projects relying on 45Q tax credits may be re-evaluating their viability. These shifts could slow progress for DACCS projects in the US, which had previously been a major hub for innovation and investment.

Still, DACCS represents a critical investment area for long-term decarbonization, particularly for sectors with unavoidable emissions. Buyers considering DACCS should prioritize offtake agreements to support infrastructure growth and secure future supply.

Bioenergy with carbon capture and storage (BECCS)

BECCS captures CO_2 released when biomass is converted into fuels or directly burned to generate energy and stores it for extremely long durations, achieving net-negative emissions. BECCS solutions show mid-range costs but rely on specific infrastructure and feedstock availability.

$406/t

Average cost

Cost: The average cost of BECCS is $406/t as of 2025. While not the highest-cost option, BECCS represents a significant investment for many buyers. Projects like Red Trail Energy and Ørsted's Avedøre facility are scaling to capture 150,000+ tonnes of CO_2 annually.

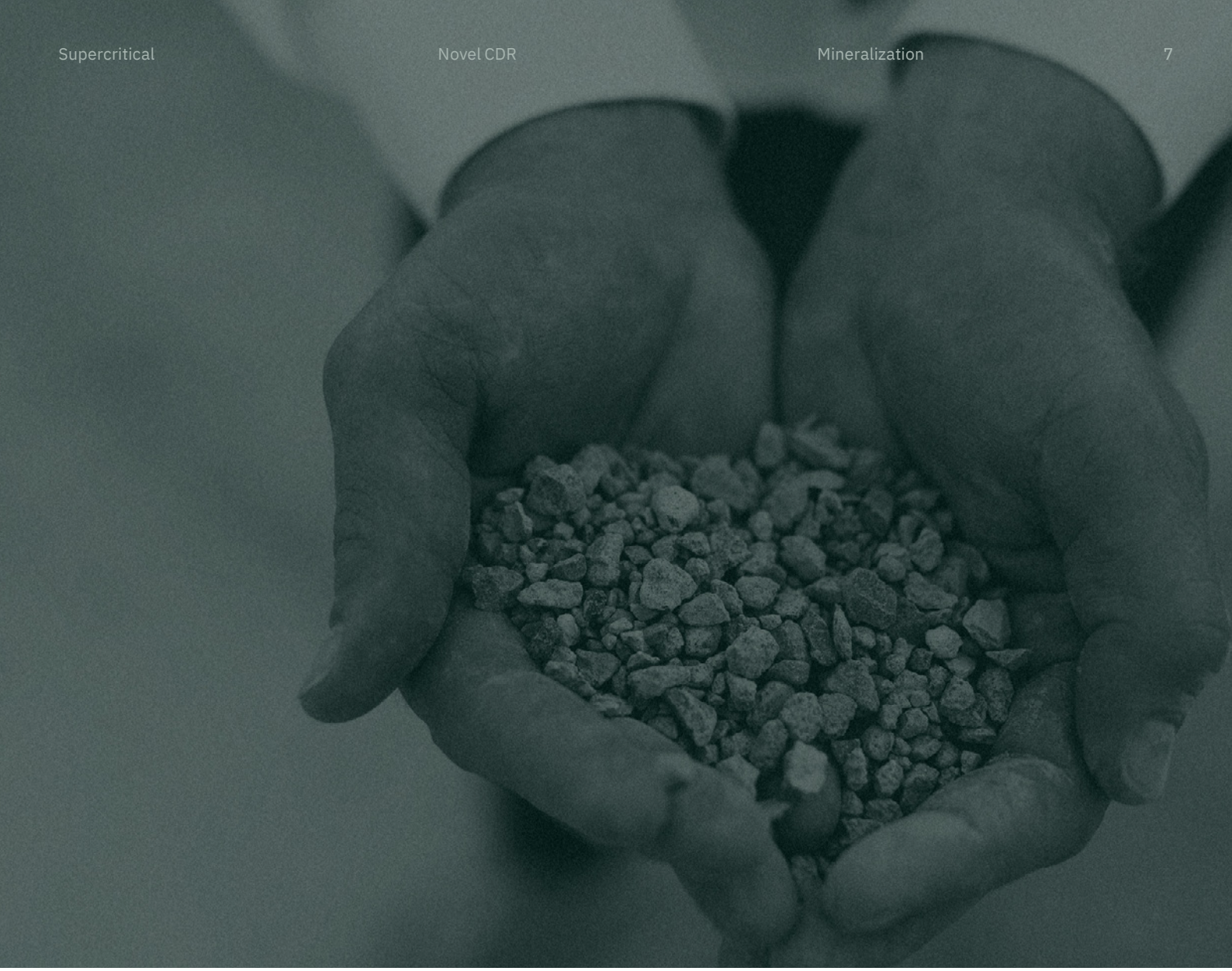
Market insights: With 13 active projects and an average transaction size of 201,621 tonnes, BECCS demonstrates significant potential for scaling. BECCS has sold considerably more tonnes than DACCS, biomass storage, and mineralization combined, but most of these have come from just a handful of buyers. Its price is much more competitive than that of DACCS. Only Red Trail Energy, which has been exploring geological storage since 2003, has delivered any tonnes, suggesting that most transactions are likely offtakes of forward purchases. BECCS also has a relatively high number of operational projects, reflecting its potential scalability, but with only one supplier delivering credits, the method is still early-stage in nature.

Strengths: BECCS leverages existing bioenergy infrastructure, creating a clear method to scale. It offers additional co-benefits, such as renewable energy generation.

Challenges: Concerns over land use, feedstock sustainability, and competition with food production must be addressed. Regulatory and logistical hurdles for CO_2 transport and storage also persist.

“BECCS has substantial scaling potential but requires robust frameworks to ensure sustainability and permanence.”

BECCS has substantial scaling potential but requires robust frameworks to ensure sustainability and permanence. Buyers should evaluate project quality criteria carefully and consider offtake agreements to support these high-potential projects.



Mineralization

Note: We have only considered mineralization from biogenic CO_2 sources, such as biogas production, and not CO_2 directly from the atmosphere. ERW is excluded from the dataset.

Mineralization accelerates the natural reaction between CO_2 and alkaline materials to form stable carbonates, locking carbon away for millennia. Mineralization projects often are miscategorized as carbon capture rather than true carbon dioxide removal (CDR) as many projects are co-located with cement production. However, projects can operate in both CCS and CDR capacities when the CO_2 point source is biogenic or atmospheric in origin, which buyers should carefully assess.

$273/t

Average cost

Cost: Costs are generally mid-range, averaging $273/t, but they vary widely, from $170 to $495, reflecting the diversity of project types utilizing biogenic sources of CO_2. The average price for mineralization using atmospheric CO_2 is $1,192.

Market insights: Mineralization has delivered around 3,000 tonnes to date. With 11 active projects, an average transaction size of 709 tonnes, and 6.71 transactions per month, the method is showing consistent market activity despite smaller deal sizes.

Strengths: High permanence and potential co-benefits, such as producing valuable construction materials, enhance its appeal. Ease of MRV (compared to enhanced rock weathering).

Challenges: Mineralization is location-dependent because it requires the biogenic CO_2 point source, other key feedstocks, and the mineralization site to be close together.

Mineralization is highly attractive due to its ability to deliver tonnes and its exceptional scalability. Many projects are already operational and actively selling credits, though the surprisingly low number of transactions to date may represent an untapped opportunity or indicate difficulties in communicating the concept of mineralization to buyers.

Although not included in this dataset, enhanced rock weathering (ERW), a subset of mineralization, has garnered attention from buyers but has faced notable MRV challenges recently. The ERW scientific methodologies and recommended measurement techniques are continually evolving, introducing potential delivery risks. Buyers interested in ERW, in particular, should ensure their purchases are backed by robust evidence and maintain close relationships with registries to stay informed about evolving verification standards.

Mineralization provides a permanent solution for carbon storage, making it an ideal choice for buyers seeking long-term climate impact. Understanding the associated delivery risks is critical—Supercritical actively monitors these developments and can guide buyers toward high-quality, credible opportunities.

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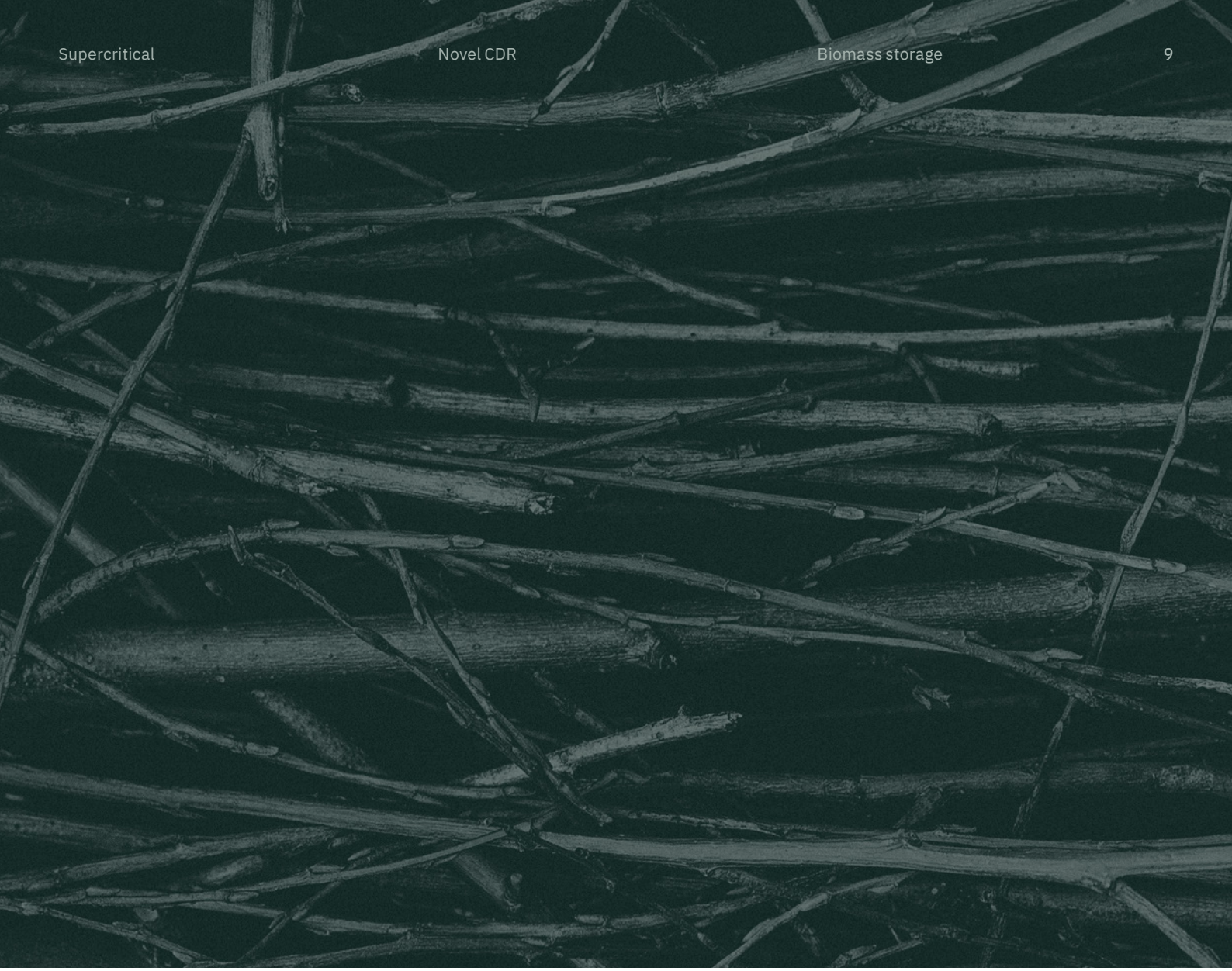

Biomass storage

Note: Injection of bio-oil could be considered within this category however, due to the small number of data points and high cost, it has been excluded from this analysis.

This method involves the direct burial of biomass in storage sites. Biomass storage includes techniques ranging from woody biomass burial to algae burial to slurry injection. Like BECCS and mineralization, biomass storage solutions show mid-range costs but rely on specific infrastructure and feedstock availability.

$230/t

Average cost

Cost: Biomass storage is the lowest-cost category of the novel methods discussed here, averaging $230/t, offering a more cost-effective solution with moderate permanence. But these costs can range from $47 to $850 per tonne.

Market insights: 10,270 tonnes of biomass storage credits have been delivered. With 8 active projects, an average transaction size of 1,927 tonnes, and 5.6 transactions per month, the method appeals to a wide range of buyers.

Strengths: Biomass storage provides a cost-effective carbon removal solution with high permanence.

Challenges: Biomass storage faces scalability challenges due to project size limitations, feedstock variability, costly supply chains, and storage and handling difficulties. Additionally, some projects have raised concerns regarding environmental co-benefits, necessitating stringent quality controls and infrastructure investments. Further, biomass storage sites may be vulnerable to carbon removal reversal. Projects require long-term plans to ensure the stored biomass is not extracted in the future.

“Buyers should prioritize high-quality projects to lock in supply at favorable prices and drive future scaling.”

Biomass storage is an attractive option for novel CDR, but projects can vary significantly in price, process, and quality. While biomass storage projects have not yet sold as many tonnes as BECCS or DACCS, their ability to deliver credits at lower costs makes them appealing. It is also worth noting that the smaller size of biomass storage projects means more sites will be required to achieve the same credit volumes as larger-scale methods like DACCS or BECCS, highlighting the need for continued development and investment in small scale solutions like biomass storage. Buyers should prioritize high-quality projects to lock in supply at favorable prices and drive future scaling.

Conclusion

Novel carbon removal methods like DACCS, BECCS, mineralization, and biomass storage are pivotal to scaling the CDR market. Each method offers unique advantages and challenges, and buyers should tailor their approach based on their goals and priorities:

- **BECCS appears the most attractive for buyers starting their CDR journey**, though most transactions will likely be offtakes. BECCS projects are large scale and require high upfront capital investment and infrastructure. Large offtake agreements can significantly reduce risks for both project developers and buyers. The high average transaction size also makes BECCS a potentially lucrative investment if secured early.
- **DACCS boasts the highest number of operational projects**, but like BECCS, transactions are primarily offtakes. Despite its high costs, its permanence and scalability make it an essential long-term option.
- **Mineralization is delivering credits with a reasonable number of active projects.** While its diversity and scalability are strengths, its cost makes it a more premium option.
- **Biomass storage is the most cost-effective** of these novel CDR methods. The smaller project sizes mean more sites are required to match the credit volumes of larger-scale methods like DACCS. This highlights the need for careful vetting and continued investment to scale high-quality projects effectively.

Supercritical's marketplace gives buyers visibility into the highest-quality projects and access to the latest innovations in carbon removal. Buyers must act decisively now to secure high-quality supply, mitigate delivery risks, and catalyze the scale needed to meet future demand.

Supercritical

Supercritical: access the carbon removal market with confidence

Supercritical is the gateway to the carbon removal market. One-third of corporate buyers, including The Economist, Virgin Atlantic, and Rothschild & Co use Supercritical's marketplace to navigate the market, build portfolios of high-quality vetted projects, and securely transact across spot purchases and offtake agreements.

Supercritical is the marketplace of choice for visionary companies with ambitious climate goals that need to be met today, not decades from now.

Request access to the Supercritical marketplace

Speak with one of our carbon removal experts