

# Biochar

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# Executive summary

01

The latest IPCC reports tell it all—we can decarbonize industry, switch to renewables, and drive electric vehicles, but we still need to remove 10 billion tonnes of CO<sub>2</sub> from the air each year by 2050 to stay below 1.5°C of warming. To do this, the carbon removal market must scale by 14,000x in the next 26 years.

Michelle You  
CEO and Co-Founder  
of Supercritical



Businesses are beginning to understand that net zero is a strategic business imperative and that they are required to buy carbon removal credits to get there: one credit equals one tonne of carbon verifiably removed from the atmosphere and permanently sequestered in long-term storage. Avoidance offsets don't count towards net zero.

But businesses lack transparent carbon removal market data to set procurement strategy, resources and expertise to do diligence on carbon removal projects and appropriately assess risk, and the legal expertise to negotiate complex contracts—a critical workflow in a purchase fraught with climate, environmental, and delivery risk. At the same time, carbon removal is rapidly moving towards serious supply constraints, where buyers will struggle to source the carbon removal credits they need. Businesses need to act now but lack the time and expertise to procure carbon removal credits with confidence.

I founded Supercritical, the leading carbon removal marketplace, to solve the problem of transparent, trusted, and secure access to the carbon removal markets. We've already helped one-third of corporate buyers enter the market, but we must go further. Biochar has rapidly emerged as the most accessible and scalable permanent carbon removal solution, with an average cost of \$176 per tonne over the next two years and representing 81% of total sales in Q1 2024. But not all biochar is created equal, presenting pitfalls for buyers. We can't allow CDR to succumb to the same reputational damage as the broader VCM.

Supercritical's upcoming launch of live pricing, availability, and capacity for the biochar category of our marketplace aims to solve this. For the first time ever, buyers will have a single place they can go for a transparent view of the entire biochar market, access to high-quality vetted credits, and simple, secure transactions.

This report synthesizes a snapshot of our upcoming live biochar marketplace data into a series of insights we hope will help buyers make more informed purchasing decisions.

# About this report

02

## The science has spoken—if we don't reduce emissions and remove carbon in tandem, we won't reach net zero by 2050.

The latest IPCC report estimates that we must remove 10 billion tonnes of CO<sub>2</sub> from the air per year by 2050 to stay below 1.5°C of warming. In the absence of government mandates on carbon emissions, rallying the VCM (voluntary carbon market, that's you) is our best tool for scaling current carbon dioxide removal (CDR) capacity to necessary levels in the next 26 years.

“the voluntary carbon market, is our best tool for scaling current carbon dioxide removal capacity to necessary levels in the next 26 years”

The CDR market is still in its infancy, and like many nascent markets, is characterized by a lack of transparency and limited access to information. There is no single source of truth for pricing, availability, and capacity data—crucial information that sustainability leaders need to set and reach their climate goals. Until now.

# 80%

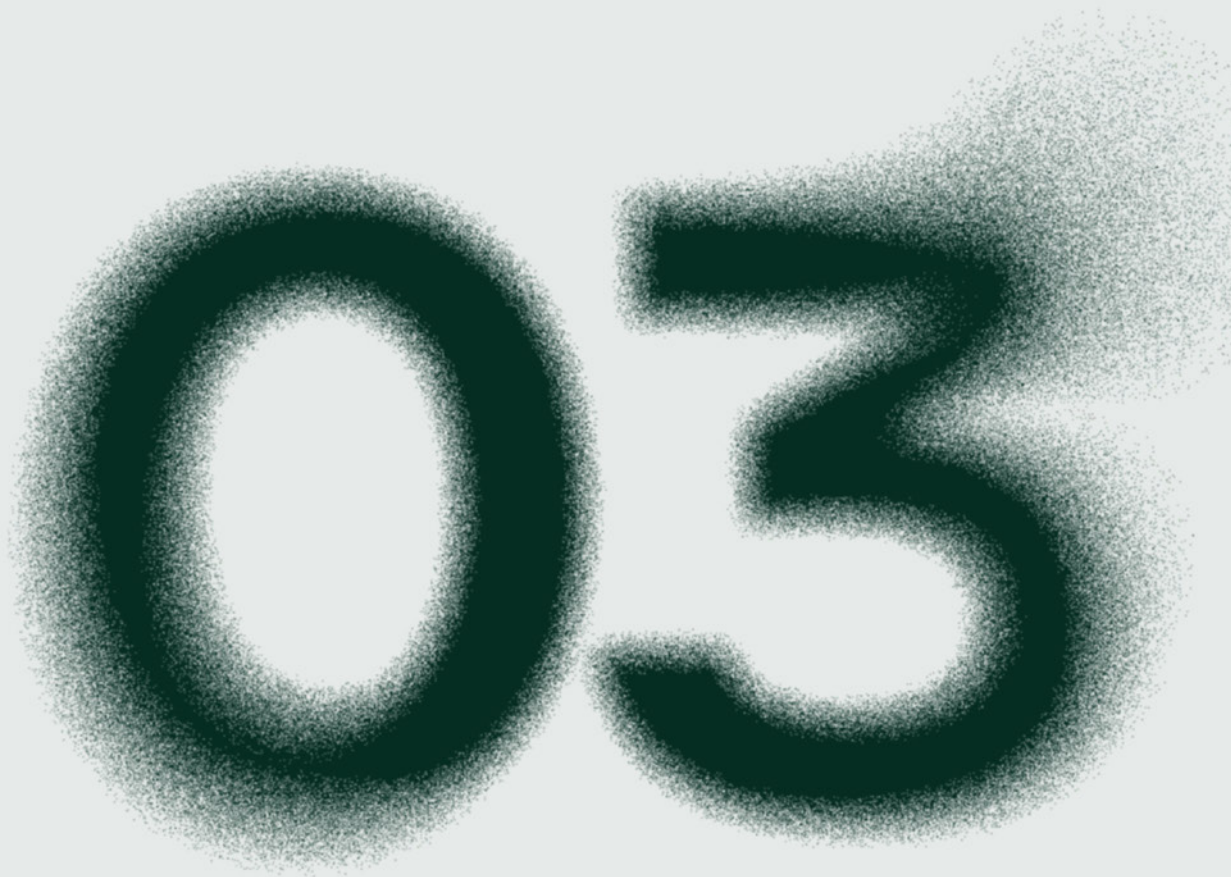
of the global biochar volume is listed in the Supercritical marketplace

Supercritical's mission is to scale the carbon removal market to the gigatonne capacity essential for meeting our 2050 net-zero targets. We operate a multi-pathway carbon removal marketplace to match demand with supply, acting as a trusted source and intermediary for risk-aware buyers. By mapping the entire CDR market, our marketplace is the only one to offer a single view of capacity, availability, and pricing across multiple carbon removal pathways.

Biochar is our leading category by volume of purchases and availability, with 80%\* of the global volume listed in our marketplace. Leveraging our live proprietary marketplace data from our listed projects, we're able to provide insights like those in this report. The report aims to bring increased market clarity for businesses at all stages of their carbon removal journey and facilitate the carbon removal decision-making process. We hope that these insights can help all buyers make knowledgeable, confident decisions that align with their net-zero strategies.

*\*Data covers 80% of global biochar volume as of March 2024.*

# What buyers need to know



# Challenges

- 1 Buyers don't know where to start.** There's a steep learning curve when entering the carbon removal market, leaving many buyers wondering which methods they should adopt.

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  - 2 Quality concerns hold back buyers.** Last year, major publications revealed that most carbon avoidance credits are fraudulent, which left buyers rightly concerned about facing the reputational damage experienced by early entrants to the VCM.

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  - 3 Buyers either aren't aware of delivery risk or do not know how to assess it.** This is a looming problem because carbon removal credits are frequently purchased in forward and offtake agreements, with delivery much later than the transaction.

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  - 4 Transactions are complex,** and buyers usually write multiple contracts for each, taking up significant time and resources. This is especially apparent when mitigating pricing and delivery risk across ex-ante delivery dates with forwards and offtakes.

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  - 5 Most buyers are unaware of the complexities of mitigating the risk of future pricing changes** and delivery risk within contracts, which opens them up to risk even if they've done due diligence.

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  - 6 Carbon removal is a new, globally distributed market.** Transacting with projects somewhere in a distant location is inherently risky.
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Biochar is a charcoal-like material rich in stable carbon.

## Price and demand

# \$176

The average spot price for biochar carbon removal credits that are available in 2024 and 2025 is \$176.

# \$220

Low-quality biochar (which failed our vetting criteria) has an average spot price of \$153 compared to \$220 for high-quality biochar available on the Supercritical marketplace.

# 41%

There is a clear concentration of demand for the highest-quality projects—only 13% of credits in low-quality biochar projects for 2024 and 2025 have sold, compared to 41% of credits in high-quality projects.

# 37%

As the supply of top-quality projects begins to dwindle, buyers are moving toward long-term offtakes to secure future supply. Buyers who are willing to purchase in bulk and pay upfront can receive discounts of up to 37% on their deals.

## Market growth, capacity, and quality

# 30x

Our marketplace data highlights 30x growth in the number of biochar credits by 2028, driven by a huge (68x) increase in credits that fail our vetting protocol and only a 9x increase in credits that have passed.

# 42%

By 2026, the biochar market is expected to reach a capacity of 2.86 MT, with only 1.2 MT— 42%— passing our vetting process. This is in stark contrast to 2028, where only 12% of new biochar capacity will meet our vetting criteria, with the remaining 88% considered low-quality.

# MRV

The majority of the increase in credit capacity fails our vetting process due to being artisanal biochar projects, which often fail monitoring, reporting, and verification (MRV) due to their distributed model and challenges with methane emissions from feedstock.

# USA

While India and some countries in Sub-Saharan Africa are starting to develop projects at scale, the US still dominates the market.

# 1/3

of corporate buyers  
purchase from Supercritical

Precisely because of this complex landscape, 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. To learn more, [sign up for our marketplace](#) or [speak with one of our carbon removal experts](#).

# Biochar insights

04

Biochar is the most accessible permanent engineered carbon removal method available today. However, demand is concentrated on high-quality credits, which will experience a supply shortage in the near term. Many ambitious suppliers are ramping up their output to help grow capacity, but we're not confident in the quality being produced.

The feedstock to produce biochar is typically waste biomass. That is then heated in an oxygen-limited environment. This process is called pyrolysis.



## Biochar is the most accessible, scale-ready CDR solution

Investment in the CDR market has surged to a staggering [\\$2.6 billion to date](#), with nearly half that amount—[\\$1.23 billion](#)—[invested in 2023 alone](#). While we're moving in the right direction, the current supply and affordability of viable and scalable solutions remain relatively limited. This underscores the need for a more immediate solution.

Biochar has emerged as the most accessible and scalable permanent CDR pathway, with a high TRL (tech readiness level) and low price

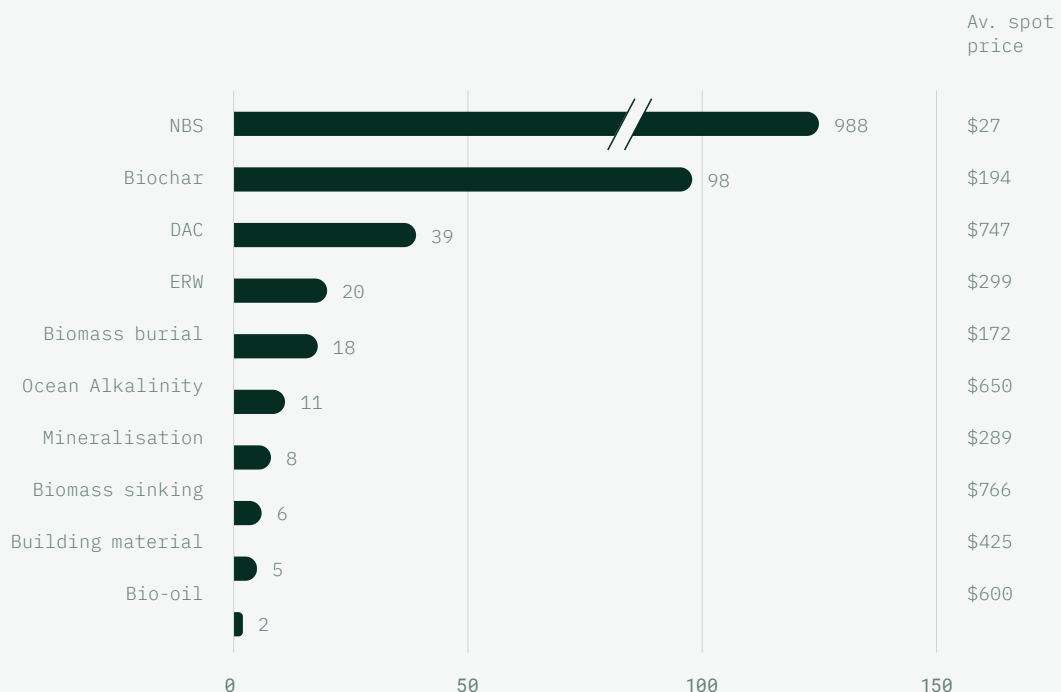
relative to other engineered solutions. With an average spot price of \$176, biochar is the cheapest removal method after nature-based solutions, which average \$27. This places it well below the next removal methods in our marketplace, like mineralization at \$289, ERW (Enhanced Rock Weathering) at \$299, and building material at \$425. Due to its low price relative to other removal methods, biochar has attracted significant interest from buyers and new suppliers.

Biochar also dominates in terms of availability, accounting for nearly 50% of engineered removal solutions listed on our marketplace.

## “biochar provides buyers the most value of all current removal methods”

However, the market is highly fragmented—most of the producers are small-scale projects owned by private entities, which makes transparent market data, vetting, and monitoring a major challenge. Our goal is to drive further investment in the biochar space to scale future capacity and increase transparency because it provides the most value to buyers compared to other removal methods. buyers the most value of all current removal methods.

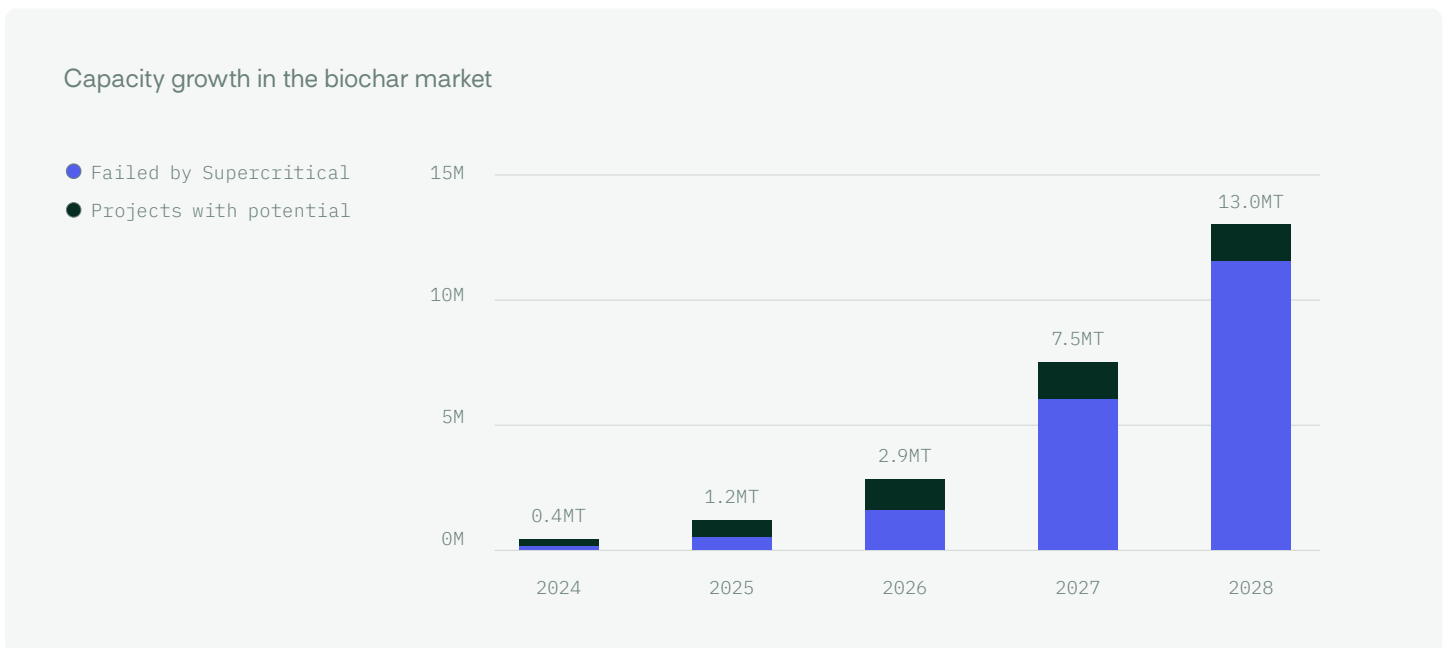
Number of projects and pricing by method



## Biochar is booming but growth is dominated by low-quality

Biochar supply is expected to grow rapidly over the next few years. Supercritical's marketplace data predicts significant growth in global biochar capacity, an expected 0.43M MT in 2024, increasing to 2.86M MT by 2026—a 160% CAGR. Biochar's potential as a carbon removal method is massive.

However, most of the expected growth comes in the form of low-quality projects—58% of expected capacity by 2026 fails Supercritical's strict vetting protocol, driven by a small number of lower-quality projects with ambitious scaling plans. While global capacity is expected to reach 13.0M MT by 2028, the share of projects that fail grows to 88%.



# 160%

compound annual growth rate in global biochar capacity expected between 2024 and 2026

CDR must avoid the fate of the avoidance market, where fraud and greenwashing are rampant. The concentration of low-quality growth is a worrying indicator for the future of biochar. There must be a market-wide shift toward the production of high-quality credits. In the meantime, buyers must work with trusted sources to inform and execute their CDR strategies and be extra vigilant as they engage in procurement.

See [Why biochar projects are failing Supercritical's vetting protocol](#) for failure reasons and more on our vetting protocol.

## Buyers are flocking to quality and willing to pay for it

In response to a turbulent 2023 plagued with reports of greenwashing for avoidance credits, serious buyers are committing to quality and real climate impact in their carbon removal purchasing strategies. [According to CDR.fyi](#), “80% of CDR buyers in 2024 are budgeting over \$100/tonne for durable CDR, a price 67% still expect to pay by 2050.”

Spot price and % sold split by Supercritical vetting outcome

● Fail  
● Pass



“80% of CDR buyers in 2024 are budgeting over \$100/tonne for durable CDR, a price 67% still expect to pay by 2050”

[CDR.fyi](#)

### Pricing

The average price for credits that did not pass Supercritical vetting is \$153, 30% lower than the average of \$220 for credits that passed.

### Demand

In 2024 and 2025, only 13% of credits from projects that did not pass our vetting process have been sold in advance, compared to 41% for projects that passed.

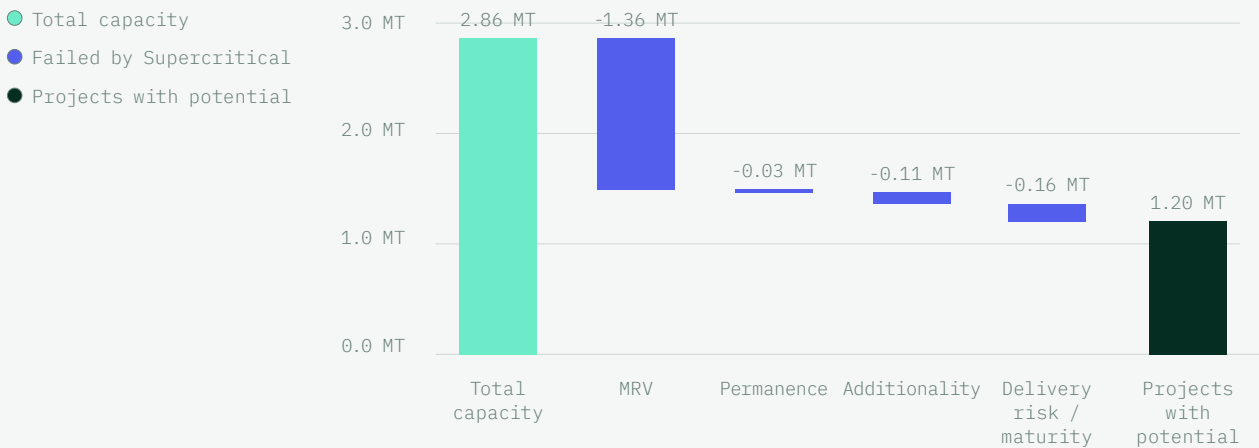
Buyers have a clear preference for high-quality biochar, leading to a concentration of demand for top-tier projects. This has implications for high-quality biochar supply in the near term: if most buyers want quality and are willing to pay for it, there is an impending supply crunch until more quality supply comes on the market. Buyers on the sidelines do not have the luxury of inaction if they're serious about net zero. To lock in their supply and drive future capacity growth, buyers must take immediate action via long-term offtake agreements.

## Why biochar projects are failing Supercritical's vetting protocol

Though the biochar market is set to expand to over 11M MT by 2028, more than 88% of the expected future biochar capacity did not pass our vetting protocol. As this market is so nascent, let's consider a capacity breakdown for biochar at a closer date: 2026.

The total capacity is expected to reach 2.86M MT by 2026, but only 1.2M MT, about 42%, passed our initial vetting process and are classified as projects with potential. The remaining 58% failed for the following reasons:

2026 biochar capacity by Supercritical fail reason



### Artisanal biochar and MRV (Monitoring, Reporting, and Verification)

# 47.5%

of the upcoming biochar capacity originates from artisanal biochar projects

1.36M MT, or 47.5%, of the upcoming biochar capacity originates from artisanal biochar projects. These credits are linked to thousands of distributed smallholder farmers pyrolyzing waste biomass into biochar using low-tech kilns. While these projects can offer socio-economic benefits, there is a significant risk of methane emissions from wet feedstock burned in these kilns, negating the carbon removal activity. This fragmentation makes it impossible to adequately monitor the quality of the feedstock. Consequently, Supercritical does not recommend purchasing these credits yet, and they fail our protocol due to inadequate MRV.



**MRV:** MRV is crucial for biochar vetting because the condition and processing method of the feedstock (biomass) significantly impact the quality of the produced biochar. If the feedstock is not thoroughly dry before burning, it produces methane, which has a significantly higher warming potential than CO<sub>2</sub>, thus undermining the project's carbon removal benefits. Additionally, MRV is essential to ensure that the biochar is properly dispersed in soil, mitigating the risk of it being repurposed as fuel, which would negate its carbon sequestration benefits.

### What is 'MRV'?

MRV is a multi-step process that seeks to prove whether a project has actually sequestered carbon emissions. CDR suppliers first measure the amount of carbon sequestered by a project, compile findings into a transparent, publicly available report, and then submit the report to an external registry for independent assessment and verification. While Supercritical does not

do MRV, we evaluate suppliers based on their approach, including how they measure baseline and reductions in emissions, monitor projects, and report their findings. Projects that do not meet our strict standards for high-quality MRV immediately fail our vetting process.

MRV was low-quality in the carbon avoidance market, which made it difficult to prove the efficacy of any given project.

In its absence, the market was plagued with millions of avoidance credits that were at best greenwashing and at worst fraudulent. To avoid this fate in the broader carbon removal market as it scales, we place significant emphasis on MRV to confirm that each project on our marketplace is high quality.

### Additionality

The biochar market's primary quality issue has historically been additionality. In 2023, 20% of biochar credit sales came from projects listed in the top 20 on CDR.fyi that failed Supercritical's vetting protocol due to additionality concerns.

At the onset of the biochar carbon removal market, most projects were already operational and had existing revenue streams, often as part of industrial biomass waste processing. When the carbon removal markets emerged, these projects began selling carbon credits. While these initial projects were crucial in establishing the biochar carbon removal market by providing necessary early-stage financing, the additionality requirement must now be taken more seriously. Only projects that rely on carbon credits for financing can generate credits that buyers can legitimately use to make compensation claims.

Looking ahead, additionality remains a significant concern. We project that 0.11 MT (3.8%) of future biochar capacity will fail to meet additionality criteria.

#### What is 'additionality'?

Additionality tests whether a carbon removal activity occurs specifically because of revenue from carbon credit sales. It evaluates if the creation of biochar would proceed without

the financial incentive provided by these credits. If a project fails the additionality test, it indicates that the project does not rely significantly or exclusively on carbon credits for funding.

This means the carbon removal activity would have occurred anyway, and therefore, it is not considered additional.

#### Delivery Risk

We determined that 0.16M MT (5.6%) of the capacity had significant delivery risk and, therefore, did not pass our vetting process.

To minimize delivery risk and give our buyers confidence that they will receive the credits they commit to buying, we conduct a thorough analysis of each project, including site operations, team experience, financials, country risk, past performance, and future plans and timelines.

#### What is 'delivery risk'?

Delivery risk measures the likelihood that a project will fail to deliver the credits it has sold. CDR is still a nascent market, which means investments in the space come with some level of risk. Many buyers are aware that they are investing in bleeding-edge science and technology and are already demonstrating a high risk tolerance by engaging in the CDR market. However, the climate leaders we work with often pursue

sustainability goals, such as removing their in-year emissions, and so their delivery risk tolerance is much lower than if they were buying purely to catalyze the nascent market. In fact, delivery risk is often underrepresented in the risk categories buyers prioritize. It's only when the credits they were relying on don't get delivered that it becomes a priority.

Delivery risk is not a significant issue for spot purchases

as they are ex-post and the carbon has already been sequestered. However, CDR purchases are dominated by forward and offtake agreements, where purchases are made for carbon to be sequestered in the future—i.e., ex-ante. These agreements are essential tools for both locking in supply and scaling the market, with credits being ex-ante.

## Permanence

An additional 0.03M MT (1.0%) failed due to lack of permanence.

By testing the chemical stability of biochar, we can determine the decay rate of carbon over 100 years. The resulting value indicates the amount of carbon that remains sequestered by the end of the period. We maintain a decay threshold of 30%, which means that any biochar projects that keep less than 70% of the carbon locked away fail our vetting criteria.

### What is 'permanence'?

Permanence is another key quality metric used to evaluate CDR projects. It helps us gauge whether a particular project is likely to keep carbon out of the atmosphere after it has been sequestered.

Buyers purchasing carbon removal credits expect the carbon being removed to be stored away for a fixed period. If the carbon is re-released, the buyer effectively receives less carbon removal than they paid for.

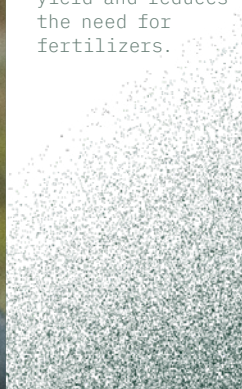
We maintain a high permanence threshold to give buyers confidence that the credits they purchase on the Supercritical marketplace offer long-term sequestration.

## Projects with potential

The remaining 1.2M MT (41.3%) passed our initial vetting protocol and were classified as projects with potential. While they still need to go through additional vetting, this segment represents projects that are currently producing or expected to produce high-quality biochar carbon removal credits.



Mixing biochar with soil prevents it from exposure to burning and re-releasing carbon into the atmosphere. Furthermore, the spreading of biochar on farmland improves yield and reduces the need for fertilizers.



## Offtakes can help budgets be up to 37% more effective and unlock project financing for suppliers

Like other forms of carbon removal, biochar can be purchased via spot, forward, and offtake agreements, depending on the goals and timeline of your CDR strategy. Buyers who commit upfront to large purchases of biochar credits can receive significant discounts while supporting projects with bankable contracts. This can help boost growth and accelerate maturity.

Discount vs. spot price for deal size and payment terms

Total deal size (tonnes)	Percentage of order paid upfront		
	0%	50%	100%
5,000	5%	15%	24%
10,000	8%	19%	27%
25,000	13%	22%	29%
50,000	18%	30%	37%

“demand for top projects grows in contrast to the dwindling supply of high-quality spot credit...this underscores the importance of early and long-term investment”

As demand for top projects grows against the dwindling supply of high-quality spot credits, a growing number of buyers are driving future capacity growth by seeking long-term offtakes—commitments to purchase credits that have not yet been produced—and even receiving discounts of up to 37% depending on deal size and amount paid upfront. This underscores the importance of early and long-term investment.

# What this means for a buyer in biochar



## Biochar holds immense promise as a scalable carbon removal solution, but its success hinges on maintaining high standards and transparency.

The influx of low-quality biochar is concerning, and we cannot allow biochar to suffer the same reputational damage that has plagued the avoidance market. Stringent quality standards and increased transparency are crucial moving forward.

At the same time, carbon removal is rapidly approaching serious high-quality supply constraints, making it increasingly difficult for buyers to source the carbon removal credits they need. Reputational risk and inconsistency in quality make it challenging for buyers to act. However, buyers cannot afford to delay their entry into the carbon removal market, and sustained corporate commitment to long-term carbon removal is vital for required market growth.

This report emphasizes the necessity of robust due diligence across climate science, environmental impact, delivery risk, and social benefits, especially when securing long-term offtake agreements. Buyers should partner with specialists to navigate these complexities effectively.

# “The market will only grow if we make it easier and safer to make the first purchase”

The market will only grow if we make it easier and safer to make the first purchase. That is Supercritical’s primary focus, and this report highlights its critical importance. In June 2024, Supercritical will launch live pricing, availability, and capacity data for our biochar category, with Nature-Based Solutions (NBS) following later in the year.

[Request access to the Supercritical marketplace](#)

# 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](#)