



 EMERGING TECH RESEARCH

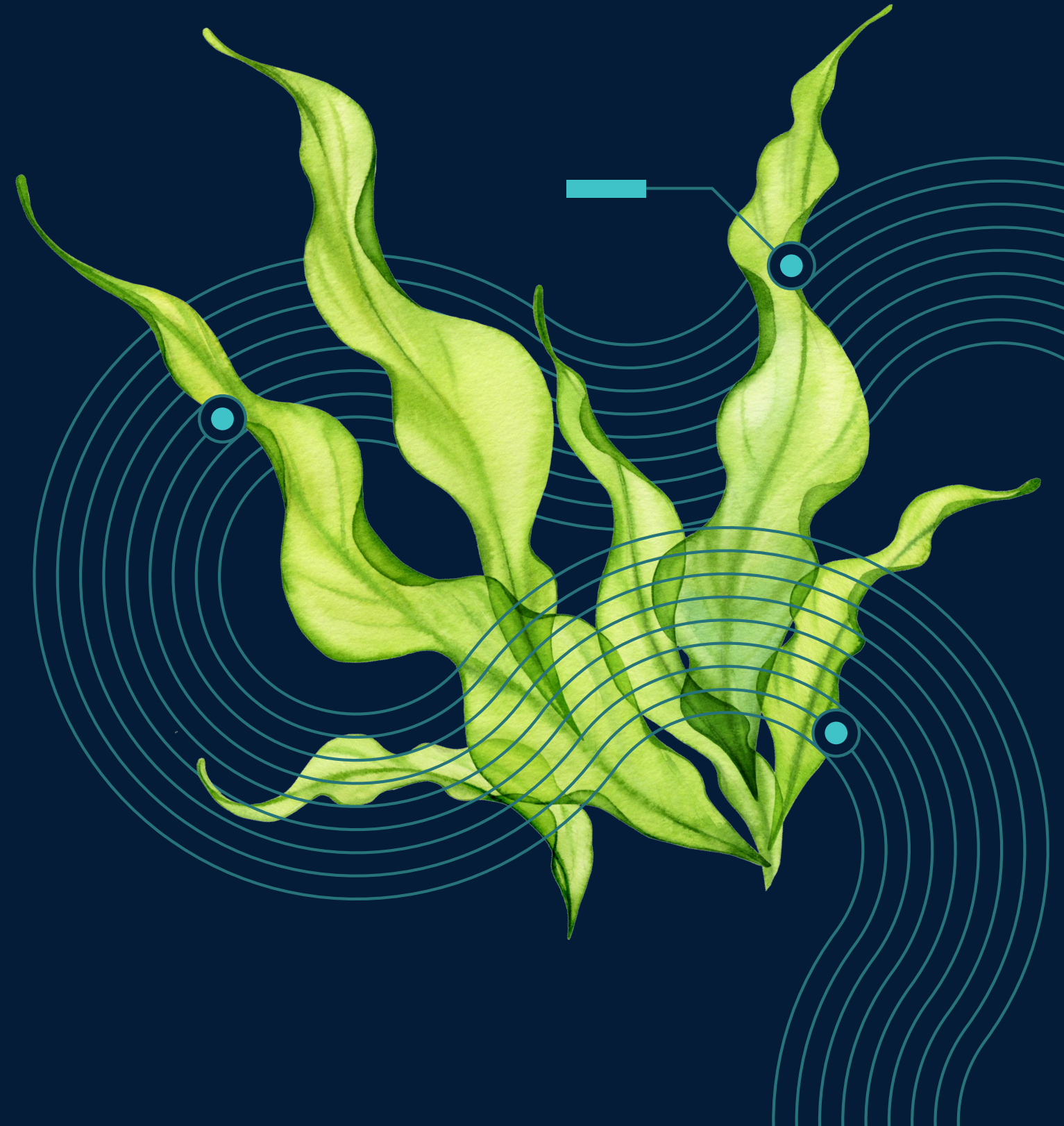
Carbon & Emissions Tech Report

VC trends and emerging opportunities

Q4
2022

REPORT PREVIEW

The full report is available through
the PitchBook Platform.





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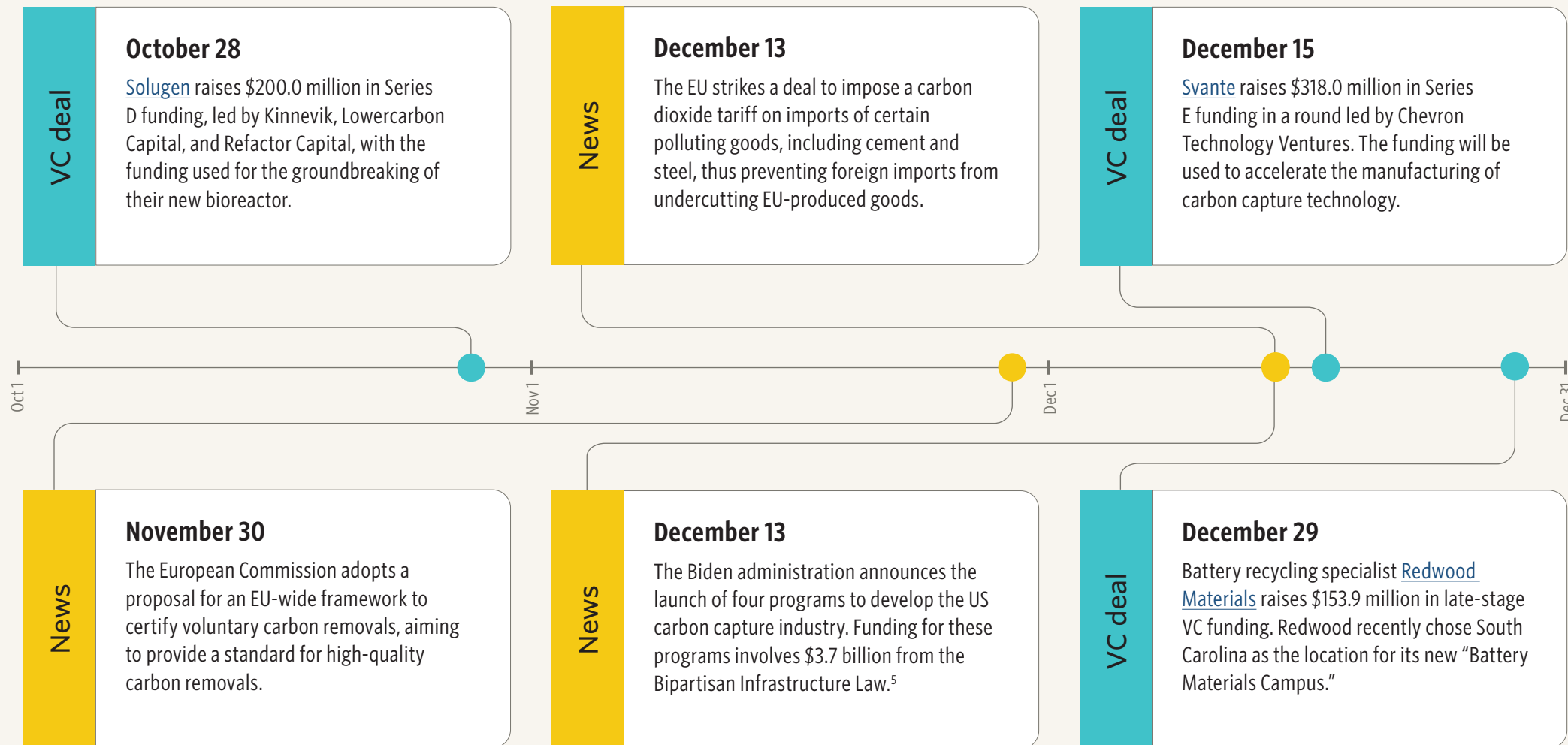
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Q4 2022 timeline



5: "Biden-Harris Administration Announces \$3.7 Billion to Kick-Start America's Carbon Dioxide Removal Industry," Department of Energy, December 13, 2022.

Q4 VC deal count summary

180
total deals

-27.1%
QoQ growth

-3.2%
YoY growth

4.3%
YTD growth

Q4 VC deal value summary

\$2.9 billion
total deal value

-42.1%
QoQ growth

23.9%
YoY growth

-1.9%
YTD growth



Carbon & emissions tech landscape

- 1 Carbon tech
- 2 Industry
- 3 Built environment
- 4 Land use

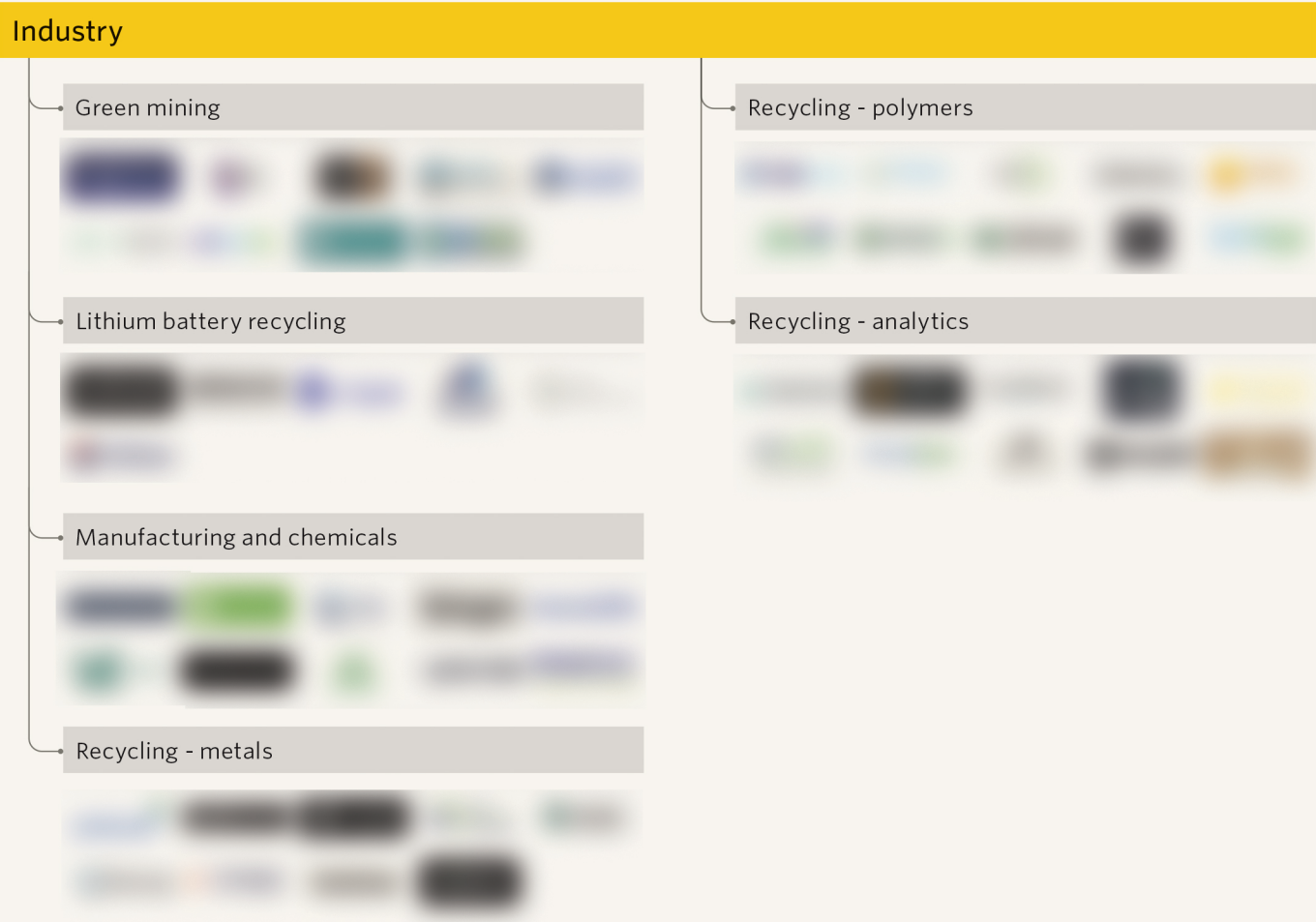
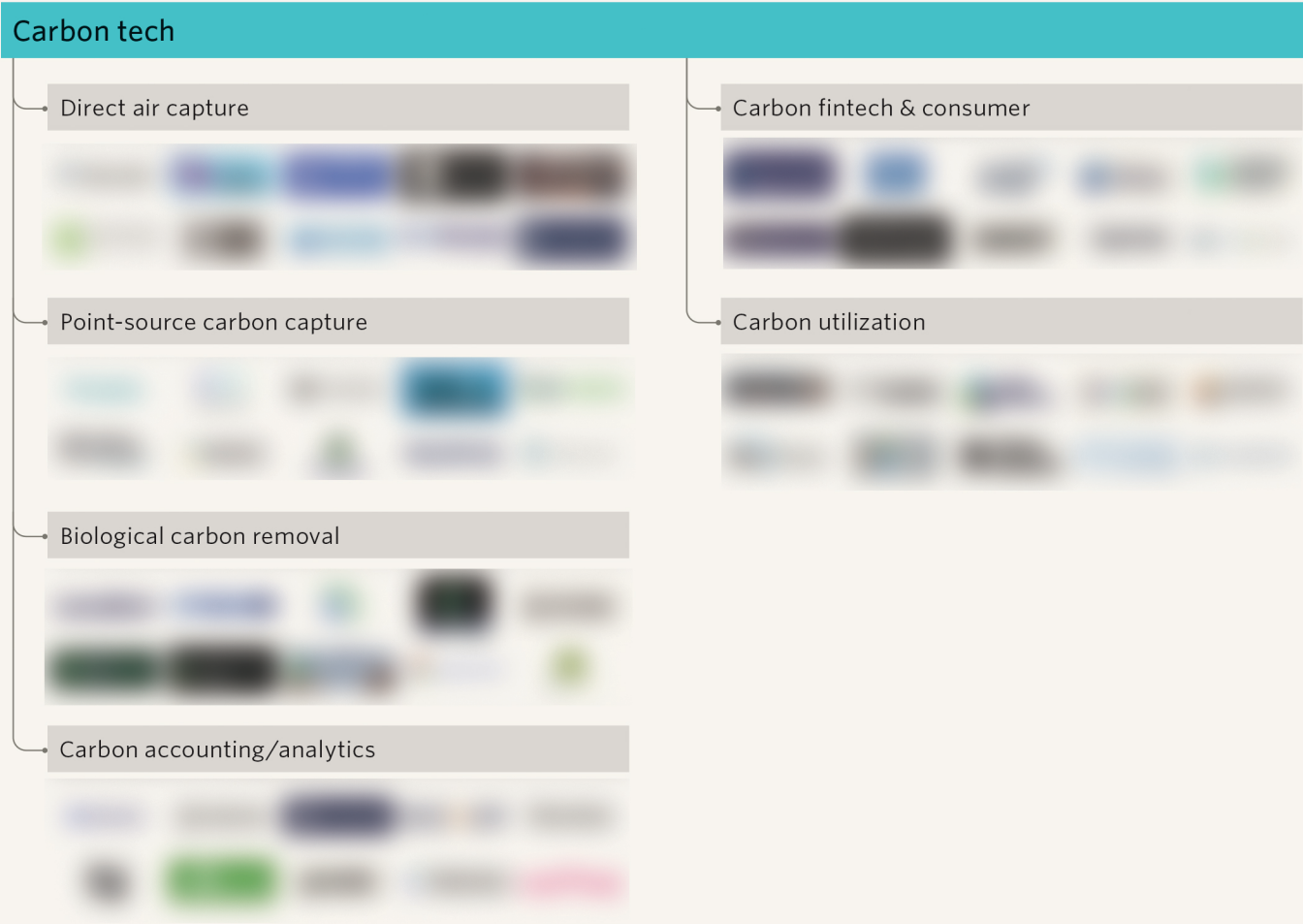




Carbon & emissions tech VC ecosystem market map

Click to view the interactive market map on the PitchBook Platform.

Market map is a representative overview of venture-backed or growth-stage providers in each segment. Companies listed have received venture capital or other notable private investments.

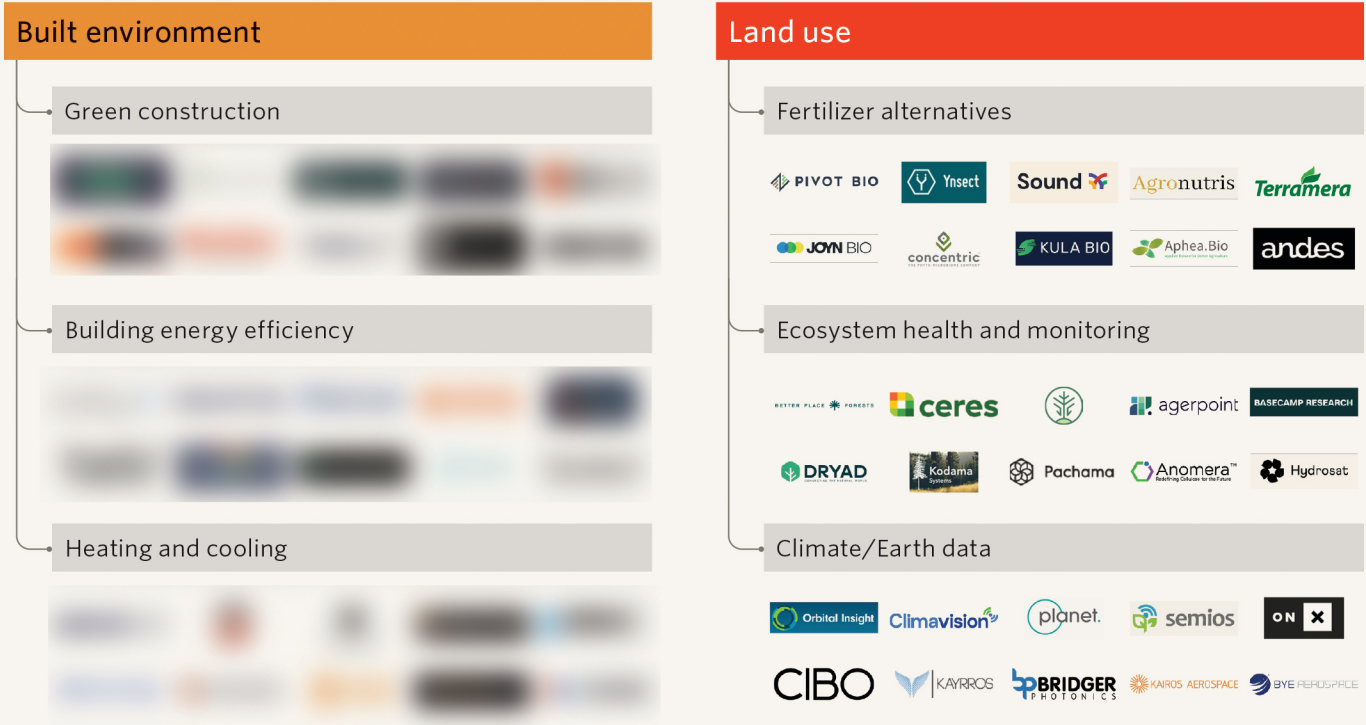




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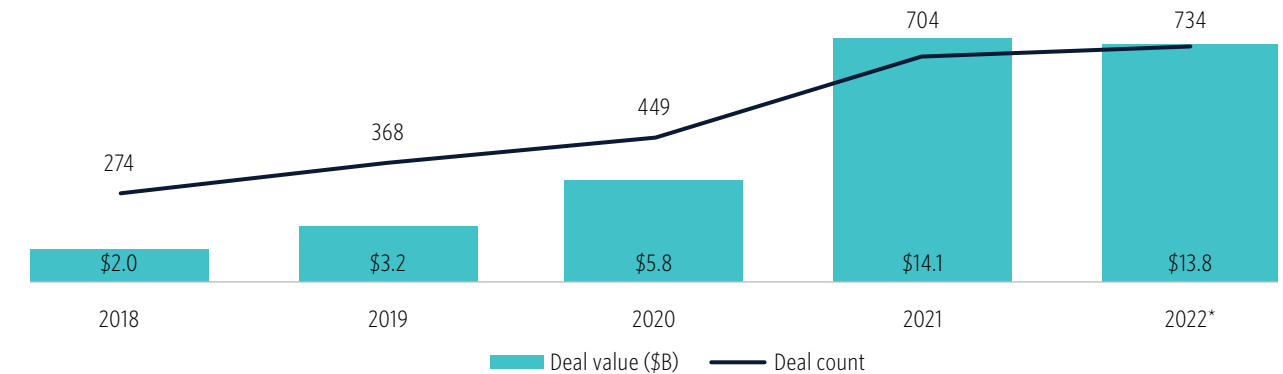
VC activity

At \$2.9 billion, Q4 2022 VC deal activity in the carbon & emissions tech space represented a fall from a very strong Q3 of \$5.0 billion, though was still higher than any quarter before 2021. While it was a decrease from the previous quarter, it was still enough to bring the full-year 2022 deal value within 2% of 2021's record deal activity, totaling \$13.8 billion in 2022, compared to \$14.1 billion in 2021. Despite this slight fall in deal value, deal count showed a slight increase in 2022, rising to 734 from 704 in 2021.

The largest carbon & emissions tech deal in Q4 2022 was the \$318.0 million Series E raised by Canada-based carbon capture hardware company [Svante](#), in a deal led by Chevron Technology Ventures. The funding from this deal will be used to support a filter manufacturing facility in Vancouver. Also among the largest deals this quarter was green chemical company [Solugen](#)'s \$200.0 million Series D.

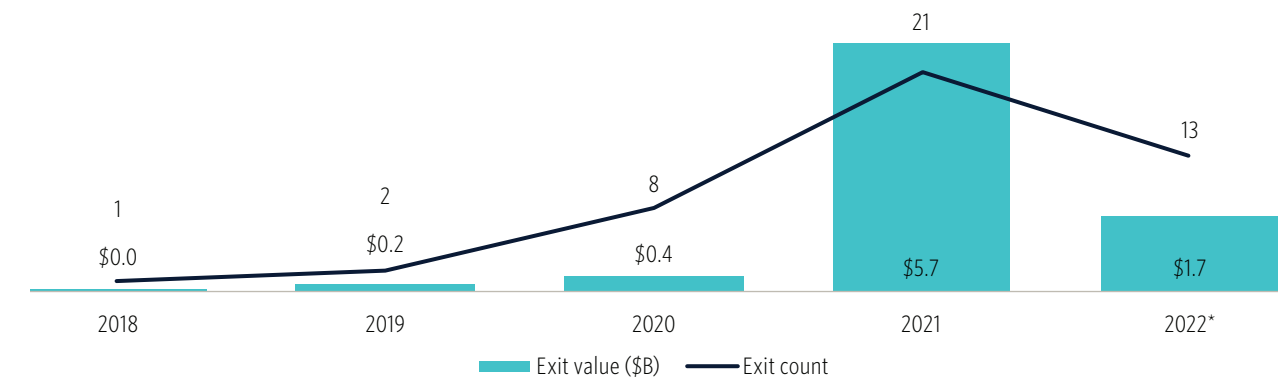
Looking at individual segments, carbon tech had its highest-ever year for VC investment in 2022, with total investment value at \$4.2 billion, up from \$3.6 billion in 2021. Deal count in carbon tech also reached a new high, with 204 deals in 2022, compared with 167 in 2021. Within carbon tech, increasing VC investment in all forms of carbon capture (point source, direct air, and biological) was enough to offset the decline in carbon fintech investment from 2021. The “industry” segment—including the decarbonization of manufacturing as well as materials generation and processing, plus recycling technologies—was largely flat relative to 2021, with the largest year-to-year shifts being a fall in lithium battery recycling investment, offset by a rise in green chemicals and manufacturing investment. The built environment segment showed a moderate increase to a new high point in 2022, but there was a drop in VC funding for “land use” technologies, in particular for climate and Earth data.

Carbon & emissions tech VC deal activity



Source: PitchBook | Geography: Global | *As of December 31, 2022

Carbon & emissions tech VC exit activity



Source: PitchBook | Geography: Global | *As of December 31, 2022



VC ACTIVITY

Key carbon & emissions tech early-stage VC deals*

Company	Close date (2022)	Category	Stage	Deal value (\$M)	Post-money valuation (\$M)	Lead investor(s)	Valuation step-up (post to pre)
Verkor	November 2	Manufacturing and chemicals	Early-stage VC	\$245.9	N/A	N/A	N/A
Reetec	November 8	Manufacturing and chemicals	Early-stage VC	\$113.4	N/A	N/A	N/A
Electra	December 11	Manufacturing and chemicals	Early-stage VC	\$57.0	N/A	Breakthrough Energy Ventures	N/A
Readline	November 23	Manufacturing and chemicals	Series B	\$41.7	\$330.5	Co-Stone Capital	N/A
Fairmat	October 1	Recycling - polymers	Series A	\$35.0	N/A	Compagnie Nationale à Portefeuille, Temasek Holdings	N/A
Viridios AI	October 28	Carbon fintech and consumer	Series B	\$34.9	N/A	ROC Partners	N/A
Samsara Eco	November 2	Recycling - polymers	Series A	\$34.2	N/A	N/A	N/A
Aro Homes	November 3	Green construction	Series A	\$21.0	\$44.3	Innovation Endeavors	84.3x
Creduce	October 19	Carbon fintech and consumer	Series A	\$20.0	N/A	N/A	N/A
Basecamp Research	December 1	Ecosystem health and monitoring	Series A	\$18.9	\$44.0	Systemiq Capital	3.2x

Source: PitchBook | Geography: Global | *As of December 31, 2022



VC ACTIVITY

Key carbon & emissions tech late-stage VC deals*

Company	Close date (2022)	Category	Stage	Deal value (\$M)	Post-money valuation (\$M)	Lead investor(s)	Valuation step-up (post to pre)
Solugen	October 28	Manufacturing and chemicals	Series D	\$200.0	\$2,175.0	Kinnevik, Lowercarbon Capital, Refactor Capital	1.2x
Redwood Materials	December 29	Lithium battery recycling	Late-stage VC	\$153.9	N/A	N/A	N/A
Mura Technology	October 6	Recycling - polymers	Late-stage VC	\$104.2	\$569.7	N/A	3.8x
RoadRunner	November 15	Recycling - analytics	Series D	\$90.0	\$1,070.0	Fifth Wall, General Atlantic	4.2x
Syzygy Plasmonics	November 16	Manufacturing and chemicals	Series C	\$76.7	\$251.4	Carbon Direct Capital Management	2.8x
Dandelion Energy	November 15	Heating and cooling	Series B1	\$69.7	\$299.7	Lennar Ventures, NGP Energy Technology Partners	1.2x
MycoWorks	October 18	Manufacturing and chemicals	Series C2	\$63.0	\$583.0	N/A	1.2x
Plant Prefab	December 3	Green construction	Series C	\$42.0	\$187.0	Gerdau Next Ventures	1.3x
Circ	November 28	Recycling - polymers	Series B2	\$35.0	N/A	Breakthrough Energy Ventures	N/A
Runwise	November 3	Heating and cooling	Series A	\$25.0	\$120.0	Fifth Wall	5.5x

Source: PitchBook | Geography: Global | *As of December 31, 2022



Ocean carbon capture

Carbon removal efforts have largely focused on terrestrial approaches, whether these are biological in nature or rely on chemical and hardware installations. However, a small group of companies is looking to use ocean-based approaches to remove carbon, essentially trying to enhance the ocean's existing ability to absorb atmospheric carbon. The world's oceans absorb carbon dioxide from the air, and some of this is taken in by oceanic organisms. This process is not limitless, and absorbing carbon dioxide also increases the acidity of ocean water, which is potentially damaging to ocean ecosystems.

As with atmospheric carbon removal, ocean-based approaches are varied. At one end of the spectrum are biological approaches involving essentially the farming of seaweed, which stores carbon that is then sequestered. On the other end of the spectrum, abiotic approaches rely on chemical and mechanical means to capture and store carbon dioxide. [Phykos](#) is a startup using a biotic approach by growing seaweed on platforms in the ocean and then sinking it in deep water to sequester carbon over long timescales. Revenue generation for these approaches involves creating and selling carbon offset credits generated by the sinking seaweed, though some challenges exist around verifying ocean carbon credits due to the difficulty in measuring deep ocean environments. Similar approaches involve fertilizing areas of the ocean with nutrients, triggering rapid growth in phytoplankton—photosynthetic microorganisms present in seawater, which capture carbon during photosynthesis—which then fall to the ocean floor as part of a natural process called “the natural carbon pump.”⁶ There are challenges with this type of approach in that the phytoplankton can have unforeseen effects on natural ecosystems and require careful evaluation to ensure their effects are limited to capturing carbon.

Abiotic approaches are also viable; they include:

- **Ocean alkalinity enhancement**, which involves increasing ocean alkalinity through either the addition of minerals or through electrochemical means. Increasing alkalinity effectively enhances the ocean's ability to absorb carbon dioxide from the atmosphere. [Ebb Carbon](#) uses an electrochemical approach to alkalinity enhancement, providing carbon removal offsets—including \$1.5 million of carbon removals purchased by [Stripe](#) in December 2021.⁷ On October 25, 2022, [Ebb Carbon](#) raised \$10.8 million in Series A funding.
- **Direct carbon removal**, which is similar to direct air capture in that seawater is extracted, the carbon dissolved in it is removed, and the water is pumped back into the ocean with the captured carbon dioxide ready for either storage or utilization. [Captura](#) uses this kind of approach, employing a patented electrodialysis technology powered by renewable energy to extract carbon dioxide from seawater before returning a stream of decarbonized water into the ocean. In late December 2022, [Captura](#) raised \$12.0 million in Series A funding in a deal led by Equinor Ventures and is currently carrying out ocean trials of its technology as a pilot project.

6: “Multi-Faceted Particle Pumps Drive Carbon Sequestration in the Ocean,” HAL, Philip W. Boyd, et al., November 27, 2020

7: “Introducing Ebb Carbon: Turning the Tide on Climate Change,” Ebb Carbon, April 14, 2022.



SELECT COMPANY HIGHLIGHTS: MYCOWORKS



Founded
2013

160 employees

Total raised:
\$256.2M over four deals

First institutional round:
\$17.0M Series A

Last financing:
\$65.0M in a Series C2

Post-money valuation:
\$583.0M

Overview

[MycoWorks](#) is a biomaterials company focusing on producing textiles from fungal mycelium—a fungal, root-like structure consisting of chitin-based branching threads—producing a product sometimes described as “mushroom leather.”¹¹ [MycoWorks](#) makes a distinction between standard mushroom leathers and its product, though, based on the process and technology used to create the final product, which is a low-impact material. “Traditional” mushroom leathers generally rely on growing fungal mycelium and compressing it, often using glues or resins to provide additional structural benefits, to then be made into textiles or solid structures used in applications like furniture-making or construction. [MycoWorks](#) uses a different approach that engineers the growth of mycelium strands, thus allowing increased strength and durability relative to standard mushroom leathers. In addition to improving strength, the technology can also allow for finer control over properties like flexibility, density, and texture.

After producing the mycelium product, [MycoWorks](#) uses a partner to finish the product into its final state, determining the color and surface texture. The mycelium product is then sold to be

used in collaborations, including one with [Hermès](#) since 2021 to make high-end bags, wherein it was chosen due to its properties as a viable leather substitute that has a lower environmental impact than plastics. [MycoWorks](#) raised \$65.0 million in Series C2 funding in October 2022, following its Series C funding in January 2022. It will use the funding to develop its “Fine Mycelium” approach and target applications in automotive design.

Leadership

- **CEO:** Matthew Scullin
- **COO:** Douglas Hardesty
- **CTO:** Philip Ross
- **Chief of Staff and Culture:** Sophia Wang
- **Chief of Product:** Mike Todd
- **Chief Infrastructure Development Officer:** Mike Lindheim

11: “Advanced Materials From Fungal Mycelium: Fabrication and Tuning of Physical Properties,” *Nature*, Muhammad Haneef, et al., January 24, 2017.

About PitchBook Emerging Tech Research

Independent, objective and timely market intel

As the private markets continue to grow in complexity and competition, it's essential for investors to understand the industries, sectors and companies driving the asset class.

Our Emerging Tech Research provides detailed analysis of nascent tech sectors so you can better navigate the changing markets you operate in—and pursue new opportunities with confidence.

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