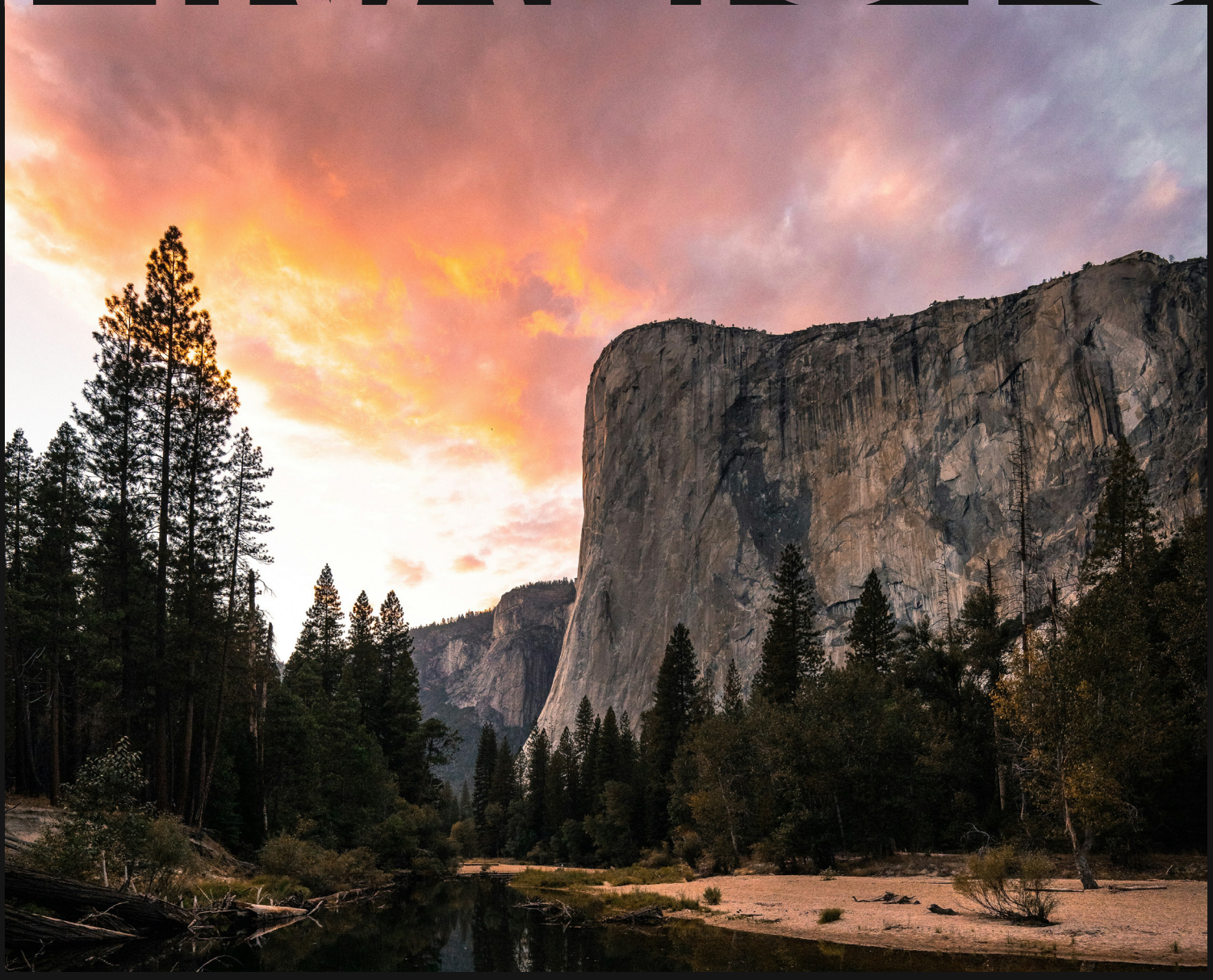
XPRIZE CARBON REMOVAL | MUSK FOUNDATION

TOP 20 FINALISTS



FINALIST TEAM PROFILES

APRIL 2025

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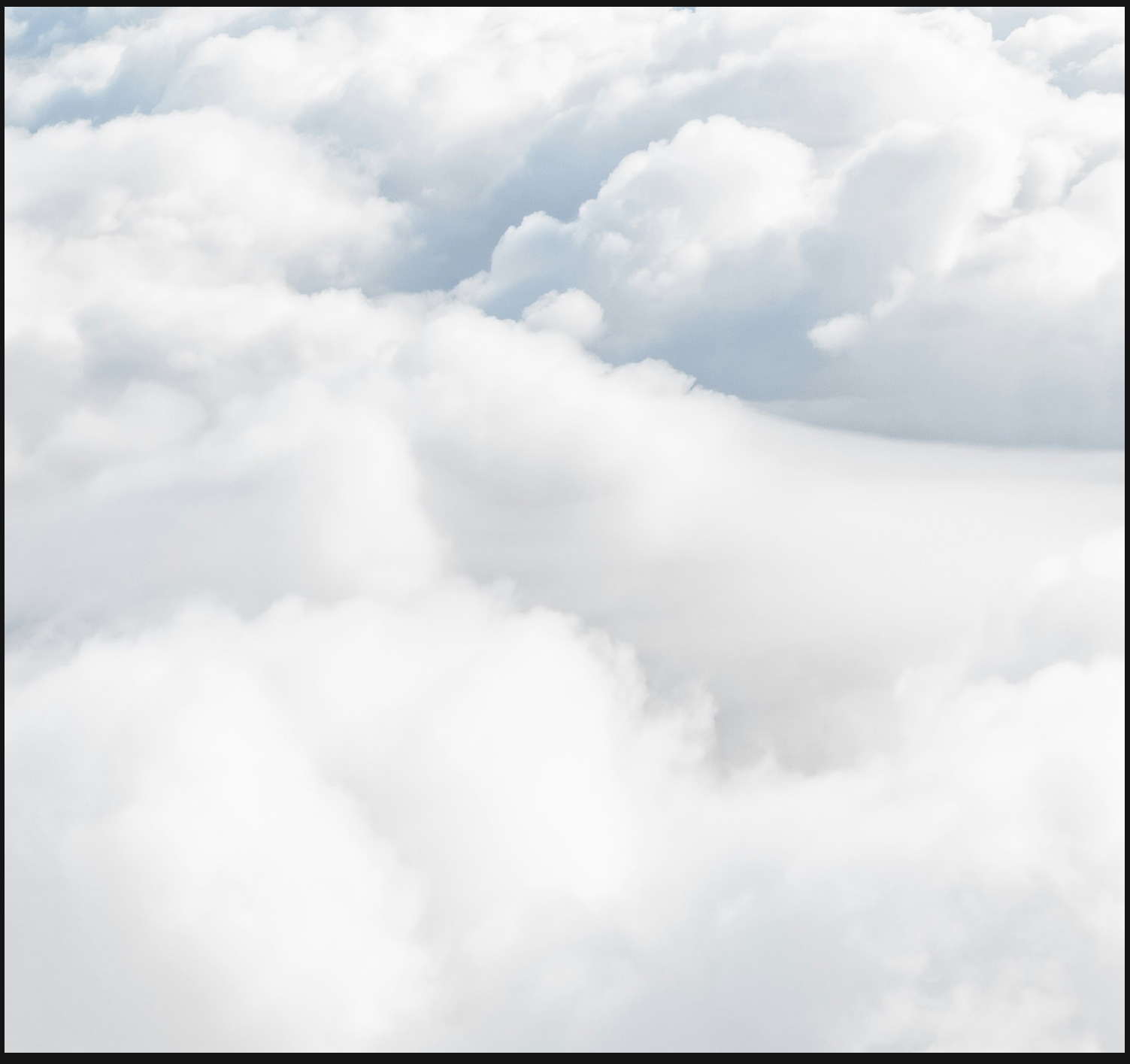

COMPANY OVERVIEW

COMPANY NAME
Airhive, Ltd.

HQ LOCATION
London, United Kingdom

FOUNDED
2022

XPRIZE TRACK
AIR

CDR PATHWAY(S)
Air - Solid sorbent direct air capture

Rocks - Mineralization of mine or industrial waste

PHYSICAL PRODUCTS:
Building Materials, Other

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AIRHIVE

COMPANY DESCRIPTION

Airhive's Direct Air Capture technology employs fluidisation to provide rapid CO_2 removal via our low-cost, non-toxic metal oxide-based sorbent. For the XPRIZE demonstration, Airhive is operating its 1,000 tpa pilot at the Deep Sky Alpha site in Innisfail, Alberta, Canada.

CORE INNOVATION

Airhive delivers a step change in DAC cost and energy requirements by using fluidisation to deliver very high air velocities and capture efficiencies with low energy requirements. Airhive's technology is also built around proven process equipment with excellent existing supply chains, enabling rapid manufacturing ramp up and commercial deployment.

CO_2 CAPTURE

1. Adsorption. Air is pushed through a horizontal fluidised bed reactor containing mixed metal oxide-based sorbent. The air causes the sorbent to form a turbulent sandstorm, stripping >99.99% of the CO_2 from air passing through the reactor in <0.1s.

2. Desorption. Carbonated sorbent is transferred to an electro-calciner where it is heated, separating CO_2 into a high-purity stream. Regenerated particles are returned to the carbonator, although in practice adsorption and desorption operate simultaneously.

CO_2 SEQUESTRATION

The CO_2 is transported to and stored at Deep Sky's CO_2 storage site, where the CO_2 is permanently sequestered in a saline aquifer.

CO-BENEFITS OR PRODUCTS

Airhive's closed system enables us to use our sorbent as thermochemical energy storage, and therefore enabling plant operation based entirely on low-capacity factor renewables. We can also sell spent sorbent in its more valuable oxide form to the cement/building industry as bulk material, reducing new carbonate mineral extraction and calcination.

COMPANY OVERVIEW

COMPANY NAME
Heirloom Carbon Technologies

HQ LOCATION
Brisbane, CA, USA

FOUNDED
2020

XPRIZE TRACK
AIR

CDR PATHWAY(S)
Air - Solid sorbent direct air capture

Rocks - Ex-situ mineralization of mined rocks

Rocks - Calcination of minerals with CO_2 capture

PHYSICAL PRODUCTS:
None

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HEIRLOOM

COMPANY DESCRIPTION

Heirloom builds a low-cost DAC technology that will permanently remove CO_2 at a billion tonnescale. Our technology rapidly accelerates a natural process to capture CO_2 from the atmosphere by forming limestone on a timespan of days. Heirloom operates the first and only commercial Direct Air Capture facility in North America and its customers are the world's biggest buyers of carbon removal including Microsoft, Meta, JPMorgan, Stripe, Klarna, Shopify and more.

CORE INNOVATION

Heirloom is one of the only companies with a real path to permanently sequestering billions of tonnes of CO_2 at < $100/t. The science underpinning our technology is well-established, allowing us to focus on scaling. Our feedstock is limestone, a low cost input with a mature supply chain, allowing us to iterate and scale quickly. Last, our energy requirements are lower than other DAC pathways due to the high thermal efficiency of our electric kilns.

CO_2 CAPTURE

Heirloom uses limestone (calcium carbonate, $Ca(OH)_3$) in a cyclic process to capture CO_2 directly from the air. When CO_2 is removed from the limestone, the remaining CaO is hydrated with water to form calcium oxide $Ca(OH)_2$. $Ca(OH)_2$ is 'thirsty' for CO_2 and acts like a sponge, pulling CO_2 from the atmosphere. Heirloom's technology accelerates this process, reducing the time it takes to absorb CO_2 from years to less than 3 days.

CO_2 SEQUESTRATION

For the purposes of the XPRIZE demonstration, we will work with CarbonCure to inject and mineralize the CO_2 captured at our demonstration site in concrete. Geological storage in Class VI wells will be Heirloom's primary permanent storage method at scale. Concrete is an important and immediately-available permanent storage method that allows us to fully validate our end-to-end capture and storage process because only 1 Class VI well is permitted and operationalized today in the US.

CO-BENEFITS OR PRODUCTS

The CO_2 captured by Heirloom at our XPRIZE demonstration site will be durably sequestered in concrete. The CO_2 improves the compressive strength of the concrete and reduces the amount of cement that needs to be used, reducing the cost and emissions footprint of the concrete. Going forward, Heirloom will permanently store CO_2 in Class VI wells, creating high-paying jobs and workforce skills and training programs in regions previously harmed by extractive industries.

COMPANY OVERVIEW

COMPANY NAME
Octavia & Cella

HQ LOCATION
Nairobi, Kenya
New York City, NY, USA

FOUNDED
2022

XPRIZE TRACK
AIR

CDR PATHWAY(S)
Air - Solid sorbent direct air capture

Rocks - In-situ mineralization

PHYSICAL PRODUCTS:
Advanced Materials, Industrial Chemicals, Chemical Polymers

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OCTAVIA & CELLA

COMPANY DESCRIPTION

Octavia and Cella have partnered to develop the first Direct Air Capture (DAC) and geological storage project in the Southern Hemisphere, within the Kenyan Rift Valley. As the Global South's first DAC company, Octavia designs, builds, and deploys highly modular machines that capture CO_2 directly from the atmosphere using DAC technology. Cella, the storage partner, provides permanent carbon removal through in-situ mineralization and is developing the necessary technology for this process.

CORE INNOVATION

To address DAC's high energy requirements, Octavia is building DAC machines that leverage low-grade heat. This allows for the integration of geothermal waste heat to cover >85% of their energy requirements which in turn also significantly cuts down their DAC OPEX. Concurrently, Cella is developing patent-pending technology for CO_2 injection that significantly enhances storage efficiency and capacity. Thereby, Cella is turning CO_2 into stone for permanent CO_2 removal.

CO_2 CAPTURE

Octavia is deploying their DAC technology to facilitate CO_2 capture for the pilot DAC+Storage facility. Their process employs low-temperature vacuum swing adsorption (TVSA) with solid-supported amines. The DAC process has two phases: adsorption and desorption. In the adsorption phase, the sorbent captures CO_2 from the air. When saturated, desorption begins by creating a partial vacuum. Geothermal waste heat indirectly heats the sorbent, releasing the captured CO_2, which is then compressed for purification and sequestration.

CO_2 SEQUESTRATION

Cella will inject the captured CO_2 underground into basalt rock formations abundant in the Kenyan Rift Valley region. The porous basaltic rocks are natural storage sites for CO_2 because of their ability to transform CO_2 into carbonate minerals, locking it away for millions of years with minimal to no leakage risk. Octavia's DAC operations will be co-located with Cella's commercial CO_2 storage well, avoiding additional infrastructural costs.

CO-BENEFITS OR PRODUCTS

Kenya's grid is 93% renewable, but high electricity costs persist due to inadequate industrial demand, leading to 1,000 MWh of geothermal energy wasted daily. Harnessing this excess capacity will stimulate green industrialization in the region and help subsidize electricity costs for marginalized communities. Additionally, as part of their community benefits plan, they are supporting initiatives in the deployment area, including an apprenticeship program aimed at developing green skills among the youth and a scholarship program.

COMPANY OVERVIEW

COMPANY NAME
44.01 and Aircapture

HQ LOCATION
Muscat, Oman

FOUNDED
2020

XPRIZE TRACK
AIR

CDR PATHWAY(S)
Air - Solid sorbent direct air capture

Rocks - In-Situ mineralization

PHYSICAL PRODUCTS:
None

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PROJECT HAJAR

COMPANY DESCRIPTION

Project Hajar is a Direct Air Capture to Mineralisation (DAC+M) joint project between Aircapture and 44.01. Aircapture is deploying its state-of-the-art modular DAC technology in Oman, positioned on 44.01's site in Hajar Mountains. Here 44.01 will take the captured CO_2 and turn it into rock, utilising its pioneering technology that accelerates the natural process of CO_2 mineralisation. Deployed at scale, DAC+M has the potential to eliminate billions of tonnes of CO_2 globally.

CORE INNOVATION

Aircapture develops highly efficient small modular DAC units which are easy to ship, install, commission, operate and maintain. Aircapture's temperature swing technology enables rapid development and scale-up with very modest CAPEX requirements. 44.01's mineralisation technology provides a truly permanent way of removing CO_2. Once mineralised, CO_2 cannot escape back into the atmosphere. This reduces the need for longterm monitoring and insurance, providing a cost-effective, scalable, global solution.

CO_2 CAPTURE

The CO_2 is captured utilizing Aircapture's DAC units. It is collected by moving air or mixtures of air across a proprietary contactor which adsorbs CO_2. The contactor is moved into a regeneration box where the CO_2 is released from the contactor and collected.

CO_2 SEQUESTRATION

44.01 takes the CO_2 and dissolves it in water, then injects this fluid into peridotite formations. Initially the CO_2 is contained through solubility trapping, where the density of the carbonated fluid is higher than surrounding groundwater. The CO_2 then mineralises in under 12 months, eliminating it permanently. 44.01 uses a range of physical and chemical monitoring and verification techniques to confirm the CO_2 is contained in the subsurface and ultimately mineralised.

CO-BENEFITS OR PRODUCTS

There are environmental and social co-benefits with DAC+M projects. Peridotite is not a resource that has traditionally been prized for agriculture, minerals or hydrocarbon extraction. Using peridotite for CDR unlocks new income streams for governments and communities, and enable the creation of green jobs in new areas all over the world. Finally, since mineralisation occurs in the sub-surface, the surface environment is preserved, enabling it to be used for other activities.

COMPANY OVERVIEW

COMPANY NAME
Skyrenu Technologies Inc.

HQ LOCATION
Sherbrooke, Canada

FOUNDED
2021

XPRIZE TRACK
AIR

CDR PATHWAY(S)
Air - Solid sorbent direct air capture

Rocks - Mineralization of mine or industrial waste

PHYSICAL PRODUCTS:
Industrial Gases/Pure CO_2, Magnesium Carbonate

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SKYRENU TECHNOLOGIES

COMPANY DESCRIPTION

We combine a direct-air capture (DAC) system with a rock carbonation process to treat mine tailings in order to lock away carbon forever. Our system is installed at an abandoned mine site in the province of Quebec in Canada, where 800 $MtCO_2$ of existing mine tailings offer a CO_2 sequestration potential of about 200 $MtCO_2$; the process is powered by the 100% renewable Hydro-Quebec grid.

CORE INNOVATION

We use proprietary (patent pending) solid sorbent DAC and waste mineralization processes. Moreover, both processes are tightly integrated such that waste heat from the DAC is exploited by the mineralization process, leading to a highly energy-efficient overall process. Our system can be directly installed at mine waste sites, thereby eliminating the need to transport CO_2 or mineral feedstock over long distances.

CO_2 CAPTURE

Our DAC device uses a proprietary continuous adsorption/regeneration process with moving bed monolith solid sorbent reactors, in a highly energy-efficient process. See Worldwide Patent Application WO2021258219A1.

CO_2 SEQUESTRATION

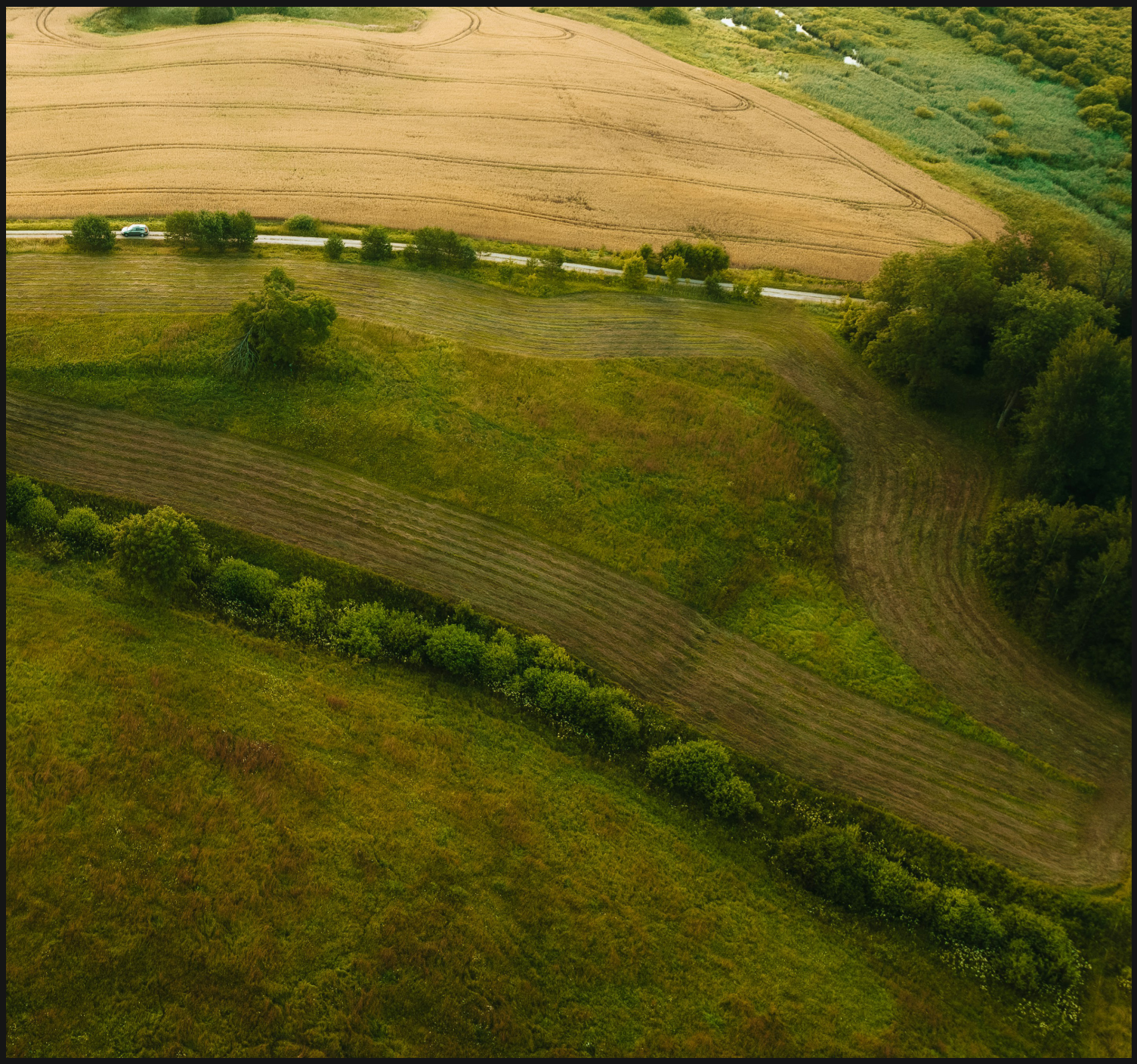
We use a proprietary low-temperature process where magnesium present in mine tailings reacts with dissolved CO_2 in an aqueous solution to form stable solid magnesium carbonate compounds. This operation also decontaminates the treated materials, as no hazardous asbestos residues remain after the process is complete. IP yet to be filed.

CO-BENEFITS OR PRODUCTS

An important added co-benefit in the treatment of mine tailings is the remediation of the hazardous nature of the mining sites.

XPRIZE CARBON REMOVAL | MUSK FOUNDATION

LAND



COMPANY OVERVIEW

COMPANY NAME
Applied Carbon

HQ LOCATION
Houston, TX, USA

FOUNDED
2020

XPRIZE TRACK
LAND

CDR PATHWAY(S)
Land - Thermal conversion of biomass (biochar)

Land - Agricultural & grassland CDR

PHYSICAL PRODUCTS:
Advanced Materials, Biochar, Soil/Soil Additives

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APPLIED CARBON

COMPANY DESCRIPTION

Applied Carbon enables broad-scale agriculture adoption of biochar which builds soil health and removes excess carbon from the atmosphere. The company's mobile technology converts crop residues into durable biochar on the move and in the field, making the economics work for farmers and our ecosystems. Applied Carbon is the largest supplier of biochar carbon removal by sales to leading carbon removal buyers like Microsoft and is headquartered in Houston, Texas.

CORE INNOVATION

Applied Carbon has developed the world's first technology to convert agricultural crop wastes into durable biochar in the field, on the move, and with one pass. While competitors have developed technologies capable of carbon removal from residues and even edge-of-field production, these processes still rely on expensive collection and bulk transport of both biomass and resulting products, dramatically increasing costs and resulting in unnecessary emissions.

CO_2 CAPTURE

Plants are made of carbon and grow by absorbing CO_2 from the atmosphere. Instead of letting plants' carbon go back into the short-term carbon cycle, Applied Carbon uses a thermal process to convert this transient plant carbon into a durable, geologically stable carbon called biochar. The magic behind unlocking broad-scale farmer adoption is the dramatic cost-savings enabled by Applied Carbon's' mobile technology for CO_2 removal via biochar production and soil application.

CO_2 SEQUESTRATION

Applied Carbon uses a low-oxygen, thermal decomposition process (pyrolysis) to convert transient plant carbon into a durable, stable carbon called biochar. Applying quality biochar to soils durably sequesters carbon out of the atmosphere long term. Applied Carbon's biochar meets lab-tested metrics that peer-reviewed research has supported lasting 1000+ years in soils.

CO-BENEFITS OR PRODUCTS

Not only does Applied Carbon's mobile technology durably remove and store atmospheric CO_2 long term, quality biochar applied to agricultural soils also helps build soil health, support rural economies, and decarbonize farming. According to the latest peer-reviewed research and Applied Carbon's field trials, biochar builds soil health resulting in higher yields and productivity due to improved pH, nutrient retention, and water retention while also reducing agricultural greenhouse gas emissions.

COMPANY OVERVIEW

COMPANY NAME
MASH Makes

HQ LOCATION
Copenhagen, Denmark

FOUNDED
2015

XPRIZE TRACK
LAND

CDR PATHWAY(S)
Land - Thermal conversion of biomass (biochar)

PHYSICAL PRODUCTS:
Biochar, Liquid Fuels

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MASH MAKES

COMPANY DESCRIPTION

MASH Makes transforms agricultural residues into sustainable, high-impact products through pyrolysis—a thermochemical process that heats biomass at high temperatures without oxygen. In 2024, the MASH Makes commercial facility in Karnataka, India transformed agricultural waste from the cashew value chain into 1,300 tonnes of biochar and 650 tonnes of biofuel. The company aims to have four sites completed by the end of 2025 and remove 1 megatonne of carbon by 2030.

MASH Makes is on a mission to remove a gigaton of CO_2 in the coming decades through carbon removal technologies. Their next innovation stage includes commercial development of the company's gasification technology in 2025, which allows for massive scale, diverse feedstocks, and versatile future-ready outputs.

CORE INNOVATION

The MASH Makes' business model is designed for scalability and maximum environmental impact. This model produces two products:

- Biochar: MASH Makes Biochar is proven to improve soil health, enhance water retention, and boost crop yields for at least four seasons.
- Marine-grade biofuel: A commodity standard, ISCC EU-certified fuel that is comparable with ISO8217 standards. It is designed to work as a drop-in fuel for the shipping industry.

CO_2 CAPTURE

MASH Makes processes biomass through pyrolysis, a high-temperature, oxygen-free method that converts carbon into stable biochar and produces engine-grade biofuel as a by-product. Unlike traditional biomass use, pyrolysis locks carbon away in a form that can remain in soils for centuries to millennia, providing a long-term solution to atmospheric carbon capture.

CO_2 SEQUESTRATION

MASH Makes sequesters carbon by transforming CO_2 into biochar, which is then applied to soil to create a long-term carbon sink. To maximise its effectiveness, biochar is mixed with nutrient-rich mediums like compost or organic fertilisers before being used as a soil additive. Once in the soil, biochar remains recalcitrant to biodegradation, resisting decomposition and remaining stable for thousands of years.

CO-BENEFITS OR PRODUCTS

MASH Makes' solutions provide multiple benefits beyond carbon removal, addressing energy, agriculture, and community development challenges.

- Marine-grade biofuel: This sustainable energy source supports the decarbonisation of hard-to-abate sectors like shipping and heavy industries.
- Enhanced agricultural yields: Biochar improves soil health, increases water retention, and boosts crop productivity. Higher yields improve incomes and food security, while generating more biomass. This creates a regenerative, circular system that feeds back into sustainable production and consumption.
- Community and environmental impact: By operating in the Global South and collaborating with marginalised communities and farmers, MASH Makes enhances local economies and supports sustainable land use practices.

MASH Makes also contributes to UN SDGs 2, 8, 9, 11, 12, and 15.

COMPANY OVERVIEW

COMPANY NAME
NetZero

HQ LOCATION
Paris, France

FOUNDED
2021

XPRIZE TRACK
LAND

CDR PATHWAY(S)
Land - Thermal conversion of biomass (biochar)

PHYSICAL PRODUCTS:
Biochar, Energy

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NETZERO

COMPANY DESCRIPTION

NetZero's mission is to bring at scale biochar as both a climate and agricultural solution. We focus exclusively on the immense volumes of unused crop residues available in the tropics, and leverage our own technology of mid-size, automated, highly optimized, and easily replicable pyrolysis plants. We operate an end-to-end model based on a fully circular approach, with local farmers being both our suppliers of biomass and clients of biochar, facilitating logistics, traceability, and local buy-in.

CORE INNOVATION

We are one of the very few integrated biochar players, controlling all project steps: from biomass collection to biochar distribution, from equipment design to factory assembly, along a highly cost-efficient model. We operate a decentralized model in the tropics, going close to biomass sources and exclusively using crop residues as feedstock. We process this biomass in mid-size, automated, and remotely monitored facilities, then returning the biochar to the same farmers who supply us the feedstock.

CO_2 CAPTURE

CO_2 is captured as hydrocarbons through photosynthesis in crop residues.

CO_2 SEQUESTRATION

We extract and stabilize the carbon contained in the crop residues through pyrolysis, with average heating temperature above 600,ÑÉ, forming biochar. The biochar is then applied as a soil amendment to nearby agricultural fields, thus sequestering the carbon over geological timescales.

CO-BENEFITS OR PRODUCTS

Our model is designed to maximize co-benefits beyond carbon removal. By using our biochar as a soil amendment in the tropics, where it is most efficient, we significantly improve farmers' standard of living, bringing higher yields, lower expenses on fertilizers, and better resilience of crop to extreme weather events. We also create well-paid industrial jobs in rural areas of developing countries and co-generate renewable energy usable locally. At a global level, our model allows to reduce the carbon footprint of crop farming through lower use of fertilizers – a key challenge in decarbonizing agri-supply chains.

COMPANY OVERVIEW

COMPANY NAME
Takachar Ltd.

HQ LOCATION
New Delhi, India
Mwea, Kenya
San Francisco, CA, USA
Vancouver, Canada

FOUNDED
2015

XPRIZE TRACK
LAND

CDR PATHWAY(S)
Land - Thermal conversion of biomass (biochar)

PHYSICAL PRODUCTS:
Advanced Materials, Biochar, Energy, Soil/Soil Additives

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TAKACHAR

COMPANY DESCRIPTION

We use MIT technology to build a decentralized internet-of-things-enabled reactor network to rapidly and profitably scale biochar deployment without being dependent on carbon offset credits. Our patent-pending, low-cost, and portable hardware and control systems enable village-based production of customizable biochar-based fertilizers using locally available crop residues and labor. The resultant standalone, government-certified fertilizer blend helps farmers improve their yield by up to 30% and net income by 50%, thereby uniquely advancing climate justice simultaneously.

CORE INNOVATION

Most crop/forest (biomass) residues are loose, wet, bulky, and too expensive to collect/ transport to centralized, one-size-fits-all biochar facilities. Our differentiation is that we make biomass technology small-scale, portable, and flexible in terms of biomass and output bioproducts. This allows us unique access to rural, decentralized, small pockets of biomass for localized utilization that larger technologies cannot reach. Furthermore, our tunable control system allows for placed-based customization of biochar produced to optimize local soil/crop needs.

CO_2 CAPTURE

CO_2 is captured by growing plants (crops and trees). In the baseline, after harvest, the non-merchantable residues are typically burned in open air, which releases the same CO_2 back into the atmosphere (and in some cases methane from anaerobic decomposition). Our thermochemical process intercepts this CO_2 cycle by turning the carbon-based plant matter into a more recalcitrant composition with persistence when applied into the soil from thousands to millions of years (Schimdt et al., 2022).

CO_2 SEQUESTRATION

The primary method of sequestration is that, after rendering the biochar noncombustible by blending it with water and nutrients, the mixture is then applied to the soil as a government-certified fertilizer blend on farms and forested lands. Mainstream methodologies, however, tend not to care about the application boundary. For example, if a certain fraction of the biochar ended up in a landfill or river, then generally the biochar remains inert, and CO_2 is still considered sequestered.

CO-BENEFITS OR PRODUCTS

Each tonne of carbon removed from our process is inextricably linked with other social/ environmental impacts overwhelmingly benefiting rural, underserved communities. Our 14,000 customers range from the poorest smallholder farmers in Kenya/India to the most remote First Nations communities in Canada. We have created >$1.5 million in unskilled rural job opportunities, enabling these communities to depend less on expensive, imported, and carbon-intensive chemical fertilizers. By utilizing high-risk residues, we also reduce the risk of catastrophic wildfires.

COMPANY OVERVIEW

COMPANY NAME
Vaulted Deep

HQ LOCATION
Houston, TX, USA

FOUNDED
2023

XPRIZE TRACK
LAND

CDR PATHWAY(S)
Land – Biomass Geologic Storage

PHYSICAL PRODUCTS:
None

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VAULTED DEEP

COMPANY DESCRIPTION

We use MIT technology to build a decentralized internet-of-things-enabled reactor network to rapidly and profitably scale biochar deployment without being dependent on carbon offset credits. Our patent-pending, low-cost, and portable hardware and control systems enable village-based production of customizable biochar-based fertilizers using locally available crop residues and labor. The resultant standalone, government-certified fertilizer blend helps farmers improve their yield by up to 30% and net income by 50%, thereby uniquely advancing climate justice simultaneously.

CORE INNOVATION

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CO_2 CAPTURE

CO_2 is captured by growing plants (crops and trees). In the baseline, after harvest, the non-merchantable residues are typically burned in open air, which releases the same CO_2 back into the atmosphere (and in some cases methane from anaerobic decomposition). Our thermochemical process intercepts this CO_2 cycle by turning the carbon-based plant matter into a more recalcitrant composition with persistence when applied into the soil from thousands to millions of years (Schimdt et al., 2022).

CO_2 SEQUESTRATION

The primary method of sequestration is that, after rendering the biochar noncombustible by blending it with water and nutrients, the mixture is then applied to the soil as a government-certified fertilizer blend on farms and forested lands. Mainstream methodologies, however, tend not to care about the application boundary. For example, if a certain fraction of the biochar ended up in a landfill or river, then generally the biochar remains inert, and CO_2 is still considered sequestered.

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XPRIZE
CARBON
REMOVAL

MUSK FOUNDATION

OCEANS

COMPANY OVERVIEW

COMPANY NAME
Captura

HQ LOCATION
Los Angeles, CA, USA

FOUNDED
2021

XPRIZE TRACK
OCEAN

CDR PATHWAY(S)
Oceans - Electromechanical CO_2 separation from seawater

PHYSICAL PRODUCTS:
Industrial Gases/Pure CO_2

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CAPTURA

COMPANY DESCRIPTION

Captura provides a scalable, low-cost Direct Ocean Capture (DOC) carbon removal solution, producing a measurable stream of CO_2 for sequestration, using only seawater and renewable energy, with no other external additives or by-products produced. DOC requires no freshwater, has a minimal land footprint and can operate with intermittent power. The technology has been fully demonstrated at 100-tonne scale since November 2023. Captura is deploying a 1,000-tonne system in early 2025 while designing larger-scale commercial systems.

CORE INNOVATION

1. Lower Cost: No purpose-built air contactors or absorbents, widespread use of standard industrial equipment and ability to leverage off-peak/intermittent renewable electricity lowers costs. No disposal costs since no by-products generated.

2. Scalability: Use of oceans makes DOC deployable globally. Only inputs are renewable energy and seawater - no supply chain constraints. No temperature or humidity restrictions. No freshwater or material land use.

3. Ocean Health: Closed-loop process adds nothing to oceans.

CO_2 CAPTURE

Captura's Direct Ocean Capture (DOC) technology harnesses the ocean's natural carbon removal powers to drawdown atmospheric CO_2, using just renewable energy and seawater as inputs, with no ocean additives. DOC captures CO_2 from surface oceans utilizing closed-loop electrodialysis, effectively making "more room" for oceans to draw down the same amount of CO_2 from the atmosphere. In this way, removal of CO_2 from the ocean results in subsequent removal of CO_2 from the atmosphere.

CO_2 SEQUESTRATION

Captura produces a measurable stream of CO_2 that is fully compatible with a wide variety of safe and durable sequestration solutions, much like DAC. Captura DOC will deliver the CO_2 capture solution, and we will employ sequestration as a service to create end-to-end carbon removal. The CO_2 product can also be used to produce low-carbon products such as synthetic fuels – these applications are another tool for achieving net zero.

CO-BENEFITS OR PRODUCTS

Captura DOC removes CO_2 from oceans faster than the ocean can replace it with atmospheric CO_2, resulting in less CO_2 in oceans while DOC is operating. This effect could help to mitigate ocean acidification and support ocean-dependent communities. The stream of CO_2 that Captura produces can be durably and safely sequestered to generate high-quality carbon credits to help corporations reach critical Net Zero targets, or re-used to create low-carbon products such as green fuels, facilitating the energy transition.

COMPANY OVERVIEW

COMPANY NAME
Ebb Carbon

HQ LOCATION
San Carlos, CA, USA

FOUNDED
2021

XPRIZE TRACK
OCEAN

CDR PATHWAY(S)
Oceans - Ocean alkalinity enhancement

Oceans - Electrochemical CO_2 separation from seawater and/or water splitting

Rocks - Ex-situ mineralization of mined rocks

Rocks - In-situ mineralization

PHYSICAL PRODUCTS:
Other

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ebbcarbon.com

EBB CARBON

COMPANY DESCRIPTION

Ebb Carbon is pioneering a new carbon removal solution by enhancing the ocean's natural ability to safely store CO_2. This electrochemical ocean alkalinity enhancement method has the potential to be one of the largest scale and lowest cost approaches to removing excess CO_2, while reducing ocean acidity.

CORE INNOVATION

Electrochemical OAE is among the most durable of all CDR methods, has among the greatest potential to scale, and is headed to be less than $100/tonne (NASEM 2021; NOAA 2023). Compared to other OAE methods, Ebb's approach has many advantages: simplified distribution of a liquid product to the ocean, avoidance of mining and transportation of the alkalinity source as well as potentially harmful impurities present in mined alkalinity sources.

CO_2 CAPTURE

The electrochemical ocean alkalinity enhancement (OAE) process uses low-carbon electricity and ion-selective membranes to separate the NaCl in seawater into dilute HCl and NaOH. The base stream is returned to the ocean to safely enhance ocean alkalinity, which in turn pulls atmospheric CO_2 from the atmosphere and transforms it into bicarbonate and carbonate ions, accelerating the oceans' natural carbon cycle.

CO_2 SEQUESTRATION

The conversion of atmospheric CO_2 to bicarbonate and carbonate ions accelerates the natural carbon cycle, specifically the long term cycling of carbon weathered from land and removed to the seafloor. Once in the ocean, bicarbonate is a stable form of carbon storage for 10,000+ years. Electrochemical OAE is expected to be among the most durable methods of carbon removal.

CO-BENEFITS OR PRODUCTS

Ocean alkalinity enhancement can help reduce the acidity of seawater locally. After alkalinization and equilibration by CO_2 absorbed from the atmosphere ocean pH will be slightly higher. Locally OAE can restore ecosystems where ocean acidification and natural low pH events harm shellfish. Other local restorative effects may include the amelioration of the low pH of treated wastewater. Use cases for the acid product include enhanced weathering to sequester additional CO_2, cement neutralization, red mud remediation and element extraction in mining

COMPANY OVERVIEW

COMPANY NAME
Kelp Blue

HQ LOCATION
Amsterdam, Netherlands

FOUNDED
2020

XPRIZE TRACK
OCEAN

CDR PATHWAY(S)
Oceans - Microalgae cultivation

Land - Agricultural & grassland CDR

PHYSICAL PRODUCTS:
Algae for Use, Soil/Soil Additives

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KELP BLUE

COMPANY DESCRIPTION

Kelp Blue cultivates giant kelp (Macrocystis pyrifera) off the coast of Namibia, New Zealand, and soon Alaska. Our offshore farms overcome scaling limits of sheltered water, whilst benefiting from local nutrient upwelling systems. The kelp grows on our innovative submerged structures, ultimately forming a canopy at the surface. The canopy biomass is trimmed and processed into sustainable products for agriculture and packaging. The remaining biomass sequesters carbon naturally, supports biodiversity and provides other ecological benefits.

CORE INNOVATION

Kelp Blue's off-shore farming method unlocks large-scale kelp cultivation, supporting carbon sequestration at significant scale without intentionally sinking biomass. The submerged structures mimic natural forest growth, from which just the canopy is harvested. The remaining forest continues to provide ecosystem services such as carbon sequestration while structuring a marine habitat with enhanced biodiversity. The environmental benefit of the kelp does not end there. Products made from the harvested canopy help other industries to move away from environmentally damaging practices. For example, our cultivated seaweed biostimulant reduces the need for chemical fertilisers and pesticides and increases farmers' ROI (in kg per hectare), and we are using alginates and fucoidan to create sustainable alternatives for the packaging and nutraceutical industries. This approach is unique in that it does not rely on carbon credits for financial support.

CO_2 CAPTURE

Kelp, like land plants, draws down carbon through photosynthesis, converting dissolved CO_2 and bicarbonic acid from surrounding waters into biomass and oxygen. This process impacts atmospheric stock carbon by allowing the ocean to absorb more of it, while countering ocean acidification. Kelp also absorbs naturally occurring nutrients from the water, thereby supporting nutrient cycling. The standing stock of the biomass, (the Net Primary Production (NPP)) can be considered a temporarily captured stock of CO_2.

CO_2 SEQUESTRATION

We harvest the canopy 4 times annually - trimming only a fraction of the annually produced biomass. The remaining biomass follows natural dispersal pathways in the ocean, as outlined by the work of, among others, Carlos Duarte. Around 90% of the carbon undergoes grazing, remineralization, or deposition in low-durability sites. The remaining ~10% will be exported to the deep sea and buried in the shelf, forming highly durable sequestration forms lasting well over 100 years.

CO-BENEFITS OR PRODUCTS

Kelp forests provide crucial ecological benefits to the marine environment. They serve as marine habitats, nurturing a diverse range of species by improving water quality and providing food to a dynamic and interconnected web of marine life. By absorbing carbon (in the form of carbonic acid) from surrounding waters, kelp regulates pH levels, counteracting ocean acidification while replenishing oxygen. Our kelp forests are nurseries and spawning grounds for fish and help replenish local fish stocks crucial to coastal economies. Kelp also aids in regulating nutrients, combating eutrophication, and providing shoreline protection from strong waves and storms. Furthermore, kelp-derived products offer sustainable alternatives across industries, including agriculture, packaging, nutraceuticals, and more.

COMPANY OVERVIEW

COMPANY NAME
Planetary Technologies Inc.

HQ LOCATION
Dartmouth, Canada

FOUNDED
2019

XPRIZE TRACK
OCEAN

CDR PATHWAY(S)
Oceans - Ocean alkalinity enhancement

Rocks - Mineralization of mine or industrial waste

PHYSICAL PRODUCTS:
None

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PLANETARY

COMPANY DESCRIPTION

Planetary enhances the ocean's natural ability to fight climate change through Ocean Alkalinity Enhancement (OAE). Working collaboratively with all our stakeholders, we are developing a number of ocean carbon removal projects worldwide. At the heart of our projects is our Ocean Carbon Platform (OCP), which provides a cost effective and sustainable set of tools for use in qualifying alkalinity sources, automating alkalinity addition operations, monitoring ocean safety, and measuring and monetizing ocean carbon removals.

CORE INNOVATION

Planetary is the cheapest CDR process at scale. Using existing byproducts and infrastructure, our process requires negligible energy and capex. With alkaline byproducts set to grow from 1Gt/y CDR potential to as high as 8.5Gt/y by 2100, and scale estimates for OAE of > 100Gt/y, the process costs will remain low even as other CDRs run out of room. This is strengthened by Planetary's unique set of IP, products, systems and partnerships.

CO_2 CAPTURE

We add low carbon alkalinity to existing coastal outfalls. The most common alkalinity examples include magnesium hydroxide or calcium hydroxide. This alkalinity neutralizes acidic CO_2 that is present in seawater by converting it into carbonate and bicarbonate ions that are already abundant in the ocean. As ocean CO_2 is chemically consumed by this process, the ocean absorbs CO_2 from the atmosphere to bring the air and ocean back into CO_2 equilibrium.

CO_2 SEQUESTRATION

The mean seawater residence time of alkaline dissolved carbon (bicarbonate and carbonate ions (charged-balanced by cations other than H^+)) is about 100,000 yrs, based on the annual input of alkaline carbon from rivers (0.3 GtC/yr), the alkaline pool of dissolved alkaline carbon resident in the ocean (about 34,000 GtC), and assuming steady state (Middelburg et al. 2020). Any additional alkaline carbon added should behave in the same way.

CO-BENEFITS OR PRODUCTS

The project provides significant ecological co-benefits due to de-acidification at the outfall, improving the marine environment and benefiting fishing and shellfish industries. Local communities gain employment, an increase in CDR research funding, educational opportunities, talent attraction, economic development, and an increased international profile. Finally, the use of byproducts remediates and returns land to local communities.

XPRIZE CARBON REMOVAL | MUSK FOUNDATION

ROCKS

COMPANY OVERVIEW

COMPANY NAME
Arca Climate Technologies

HQ LOCATION
Vancouver, Canada

FOUNDED
2021

XPRIZE TRACK
ROCKS

CDR PATHWAY(S)
Rocks - Mineralization of mine or industrial waste

PHYSICAL PRODUCTS:
None

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ARCA

COMPANY DESCRIPTION

At Arca, we believe that to stabilize the climate, humanity needs to leverage the capacity of existing large-scale industrial operations. It makes sense to partner with industries like mining that handle billions of tonnes of material every year. We can harness mining's scale for positive climate impact by turning their waste into a carbon sink. Our ISO-validated approach, which accelerates the natural process of carbon mineralization, has been deployed and is removing carbon dioxide today.

CORE INNOVATION

Carbon mineralization is a natural process that occurs when carbon dioxide (CO_2) reacts with iron (Fe), magnesium (Mg) and calcium (Ca) at Earth's surface to form carbonate minerals - permanently removing and storing CO_2 as rock. This process naturally occurs over millennia and has played the defining role in the long-term carbon cycle. However, the rate of natural carbon mineralization is insufficient for combatting climate change today. Arca's portfolio of technologies accelerate this natural process in a number of ways. Our patented mineral activation technology uses microwave energy to liberate magnesium for reaction with CO_2. Based on our capability for real-time monitoring of carbon flux we can optimize the conditions and obtain the best possible rate of carbon mineralization.

CO_2 CAPTURE

Mine tailings are a type of fine-grained mine waste that consist of crushed rock, which at the microscopic scale, contain water between the grains, known as porewater. Due to the alkaline nature of certain types of mine waste, the porewater attains a high pH - a condition favourable for carbon mineralization. This induced alkalinity causes atmospheric CO_2 to spontaneously dissolve into the porewater where it is converted to bicarbonate ions.

CO_2 SEQUESTRATION

Some types of mine tailings naturally contain a lot of magnesium, which reacts with bicarbonate ions in the porewater to produce magnesium carbonate minerals, thereby sequestering carbon. These carbonate minerals are environmentally benign, thermodynamically stable and insoluble, providing storage for more than 10,000 years.

CO-BENEFITS OR PRODUCTS

Carbon mineralization is a form of cementation which may increase the stability of mine tailings, reducing the environmental, social and financial risk of tailings dam failure. Arca's mineral activation process may also improve crushing and grinding efficiency, reducing production costs for the mine operator. Due to their high magnesium content, our initial focus is on ultramafic tailings, which are produced from mining nickel. Experimental results show that Arca's mineral activation technology improves nickel yields from ultramafic mine tailings, which supports the industry's trend towards upcycling waste.

COMPANY OVERVIEW

COMPANY NAME
Lithos Carbon, Inc.

HQ LOCATION
San Francisco, CA, USA

FOUNDED
2022

XPRIZE TRACK
ROCKS

CDR PATHWAY(S)
Land - Agricultural & grassland CDR

Rocks - Ex-situ mineralization of mined rocks

Rocks - Mineralization of mine or industrial waste

PHYSICAL PRODUCTS:
None

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LITHOS CARBON

COMPANY DESCRIPTION

Lithos Carbon accelerates Earth's natural carbon cycle to permanently remove CO_2 from the air. Leveraging a decade of research, we deploy enhanced rock weathering in agriculture while simultaneously improving crop yields and soil health for farmers. We provide farmers with organic-grade volcanic basalt dust and empirically measure each tonne of CO_2 removed with state-of-the art science. Join our mission to decarbonize our food system, which is responsible for 25% of worldwide anthropogenic greenhouse gas emissions.

CORE INNOVATION

Lithos has carefully curated its feedstock sources, seeking superfine basalt that optimizes simultaneously for high carbon capture potential and low lifecycle emissions contribution. We've also pioneered an approach to MRV, historically a challenge in the ERW space. Lithos's cost-effective empirical attribution was developed by our founding team (professors / collaborators at Yale and Georgia Tech) to operationalize redundant and cradle-to-grave MRV.

CO_2 CAPTURE

Silicate rocks exposed to acidic rain will dissolve through a chemical weathering reaction, which simultaneously turns CO_2 in the rain into stable bicarbonate. This slow but powerful biogeochemical process effectively "locks up," carbon for tens of thousands of years, acting as a climate stabilizer. Lithos accelerates natural weathering by spreading fine basalt rock dust onto farmland. Very high porewater CO_2 concentrations help the soil environment function as a powerful natural weathering reactor.

CO_2 SEQUESTRATION

The dissolved bicarbonate formed through chemical weathering is transferred by rivers and streams to the coastal ocean, where it remains for thousands of years. Over time, the bicarbonate is biomineralized into calcium carbonate, which supports marine life and counteracts ocean acidification. Eventually, the calcium carbonate sinks to the ocean floor and becomes solid limestone.

CO-BENEFITS OR PRODUCTS

Basalt replaces liming, an essential aspect of farming to balance acidic soils. Unlike liming, basalt dissolution and pH control is complicated, so our technology creates a site-specific guide calibrated to local climatology and farm specific soil parameters. Basalt includes many micronutrients not present in limestone and releases a steady stream of these to a field as it dissolves. Our partner farmers benefit from significant benefits including drought and pest resistance, crop yield increases of up to 40%, and topsoil regeneration.

COMPANY OVERVIEW

COMPANY NAME
Mati Carbon

HQ LOCATION
Houston, TX, USA

FOUNDED
2022

XPRIZE TRACK
ROCKS

CDR PATHWAY(S)
Rocks - Ex-situ mineralization of mined rocks

PHYSICAL PRODUCTS:
None

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MATI CARBON

COMPANY DESCRIPTION

Mati Carbon is a Delaware registered Public Benefit Corporation that is controlled by a US 501(c)(3) with a mission to enable smallholder farmer climate resilience. Mati durably removes carbon from the atmosphere using basalt based Enhanced Rock Weathering (ERW) in smallholder rice paddy farms. This process removes atmospheric CO_2 while adding key nutrients in the soil helping to restore degraded soils to benefit smallholder farmers. Mati has developed robust monitoring and verification methodologies by partnering with Yale University to quantify and validate carbon removal through ERW. Mati is currently operational in India, Zambia and Tanzania and is in the process of expanding to other southeast asian countries.

CORE INNOVATION

Mati has developed a software platform to handle the logistical complexities of working with large numbers of smallholder farmers in remote areas of India. Mati's relationship with the non-profit Swaniti provides inroads with local government and stakeholders in remote farming regions of India. Additionally, Mati providing best-in-class Monitoring Reporting and Verification (MRV) for ERW. Our MRV tech-stack includes novel methods for soil monitoring coupled with sophisticated mass-balance and interpolation calculations to determine bulk CO_2 removal.

CO_2 CAPTURE

ERW is the practice of applying crushed rocks and minerals to agricultural land. Mati uses basalt as a mineral feedstock for this process. When the dissolution of Mati's feedstock occurs, base-cations liberated from the basalt react with carbonic acid (CO_2 dissolved in water) from rainwater and root respiration. This converts atmospheric CO_2 to bicarbonate. Effectively, ERW stoichiometrically rearranges the dominant dissolved species of carbon to a new form that does not revert to CO_2.

CO_2 SEQUESTRATION

Once bicarbonate is formed by ERW reactions, conversion to carbonic acid (dissolved CO_2) is not chemically favoured because the porewater must maintain charge balance with base-cations released by basalt feedstock. The bicarbonate ions then percolate into streams and rivers, and then to oceans. Bicarbonate ions may reside in groundwater within the soil column for decades to centuries. The eventual transport of these bicarbonate ions to oceans sequesters the carbon for >10,000 years.

CO-BENEFITS OR PRODUCTS

Mati's mission is to enable climate resilience for millions of smallholder farmers in the global south. Basalt dust enriches soil with macro-nutrients like silicon, calcium, and magnesium essential for plant structure and growth, and micro-nutrients like manganese and zinc for enzyme function and disease resistance in crops. As per our initial trials results, adding basalt dust to rice paddies has led to ~20% improvement in crop productivity, lowered diseases and increased water retention capacity.

COMPANY OVERVIEW

COMPANY NAME
Silicate Carbon Ltd.

HQ LOCATION
Dublin, Ireland

FOUNDED
2021

XPRIZE TRACK
ROCKS

CDR PATHWAY(S)
Rocks - Ex-situ mineralization of mined rocks

Rocks - Mineralization of mine or industrial waste

Rocks - Other

PHYSICAL PRODUCTS:
None

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SILICATE CARBON

COMPANY DESCRIPTION

Harnessing a natural geochemical process, Silicate Carbon permanently removes carbon dioxide from the atmosphere via the acceleration of mineral weathering. Silicate Carbon applies fast weathering carbonate minerals to agricultural land to amend soil pH, boost crop productivity, and – most importantly - permanently remove excess carbon dioxide from the atmosphere.

CORE INNOVATION

Silicate Carbon's climate solution lets the rocks do the work. The chemical weathering of minerals is a natural sink for carbon capturing around one billion tonnes of carbon dioxide each year. Silicate Carbon accelerates and enhances this natural process, so that it can be added to the toolkit of climate change mitigation solutions. Their process tackles three problems in one: (i) increase the resilience of farmland to climate change, (ii) improve soil pH for optimised plant growth and (iii) durably sequester carbon dioxide.

CO_2 CAPTURE

The team is focused on enhancing the chemical weathering of calcite and milled returned concrete (MRC). Silicate Carbon applies these carbonate-bearing materials to agricultural land following its science-led amendment protocol, and then measures soil waters, soils and greenhouse gas fluxes to measure carbon removal. The weathering reaction takes carbon from the atmosphere and stores it as soluble bicarbonate ions (HCO_3-). This is a natural reaction that occurs every day. By spreading milled material, the surface area available for weathering is increased and CO_2 capture is accelerated.

CO_2 SEQUESTRATION

The bicarbonate ions flow to the ocean via surface and ground waters. The residence time of bicarbonate in the oceans is ~80,000 years (Berner and Berner, 1987). It is this ocean residence time that ensures that the carbon dioxide is durably sequestered well beyond a 100-year timescale. After ~80,000 years, negatively charged bicarbonate ions bond with positively charged calcium ions, forming $CaCO_3$ (limestone).

CO-BENEFITS OR PRODUCTS

Because of its rapid weathering kinetics, calcite and MRC can be used to amend soil pH in farmland, which not only can unlock crop productivity gains, but the adjustment of pH can reduce N_2O fluxes. The addition of silica to soil from the MRC also strengthens crop roots and can increase the resistance of plants to herbivory (Ahmed et al., 2023). Another widely discussed co-benefit of EW is that once the dissolved bicarbonate makes its way to the ocean, it can facilitate the remediation of ocean acidification.

COMPANY OVERVIEW

COMPANY NAME
UNDO Carbon Ltd.

HQ LOCATION
London, United Kingdom

FOUNDED
2022

XPRIZE TRACK
ROCKS

CDR PATHWAY(S)
Rocks - Ex-situ mineralization of mined rocks

PHYSICAL PRODUCTS:
None

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UNDO CARBON

COMPANY DESCRIPTION

With nature-enabled enhanced rock weathering technology, UNDO generates permanent, high-quality carbon removal credits with added co-benefits to support businesses on their pathway to net zero. UNDO aims to remove one million tonnes of CO_2 annually by 2030, a first step towards gigatonne-scale operations.

CORE INNOVATION

UNDO built its own tech platform, has world-leading scientific R&D and has written the partnership playbook to harness global networks on scaling carbon removal globally. The global ERW company has spread more crushed silicate rock than any other ERW developer and uses its operational, scientific and commercial knowledge to drive down the cost of high-quality carbon removal. Critically, UNDO's MRV encompasses a multi-proxy approach across solid, aqueous and gaseous measurements combined with a best-in-class geochemical model.

CO_2 CAPTURE

For millions of years, CO_2 has combined with rainwater to form carbonic acid. When this dilute acid falls, the CO_2 interacts with rocks and soil, mineralises and is safely stored as solid carbon for hundreds of thousands of years. UNDO does enhanced rock weathering, accelerating this natural weathering process by spreading crushed silicate rock such as wollastonite on agricultural land, vastly increasing the surface area of the rock and therefore its contact with CO_2.

CO_2 SEQUESTRATION

When carbonic acid rainwater falls and contacts the crushed silicate rock, weathering occurs. This releases solutes, including bicarbonate ions (HCO3-) which chemically mineralise atmospheric CO_2 into a stable solid. These bicarbonates drain into surface waters or are transported via rivers to the oceans, where they are locked away for tens of thousands of years.

CO-BENEFITS OR PRODUCTS

ERW releases calcium, magnesium, silicon, and other macro and micronutrients into the soil, acting as a beneficial input. This results in greater crop yields, increased pest resistance, improvement to the pH of soils and a reduced need for CO_2-emitting lime inputs. UNDO provides its product to farmers for free or heavily subsidised, meaning they are saving money on inputs and reaping more during harvest time. On a UK crop trial in partnership with Newcastle University, an average 15% yield increase on spring oats was observed.

COMPANY OVERVIEW

COMPANY NAME
Yuanchu Technology (Beijing) CO., Ltd.

HQ LOCATION
Beijing, China

FOUNDED
2014

XPRIZE TRACK
ROCKS

CDR PATHWAY(S)
Rocks - Mineralization of mine or industrial waste

PHYSICAL PRODUCTS:
Building Materials, Other

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YUANCHU

COMPANY DESCRIPTION

Yuanchu is a leading start-up dedicated to developing disruptive direct air mineralization (DAM) technology for removing CO_2 from air and permanently sequestering it into solid carbonated material at gigatonne scale. The mineralization products keep stable for 1000 years.

CORE INNOVATION

1. Capture and sequestration of carbon dioxide are completed in one step;

2. High reaction efficiency (>90%);

3. Low capital cost, less than $100 per tonne CO_2 when scaling up to the megatonne level or gigatonne level.

CO_2 CAPTURE

The CO_2 in the air flows into the YAM mineralization reactor and reacts with Ca2+ from the feedstock (natural minerals, industry waste) to directly form calcium carbonate. It combines the carbon capture and mineralization into one step, which significantly reduces the CapEx and OpEx.

CO_2 SEQUESTRATION

Calcium carbonate, as the main reaction product, is the most stable chemical form of carbon and can stably sequester carbon dioxide for over thousands of years.

CO-BENEFITS OR PRODUCTS

We are utilizing the calcium resource from either industrial waste or natural ores. Once we use the industrial waste as the feedstock to form carbonates, it can be used as mine fillers, bulk building materials aggregates or road materials, forming a circular economy to recycle industrial waste materials.