



**CARBON DIOXIDE  
REMOVAL**  
MISSION

# Carbon Dioxide Removal (CDR) Launchpad Projects

February 2024



# Introduction

The Carbon Dioxide Removal (CDR) Launchpad is a coalition of governments who have agreed to work together to accelerate the pace of CDR technologies, which remove CO<sub>2</sub> directly from the air, by investing in demonstration projects and sharing data and experiences.

Launchpad members commit to support at least one, 1,000+ tonne CO<sub>2</sub> per year CDR project by 2025 and share data and information from the projects. Accordingly, this document provides information about Launchpad projects.

Such information promotes transparency and integrity and facilitates knowledge exchange among members.

The Launchpad initiative focuses on a portfolio of technological CDR approaches, including direct air capture with storage, enhanced mineralization (enhanced rock weathering), and biomass with carbon removal and storage. In time, this sprint could expand to include additional carbon removal approaches.

Demonstration projects of 1,000 tonnes or more per year of CO<sub>2</sub> removal are critical for driving down costs and scaling up CDR approaches. For example, demonstrations:

- Promote learning-by-doing cost reductions
- Prove emerging technologies and reduce technical risk
- Provide valuable data for scientists and engineers to optimize operations
- Can provide examples for constructive community engagement
- Illustrate potential co-benefits, such as water production and removing hazardous pollutants

# CDR Launchpad Projects



## Canada projects

### CARBONITY

- Location: Port-Cartier, Quebec, Canada
- Brief Project Description: Construction of a new plant that will transform biomass waste (i.e., wood residues) into value-added biochar products.
- Capacity: Starting at 10 000 t/biochar per year from 2024 and then progressing towards 30 000 t/ biochar per year in 2026 at full capacity will generate at full capacity 75 000 CO2 removal
- CDR Type: BiCRS
- Technology category: Biochar
- Storage / utilization mechanism: Biochar
- Feedstocks: Forest residues – low-grade wood residuals and forest waste, including insect-infested wood.
- Heat / energy sources: Excess heat (syngas) stemming from the production of biochar is recirculated to generate the needed heat in the process. Propane is used, but only for the pre-heating of the process. Electric consumption from hydroelectricity is required for the plant
- Siting characteristics: The site is a brownfield, since the plant will be in a former Groupe Arbec building that has been retrofit to host the biochar production plant. The storage is onsite, and we can assume will remain onsite prior to delivery to customers (estimate of 1 to 2 months).

Carbonity plant is considered part of an industrial cluster because Bioenergy AE for revalorization of bio-oil (resulting from the pyrolysis process) is on site and Groupe Arbec as well for provisioning the used biomass residues. Furthermore, industrial customers for pyrolytic oil are within 10 km of the production site.

- Year construction begins: 2023

- Year operation begins: First phase of plant finalized in 2024, with production capacity of 10,000 tons of biochar / year. By 2026, aiming to triple annual production capacity (30,000 tons of biochar/year)
- Owners/operators: Joint-Venture: Airex Énergie, SUEZ, and Groupe Arbec
- Total project cost: \$38,000,000
- Co-benefits: Production of pyrolytic oil as a source of energy for an industrial nearby. Biochar can be used in several applications, including as soil amendment; for water and soil remediation; as an additive in construction materials; and animal feed supplement and litter.
- Government support:
  - Government of Canada (NRCan): \$7.5M CAD
  - Government of Canada (DEC): \$3M CAD
  - Government of Quebec: \$16.2M CAD
- References/urls:
  - Government of Canada [news release](#)
  - Airex Énergie [website](#)
  - Carbonity Project [website](#)

## Rocky Mountain Carbon

- Location: Hinton, Alberta, Canada 53.414631 / -117.569497
- Brief Project Description: A front-end engineering design (FEED) study to de-risk the proposed Rocky Mountain Carbon project, a bioenergy carbon capture and storage (BECCS) project for negative emissions at the Hinton Pulp Mill Site. Chemical pulp mills are the largest point source emitter of biogenic CO<sub>2</sub> in Canada and Hinton Pulp Mill is well placed for geological storage. The project includes capture a four separate point sources at the project site in Hinton, Alberta. The project aims to:
  - Contribute to the final investment decision for a project-to-be-constructed that has the potential to generate 1,500,000 tCO<sub>2</sub>/year of permanent carbon dioxide removals (CDRs).
  - Provide information on the feasibility of BECCS projects – particularly those at chemical pulp mills.

- Help others leverage knowledge gained from the project to further de-risk and develop forest products BECCS hubs in Canada.
- Capacity: 1,500,000 tCO<sub>2</sub>/year [Note: FEED Study for a potential project]
- CDR Type: BiCRS, BECCS
- Technology category: solvent
- Storage / utilization mechanism: Onshore geologic storage
- Feedstocks: Black liquor (pulping byproduct), mill residues, forest residues, fire risk reduction thinnings
- Heat / energy sources: Biomass CHP will provide process heat and power while adding to CDR generation.
- Siting characteristics: Co-located with existing pulp mill. Part of the objectives of the FEED study are to study potential underground sequestration sites located near the plant and pipeline routes.
- Year construction begins: 2026
- Year operation begins: 2029
- Owners/operators: Vault 44.01 Ltd
- Total project cost: \$15,575,000 CAD
- Co-benefits: Reduced wildfire risk, generation of CDRs for export
- Community engagement undertaken through the process: Made initial contacts with government and Indigenous communities in the area ahead of the announcement of award for pore space required for the project.
- Government support:
  - Government of Canada (NRCan): \$5,300,000 CAD
  - Emissions Reduction Alberta: \$2,487,500 CAD
- References/urls
  - NRCan Funding Opportunities – [Current Investments](#)
  - [Rocky Mountain Carbon webpage: www.rockymountaincarbon.com](http://www.rockymountaincarbon.com)
  - Vault 44.01 [webpage](#)

## Hydrogen Naturally

- Location: Alberta's Industrial Heartland (northeast of Edmonton, Alberta, Canada)

- Brief Project Description: Hydrogen Naturally is Canada's largest BECCS project currently underway. H2N is using proven technologies that will convert forestry residues to carbon-negative hydrogen via gasification with CCS. Built as central Hubs with 4 equally scaled units, H2N is planning to develop four hubs across North America, three in Canada, one in the U.S. Gulf Coast. Wood residues are railed from remote communities to each Hub.
- Capacity: 4,000,000 tonnes CO<sub>2</sub> per year (1M tonnes CO<sub>2</sub>/year per unit)
- CDR Type: BECCS
- Technology category: Gasification and amine solvent
- Storage / utilization mechanism: Onshore geological storage in saline formation.
- Feedstocks: Forest residues
- Heat / energy sources: H2N will use grid electricity in addition to consuming a portion of the H<sub>2</sub> product for heat.
- Siting characteristics: The first greenfield site is in Alberta's Industrial Heartland and near the Alberta Carbon Trunk Line (ACTL). The ACTL was conceived by one of H2N's founding partners, North West Capital Partners, with an installed capacity of 15 MT/year and has catalyzed CCS in Canada. The site is also close to existing high volume hydrogen users such as refiners and fertilizer producers. Feedstock pellet mills, located in remote Indigenous communities, will rail pellets to the hydrogen Hub.
- Year construction begins: 2025
- Year operation begins: 2028
- Owners/operators: Hydrogen Naturally for Hub 1; additional project partners anticipated for other Hubs.
- Total project cost: \$2Bn CAD for Unit 1 of Hub 1; \$1.3Bn CAD for additional units.
- Co-benefits: Use of forest residues leads to improved forest health and reduction in forest fires (Canada had nearly 2 GT of CO<sub>2</sub> emissions in 2023 from forest fires) and associated emissions. By using forest residuals, H2N will help avoid emissions from rotting and slash pile burning which contributes ~ 100 MT/year of CO<sub>2</sub>.  
  
H2N's negative emission hydrogen can decarbonize hard to abate industries and avoid emissions from fossil fuel consumption.
- Community engagement undertaken through the process: From conception, H2N has been engaging with First Nation communities in AB, BC and Sask with

the plan for these communities to construct and own wood fibre pellet mills leveraging long term supply contracts from H2N to obtain low cost of ownership for the First Nations.

- Additional information: H2N has completed 3 independent LCA's, each demonstrating a carbon intensity of negative ~150 gCO<sub>2</sub>/MJ. LCA's were completed using approved protocol for the Canadian Clean Fuel Standard and British Columbia Low Carbon Fuel Standard.
- Government support:
  - Alberta ACCIP
  - Anticipated support through Federal Investment Tax Credits (ITC)
  - Grant funding for Pre-FID engineering
- References/urls:
  - <https://www.h2naturally.com/>

## Deep Sky

- Location: HQ: Montreal, DAC Site: Quebec (Site TBC)
- Brief Project Description: Deep Sky Alpha will be the world's first carbon removal and innovation centre that brings together the best direct air and direct ocean capture technologies under one roof. With a total capacity of 3000 tonnes per year, Alpha will operate pilot units, between 50 tonnes per year to 1000 tonnes per year capacity, side by side to test, validate, and benchmark their performance. The best technologies that are identified at Deep Sky Alpha will be scaled in partnership with the technology providers for Deep Sky's commercial operations. Canada is the perfect testbed for carbon removal technologies from around the world as it offers a broad range of seasonal climates for testing, a supportive policy regime, and a highly educated and skilled innovation workforce. Deep Sky Alpha will start operations in Summer of 2024 and will become the worldwide industry standard for technology validation in carbon removals.
- Capacity: Individual pilot units: 50-1000 tpa; Facility total: 3000 tpa
- CDR Type: DAC
- Technology category: Solvent and sorbent (across multiple pilots)



- Storage / utilization mechanism: Ex-situ mineralization, deep saline injection (off-site)
- Feedstocks: Air
- Heat / energy sources: All processed energy is from grid electricity
- Year construction begins: 2024
- Year operation begins: 2024
- Owners/operators: Deep Sky
- Total project cost: ~\$50M
- Co-benefits: Several pilot units produce water.
- Community engagement undertaken through the process: Spoken to local municipalities about the project. It has been met with enthusiasm and interest by those in the respective mayor's offices. Community engagement will ramp up as project progresses.
- Additional information: Quebec's electricity is clean with 95% from hydroelectricity and 99% from renewable sources. Hydro-Quebec modulates the output of their large hydroelectric plants to match demand but there is many TWh of additional low-carbon electricity which could be produced annually by HQ if it were needed. Quebec experiences a wide range of environmental conditions (e.g., temperature, humidity, precipitation) over the course of the year which enables yields a deep understanding of how these DAC technologies handles different conditions.
- Government support:
  - Investissement Québec
  - Business Development Bank of Canada (BDC)'s Climate Tech Fund
- References/urls:
  - <https://www.deepskyclimate.com/>





## European Commission projects

### BECCS Stockholm (KVV8 plant)

- Location: Stockholm (Värtan area), Sweden
- Brief Project Description: Stockholm Exergi is building a full-scale BECCS-plant connected to its existing biomass CHP (Combined Heat and Power) plant KVV8 in central Stockholm. BECCS Stockholm aims at capturing and storing up to 800 000 tons of biogenic CO<sub>2</sub> per year, and further improve the technology in the future. The plant will remove/avoid the emissions of 7.8 Mt CO<sub>2</sub>eq of absolute GHG emissions during its first ten years of operation. From the overall emissions removed/avoided, 90% will come from CO<sub>2</sub> capture and storage (emissions removal), and 10% will be associated with renewable electricity and heat generation from a renewable source (emissions avoided). Based on the experience and successful outcome of this project, Stockholm Exergi plans to develop additional BECCS facilities at its other bio-CHP and waste incineration plants after 2030. The potential total capture capacity could therefore reach up to 1.7 million tons of biogenic CO<sub>2</sub> by 2045.
- Capacity: 800 000 tons per year (once complete and fully operational)
- CDR Type: BECCS
- Technology category: Hot Potassium Carbonate
- Storage / utilization mechanism: After liquefaction and buffering, the CO<sub>2</sub> will be transported by ship to an underground storage site either off-shore in the North Sea or on-shore/near-shore in Denmark or Iceland.
- Feedstocks: Locally sourced biomass waste.
- Heat / energy sources: Combined Heat and Power from biomass (bio-fueled CHP).
- Siting characteristics: The carbon capture unit is connected to the existing KVV8 plant as a retrofit.
- Year construction begins: Q4/2024 (Project began on 01/07/2021)
- Year operation begins: Q3 2027
- Owners/operators: Stockholm Exergi

- Total project cost: EUR 2 707 453 271 (original amount, not updated since the GA)
- Co-benefits:
  - Reuse of process water to eliminate or reduce the use of fresh water.
  - Supply sustainably managed forests with fly ash coming from the co-incineration of the current biomass waste with phosphorous-rich sludge. This could increase Swedish forest sequestration of carbon by 0.45 Mt CO<sub>2</sub>eq per year.
  - Jobs creation in and outside Sweden.
- Government support: The project is supported by the EU's Innovation Fund and received 180 million EUR in EU funding.
- References/urls:
  - [https://climate.ec.europa.eu/system/files/2022-07/if\\_pf\\_2022\\_beccs\\_en.pdf](https://climate.ec.europa.eu/system/files/2022-07/if_pf_2022_beccs_en.pdf)
  - <https://www.stockholmexergi.se/en/bio-ccs/>

## Net Zero Energy Carbon Capture at ARC

- Location: Vindmoellevej 6, 2300 Copenhagen S. Denmark
- Brief Project Description:

Objective and hypothesis: The objective of the project is to investigate how to best integrate carbon capture with waste incineration and whether it can be done in an energy-neutral manner, so the excess heat from the carbon capture process is utilised for district heating. The project, therefore, aims to construct, commission and operate a cost-effective demonstration-scale Carbon Capture unit at ARC.

Approach: ARC has been conducting experiments with a smaller pilot unit since 2021. The unit has subsequently been used in several other locations in Denmark. Due to the positive results, ARC did open a larger demonstration facility in 2023 with a capacity of nearly 4 tons of CO<sub>2</sub> per day. The purpose of the demonstration facility is: 1. To gain a better understanding of the technology to enable the construction of the best possible full-scale plant. 2. To further reduce the energy requirements beyond what was achieved in the pilot plant. 3. To simulate the connection to the district heating network, maximising the utilisation of the heat generated.

Expected impact/output: The outcome of the project will be a complete demonstration-scale CC unit that will be constructed at ARC, integrated with the waste-to-energy plant, and optimised for net zero energy consumption. The project will be part of a decision base for ARC to decide upon an investment in a large -scale Carbon Capture unit to capture all the 500,000 tons of CO<sub>2</sub> emitted by ARC every year.

- Capacity: 1200 tons per year
- CDR Type: BECCS (waste with high biogenic content) where heating, power and CO<sub>2</sub> is utilized.
- Technology category: Amine solvent.
- Storage / utilization mechanism: Planned for saline formation. Until a sustainable site is ready the CO<sub>2</sub> is utilized in greenhouses.
- Feedstocks: Municipal waste.
- Heat / energy sources: Steam and power from the waste-to-energy plant.
- Siting characteristics: The carbon capture unit is located inside the existing waste-to-energy plant.
- Year construction begins: 2023
- Year operation begins: 2023
- Owners/operators: ARC – Amager Ressourcecenter
- Total project cost: 62,6. millions Dkk.
- Co-benefits: CO<sub>2</sub>-removal. Knowledge building.
- Community engagement undertaken through the process: More than 1200 people have visited to see the pilot and demo-plant. Many local, national and international news stations, senior politicians and head-of-states have visited. Local businesses have enquired to off take CO<sub>2</sub> or simply to learn more about how it works.
- Additional information: Quote from project leader Jannik Kappel: "ARC is working towards making Amager Bakke CO<sub>2</sub>-neutral. And the demonstration carbon capture unit is an important steps towards meeting that goal".  
Clarification from Jannik Kappel: this project is mostly about learning how to do carbon capture effectively. The main purpose is thus not to capture CO<sub>2</sub> but gain knowledge and disseminate and use the knowledge.
- References/urls:

- <https://a-r-c.dk/klima-og-miljo/co2-fangst/demonstrationsanlaeg-til-co2-fangst/>

## Ørsted Kalundborg Hub

- Location: Avedøre power plant, Copenhagen, Denmark  
Asnæs power plant, Kalundborg, Denmark
- Brief Project Description:

Ørsted will establish carbon capture at its wood chip-fired Asnæs Power Station in Kalundborg in western Zealand and at the Avedøre Power Station's straw-fired boiler in the Greater Copenhagen area.

Ørsted will capture 150,000 tonnes of biogenic CO<sub>2</sub> per year from the straw-fired unit at Avedøre Power Station. The CO<sub>2</sub> will initially be transported by lorry to Asnæs Power Station until a shared pipeline infrastructure across Zealand has been established.

The straw-fired unit at Avedøre Power Station converts locally sourced straw into electricity and district heating annually. The straw is a by-product of agriculture. Ørsted will capture 280,000 tonnes of biogenic CO<sub>2</sub> per year from the wood chip-fired unit at Asnæs Power Station, which will also function as a CO<sub>2</sub> hub, handling and shipping biogenic carbon from both the Avedøre and Asnæs combined heat and power stations to the Northern Lights storage reservoir in the Norwegian part of the North Sea.

The wood chip-fired unit at Asnæs Power Station converts wood chips from primarily the Baltics into electricity, district heating, and process steam for the local industry. The wood chips come from sustainably managed production forests and consists of residues from trimming or crooked trees
- Capacity: 430,000 tonnes of biogenic CO<sub>2</sub> per year.
- CDR Type: BECCS
- Technology category: As carbon capture provider, Aker Carbon Capture will deliver five Just Catch™ units to the CHP plants. The Just Catch™ standardised concept is a modular and configurable offering, which enables the deployment of carbon capture units.
- Storage / utilization mechanism: The 430,000 tonnes of biogenic CO<sub>2</sub> from the Asnæs and Avedøre combined heat and power stations will be shipped to the

Northern Lights storage reservoir in the Norwegian part of the North Sea. Ørsted has entered a contract with Northern Lights, who is developing a CO<sub>2</sub> transport and storage infrastructure.

- Feedstocks: Straw and wood chips.
- Heat / energy sources: Bioenergy.
- Siting characteristics: Two existing combined heat and power plants (CHPs).
- Year construction begins: 2023
- Year operation begins: During 2025, the Asnæs and Avedøre combined heat and power plants will begin to capture and store biogenic carbon, and at the beginning of 2026, the two units will capture and store approx. 430,000 tonnes of biogenic CO<sub>2</sub> every year.
- Owners/operators: Ørsted
- Co-benefits: The carbon capture process will be heat-integrated with the combined heat and power plants, enabling district heating to be supplied both in Kalundborg and the Greater Copenhagen area. The carbon capture process at Avedøre Power Station's straw-fired boiler has the potential to regenerate approximately 35 MW of surplus heat, and the carbon capture process at Asnæs Power Station has the potential to regenerate approximately 50 MW of surplus heat, corresponding to the annual district heating consumption of approx. 11,000 and 20,000 Danish households, respectively.
- Community engagement undertaken through the process: Close dialogue with local municipalities.
- References/urls: <https://orsted.com/en/what-we-do/renewable-energy-solutions/orsted-awarded-ccs-contract>



## Iceland projects

### Orca

- Location: Hellisheidi, Iceland
- Brief Project Description
- The Orca facility consists of eight collector containers, with an annual capture capacity of 500 tons each. The containers are arranged around a central process hall that accommodates all electrics, such as the processing unit, allowing operation and control of the facility from afar. Amine-functionalized solid sorbents are used to separate the CO<sub>2</sub> from air, drawn in by fans. Heat is used to release the CO<sub>2</sub> from the sorbent, after which the CO<sub>2</sub> gets mixed with water and injected into basalt rock and forms permanent carbonate minerals.
- Capacity: Up to 4,000 tonnes per year
- CDR Type: DAC
- Technology category: Climeworks – sorbent
- Storage / utilization mechanism: Carbfix – in-situ mineralization in basalt. The rock under Hellisheidi is young (less than 1 million years old) volcanic, porous basalt.
- Feedstocks: Air
- Heat / energy sources: The heat and electricity required to run the direct air capture process is supplied by the Hellisheidi Geothermal Power Plant, operated by Reykjavik Energy. The plant draws hot water from over a mile below the ground, where it's naturally warmed by a volcanic hotspot. The electricity is used by fans to move air through the collector, and the heat is used to release captured CO<sub>2</sub> from the filter material, which happens at around 100 degrees Celsius
- Siting characteristics: Co-located with geothermal power plant, Hellisheidi, and CO<sub>2</sub> injection into volcanic basalts.  
An important design aspect was that Orca is integrated into the Icelandic landscape. The facility uses earthy colours and natural materials.
- Year operation begins: 2021

- Owners/operators: Climeworks and Carbfix
- Total project cost: Estimated to be \$10–15 million USD
- Additional information: Carbfix is a subsidiary of Reykjavik Energy, the municipal-owned utility that operates the geothermal plant.
- References/urls: <https://climeworks.com/plant-orca>

## Mammoth

- Location: Hellisheidi, Iceland
- Brief Project Description

The Mammoth project will use Climeworks' DAC technology where ambient air is drawn in by fans into collector containers. Mammoth will consist of 72 collector containers (in contrast to the 8 containers deployed at Orca), three of which are stacked together on one foundation (vs. two at Orca). The containers represent the modularity of technology. In the collector containers, amine-functionalized sorbents are used to separate the CO<sub>2</sub> from other molecules in the air. Heat is used to release the CO<sub>2</sub> from the sorbent filter, after which the CO<sub>2</sub> gets mixed with water and injected into basalt rock and forms permanent carbonate minerals.
- Capacity: Nominal design for up to 36,000 tonnes of CO<sub>2</sub>
- CDR Type: DAC
- Technology category: Climeworks – sorbent
- Storage / utilization mechanism: Carbfix – in-situ mineralization of CO<sub>2</sub> mixed with water and injected in basalt.
- Feedstocks: Air
- Heat / energy sources: The Hellisheiði electricity power plant operated by ON Power (a subsidiary of Reykjavik Energy) will supply Climeworks' Mammoth plant and the Carbfix CO<sub>2</sub> injection sites with renewable energy to run the entire direct air capture and storage process. The plant was launched in 2006 and has a capacity of 200 MW in thermal power and 303 MW in electricity. A hydrogen sulphide abatement unit is located at the plant, which uses the Carbfix process to filter out 75% of the hydrogen sulphide and 30% of the carbon dioxide which is dissolved in the geothermal fluids and conducted into the re-injection system.
- Siting characteristics: Same location as Orca facility, but about 10 times bigger.



Co-located with geothermal power plant, Hellisheidi, and CO<sub>2</sub> injection into volcanic basalts.

- Year construction begins 2022. Construction is expected to last 18-24 months before operations start.
- Year operation begins: 2024 / 2025. The collector containers entered the manufacturing phase in the first quarter of 2023, but supply chain delays are impacting timelines.
- Owners/operators: Climeworks and Carbfix  
Ramboll providing engineering services
- Additional information: Mammoth is using technology learnings from operating nearby Orca facility. Mammoth is Climeworks' second kiloton scale plant.
- References/urls:
  - <https://climeworks.com/plant-mammoth>
  - <https://www.on.is/en/about-us/power-plants/>



## Japan projects

### NEDO Fund "Green Japan, Green Innovation" Project

- Location: Hibiya Mitsui Tower 11th Floor, 1-1-2 Yurakucho, Chiyoda-ku, Tokyo (Gurunavi, Inc.)
- Brief Project Description:
 

Develop technologies to effectively realize the use of highly functional biochar which can enhance crop yields by around 20%, while sustainably removal (3 tCO<sub>2</sub>/ha/yr) from cropland.

Develop methods to objectively assess the "environmental value" of agricultural products grown through carbon capture and storage activities.
- Capacity: 3 tCO<sub>2</sub>/ha/yr from cropland (equivalent to 1.9 t<sub>biochar</sub>/ha). Project target: 500,000 tCO<sub>2</sub>/yr (in 2030)
- CDR Type: BiCRS
- Technology category: Organic carbon
- Storage / utilization mechanism: Soil carbon sequestration with biochar
- Feedstocks: Rice husk, Pruning branches, etc.
- Heat / energy sources: Setting up high-functional biochar production machine by oil fuel at biomass collection centers, like country elevators (CE), to locally manufacture efficient biochar and evaluate LCA for soil carbon sequestration through regional self-sufficiency.
- Siting characteristics: Rural area (Paddy field area)
- Year construction begins: 2023
- Year operation begins: 2023
- Owners/operators: Manager: Gurunavi, Inc., Katakura & Co-po Agri Corporation, YANMAR ENERGY SYSTEM CO., LTD., National Federation of Agricultural Cooperative Associations (ZEN-NOH), Agricultural cooperatives in various regions, National Agriculture and Food Research Organization (NARO)
- Total project cost: JPY 94,600,000,000 (2022~2030)
- Co-benefits:
  - Enhancing crop yields by around 20%

- Environmental value of agricultural products
- Community engagement undertaken through the process: On Nov 2, 2023, Dr. SUDO Shigeto (Research group leader, NARO) introduced this project at Mission Innovation Carbon Dioxide Removal Mission/BiCRS, International webinar.
- Additional Information: Improving biochar farming profitability and motivating farmers by:
  - Reducing costs of biochar production and application
  - Increasing crop yields with high-functional biochar
  - Showing the environmental benefits in transaction prices, like GHG reduction
  - Comprehensive integration of ICT technology for enhanced farmer incentives through “environmental value (EV)” visualization
- References/urls:
  - <https://green-innovation.nedo.go.jp/en/project/development-co2-agriculture-forestry-fisheries-industries/>
  - <https://green-innovation.nedo.go.jp/en/project/>



## Norway projects

### Hafslund Oslo Celsio's waste-to-energy (WtE) plant (CCS Oslo)

- Location: Klemetsrud in Oslo, Norway
- Brief Project Description: The project will capture the CO<sub>2</sub> emissions from Celsio's waste-to-energy plant. The waste treated at the plant consists of approximately 50 percent biological carbon. The project will be delivered based on Aker Carbon Capture's modularized Just Catch 400 unit, with a design capacity to capture 350,000 tonnes of CO<sub>2</sub> per year. Celsio's carbon capture unit will remove about 175 000 tonnes of biogenic CO<sub>2</sub> from the carbon cycle every year.
- Capacity: Net removal of about 175,000 tons of CO<sub>2</sub> per year
- CDR Type: BECCS
- Technology category: Solvent - Aker Carbon Capture amine technology, with 90+% capture rate
- Storage / utilization mechanism: Celsio's CCS project is part of Longship. The captured CO<sub>2</sub> at Celsio's project will be compressed and liquefied at Klemetsrud plant site and then trucked by electric truck to the Port of Oslo. The expected number daily loading and unloading transport operations are approximately 45, depending on the trailer payload. Specially designed ships will then take it to a temporary storage site in Øygarden in western Norway, from where it will be piped for permanent storage to the Aurora reservoir, a saline aquifer about 110 km from shore and 2.6 km under the seabed.
- Feedstocks: Municipal waste, 50% biogenic
- Heat / energy sources: Combustion of municipal / residual waste
- Siting characteristics: The carbon capture unit, intermediate storage, and truck loading, will be located next to the existing WtE facility.
- Year construction begins: 2024
- Year operation begins: 2028
- Owners/operators: Hafslund AS, Infranode and Hitec Vision

- Co-benefits: Avoids emissions from landfills by treating non-recyclable, residual waste in the most sustainable manner, and utilizes the excess heat from the incineration to produce district heating and electricity for the community.
- Community engagement: Since the start of the project, knowledge sharing, and advocacy have been at the centre of Celsio's CCS strategy. Through proactive participation in research projects and discussions with industry associations, NGOs and authorities, Celsio has contributed to raising the awareness of CCS, BECCS and WtE, and its role in the circular economy.
- References/urls:
  - <https://ccsnorway.com/capture-hafslund-oslo-celsio/>
  - [https://akercarboncapture.com/?cision\\_id=6D219225D18B0C1B#:~:text=Celsio's%20waste%2Dto%2Denergy%20plant,company%20employs%20a%20pproximately%20230%20people](https://akercarboncapture.com/?cision_id=6D219225D18B0C1B#:~:text=Celsio's%20waste%2Dto%2Denergy%20plant,company%20employs%20a%20pproximately%20230%20people)
  - [https://ccushub.ogci.com/focus\\_hubs/northern-lights/](https://ccushub.ogci.com/focus_hubs/northern-lights/)
  - <https://www.cewep.eu/hafslund-oslo-celsio-norway-ccs-project/>



## United Kingdom projects

### Sizewell C: DAC powered by Nuclear Power Plant

- Location: Lowestoft, UK
- Brief Project Description:

Sizewell C, together with its partners, University of Nottingham, Strata Technology, Atkins and Doosan Babcock, is developing and constructing an innovative heat-powered DAC demonstrator plant that could in the future be scaled up and integrated with the Sizewell C power plant.

Heat from a nuclear power plant is the cheapest form of low-carbon heat (according to a recent study by Columbia University) and the unique heat-powered DAC design will offer increased efficiency and less reliance on electricity compared to existing DAC technology.

A future scaled-up implementation could contribute substantially towards the decarbonisation of difficult-to-decarbonise sectors and help the UK achieve its Net-Zero ambitions. For example, a larger DAC plant integrated with Sizewell C could utilise c.400MWth of heat from the power plant to capture 1.5 million tonnes of CO<sub>2</sub> per year which is enough to almost offset the UK's entire emissions from railway transport
- Capacity: Over 1000 t/yr demonstrator
- CDR Type: DAC
- Technology category: Solvent
- Storage / utilization mechanism: Storage
- Feedstocks: Air
- Heat / energy sources: Waste heat nuclear power station
- Siting characteristics: Brownfield site
- Year construction begins: Demonstration 2023/4
- Year operation begins: Demonstration 2024

### Swindon GGR Plant

- Location: Swindon, UK

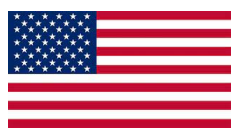
- Brief Project Description: The Advanced Biofuel Solutions Ltd Swindon Plant will convert waste wood or refused derived fuel into biomethane, biohydrogen and carbon dioxide. The biomethane is injected into the gas grid, the biohydrogen is metered into bottles and used in transport and the carbon dioxide is liquified and used in industry.

The process combines an oxy-steam fluidised bed gasifier with a direct current plasma furnace to produce a clean synthesis gas. This is catalytically converted into biomethane and biohydrogen and then carbon dioxide is removed using a potassium carbonate solvent. The biohydrogen will be purified using a pressure swing absorption system.

The aim of the plant is to provide a commercial demonstration of the process that will provide the evidence required to support development of commercial scale plants.

- Gross removals per year: 6,000 tonnes
- Net removals per year: 5,500 tonnes
- Year design completed: 2022
- Year construction begins: 2023
- Year operation begins: 2024
- Owners/operators: Advanced Biofuel Solutions Ltd
- References/urls: [www.absl.tech](http://www.absl.tech)





## United States projects

### Project Stratos

- Location: Ector County, TX, USA
- Brief Project Description:

The project will capture CO<sub>2</sub> directly from the atmosphere and store deep underground or could use the CO<sub>2</sub> to produce low carbon products. The initial facility will have the ability to store CO<sub>2</sub> in saline formations, which creates a carbon removal credit that businesses can purchase to address their emissions. The developer, IPointFive, has applied for a EPA Class VI permit for geologic sequestration.
- Capacity: 500,000 tpa
- CDR Type: DAC
- Technology category: Solvent
- Storage / utilization mechanism: Saline formation, oil & gas reservoirs, or products
- Feedstocks: Air
- Heat / energy sources: The facility will be powered by zero-emission energy sources, such as wind, solar or natural gas with carbon capture and storage.
- Siting characteristics: Located in the Permian Basin, with the facility in proximity to production wells for EOR and saline storage aquifers via Class VI wells (permit pending)
- Year construction begins: 2023
- Year operation begins: 2025
- Owners/operators: IPointFive will own Stratos. IPointFive is a subsidiary of Occidental. Through a fund managed by its Diversified Infrastructure business, BlackRock formed a joint venture with Occidental.
- Co-benefits: The project is expected to employ more than 1,000 people during the construction phase and up to 75 once operational.

- Additional information: 1PointFive has signed CO<sub>2</sub> removal credit purchase agreements with customers, including Amazon, Airbus, All Nippon Airways (ANA), TD Bank Group, the Houston Astros, and the Houston Texans
- References/urls:
  - [Ector County, TX | 1PointFive](#)
  - [DAC Technology | 1PointFive](#)

## Heirloom – Tracy Plant

- Location: Tracy, CA
- Brief Project Description

Heirloom's facility in Tracy, California, employs a DAC process that uses Earth-abundant minerals, namely limestone - calcium carbonate (CaCO<sub>3</sub>), and renewable energy to capture carbon dioxide (CO<sub>2</sub>) directly from air. The process is divided into two steps, regeneration and carbonation. During regeneration, limestone mineral powder is heated in a renewable-energy powered kiln to remove the CO<sub>2</sub>, which is then injected into concrete for long lasting storage. Once the CO<sub>2</sub> is removed from the limestone, the carbonation step involves the mineral powder being spread onto vertically-stacked trays and optimized to uptake CO<sub>2</sub> in different environmental conditions. The mineral powder is looped in a cyclic process to continuously separate CO<sub>2</sub> from the atmosphere.
- Capacity: 1,000 tonnes of CO<sub>2</sub>/yr
- CDR Type: DAC
- Technology category: Solid oxide sorbent derived from limestone. Naturally occurring minerals are used instead of synthetic sorbents. Although the approach can theoretically accommodate any mineral carbonate feedstock, Heirloom uses calcium carbonate, CaCO<sub>3</sub>
- Storage / utilization mechanism: Utilization in concrete with CarbonCure as the utilization project partner
- Feedstocks: Air
- Heat / energy sources: Powered by renewable energy supplied locally by Ava Community Energy
- Siting characteristics: Co-location with cement production facility
- Year operation begins: 2023

- Owners/operators: Heirloom, CarbonCure
- Community engagement undertaken through the process: Heirloom is implementing a community governance model, gathering stakeholder input on financial and programmatic investments into Tracy and San Joaquin County community organizations. Via quarterly meetings, this process gathers routine community feedback on the facility and its operations and help to steer input for how Heirloom will provide financial and programmatic investments in community organizations.
- Additional information: Removal credit contracts with Microsoft and Stripe.
- References/urls: [Technology \(heirloomcarbon.com\)](https://heirloomcarbon.com)

## South Texas DAC Hub

- Location: Kleberg County, TX, USA
- Brief Project Description

IPointFive, a subsidiary of Occidental, will develop the South Texas DAC Hub that demonstrates the technical and commercial viability of DAC as well as delivering regional economic, environmental, and social benefits to provide a model for the development of DAC Hubs across the U.S. and abroad. The South Texas DAC Hub is expected to include a Direct Air Capture facility designed to remove up to 1 million metric tons of CO<sub>2</sub> annually with an associated saline geologic CO<sub>2</sub> storage site.
- Capacity (tonnes per year): up to 1 million
- CDR Type: DAC
- Technology category: Solvent
- Storage / utilization mechanism: Saline formation
- Feedstocks: Air
- Heat / energy sources: On-site solar power with electricity connection to the grid
- Siting characteristics: A lease with King Ranch, a privately held agribusiness, real estate, energy, and resource management company, provides storage potential of 3 Gt of CO<sub>2</sub> in saline formations over 106,000 subsurface acres over two separate parcels.
- Year construction begins: 2025
- Year operation begins: 2027

- Owners/operators: 1PointFive will act as the DAC Hub owner and Carbon Engineering Ltd. is the DAC technology provider.
- Community engagement undertaken through the process: DOE co-hosted an in-person meeting in Houston, Texas on September 20, 2023, for the local host community to hear directly from the DAC Hubs selectees and DOE about the proposed DAC Hub projects and potential community benefits.

The project developers are creating a Community Benefit Plan (CBP). The CBP includes strategies to conduct meaningful engagement, including creation of a Community Advisory Board for active two-way engagement with the community, support workforce development, promote local hiring of a diverse workforce, and track benefit flows to disadvantaged communities in support of the Justice40 Initiative.

- Additional information: The Worley Group Inc. is the expected engineering, procurement, and construction (EPC) contractor; Carbon Direct Inc. will advise on the CBP and provide life cycle analysis; and Lawrence Livermore National Laboratory will provide workforce analysis and Justice40 tracking.
- References/urls:
  - [Regional Direct Air Capture Hubs Selections for Award Negotiations | Department of Energy](#)
  - [South Texas DAC Hub | 1PointFive](#)
  - <https://www.oxy.com/news/news-releases/occidental-and-1pointfive-king-ranch-lease-agreement-to-support-up-to-30-direct-air-capture-plants-on-leased-acreage/>

## Project Cypress

- Location: Calcasieu Parish, LA, USA
- Brief Project Description: Project Cypress, a Regional DAC Hub to be located in southwest Louisiana, aims to capture more than 1 million tonnes of existing carbon dioxide (CO<sub>2</sub>) from the atmosphere each year and sequester the CO<sub>2</sub> permanently deep underground.
- Capacity (tonnes per year): up to 1 million
- CDR Type: DAC
- Technology category:

- Climeworks – Sorbent. Amine-functionalised solid sorbent, temperature-vacuum swing
  - Heirloom – Minerals (e.g., lime/limestone). Solid oxide sorbent derived from minerals, passive contacting
- Storage / utilization mechanism: Project Cypress intends to rely on Gulf Coast Sequestration (GCS) for the offtake and geologic storage of captured atmospheric CO<sub>2</sub> Class IV wells into a saline formation
- Feedstocks: Air
- Heat / energy sources: Project Cypress will be operated fully by renewable electricity. A virtual power purchase agreement has been signed such that 100% of the electricity will be made available through renewable energy certificates generated by solar energy development.
- Year construction begins: 2025
- Year operation begins: 2029 (full scale)
- Owners/operators: Battelle, Climeworks, Heirloom
- Co-benefits (e.g. water production, removal of other pollutants): Job creation, improved water resilience and minimized environmental impact to the surrounding area.
- Community engagement undertaken through the process: DOE co-hosted an in-person meeting in Louisiana on November 7, 2023, for the local host community to hear directly from the DAC Hubs selectees and DOE about the proposed DAC Hub projects and potential community benefits.  
A Community Engagement Council was established to solicit ongoing community input and feedback at every stage of project development.  
Developers are also pursuing workforce and community agreements as part of a job creation strategy.  
A Project Cypress website is being developed for community access information and updates.
- References/urls
  - [Regional Direct Air Capture Hubs Selections for Award Negotiations | Department of Energy](#)
  - [Project Cypress](#)

## Project Bison

- Location: Sweetwater County, Wyoming, USA -41.9700, -108.4991
- Brief Project Description: Project Bison uses CarbonCapture Inc. modular direct air capture systems to filter CO<sub>2</sub> out of the air. Frontier Carbon Solutions then gathers and injects that CO<sub>2</sub> into deep saline aquifers via Class VI injection wells.
- Capacity: Targeting 5 million tonnes per year by 2030
  - Offtake agreement with Frontier for 45,000 tonnes by 2030
  - BCG offtake agreement for 40,000 tonnes over 5 years
  - Purchase agreement with Microsoft (tonnes not disclosed)
- CDR Type: DAC
- Technology category: Sorbent; Zeolite molecular sieves, temperature-vacuum swing
- Storage / utilization mechanism: Saline formation; injection via Class VI well
- Feedstocks: Air
- Heat / energy sources: Currently evaluating renewables or biomass with all CO<sub>2</sub> captured and sequestered.
  - CarbonCapture Inc estimates facility would initially require about 5 megawatts of power with demand increasing to as much as 1 gigawatt when Project Bison is completed at full capacity
- Siting characteristics: Within 15 miles of 3 Class VI wells that Frontier is planning to build
- Year construction begins: 2024
- Year operation begins: 2025
- Owners/operators: CarbonCapture Inc. (capture) and Frontier Carbon Solutions (gather and inject CO<sub>2</sub> via Class VI well)
- Community engagement undertaken through the process: On October 5, 2022, CarbonCapture Inc. and Frontier Carbon Solutions held a town hall event in Rock Springs, WY to answer questions about Project Bison. Invitations were sent to all households in Sweetwater County and an advertisement was placed in the online publication Sweetwater Now.
- Additional information: Offtake agreement with Frontier for 45,000 tonnes for \$20M
- References/urls [Project Bison - Wyoming \(carboncapture.com\)](https://www.carboncapture.com/project-bison-wyoming)

## Global Thermostat – Colorado

- Location: Commerce City, Adams County, Colorado, USA
- Brief Project Description: Global Thermostat’s demonstration unit near Denver CO uses a solid adsorption process with industrial fans to blow ambient air through contactors that bind to CO<sub>2</sub>, which is then separated out with low-temperature heat. The unit has been capturing carbon dioxide from the atmosphere since the end of 2022 with a capacity of over 1,000 tons a year,
- Capacity (tonnes per year): 1,000
- CDR Type: DAC
- Technology category: Solid amine sorbent on honeycomb ceramic monoliths
- Storage / utilization mechanism: Project demonstrates capture performance for the technology. CO<sub>2</sub> is released after demonstrated separation.
- Feedstocks: Air
- Siting characteristics: 2 acre site
- Year operation begins: 2022
- Owners/operators: Global Thermostat
- Additional information: The process focuses on using process heat to regenerate the sorbent after capture, with steam near 100 °C up to roughly 130 °C, with the preferred range being 105 °C–120 °C
- References/urls [Global Thermostat unveils one of the world’s largest units for removing carbon dioxide directly from air \(prnewswire.com\)](https://prnewswire.com/global-thermostat-unveils-one-of-the-worlds-largest-units-for-removing-carbon-dioxide-directly-from-air)

## Charm Industrial

- Location: Distributed. Biomass is hauled from farms in Kansas to a pyrolyzer, then bio-oil is transported by vehicles to underground injection wells.
- Brief Project Description: Charm collects biomass wastes and residues, such as leftover corn stalks, and heats them to high temperatures in a low-oxygen environment. The process, called pyrolysis, breaks down the biomass into three products: syngas, biochar, and carbon-rich bio-oil. The resulting syngas is used to power the pyrolyzers.  
  
The biochar can be returned to fields to replace nutrients and improve soil health. The bio-oil, which retains much of the carbon present in the original biomass, is injected into EPA-regulated wells.



- CDR Type: BiCRS
- Technology category: Pyrolyzer
- Storage / utilization mechanism: Bio-oil injection in EPA-regulated injection wells or salt caverns; Biochar production
- Feedstocks: Residue biomass: Corn Stover, nut shells, bagasse, rice straw, and forest mechanical thinning.
- Year operation begins: 2021
- Owners/operators: Charm Industrial
- Co-benefits: For crops already processed at central facilities, Charm expects to decrease particulate, NOX and road traffic by condensing (and possibly injecting) bio-oil immediately on-site rather than grinding up the shells and applying them across broad areas.
- Additional information:
  - Charm published bio-oil sequestration protocol
  - Frontier purchased from Charm \$53M of removals for 112,000 tons.
  - JPMorgan Chase agreed to pay Charm for nearly 29,000 metric tons of carbon removal over five years.
- References/urls:
  - [Next Level Transparency in Carbon Removal | Charm Industrial](#)
  - [Biooil Sequestration Protocol for Measurement Reporting and Verification.pdf \(charmindustrial.com\)](#)

## Lithos Carbon Enhanced Rock Weathering

- Location: Farms in different parts of the U.S.
- Brief Project Description: Lithos recycles basalt dust by providing it to farmers and spreading it on their cropland. Lithos acquires finely ground basalt from existing quarries waste byproducts that produce construction aggregates. Lithos transports this basalt to farmers, who use it in place of ag-lime to deacidify the soil, and remove CO<sub>2</sub>.  
  
The process entails first applying basalt to farmland with a spreader. The basalt reacts with rainwater, converting atmospheric CO<sub>2</sub> to dissolved bicarbonate and releasing macro- and micronutrients to the soil. Dissolved bicarbonate is transferred by rivers and streams to the coastal ocean, where it is stable for

thousands of years. Eventually, dissolved bicarbonate reacts to form calcium carbonate minerals that are permanently deposited at the ocean floor.

- Capacity (tonnes per year): The Lithos projects are aiming to capture about 10,000 tonnes of carbon in 2023
  - Lithos estimates that existing partnerships could result in ~2.1million tonnes CO<sub>2</sub>/year of removal in the immediate future.
  - Frontier buyers will pay Lithos \$57.1 million to remove 154,240 tons of CO<sub>2</sub> between 2024 and 2028.
- CDR Type: Enhanced Rock Weathering
- Technology category: Basalt
- Storage / utilization mechanism: Ex-situ mineralization
- Feedstocks: Air, Basalt
- Siting characteristics: Farms
- Year operation begins: 2022
- Owners/operators: Lithos Carbon, Yara International, Agoro Carbon Alliance
- Co-benefits (e.g. water production, removal of other pollutants): Lithos states that the basalt, which is filled with nutrients like calcium and magnesium, can increase crop yields as much as 47% as farmers apply it each year.
- References/urls
  - <https://www.lithoscarbon.com/>
  - <https://frontierclimate.com/writing/lithos>

## Eion Enhanced Rock Weathering

- Location: Application in Illinois and Mississippi farms, USA
- Brief Project Description: Eion is replacing agricultural lime with olivine to balance soil pH while removing carbon dioxide.
- Capacity (tonnes per year): Eion claims it has developed an olivine soil amendment with a carbon absorption rate of nearly 1:1—meaning for every ton of pulverized rock applied on fields, about 1 tonne of CO<sub>2</sub> is removed. In 2022, Eion applied 500 tons of olivine, and in 2023, they spread another 15,500 tons. Eion aims to remove 10 million tons of carbon dioxide annually starting in 2030.
- CDR Type: Enhanced Rock Weathering
- Storage / utilization mechanism: Ex-situ mineralization

- Feedstocks: Air, Olivine
  - Eion sources olivine from Sibelco, a mineral supplier, at their operation in Åheim, Norway,
- Siting characteristics: Farms
- Year operation begins: 2022
- Owners/operators: Eion Carbon
- Co-benefits: Improve soil health, create jobs in rural communities
- References/urls: [Eion Carbon | Carbon removal that checks all the right boxes](#)

## Filer City Generating Station

- Location: Filer City, MI, USA
- Brief Project Description

The project is converting a coal/biomass generation facility to a 30MW BECCS facility. Existing boilers are to be retrofitted to 100% woody biomass, with design for 95% CO<sub>2</sub> capture of about 500,000 tons per year. The project is using a solvent post-combustion capture system to capture CO<sub>2</sub>. The project will complete studies to confirm the boilers are capable of operating on 100% biomass as a feedstock and the facility can obtain sustainably-source biomass.
- Capacity (tonnes per year): 500,000
- CDR Type: BECCS
- Technology category: BECCS - Solvents
- Storage / utilization mechanism: Geologic
- Feedstocks: Woody biomass – sustainable waste wood
- Siting characteristics: The power plant is less than 0.5 miles from existing pipeline infrastructure for transport of CO<sub>2</sub> to the well characterized Niagaran Reef trend.
- Year construction begins: 2025
- Owners/operators: NorthStar Clean Energy Company
- Co-benefits: Project estimates are that over the first 12 years of commercial operation, over \$1.2 B of economic impact will accrue to Michigan, including 220 permanent jobs
- References/urls
  - [Project Landing Page | netl.doe.gov](#)

- [Filer City Biomass Carbon Removal and Storage \(BiCRS\) Net-Negative Study.pptx \(live.com\)](#)

## Graphyte Loblolly facility

- Location: Pine Bluff, Arkansas, USA
- Brief Project Description: Graphyte collects biomass waste byproducts from timber and agriculture industries and then dries, wraps and buries them. Drying the biomass eliminates microbes, and impermeable barriers prevent water and gas from restarting the decomposition process. The dried biomass is compressed into dense carbon blocks protected by a barrier. The process preserves nearly all the carbon captured in the biomass and consumes only small amounts of energy.
- Capacity: 15,000 tonnes of CO<sub>2</sub> in 2024; 50,000 tonnes in 2025
- CDR Type: BiCRS
- Storage / utilization mechanism: The biomass waste is converted into bio-bricks that the company refers to as carbon casting. The bio-bricks are buried underground, which requires a construction debris landfill permit. The burial site is monitored with sensors and tracers.
- Feedstocks: Residual biomass from papermills, timber industry and agriculture.
- Year construction begins: 2023
- Year operation begins: 2024
- Owners/operators: Graphyte
- Total project cost: Facility cost "in the \$10 million-range of capital expenditures"
- Additional information
  - Graphyte supported by clean technology investment firm Breakthrough Energy Ventures
  - Selling removals at a price of \$100/tonne
- References/urls:
  - <https://www.graphyte.com/>
  - <https://www.eenews.net/articles/exclusive-worlds-largest-carbon-removal-plant-is-about-to-open/>



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