The Top 10 Carbon Capture Projects in 2023

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Selection criteria

- Projects that became active this year (or a major change was done this year),
- Large projects (for e.g. 500,000+ TPA)
- New or innovative designs or technologies

Exclusions

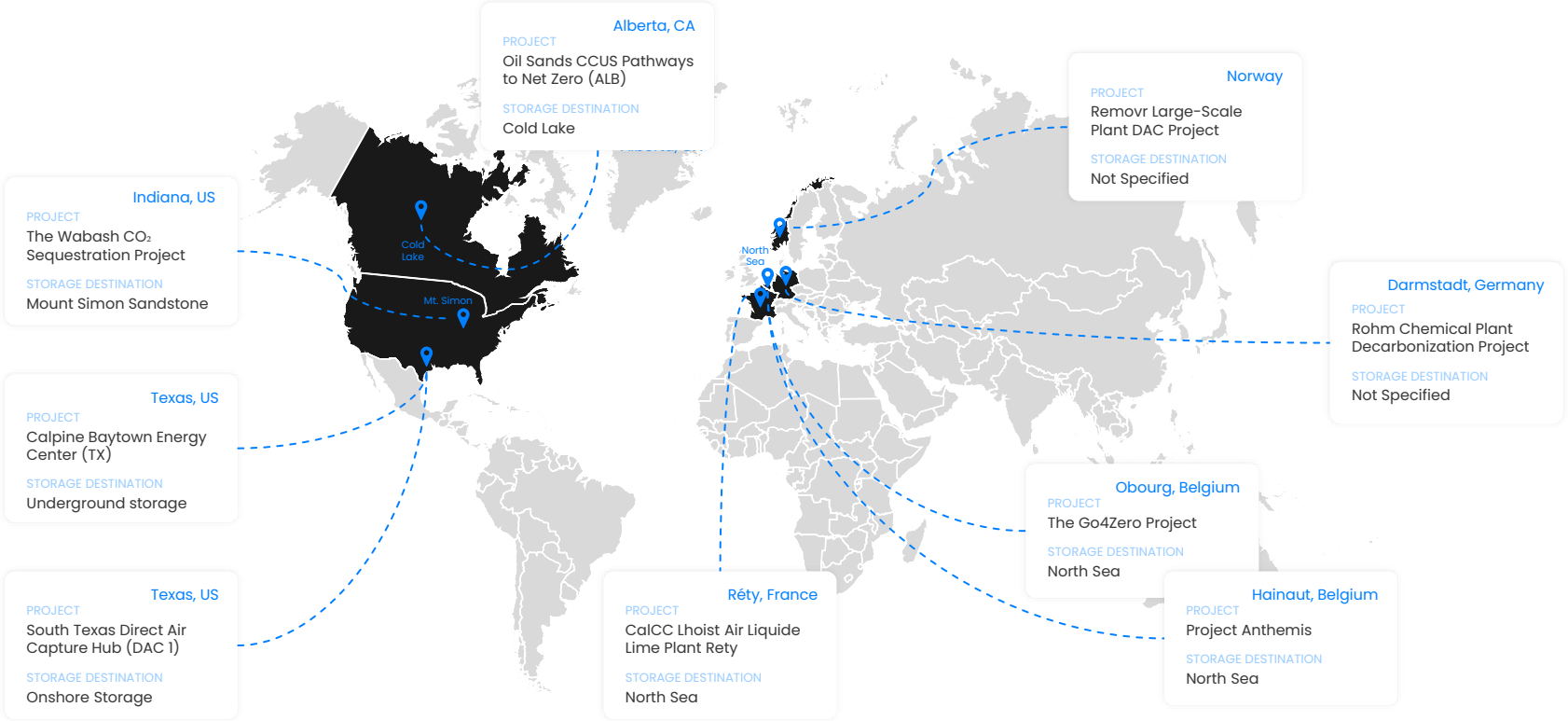
- Projects that did not disclose sufficient information to assess.

Key data points included

- Technology suppliers, users and other partners or participant
- Size (TPA)
- Costs
- Efficiencies
- Type of technology for capturing
- Industry
- Final destination of the captured carbon

Project	Technology Suppliers	Size (Million TPA)	Technology Type	Efficiency
Oil Sands CCUS Pathways to Net Zero	Honeywell UOP carbon capture technologies	10-12	Amine-based carbon dioxide capture	95%
The Wabash CO_2 Sequestration Project	Honeywell UOP carbon capture technologies	1.65	Ortloff CO_2 Fractionation unit, Polybed™ PSA unit	99%
The Go4Zero Project	Air Liquide, TotalEnergies	1.1	Oxyfuels combustion (Cryocap™ Oxy technology)	95%
Calpine Baytown Energy Center	Shell Catalysts & Technologies	1.5	Shell CANSOLV® CO_2 Capture System (Amine-based)	>90%
The Rocky Mountain Carbon Project	To be determined by October 2023	1 - 1.3	To be determined by October 2023 (Q4)	*Not provided*
Project Anthemis	Undisclosed	0.8	OxyCal concept: Oxyfuel and Amine capture technology	97%
CalCC Lhoist Air Liquide Lime Plant Rety	Air Liquide	0.6	Cryocap™ FG (Flue Gas)	95%
Rohm Chemical Plant Decarbonization Project	Aker Carbon Capture	0.5	Liquid amine solvent to absorb CO_2	>90%
South Texas Direct Air Capture Hub (DAC 1)	Carbon Engineering Ltd	0.5 - 1	DAC Potassium hydroxide solution/calcium carbonation	99%
Removr Large-Scale Plant DAC Project	Removr	0.002 - 0.1	Zeolite DAC technology	*Not provided*

Global distribution of the top 10 carbon capture projects



Oil Sands CCUS Pathways to Net Zero

An initiative by six of Canada's largest oil sands producers to reduce greenhouse gas emissions from their operations by about 22 million TPA by 2030 in Alberta, Canada[1].

Technology supplier(s)	Honeywell UOP carbon capture technologies
Partners	Pathways Alliance: Canadian Natural Resources, Cenovus Energy, Imperial Oil, MEG Energy, Suncor Energy, and ConocoPhillips[2]
Size (TPA)	10-12 Million TPA
Costs	US$ 16.5 b (phase I)[3]
Type of technology for capturing CO_2	Amine-based carbon dioxide capture (although partners are investing $7.6 billion in new and existing technology, research, and ongoing energy-efficiency projects)
Efficiencies	95% [4]
Type of industry	Oil sands
Final destination of the captured CO_2	Carbon storage will take place at a hub in northeastern Alberta's Cold Lake area, capable of sequestering over 1.1 billion tonnes of CO_2[5]

The Pathway Alliance

Canadian Natural · cenovus energy · Imperial · ConocoPhillips · MEG Energy · Suncor Energy

The Pathway Alliance outlines a 3-phase plan for net-zero emissions, and has already begun work to eliminate 68 Mt of annual oil sands production emissions in three phases*:

(2021 – 2030) **22 Mt**

(2031 – 2040) **25 Mt**

(2041 – 2050) **21 Mt**

*Emissions reductions for each phase are estimates.

The Wabash CO_2 Sequestration Project

Wabash Valley Resources aims to start a major carbon-sequestration project in 2026, storing 1.65 million tons of CO_2. The facility, located in the West Terre Haute, Indiana, U.S, will transition from syngas to ammonia fertilizer production with CO_2 capture[1].

Technology supplier(s)	Honeywell UOP carbon capture technologies
Partners	Wabash Valley Resources (WVR), Honeywell UOP, OGCI Climate Investments, Department of Energy (DOE), Indiana Department of Environmental Management (IDEM), and Vigo County Commissioners
Size (TPA)	1.65 Million TPA
Costs	US$ 600 M (Financed partly by the US Department of Energy as part of the Carbon Storage Program[2]
Type of technology for capturing CO_2	Ortloff CO_2 Fractionation unit separates the CO_2 from the other gases, and the Polybed™ PSA unit further purifies the CO_2[3]
Efficiencies	99% [4]
Type of industry	Fertilizer Plant
Final destination of the captured CO_2	Captured CO_2 will be stored in a saline sandstone aquifer known as Mount Simon Sandstone[2]

WABASH VALLEY RESOURCES

Residents of Vigo and Vermillion counties in western Indiana, **are expressing concerns** about the **Wabash CO_2 storage**.

The Wabash Valley Resources are addressing these concerns, specifically **regarding** potential **long-term environmental impacts** and **safety issues**.

The company is **currently awaiting permits** from the **Environmental Protection Agency** for the construction of **injection wells and an 11-mile pipeline** to transport carbon dioxide underground[5].

The Go4Zero Project

GO4ZERO stands out as a highly innovative and ambitious initiative aimed at decarbonizing the cement industry. It embodies the industrial-scale execution of Europe's Green Deal Industrial Plan[1].

Technology supplier(s)	Air Liquide[2] TotalEnergies[3]
Partners	Holcim Group, TotalEnergies, Fluxys, and Air Liquide
Size (TPA)	1.1 Million TPA
Costs	€ 350 M (partially funded by the EU Innovation Fund in 2023[4]
Type of technology for capturing CO_2	Oxyfuel combustion (CryocapTM Oxy technology to capture and purify CO_2)
Efficiencies	95% [4] up to 95% of the CO_2 generated from Holcim's production unit in Obourg
Type of industry	Cement Plant
Final destination of the captured CO_2	Captured CO_2 will be stored in depleted oil and gas reservoirs in the North Sea

The project revolves around creating a carbon-negative, large-scale clinker plant by pioneering a concept that utilizes flue gas recirculation and concentration, alongside a comprehensive carbon capture and storage (CCS) solution[5].

The project was selected for a grant from the EU Innovation Fund in 2023.

Calpine Baytown Energy Center

The Baytown Energy Center aims to capture over 95% of CO_2 emissions from turbines and auxiliary boilers. Close to Calpine's Deer Park Energy Center, TX, it has access to CO_2 storage resources along the Texas Gulf Coast. This facility plans to provide low-carbon industrial heat to nearby facilities and low-carbon power to the Texas grid through carbon capture[1].

Technology supplier(s)	Shell Catalysts & Technologies
Partners	Calpine, Technip Energies, Shell Catalysts & Technologies, and Zachry Group[2]
Size (TPA)	1.5 Million TPA
Costs	Undisclosed
Type of technology for capturing CO_2	Shell CANSOLV® CO_2 Capture System technology[3]
Efficiencies	>90% [4]
Type of industry	Power Generation
Final destination of the captured CO_2	Underground storage in the Gulf Coast of Texas [5]

CALPINE®

The place selected for underground storage is located in the Gulf Coast of Texas which has the capacity to store about 150 gigatons (330 trillion pounds) of CO_2[5].

The Rocky Mountain Carbon Project

The Rocky Mountain Carbon Project holds the distinction of being the largest BECCS (Bioenergy with Carbon Capture and Storage) initiative globally. It stands out as the pioneering endeavor to capture biogenic carbon dioxide emissions generated by a forest-based renewable materials facility. The location of the project is in the West Fraser unbleached Kraft pulp mill in Hinton, Alberta, Canada[1].

Technology supplier(s)	The project is scheduled to determine the primary technology suppliers by October 2023 (Q4)[1]
Partners	Vault 44.01, West Fraser, Torchlight Bioresources
Size (TPA)	1 - 1.3 Million TPA
Costs	Funded by the Alberta Government[20] (estimated cost per ton of CO_2 in Canada ranges from CAD 50-200)[2-3]
Type of technology for capturing CO_2	Undetermined
Efficiencies	Undetermined
Type of industry	Oil & Gas and other CO_2 emitters within the region
Final destination of the captured CO_2	Storage Rocky Mountain Carbon Vault (ALB)

The primary objective is to utilize renewable materials for packaging, specialty products, and replacing single-use and other plastics.

Currently, the project is in the Front-End Engineering and Design (FEED) Study stage, with continuous engagement with potential suppliers and CDR buyers.

The Government of Alberta granted CO_2 storage evaluation rights for this site to the Vault 44.01, a project partner of Rocky Mountain Carbon.

To meet the project's requirements, a pipeline exceeding 30 kilometers and multiple sequestration and monitoring wells will be necessary.

Project Anthemis

CBR, a Heidelberg Materials subsidiary, is set to enhance its Antoing cement plant with an innovative hybrid carbon capture unit. Antoing's efficient kiln requires no further modifications. The advanced OxyCal concept merges Oxyfuel and Amine technologies, reducing construction needs and enhancing resource efficiency. The project aims to capture over 97% of emissions, about 800,000 tonnes of CO_2 annually, once operational[1].

Technology supplier(s)	Undisclosed
Partners	Heidelberg Materials and subsidiary CBR Antoing
Size (TPA)	800,000 TPA
Costs	Undisclosed. The company is still seeking national, regional, and EU funding[2]
Type of technology for capturing CO_2	OxyCal concept: Oxyfuel and Amine capture technology in a hybrid unit that no longer requires an additional preheater tower[3]
Efficiencies	97% [4]
Type of industry	Cement Plant
Final destination of the captured CO_2	Storage, to be sequestered in the North Sea as part of the D'Artagnan project

Over its first decade of operation, the Antoing plant plans to supply over 15 million tonnes of carbon-neutral cement to the construction industry, significantly aiding Belgium's journey to net-zero greenhouse gas emissions.

Antoing's location, more than 100 kilometers inland from the coast, positions it as Western Europe's first inland cement plant to offer carbon-free cement.

CalCC Lhoist Air Liquide Lime Plant Rety

The project seeks the decarbonization of Lhoist's lime production plant in Réty, France. Lime is one of the “hard-to-abate” industries as its production primarily generates CO_2 from the decomposition of limestone[1].

Technology supplier(s)	Air Liquide
Partners	Lhoist and Air Liquide
Size (TPA)	600,000 TPA
Costs	€ 3 b[2]. € 125 M granted through the Innovation Fund Grant EUR
Type of technology for capturing CO_2	CryocapTM FG (Flue Gas)
Efficiencies	>95% [4] >95% (Cryocap can produce up to 99.9%)[3]
Type of industry	Lime Plant
Final destination of the captured CO_2	Storage, to be sequestered in the North Sea as part of the D’Artagnan project

Lhoist

The CalCC project serves as a demonstration of the decarbonization potential within the European lime industry.

This initiative encompasses the entire CO_2 value chain, including capture, pipeline transport, liquefaction, shipping, and offshore geological storage.

The Cryocap™ technology, utilizing cryogenic temperatures, effectively separates gases, resulting in a 99.99% pure CO_2 stream essential for CO_2 transport and geological storage.

The project aims to achieve an 87% reduction in greenhouse gas emissions compared to the reference scenario.

Rohm Chemical Plant Decarbonization Project

The project is currently in the feasibility study stage in partnership with Aker Carbon Capture. The objective is to achieve a reduction of over 90% in direct emissions from flue gases. This CO_2 reduction initiative encompasses significant methyl methacrylate production site located at the German facilities located in Wesseling and Worms[1].

Technology supplier(s)	Aker Carbon Capture[2]
Partners	Rohm, Aker carbon capture
Size (TPA)	500,000 TPA
Costs	Undisclosed
Type of technology for capturing CO_2	Aker Carbon Capture's proprietary carbon capture technology. Liquid amine solvent to absorb CO_2 from the flue gas. The CO_2-rich solvent is then regenerated to release the CO_2[2]
Efficiencies	>90% [4]
Type of industry	Methacrylate
Final destination of the captured CO_2	Utilization as a raw material for the production of methyl methacrylate[1]

RÖHM

The feasibility study is exploring carbon capture within Röhm's primary manufacturing sites in Germany, with a combined annual CO_2 capture potential nearing 500,000 tons.

Preliminary analysis indicates that potentially disruptive substances such as SO_2 and NOx, commonly found in the operational units' flue gas, do not pose a technical obstacle for Aker Carbon Capture technology.

South Texas Direct Air Capture Hub (DAC 1)

The project is set to become the world's largest direct air capture (DAC) facility in Texas Permian Basin, U.S. Updated since inception in 2019[1].

Technology supplier(s)	Carbon Engineering Ltd (bought by OXY in August 2023[2])
Partners	Occidental (OXY), 1PointFive, US Department of Energy
Size (TPA)	0.5 M TPA to reach by 2024 1 M TPA
Costs	Unknown but financed by United Airlines as part of Oxy Low Carbon Ventures, LLC (OLCV). Algo funded by the US Department of Energy Grant[3]
Type of technology for capturing CO_2	DAC Potassium hydroxide solution/calcium carbonation[4]
Efficiencies	99% [4]
Type of industry	Oil & Gas
Final destination of the captured CO_2	Onshore Storage

In August 2023, Occidental (OXY) announced its entry into a purchase agreement to acquire Carbon Engineering Ltd. for a total of $1.1 billion.

Occidental has been collaborating with Carbon Engineering on direct air capture (DAC) deployment since 2019.

This acquisition is in line with Occidental's integrated net-zero strategy and offers Occidental, through its subsidiary 1PointFive, the chance to expedite technological advancements in DAC and accelerate the deployment of DAC [5].

Removr Large-Scale Plant DAC Project

The first operational DAC plant relying on zeolites was commissioned in 2022 in Norway, with plans to scale the technology up to 2,000 TPA CO_2 by 2025 through the project Removr[1]. The commercial-scale facility will be developed in Iceland.

Technology supplier(s)	Removr[2]
Partners	Removr (Greencap 40%, Vanir Green Industries 60%), Carbfix
Size (TPA)	Currently 2,000 TPA, expected to reach 100,000 by 2025[1]
Costs	Undisclosed
Type of technology for capturing CO_2	Zeolite DAC technology. Zeolites are now being adopted for DAC thanks to their porous structure suitable for CO_2 adsorption
Efficiencies	Expected to be energy efficient, 50% less energy required to extract 1 ton of CO_2
Type of industry	Still limited to greenhouses
Final destination of the captured CO_2	At the current stage, Removr can capture emissions from stationary point sources of CO_2, including fossil fuel power plants and cement factories that emit up to 4% CO_2[1]

REMOVR
Carbon Removal Solutions

The place selected for underground storage is located in the Gulf Coast of Texas which has the capacity to store about 150 gigatons (330 trillion pounds) of CO_2[5].

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As you grapple with cost evaluations and delve into the nuances of implementation, the dynamic nature of the industry presents additional challenges. Recognizing this, we introduced the CCUS Database: a meticulously curated, continually updated resource designed to empower you with clarity and confidence in every decision.

CARBON CAPTURE TECHNOLOGIES

104

Covering all of the 8 technology families

ORGANIZATION PROFILES

469

Encompassing all of the companies & institutions involved in this field (e.g. suppliers, developers and users)

CARBON CAPTURE PROJECTS

728

Including robust data for each project that is also fed into our carbon cost calculator

+

Proprietary Carbon Cost Calculator

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