Clearing the air

Canada could be a global leader in carbon removal management. How can we scale this emergent sector?

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Solving our carbon problem

To keep global temperatures within a safe range, ramping up large-scale carbon removal is increasingly becoming an imperative.

The shift to lower-carbon solutions isn't happening fast enough. With just five years to meet the first of the Paris Accord's climate targets, we're still headed in the wrong direction — global greenhouse gas (GHG) emissions keep breaking new records. A great deal more action is required to limit temperature gains to the 1.5-degree Celsius threshold by 2050 — not just with reduction and mitigation policies, but also through large-scale atmospheric carbon dioxide removal measures.

By mid-century, we need to remove an estimated 10 gigatonnes of carbon dioxide per year, a massive figure equivalent to all the greenhouse gases emitted through global coal mining annually. As the Intergovernmental Panel on Climate Change has noted, "the deployment of carbon dioxide removal (CDR) systems to counterbalance hard-to-abate residual emissions is unavoidable if net zero CO2 or GHG emissions are to be achieved." With each record-breaking year, however, it's becoming increasingly clear that CDR — the removal of atmospheric carbon dioxide — needs to play a much larger role in GHG reduction generally, and not just to tackle difficult-to-abate industrial emission streams. CDR technologies offer viable methods of addressing legacy emissions.

Addressing legacy emissions

Carbon dioxide removal solutions mitigate the impacts of climate change by reducing the concentration of carbon dioxide in the atmosphere. While point-source capture (also known as carbon capture) traps emissions directly from industrial facilities, CDR solutions extracts carbon dioxide that has already been emitted.

By the numbers

5-10 gigatonnes

The amount of carbon dioxide we need to remove annually by 2050.

40

The number of organizations in Canada working on carbon dioxide removal initiatives.

U.S.$925M

The amount that carbon-removal fund Frontier has raised to invest in CDR credits.

300,000

The number of jobs CDR could create in Canada by 2050.

$143B

The amount the CDR industry could add to Canada's economy by 2050.

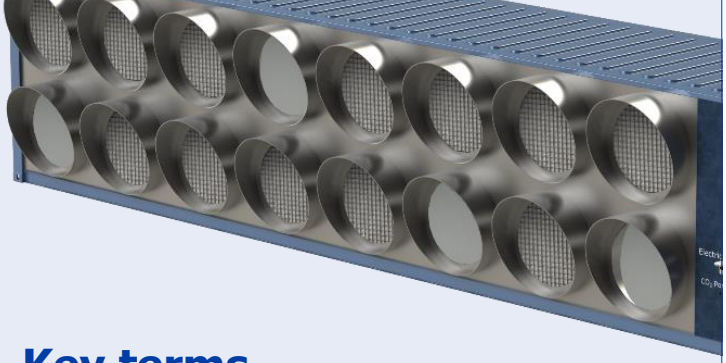
Sources: CDR.Fyi, Frontier, Carbon Removal Canada

Nurturing Canada's CDR sector

To accelerate the adoption of permanent carbon dioxide removal solutions and advance the development of the carbon markets ecosystem, MaRS launched the Mission from MaRS: Carbon Management in May 2023. MaRS convened 31 leaders from banking, cement, utility and other industries, as well as investors, government representatives and other key stakeholders to discuss what it will take to commercialize negative-emission technologies. The program aimed to empower buyers, sellers and decision-makers in the Canadian carbon market and support the adoption of carbon dioxide removal and carbon utilization solutions to help fulfill climate action commitments.

Though still in its infancy, the CDR technology landscape "is complex and expanding," according to a 2024 state of innovation survey from the International Energy Agency (IEA). Encouragingly, hundreds of CDR startups have been founded around the world in the past few years to meet this growing need, says Andy Lam, director of business development and operations for CarbonRun, a three-year-old Halifax firm. And Canada is emerging as a leader in this space with 40 organizations working on carbon removal initiatives. The suite of technologies, many still in the testing phase, includes highly engineered approaches, such as direct air capture (DAC), sequestering carbon in building materials and the production of biochar using pyrolysis, as well as solutions aimed at increasing the absorptive capacity of oceans, rivers and even mine tailings.

Startups in this sector need to clear the major hurdle of capital-intense development in order to lower the cost of removal, a challenge that is compounded by the hesitancy of investors to make the first big bets. The expense of carbon removal today is still fairly high, costing between $500 to $1,000 per tonne. Indeed, the IEA cautions that the wide-spread adoption of these technologies in the coming years "depends largely on whether the costs for today's pre-commercial technologies are successfully reduced through innovation."



Key terms

Carbon offsets offer credits for activities that reduce or avoid GHG emissions. These offsets, which are meant to compensate for an individual's or an organization's own emissions, account for 97 percent of total carbon credit sales globally; carbon removal credits make up the remaining 3 percent of the market.

Carbon capture solutions trap emissions at the industrial source.

Carbon removal solutions extract carbon dioxide from the atmosphere (either through nature-based or technological solutions) and store it. Nature-based solutions dominate the carbon removal market, constituting more than 99 percent of CDR credits.

High-quality carbon removal solutions offer more than simple extraction and sequestration. They offer permanent storage, are measurable, and provide social and environmental co-benefits. These solutions are:

- **Additional**: The removal of carbon dioxide is above and beyond any normal activity.
- **Durable**: The carbon dioxide will remain out of the atmosphere for 100 to 1,000+ years.
- **Accountable and verifiable**: The CDR project adheres to a long-term monitoring, reporting and verification (MRV) plan with reputable, third-party organizations.
- **Equitable**: The CDR project does not have negative impacts on the local environment or communities and upholds the principles of free, prior, informed consent and adheres to the United Nations Declaration on the Rights of Indigenous Peoples Act.

The need for high-quality solutions

It's important to distinguish between carbon capture and carbon removal. Capture is associated with preventing carbon dioxide from entering the atmosphere by intercepting it at the industrial source, while removal is the extraction of carbon dioxide that is already in the atmosphere. Growing interest in removal is a recognition that, to keep global warming in check, we need to take carbon dioxide out of the atmosphere that has been built up over decades. (Indeed, even if every country in the world were to stop emitting carbon tomorrow, the Earth's temperature would continue to increase for years, given all the GHGs already in the atmosphere.) To date, the most dominant form of carbon removal has involved the sale of credits on the voluntary market related to reforestation projects, which may or may not yield the desired results. "There's millions of carbon offset credits that have been issued with questionable climate impact," says Stacy Kauk, chief science officer for Isometric, a CDR registry. "To me, that's just not providing the climate benefit that we need in order to truly stop and reverse climate change."

What's needed are high-quality solutions that remove carbon and sequester it for hundreds or even thousands of years. "Hitting net zero is just a milestone, not the end goal," says Lam. To help the planet return to livable, sustainable conditions, we need to remove more carbon dioxide than we emit. "That's why we need to go beyond net zero and reach negative emissions."

To achieve verifiably durable carbon removal, market mechanisms begin with the purchase of credits by corporate buyer groups, such as Frontier Climate, as well as public sector initiatives, such as the Government of Canada's $10-million Low Carbon Fuel Procurement Program. Shopify invested $36.3 million in CDR credits as of 2024, mainly in direct air capture (DAC); it's also a co-founder of carbon removal fund Frontier, which has raised U.S.$925 million to invest in CDR credits. In addition, the Mission from MaRS: Carbon Management Program includes a carbon credit purchasing program.

All these funding initiatives provide emerging CDR firms with the capital they require to test and start to scale their technologies. As with any venture investment, the funders carry out their own technical due diligence. And to ensure the carbon has indeed been removed and to certify credits to prevent double counting, CDR companies rely on third-party verification platforms and registries, such as Isometric and puro.earth. Absent universal evaluation standards and government regulations mandating emitters to acquire credits generated by CDR firms, these platforms aim to inject certainty into a nascent market, with the goal of attracting new funders as well as purchasers of the CDR credits.

Canadian advantage

The bulk of Canada's electricity — 80 percent — is generated from renewable sources, providing clean and affordable power for direct air capture projects.

Canada's geology is well suited for carbon storage. Carbon Removal Canada estimates between 198 to 678 gigatonnes could be sequestered across the country. Saline formations across Saskatchewan and Alberta are particularly well suited for permanent storage.

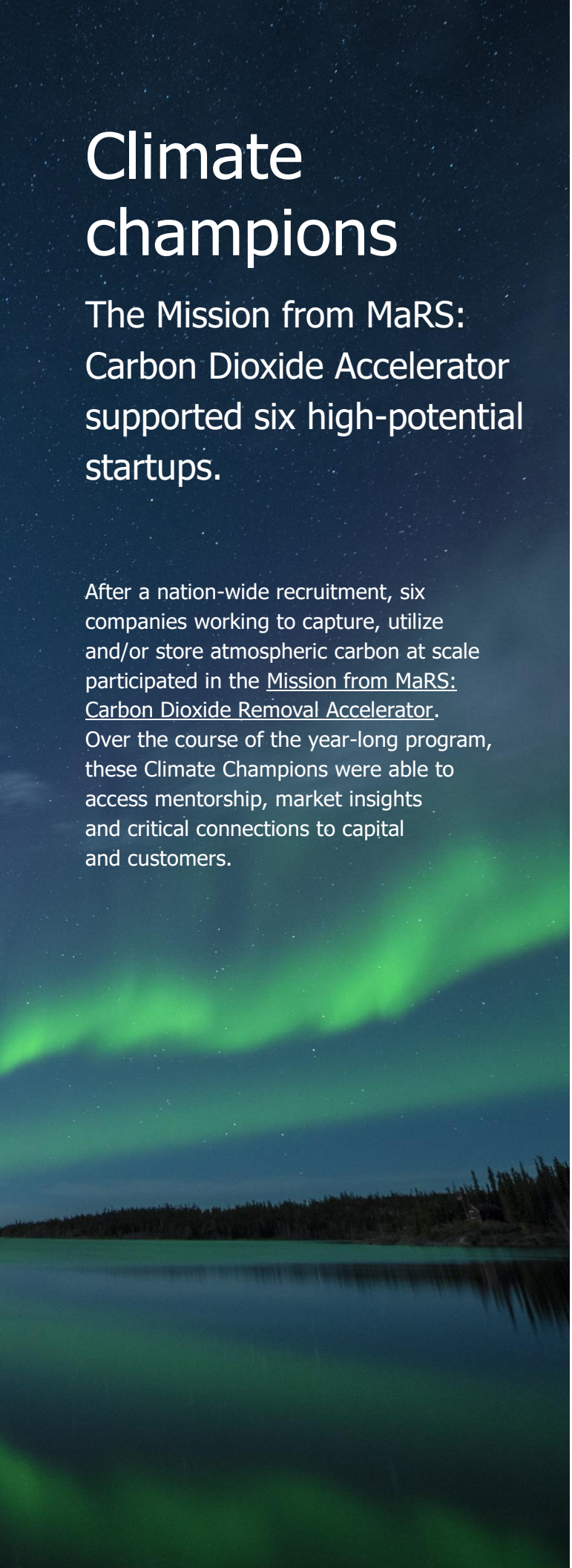
A quarter of the finalists for the global XPRIZE Carbon Removal challenge for CDR innovation are Canadian.

By virtue of Canada's size and the diversity of its land mass, as well as the availability of non-dilutive funding for early-stage companies, CDR startups in this country have a unique opportunity to stoke the development of the sector. According to research by Carbon Removal Canada, an industry association, CDR could create more than 300,000 jobs and add $143 billion to Canada's economy by 2050 while removing millions of tonnes of carbon dioxide from the atmosphere.

CDR suppliers are increasingly looking at Canada as the next place to invest, says Mitchel Selby, the lead of Shopify's sustainability fund, which buys CDR credits through the Frontier buying group. Canada's stable political environment, potential government support, favourable geologic storage opportunities and skilled workforce does make it an attractive destination for investment. Montreal-based venture Deep Sky, which has built a hub for testing direct-air carbon removal technologies in Innisfail, Alta., says that it has seen a marked uptick in interest from American carbon tech developers looking to test their solutions in Canada in the wake of climate policy shifts in the U.S.

Commercialization remains a work-in-progress, however, and there are a number of questions that need to be resolved, says Selby. "Is the market around CDR innovators supporting their scale up? Are they getting money to keep building? Are they getting contracts to keep building? Is the technology working at larger and larger scales? And is it getting cheaper?" he asks. "I would say there's been progress on all of those fronts, but not as fast as the world needs to meet our climate goals."

Given sluggish progress on GHG reduction and the annual record-breaking emission levels, the case for massively upscaling this emergent sector is both compelling and urgent.



Climate champions

The Mission from MaRS: Carbon Dioxide Accelerator supported six high-potential startups.

After a nation-wide recruitment, six companies working to capture, utilize and/or store atmospheric carbon at scale participated in the Mission from MaRS: Carbon Dioxide Removal Accelerator. Over the course of the year-long program, these Climate Champions were able to access mentorship, market insights and critical connections to capital and customers.

CarbonRun adds powdered limestone to rivers to help draw down carbon dioxide to generate credits and restore ecosystems, particularly salmon populations.

Carbon Upcycling permanently sequesters carbon dioxide into industrial byproducts and minerals by integrating them into enhanced cementitious materials.

Gaia Refinery is developing a CDR technology that captures carbon dioxide from both air (DAC) and biomass (BiCR) sources.

Hyperion has developed a carbon-recycling system that converts waste carbon dioxide emissions into high-value mineral commodities.

Planetary Technology adds alkaline minerals to the water flowing out of existing wastewater and power plant pipes to help more atmospheric carbon dioxide dissolve into the ocean, permanently removing it from the atmosphere.

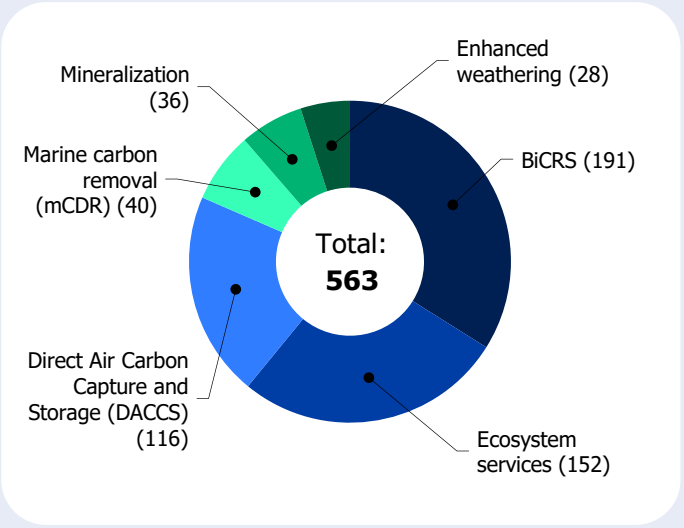
TerraFixing has developed a DAC system that is specifically designed for cold climates.

The CDR market sees promising growth

To create a sizeable impact on global emissions, the sector needs to expand quickly.

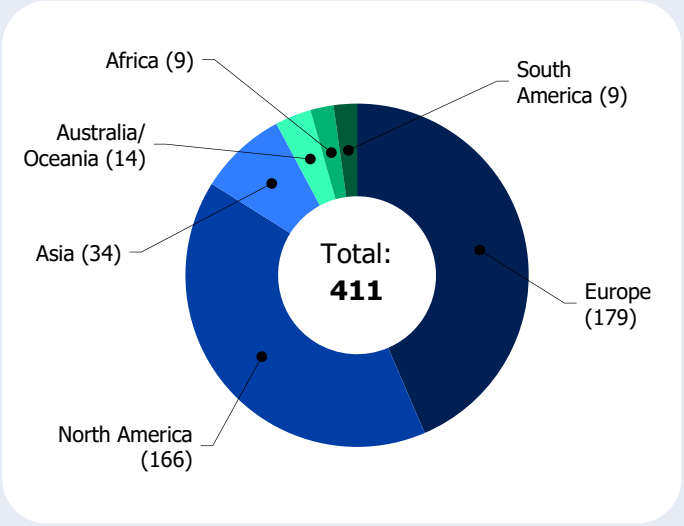
According to cdr.fyi, a reporting platform for the carbon removal market, there are currently 563 CDR organizations worldwide, including 411 suppliers and 152 services firms that focus on market-making or industry development. The U.S. has the largest number of suppliers, followed by the U.K., Canada, Germany and France.

Organizations working in CDR by category



Source: CDR.Fyi

CDR organizations by continent



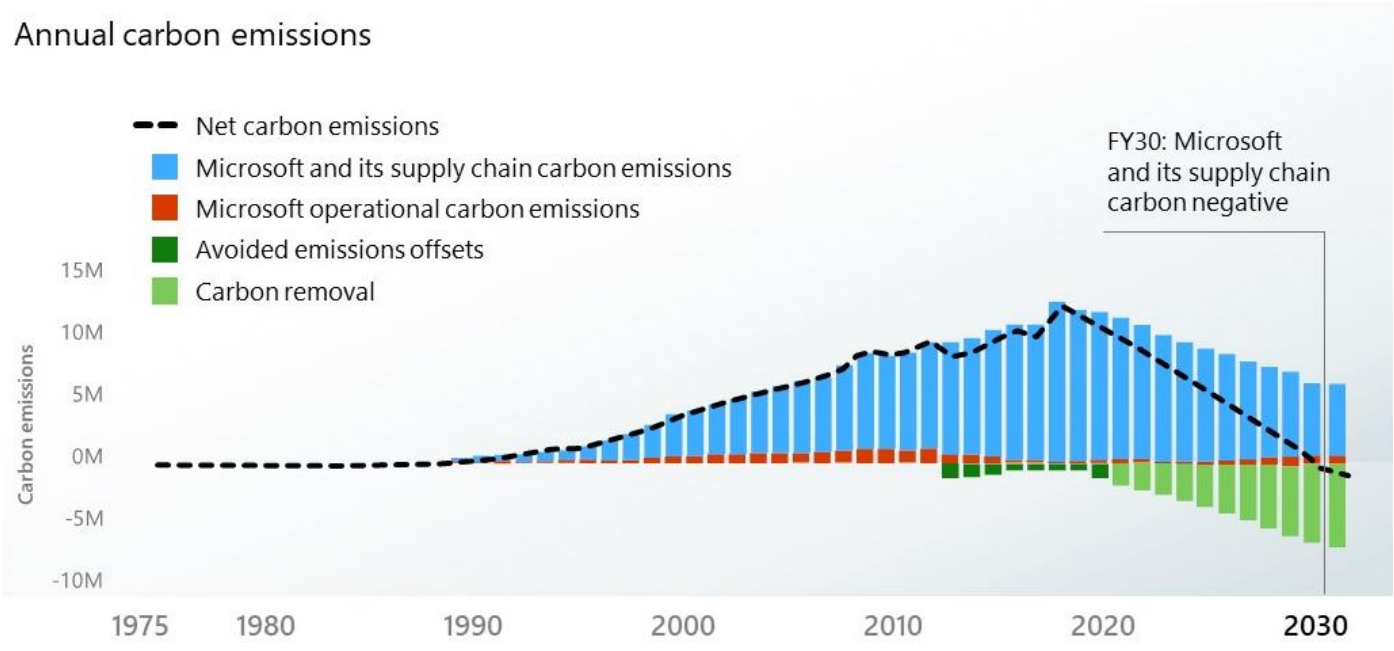
Source: CDR.Fyi

Canada is building up bench strength in this sector. As of July 2025, there are 40 CDR organizations working on 18 projects across the country. This includes the B.C. test plant for Carbon Engineering, the first mover in the DAC sector, which is now owned by Oxy Low Carbon Ventures, a subsidiary of Occidental Petroleum, as well as several biochar and mineralization projects.

On the other side of the ledger, Frontier, which includes such multinationals as Shopify, Google, JP Morgan and Salesforce, is the largest group purchaser, having allocated U.S.$551 million to procure 1.25 million tons of durable carbon removal credits tied to 47 projects, with about 70 percent of those transactions logged since April 2024. Other significant corporate buyers include Airbus and Amazon.

Microsoft is by far the world's largest individual purchaser of CDR, with 24.96 million tonnes contracted for delivery over the next 15 years. Its purchases account for 79.5 percent of the global market of tonnes contracted for removal. The software giant has committed to investing $1 billion on reduction, capture and removal technologies to reach net zero by 2030, with CDR figuring heavily in its efforts. The majority of its CDR portfolio is made up of bio-energy projects, such as a Swedish bio-energy carbon capture plant that incinerates forest biomass and then captures the flue-gas carbon and stores it for thousands of years, as well as DAC and afforestation. Microsoft's CDR initiative is part of a broader suite of moves to reduce and offset not just operational emissions, but all emissions generated since the company's founding in the 1970s.

Microsoft's path to net zero



Source: Microsoft

While these commitments seem impressive, the reality is that CDR has to expand far more ambitiously, and faster, for it to make a dent in global emissions. For context, the Microsoft investment in CDR amounts to about two one-thousandths of the amount of atmospheric carbon removal required globally by 2050.

Nature-based carbon removal techniques account for 99 percent of the market today. But methods like afforestation/reforestation don't durably store carbon for extended periods. Due to climate change, wildfires are becoming increasingly common and intense. In 2023, wildfires in Canada released 647 megatonnes of carbon dioxide — comparable, in magnitude, according to a NASA assessment, to the annual fossil fuel emissions of a large industrialized nation. And 2025 may end up surpassing that record.

Among the emerging engineered solutions, three CDR technologies dominate:

Biochar: A charcoal-like material made by burning organic matter from agricultural and forestry wastes in a controlled process called pyrolysis, which reduces both pollution and permanently locks in carbon that might otherwise escape. The material is used as a soil supplement.

Direct air capture (DAC): A technology that deploys specialized membranes and/or materials to extract carbon dioxide from air that is drawn in by large turbine-like devices. The carbon is then sequestered in a separate process.

Bio-energy carbon capture (BECCS): In this method, biomass is converted into carbon-rich oil that is either pumped underground for permanent storage or burned to generate electricity with the resulting emissions captured and stored.

Canada is one of the leaders in terms of startup-based innovation; indeed, a quarter of finalists in CDR innovation for the Musk Foundation's XPRIZE are Canadian. And many are working on other promising methods for removing carbon dioxide from the atmosphere.

Ocean alkalinity enhancement

Planetary Technologies, which won an XPRIZE award this past April, works in ocean alkalinity enhancement, using basic chemistry to reduce acid levels in our water systems and encourage the uptake of more atmospheric carbon. Headquartered in Dartmouth, N.S., the company adds alkaline materials to the ocean at select sites, and as these minerals dissolve, they convert carbon dioxide in the water into bicarbonate salt, which effectively "fixes" the element and makes space for the ocean to absorb more atmospheric carbon. "Essentially, what we're doing is restoring that sea water back to its pre-Industrial Revolution state through ocean alkalinity enhancement," says CEO and founder Mike Kelland.

The alkaline material used allows for permanent carbon removal from the atmosphere. Last fall, it completed a $15.8-million Series A round. And in August 2025, Frontier announced it is purchasing 115,211 tons of carbon removal from Planetary, a deal that is worth U.S.$31.3 million.

River restoration

CarbonRun, which last September signed a $25.4-million offtake agreement with Frontier, uses a similar methodology, only with rivers. As Lam explains, the "liming" approach — adding alkalinity to acidified rivers, originated with research conducted in the 1980s to help re-introduce salmon stocks to rivers affected by acid rain. Limestone, an alkaline material, dissolves in the river basin to produce calcium, which supports habitat rejuvenation and a bicarbonate that binds carbon for centuries. "We see ourselves as a river restoration company first," Lam says. "But the benefit of the carbon markets is that it also gives us a mode of revenue to finance restoration projects."

Canada's vast coastline offers a huge advantage with these technologies. "From a marine CDR perspective," says Jane Kearns, a partner at Evok Innovations, a venture capital firm that invests in hard tech in the industrial space and holds stakes in three CDR firms. "We're pretty ideally positioned, because we've got the minerals, as well as the oceans and rivers that have an immense capacity to draw carbon dioxide down out of the atmosphere in a very safe and yet efficient and effective way."

Rock weathering

Rock weathering leverages high-alkaline mining waste that can absorb atmospheric carbon through various chemical and mechanical means. B.C.-based Arca Climate, a finalist for the XPRIZE, has developed autonomous rovers that "go out over the surface of the mining waste to stir it and to increase the surface roughness and increase the amount of rock that's in contact with the air," explains Sean Lowrie, head of external affairs. The goal, he says, is to bring unreactive rocks to the surface as a means of accelerating the absorption process. Their clients are mining companies looking to reduce or offset operational emissions.

Skyrenu, a startup based in Sherbrooke, Que., uses a slightly different method, which can also be deployed directly on mine waste sites. It combines a direct air capture (DAC) system with a rock carbonation process involving mine tailings. Its integrated, energy efficient solution utilizes the waste heat from the DAC for the mineralization process. And Exterra Carbon Solutions, another Quebec-based startup, has developed an approach that produces high-purity and fast-acting minerals that bind with carbon dioxide, and can be used in various carbon removal applications and industrial site rehabilitation.

Building trust

Third-party CDR verification is key to the growth of the sector.

The strength of CDR is that it is removing emissions already in the atmosphere, providing a net reduction of GHGs. When this is done in a way where those emissions are stored permanently (underground or in cement or other materials), CDR is a durable solution. And when companies know the carbon will be sequestered for centuries, they will pay to acquire credits to offset hard-to-abate emissions.

In practical terms, CDR companies rely on offtake agreements (deals where a company agrees to purchase portions of upcoming removals) or partnerships to generate revenues, and those transactions only occur if the buyers have confidence in their carbon removal technologies and their durability. (As recent wildfires in Canada have shown, forest-based carbon sinks are exceptionally vulnerable to climate change, and thus forestry-based carbon credits don't pass the durability test.)

Recent controversies involving some of the organizations that tabulate voluntary carbon offset credits (such as those promoted by airlines to travellers) have demonstrated a need for more rigorous third-party assurance platforms as a means of unlocking investor and purchaser capital. Several verification and registry platforms geared specifically to CDR have emerged in recent years, including Isometric, puro.earth and Gold Standard, to provide stringent technical assessments about the durability of a carbon removal credit (equivalent to a single tonne of carbon). There's clear demand for this kind of third-party verification: A 2024 Pembina Institute survey of potential purchasers of CDR credits found that almost two-thirds were looking to have technologies assessed under the Science Based Targets initiative (SBTi) for validating corporate net-zero targets.

Isometric, founded in 2022, issues carbon credits for customers, including Microsoft, Google, Shopify and the Frontier buyers' group. Stacy Kauk, Isometric's chief science officer and Shopify's former head of sustainability, says that when the Canadian e-commerce platform began investing millions in CDR credits in 2020, she had to do the technical due diligence on her own. "While that might be all right for a skill set that I have" — Kauk is an environmental engineer — "that is certainly not a skill set that other corporate buyers are going to have. They're going to have to build out teams of scientists and researchers who do due diligence for a living. And that's just not how a market's

going to scale." In the years prior to the pandemic, she explains, there were millions of carbon credits — mainly rain-forest projects — that had been issued with questionable climate impact. "Companies were out there buying them for pennies on the dollar, and retiring them against their carbon emissions," she says.

A member of the advisory board of Carbon Removal Canada, Kauk adds that Isometric's approach is to build trust in carbon removal by developing scientifically rigorous protocols and science-based methods for verifying CDR. Once verified, Isometric issues the resulting credits, alongside the supporting evidence and calculations, publicly on the registry. "We have that for direct air capture, enhanced rock weathering, ocean alkalinity enhancement, reforestation," she says, adding that Isometric also selects and directly pay third-party verifiers to audit carbon removal projects before credits are issued, ensuring each credit represents a tonne of carbon dioxide removed from the atmosphere.

Ultimately, CDR developers/suppliers base their offtake prices on third-party verification, as well as capital and operational costs. According to a January 2025 price survey conducted by cdr.fyi and Opis, supply break-even rates range from $140/tonne to $340/tonne, depending on the technology, with decreases anticipated as these approaches scale. The survey also showed a significant gap between supplier and purchaser perceptions of what constitutes a reasonable profit and an expensive credit. "Despite these gaps," the survey noted, "many suppliers' break-even prices are below what buyers label as expensive/high side. This indicates that there is a possibility of finding prices that work for both buyers and suppliers."

For now, buyers rely on a range of considerations in making investment choices. Shopify's Selby says his firm has used a "portfolio approach," seeking to boost several technologies. "Every year, we collect data from each of the companies in our portfolio," he says, noting that Shopify has 50 CDR firms in its portfolio. "We look at cost, capacity growth, whether they're able to raise money, whether they're bringing in other buyers, whether they're able to hire and whether their teams are growing. A bunch of companies in our portfolio are doing well, a couple are ahead of schedule and a lot of them are behind schedule."

Establishing collaborative partnerships

Deep engagement with Indigenous communities is vital to make sure the shift to net zero is a truly inclusive one. As Michael Maracle-Polak, chief administrative officer at Glooscape First Nation says, project developers need to demonstrate their trustworthiness and be a true partner in establishing best practices for the ongoing stewardship of this land. "Canada can lead the way," he wrote in a recent post on LinkedIn. "Just as importantly, these innovations should consult and engage Indigenous Nations, who have long championed harmony with the environment."

Hitting new milestones

A growing number of startups are embarking on pilot projects.

The CDR space includes a large number of startups whose technology is still under development. But a growing contingent are launching pilot projects.

For instance, TerraFixing is firing up its first project this year: a $10-million pilot in Northern Quebec that will test the company's technique for capturing atmospheric carbon in cold climates using filters made of a substance known as zeolite. Once captured, the carbon is then liquified and buried.

Other ventures in the utilization space (which can help in the sequestration of carbon) are maturing quickly and some are graduating to higher TRL levels, with commercial scale pilots well under development. Calgary-based Carbon Upcycling is in the midst of building a Canadian first-of-its-kind carbon capture and utilization facility in Mississauga, which will permanently sequester carbon dioxide from the cement kiln and utilize it to transform locally produced industrial byproducts into high-quality, low-carbon cement materials. The resulting materials will be blended into the plant's cement product lines. "It's going to help CRH create a lower carbon product that'll be used by the local industry to make low-carbon construction materials," says CEO Apoorv Sinha, who founded the firm in 2014. It closed an U.S.$18-million investment round in June, and signed a memorandum of agreement with TITAN to assess potential projects at two of the multinational company's cement plants.

The company offers a case study in how steadily maturing technology can produce predictable revenues from product sales and environmental attribute credits. Sinha estimates that 80 percent of Carbon Upcycling's revenues will come from the sale of the cementitious material yielded by its process, with the balance deriving from third-party purchases of carbon credits. It's looking at more potential sites across North America and Europe, particularly in communities where it can bridge the gap left by the dwindling supply of traditional cement materials with regionally available byproducts, such as legacy coal ash, steel slag or natural pozzolans enhanced by its technology. "Our thesis is that we need to provide a hyper-local solution that works at the cement-plant level," he says.

"We believe the Far North holds the key to our low-carbon world. There's tremendous potential for renewable energy, the geology is ideal for carbon storage and now we have tech that can capture it very efficiently in a cold, dry climate."

– **Vida Gabriel**, Co-founder, TerraFixing

Recent developments from other Canadian CDR ventures

CarbonRun opened its West Pictou River alkalinity project last year, and the project went online this May. It also announced a proposal to add a site where limestone can be deposited into the East River of Pictou.

Hyperion, an Ottawa-based mineralization startup launched a pilot project with construction giant Lafarge (now AMRIZE) last year at the company's cement plant in Bath, Ont. The project has the capacity to remove 1,000 tonnes of carbon dioxide annually, with plans to scale 10-fold. Hyperion's patented Tandem Carbon Recycling system diverts waste carbon dioxide emissions from the plant and uses a novel reactive mineralization process to convert waste emissions into valuable mineral components that are used to make concrete and other sustainable building materials, permanently storing the carbon.

Arca recently announced a partnership with an Australian miner to test its carbon mineralization process, which aims to accelerate natural mineralization as a means of capturing atmospheric carbon. The company, using technology developed at the University of British Columbia, uses mine waste as a raw material, and their process also assists in mine clean-ups. Arca secured $8 million from a pair of Australian venture capital firms, with the proceeds going to support the build out of its system.

NULIFE GreenTech, a Saskatoon-based startup that uses a process called hydrothermal liquefaction to transform wet waste biomass into bio-oil, is expanding into its first commercial facility later in 2025. The company has identified sites in the Prairies where it can inject the bio-oil for permanent storage.

Exterra Carbon Solutions announced a strategic partnership earlier this year with Winsome Resources, a lithium exploration and development company. They plan to explore the use of mining residues from a diamond mine in northern Quebec for carbon sequestration.

Hyperion's carbon recycling system converts waste emissions into valuable mineral components.

Notable purchase plans

Canadian CDR firms will benefit from the federal government's plan to acquire $10 million in durable carbon removal credits through the Low Carbon Fuels Procurement Program, launched last winter. The procurement is the first of its kind by a national government. CDR developers will respond to an RFP to provide removal credits to offset hard-to-abate emissions from fuels used by government fighter jets and naval vessels. The goal is to advance a federal green government initiative and stimulate the Canadian CDR market by acquiring removal credits derived from a wide range of technologies. The program also allows successful CDR suppliers to leverage the experience of having a large government customer to win new clients.

"We think that direct government procurement of carbon removal services is a really high ROI policy lever that can drive more investment in the space," says Na'im Merchant, executive director of Carbon Removal Canada, an industry advocacy group. "The government is buying carbon removal to address emissions from its national security fleet, where it's difficult to find alternatives to reduce emissions. They're buying carbon removal from Canadian companies to address that challenge, and that has the benefit of creating a high degree of credibility for those companies. It helps those companies find other buyers from the private sector. So, it has a really important multiplying effect."

Spurring the market

How MaRS is building momentum in carbon markets.

To help build domestic demand for Canadian carbon removal solutions, MaRS pre-purchased carbon credits and is sharing learnings with corporate and ecosystem partners. "Without early adopters, the industry won't be able to scale fast enough and drive down cost," says Tyler Hamilton, senior director of climate at MaRS. "MaRS is well-equipped to educate and collaborate with corporations to ensure they make informed, impactful investments that will drive real climate action."

April 2024
MaRS pre-purchased 84 tonnes of carbon dioxide — the equivalent to the annual GHG emissions of 19 gasoline-powered passenger vehicles — from five Canadian ventures (Arca, CarbonRun, Gaia Refinery, Planetary Technologies and TerraFixing). As the first Canadian charitable organization to buy carbon removal credits, MaRS aimed to not only kick-start the market, but to also offset emissions from the annual MaRS Climate Impact conference.

December 2024
MaRS announced the launch of the MaRS Carbon Removal Donation Program, the first of its kind in Canada. The program pools tax-deductible donations from individuals and organizations to purchase high-quality carbon dioxide removal credits from early-stage Canadian companies permanently removing carbon dioxide from the atmosphere.

April 2025
MaRS pre-purchased 120,000 carbon credits from six ventures as a means of further spurring the market. MaRS's pre-purchase initiative included a six-month-long collaboration with M-Lab, a consortium of Japanese companies led by Mitsubishi, that aimed to educate members about strategies and tools so that they could begin to make their own carbon credit purchases, aligning with Japan's net-zero commitments. With the support of M-Lab, MaRS launched a national call for applications to identify promising early-stage carbon removal ventures. The selected companies — NULIFE GreenTech, Skyrenu, Exterra Carbon Solutions, TerraFixing, CarbonRun and Arca — will provide carbon removal credits over a period of up to three years, allowing them to demonstrate market traction and attract future buyers.

"For the M-Lab companies, this is an early step in their corporate journey to meet net-zero goals through Canadian carbon removal technology. We've emerged from this partnership with MaRS with the know-how to begin making our own purchases in the future."

– **Reina Ozaki**, Manager, Strategic Partnership and Business Development, Mitsubishi Corporation (Americas), Silicon Valley Branch

Overcoming barriers

In order to scale, the CDR market needs to clear several hurdles.

What Canadian CDR firms need are corporate buyers and strategic investors interested in helping these companies scale. For policy-makers, the goal shouldn't just be to keep pace with the rest of the world, but rather to help Canada become the best place for CDR firms to establish themselves.

The market opportunity is vast, but the competition will be intense. In its recent innovation survey, the IEA estimated that the CDR market worldwide could reach U.S.$250 billion per year by mid-century, depending on a range of variables, including energy pathways and the state of carbon pricing. Startup activity and venture capital investment are both increasing, especially in the DAC and bioenergy (BECCS) segments. These two options make up three-quarters of cumulative CDR credits sold in the past five years, though the cumulative share decreased for the first time between 2023 and 2024, as other approaches saw increased development, including mineralization and biomass-based methods, such as biochar, underground biomass storage and bio-oil storage.

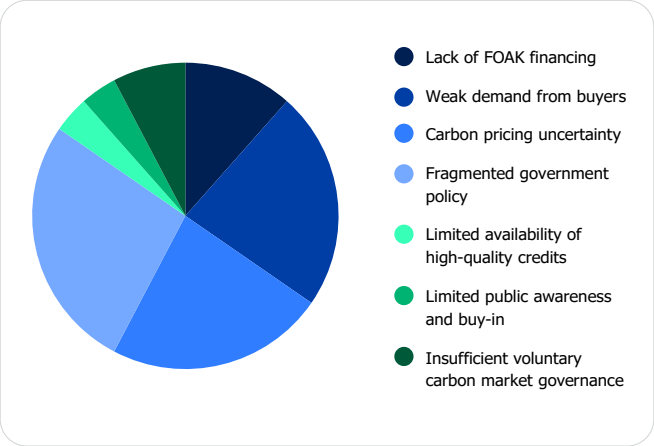
Market drivers will include policy mechanisms and regulations that cause emitters to turn to CDR firms to capture difficult-to-abate emissions. But there are also dividends from CDR that will allow partners or customers to reduce their own costs and emissions, thereby increasing efficiency. "Different carbon removal pathways offer distinct co-benefits," says Ben Rubin, executive director of the Carbon Business Council, which is a global coalition with an active footprint in Canada. "For instance, agricultural firms may invest in biochar to enhance soil health and crop yields, while energy utilities may collaborate with DAC developers to leverage their power infrastructure and operational expertise."

This diversity in approaches helps match solutions to local strengths and needs. "Supporting a range of pathways, business models and geographies unlocks a broader set of co-benefits," says Rubin. "By investing in diverse pathways, communities can realize economic, environmental and social benefits. Public and private investment for carbon removal increases the likelihood of scalable removals with localized advantages. There's a multiplier effect by taking the portfolio approach."

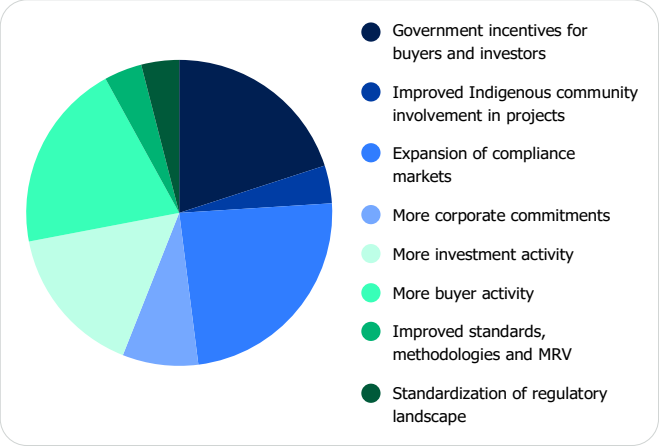
Investor Jane Kearns adds that hard tech funds, such as Evok, have identified potential strategic acquirers of CDR developers, including the suppliers of the inputs or mining companies looking to reduce tailings risk. (No exits have occurred yet, however.) While Carbon Engineering was acquired by Oxy Petroleum in 2023 for U.S.$1.1 billion, Kearns says that strategic investors aren't looking for enhanced oil recovery applications. "I've been in the cleantech climate world for a really long time," Kearn observes. "Many investors who invest in CDR don't want to see the carbon dioxide used for enhanced oil recovery. They want to see it stored or used, both of which are difficult because the added cost makes the economics more challenging."

In short, the value proposition for CDR investors is that these cleantech firms deliver a benefit that reduces costs associated with waste and mitigates regulatory risk — in other words, a quantifiable return.

Main barriers facing the Canadian carbon market



What solutions could help accelerate carbon reduction



Source: Mission from MaRS survey of Carbon Management Coalition

Despite the growth opportunities in the CDR vertical, several obstacles remain.

Market uncertainty

Most CDR ventures have yet to reach full technical readiness, and some are taking longer to test and scale than anticipated. Selby of Shopify also points out that the pool of purchasers outside of Frontier hasn't grown significantly. More worrisomely, political instability in the United States is threatening Inflation Reduction Act incentives, such as the 45Q tax credit, which provides an $85 credit for every tonne of carbon dioxide captured and permanently stored in geological formations. The Trump Administration has cancelled or reversed many of the IRA incentives. Anecdotally, the uncertainty in much of the climate sector, and the economy more generally, is negatively impacting the voluntary carbon credit market, as investors and corporate buyers cancel discretionary CDR purchases.

The Canadian government as well as the provinces can seek to fill the gap by expanding their CDR procurement budgets and providing other incentives to attract buyers from impact investing groups and corporations. Carbon Removal Canada is also working on a strategy to promote buying opportunities.

Regulatory gaps

Besides the extreme policy flux in the U.S., Canada's CDR regulations and incentives are a work-in-progress. Low-carbon fuel standards include provisions for carbon credits but there are many regulations, both nationally and at the state or provincial levels, which makes compliance more difficult. "Stimulating demand for carbon removal across both public and private sectors are essential to scaling the market," says Rubin. "The key challenge is developing clear, practical ways to drive demand, such as putting the right policy framework in place." Ottawa's push for new pipelines, energy projects and critical mineral approvals potentially adds opportunities for CDR firms to seek strategic partnerships with proponents in some of these ventures.

Nascent technologies and business models

Many approaches to CDR involve the deployment of capital-intensive hard tech, such as DAC facilities or rock-weathering projects at mine tailing sites. "Most of the approaches are either at low technology readiness levels (TRL) or are physically limited in their capacity to scale up globally," according to the IEA. Not only do they need to reduce the cost per tonne of carbon removed, they need to define workable business models.

Models that are centred on offsets as the principal source of revenue can make it difficult for mid-size and large venture firms to invest. When there is flux in pricing and demand, it can be challenging for CDR firms to forecast and plan.

Finding first customers

Many CDR developers face a classic Catch-22: they must attract up-front investment in order to test and scale their technologies to commercially viable levels. But they also need long-term offtake agreements with corporates or governments to hone business models that will eventually generate sustainable revenues, which in turn depend on the existence of incentives for emitters to acquire offset credits. Currently, only 3 percent of the global carbon credit market are classified as removals.

"Purchasers want to be confident that they will receive what they pay for," says Alexander Rink, co-founder and CEO of CDR.fyi. "Some carbon removal technologies are still scaling, introducing technology and time-to-delivery risk," pointing to the fact that by the end of 2024, only an estimated 4 percent of the contracted volume of carbon removal had been delivered. CDR.fyi analysis shows that so far this year the significant purchases have been directed to long-term BECCS supply, and the delivery-to- contracted ratio has dropped to 2.2 percent. While there has been a decrease, it is for a promising reason, explains Rink. It's "a reflection of a growing top line, not any issue with the growth in deliveries."

To date, most carbon removal purchases have been made by large tech companies (such as Microsoft) or buying groups (such as Frontier). For the market to mature, however, organizations of all types and sizes need to include CDR as part of their net-zero strategies.

The evolution of third-party verification/registry platforms, which give buyers assurance about long-term and durable removal, is a necessary precondition for a demand-side market to take root.

Lack of public awareness

A 2024 study published in *Nature Communications* assessed feedback from the general public on CDR, conducting 44 focus groups in 22 countries, including Canada. The authors found that participants generally favoured nature-based approaches to carbon sequestration (such as reforestation, afforestation or mangrove restoration) and tended to be more skeptical of engineering intensive solutions (such as DAC). Concerns included risk of leaks, energy consumption and CDR as a distraction from the broader need to decarbonize the global economy. "Our results confirm a key insight from the public perceptions literature: participants across the global North and South commonly questioned carbon removal's desirability in the context of the underlying need to reduce emissions and unsustainable resource use," noted the report authors.

To confront public skepticism about CDR, policy-makers need to prioritize public engagement and go beyond talking about CDR as simply another climate technology that needs to be de-risked and scaled up.

"Education is essential for the many companies new to carbon removal," says Rink. "Many still confuse avoidance with removal or haven't looked closely at the benefits of multi-century durable removal versus short-lived solutions."

Key takeaways

As emissions, including those generated by climate change–related natural disasters continue to rise, policy-makers have grown increasingly aware of the reality that mitigation measures on their own, even when successfully executed, aren't sufficient to ensure that global temperature increases remain below the 2-degree threshold. What's more, mitigation alone won't remove carbon that has accumulated in the atmosphere since the Industrial Age. These implacable facts are spurring the emergence of carbon removal as the other critical tool in the fight against global warming. To further spur Canada's CDR sector and capitalize both on U.S. uncertainty and the emerging recognition of removal as a legitimate response to climate change, Canadian corporates, non-profits and governments should aim to:

- Raise the profile of CDR buying groups among foundations, family offices and charities in order to attract more seed capital to test, refine and scale their technologies.
- Develop additional policy incentives, such as tax credits, to encourage potential corporate purchasers to invest in durable carbon removal credits.
- Reduce the gaps between competing technical evaluation standards, including those used in government programs, to simplify access to emerging commercial CDR markets.
- Initiate public awareness campaigns that seek to confront attitudes and potential misconceptions about CDR in order to confer legitimacy on such technologies in the broader fight against climate change.

Tammy Cai, chief technical officer at Gaia Refinery, is developing a modular plug-and-play system.

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Each Mission from MaRS coalition includes subject-matter experts from corporate, government, non-profit and venture organizations.

These advisors share insights from their respective sectors and collectively identify major challenges, providing guidance and good governance in the development of high-impact solutions.

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