Carbon Capture Journal

CCUS in Canada

Canada CCUS policy roundup - a suite of policies to induce investment in CCUS technologies and projects

Entropy Inc. - leading the world in post-combustion carbon capture

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Canadian CCS projects gaining momentum

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Canadian CCS projects gaining momentum

In early spring of this year, the Canadian government gave CCUS development a significant boost, putting an anticipated tax credit in writing in the 2022 federal budget.

The investment tax credit, along with escalating carbon pricing and a comprehensive federal climate plan, sent strong signals to industry that now is the time to invest in carbon capture technology, infrastructure, transportation and storage.

As federal policy and incentives have fallen into place in Canada, they've been met by an industry that has already begun laying the groundwork for CCS technology development across heavy industries. In western Canada in particular, where oil and gas, agriculture, and manufacturing provide the economic foundation for the region, meeting ambitious climate targets around emissions reduction has become a driving force.

Canada has been a world leader in the first generation of CCS projects, as home to five of the 27 commercial-scale facilities in the world today. This pioneering expertise is providing a strong platform for the development of the next wave of projects now on the horizon. SaskPower's Boundary Dam Unit 3 (BD3) CCS facility outside Estevan, Saskatchewan, in particular, provides almost a decade's worth of experience as the world's first fully integrated, full-chain CCS facility on a coal-fired power plant.

The BD3 CCS facility has now captured more than 4.5 million tonnes of CO2 since it began operation in 2014 and has proven capable of its design capacity of capturing 90 per cent of the CO2 in the flue gas it is sent from the power plant.

This impressive performance for a first-of-a-kind facility - and the valuable lessons that are serving to reduce risk levels and save new projects time and money - were recognized by the Carbon Sequestration Leadership Forum, which recognized the BD3 CCS facility with a Global Achievement Award at the CSLF's Technical Group Mid-Year Meeting held in Bergen, Norway in late-June.

All of this has put Canada in a strong position for current and future project development.

Lehigh Hanson's cement plant in Edmonton, Alberta, Canada

Lehigh Edmonton CCS study proves cement industry feasibility

Building directly upon the knowledge derived from the BD3 CCS project, the Canadian-based International CCS Knowledge Centre (the Knowledge Centre) worked with Lehigh Hanson Materials Limited (Lehigh) to study the feasibility of a CCS retrofit on an urban cement production facility in Edmonton, Alberta. Studying the potential for installation of a full-scale, post-combustion, amine-based CO2 capture system, the project represents a first in North America for CCS application in the cement industry and was made possible through an investment of CDN$1.4 million from Emissions Reductions Alberta (ERA) and funding from Lehigh.

The Lehigh feasibility report, released earlier this year, studied costs, optimal design, potential incentives, job creation and public perception. The overall conclusion of the study showed that a retrofit using technology at a readiness level of TR9 would cause minimal disruption to the site and to ongoing operations at the plant. The CCS facility could feasibly capture up to 95 per cent of CO2 emitted by the cement plant and an auxiliary boiler required for the capture process. This captured CO2 could be safely and permanently stored in a compatible deep geological saline aquifer.

Throughout the study, the Knowledge Centre drew on learnings from BD3 and also from a feasibility study for second-generation CCS project on SaskPower's Shand Power Station, which investigated a CCS retrofit on a 300-megawatt single-unit coal-fired power plant with double the capacity of BD3.

The Shand study showed the potential for significant cost savings through realizing greater efficiency and economies of scale on a second-generation project — results also seen in the Lehigh feasibility study.

Based on results from BD3, and similar technology potentially deployed at Lehigh's Edmonton cement plant, the amine-based carbon capture process was also found to coincidentally diminish concentrations of certain released pollutants – including significant reductions of sulphur dioxide and particulate emissions.

This feasibility study made a particularly close examination of potential energy needs and ideas around innovative repurposing of excess energy and wastewater. The economics of installing an efficient combined heat and power generation system that could power a steam-generated CO2 compressor and provide further reductions of indirect greenhouse gas emissions, will be examined in a subsequent phase of the study.

Because of the continuous operation typical of heavy industry such as cement manufacturing, the Lehigh study incorporated a selection of design changes to mitigate amine degradation and ensure that the capture facility could be maintained and upgraded without significantly impacting plant operations. These mitigations included an added filtration system that removes particulates and limits degradation of amines over time.

As well, redundancy and isolation were proposed for key components of the capture facility, to reduce shutdowns, improve reliability and minimize maintenance costs. The study also proposed an innovative combination of wet and dry cooling processes that reduced usage of fresh water and eliminated wastewater.

The Knowledge Centre estimated that the life-cycle cost of capture for the Lehigh plant will fall within the range of US$100-200 per tonne of CO2 captured. This aligns with estimates in a comprehensive report released by McKinsey and Company in 2020 that studied the costs of a variety of methods for decarbonizing cement manufacture.

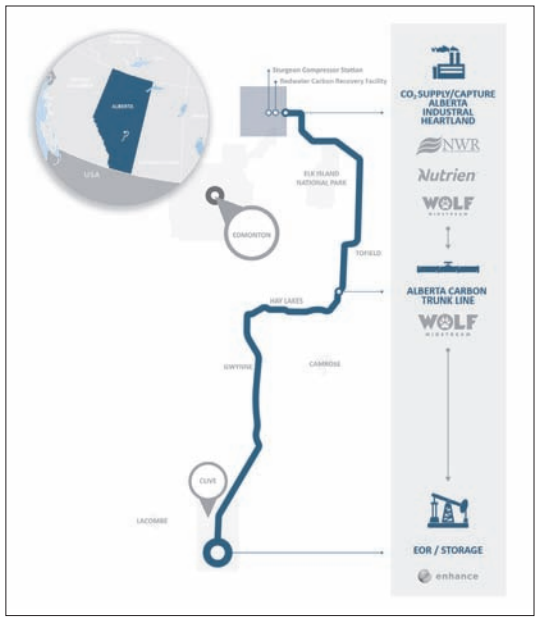
With the global demand for cement expected to grow by 12 to 23 per cent by 2050, this study provides an early forecast for the potential to decarbonize cement manufacturing with existing technology. It also creates a path forward for further study and testing.

The Knowledge Centre and Lehigh will soon begin work on a Front-End Engineering and Design (FEED) study to establish detailed engineering design and integration to Class Three estimate, to result in a business case for moving forward.

Funding round boosts 11 new projects

All of this groundwork and early deployment of technology has created a baseline of knowledge and expertise that will be leveraged in the development of new projects around the world, as well as a suite of other large-scale CCS projects in Alberta. In July, the provincial government in Alberta announced backing for 11 diverse, large-scale CCS projects through ERA.

The Carbon Capture Kickstart funding competition provided more than CDN$40 million for pre-construction engineering and design for innovative projects in a wide range of industrial sectors, including power generation, fertilizer, cement, forest products and oil and gas. Many of these projects represent the first stage of significantly larger overall project plans that could lead to an estimated CDN$20 billion in planned capital expenditures. Together, the projects are anticipated to eliminate approximately ten per cent of Alberta's total GHG emissions annually.



Alberta Carbon Trunk Line, the world's largest CO2 pipeline, began operation in 2020 with a capacity of 14.6 million tonnes per year of CO2, to connect multiple large-scale CCS projects and sequestration facilities through a transport hub

Carbon Capture Kickstart signals ongoing interest and investment in CCS projects in Canada, a sign that confidence in homegrown technology and access to significant carbon transport and storage infrastructure will transform the country's approach to emissions reduction in the decades to come

These 11 projects will share in national expertise built through successful projects including the BD3 CCS Facility, Shell Canada's Quest CCS facility outside Edmonton, Alberta, which has sequestered more than six million tonnes of CO2 so far, and the Alberta Carbon Trunk Line – the world's largest CO2 pipeline that began operation in 2020 with a capacity of 14.6 million tonnes per year of CO2, to connect multiple large-scale CCS projects and sequestration facilities through a transport hub.

The 11 projects chosen for ERA's Carbon Capture Kickstart program will advance CCUS-related technologies in step with emerging provincial and federal policies. In addition, ERA is providing funding for the Knowledge Centre to provide up to 200 hours of consultation and technical advice to each project, helping to increase performance while reducing the risk and cost of new projects, and ensuring that important new knowledge gained is documented and shared as broadly as possible.

ERA awarded project development funding to projects that are expected to be operational by 2030. They include CCS projects across a range of industries, all based in Alberta, with a combined estimated emissions reduction equivalent of taking five million cars off the road annually. They are all chosen in part as projects of sufficient technical and commercial scale to be deployment-ready, selected through a unique proposal structure designed to fill knowledge gaps and promote cross-collaboration to build networks of CCS projects that will have a lasting impact on current and future industry.

Among the planned projects, Calgary-based Entropy, Inc. is developing CCS technology for Athabasca Oil's Leismer SAGD oil sands facility. The project will deploy the company's trademarked Modular Carbon Capture and Reverse Entropy Storage processes to demonstrate capture on Athabasca's once through steam generator (OTSG) boilers. This is estimated to capture 164,000 tonnes of CO2 per year and will refine the design for future applications at the Leismer facility and to other OTSG applications around the world.

Nutrien, the world's largest producer of potash, and the third-largest producer of nitrogen fertilizer, will develop technology feasibility, preliminary engineering, and business case for carbon emissions reduction at the company's

Redwater, Alberta ammonia plant. The plant is already capturing CO2 from on-site hydrogen production (transported through the Alberta Carbon Trunk Line), and the goal for this study and project development is to achieve net-zero emissions for ammonia nitrogen fertilizer production out of Redwater.

ERA will provide CDN$2.5 million to the city of Medicine Hat, Alberta for a FEED study to develop the Project Clear Horizon regional CCUS facility, planned to capture and permanently sequester up to three million tonnes of CO2 annually. The study will include scope, planning, costs, and expected environmental and economic outcomes for development of capture technology on natural gas-fired power plants, plus pipeline transport, and a sequestration hub in this city in the southeastern corner of the province.

The project development team at Vault 44.01 received CDN$2.5 million from ERA for a Bioenergy Carbon Capture and Sequestration study at West Fraser Timber's Hinton, Alberta pulp mill. The study would outline a project to capture and store up to 1.3 Mt of biogenic CO2 emissions per year. Part of the study will also detail the economic value of the mill's negative emissions, which could be used to offset CO2 in hard-to-abate industries such as aviation and shipping.

Two of the province's largest electric utility companies, Enmax and Capital Power, received development funding for projects. Enmax will fund a FEED study for a carbon capture unit on its Shepard Energy Centre commercial scale combined-cycle natural gas generating plant in Calgary, which, when completed, will be the largest facility of its type in Canada.

Edmonton-based Capital Power has already completed a FEED study for retrofitting CCS technology on its Genesee natural gas-fired combined-cycle generating plant near Wabamun, Alberta. With a goal of net-zero emission electricity generation, this project could remove approximately three million tonnes of CO2 annually and be in operation as early as 2027.

Oil sands operators Canadian Natural and Suncor will use ERA funding to advance carbon capture technology in this hard-to-abate industry. Suncor will fund a FEED study to apply Svante's post-combustion absorption technology to the flue gas stream at the company's Fluid Catalytic Cracking Unit at their Edmonton refinery. Funding for Canadian Natural will support a study that would analyze emissions reduction among major oil sands producers, an alliance with a plan to reduce greenhouse gas emissions by approximately 22 million tonnes per year.

The Boundary Dam 3 CCS facility has now captured more than 4.5 million tonnes of CO2 since it began operation in 2014 and has proven capable of its design capacity of capturing 90 per cent of the CO2 in the flue gas it is sent from the power plant

This preliminary funding will contribute to planning for a CCS network to encompass approximately 20 oil sands producers, including development of a carbon pipeline and a storage hub in the Cold Lake region of Alberta.

Also at Cold Lake, Calgary-based Strathcona Resources received CDN$5 million for a feasibility and FEED study for post-combustion flue gas carbon capture on three SAGD oil sands operations. The company is interested in developing modular CCS technology that can be optimally applied to facilities with boiler and power supply configurations, which combined currently emit approximately 2.2 million tonnes of CO2 per year.

Remaining funded projects include CDN$5 million to Heartland Generation to study the feasibility of converting the company's Battle River Generating Station from natural gas to hydrogen with carbon capture, producing zero-emission electricity. Funding to Lafarge Canada will explore the feasibility of retrofitting the company's Exshaw, Alberta cement plant with CCS technology, including the possibility of linking this plant located in the province's Bow Valley with other industrial capture facilities through a transport and sequestration hub.

Federal policy aligns with support for CCS

These funded studies will advance CCS technology and deployment across industries, and will help to prove the value of Canada's existing innovations, and take advantage of the country's extensive energy industry expertise and the porous geological formations in the Western Canadian Sedimentary Basin that provide enormous CO2 storage capacity.

The work is all part of a focus on developing business cases for clean technology that work with Canada's existing industry, building capacity in innovation, job creation, and investment, and align with federal policy and incentives.

With the successful deployment of CCS at BD3, through smaller-scale capture facilities, comprehensive study of technology for other hard-to-abate industries, and funding, incentives and support from various levels of government, carbon capture and storage technology is poised for significant advancement in Canada through the next decade and beyond.

More information

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