Canadian institute focused on accelerating CO2 conversion tech

Three organizations in western Canada have teamed up to create the Carbon Capture & Conversion Institute, aimed at advancing technologies to capture carbon from industrial facilities and convert it into valuable products.

By Mark Lowey

Based in Vancouver, British Columbia, the Institute is the first initiative of its kind in Canada. It will bring together a global community of experts to accelerate the development, piloting, scale-up and validation of new carbon capture and conversion technologies, while also training the next generation of engineers, scientists and technicians. The institute is a collaboration between CMC Research Institutes, headquartered in Calgary, Alberta, and the University of British Columbia, and BC Research Inc. – both located in Vancouver.

The new institute will address the "pressing challenge" to develop and deploy carbon capture and conversion technologies in existing industrial plants, and is expected to help Canada fulfill its Paris Agreement commitments to significantly reduce greenhouse gas emissions, says Richard Adamson, president of CMC Research Institutes which spearheaded the initiative.

"In addition to the electric power sector, within the industrial economy there are a lot of processes that result in CO2 emissions, whether it's cement production or chemicals and plastics production or metallurgical processing or mining," he says.

Since there are already trillions of dollars invested in such facilities around the world, "we can't just flip a switch and change out all of that investment all at once. So we have to find a way to address, in the near term, the emissions associated with the industrial economy we have now," Adamson says.

A huge hurdle for the widespread deployment of carbon capture technology is cost. Existing technologies, such as capturing CO2 from flue gas streams with amine 'scrubbers,' which is the most common commercial application, are expensive – typically about $80 per tonne of CO2.

"The challenge is to find an alternative technology which is economic," says Hassan Hamza, president of BC Research. "This technology must be properly scaled up, through bench-scale to pilot scale, to demonstration plants, for successful commercial deployment."

The new institute will focus not only on technologies that reduce the cost of the CO2 capture process, but which also use the captured CO2 to produce valuable products that will generate revenue to offset the carbon capture costs.

Each partner brings particular strengths

"The Carbon Capture & Conversion Institute is an ecosystem, with all three organizations bringing experts able to address challenges ranging from fundamental science all the way through to commercial implementation," Adamson says.

Richard Adamson, President, CMC Research Institutes

CMC Research Institutes, the mission-driven, not-for-profit operator of the institute, works with researchers and institutions across Canada and worldwide, such as the U.S. Department of Energy, Norwegian research laboratories like SINTEF and others, private companies in the U.K. and U.S., and research groups in Europe and Korea.

"We reach broadly to be able to integrate technology elements into what might become a solution or solutions," Adamson says. The new institute is the second of several centres across Canada – each focused on key challenges for decarbonizing the industrial economy – envisioned by CMC. The first one was the Containment & Monitoring Institute, hosted by and affiliated with the University of Calgary, and its Field Research Station (featured in the May-June, 2015 issue of Carbon Capture Journal).

The University of British Columbia (UBC), the host academic institution for the Carbon Capture & Conversion Institute, is critical in sourcing and evaluating early-stage ideas, with a research team at the university's Department of Chemical and Biological Engineering and a multidisciplinary group at its

affiliated Clean Energy Research Centre. The UBC team focuses on developing industry-compatible processes to adapt research from bench-scale and batch processes to continuous, large-scale operations.

Naoko Ellis, professor of chemical and biological engineering at UBC and the new institute's acting senior research director, says a team that includes all three partner organizations will assess technologies and select the most promising for further development. "We need to accelerate the rate and number of technologies reaching commercial status," she says. "Another key benefit of the institute will be training the next generation of engineers – the next generation of leaders – by exposing them to research challenges unique to industry and providing the opportunity for significant interactions with the industrial partners," Ellis notes.

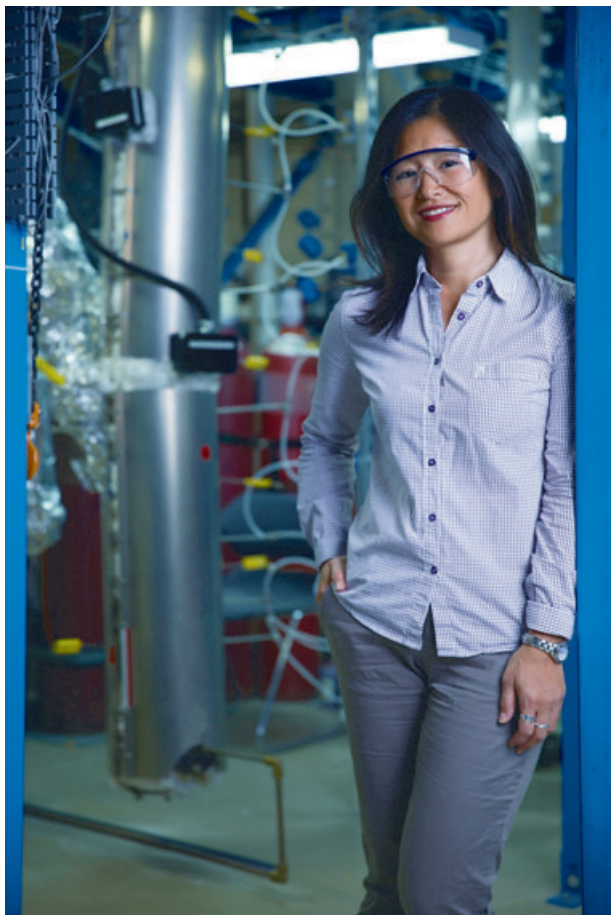
To support the institute's core research team at UBC, the collaborating organizations are seeking $1.5 million from an industry partner or conglomerate to establish a five-year research chair, co-sponsored by the Natural Sciences and Engineering Research Council, a federal funding agency.

BC Research Inc., a leading innovation centre specializing in the incubation and commercialization of emerging technologies, brings engineering design, development and scale-up capacity to the institute. Its services include experimental research, process development, pilot plant design, construction and operation, mechanical and material process engineering consulting, and laboratory analysis and testing.

"We are very good at scale-up of technologies – this is our business," Hamza says. BC Research is also the R&D arm of Vancouver-based NORAM Engineering and Constructors Ltd., a global firm that develops, engineers, and commercializes technologies for the process and resource industries. NORAM also owns Axton Incorporated, which is able to fabricate pilot plant components and can provide insights into development paths that will lead to capital cost savings at full scale.

New pilot-scale testing centre being built

BC Research will host the Carbon & Capture Institute at its new Technology Commercialization and Innovation Centre, now under construction in Richmond, B.C. and scheduled to open by early 2017. About one-third of the $4.5-million (for construction and furnishings), 40,000-square-foot facility will be devoted to the institute, Hamza says. The centre will provide the capacity to demonstrate, operate, test and analyze carbon capture and conversion technologies capable of handling up to one tonne of CO2 per day.



Dr. Naoko Ellis, Department of Chemical and Biological Engineering, University of British Columbia

New TCIC Building – Currently under construction, the new Technology Commercialization and Innovation Centre has space dedicated to piloting facilities for carbon capture and conversion technologies.

Along with on-site analytical services for improving process operational performance, the centre will provide CO2-rich streams (using natural gas) and utilities for operating large-scale pilot plants. The centre also will be able to accommodate a range of technologies – from solvent systems, membranes and sorbents on the capture side, to chemical, electrochemical and biological systems in the conversion stream.

"We are creating a platform of infrastructure in the facility where an innovator or a company can plug in their technology for testing and comparison, side-by-side, with a known technology," Hamza says. The centre will create a "hotbed" of innovation, he says, bringing together students and professors, researchers from universities, industry and government, experienced field engineers and new innovators, international collaborators, and companies that are looking at a technology that can solve their problems. "The outcome will be a sprint forward of technologies which are economic and viable."

The three organizations have chosen two

technologies for initial testing. One uses metal organic frameworks – networks of metal ions or iron clusters bridged by organic molecules into a porous structure – for CO2 capture. Its development is being led by George Shimizu, professor of chemistry at the University of Calgary.

The other technology uses the formation of gas hydrates from flue and fuel gas mixtures to capture CO2. This approach is being developed by Peter Englezos, professor and department head of chemical and biological engineering at the University of British Columbia.

Converting CO2 into valuable products

Converting CO2 into valuable products is technologically feasible and is already being done. CarbonCure Technologies Inc., based in Dartmouth, Nova Scotia, retrofits concrete plants with a technology that recycles waste carbon dioxide to make affordable, greener concrete products.

Another Canadian firm, Carbon Engineering based in Calgary, Alberta, and which operates a pilot plant in Squamish, British Columbia, is commercializing technology to capture CO2 directly from the atmosphere, for use in producing ultra-low carbon fuels.

Carbon dioxide can also be used to make methanol, although there already is a global industry producing this product. Other potential products include dimethyl ether, which can be used as a substitute for diesel fuel in engines, or perhaps a construction material that displaces carbon-intensive cement.

"Each one of these technologies and target products only take off a relatively thin slice of the total, global CO2 emissions profile," CMC's Adamson notes. "But as we develop the pathways and drive the costs down and get more versatile processes in place, the wedges will add up substantially."

Dr. Hassan Hamza, President, BC Research Inc.

The Carbon Capture & Conversion Institute may find solutions for addressing emissions from natural gas combustion, which could make natural gas not only a "transitional" fuel to a low-carbon world but a "destination" fuel with a longer economic life, Adamson says.

Significantly reducing natural gas emissions would also help British Columbia shrink the carbon footprint of its planned liquefied natural gas export industry and associated natural gas production. CMC Research Institutes is also working with industry in Alberta on related activities that may be linked with the new institute.

So what would success for the institute look like?

"My vision is for it to become a globally renowned and acknowledged centre for innovation in addressing carbon emissions associated with continuous industrial processes," Adamson says.

"Innovation means that the products developed through the institute are commercially or industrially applied broadly around the world. Solutions are incorporated into legacy plants and next-generation plants that are being installed all around the world to address greenhouse gas emissions."

Mark Lowey is the managing editor of EnviroLine and has worked as a professional journalist in Calgary for 35 years.

Carbon capture and conversion technologies, such as the systems being developed by Mantra Energy Alternatives, will be piloted at the new Technology Commercialization and Innovation Centre in Vancouver, British Columbia. Photo courtesy Mantra Energy Alternatives

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