CCS

Capturing Attention

Saskatchewan taking the lead on carbon capture and storage

THERE'S MORE TO SASKATCHEWAN than inexpensive real estate, a burgeoning oil and gas industry and golden prairie.

Boasting a university that's getting world famous, a ground-breaking international pilot project and a company that specializes in commercializing carbon capture and storage (CCS) technologies, the province is fast becoming known as a world leader in research into carbon dioxide (CO_2) capture and storage.

Some of the world's top experts on CCS work at the University of Regina (UofR), which has two major testing facilities: a semi-commercial CO_2 extraction demonstration plant adjacent to SaskPower's Boundary Dam power station and a development pilot plant, the International Test Centre for CO_2 Capture (ITC). The ITC has been recognized by the International Energy Agency as one of the best CO_2 capture research facilities in the world.

The Boundary Dam CO_2 recovery facility is used to evaluate the performance and reliability of solvent absorption-based technologies as well as to obtain process design information under a wide range of operating conditions.

The technology development natural gas plant at the ITC tests and evaluates the performance of solvent absorption-based CO_2 capture from natural gas exhaust streams. The facility can control, monitor and record the full spectrum of process parameters. It is now being used to test and develop cost-effective strategies for capturing CO_2 using enhanced post-combustion scrubbing technologies, including minimizing the energy needs for solvent regeneration in the stripping column and other alternative operating procedures.

Some of the university's engineers and scientists have been working on CCS for more than 20 years. "Two of the leaders and the most published, technical people in the world are at the University of Regina," says Jeff Allison, senior vice-president of HTC Purenergy Inc., which has a licence agreement with the university to commercialize the school's CO_2 capture technologies. "We've worked on projects all over the world, putting together design and engineering for CO_2 capture plants on coal plants and natural gas-fired plants," says Allison. The company has engineered projects in Norway and Australia, and is working on some in the Middle East and elsewhere that have not yet been announced, he says.

The two leaders Allison refers to are Malcolm Wilson and Paitoon Tontiwachwuthikul. Wilson is the director of energy and environment at the UofR and a member of the United Nation's

LEAK DETECTOR
Solid state flux probes measure soil CO_2 emissions. Designed to be simpler and tougher than common automated chamber systems, the probes capture continuous (every 60 seconds) emissions data in challenging conditions, including under snow.

Intergovernmental Panel on Climate Change, which was a co-recipient of the 2007 Nobel Peace Prize, along with former United States vice-president Al Gore. Wilson is a recognized pioneer in CCS and has been advising governments, industry and organizations for more than two decades.

Tontiwachwuthikul is the school's dean of engineering. He is the leader of the CO_2 capture program at the UofR and played a key role in establishing the ITC in Regina. He has published more than 180 peer-reviewed papers on CO_2 capture.

Wilson says the UofR's most promising technology is basically ready to become commercial but first needs to be attached to a coal- or natural gas-fired power plant to determine actual costs of a full-scale system. Current estimates are that the thermal kinetics optimization (TKO) system will improve energy efficiency and thus cut operating costs by around 10%. "It's not cheap but neither is moving to renewable energy," says Wilson.

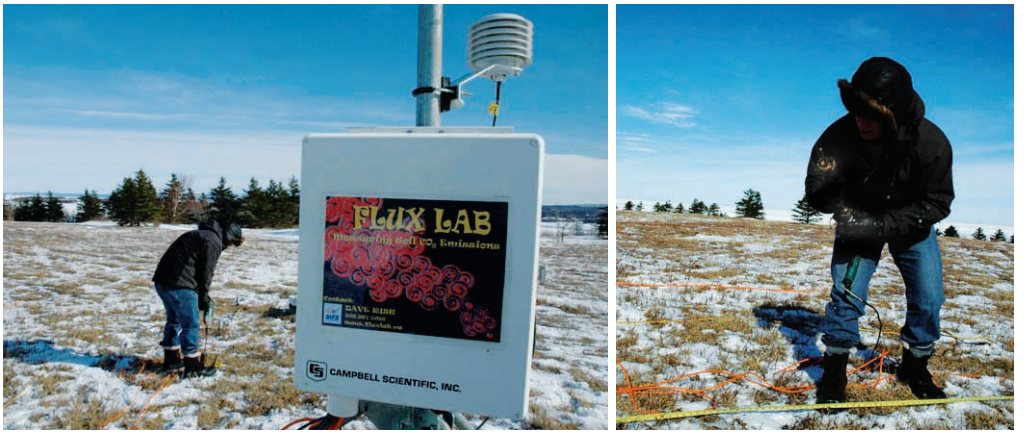
The TKO system removes CO_2 from power plants' flue gases and reduces the steam used in the process. The pure CO_2 is then compressed and transported for storage in the deep subsurface. Only 13% of what comes out of coal-fired power plants and only four per cent from natural gas-fired ones is CO_2, he says.

Recently the government of Saskatchewan, Royal Dutch Shell plc and the UofR launched a new international centre designed to help make Western Canada a global leader in the worldwide deployment and acceptance of CCS. The International Performance Assessment Centre for Geologic Storage of CO_2, located at the UofR, will focus on:

- assessing the risk planning on CCS projects around the world and advising on the proper management of technical issues and performance monitoring;
- informing stakeholders and the public about CCS from an independent, science-based perspective; and,
- networking internationally to share and build on the findings of other research organizations.

Collaborating at the centre are: the University of Calgary, the University of Alberta, Dalhousie University and groups in Australia, Europe, South Africa and Brazil, with the potential of China and India joining. The group held its first meeting in February. Wilson is its acting director.

Saskatchewan is also home to the internationally recognized Weyburn Enhanced Oil Recovery CO_2 Project, the world's first CO_2 measuring, monitoring and verification initiative. Launched in 2000, the $80-million international project studies CO_2 injection and storage in oilfields. The goal of the project's final phase (2005-2011) is to deliver the framework necessary to encourage implementation of CO_2 geological storage on a worldwide basis.



CARBON MONITOR
Several flux solde probes, placed over a large area, will beam data to a central location to monitor ground surface CO_2 emissions.

Word of the university's accomplishments is getting out. The UofR held a session to profile its worldwide reputation as a leader in CCS technology at the United Nations Framework Convention on Climate Change in Poznan, Poland, in December 2008.

And three of the UofR's process systems engineering group — Tontiwachwuthikul, Raphael Idem and Don Gelowitz — have been awarded Canadian Innovation Awards for developing a variety of CO_2 capture technologies and processes that include:

- optimum equipment selection processes for CO_2 capture plants;
- techniques for optimizing the economics and operation of CO_2 capture plants; and,
- a number of other process improvements, devices, designs and software applications for CO_2 capture.

They also developed a group of reactive liquid absorbents to remove CO_2 from flue gas.

Advancing projects

HTC and the UofR have more than 20 years of affiliated research, test and optimization operating experience in CO_2 capture systems. One of HTC's latest CO_2 capture products is a modular, pre-engineered system that will capture CO_2 from the flue gas exhaust of power plants and large industrial emitters. Based on technology developed at the university, the Purenergy CCS 1000 can be retrofitted to existing coal-fired power plants. It was launched commercially in December 2007.

"You get a lot of people arguing that post-combustion CO_2 capture isn't very cost effective, but it is," says Allison. "It's significantly more effective to put a CO_2 capture [system] on an existing coal plant and make that coal plant effective for maybe one or two cents a kilowatt versus spending probably twice that or three times that to put in solar or wind. Plus it's a lot more reliable. That's what we've been doing — working on ways to make the process more efficient."

HTC is working on a number of CO_2 capture design projects around the world. It has recently delivered front-end engineering and design for the construction of a European CO_2 test centre at Mongstad, Norway, in conjunction with its consortium partner, Bechtel Overseas Corporation. The Mongstad project will demonstrate that CO_2 capture technology is viable and that the technology can be used in large-scale CO_2 capture plants. Scheduled to begin operations in 2010, the experience gained from this project will be used to build a large-scale, two-million-tonnes-per-year CO_2 capture facility.

In addition, HTC is studying the potential of an amine-based CO_2 capture facility on

a coal-fired power plant for EPCOR Power Development Corporation.

HTC and Global Energy, Inc. have formed Cincinnati-based Carbon Management Technologies LLC to deliver CO_2 management, sequestration and EOR solutions to gasification projects and facilities in the United States.

Last June, the company announced a new CO_2 capture cost-reduction breakthrough: the TKO process which it says reduces steam consumption by up to 30%. The process improves capture through heat recovery, thermal balancing and optimized process flow. The primary advantage of the newly patented system is that it directly reduces the largest single cost of CO_2 capture — the use of power plant steam — to a ratio of below one unit of steam required to one unit CO_2 captured, says the company.

And in November the UofR, St. Francis Xavier University (StFX) and HTC signed a memorandum of understanding to introduce innovative measurement, monitoring and verification technologies at CCS projects around the world. The technologies were developed by David Risk, an earth scientist and assistant professor at StFX's Environmental Sciences Research Centre.

While the previously mentioned technologies relate to carbon capture, Risk's work is on the side of monitoring and assessing, well, risk. He has two technologies — hardware and software — that are complementary and expected to go commercial within the year. The hardware, a small monitoring probe called a flux solde, measures ground surface CO_2 emissions. It has no moving parts, is easily replicated, very simple and works in harsh environments like Canada's, he says. "We're even proving it under snow, which is an environment that's very tough for other monitoring technologies." It's not cheap, though. Dozens, even hundreds of these so-called nodes, which are expected to cost a few thousand dollars each, are placed over a large area. They beam information to a central location, requiring infrequent checking.

The software, called Flux Map, answers how many probes are needed and where, and works with all commercially available instruments. The software can design a statistically robust network and at later stages in the project help identify leaks. "Because it's a statistical approach it helps identify where there are statistical anomalies in the network," says Risk.

Wilson is convinced that all this research is leading to widespread use of CCS to combat climate change, but the economic climate is not helping. "Quite clearly, we're demonstrating that research can bring down the costs," he says. "But to get widespread deployment, we really need to confirm what those costs are, based on our pilots."

So far, indications are that costs can come down by around 30% from estimates that are currently being given for field-built units. Exact numbers are needed and to get them a project must be built to commercial scale, probably at a number of plants around the world. "We're working against current financial circumstances globally. People don't have money to invest in this type of thing at the moment."

• Lynda Harrison

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