



Canada's CO₂ Capture and Storage Information Source

CANADA LAUNCHES ITS ONE STOP-SHOP FOR INFORMATION ON CCS



Welcome to CCS101.ca
CCS is gaining unprecedented public attention and so the IEA GHG Weyburn-Midale CO₂ Monitoring and Storage Project, along with the Government of Canada and participating Canadian provincial governments, have come together to create an educational website on CCS.

The www.ccs101.ca website is a one-stop-shop for information on CCS. At CCS101.ca visitors can access the latest knowledge on CCS in Canada and from around the world. As Canada leads global CCS development, this website aims to make information on this important suite of technologies available to everyone both domestically and internationally.

CCS101.ca was funded through the IEA GHG Weyburn - Midale CO₂ Monitoring and Storage Project and Canada's CCS Network. The project at Weyburn and Midale is the world's largest and most extensively researched CO₂ monitoring and storage project, involving researchers from around the globe. "It is important for us to look beyond the project and put forward information about this technology in a way that is accessible to people globally," said Steve Whittaker of the Petroleum Technology Research Centre, and Project Manager for the IEA GHG Weyburn - Midale CO₂ Monitoring and Storage Project.

The new CCS101.ca website has three main navigation areas:

- **CCS Basics:** informs people of the technology fundamentals
- **CCS Communities:** this section features videos of people living in injection areas and seeks to show how projects are perceived by the people who actually live in areas with CCS development.
- **CCS Pro:** has detailed project listings, RD&D and commercial projects, the Canadian CCS Technology Roadmap, & virtually all public information on CCS.

"We hope this new online portal will become one of the world's most robust websites on CCS, with links to every other online resource on the subject. CCS101.ca is an excellent example of how researchers, industry and governments can work together to build better public understanding," said Dr. Frank Mourits, who initiated work on CCS101.ca as the Government of Canada's Project Integrator for the IEA GHG Weyburn-Midale CO₂ Monitoring and Storage Project.

For more information on CO₂ Capture and Storage please visit www.ccs101.ca.





CO₂ CAPTURE AND STORAGE IN CANADA

There are several pilot and demonstration projects currently proceeding in Canada as a means to understand the potential for a reduction in CO₂ emissions using CCS technology. Among them is the IEA GHG Weyburn-Midale CO₂ Monitoring and Storage Project. This project stands out as the world's first measurement, monitoring and verification program in connection with CO₂ Enhanced Oil Recovery (EOR) operations. It is the planet's largest CO₂ injection operation, and as of January 1, 2010 had 17 million tonnes of CO₂ underground. The project is proud to sponsor CCS101.ca.

QUICK FACTS

The Sleipner project in Norway (injecting CO₂ into a deep saline formation since 1996), and Weyburn-Midale in Saskatchewan, Canada (injecting CO₂ into a depleted oil field since 2000) have set an excellent standard for sequestering CO₂ with no incidents.

The business operations of this project focus on EOR using CO₂ to improve oil recovery from two oilfields in Canada's province of Saskatchewan. The two oil fields where CO₂ is being injected are operated by separate companies – the Weyburn field by Cenovus Energy and the Midale field by Apache Corporation. The fields are located in the southeastern part of the province and utilize CO₂ from the Dakota Gasification Company in Buelah, North Dakota, USA via a 320 km pipeline.

The CO₂ supplied by the Dakota Gasification Company, first is extracted from gas streams typically emitted during their industrial processes. Once captured and compressed, the CO₂ is transported by pipeline to the injection site, where it is injected at a depth of 1.5 km below the surface as a liquid into the storage site (or geological formation), where it will be safely stored for the long-term after oil recovery operations have ceased. Some other Canadian projects utilize tankers to transport captured CO₂ to injection/storage sites.

The research project that runs in parallel to the EOR operations at the Weyburn and Midale fields lead international knowledge on measurement, monitoring and verification of injected CO₂ at volumes that are at a commercial scale. At the end of oil recovery operations the sites are projected to have stored 40 million tonnes of CO₂ that would have otherwise been vented into the atmosphere – that's over one tonne for every Canadian.

The research conducted on this project will develop best practices for transitioning CO₂-EOR operations into long-term CCS projects around the world and will solidify Canada's position as a world leader in CO₂ mitigation technologies. In early 2009, the project was cited by US President Obama and Prime Minister Harper as an excellent example of cross-border cooperation on mitigating climate change.

For more information on the IEA GHG Weyburn-Midale CO₂ Monitoring and Storage Project follow this link (http://www.ptrc.ca/weyburn_overview.php) to the Petroleum Technology Research Centre, which heads this international CO₂ research initiative.

CO₂ CAPTURE AND STORAGE IN CANADA, CONT'D

The international research underway in Canada on CCS technology bolsters Canada's position as a world leader in science and technological innovation. Through technology, Canada can offer the world vital solutions set in meeting the challenges of climate change.

Renewable energy, energy efficiency, and other tools will all be needed to find solutions for climate change. CCS can play an important role in mitigating the CO₂ that contributes to climate change because CCS is the most immediate solution existing for large point emitters of CO₂.

The challenges of climate change are not simply those of transitioning to newer forms of energy, but doing so in a way that gives society and economies the much needed time to adjust to change. As indicated in the scenarios work done by Canada's National Energy Board (NEB), it is expected that fossil fuels will continue to dominate energy demand in the near future.

Canada also has abundant energy resources, and it's fossil fuels in particular are world-class in scale. With the recent addition of Alberta's vast oil sands deposits to its total reserves, Canada quickly became the second largest nation in terms of established reserves in 2002, with 178 billion barrels in place (NEB, 2004). Canadian coal reserves are also large at 6.6 billion tonnes (WEC, 2004).

Fossil fuels are of strategic national importance to Canada because a number of essential sectors depend on these resources. This includes coal-fired power generation, oil and gas production, oil sands development, petrochemical manufacturing and transportation – much of which helped build Canada as a nation and as such are deeply bound to our shared quality of life.

Developing CCS will enhance the future value of these sectors while increasing the value of industries that use fossil fuels in their day-to-day activities (such as forestry, mining, cement, steel and manufacturing).

It is imperative that Canada aggressively pursue CCS R&D to take advantage of current Canadian strengths and to capitalize on domestic and international opportunities. As already noted, inherent CCS opportunities exist in Canada, which, in combination, set Canada apart from many other parts of the world. These include the nation's current position as a country with:

- Vast fossil fuel resources, particularly oil sands and coal
- Internationally competitive industry producers and exporters of fossil fuels
- Enormous potential for geological storage of CO₂ in various regions across the country
- Existing, leading-edge knowledge and expertise in CCS applications

OTHER CANADIAN CCS PROJECTS INCLUDE:

- Alberta Carbon Trunk Line
(<http://www.enhanceenergy.com/>)
- Aquistore
(http://www.ptrc.ca/aquistore_overview.php)
- Heartland Area Redwater Project (HARP)
(<http://www.arc.ab.ca/media-resources/news--announcements/2008-news/heartland-co2-project-strikes-at-the-heart-of-oil-sands-greenhouse-gas-emissions/>)
- Project Pioneer
(<http://www.projectpioneer.ca/>)
- Quest CCS Project
(http://www-static.shell.com/static/can-en/downloads/aboutshell/our_business/quest-public-disclosure-v9.pdf)
- Spectra Energy
(http://www.spectraenergy.com/our_responsibility/climate/carbon_capture/)
- Swan Hills ISCG/Sagitawah Power Project
(http://www.swanhills-synfuels.com/projects_sagitawah.htm)
- Wabamun Area CO₂ Sequestration Project (WASP)
(<http://www.ucalgary.ca/wasp/>)
- Zama CO₂ EOR Pilot Project
(<http://www.apachecorp.com/Operations/Canada/Stewardship/EOR.aspx>)

SWAN HILLS SYNFUELS ISCG PROJECT, ALBERTA CANADA

Swan Hills Synfuels (“Synfuels”) is moving forward with the implementation of a commercial in-situ coal gasification (ISCG) – power generation project in Alberta.

The project will use ISCG to gasify coal in place in its original seam at a depth of 1400m to manufacture synthesis gas (syngas), which will be processed in a gas plant at surface to capture 1.3 million tonnes per year of CO₂ from the syngas via a highly efficient, low-cost, commercially proven capture process. The CO₂ will be sold to nearby enhanced oil recovery (EOR) operators for permanent sequestration.



Making Clean Gas from Deep Coal

The clean, low-carbon syngas will be used to fuel a 300 MW high efficiency power generation facility, resulting in an electricity generation greenhouse gas intensity that is about one-quarter that of existing coal-fired power generation in Alberta, and just over half that of natural gas-fired combined cycle generation.

This innovative coal-to-power system features excellent environmental attributes, such as major step-change reductions in greenhouse gas intensity, virtually no freshwater use in the ISCG process, and a compact land use footprint with minimal impacts as a result of no coal mining or solids handling being required – while offering the long-term economic stability and energy security of abundant deep coal reserves beneath the project site.

Synfuels started up a demonstration phase of the project in the summer of 2009, proving that the deep coal resources of the Swan Hills, Alberta area secured for the project have excellent gasification characteristics. The pair of wells used in the demonstration phase is a full commercial-scale well pair; as Synfuels moves now into the commercial project development, the demonstration phase well pair will be simply replicated to provide the aggregate volume of syngas required for the commercial project. The ISCG process itself dates back to the 1930’s with deployments on a wide scale elsewhere in the world in the intervening decades.

The Project is now advancing towards a completion of FEED engineering, commercial contracting, and receipt of regulatory approvals by mid-2012, with construction start planned thereafter. A 2015 commercial in-service date is planned, with at an overall project cost of about \$1.5 billion. The project has been funded to date through private equity sources and with significant grant funding support from the Province of Alberta Carbon Capture and Storage Program. The project has also been identified by the Global CCS Institute as a large-scale, integrated CCS project that could potentially contribute to the achievement of the G8 Leaders’ goal of launching 20 large-scale CCS demonstration projects by 2010. In addition, the Project was recently ranked #1 in Alberta Oil Magazine’s annual ranking of the top 25 Canadian energy infrastructure projects.

“NATURE’S POWER FOR CARBON CAPTURE”

A BREAKTHROUGH, MADE-IN-CANADA CO₂ CAPTURE INNOVATION



CO₂ Solution Inc. (www.co2solution.com) of Quebec City is tackling one of the greatest challenges facing commercial scale

carbon capture and sequestration today: the present high cost of capture. CO₂ Solution’s technology to accomplish this is based on utilizing nature’s solution to the problem: the enzyme which efficiently manages carbon dioxide in humans and other mammals. Based on the ability of this enzyme, carbonic anhydrase, to convert one million molecules per second of CO₂ into bicarbonate, it is the fastest catalyst known to increase the efficiency of commercial CO₂ capture systems. Thus, CO₂ Solution is employing a ‘biomimetic’ solution to industrial emissions, leveraging millions of years of natural evolution. CO₂ Solution is commercializing its technology for coal fired power generation, the oil sands and other CO₂-intensive industries where a low-cost carbon capture solution is key to addressing climate change in a cost effective manner.

For the past several years, CO₂ Solution has been working diligently to adapt this natural mechanism to function effectively for industrial gas scrubbing. In the process, a significant portfolio of patents has been obtained, providing broad protection in application of the enzyme for carbon capture. CO₂ Solution’s enzymatic platform is poised to be a transformational technology for carbon capture and storage (CCS), by enabling currently high cost chemical processes to be dramatically more efficient.

One of the most significant barriers to the broad adoption of carbon capture and storage technology on a large scale is the cost of capture. For instance, as is commonly known, conventional CO₂ capture with monoethanolamine (MEA) is very effective at absorbing CO₂, however, it suffers from a significant energy penalty when the CO₂ is subsequently separated and the solvent is regenerated. Capturing 90% of the CO₂ of a typically coal-fired power plant with MEA would nearly double the cost of electricity production (COE).

With CO₂ Solution’s technology, on the other hand, the enzyme accelerates the absorption of CO₂ with low-energy, but normally kinetically limited solvents which would otherwise be too slow for CO₂ capture without the use of this catalyst. Thus, with such low-energy amine solvents as MDEA and AMP, and carbonate solvents such as potassium carbonate and ammonium carbonate, the use of the enzyme can provide a cost effective overall solution with efficient capture and lower energy consumption. In addition, the technology is compatible with existing packed column type equipment already familiar to the gas scrubbing community. Through its enzymatic technology, CO₂ Solution’s target is to significantly reduce the overall cost of capture and thus make large-scale CCS economically viable.

A significant milestone of the Company’s development was reached in December, 2010 through the signing of a Joint Development Agreement with Codexis, Inc. (www.codexis.com) of Redwood City, California, who also invested \$2 million in CO₂ Solution for a 17% ownership stake. Codexis is a leader in the design and production of “super enzymes” for harsh industrial processes, through its proprietary ‘directed evolution’ technology. Through the exclusive agreement, Codexis will provide its evolved carbonic anhydrases to further advance CO₂ Solution’s process towards commercialization.

In June, 2010, CO₂ Solution announced further



Scientists working in the laboratories at CO₂ Solutions



Scientist performs tests in the CO₂ Solutions lab

progress with the release of results towards validating the impact of its enzymatic process on reducing the cost of carbon capture at commercial scale. In conjunction with its consultant, Procede Group B.V, lab scale testing and process modelling demonstrated the potential to reduce the size of CO₂ absorber columns at coal-fired power plants by more than 90% when

the enzymatic technology was used with MDEA, as opposed to pure MDEA. MDEA is a widely used solvent for natural gas treating, but is generally regarded as too kinetically limited for CO₂ capture from power plant flue gas and other low-pressure gas effluent streams. By employing the enzyme, the rate of CO₂ absorption in MDEA was increased more than 10 fold, reducing the height of the modelled CO₂ absorption column from more than 200 meters to approximately 20 meters. Additionally, by taking advantage of the low-energy properties of MDEA, solvent regeneration and process energy consumption is predicted to be reduced by approximately 30% compared to a standard MEA process.

The results point to a significant reduction in capital and operating costs of commercial scale carbon capture at typical coal-fired power plants or other large emitters, while utilizing a widely available commercial solvent. The work also illustrates that the use of the enzyme holds a distinct advantage in that its use is energy-neutral to the process, as opposed to chemical CO₂ absorption promoters, such as piperazine or primary amines, which increase the energy required for subsequent CO₂ stripping. Furthermore, the process benefits from the favourable properties of MDEA for application to CO₂ capture from flue gas including lower corrosiveness and volatility.

CO₂ Solution's goal in the near term is to further

validate its technology at large bench scale and in small field pilots, and to form partnerships towards commercial deployment with leading organizations in key market sectors such as power generation and cement production. In this regard, the Company is currently in discussions with a number of such organizations towards scale-up and deployment of its technology, including Canadian and U.S. venues for field scale testing which may be able to leverage Canadian government funding opportunities.

CO₂ Solution's President & CEO Glenn Kelly remarked that "Our technology is positioned as the solution by which domestic and global greenhouse gas emissions from the largest emitters – power generation, cement and oil and gas – can be cost effectively managed, while allowing the continued use of fossil fuels as an economic energy resource. The reality is that coal and other fossil fuels will continue to dominate the energy mix for the foreseeable future, so the key will



Glenn Kelly, President & CEO

be to cost effectively manage their carbon footprint, and that is what our technology aims to accomplish. We believe it is a transformational innovation for helping mitigate the threat of climate change while its commercialization will contribute to the engine of economic growth of the new green economy."

As a 'made-in-Canada' industrial biotechnology breakthrough with significant potential both domestically and abroad, CO₂ Solution will help position Canada as a clean energy technology leader in the years to come.

UNIQUE CO₂ CAPTURE FACILITY OPENS

on April 20th, 2010, The Honourable Christian Paradis, Minister of Natural Resources, officially opened the CanmetENERGY CO₂ Research Facility (CanCO₂). This integrated and efficient pilot-scale carbon dioxide (CO₂) capture facility simultaneously removes pollutants while purifying and compressing CO₂ for transport, storage or use. The CanCO₂ is located at the Natural Resources Canada's Ottawa Research Centre in Bells Corners.

"Today, we are showcasing innovative technology and demonstrating that government and private industry collaboration not only works but is essential in the development of clean energy technology," said Minister Paradis. "Natural Resources Canada's CanmetENERGY has shown leadership in the development of carbon capture and storage technology, supporting the Government of Canada's commitment to reducing greenhouse gas emissions by 17 percent by 2020, a target that reflects the importance of aligning with the U.S."



Dr. Kourosh Zanganeh tours Minister Paradis through the CO₂ Research Facility at the CanmetENERGY labs

The Zero Emission Technologies group at Natural Resources Canada's Ottawa Research Centre has developed a CO₂ capture and compression unit suitable for separating CO₂ generated by an oxy-fuel (burning of fuel and pure oxygen) power plant and also from other industrial sources. The CanCO₂ is a trailer-mounted modular unit that is transportable and suitable for field testing and pilot-scale demonstrations.

As a portable near-zero emission test platform, this advanced facility is in demand by industry and research organizations to optimize, reduce costs, evaluate and test technology options for CO₂ capture from a host of fossil fuel-fired plants.

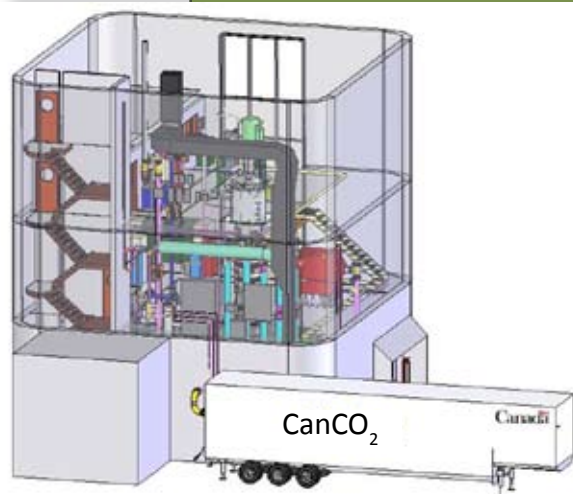
With this project, the Government of Canada continues its commitment to clean energy technology development by investing in projects that will reduce greenhouse gas emissions and produce high-quality jobs for Canadians.

For more information, see the NewsRoom section on the Natural Resources Canada website. Visit the Clean Fossil Fuels section to find out more about CanmetENERGY's related activities (http://canmetenergy-canmetenergie.nrcan-rncan.gc.ca/eng/clean_fossils_fuels.html).

QUICK FACTS:

Scientists at CanmetENERGY are leading the research and development of a diverse set of innovative technologies that will make fossil fuel combustion cleaner and contribute to the sustainable use of this resource.

Visit the [CanmetENERGY Website](#) to learn more.



The CanCO₂ trailer adjacent to the oxy-fuel pilot plant

PROJECT PIONEER CCS

PROJECT PIONEER - MAKING COAL A CARBON-NEUTRAL FUEL

Project Pioneer

Successfully implementing carbon capture and storage (CCS) is crucial if Canada and the world are to address the CO₂ emissions challenge. On a smaller scale, CCS has already proven to be a safe and effective

way of reducing the level of green house gases that enter the atmosphere. What makes the case for CCS so powerful is that it can be retrofitted on existing coal-fired power plants and other fossil energy infrastructure. By retrofitting coal fleets across the country, CCS has the potential to make coal a carbon-neutral fuel.

Project Pioneer will be among the world's largest fully-integrated CCS initiatives within the power sector. It will be a near-commercial scale demonstration of all elements of the CCS chain through a unique combination of partners, technology and integration.

Operating by 2015, Project Pioneer will be integrated with Keephills 3 (K3) – a 450 MW super-critical coal-fired plant jointly owned by TransAlta and Capital Power. Located 70 kilometres west of Edmonton, Alberta, K3 is ideally situated overtop potential permanent geological storage sites and near large, oil fields suitable for enhanced oil recovery (EOR).



*Construction of Keephills 3 (K3) –
a 450 MW super-critical coal-fired plant*

Project Pioneer will also be the first CCS project with an integrated underground storage system. The pilot project will involve the development of a carbon capture system, CO₂ compression facilities, a pipeline for transporting the CO₂ and an injection site where CO₂ will be injected underground for permanent geological storage and enhanced oil recovery (EOR). It is projected that once in operation the project will annually remove approximately one megatonne of CO₂ ---- which is equivalent to taking 175,000 cars off the road. It will also significantly reduce sulfur dioxide (SO₂) emissions which would otherwise be emitted to the atmosphere and store it in geologic formations.

The Project Pioneer CCS process will separate CO₂ from coal-fired generation flue gas and transport the CO₂ to injection sites in both permanent geological storage sites and mature oil and gas reservoirs. With a concentrated focus on reducing costs in all aspects

of this project, the Project Pioneer partners consider the competitive future of CCS as an alternative form of GHG mitigation.

Project Pioneer will utilize post-combustion retrofit technology that we expect will be cost-effective and have the broadest application and ability to affect global emissions in the next 20 years.

Project Pioneer has the potential to benefit everyone – from those who live near and around the facility to those who live a world away. And, the benefits will be felt at many levels. Project Pioneer will produce jobs, improve energy security, and lessen the impact the world's power infrastructure has on the environment.

What makes Project Pioneer a unique CCS project is: the approach, integration, knowledge transfer and the Alberta Advantage.

Approach. Project Pioneer will be financed, designed, built and operated by a consortium of governments

and industry. The intent is to bring together top companies in each of the respective CCS disciplines to deliver the best project possible. This approach will allow the sharing of cost and risks, as well as knowledge recognizing the project is potentially a prototype for full-scale CCS deployment.

Integration. Project Pioneer will create the opportunity to fully explore all aspects of the CCS business – from capture through to sequestration and enhanced oil recovery (EOR). One of the principal objectives is to drive down overall costs through an intense focus on integration across all CCS elements, as part of the design, construction and operation of the facility.

Knowledge Transfer. As recipients of significant public funding and recognizing the early stage of development of this technology, Project Pioneer is committed to extensive knowledge transfer from the project. We intend to work with other practitioners, institutions and academia to both extend our CCS experience outwards, and to acquire new information from the experience of others.

Alberta Advantage. There are unique opportunities in Alberta to explore integrated CO₂ transportation infrastructure by combining pipeline resources and delivery markets from the multiple projects and further the regulatory framework to support CCS. Project Pioneer will explore these opportunities.

Project Pioneer brings together public and private partners who have been leaders in power generation and on environmental issues for years. Partners include:

TransAlta, project leader

Founded in 1909 and producing power since 1911, TransAlta is Canada's largest publicly traded generator of electric and renewable power. As the project leader, TransAlta provides technical, commercial and project management for Project Pioneer.

Capital Power, generation partner

Capital Power shares a long history with TransAlta and is a co-owner, along with TransAlta, of the Genesee 3 power plant as well as the Keephills 3 power plant, site of Project Pioneer.

Enbridge, pipeline infrastructure leader

Enbridge is a leader in the design and construction of pipeline infrastructure, as well as extensive knowledge in CO₂ sequestration.

Alstom Canada, capture technology leader

Alstom is a global leader in energy technology with extensive experience with the chilled ammonia carbon capture process.

The Government of Canada, public funding

The Government of Canada will contribute \$343 million through the Clean Energy Fund and the federal ecoENERGY Technology Initiative.

The Government of Alberta, public funding

The Government of Alberta will contribute \$431 million through its \$2 billion CCS fund, with an additional \$5 million to support front-end engineering and design work



TransAlta and its partners believe that maintaining the long-term viability of fossil-fired generation is a global necessity. Through economic CCS we can keep coal and gas as fuel options while addressing climate change.

For more information on this unique partnership please visit the Project Pioneer Website:

<http://projectpioneer.ca/>

CO₂ STORAGE DEVELOPMENTS IN THE PROVINCE OF QUÉBEC

The research Chair on CO₂ geological storage (CCS) was created in June 2008 by the Government of Québec¹ with a budget of \$5 million for 5 years. The chair holder is Professor Michel Malo at the INRS (Institut national de la recherche scientifique). The main



Stefan Bachu at the 2nd annual conference of the Chair in April 2010

research objectives are to evaluate the CO₂ storage capacity in the province of Québec, to characterize the potential reservoirs, to develop a site pilot for injection of CO₂, and to create an expertise in Québec in the field of CCS.

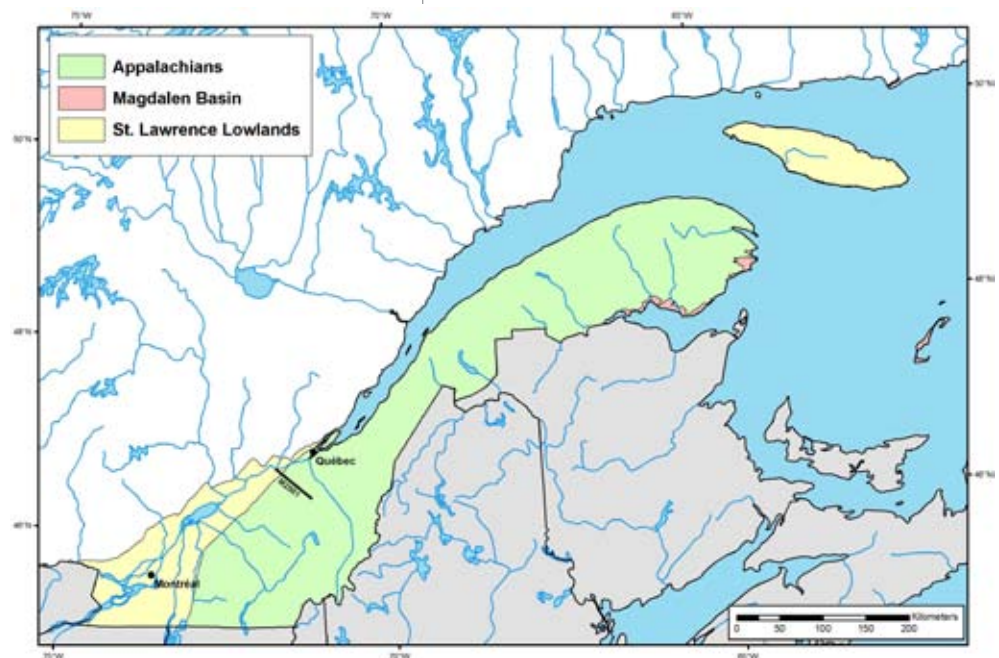
Additional work includes the assessment of socio-economic challenges for the implementation of CCS technology in Québec (laws, safety, public outreach, etc) and a techno-economic study for the establishment of a plant to capture industrial CO₂ in order to provide a complete CCS pilot-project.

One of the first actions of the Chair was to create a bilingual website² to inform on its research activities, publications, events and, more generally, on CCS. The website contains, in particular, scientific outreach for the public, a “news” section to constantly stay informed about CCS, a glossary of CCS related terms and a quiz to allow the public to test its knowledge on CCS. Questions such as “What is CCS?”, “Why CCS is an essential instrument to fight global warming?” or “What is CO₂?” are answered by providing detailed information on these topics. In order to inform the general public on CCS, a documentary film on the Chair was broadcast on Télé-Québec channel in March 2010³. This film allowed the viewers to understand the

areas of expertise and the research projects of the Chair.

In Québec, CO₂ storage could only take place in oil or gas reservoirs or in deep saline aquifers, since as there are no coal seams in the province. These potential storage reservoirs are located in sedimentary basins of the St. Lawrence platform, the Appalachians and the Magdalen basin. Up to now, the Chair’s research focused on the St. Lawrence Platform Lowlands where there is more geological and geophysical data available. Simply, if potential CO₂ reservoirs are matched with CO₂ emitters, CCS could happen between Québec City and Montréal, south of the St. Lawrence River. In the next three years, the main research activities of the Chair will be centered on deep saline aquifers found in the St. Lawrence Lowlands and possible CCS pilot-projects.

In order to obtain more information about CCS pilot-projects, Michel Malo and other members of the Chair team visited two CCS pilot-projects around the globe. First, they



Québec sedimentary basins and location of the M-2001 seismic line

1 Action 20 of the 2006-2012 Action Plan on Climate Change from the Minister for Sustainable Development, Environment and Parks.

2 <http://chaireco2.etc.inrs.ca> Please note that all pages are not yet translated in English.

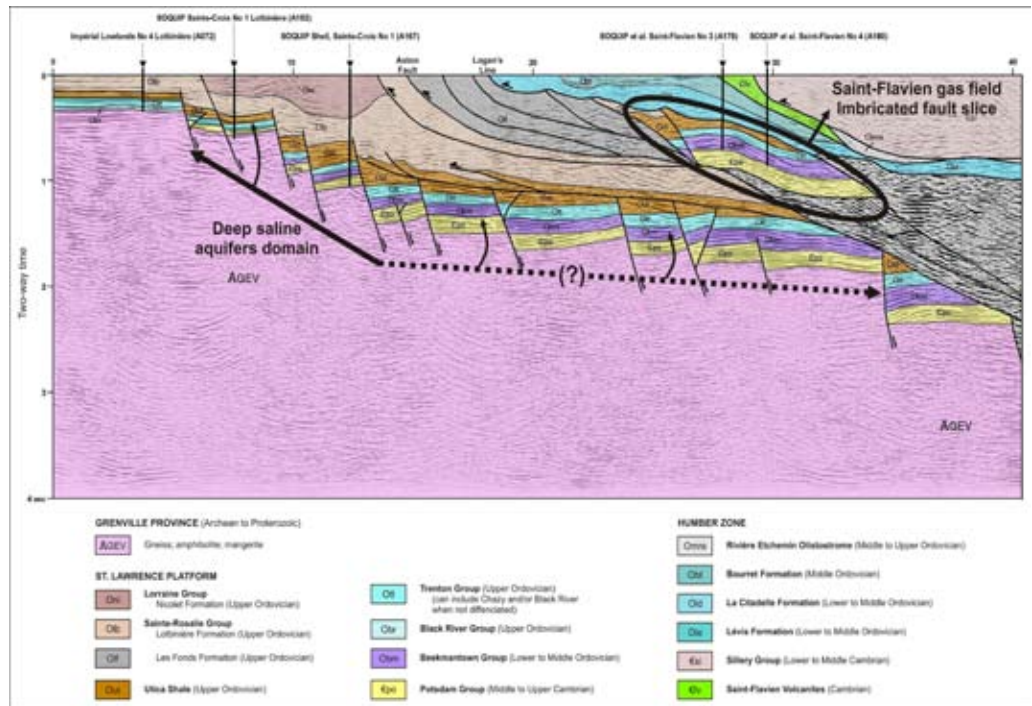
3 <http://www.canal.qc.ca/campus/emission09.htm>

visited the pilot-project in Otway (Australia) conducted by the Australian Cooperative Research Centre for Greenhouse Gas Technologies. Secondly, they visited the CO₂SINK pilot-project in Ketzin (Germany) coordinated by GFZ, the German Research Centre for Geosciences.

In April 2010, the 2nd annual conference of the Chair took place in Québec City. The conference topic was CCS in Eastern Canada. In addition to the presentations made by the Chair team, presentations of several invited speakers were made. Firstly, Dr Stefan Bachu from Alberta Innovates presented a detailed overview of CO₂ geological storage.

Secondly, David Keighley from the University of New Brunswick presented a preliminary evaluation of CO₂ storage potential in his province. Thirdly, Andrew E. Hewitt from the Ministry of Natural Resources in Ontario presented the CCS technology in a North American and Ontarian “Cap-and-Trade” context⁴. The Chair will continue its annual conference; the next one should be held in April 2011 and will again be open to everyone.

In 2010, the Chair submitted research reports for the Government of Québec. These technical and legal reports are accessible online on the Chair website⁵. At GeoCanada 2010 in Calgary, two presentations and two posters were presented to show the work being conducted by the Chair. Finally, the Chair is looking for candidates to start Masters and Doctorates at the INRS⁶ to become tomorrow’s experts in the CCS promising research field.



Architecture of the St. Lawrence Lowlands platform and the frontal part of the Appalachian fold-thrust belt, the two domains hosting potential CO₂ storage sites, on seismic line M-2001 (modified from Castonguay et al., 2006)⁷

QUÉBEC

*Stay up to date on Quebec's
Research Chair on
CO₂ geological storage:*

<http://chaireco2.ete.inrs.ca/?q=en>

<http://chaireco2.ete.inrs.ca/?q=fr>

The complex block features a green background with a map of Québec and surrounding regions. The map shows the St. Lawrence Lowlands and the Appalachian fold-thrust belt. Key locations like Ottawa, Montreal, and the Atlantic Ocean are marked. The text is centered and includes the title 'QUÉBEC' in bold, followed by the chair's name and two URLs for more information.

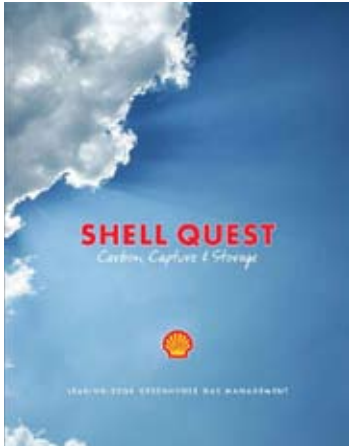
⁴ These presentations are available on the Chair website : http://chaireco2.ete.inrs.ca/?q=en/colloque_2010_eng

⁵ http://chaireco2.ete.inrs.ca/?q=en/publications_en Please note that reports are in French only.

⁶ M.Sc. and Ph.D. projects can be found online : <http://chaireco2.ete.inrs.ca/?q=en/recruitment>

⁷ Castonguay, S., Dietrich, J., Shinduke, R., Laliberté, J.-Y., 2006. Nouveau regard sur l'architecture de la Plate-forme du Saint-Laurent et des Appalaches du sud du Québec par le retraitement des profils de sismique réflexion M-2001, M-2002 et M-2003. Geological Survey of Canada, Open File 5328, 19 pages (2 sheets).

SHELL'S PROPOSED CARBON CAPTURE AND STORAGE PROJECT TO REDUCE CO₂ BY OVER ONE MILLION TONNES/YR



Shell Canada and its co-owners in the Athabasca Oil Sands Project are proposing a carbon capture and storage project that could reduce carbon dioxide (CO₂) emissions – one of the most important challenges facing society -- by more than one million tonnes per year.

The fully integrated project, known as Quest, would capture up to 35 per cent of CO₂ produced from the Shell Scotford upgrader's three steam-methane reformers, ship it up to 90 km north via pipeline and inject it about two kilometers below the ground where it would remain permanently. That's the equivalent of taking 175,000 vehicles off the road per year.

Shell believes it is important to look at all the options to reduce CO₂ emissions - including energy efficiency, renewable energy and biofuels. However, as fossil fuels will play a large role in helping the world meet its energy needs for the foreseeable future, CCS will play a key role in helping to reduce emissions needed this century to avoid the worst effects of climate change.

Quest will use technology that has been used safely and reliably in other applications in Canada and elsewhere around the world. CCS projects are already being operated safely in several locations, including Weyburn, Saskatchewan.

While the technology involved in all three aspects of CCS -- capture, transport and storage – is not new, one of the challenges the early projects face is building public familiarity and support for CCS – particularly in the local communities where the projects will operate. While the CCS team at Shell is looking for solutions for climate change, it's also trying to be as neighbourly as possible.

"It's absolutely crucial to be a good neighbor," said Kathy Penney, Environmental and Regulatory Manager for the Quest Project. "We need to demonstrate we're good neighbours and incorporate their concerns into our plans ... We've done 30-40 small re-routes (of the proposed pipeline as a result of speaking with neighbours). "If we receive approval to proceed with the CCS project, we're going to be operating

these facilities in the area for the life-time of Scotford," Penney said, adding that's what makes creating good relations with neighbours even more important.

Since 2008, when Quest was announced, project representatives have been consulting with residents living near the upgrader and along the proposed pipeline route. In 2008 Quest held an open house in Fort Saskatchewan, about 40 km northeast of Edmonton. Quest held four more open houses in March 2010 in the communities of Radway, Thorhild, Fort Saskatchewan and Bruderheim all located northeast of Edmonton. This was followed in 2010 by discussions with landowners along the proposed pipeline route as well as landowners affected by planned seismic activities in the area.

Besides public support the other challenge that early projects face is economics. Demonstration projects like Quest require significant capital investment and are currently not economic for companies to fund themselves. This is where governments can play a leadership role. Government support is required for the first wave of demonstration projects in order for companies to gain experience and expertise using this technology and bring down costs.

Last October, the government of Canada and the government of Alberta signed a letter of intent for funding towards the Quest Project. The federal government chose Quest as one of several demonstration projects to fund. Delivery of the \$120 million is contingent upon a financial agreement and federal approval of the project under the Canadian Environmental Assessment Act. The Alberta government has also offered to provide \$745 million.

If Quest receives regulatory approval from both levels of government and a financial investment decision from its three owners, construction could begin in 2012 with the first carbon dioxide going into the ground by 2015. ([Shell Quest Website](#))

ALBERTA INVESTING IN TRANSFORMATIVE TECHNOLOGIES

REGULATORY PROGRAM FOR LARGE INDUSTRY USES

CARBON PRICING TO SUPPORT CCS

Submitted by: The Government of Alberta

Alberta is not only a global leader in funding large-scale carbon capture and storage (CCS) projects, it is also a leader in funding new technologies.

Since July 1, 2007 Alberta has required facilities that emit more than 100,000 tonnes of greenhouse gases annually to reduce their emissions intensity by 12 per cent.

To meet this goal, companies were given four options: improve operations, purchase Alberta-based offset credits, purchase or use Emission Performance Credits, or contribute to the Climate Change and Emissions Management Fund (CCEMF).

The companies that choose the CCEMF route are required to pay \$15/tonne for emissions that exceed their targets. The goal of the fund is to help finance clean technology that will have a significant, sustainable reduction in greenhouse gas emissions.

Over the past three years, more than \$187 million has been managed by Climate Change and Emissions Management Corporation (CCEMC). This arms-length organization, which is independent from government, has a multi-stakeholder board. It is comprised of industry leaders from a variety of sectors including chemical producers, oil sands, conventional oil and gas, pipeline, electricity and forestry, academia, municipalities and the public at large.



Alberta Environment Minister Rob Renner, left, and Climate Change Emissions Management Corporation chairman Eric Newell recently announced a number of projects that will receive funding for clean energy/carbon capture and storage research.

The CCEMC's board is chaired by Eric Newell, the retired Chair, CEO and President of Syncrude Canada Ltd. Jim Carter, chair of the Alberta Carbon Capture and Storage Development Council and former president of Syncrude, is also on the board.

The Corporation issued its first call for proposals in 2009 and received more than 230 submissions from all over the world. It culled through the applications and asked 30 proponents whose projects best met the criteria to submit more extensive proposals.

Those proposals went through a rigorous process which was overseen by a fairness monitor and reviewed by panel members with varied expertise.

The first set of funding worth \$ 71.3 million has been allotted into categories with six energy efficiency projects receiving \$5.7 million, five renewable energy projects receiving \$37.5 million and five CCS and greening energy projects receiving \$28.1 million.

Two major cleaner energy projects received \$23.3 million. E-T Energy received \$6.86 million for its electro-thermal dynamic stripping process for oil sands development and a consortium of companies, including Nexen Inc. and Suncor Energy, received \$16.47 million for its enhanced solvent extraction incorporating electromagnetic heating.

Three CCS projects received \$4.8 million:

- HTC Pure Energy Inc. received \$315,000 for a CO₂ capture FEED study for Devon's Jackfish SAGD facility in northern Alberta;
- GE and partners received \$2 million for ceramic membrane-based technology for H₂ production with CO₂ capture and sequestration and;

- Suncor Energy Inc. and partners received \$2.5 million for its OTSG oxy-fuel demonstration project at an oil sands in-situ operation in northern Alberta.

All of companies receiving funding for their projects funded by CCEMF will at a minimum match the dollars being invested.

Full details on the fund and the projects chosen for funding are available at <http://ccemc.ca> and details on Alberta's regulations on greenhouse gas emissions are available at www.environment.alberta.ca.

Alberta is also providing funding for large-scale CCS projects. In 2008 the province allocated \$2 billion to kick-start four steel-in-the-ground projects. The project proponents have all signed Letters of Intent with the province and are working toward signing Grant Agreements.

The projects being pursued are: Enhance Energy's Alberta Carbon Trunk Line (ACTL), a 240-kilometre pipeline that would capture CO₂ from a bitumen upgrader and fertilizer plant for use in Enhanced Oil Recovery (EOR); Shell's Quest Project which will upgrade bitumen from Alberta's oil sands and store the CO₂; Swan Hills Synfuels will use an in-situ coal gasification process to access deep coal seams to convert the coal to synthetic gas (syngas); TransAlta will use CCS technology to capture CO₂ from an electricity plant and use it either for enhanced oil recovery or for permanent storage.

To learn more about Alberta's CCS pursuit, visit www.energy.alberta.ca.

FEATURE ARTICLES IN THE SUMMER 2010 ISSUE

- CO₂ Capture & Storage in Canada
- Swan Hills Synfuels ISCG Project, Alberta Canada
- "Nature's Power for Carbon Capture"
A Breakthrough, Made-in-Canada CO₂
Capture Innovation
- Unique CO₂ Capture Facility Opens
- Project Pioneer - Making Coal a Carbon-
Neutral Fuel
- CO₂ Storage Developments in the
Province of Québec
- Shell's Proposed Carbon Capture and
Storage Project to Reduce CO₂ by Over
One Million Tonnes/Yr
- Alberta Investing in Transformative
Technologies

Thank you to all of this month's contributors.

Submit articles for CCS101's Fall Newsletter by October 21st to:

webmaster@ccs101.ca