



# CO<sub>2</sub> Capture and Storage (CCS) for Domestic and International Markets

## Challenge

Burning fossil fuels is a major source of greenhouse gas (GHG) emissions. CO<sub>2</sub> is by far the predominant man-made GHG.

More countries are now looking to have energy producers and consumers reducing GHG emissions. Coal, which is abundant and commonly used is a major CO<sub>2</sub> source. Oil and gas emit less CO<sub>2</sub>, but are less abundant and are depleting. Renewable energy is unlikely to replace fossil fuels in the short to medium term.

Governments and industry need long-term solutions to these energy challenges. It is in their economic best interests that this be done at the lowest possible cost with maximum economic and environmental benefits.

One solution is CO<sub>2</sub> Capture and Storage (CCS). This technology captures CO<sub>2</sub> and stores it in depleted hydrocarbon reservoirs or saline aquifers, thus reducing GHG emissions to the atmosphere. This, along with carbon conversion technologies, can lead to a cleaner environment and continued use of our fossil fuel resources.

No one company possesses all of the expertise essential to develop successful CCS projects. The Canadian CO<sub>2</sub> Capture and Storage Alliance (CCCSA) is a group of companies that offer a broad range of expertise to take on any CCS project.

## Opportunity

Potential geological storage sites are large and widely distributed across all continents. Saline aquifers have the greatest potential but are largely unproven, costly and revenue deficient. Siliciclastic, carbonate and coal reservoirs containing oil and gas have much smaller storage capacities. However, these reservoirs present an opportunity for dual benefit - the storage space is increased by displacing and recovering the oil and gas, at the same time creating a revenue stream.

CCS is not just for developed countries - its greatest potential is in developing countries such as China, India and South Africa where CO<sub>2</sub> emissions are abundant, and production and use of fossil fuels is growing.

CCS can also be integrated with gasification or oxyfuel combustion technologies. These technologies generate cleaner power, and a concentrated CO<sub>2</sub> source for geological storage. This can reduce CO<sub>2</sub> capture costs, a major cost in CCS projects.

## Solution

Maximizing the benefits of CCS requires expertise in all aspects of the technology, from capture to pipeline transport to injection. Our alliance has this expertise and will help you design a CCS process that offers the greatest benefits for the lowest possible cost.

Our expertise can be used for coal, oil and gas reservoirs and saline aquifers anywhere in the world. We can help you:

- Match CO<sub>2</sub> sources with appropriate geological sinks.
- Select CO<sub>2</sub> pipeline routes and design pipelines.
- Select and design capture technologies for your CO<sub>2</sub> sources.
- Design and install CO<sub>2</sub> injection well equipment.
- Assess CO<sub>2</sub> geological/hydrogeological storage capacity at country, basin, regional, local and/or site scales.
- Assess injectivity and distribution of CO<sub>2</sub> at site scale through reservoir simulation.
- Optimize CO<sub>2</sub> storage with enhanced oil and gas production at site scale.
- Assess caprock stability and well integrity for long term containment of CO<sub>2</sub> in a storage site, and design and implement remedial/ mitigation measures if necessary.
- Assess long term trapping capabilities of specific geological storage sites.
- Recommend, design and provide cost estimates for micro-pilot testing, field demonstrations, and commercial operations for CCS.
- Implement micro-pilot and field-pilot CCS operations.
- Perform life cycle economics including emissions trading for CCS.
- Analyze performance and long term risk of leakage from the storage site and design the management plan.
- Design and implement long term monitoring programs to detect leakage and seepage of CO<sub>2</sub>.
- Build capacity in CCS expertise through tailored courses for your specific needs, including public outreach.
- Provide regulatory advice related to CCS deployment.
- Provide comprehensive project management and execution strategies and services for integrated carbon projects.

# Canadian CO<sub>2</sub> Capture and Storage Alliance (CCCSA)

## Alberta Research Council Inc. (now part of Alberta Innovates - Technology Futures)

ARC has spent over 15 years advancing CCS technologies. Recent projects include:

- leading international consortiums for piloting CO<sub>2</sub> enhanced coalbed methane recovery (ECBM) technology in Canada and China, recognized by the Carbon Sequestration Leadership Form.
- research participant in the Weyburn EOR and CO<sub>2</sub> storage and monitoring project, sponsored by the International Energy Agency.
- research lead for the Penn West EOR and CO<sub>2</sub> monitoring projects in Canada.
- research lead for the Heartland Aquifer Redwater Project (HARP) in Canada.
- building CCS capacity through APEC workshops in China and Mexico.
- lead authorships for the IPCC special report on CCS.

## Calfrac Well Services Ltd.

Calfrac is an oil and gas well pumping service company specializing in fracturing stimulation, acidizing stimulation, coiled tubing, cementing, CO<sub>2</sub> and N<sub>2</sub> services. We have provided services to Canada, USA, Russia, China, Mexico and Argentina. Calfrac has business and technical alliances with numerous operators, internationally, for its services.

## Computer Modelling Group Ltd. (CMG)

CMG is a numerical reservoir model developer. We provide software development, application, technology support and consulting services to help the petroleum industry increase their oil and gas production worldwide. CMG has unique simulators to (i) model CO<sub>2</sub> storage in coals in an ECBM process and (ii) model CO<sub>2</sub> storage in saline aquifers including the trapping by geochemical reactions.

## DRG Resources Ltd. (DRG)

DRG has conducted consulting services and training programs in the U.K., Egypt, India, South America, as well as the Middle and Far East. DRG is known for its expertise in horizontal drilling and well completions, well stimulation, primary and remedial cementing, sand production management, and formation damage.

## Energy Navigator

Energy Navigator supplies property evaluation software for the oil and gas industry which

includes the effect of royalty regimes etc. in the assessment. Currently, we are working together with ARC on an integrated CCS package.

## Golder Associates

Golder Associates specializes in ground engineering, environmental, and energy services. Our integrated suite of services assists CCS project proponents develop, license and operate safe, long-term carbon dioxide disposal sites such as subsurface characterization, environmental impacts assessment, data management, monitoring and verification, and risk and performance analyses.

## Sproule International Ltd.

Sproule is an international consulting company and specializes in oil and gas property evaluation. Our services in CCS include:

- geological assessment of reservoirs (including screening for CCS, seismic interpretation, petrophysics and geological modeling.)
- reservoir engineering (including dynamic modeling, CO<sub>2</sub> EOR and ECBM.)
- economic evaluation, risk and performance assessment.

## SNC-Lavalin Inc. (SLI)

SNC-Lavalin is one of the leading engineering and construction groups in the world and a major player in the ownership of infrastructure, and in the provision of operations and maintenance services. With offices in Canada and around the world, we have extensive experience in designing facilities for capturing and transporting CO<sub>2</sub>. We have undertaken studies of CCS facilities globally in regions such as Canada, China, United Middle East, South America and Europe. Using our extensive expertise in environmental management, we provided technical assistance to set up an environmental management department for an Indian electric utility. We also managed the development of the Cleaner Production Strategy for China.

## Weatherford

Weatherford International Ltd. (NYSE:WFT) is one of the largest global providers of products and services that span the drilling, evaluation, completion, production and intervention cycles of oil and natural gas wells. We have doubled research and development over the past six years and spent more than \$0.5 billion acquiring technology. We have created a large inventory of intellectual property and encouraged a burgeoning technology culture. We are proud to apply this capability to help progress carbon capture and storage capability in Canada and globally.

The alliance has expertise in:

- combustion & gasification
- CO<sub>2</sub> capture & credits
- surface facilities including pipelining
- carbonate, siliciclastic & coal geology
- groundwater & sedimentary basin hydrogeology
- geophysics, geomechanics & geochemistry
- drilling, logging & laboratory testing
- completions, stimulation & well testing
- reservoir engineering & reservoir modelling
- injection & production engineering
- monitoring & field validation
- risk and performance assessment
- database & project management
- life cycle economics
- environmental management
- training & regulatory

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