Testimony prepared for hearing on the *"Future of Fossil Fuels: Geological and Terrestrial Sequestration of Carbon Dioxide"*
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Prepared by
Judy Fairburn, Vice President Downstream Operations
EnCana Corporation, Calgary, Alberta, Canada

My name is Judy Fairburn. I am Vice President of Downstream Operations for EnCana Corporation. EnCana is a dynamic North American industry leader in unconventional natural gas and integrated oilsands development. I am currently responsible for EnCana's co-ownership in two United States refineries, a result of the recently announced Oilsands partnership with ConocoPhillips.

Previously to my current position I was Vice-President of EnCana's Weyburn Business Unit, a technology driven business that is both Canada's largest enhanced oil recovery project as well as the world's largest CO_2 geological storage project. In that capacity I was responsible for all aspects of the Weyburn business including strategy, business development, technology, drilling, operations and stakeholder relations. Prior to my Weyburn responsibilities. I was Vice-President, Portfolio Management for EnCana Upstream operations.

I come here today at the invitation of the Chairman to discuss the technology that EnCana developed in the storage of carbon dioxide and our experiences at our Weyburn Enhanced Oil recovery operation in Saskatchewan, Canada.

Introduction

The Weyburn oilfield, operated by EnCana, is demonstrating that oil production can be increased in an environmentally responsible manner through underground injection of carbon dioxide (CO_2). CO_2 has been injected into this oilfield since 2000, making valuable use of a by-product that would have otherwise been emitted from Dakota Gasification Company's coal gasification facility located in the northern United States. The field is projected to store 30 million tonnes of CO_2 over the EOR life, equal to taking about 6.7 million cars off the road for one year. I will discuss in more depth how EOR is prolonging the life of the Weyburn oilfield, while at the same time contributing to reducing CO_2 emissions.

The Weyburn oilfield has also served as the highly coveted, commercial-scale laboratory for the International Energy Agency (IEA) Green House Gas Weyburn CO_2 Monitoring and Storage Project. This multi-party, international research project, run under the auspices of the International Energy Agency, recently concluded that storage of CO_2 in an oil reservoir is viable and safe over the long term, thus providing a good foundation for the development of solid policy, regulations and operating practices for future CO_2 storage/EOR. The results of the first phase of the IEA project will be covered as well as the key elements of the final phase, which has recently been launched.

EnCana Corporation – An Overview

EnCana was formed in 2002 from the merger of two highly respected Canadian companies, PanCanadian Energy and Alberta Energy Company. Headquartered in Calgary, Canada, EnCana is one of North America's largest natural gas producers. It is uniquely positioned as an industry leader in unconventional natural gas and integrated oilsands development, focused on creating long-term value. EnCana's portfolio of long-life resource plays includes 12 key plays in Canada and the United States, with nine producing natural gas and three focused on oil. In 2006, total sales volumes were 4.4 Billion cubic feet equivalent per day (about 725 Million barrels oil equivalent per day). EnCana has extensive operations in the United States (approximately one third of total production) with EnCana USA headquarters in Denver, Colorado.

EnCana strives to increase the net asset value of the company for shareholders, make efficient use of resources and minimize its environmental footprint. The company's success is determined not only through its bottom line but also through its behaviour. Weyburn is an example of that commitment

Weyburn Oilfield – Enhanced Oil Recovery

Located in the southeast corner of the province of Saskatchewan in Western Canada, Weyburn is a 180-square-kilometer (70-square-mile) oil field discovered in 1954. It is part of the large Williston sedimentary basin, which straddles Canada and the U.S. Production is 25- to 34-degree API medium gravity sour crude. The reservoir is a Mississipian-aged Midale Marly zone, a low permeability chalky dolomite overlying the Midale Vuggy zone, a highly fractured and permeable limestone.

Water-flooding to increase oil recovery was initiated in 1964 and significant field development, including the extensive use of horizontal wells, was begun in 1991. In September 2000, the first phase of a CO_2 enhanced oil recovery scheme was initiated. The EOR project is to be expanded in phases to a total of 75 patterns over the next 15 years. The CO_2 is a purchased byproduct from the Dakota Gasification Company's (DGC) synthetic fuel plant in Beulah, North Dakota. If this CO_2 had not been used for EOR and stored, it would have otherwise been emitted into the atmosphere. It is transported through a 200 mile pipeline to Weyburn then injected into the reservoir, one mile underground. The CO_2 is 95% pure and Weyburn's current take is 6600 tonnes/day (equivalent to 125 mmscfd).

EOR has given the Weyburn field a new life. It currently produces over 30,000 bbls/d of light crude oil, the highest production level in 30 years, with 155 million gross barrels of incremental oil slated to be recovered over the project life. Without EOR, only 13,000 bbls/d would have been produced leaving a huge resource untapped. The environmental benefits are also significant. CO_2 storage contributes to mitigating emissions. The Weyburn project has stored approximately 7 million tonnes of CO_2 to date and over the lifetime of the EOR project, it is projected that an additional 23 million tonnes of CO_2 will be sequestered.

IEA Green House Gas Weyburn CO_2 Storage & Monitoring Project - Phase I

Project description

The IEA Green House Gas Weyburn CO_2 Storage and Monitoring Project is a significant CO_2 monitoring and storage R&D effort that has run in parallel with the commercial Weyburn EOR project. Phase 1 of this project was designed to contribute significantly to the understanding of greenhouse gas management, specifically the technical feasibility and long term fate/security of CO_2 storage in geological formations.

Initiated in 2000 by the Saskatchewan Ministry of Energy and Mines (now Saskatchewan Industry and Resources), the federal Department of Natural Resources, and PanCanadian (now EnCana), this $40 million multi-disciplinary project has been endorsed by the International Energy Agency GHG Research and Development Programme. It has been managed by the Petroleum Technology Research Centre (PTRC) of Saskatchewan.

This project constitutes the largest, full-scale, in-the-field scientific study ever conducted in the world involving carbon dioxide storage. Weyburn has become the international flagship project on GHG geological storage research, routinely receiving senior level business and government personnel, as well as media, from around the globe.

This collaborative research was funded by 15 public and private sector institutions. In addition to the two previously mentioned government departments, other government partners included the United States Department of Energy (US DOE), the European Union, and the province of Alberta through the Alberta Energy Research Institute. Industry sponsors

included EnCana, BP plc, ChevronTexaco Corp., Dakota Gasification Company, Engineering Advancement Association of Japan, Nexen Inc., SaskPower, TransAlta Corporation and Total SA of France. The project also involved 24 research and consulting organizations in Canada, Europe and the United States.

The overall objective of Phase 1 of the project was to predict and verify the ability of an oil reservoir to securely store and economically contain CO_2. The scope of work focused on understanding the mechanisms of CO_2 distribution and containment within the reservoir into which the CO_2 is injected and the degree to which the CO_2 can be permanently sequestered.

Phase 1 results[1]

Completed in 2004, Phase 1 successfully concluded that CO_2 can be securely stored underground in an oil reservoir such as Weyburn. Through extensive geological, geophysical and hydrogeological work, as well as deterministic and stochastic (probabilistic) modeling, the work concluded that after 5000 years, 99.8% of the CO_2 injected into the Weyburn field would remain trapped underground.

A key feature of the project was the pre-injection baseline monitoring that was done prior to CO_2 injection at the field. While there are already commercial applications of CO_2 EOR in the United States, the Weyburn oilfield and the IEA project are unique, due to the comprehensive knowledge of pre-injection reservoir conditions as a result of an extensive historical database of geological and engineering information. This has proven critical to following the movement of CO_2 in the Weyburn reservoir over the four years of the Phase 1 project.

Excellent monitoring techniques were progressed through the project; the movement of the CO_2 was predicted, monitored and verified by different methods. The greatest success was encountered with four-dimensional time lapse seismic surveys, which can reliably detect relatively small volumes of CO_2 underground. Geochemical fluid sampling also gave good insights into the movement of CO_2 within the reservoir and can detect any CO_2 breakthrough at wells.

IEA Green House Gas Weyburn CO_2 Storage & Monitoring Project – Final Phase

Phase 1 of the IEA project has provided a good foundation for the development of solid policy, regulations and operating practices for future CO_2 storage/EOR projects; however, there is more work to be done. The September 2004 final report identified a number of important gaps and recommended a follow-up “Final Phase” to enable transfer of knowledge and technology gained in Weyburn to a more widespread industrial implementation of this technology and to ensure public confidence in geological long-term storage of CO_2. We foresee a future where Weyburn has paved the way and future projects will not need to expend nearly as much research and monitoring resources to be assured of safe geological storage.

Next steps: Technical

Extensive investment and effort have been expended to get to the current level of understanding of geological storage at Weyburn but additional work is still necessary to develop cost-effective protocols to enable efficient site selection, design, operation, risk assessment and monitoring of future projects.

The key gaps identified in Phase I and the measures being taken in the Final Phase to address them and achieve win-win solutions include:

(i) Drafting of firm protocols for storage site selection.
(ii) Final selection of the most effective underground monitoring methods for CO_2 movements.
(iii) Identifying the most effective reservoir methods for maximizing storage capacity and oil recovery.

(iv) Finalizing the development of the most cost-effective and credible risk assessment methods and risk mitigation techniques to ensure the integrity of the storage medium.

Next steps: Non-technical

Advancement of the technical aspects of CO_2 storage is a necessary but insufficient requirement for the management of geological storage of CO_2 on a large scale. A successful CO_2 geologic storage "industry" must encompass a suite of technologies linked by a network of institutions, financial systems and regulations, along with public outreach activities, that are able to achieve broad public understanding and acceptance. Additional work is necessary in the following areas.

Regulatory Issues

For CO_2 storage to flourish, a predictable, science-based regulatory regime needs to be in place. Fortunately, regulations governing the injection of acid gases with a CO_2 component and other industrial applications are already in place. A complementary regulatory framework for long term storage applications with respect to safety and reliability may be required.

The experience from current provincial regulations on issues such as emergency planning and protection, health and safety, and drilling and well completion standards, as well as the fact the oil has been kept in the geological structure for many years should prove very helpful to future CO_2 storage regulatory efforts.

Finally, a transparent registry system should be created, with well-defined measurement protocols and verification requirements, to ensure proper accounting for greenhouse gas reductions created by geological storage and recognition of offset credits.

Public outreach

Geological Storage of CO_2 is increasingly recognized as a pragmatic way to address CO_2 emissions. As Julio Friedmann and Thomas Homer-Dixon wrote in *Foreign Affairs*, "the technology may be the only realistic way to satisfy the world's gargantuan energy needs while responsibly mitigating their side effects[2]." An effective public outreach and consultation process could be helpful to ensure public understanding and acceptance of geological storage as a viable means of CO_2 sequestration. The technology needs to be communicated to the public in the context of GHG mitigation options, with clear explanations regarding why it is safe and viable over the long-term.

Current Status – Final Phase

The initial technical research package was approved by the sponsors in November 2006 along with a first year budget of $2.9 million (Canadian). Research agreements are currently being reviewed, and the research providers will launch research as soon as the agreements are finalized.

Conclusion

It is EnCana's hope that the experience at Weyburn will enable the start-up of a significant number of commercial-scale EOR-based CO_2 geological storage projects, a win-win scenario for the economy and the environment. These projects would provide substantial environmental benefits by enabling the geological storage of significant quantities of CO_2 that would otherwise be emitted to the atmosphere. Ramping up development of CO_2-based EOR projects would also increase oil recovery and hence improve energy security. Conventional methods in North America only recover approximately 30% of oil in place, leaving a tremendous resource in the ground for EOR.

Although EnCana's activities have focused on EOR-based operations and not on other storage alternatives such as deep saline aquifers or coal bed methane, many of the operating practices so developed would be applicable to these other storage alternatives. Furthermore, the operating practices developed for Weyburn's geological environment would also be transferable to other sites with different geological characteristics. EOR projects currently represent the storage alternative that is the closest to being economic and with the right policy and regulatory framework, market signals and economic conditions, a number of projects could realistically be initiated.

Finally, Weyburn, particularly the IEA Project, demonstrates the power of collaboration and partnerships between governments, researchers and industry to unlock value through technology. The research was valuable to EnCana as it helped the company to better understand its oil field and to innovate (e.g. CO_2 monitoring by four-dimensional seismic survey). It provided the opportunity for a Canadian research centre to develop expertise and potentially become the world leader in CO_2 geological storage monitoring and assessment. Finally, it has enabled government to advance their innovation, technology and sustainability agendas.

References

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2. Friedmann S. J. and Homer-Dixon T., Out of the Energy Box, *Foreign Affairs*, November/December 2004, pp 72-83.