The promise of energy with lower CO_2 emissions

How carbon capture and storage can help get us there

Lower CO_2 emissions.

Energy for tomorrow.

Complex topics that will require new ideas, extensive experience and working knowledge to move forward. Carbon capture and storage can help get us there.

The Carbon Challenge

Weyburn Enhanced Oil Recovery Project

At Weyburn oil field in southern Saskatchewan, carbon dioxide piped from a coal gasification plant in North Dakota is injected underground to increase oil production. The project, which is supported by the International Energy Agency and several academic institutions and industrial partners, could extend the life of the oil field by 25 years and store 20 million tons of CO_2. It is the largest greenhouse gas storage project in Canada and one of the largest in the world.

Oil, natural gas, and coal help us light our way, cook our meals, run our cars, and keep our economy humming.

Carbon storage, along with reduced carbon content of fuels and improved efficiency of energy production and use, must play major roles if the nation is to enjoy the economic and energy security benefits which fossil fuels bring to the energy mix. • U.S. Department of Energy

Oil, natural gas, and coal supply more than 85 percent of the world's energy.

The power plants, vehicles, homes, business and factories that use these fuels also produce more than 25 billion tons of carbon dioxide (CO_2) emissions annually, a potential contributor to climate change. While no single technology is sufficient to address climate change, capturing CO_2 from power plants and other industrial sources and storing the CO_2 in formations deep under the Earth – along with more efficient use of fossil fuels and use of emerging energy sources – could play an important role.

Carbon capture and storage, or CCS, is a promising technology in part because vast expanses of geologic formations potentially suitable for storing CO_2 exist around the world. In the U.S. alone there may be about 3,900 billion metric tons (Mt) of CO_2 storage, compared with total annual emissions from large stationary sources in the U.S. of 2.9 billion Mt CO_2.

The oil and natural gas industry has experience with several of the technologies that constitute carbon capture and storage. Oil and natural gas companies routinely separate CO_2 from raw natural gas to make the natural gas suitable for pipeline shipment, and some fields in the U.S. have been safely injecting CO_2 into porous rock formations deep underground to increase oil production for over 30 years.

However, before capture and storage can play a large role in controlling CO_2 emissions, challenges, including the cost of capturing CO_2 and the lack of regulations governing long-term storage and potential liability, must be addressed. If these hurdles can be surmounted and supporting policies put in place, CCS can help meet the energy needs of the world's growing population with far lower CO_2 emissions.

Rock on

Photo: Statoil

North Sea Sleipner Field Project

Beneath a cap of shale more than a half mile under the floor of the North Sea at a location midway between Norway and Scotland, more than seven million tons of CO_2 lies trapped in a brine-saturated sandstone, capped by a thick layer of shale. Before being injected in the sandstone, the CO_2 was produced from an offshore natural gas field along with the natural gas and was separated from the much larger quantities of natural gas. Ordinarily, this CO_2 would have been vented to the atmosphere.

CO_2 can be safely stored by injecting it into deep underground sedimentary rock formations, reducing emissions to the atmosphere.

For well-selected, designed and managed geological storage sites, the vast majority of the CO_2 will gradually be immobilized by various trapping mechanisms and, in that case, could be retained for up to millions of years. • Intergovernmental Panel on Climate Change

Underground geological storage is a promising technology for reducing emissions.

That's because a potentially huge storage capacity exists primarily in saline reservoirs, but also in depleted oil and gas reservoirs and deep coal seams that cannot be mined.

According to a major report by the Intergovernmental Panel on Climate Change (IPCC), as much as 55 percent of a worldwide carbon mitigation effort thru 2100 might be achieved through carbon capture and storage. The IPCC report also indicates that CO_2 can be stored safely over very long periods of time and cites several studies indicating that the potential for leakage decreases the longer the CO_2 is underground.

Oil and natural gas companies have experience safely injecting CO_2 into oil and gas formations to boost domestic production from old fields. In the United States, more than 70 enhanced oil recovery (EOR) projects are underway, with over 30 million tons of CO_2 injected annually. Cumulatively, over 600 million metric tons of CO_2 has been injected for EOR in the U.S. The quantity transported and injected without incident indicates large-scale storage sites could be operated safely.

While most of the CO_2 injected in these EOR projects is not captured from industrial processes, major EOR projects using captured CO_2 include Salt Creek/Monell in Wyoming, Weyburn in Saskatchewan, Canada, and Rangley in Colorado.

In addition to these EOR projects, there are a few natural gas fields injecting CO_2 solely for the purpose of storing it. The Sleipner and Snohvit projects in the North Sea and the In Salah project in Algeria are storing CO_2 that was captured from their natural gas processing facilities and would have been vented otherwise. These projects have extensive monitoring and verification programs to ensure the CO_2's long-term isolation from the atmosphere and will help build confidence in the ability to safely store CO_2 for very long time periods. Many more CO_2 capture and storage projects are in the planning and development stages.

Catch and compress

We believe it is safe; it is certainly technically feasible and really has very little environmental downside. • Dr. Andrew Chadwick, British Geological Survey

BP PLC 2007

In Salah Gas Project

A project in Algeria is separating carbon dioxide from natural gas production and injecting it more than a mile underground instead of venting it into the atmosphere. Several layers of mudstone as much as 950 meters thick seal the formation and hold the CO_2 in place. Noble gas tracers,pressure surveys, tomography, gravity baseline studies, microbiological studies, and four-dimensional seismic and geomechanical technologies are being employed to monitor project performance.

The capture step involves separating the CO_2 from other gases and compressing it to aid transport through a pipeline.

The four primary separation applications for CO_2 capture from industrial and power plant operations include:

- Separation of industrial process gas streams – this includes separation of CO_2 from natural gas before pipelining and a number of other industrial processes involving chemical reactions that form CO_2;
- Flue gas separation – CO_2 is separated from the flue gases produced by combustion of a primary fuel (coal, natural gas, oil, or biomass) in air;
- Oxy-firing combustion – uses oxygen instead of air for combustion, producing a flue gas that is mainly water and CO_2 and which is readily captured. This option is still under development; and
- Gasification where a primary fuel (coal, natural gas, oil, or biomass) is reacted to produce separate streams of CO_2 for storage and hydrogen for combustion or other use.

Much of the focus of research has been in applying CO_2 capture to electricity production from coal. This is due in part to predictions that by the end of the century, coal could account for more than 80 percent of global CO_2 emissions. But capture need not only apply to coal plants; indeed, any point source of CO_2 can potentially be captured, including biomass combustion which would result in negative emissions.

Many of the component and/or enabling technologies required for CO_2 capture in the last three categories are known, however experience with the practical and/or commercial demonstration of integrated systems is lacking. Similarly, while there are niche applications of technologies where CO_2 can be captured relatively inexpensively today, capture usually requires large investments in capital and consumes significant amounts of costly energy. The cost of capture is a significant hurdle to its widespread use. The oil and natural gas industry is actively researching ways to address these challenges.

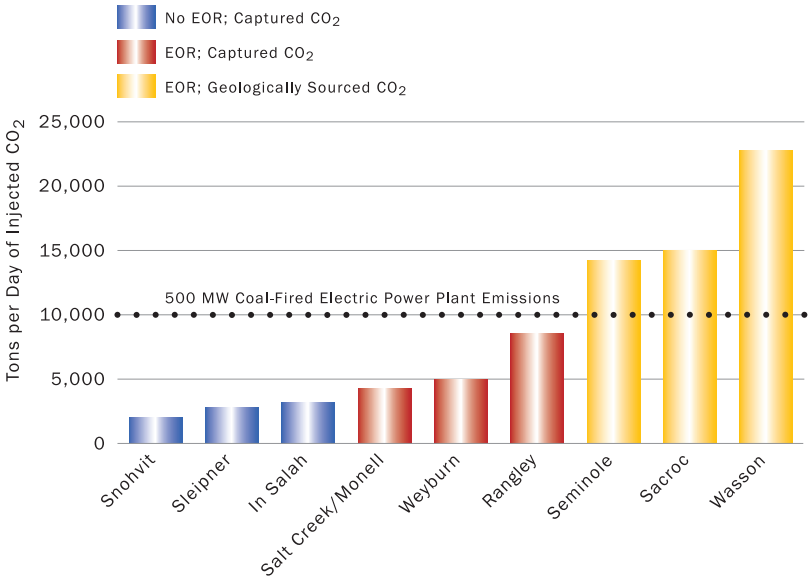
Moving forward

Seismic photo courtesy of ConocoPhillips

Before large-scale deployment, we'll need policies – based on the best science – that create a clear and stable business environment.

That's why API member companies participate in research consortiums and fund research at major universities, to answer the remaining technical and policy questions surrounding carbon capture and storage. The CO_2 Capture Project (CCP), Gulf Coast Carbon Center (GCCC), CO_2 ReMoVe, Carbon Mitigation Initiative, and the Global Climate and Energy Project (GCEP) are prominent examples.

API is actively engaged in the regulatory development process for carbon capture and storage. Additionally, API and IPIECA (the International Petroleum Industry Environmental Conservation Association) are developing guidance on accounting for CO_2 emission reductions associated with CO_2 storage projects. API also supports MIT's Carbon Sequestration Initiative and is a member of the West Coast Regional Carbon Sequestration Partnership.



CO_2 Injection Projects

Industry has experience injecting CO_2 in quantities comparable to that produced from a large coal-fired power plant.

For more information about carbon capture and storage, visit these websites:

API
www.api.org

CO_2 Capture Project
www.co2captureproject.org

Gulf Coast Carbon Center
www.beg.utexas.edu

CO_2 ReMoVe
www.co2remove.eu

Carbon Mitigation Initiative
www.princeton.edu/~cmi

Global Climate and Energy Project
gcep.stanford.edu

International Petroleum Industry Environmental Conservation Association
www.ipieca.org

MIT Carbon Sequestration Initiative
sequestration.mit.edu

West Coast Regional Carbon Sequestration Partnership
www.westcarb.org

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