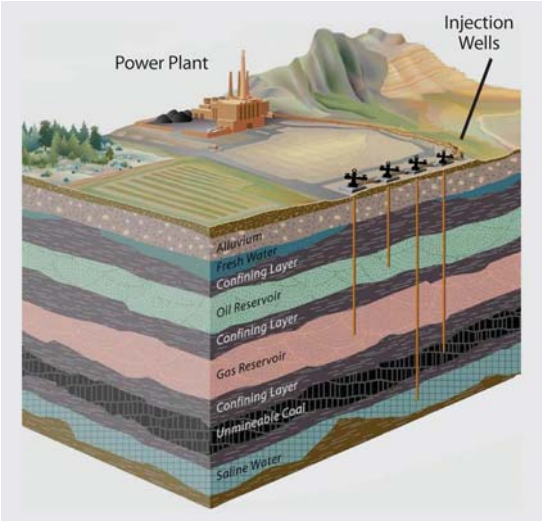
CCS

inFocus Carbon Capture & Storage

10 Facts About CCS

#1 Carbon Capture and Storage (CCS) is a combination of technologies for capturing, compressing, transporting, and permanently storing carbon dioxide (CO_2) emissions from large, stationary fossil energy facilities.



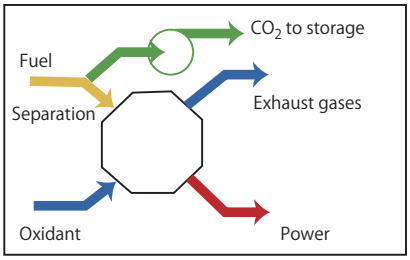
CCS is one part of a wider "portfolio" strategy (including increased efficiencies, greater use of nuclear and renewable energy, and other approaches) for achieving significant reductions in atmospheric CO_2 emissions.

Schematic illustrating the process of carbon capture and storage (also known as sequestration). Adapted from Energy and Geosciences Institute, The University of Utah illustration.

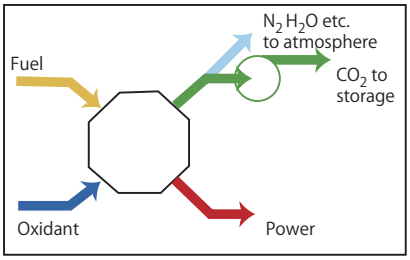
#2 There are three basic types of technology to capture CO_2 from power plants: Pre-Combustion, Post-Combustion, and Oxyfuel.

- **Pre-Combustion processes** convert fuel into a gaseous mixture of hydrogen and carbon dioxide. The two gases are then separated and the hydrogen can be burned without producing any CO_2 in the exhaust gas.
- **Post-Combustion technology** separates CO_2 from combustion exhaust gases in air and captures it using a liquid solvent.
- **Oxyfuel** uses oxygen rather than air for fuel combustion, producing exhaust gas that is mainly water vapor and CO_2, which facilitates capture.

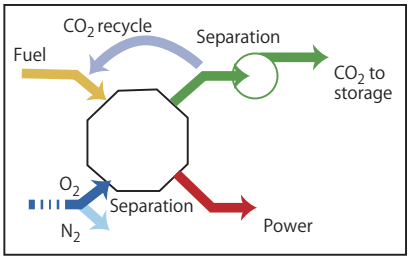
Pre-Combustion Capture Schematic



Post-Combustion Capture Schematic



Oxyfuel Capture Schematic

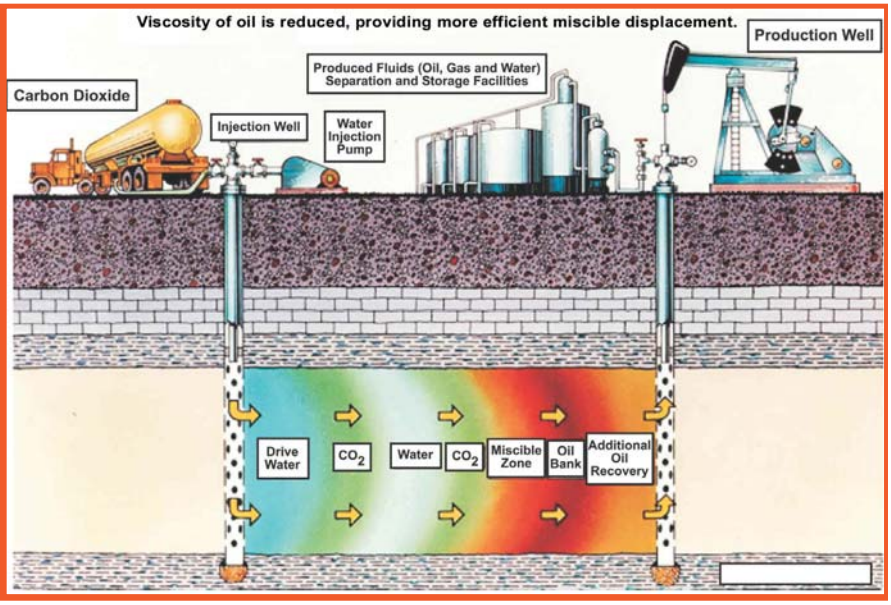


Source: Carbon Dioxide Capture and Storage (2005), United Nations Intergovernmental Panel on Climate Change, page 6.

#3 CO_2 capture and injection technology is not new or particularly unique — it has been used successfully for several decades in the petroleum, chemical, and power industries.

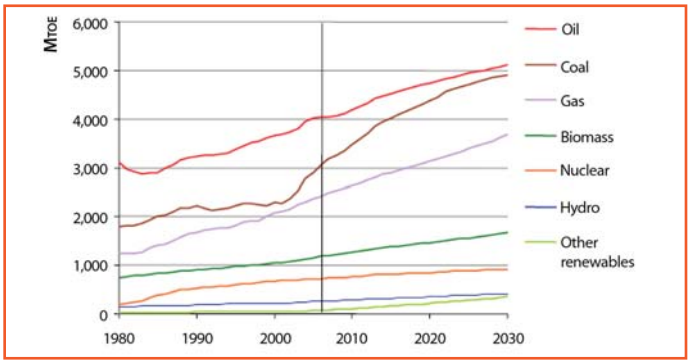
What is novel about it in terms of the climate change debate is the research effort to optimize and integrate existing technologies in order to reduce human-generated atmospheric CO_2 emissions.

Enhanced Oil Recovery (EOR) refers to techniques that allow increased recovery of oil in depleted or high viscosity oil fields. The use of CO_2 in this application can both increase yields from oil (and natural gas) fields while permanently sequestering carbon dioxide. The United States performs about 96 percent of worldwide CO_2 EOR; currently about 48 million tonnes of mostly naturally produced CO_2 are injected annually for these operations.



Source of illustration and EOR information: U.S. Department of Energy, National Energy Technology Laboratory, "Carbon Sequestration Through Enhanced Oil Recovery (2008),"pages 1-2.

#4 CCS is among the most promising potential climate change solutions, especially for countries reliant on large fossil energy (coal, oil, and natural gas) resources.



The International Energy Agency (IEA) projects world energy demand could grow 40 percent between now and 2030, with coal accounting for one-third of the overall rise (source: IEA World Energy Outlook 2010).

Fossil fuels provide about 80 percent of the world's daily energy (particularly electricity) needs, but are also among the most carbon-intensive options. Most forecasts project that fossil fuels will continue to be an energy mainstay for both developed and developing nations for the foreseeable future. If this occurs without an effective way to limit and reduce CO_2 emissions, experts believe the worldwide buildup of carbon dioxide in the atmosphere will greatly increase, with possible dire climate consequences.

" . . . the observed increase in (greenhouse gas) concentration since 1750 has most likely committed the world to a warming of 1.4–4.3 degrees Celsius above pre-industrial surface temperatures . . . throughout the 21st century" (UN Environment Programme) . . . . (without a change in policy) "the world is on a path for a rise in global temperature of up to 6 degrees Celsius, with catastrophic consequences for our climate" . . . . (International Energy Agency).

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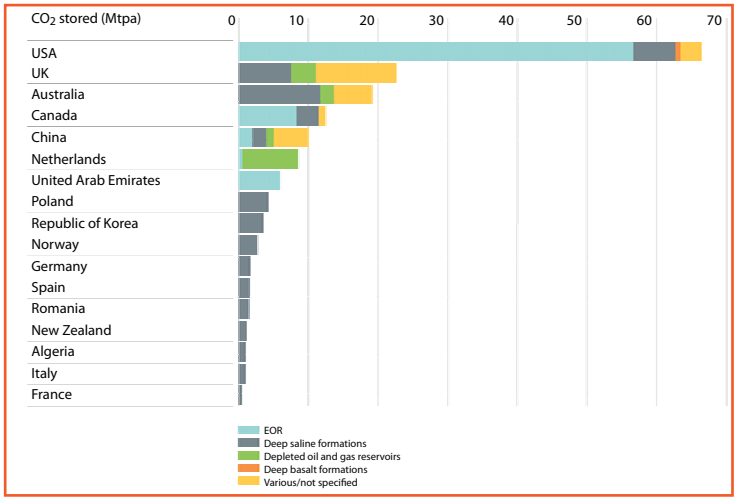
#5 Worldwide there are several operational large-scale facilities, along with numerous smaller projects, successfully demonstrating specific elements of carbon capture and storage.

According to the Global CCS Institute, there are currently 234 carbon capture and storage projects active or planned worldwide, 77 of which are large integrated projects. But at present, there are no fully integrated, large power plants in operation equipped with CCS. Building and operating such facilities in a variety of settings is essential for meeting research and development (R&D) challenges and widely deploying the technology.

Source: "A Perspective on the International CCS Scene," presentation by Nick Otter, UK APGTF/ KTN Energy and Generation Workshop, London, England, March 14, 2011

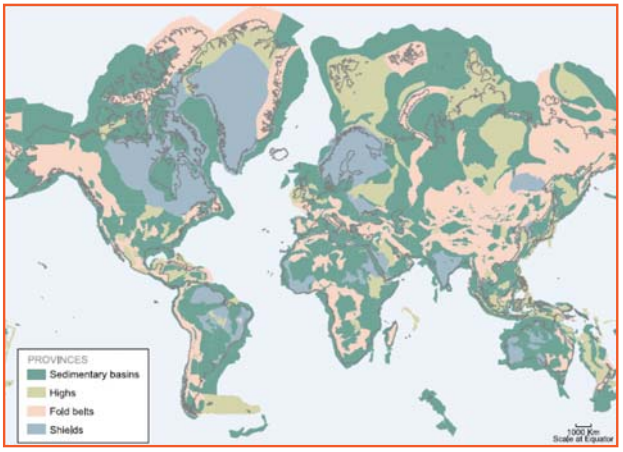
Large CCS Projects by Country and Storage Type



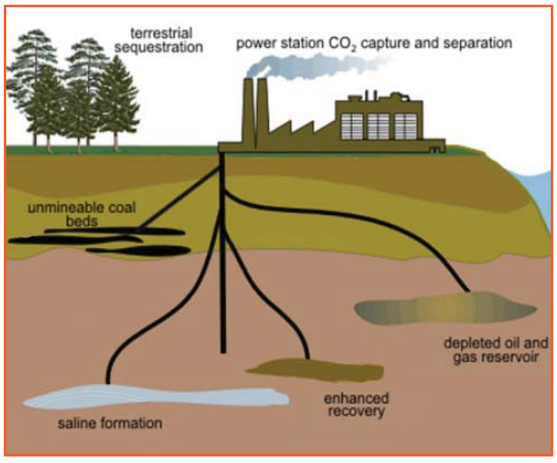
#6 Geologic CO_2 storage is possible in a number of ways, including injecting depleted and declining oil and natural gas fields, where it can be used to enhance resource recovery; very deep saline formations; unmineable coal seams; and other geologic formations, such as basalts.

The U.N. Intergovernmental Panel on Climate Change (IPCC) in 2005 estimated the world's potential CO_2 storage capacity at 2 trillion tonnes, although there could be a "much larger potential." Other experts believe it may be as high as 11 trillion tonnes with the use of future technology and gained storage experience.

Most Prospective Areas for Storage Sites



IPCC, Special Report on Carbon Capture and Storage (2005), Figure 5.1.4, page 214, "Distribution of Sedimentary Basins Around the World."



Source: http://coreenergyholdings.com/GeologicCO2Sequestration.html

According to the United Nations IPCC, "There could be a much larger potential for geological storage in saline formations, but the upper limit estimates are uncertain due to lack of information and an agreed methodology."

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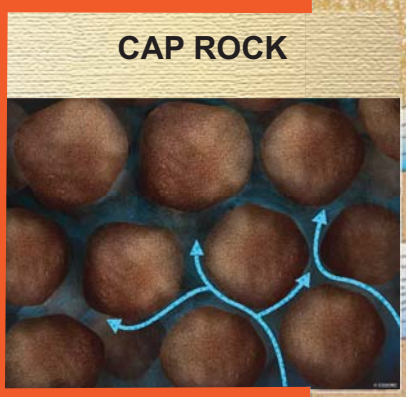
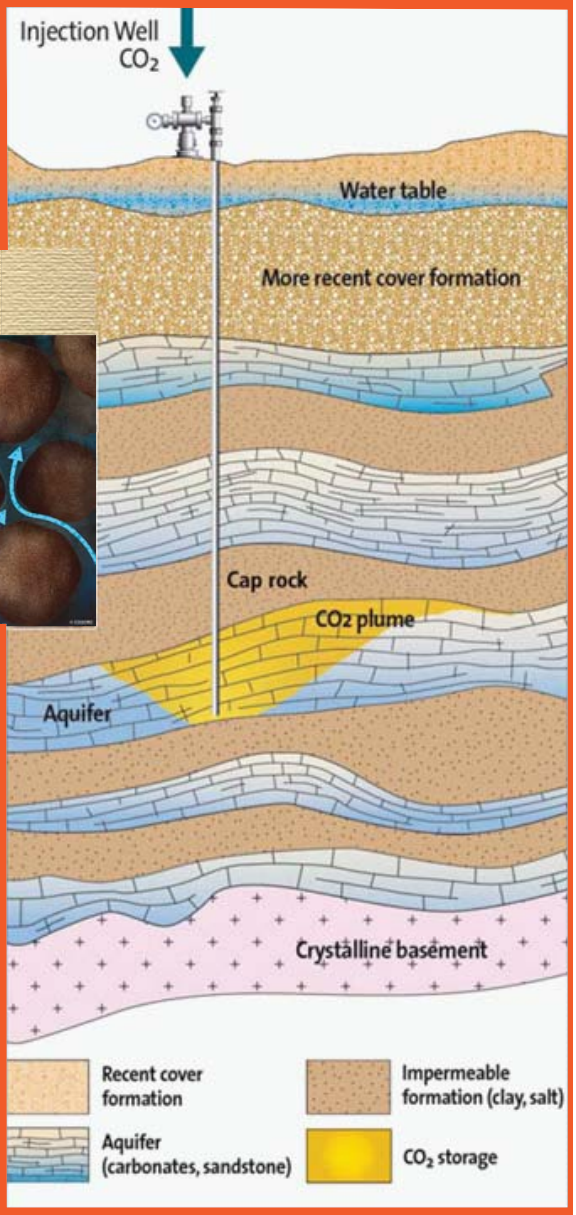
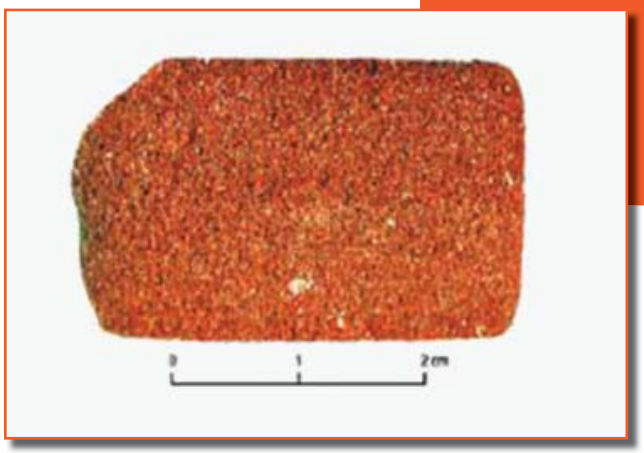
#7 There is a growing body of evidence that geologic CO_2 storage is both safe and permanent.

CO_2 storage via CCS uses the same natural trapping mechanisms which have kept huge volumes of oil, natural gas, and naturally produced carbon dioxide underground for millions of years. Ongoing global research is helping scientists accumulate information needed to conclusively verify all operational and safety aspects of long-term storage of CO_2 resulting from energy production, a vital step before commercial CCS deployment can occur.



CO_2 is compressed into a dense fluid, then pumped into a porous geological formation; it is trapped beneath a layer of impermeable caprock, which acts as a seal — the same caprock that has trapped oil, gas, and CO_2 underground for millions of years.





Left, sandstone typical of the type of rock that would be suitable for geologic storage of CO_2 (source: World Coal Institute/IEA Greenhouse Gas R&D Programme, Storing CO_2 Underground, page 4.)

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#8 CO_2 transport, primarily via pipelines, is already a reality, occurring on a daily basis for EOR, industrial, food and beverage, and other uses.

Nearly all existing long-distance CO_2 pipelines are located in the United States and Canada (one is in Turkey), and these have operated for years without any environmental or health and safety issues for the public. However, a greatly expanded worldwide pipeline infrastructure costing billions of dollars will need to be built within a relatively short timeframe to help implement widespread CCS commercial deployment. Conservative estimates suggest that over 100,000 kilometers of new pipeline will be needed globally before 2030 to meet the challenge presented by CCS (source: Pipelines International, September 2010, retrieved from: http://pipelinesinternational.com/news/transporting_co2_issues_discussed_in_newcastle/043754/.

Dakota Gas captures and sells CO_2 produced at the Great Plains Synfuels Plant to two customers and transports it through a 205-mile pipeline to Saskatchewan, Canada, to be used for enhanced oil recovery (EOR) in the Weyburn and Midale fields.

#9 Although CCS is promising, there are a number of existing challenges — none of which are insurmountable — that must be resolved before the technology can be fully demonstrated and deployed as a global CO_2 emissions control option.

Key technical challenges include: (1) addressing the cost and "energy penalty" of CO_2 capture; (2) proving CO_2 storage permanence; (3) verifying the existence of sufficient storage capacity; and (4) developing best practices for the lifecycle of CCS projects. There are also non-technical barriers, including: (1) the need for significant global financial investments; (2) establishing an adequate legal and regulatory framework; and (3) building public understanding, awareness, and acceptance.

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#10 Atmospheric CO_2 buildup from human activity is a global problem requiring an international effort for an effective solution.

Because climate change poses a global challenge, the world community must take effective steps to mitigate the increase of CO_2 while sustaining economic growth, especially in developing countries. An effective solution will require an international effort to establish a precedent in technical, political, and scientific cooperation. This effort will need to be implemented within 10 years or less to avoid possible dire climate consequences, according to the IPCC. The members of the Carbon Sequestration Leadership Forum represent one of several multi-national bodies working diligently in the forefront of international efforts to help meet the challenge of rising atmospheric CO_2 levels.

Delegates at the Carbon Sequestration Leadership Forum's Ministerial Meeting Held in London, United Kingdom, October 2009.