Carbon Sequestration and the Environment

Carbon dioxide (CO_2) capture and storage (CCS) consists of separating CO_2 from emission sources, compressing it, transporting it to a storage location, and ensuring its long-term isolation from the atmosphere, usually through injection into a geological storage area deep underground. Because no single technology option can provide all of the reductions needed to accomplish CO_2 emission stabilization, CCS is one option among a number of mitigation actions, including increased energy efficiency and greater use of nuclear and renewable energy. Combined, this "portfolio" of options could achieve a range of stabilization levels.

Are There Environmental or Safety Concerns Related to Carbon Sequestration?

There is scientific consensus, and growing evidence, that geologic storage has great potential for safely and permanently storing carbon dioxide. Additional research is underway to acquire the data needed to validate CO_2 storage potential, capability, reliability, and safety. A strong base of industry experience already exists in enhanced oil recovery, a process in which water and then carbon dioxide are pumped into depleted oil wells to re-pressurize wells and increase oil production. Recent sequestration research is building on this experience. Scientists know that storage sites need to be selected very carefully to ensure that drinking water supplies are well protected, that the caprock is impermeable and leakage will not occur, and that the area is seismically inactive. Additionally, scientists are examining the extent to which carbon dioxide moves within the formations, as well as the physical and chemical changes that occur. Importantly, they are also developing ways to improve monitoring equipment and techniques to ensure that the carbon dioxide is secure.

Proper site selection based on available subsurface information, as well as an effective monitoring and verification program, regulatory system, and appropriate mitigation to stop or control CO_2 releases should they arise, are expected to minimize environmental and safety concerns.

How Can You Detect Leaks? What Would be Done if a Leak Was Detected?

Potential geologic storage sites will need to be carefully selected and managed so as to minimize any chance of CO_2 leakage. Given the complexity of most geologic reservoirs and the potentially huge volumes of CO_2 that may be injected, the possibility of some leakage over time may never be completely eliminated. But scientists expect the reservoir characterization process (using geologic and engineering data to quantify a potential storage area's characteristics) will rule out geologic formations that do not have adequate caprocks or other natural seals, are intersected by faults or fractures that might be pathways for escaping CO_2, or are in areas prone to earthquake or volcanic activity. Additionally, measuring, monitoring and verification programs will be used to plot the migration of injected

CO_2 over time to detect potential reservoir leakage.

If a CO_2 storage site were leaking in a way that posed an unacceptable risk of any type, the project operators would apply leak mitigation technologies. These technologies have been tested in the oil and gas industry and researchers are currently evaluating their applicability for sequestration and making any needed modifications.

Is Carbon Dioxide Harmful to Humans and Animals?

Although it is a major greenhouse gas, carbon dioxide is also a fundamental and essential part of nature. Plants need it to grow, while animals and humans exhale it. It also leaks naturally from volcanoes and geysers. CO_2 does not burn or explode; in fact, it is a flame retardant commonly used in fire extinguishers. It also is not a poison like carbon monoxide (CO) and poses no health risk at low or modestly elevated concentrations. It only becomes problematic at very high concentrations.

How Can We be Sure Injecting CO_2 in the Ground Won't Cause Earthquakes?

CO_2 storage operations are designed to avoid inducing earthquakes. A detailed survey takes place to identify any potential leakage pathways (including seismic faults) before a CO_2 storage site is selected — if these are discovered, the site will not be selected for CO_2 injection. During injection, scientists and engineers can ensure that CO_2 pressure does not exceed the strength of the rock by limiting injection rates and volumes, thereby avoiding over-pressurization of the reservoir.

Additionally, CO_2 storage sites have demonstrated the ability to retain injected carbon dioxide, even if a natural earthquake occurs nearby. In October 2004, a major earthquake measuring 6.8 on the Richter scale occurred 12 miles from the injection site of a CO_2 geologic storage site at Nagaoka, Japan. This project stored CO_2 in a saline formation nearly a mile deep. Injection activities were halted immediately after the earthquake, but were resumed shortly thereafter. The storage formation was monitored before, during and after the earthquake, and no leakage has ever been detected. Further evidence that earthquakes are unlikely to cause leaks is present in the large number of producing oil and gas fields in the western United States that are near seismically active faults — earthquakes over many years have not caused them to leak.

Can Geologic CO_2 Storage Cause Groundwater Contamination?

To date, no known contamination of groundwater has occurred from the capture and geologic storage of CO_2. Storage sites must be properly selected and designed, fully characterized, and appropriately monitored. Usually CO_2 injection is more than a mile underground below many usable sources of groundwater, and is contained by one or more layers of thick, impermeable caprock.

CO_2 injection is proposed for deep saline formations containing water that is unusable because of its high salt and mineral content. Given proper site selection and operation, the risk to usable water supplies is extremely small. Seismic monitoring, groundwater analysis, and chemical tracers would likely detect the unlikely event of CO_2 migrating upward toward shallower groundwater supplies.