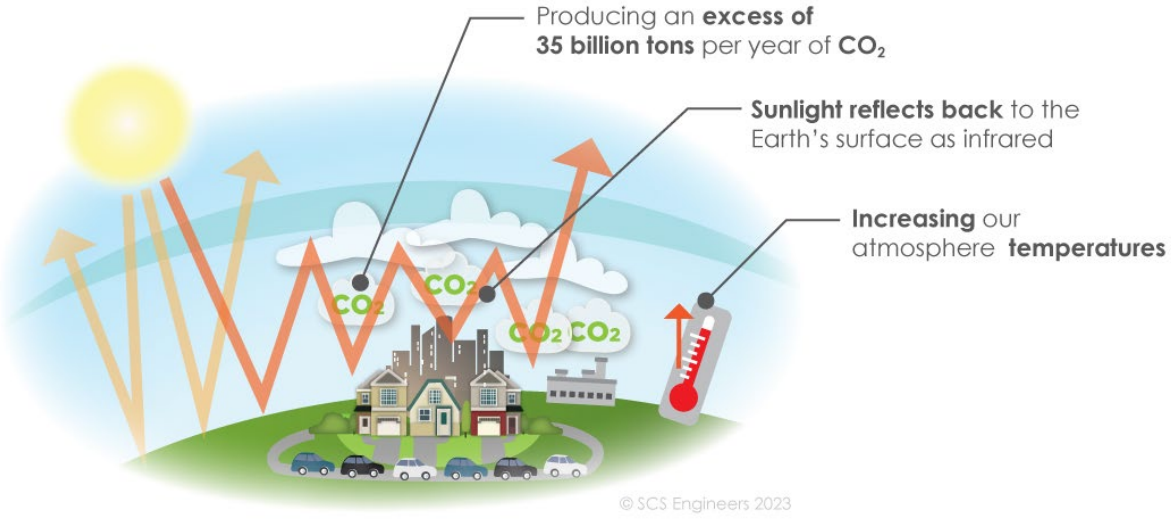
Carbon Capture and Sequestration: A Primer

By Patty Herman, SCS Engineers Staff Scientist

If you are new to Carbon Capture and Sequestration projects, there are several nuances associated with the topic that may require some clarification or at least a clearer definition for a deeper understanding of the technology. You may be intrigued by the complexity of the process and ask, "What are the differences between biologic sequestration, geologic sequestration, and carbon utilization?" This paper is the first in a short series of Carbon Capture Storage and Sequestration basics for newcomers to the industry that will help you learn more about the basics.

Why should we care?

Carbon dioxide, or CO2, is the most commonly produced greenhouse gas from natural and anthropogenic activities. Greenhouse gases, such as methane, nitrous oxide, and carbon dioxide, have been correlated with global climate change and the warming of the Earth's surface. Greenhouse gases are crucial for supporting life on our planet; however, NOAA estimates the rate at which humans add CO2 to the atmosphere exceeds 35 billion tons annually.



As illustrated above, the volume of CO2 produced reflects sunlight to the Earth's surface as infrared radiation or heat. As CO2 levels increase in our atmosphere, temperatures rise, resulting in global climate change.

The current paradigm is to fully investigate the potential and application of carbon sequestration to combat our global crisis.

Because carbon capture and sequestration projects are complex, environmental engineering teams have a deep understanding of the science. These teams include each part of the process and financial incentives to help navigate a sustainable and safe path to successful sequestration.

What exactly is Carbon Capture and Sequestration?

Carbon sequestration is capturing, removing, and storing carbon dioxide to prevent the gas from entering the Earth's atmosphere. The sequestration process happens naturally on an enormous scale, yet anthropogenic activities cause the release of CO2 at a rate exceeding the natural rate of sequestration.

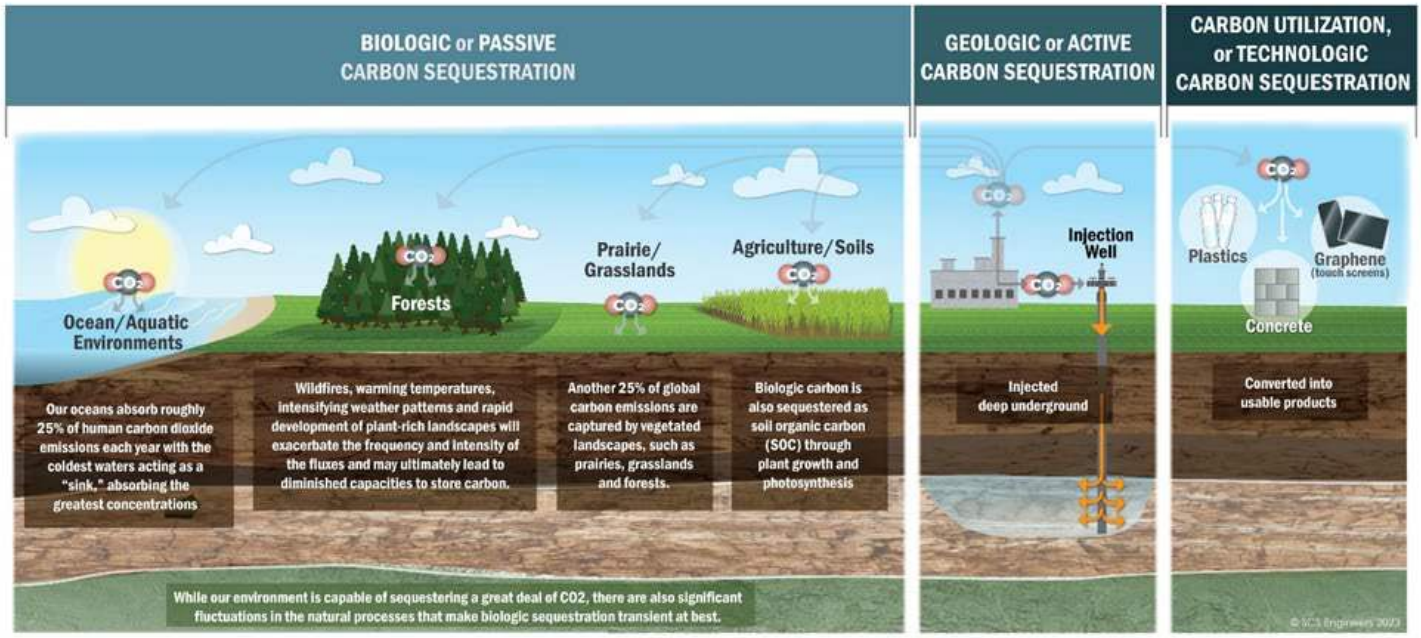
Technological advances and strategies being pursued sequester or entomb the gas deep in the earth to prevent additional emissions from contributing to global climate change. Carbon sequestration primarily happens in two forms, described as biological or geological; however, a third form is under development to utilize CO2 as a commodity.

What are the differences between the types of sequestration?

Biologic carbon sequestration, or passive sequestration, is the storage of atmospheric carbon from forests, aquatic environments, agriculture, grasslands, and soils. Our oceans absorb roughly 25% of human carbon dioxide emissions each year, with the coldest waters acting as a "sink," absorbing the greatest concentrations. Biologic carbon is also sequestered as soil organic carbon (SOC) through plant growth and photosynthesis. Vegetated landscapes, such as prairies, grasslands, and forests, capture another 25% of global carbon emissions.

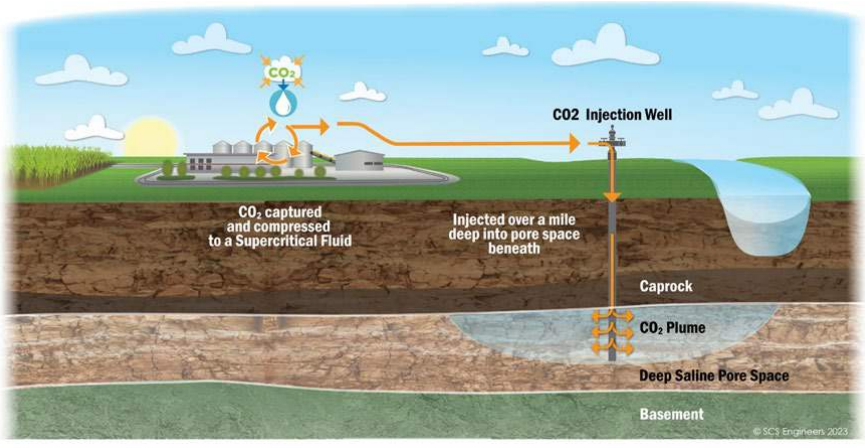
While our environment can sequester a great deal of CO2, there are also significant fluctuations in the natural processes that make biologic sequestration transient at best. Wildfires, warming temperatures, intensifying weather patterns, and rapid development of plant-rich landscapes will exacerbate the frequency and intensity of the fluxes. They may ultimately lead to diminished capacities to store carbon.

Types of Sequestration



Geologic carbon sequestration, or active sequestration, is generalized as the storage of carbon dioxide in geologic formations deep within the earth. Typically, CO2 is captured for sequestration from large industrial complexes such as but not limited to power plants, fuel processing plants, and oil recovery operations.

The CO2 is compressed and conveyed to a location suitable for long-term storage (100+ years) and injected deep into the earth into a porous zone or interstitial spaces for the injectate to infiltrate. The confining layers are impermeable, trapping the carbon dioxide and preventing it from releasing into the atmosphere.



Active Sequestration

While this has great potential for reducing harmful greenhouse gases and emissions, the cost may be prohibitive without government incentive programs.

The third type is carbon utilization or technological carbon sequestration. It is an emerging science that involves innovation to utilize carbon dioxide as an extractive resource rather than a nuisance by-product. Some

technologies exploring the capture and use of carbon dioxide for industrial use include using engineered particles or compounds that bind CO2 from the air. One specific example of carbon utilization captures carbon dioxide to produce graphene, a material used to produce touchscreens for smartphones and other devices. At this stage, carbon utilization is in its infancy and will require innovations to actualize profitability.

What's next?

Technologies continue to develop and innovate, enabling carbon capture and sequestration to occur on an immense scale. The ultimate goal is to be able to capture carbon from any emissions or activities that contribute to excess greenhouse gas emissions. Not only will advancements in science, technology, innovation, and engineering improve carbon capture globally, but protection, restoration, reclamation, and regeneration of our natural habitats will allow the ability to scale carbon capture at a level that meets or exceeds emission offsets. One strategy is not mutually exclusive to the other, and a globally scaled approach will be critical to reducing greenhouse gas emissions.

In conclusion, the carbon capture and sequestration process is a multifaceted approach to mitigating climate change and involves various techniques and strategies. Continued research, innovation, and investment in CCS are essential to address global greenhouse gas emissions challenges effectively.

SCS's Underground Injection Control and Carbon Sequestration Team develops educational videos and blogs to share with clients and for public edification. If you or your clients want to learn about Carbon Capture and Sequestration and the incentives associated with reducing carbon emissions, please visit our Video Learning Library: Clean Air and GHG Reduction.