# What is Carbon Capture, Utilization and Storage (CCUS)?

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## What is $CO_2$?

Carbon dioxide ($CO_2$) is one of the most important gases on the planet. Plants need it to grow, animals exhale it, and many of our most important industrial processes emit it. It is what makes the gas bubbles (fizz) in sodas, beer, and champagne. $CO_2$ is also the product of burning anything made of carbon.

$CO_2$ is one of the gases that has influenced the climate for millions of years. It's a greenhouse gas (GHG), meaning it traps heat that would normally be radiated back into space. In other words, $CO_2$ in the atmosphere works like the glass in a greenhouse, warming the planet by preventing heat from escaping.

Over the past 150 years, the concentration of $CO_2$ in the atmosphere has increased from about 280 parts per million to about 420 parts per million as of 2023. This has already contributed to the planet warming by about 1 degree Celsius, or about 2 degrees Fahrenheit compared to the average of the 20$^{th}$ century. If humanity continues to emit $CO_2$ at current rates, scientists believe that warming will continue. Continued warming can lead to sea level rise, increased extreme precipitation events, and other effects that will impact humans. The Paris Agreement addressing anthropogenic (human caused) GHG emissions was ratified by over 190 countries, representing 97 percent of the global population. Customers and investors worldwide are telling companies with operations in Louisiana they want the products to be made without emitting so much $CO_2$.

## What is Carbon Capture?

Many of our industrial facilities and processes emit $CO_2$, including refineries, chemical plants, fertilizer plants, as well as power generation from certain sources like coal and natural gas. Louisiana industrial facilities produce products that make modern life possible and sell these products worldwide. For example, without fertilizer, we could not produce enough food for the world's population. Likewise, polymers produced in Louisiana are used to make the detergents, clothing, tennis shoes, and packaging materials that we use every day.

Carbon capture occurs when the $CO_2$ emissions from an industrial facility or power plant are captured before they can be emitted to the atmosphere. This typically involves an "amine scrubber" that is used to remove $CO_2$ from chemicals and gasses. Amine scrubbing takes advantage of the fact that some chemicals (amines in the liquid phase) bind or "capture" $CO_2$. These systems, though, are expensive to install in an industrial facility, and once operational require significant energy to run. The amount of energy required depends on the $CO_2$ concentration in the emissions stream, among other factors. If the emissions from an industrial facility have a high concentration of $CO_2$, the energy required to capture the $CO_2$ decreases. Some industrial processes, especially fertilizer production, already produce very pure streams of $CO_2$.

Capture from these sources is thus relatively low cost and low energy. On the other hand, capturing $CO_2$ emissions from a power plant requires more energy and costs. It is even possible to capture $CO_2$ directly from the air, oftentimes referred to as direct air capture (DAC). Thus, individual facilities will have to make the economic decision on whether capturing $CO_2$ for sequestration is a viable option.

## What is Utilization and Storage?

Once $CO_2$ is captured, it can either be used to make something (utilized) or stored. Utilization can take many forms, but one example is converting $CO_2$ and water to carbon products like ethylene. Ethylene is a common chemical building block and can be used to make products like detergents.

"Storage" typically means $CO_2$ is transported, injected, and stored underground. In nearly all cases, the $CO_2$ is transported in a pipeline in a liquid-like "supercritical" state.[1] Then, the $CO_2$ may be injected into a well connected to a saline reservoir, typically one that is several thousand feet below the surface. The $CO_2$ is trapped in the formation by the same mechanisms that trap oil and gas under the surface. While these formations are often called "aquifers," the water contains too much salt to be drinking water. These aquifers are separated from drinking water aquifers by hundreds or thousands of feet of impervious rock. Over time, the $CO_2$ becomes irreversibly trapped underground.

## What are the risks?

Subsurface injection of unwanted byproducts has been a part of industry in Louisiana for decades. By-products from chemical plants are often injected underground instead of being handled or transported at the surface.

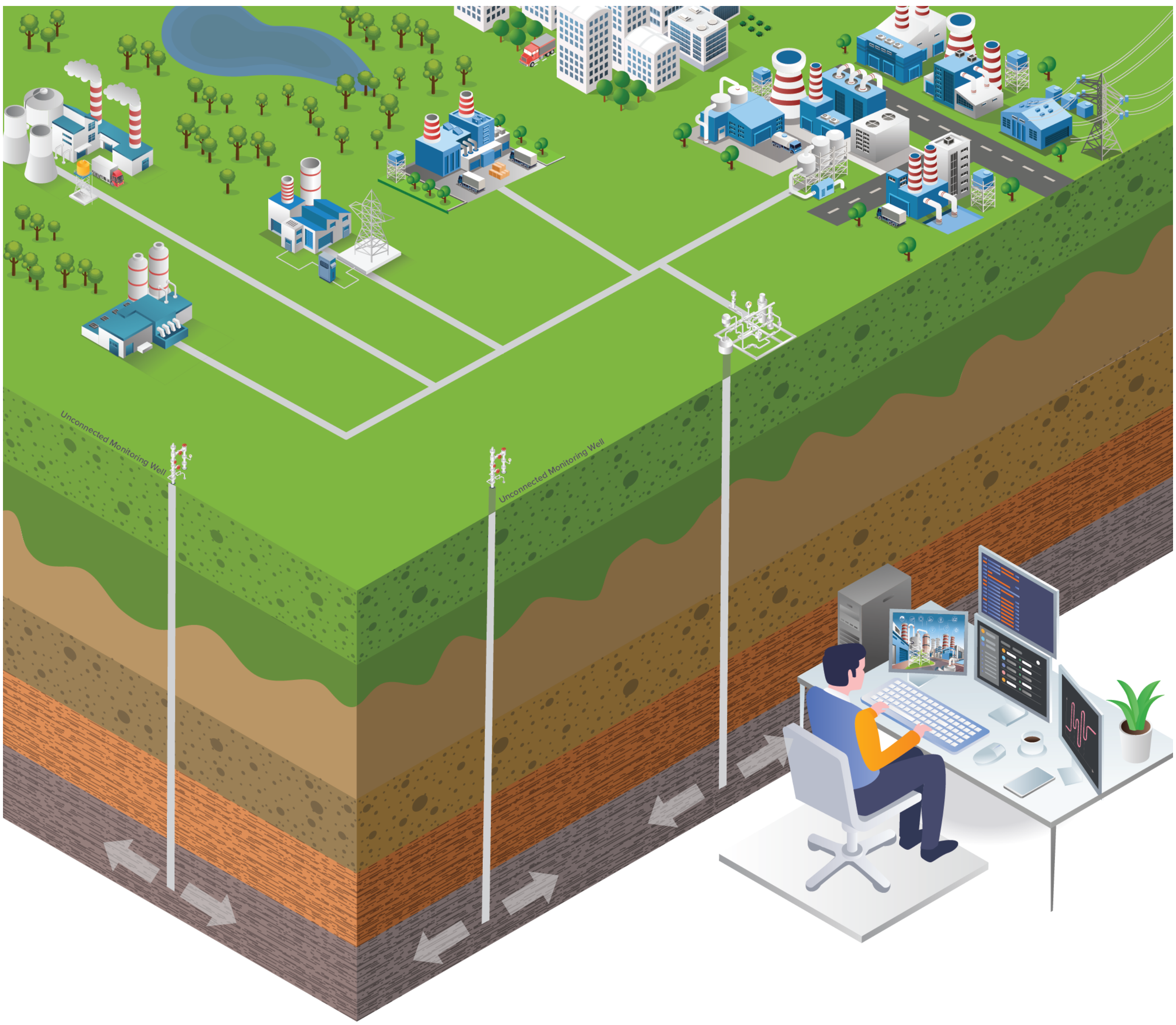
In addition, companies have also been injecting $CO_2$ for the purposes of enhanced oil recovery (EOR) for decades. The first EOR injection in Louisiana began in 1978, and in 1982 Texaco began injecting $CO_2$ from a nearby fertilizer plant into the Paradis field, making Louisiana the first place in the world that anthropogenic $CO_2$ was injected underground. Based on the subsequent 40 years of data, the $CO_2$ is safely stored underground; however, as with all industries, there are risks. For carbon capture utilization and storage (CCUS), these surface risks are most likely to occur during the transport stage. While $CO_2$ is nontoxic and nonflammable, it is transported at high pressure and therefore pipelines need to be sited and constructed carefully, as well as monitored. There is also a possibility that some $CO_2$ injected underground might leak to the surface; however, conventional engineering practices are effective in detecting and preventing leaks. There has been significant analysis and modeling, both within industry and academics, to better understand and site locations and geology.[2] Companies are required to obtain permits and provide detailed engineering data before being allowed to inject and store $CO_2$ underground.

All technologies come with some level of risk. Risks can be managed, but risks can never be eliminated. There are risks involved with air travel and driving on the interstate, as well as risks associated with oil and gas exploration and production. But for these activities, society has decided that the risks are worth the societal benefits (e.g. transportation and access to energy). Although regulators, academics, and companies believe the risks of CCUS are low based on prior experience with $CO_2$ pipelines and EOR, much more information will be known as large projects are completed and monitored for decades to come.

[1] "Supercritical" references a substance that is lighter than water but heavier than gas. In other words, it is in between a gas and a liquid state.
[2] Grant et al., 2017. NETL CO2 Injection and Storage Cost Model. https://edx.netl.doe.gov/dataset/fe-netl-co2-saline-storage-cost-model-2017

## Why here?

The Gulf Coast, and Louisiana specifically, exports liquid fuels, chemicals, polymers and fertilizers all over the world. Between 2011 and 2021, Louisiana added approximately $87 billion in investment in these sectors, and as a result exports of these products and employment have increased.[3] Given Louisiana's large industrial base, approximately two-thirds of Louisiana's GHG emissions (which includes $CO_2$) come from industrial sources. For comparison, nationwide industrial GHG emissions make up less than 20 percent.[4] In addition, geologists indicate that Louisiana has very good geology for storage. Thus, there is a confluence of four factors that make CCUS attractive right now in Louisiana: (1) large sources of industrial emissions, (2) advantageous geology, (3) global buyers of products communicating to Louisiana companies that they want lower emissions-intensive products, and (4) current federal tax credits for CCUS (known as "45Q" tax credits). As a result, CCUS is likely to expand in Louisiana in coming years.




[3]Dismukes & Upton. 2023 Gulf Coast Energy Outlook. LSU Center for Energy Studies.

[4]Dismukes. Louisiana 2021 Greenhouse Gas Inventory. Prepared on behalf of the Governor's Office of Coastal Activities. October 2021. See Figure 4.

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