Iowa Chapter
Physicians for Social Responsibility

The structures in the right mid and lower are the carbon-capture column and related equipment at the Petra Nova facility.

This is the first in a series exploring the ramifications and controversies surrounding current efforts to capture, store or utilize CO2.

What is "Carbon Capture" and Why Should We Care?

When we think about preventing runaway climate change, the terms carbon capture, carbon sequestration, and hydrogen fuel production have recently become essential parts of the discussion. In April of 2021, President Biden announced his climate policy goals: cutting U.S. greenhouse gas emissions by 50 percent by 2030 and creating a carbon pollution-free power sector by 2035. As outlined in the announcement, the steps involved in meeting these goals include "expanding carbon capture and green hydrogen." In June of 2021, the White House Council on Environmental Quality released a report that stated: "To reach the President's ambitious domestic climate goal of net-zero emissions economy-wide by 2050, the United States will likely have to capture, transport, and permanently sequester significant quantities of carbon dioxide (CO_2)." However, carbon capture, transport, and sequestration entail numerous confusing, costly, complex, and sometimes dangerous concepts.

Carbon Capture Types

It is essential to distinguish between two types of carbon capture/sequestration (CCS). Biologic carbon capture refers to nature's storage of CO_2 in soils, grasslands, forests, and oceans. Geological carbon capture is a technological process that involves capturing human-made CO_2 at its source and storing it permanently underground in geologic formations. This series focuses on the technology being promoted to capture, store or utilize CO_2.

Geologic CCS

The CCS technology utilizes three main steps: capturing the CO_2 and separating it from other gases, compressing the CO_2 into liquid form, transporting it to the storage site, and injecting the CO_2 into the storage site. Carbon capturing equipment is energy-intensive to operate. CCUS is different from CCS in that the former entails injecting the CO_2 into an existing oil well to collect more oil. The CO_2 acts to lower the oil's viscosity, enabling it to be pumped to the surface more easily. This process is known as enhanced oil recovery (EOR); EOR has been conducted in the US since the 1980s. Most of the CO_2 used for EOR is currently sourced from natural underground CO_2 reservoirs.

The Clean Air Task Force (CATF) believes that the Federal Infrastructure Investment and Jobs Act (IIJA) which was signed in November 2021, will accelerate the next stage of the CCS industry's growth. CATF calls it "the largest single investment in carbon management provisions since DOE began funding carbon capture research in 1997." Presently, there are 12 carbon-capturing facilities in the U.S. Only one project, Illinois Industrial Carbon Capture and Storage, actually sequesters carbon in an underground sandstone formation.

The other 11 projects are capturing CO_2 for EOR. In Texas, the Petra Nova facility was the first industrial-scale coal-fired electricity generating plant with a carbon-capturing system in the US but used the captured CO_2 for EOR. Proponents of coal carbon capture projects have often pointed to the Petra Nova plant as a success story. Reports indicate that the project only captured 7% of the power plant's total CO_2 emissions, and the facility experienced frequent outages—1 out of every 3 days. Additionally, the capturing infrastructure had to be powered by a methane-fired power generator whose CO_2 emissions were not captured. Perversely, what is not accounted for are the emissions ultimately from burning the oil retrieved via EOR. The Petra Nova facility suspended carbon capture operations in 2020 due to the COVID-19 pandemic-related fall in oil prices, underscoring how vulnerable successful CCS operations are on market economics.

The Illinois Industrial Carbon Capture and Storage Project began operations in 2017, but the company has yet to reach its stated goal of one million tons of carbon stored annually. According to the EPA, carbon emissions stored have been about half of that.

Direct Air Capture

Direct Air Capture (DAC) is distinct from CCU/CCUS. DAC is expensive and requires significant new technology and materials. A total of 19 DAC plants exist globally; the plants are minuscule and sell the captured CO_2 for carbonated drinks, for example, but do not store or sequester it.

Pipelines

The primary mode of large-scale CO_2 transport in the US is via pipeline. Approximately 4500-miles of CO_2 pipelines are currently in use for EOR. Wide-scale development of CCS/CCUS across the United States will require expansion of the existing CO_2 pipeline infrastructure and the construction of new pipelines to an estimated total of 29,000 miles. The IIJA provides $2.1 billion for low-interest loans for shared CO_2 transport infrastructure, as well as $2.5 billion in grant funding for commercial large-scale carbon sequestration projects and associated CO_2 transport infrastructure.

Incentives and Credits

The key revenue stream for a CCS project provides a credit for CO_2 that is captured and stored at an approved facility. The Bipartisan Budget Act of 2018, signed into law in February 2018, raised the rate for permanently stored CO_2 to $31.77/mt in 2020 for new CCS facilities and set the rate at $50/Mt in 2026, plus annual inflation adjustments. For storage-plus-EOR, the rate was $20.22 in 2020 and will rise to $35 in 2026. Approved facilities may claim Allowances for 12 years. The Build Back Better legislation proposes to increase the credit to $85/Mt for permanent storage.

Hydrogen as Fuel

There are several methods of hydrogen fuel production. Currently, hydrogen is produced chiefly via steam methane reforming (SMR). SMR uses heat and pressure to convert the methane in natural gas to hydrogen and CO_2. The hydrogen thus produced is referred to as "Gray hydrogen." Emissions from gray hydrogen are extensive, which has led to the promotion of "Blue hydrogen."

Blue hydrogen is produced if the CO_2 produced is captured and stored. As of 2021, there were only two Blue hydrogen facilities globally that used natural gas to produce hydrogen commercially, one in Canada and one in Texas.

"Green" hydrogen does exist theoretically, but it is not yet commercially viable. Electrolysis of water yields hydrogen and oxygen. When the electricity source for electrolysis is a clean, renewable source such as solar or wind, then the hydrogen is "green." Blue hydrogen is promoted

as a climate-friendly solution. Still, recent research indicates blue hydrogen's carbon footprint is 20% greater than burning either natural gas or coal directly for heat and 60% greater than using diesel oil for heat.

Superhero?

That industries poised to benefit from an expansion of CCS governmental financial incentives to promote CCS and Blue hydrogen cannot be underestimated. As an example, a recent tweet by Exxon claimed: "Carbon capture and storage is the emissions-fighting superhero you may have never heard of." CCS opponents call it a distraction and a false hope. They express concerns that reliance on CCS as a solution prolongs the dependence on fossil fuels and increases oil production and CO_2 through EOR. Moreover, CCS does not remove CO_2 from the atmosphere; CCS merely prevents some industry-generated CO_2 from entering it.

Healthy Skepticism

Additional concerns about support for CCS include the funneling of critical funds away from rapidly deployable non-carbon-emitting renewable alternatives and efficiency initiatives. The science of "permanent" storage has not been tested. For CCS to be successful, the sequestration of the captured CO_2 must continue indefinitely, or CCS is simply a way of postponing the problem and handing it off to future generations. Environmental justice advocates have also voiced concerns about the placement of the pipelines and the injection sites in Indigenous, Black, and Brown communities.

Supporters of CCS are expecting it to deliver in several ways. But energy producers themselves are skeptical. Mid-American Energy, which Warren Buffet's Berkshire Hathaway owns, said in January 2022 that they must investigate whether CCS is "technically and economically feasible" before considering using it.

Dear Reader

In the coming weeks, we will examine several crucial issues in the carbon capture debate. Stay tuned for our next installment, where we shine a light on the public health implications of CCS/CCUS.

Glossary

Biologic carbon sequestration: Sometimes called *terrestrial sequestration*; refers to the storage of CO_2 in vegetation, soils, and aquatic environments, i.e., by encouraging the growth of trees or restoring wetlands.

Carbon sequestration: Broad term usually referring to the capture and storage of CO_2.

CCS: Carbon capture and storage/sequestration—Capturing human-made CO_2 at its source and storing to prevent its release into the atmosphere.

CCUS: Carbon capture, utilization, and storage/sequestration—The captured CO_2 is utilized in some way, typically for enhanced oil recovery.

CO_2: Carbon dioxide.

DAC: Direct air capture—The capturing of CO_2 directly from the atmosphere.

EOR: Enhanced oil recovery—The "U" of CCUS; EOR involves injecting CO_2 into an oil reservoir to increase production by lowering the viscosity of the oil, which allows it to be pumped more easily from the formation. Used to extract more oil from aging oil fields.

Geologic carbon sequestration: The process of storing CO_2 in underground geologic formations.

(Gray, Blue, or Breen) Hydrogen: A carbon-free fuel that when burned produces only heat and O2. Increasingly promoted as a solution for decarbonizing sectors that require liquid fuels or that are difficult to electrify.

IIJA: The Federal Infrastructure Investment and Jobs Act (IIJA) which was signed by President Biden in November 2021.

Net-zero: A nebulous term referring to emissions and promoted by some as meaning an overall balance between emissions produced and emissions taken out of the atmosphere. Net-zero seems to have replaced the term *carbon neutral* in some arenas. Net-zero can also be achieved by eliminating emissions.

Mt: Metric ton. 1000 kilograms equivalent to 2200 pounds or 2.2 English tons.

Tertiary recovery: Another name for EOR