# Understanding CO2 Liquid Transmission Concepts and Impacts for Rural Iowa

## Introduction

The proposed project is a tremendously hot topic among many rural citizens and those in small towns near where the CO2 pipeline will run. This is true in Linn County, but we understand the scheme is equally unpopular in other rural counties.

The purported impetus for the proposed CO2 pipeline is that CO2 (carbon dioxide) is a greenhouse gas that is a (or, perhaps, the) major contributor to climate change.

We respectfully suggest that in several areas of rural Iowa the CO2 pipeline may become the single issue most important to rural voters.

## Disclaimer

In writing this White Paper, the author has relied on a review of available literature, read information on all sides of the issues, attempted to screen out the shrill voices on every side, and worked to capture a true and accurate review of the situation. It will not be completely palatable to anyone. But it is the truth as the author sees it.

## Executive Summary

Four Questions:

1. Does it make sense as a method to fight climate change? No
2. Does it make sense as an investment in alternative energy? No
3. Is it safe? No
4. Would anyone pursue it if not for the huge financial bonanza that will flow from government (read “taxpayer”) dollars? No

**The Concept (Quick Overview)**

1. CO2 is captured at a manufacturing plant, dehydrated, and compressed until it becomes liquid.
2. The liquid CO2 is kept at high pressure and pumped through special pipelines to a sequestration (storage) site.
3. The liquid CO2 is pumped about a mile underground where it will be sequestered (stored) forever.

**Terminology**

- **CCS** Technology: Carbon Capture and Sequestration
- **CCUS:** Carbon Capture, Use, and Storage
- **PHMSA:** Pipeline and Hazardous Materials Safety Administration, U.S. Department of Transportation agency created in 2004. PHMSA is responsible for developing and enforcing regulations for the safe, reliable, and environmentally sound operation of the country's 2.6-million-mile pipeline that transports 64% of the energy consumed in the U.S.
- **PHMSA** made up of:
    - Office of Pipeline Safety (**OPS**)
    - Office of Hazardous Materials Safety (**OHMS**)
- **EOR**: Enhanced Oil Recovery, which uses CO2 to flush more oil out of wells, more than doubling oil production compared to no injection (the process is called "fracking.")
- In 2019, industry reports more than 3.5 billion cubic feet of CO2 was transported daily in pipelines in the United States. The majority was used in EOR.

**Use of the Word "pipelines" or "CO2 pipelines"**

Shrill voices on every side of the issues involved in this paper refer to "CO2 pipeline," sometimes shortened to "pipeline." While some of the shrill voices are against ALL pipelines (including new natural gas pipelines and crude oil pipelines such as the Keystone XL Pipeline), there are many more in rural Iowa who would not be opposed to oil or natural gas pipelines but who are militantly against the proposed high-pressure liquid CO2 transmission lines. It is important to those who are opposed to CO2 transmission that they clarify whether they are opposed to ALL pipelines.

Being that natural gas is a "clean" fuel, forgetting to say, "CO2 pipeline" and saying only "pipeline" misrepresents what those who oppose the proposed high-pressure liquid CO2 pipeline mean to say. Words matter.

**"Sequestration"**

The meaning of the word is in question. The reason this is important is that two or more people can be in conversation using the same term, but not having the same understanding of the word.

Merriam-Webster dictionary:

> These days, we most frequently hear *sequester* used in legal contexts, as juries are sometimes sequestered for the safety of their members or to prevent the influence of outside sources on a verdict. In a different sense, it is possible to sequester property in certain legal situations. Examples of "sequester" in a sentence:
>
> > The jury was "sequestered" until a verdict was reached.
> >
> > He was "sequestered" in his room.

When used in today's conversations about CO2, "sequestration" tends to mean pumping liquified CO2 into porous rock/sand formations deep underground where it will (theoretically) be kept "sequestered" forever away from anything it could damage.

However, the term is also used to refer to the natural process of growing plants (from grass to forests) absorbing CO2. For example, a quote from a USDA publication:

> The benefits to people's everyday lives from National Forests absorbing carbon, also known as "carbon sequestration," comes from a reduction in the effects of climate change.

Proponents of deep ground sequestration point out that growing plant sequestration does not "permanently" sequester the CO2. It is captured by the plant but when the plant dies or is burned, the CO2 is released into the atmosphere.

So, know which types of "sequestration" your audience is thinking of when you and they are discussing sequestration.

**What's the Deal and All the Fuss?**

CO2 has been identified as the primary greenhouse gas responsible for climate change. This paper isn't to argue climate change but explain the situation. (There is question about if, in fact, CO2 is the primary gas; some suggest methane is more damaging than CO2.)

CO2 is a naturally occurring gas that mankind has put to work in many ways, from the fizz in your carbonated beverage to dry ice to high-pressure CO2 used in cracking rock layers (fracking) to release oil and natural gas for pumping to the surface.

CO2 is a gas that can be compressed to the extent that it becomes liquid; however, maintaining its liquid state requires that the CO2 be maintained at a pressure of over 1,000 psi.

**Explaining PSI.** Pressure is measured in psi (pounds per square inch) or "Pascals" or "Bars" or "Thors." PSI and PSIG are nearly the same. PSIG takes into consideration atmospheric pressure, but that difference is not significant for our explanation below.

- Your car tires run at about 35psi. *You don't want to be standing nearby when one blows out.*

- Your home water system has pressures generally from 45 to 60 psi. *You don't want to be nearby when a pipe ruptures.*

- Your propane tank used in backyard gas grill when fully charged would have from 145 psi to 325 psi, depending on the ambient temperature (from 70 degrees F to 135 degrees F (for example if placed for hours in the hot summer sun)). *You don't want to be standing there when it explodes.*

- Skyscrapers have water systems that can produce up to 230 psi so as to fight fires on multiple levels simultaneously. *You don't want one of those streams of water to hit you!*

- A CO2 pipeline operates at 1,600 to 2,200 psi.

**From Where to Where?**

In Iowa, ethanol plants are the largest "releasers" of CO2. (The plants say they don't "produce" CO2; instead, they "release" CO2 in their processes.) In other states, electrical generating plants and certain types of manufacturing "release" the most CO2.

The CCS process is as follows:

1. **Capture.** CO2 is released in the manufacturing process. Currently, that CO2 is released into the atmosphere. In the CCS process, some portion of that CO2 is captured and dehydrated. If not dehydrated, the CO2 will contain moisture, which will degrade pipelines and produce other lethal substances such as carbonic acid or hydrogen sulfide. After dehydrating, the CO2 is compressed at such high pressure that it becomes liquid.
2. **Transportation.** The liquid CO2 is then transported via a steel pipeline at 1,500 psi to 2,000 psi to a sequestration site.
3. **Sequestration**. The liquid CO2 is injected one mile or more into the ground. Theoretically, the CO2 will remain there forever (called "sequestration for permanent storage").

It is fair to note that while the use of CO2 is common in the fracking process, there have been several instances of what is called in the business a "CO2 blowout." That's when high-pressure CO2 pumped underground to crack rock finds its way to the surface and blows out into the atmosphere. In those cases, citizens have been evacuated because CO2 gas is lethal (see more below). Drillers using CO2 for fracking are prepared for dangerous CO2 blowouts and those preparations help keep citizens safe. A concern of citizens who will live near CO2 pipelines is how well local responders will be prepared in the event of a line rupture. Additionally, they are concerned that a blowout may occur after several years, long after first responders have lost their "edge" in knowing how to help people who have been massively exposed to CO2 gas.

It is not clear that CO2 gas is lethal in and of itself. According to WHO, those tests have never been made. CO2 is in the air we breathe in miniscule quantities. We inhale atmospheric air and expel primarily cardon dioxide. But if we put someone in a barrel and seal the barrel, it is well known that the person will die of oxygen deprivation quickly. So, the biggest danger of CO2 is when it displaces oxygen. Being heavier than air, CO2 is lethal when it collects in low-lying areas, forcing air up and away from gasping lungs.

Even moderate concentrations of carbon dioxide can cause headaches, fatigue, nausea, and vomiting. In higher concentrations, carbon dioxide poisoning can also damage the central nervous system and cause respiratory problems in humans and other breathing animals. This has been prevalent following the Sartartia, Mississippi CO2 pipeline disaster covered later in this paper.

**More About CO2 and Comparison to Natural Gas**

Proponents of CO2 pipelines point to the proliferation of oil and natural gas pipelines in America as proof that liquids can be transported safely. A few facts to understand:

- Natural gas travelling through distribution pipelines is allowed a maximum pressure rating of 1,480 psig and requires American National Standards Institute (ANSI) as Class 600 pipelines. *1,480 psi is 42 times as much pressure as your car tire.* (Note, pressure in the natural gas pipeline coming into your home has been reduced to 2-3psi.)
- Conversely, a pipeline built for CO2 service is designed for 2,200 psig, which requires ANSI Class 900 piping. That's 49% greater pressure than a natural gas pipeline, and 63 times as much pressure as in your car tires. *Not only may a rupture in a nearby CO2 pipeline tear off your arms and legs, but the CO2 itself can asphyxiate you.*
- Natural gas is lethal, but if a natural gas pipeline explodes, the gas is much lighter than air and it goes straight up into the atmosphere. It does not "hang around" at ground level.
- If a CO2 pipeline explodes, the CO2 is heavier than air and it will run along the ground level and accumulate in low-lying areas, most likely killing everything in its presence (depending on CO2 concentration, which will be primarily a function of the amount of CO2 and fortunate winds).
- CO2 will gather in low-lying areas (areas that happen to be lower than the height of the plume of cold CO2 in the case of a pipeline leak or rupture). If the area is in a bowl, the CO2 will not dissipate (or dissipate very slowly). For example, on a summer day in 1986, a thick plume of naturally occurring CO2 rose from the bottom of a volcanic lake in Cameroon and killed 1,746 people. Birds dropped out of the sky and whole families died together in minutes. The area is in the top of a volcano and where the people lived near the lake is below the surrounding mountains. The CO2 bubbled up from the bottom of the lake; when it hit the air it spread out across the top of the water, forcing normal air and its oxygen up. The CO2, being trapped in the bowl of mountains, continued to grow in depth until it could escape over the mountaintops. During this time, the air was so dense with CO2 that nothing could survive.

**Additional Safety Issues**
(The reader is referred to an excellent article in the Huffington Post *The Gassing Of Satartia* by Dan Zegart, August 26, 2021. The picture is also from the same article.)

- The only known CO2 pipeline explosion in the US occurred in Sartartia, Mississippi on the evening of February 22, 2020. Fortunately, no deaths were recorded but hundreds of people were gassed, and many have suffered long-term health problems. The pipeline ran above the level of the town and when the line exploded the CO2 floated down on the unsuspecting townspeople.
- Marcelo Korc, chief of the World Health Organization's Climate Change and Environmental Determinants of Health Unit has worried that the basic science done long ago on many toxic chemicals, including petroleum products, has never been done for CO2.
- On the other hand, the CCS and CCUS industry will claim that transport of CO2 involves well understood technologies and has been done safely at scale for more than 40 years. In the United States, the primary mode of large-scale CO2 transport is via pipeline, and there is a network of more than 5,000 miles of CO2 pipelines operating today. The author cannot corroborate the accuracy of those claims.
- Some CO2 pipeline companies come and go, sell lines to each other, declare bankruptcy, and so forth. Some (most?) companies are limited partnerships sold to institutional investors and have no real interest in the welfare of people near the pipelines. A pipeline operator may be operating a pipeline today and gone tomorrow. In this situation, longevity of quality management is questionable. It is fair to say that most Linn County residents who have attended hearings have concluded that the pipeline operators are shady organizations that intend to **exploit** Linn County and its people for the organization's profit.
- Operating excellence is spotty, and regulation is inconsistent. In the case of the CO2 pipeline in Sartartia, the company's monitoring equipment far away noticed the loss of pressure in the line. (Of course, the pressure loss was due to the eruption of the line, but the operators didn't know that.) The operators shut the valves, but by that time enough CO2 had blown into the atmosphere it was extremely lucky no one died. Regulatory reports about the incident are incomplete and seem mired in bureaucracy. The company that owned the pipeline filed for bankruptcy; within a short time, a new company with a similar name and management was pumping CO2 through the pipeline.
- After the repair, the operator attempted to restart the flow, but at least one valve had frozen (extremely high-pressured gas flashing to atmosphere tends to freeze

stuff—that's how refrigeration works) and additional leakage occurred that took the company several weeks to find and correct, exposing people nearby to additional hazard.

**CO2 Injection**

In all the sequestration injection schemes, the premise is that CO2 at pipeline pressure (1,600 psi to 2,200 psi) or higher will be injected more than a mile below the ground, "far below water resources used by communities and farms, for permanent storage."

One might ask, "So, what could go wrong?" One might then reflect on the term "permanent storage." That's a long time and reflects the belief that the high-pressure CO2 will stay where it is put.

But we know that highly sophisticated drilling operators who keenly study the underground strata sometimes have CO2 blowouts from their injections (fracking) to release oil and gas. It appears that CO2 goes where is pleases, finding passageways that no one knew were there.

I'm recalled of the problem of finding a "slow leak" in a car tire. The tire runs for several days and then is so low that it requires more air to run. It is extremely frustrating to locate a small hole in the tire….the offending passageway the air uses to escape is very small and difficult to locate. The air pressure on the tire is 35-50psi. Do we believe that CO2 at 2,000 psi can't find passageways through rock strata to lower pressure areas?

When one reflects on these pipeline pressures and the "permanent" storage location, one might believe a disaster is possible; actually, it's not a matter of if, it is only a matter of when and what the damage will be to people.

**Proposed CO2 Transmission Line in Linn County**

The company proposing to build, construct, and operate the CO2 pipeline is Navigator CO2 Ventures LLC (hereinafter "Navigator"). The company named the project "Heartland Greenway." According to records filed with the Texas Secretary of State Navigator filed as a Foreign Limited Liability Company on October 22, 2021. At the time of that filing, Navigator claimed to be one year old. Conversely, Navigator presentations claim the company has built 1,000 miles of CO2 pipeline since their "inception in 2012."

Navigator claims to be "mid-west based." Navigator is based in Dallas, TX. The reader can decide if Dallas is in the Midwest. The only reason this would matter is if the reader might think that a small claim such as location doesn't match with general perception, what else might be "hedged or stretched?"

Navigator obtains financing primarily from BlackRock. "BlackRock is one of the world's leading providers of investment, advisory and risk management solutions" according to their website. They are a global financial firm, acting as a bank to Navigator. We do not

know of the financial arrangement (lending/ownership, etc.) between the two; the identify of persons, companies, or countries that invest in either Navigator or BlackRock; nor the ongoing engagement of BlackRock with Navigator as the project continues.

While Navigator claims long-term operation of the CCS system, and talks of partnerships/arrangements with other firms, one would assume that Navigator could/might walk away from the project at any time, sell the project, or change the project overview, even if tight agreements exist between Navigator and individual landowners. (Enforcing "tight" agreements is costly, especially if one of the parties has simply disappeared.)

The plan to put this Navigator CO2 pipeline (and a similar CO2 pipeline in western Iowa) is an extremely hot issue with rural Iowa citizens. One might assume that the great mass majority (read that practically all) citizens who are aware are militantly opposed.

As with any such controversial project, plenty of information is available; however, determining what is true and what is not can be challenging.

In general, companies proposing CO2 pipelines explain that this plan is driven by an altruistic vision to fight climate change; however, there are huge federal grants, subsidies, and tax incentives to capture CO2 and sequester it. It becomes clear that absent federal money, the pipelines would not be financially feasible. (How does one make money compressing and dehydrating CO2, transporting it long distances, and then pumping it into the ground? Clearly there is no economic benefit.)

There is no guarantee that the companies will, in fact, sequester the CO2. Many companies purchase CO2 for their manufacturing processes, and one would assume that (having completed the pipeline) the companies will seek outlets for sale of the CO2 instead of injecting it into the ground. Where, then, is the "common good" required for condemnation?

The CO2 pipeline locations in Linn County are 1) all the way down the east side of the county north to south about 10 miles from the Linn-Jones line and 2) all the way across the southern edge of county from east to west. Most citizens in the affected areas are up in arms about the danger from the CO2 pipeline.

> NOTE: As of this update, Navigator has announced intention to re-route the pipeline so that it doesn't go through Linn County. This is undoubtedly due to the extreme opposition voiced by Linn County citizens.

**Taking by Eminent Domain**

The Fifth Amendment to the US Constitution as interpreted establishes the right of eminent domain: … "nor shall private property be taken for public use, without just compensation."

Iowa code grants the Iowa Utilities Board (IUB) the power to "take" private land (eminent domain) for electric power plants, transmission lines, intrastate natural gas pipelines, and hazardous liquids pipelines.

The formal process for "taking" private land is call "condemnation."

In the case of pipelines, land itself is not "taken" but the taking will be for an easement. The exception is taking of land for pumping stations, maintenance facilities, and the like.

Iowa code allows the IUB to grant their own power of eminent domain to any company it choses for purposes (in this case) of building a pipeline. The law says the taking must serve a public purpose. The company will claim its public purpose is to remove CO2 as a way to combat climate change.

**However…**

Navigator claims they will meet requirements by using ANSI 900 steel pipe.

An influential white paper produced jointly by the Energy Futures Initiative (headed by former U.S. Energy Secretary Ernest Moniz) and the AFL-CIO proposes transporting CO2 through natural gas pipelines that were never built to withstand the pressures and corrosion inherent in CO2 transportation. "Repurposing the expansive U.S. network of existing oil and gas pipelines presents a ripe opportunity to lower costs for CO2 transport," said the report.

Moniz was Biden's energy adviser in his 2020 presidential campaign and oversaw billions in spending on CCS in his time at the Department of Energy. He and his team are considered leading experts on both natural gas and carbon dioxide infrastructure. Yet the petroleum industry's own longstanding warnings about mixing gas technology with carbon dioxide are nowhere to be found in a 79-page report or its 299 footnotes.

Carroll Muffett (president of the Center for International Environmental Law and co-author of a highly critical report on CCS and CO2 pipelines) notes that CO2 behaves differently from natural gas inside a pipeline—in ways that make a CO2 rupture uniquely dangerous.

"Because of the intense pressures involved, explosive decompression of a CO2 pipeline releases more gas, more quickly, than an equivalent explosion in a gas pipeline," noted a report by CIEL and the Environmental Working Group, and "even a modest rupture can spread freezing CO2 over a wide area within seconds."

It is possible that by the time construction is finished on the proposed CO2 pipeline, rules may allow use of pipe of less strength than current requirements. There has been talk from some CO2 pipeline companies of using a woven fiber pipe, which is of tremendous concern to worried citizens. The rules are set by politicians and right now the Democratic politicians believe they have a competitive advantage because of their stand against climate change, and they can point to CCUS activities to show they are doing something (and, of course, measuring their success by how much taxpayer money they can spend).

**Assurances of Quality Construction**

CO2 pipeline companies at public meetings provide "assurances" of quality and safe construction. Additionally, the companies claim that minimum damage will be done to highly productive Iowa farmland.

However, experience has shown that these pipeline companies hire contractors who have every incentive to cut corners, work quickly, and permanently damage farmland.

**Political Situation in General**

This entire concept of CCUS deserves consideration.

First, there is no "economic force" driving this concept. It is driven by government monies and subsidies; in other words, taxpayer dollars and debt. Because these CO2 pipelines companies are built around government money instead of producing a product or service, they tend to attract people who are "connected" with the intention of making big money from government largess.

In contrast, a natural gas pipeline or oil pipeline is operated by a company that receives an economic benefit to company (sale of product). Because of that profit opportunity, companies continue to support the pipeline over years without relying on government programs.

On the other hand, CO2 pipelines as imagined and described, will only continue to function with ongoing government spending that benefits no one except well-connected players. CO2 pipelines require Big Government. And ever-growing Big Government.

This should be seen as an anathema to Republicans, who should stand for small government and believe in private enterprise.

**Financial Incentives**

There are huge financial incentives for companies to invest in CCS technology including pipelines and sequestration. On March 29 President Joe Biden railed against the largest corporations that paid "NO income tax last year." The reason they didn't pay income tax is often because they took advantage of government programs and subsidies such as the financial incentives in CCUS.

Sensing large federal payouts, Microsoft, United Airlines, and other companies have announced large investments in carbon removal. Billionaires including Bill Gates and Jeff Bezos have been pouring money into startups.

Companies that invest in CCUS don't need to make money from the technology; their profit is in subsidy payment and tax reductions for the investment in CCSU (tax reductions for other parts of their businesses).

Some producers will be eligible for a federal tax credit up to $50 per metric ton of sequestered carbon. Ethanol facilities that reduce emissions will also have the potential to achieve a premium in Low-Carbon Fuel Standard markets, leading to 20 to 40 cents increased value per gallon and annual revenue gains between $20 and $40 million per plant.

Just as there wouldn't be any windmills in Iowa if it hadn't been for government payments because the windmills didn't make enough electricity to pay for themselves, one would believe that CO2 pipelines wouldn't make financial sense without government money. If and when the money dries up, what will happen to the CO2 pipelines?

**Does it Work?**

Among all the information, one item should be considered: Does this CCS scheme actually work?

The incentives to do CCS were begun in the Bush administration and were updated by a federal tax credit that was increased in 2018 and gives companies up to $50 per metric ton for capturing and storing carbon dioxide. The Infrastructure Investment and Jobs Act of 2021 appropriated more than $12 billion to carbon capture and removal. The Build Back Better legislation would have raised the value to up to $85 per ton for carbon dioxide removed from smokestacks, and up to $180 per ton when the gas is removed directly from the air.

Perhaps surprisingly, the global proponents of the scheme are primarily energy companies and unions. For example, the Carbon Capture Coalition describes itself as "a nonpartisan collaboration of more than 100 companies, unions, conservation, and environmental policy organizations, building federal policy support to enable economywide, commercial scale deployment of carbon management technologies. This includes carbon capture, removal, transport, utilization, and storage from industrial facilities, power plants, and ambient air." One assumes the primary driver of those companies is federal (read "taxpayer") money. Taxpayer money ensures more profit by utilizing what is currently wasted (CO2).

Interestingly, major opponents of CCUS include progressive think tanks such as Inside Climate News, which notes that by incentivizing energy companies to sequester CO2, the Biden administration is truly "doubling down" on supporting fossil fuel companies.

Progressive climate groups such as Greenpeace and 350.org say oil companies are promoting the technologies as a distraction to avoid phasing out their products. At best, they argue, carbon capture and removal will play a marginal role in limiting emissions. At worst, they warn, subsidies for the technologies will prolong demand for fossil fuels, squandering money that would be better spent on replacing coal, oil and gas altogether.

In 2020, U.S. greenhouse gas emissions totaled nearly 6 billion metric tons of carbon dioxide equivalent, including other pollutants such as methane. Even optimistic projections say that carbon capture and removal technologies will be able to cut only about 250 million metric tons annually by 2035, or about 4 percent of 2020 emissions.

In fact, despite decades of research and development, and billions of dollars spent, carbon capture and removal remains extremely expensive and energy-intensive, even as the costs of alternatives have plummeted.

Most enlightened people recognize that as a society, we must move away from fossil fuels, and we should be investing in alternative sources of energy. By investing untold billions in CO2 capture and sequestration, we are limiting what could be spent to explore

different alternative sources. Adding hundreds of millions or billions of dollars to build and operate a carbon capture system only worsens the math.

**Aftermath of Construction**

Construction of CO2 pipelines has destroyed or reduced the productivity of the land over which the pipeline has been laid….and this isn't just the 6'-8' wide trench, but the productivity of land many dozens of feet either side of the trench location. Broken and destroyed drainage tiles, mixing of subsoil with topsoil, and extreme soil compaction has resulted in decreasing the productivity of highly productive land. And that's not just for a few years, but for a minimum of decades. Most of that rich Iowa topsoil was centuries or millennia in the making and it will probably never again reach its former productive capacity.

Pictures of CO2 pipeline locations taken years after pipeline construction show a devasting effect hundreds of feet wide.

The companies have no intention of paying for that destruction. They want to construct with the lowest possible cost and reap the most financial incentives in the form of taxpayer dollars.

**Conclusion**

Many years ago, most of us were shocked at the pollution of the Love Canal near Niagara Falls, New York. Greedy and heartless corporations (keep in mind I'm a Republican saying that) poisoned the canal and nearby landfill for years. By the time the extent of the devastation was known, the companies had long since gone elsewhere and nobody was ever held accountable.

The same type of greed will destroy thousands of acres of irreplicable Iowa farm ground. The money made will be far away and it all will have happened on our watch.