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The Opportunities and Risks of Offshore Carbon Storage in the Gulf of Mexico

Chairman Lowenthal, Ranking Member Stauber, and members of the subcommittee, thank you for the opportunity to address you today on the issue of carbon capture and offshore carbon dioxide storage.

Since 1989, the nonprofit Center for International Environmental Law (CIEL) has used the power of law to protect the environment, promote human rights, and ensure a just and sustainable society. As part of that mission, CIEL has undertaken legal and policy research on the causes, consequences, and responses to the climate crisis for more than three decades. This work includes active and ongoing research into the role of fossil fuels in driving the climate crisis, the history of carbon capture technologies, the potential role of such technologies in addressing the drivers of the climate crisis, and the corresponding risks to communities and the environment.

The proposed large-scale, publicly subsidized, deployment of carbon capture and storage (CCS) and carbon capture utilization and storage (CCUS) (herein collectively referred to as "CCUS") is neither a necessary nor an appropriate strategy for addressing the climate crisis and the enormous, systemic, and unjust pollution burdens the fossil economy imposes on frontline and fenceline communities across the United States, particularly on communities of color. Despite billions of dollars of investment and decades of development, deployment of CCUS has consistently proven ineffective, uneconomic, and counter-productive for the needed transition to fossil-free energy. Existing CCUS facilities have the capacity to capture only approximately one-tenth of one percent (00.1%) of annual global CO_2 emissions from energy combustion and industrial processes.[1] Proposals to massively expand CCUS and build enormous new networks of CO_2 pipelines and storage sites across the United States are not only unrealistic, but risky for people and the environment. Offshore storage of CO_2 poses heightened environmental and health risks, particularly in the Gulf of Mexico. The complexity of monitoring and managing geologic pressure underground is only magnified when injection takes place subsea at great depths, and interaction with existing oil and gas production and ill-maintained legacy wells in the Gulf only increases the risk of leak and accident.

As a result, CCUS faces significant and growing public opposition. The White House Environmental Justice Advisory Council called out CCUS as a "type[] of project that will not benefit a community," noting that "it would be unreasonable to have any climate investment working against historically harmed communities."[2] The 1,500 member-organizations of Climate Action Network ("CAN") International adopted a shared position statement declaring that the members "do[] not consider currently envisioned CCUS applications as proven sustainable climate solutions."[3] In July 2021, over 500 international, U.S., and Canadian organizations sent an open letter to lawmakers calling on them to reject CCUS as a "dangerous distraction."[4]

Carbon Capture is Not a New Technology

The technology for capturing carbon dioxide from smoke stacks and waste streams has been well known for more than half a century. A patent application filed by Standard Oil (now Exxon) researchers in 1949 described the process of removing CO_2 from flue gases as "perfectly workable, but cumbersome" and energy intensive.[5] As early as 1980, internal Exxon documents acknowledged that the industry had the technology to cut CO_2 emissions from flue gases by up to 50%, but asserted that doing so was simply too expensive.[6] Similarly, oil and gas companies patented the first technologies for injecting CO_2 into the ground at least fifty years ago, for the purpose not of addressing the climate crisis but of producing more oil.[7] Even as it downplayed the value of carbon capture for combating climate change, however, the oil industry spent decades expanding its infrastructure to capture and inject CO_2 for use in Enhanced Oil Recovery (EOR).

EOR —using captured carbon to produce more oil and gas, which itself will emit more CO_2 when burned— is fundamentally incompatible with responding to the climate emergency. The vast majority of captured carbon to date has been used for EOR. In the United States, more than 95% of all CCUS capacity is designed for EOR,[8] meaning "CO_2 waste products from a fossil fuel-burning activity are used to generate more fossil fuels."[9] In other words, the one use of captured CO_2 that has scaled, EOR, generates *more* CO_2 emissions than what is captured because of the oil it subsequently produces.

CCUS Is Not Carbon Negative, or Even Carbon Neutral

CCUS is not carbon negative, or even carbon neutral. Proponents of point-source CO_2 capture, which involves collecting emissions from a polluting facility, often claim that CCUS can *remove* carbon dioxide from the atmosphere. But CCUS is not carbon removal. At best, even if CCUS functioned in practice as it does in theory, it could only *prevent some* emissions from being released, not eliminate those already in the atmosphere.

In practice, however, CCUS projects around the world have consistently failed to meet even those partial emission reduction targets. Indeed, the history of CCUS is riddled with failures. High-profile projects such as Petra Nova,[10] Boundary Dam,[11] and Archer Daniels Midland's Illinois Industrial Carbon Capture and Storage Project[12] have all failed to meet capture or performance targets. These failures apply to pre-combustion capture as well. The Gorgon gas separation plant in Australia is the country's only commercial- scale CCUS project and one of the largest in the world. In July 2021, Chevron, operator of the project, admitted that the project failed to meet its five-year capture target of 80% CO_2, and is now seeking a deal with regulators on how to make up for millions of tons of CO_2 emitted.[13]

Proponents of CCUS have all but admitted that projects cannot achieve a 75% minimum capture rate, let alone the 90-95% capture rates promised in project proposals and assumed in scientific models.[14] During the recent debate over the Build Back Better Act, a proposal was included to require electricity-generating facilities to capture 75% of their carbon emissions to qualify for tax credits under section 45Q. A letter from CCUS proponents challenged this requirement, noting that 75% capture would be difficult to guarantee and would impede any projects from receiving financing.[15] Clearly, the 90% or greater capture rates promised by the industry—and relied on in models demonstrating the value of CCUS—are simply aspirational.

Contrary to industry portrayals, point-source carbon capture may actually increase lifecycle greenhouse gas emissions and criteria pollutants due to the increased energy needed to operate the energy-intensive capture equipment. Energy penalties associated with carbon capture can increase the energy used by the underlying facility by 20-30% or more,[16] requiring additional combustion of fossil fuels which in turns produces significant additional emissions of other pollutants.[17] The additional energy required by CCUS also increases upstream emissions from the additional oil and gas production or coal mining required to fuel the process. A study examining the lifecycle impacts of CCUS at fossil fuel power plants found that even if facilities achieved a 100% capture rate, the social cost would still be greater than replacing fossil fuels with renewable energy, which reduces air pollution and avoids the expense of capture equipment.[18] In other words, the lifecycle pollution and social harms from CCUS at fossil fuel-fired powerplants result in more harm than good.

Large-scale CCUS Is Neither Viable nor Necessary

The unproven scalability of CCUS technologies and their prohibitive costs mean they cannot play any significant role in the rapid reduction of global emissions necessary to limit warming to 1.5°C. Despite the existence of the technology for decades and billions of dollars in government subsidies to date, most notably through the 45Q tax credit, deployment of CCUS at scale still faces insurmountable challenges of feasibility, effectiveness, and expense. As an analyst from JP Morgan Chase put it, "The highest ratio in the history of science" is "the number of academic papers written on CCUS divided by real-life implementation of it."[19]

CCUS is exceedingly expensive and projects routinely face substantial cost overruns. A study by the Government Accountability Office of nine CCUS projects funded by the Department of Energy since 2009 (of which only three ever became operational) identified significant cost overruns and poor economic prospects as key obstacles to CCUS deployment.[20]

The latest report from the Intergovernmental Panel on Climate Change (IPCC) concurs, ranking CCUS as one of the highest cost, lowest potential options for reducing greenhouse gas emissions this decade.[21] The cost of emissions reductions from wind and solar by 2030 may be as much as $50-$200 cheaper per ton of CO2 equivalent than the cost of emissions reductions through CCUS.[22] The IPCC found that "The capital cost of a coal or gas electricity generation facility with CCUS is almost double one without CCUS. Additionally, the energy penalty increases the fuel requirement for electricity generation by 13–44%, leading to further cost increases."[23] Ultimately, as the IPCC notes, CCUS "always adds cost."[24]

Research has shown that the cost reductions seen in recent years for clean renewable energy will further erode the value of CCUS in decarbonization efforts.[25] The necessity of CCUS is even more suspect since investment in carbon capture directly competes with renewable energy generation, diverting financial resources away from proven, available, fossil-free solutions to technology that has consistently demonstrated itself to be infeasible from both an economic[26] and technical standpoint.[27]

Hard-to-Abate Industrial Emissions Do Not Justify Large Scale CCUS Buildout

Applying CCUS to high-emitting industrial activities, like petrochemical, steel, or cement manufacturing, is not economical. GHG emissions from these industries come from a diverse array of sources, including electricity consumption, on-site fossil fuel combustion, and process emissions, which make installing and operating CCUS even more complex and generally more costly than it is in the power sector.

A 2020 study, co-authored by a Chevron researcher, of the potential application of carbon capture to industrial facilities in the United States found that a shockingly small percentage of industrial emissions were economically suitable for carbon capture. Out of more than 1,500 industrial facilities identified by the US Environmental Protection Agency, the researchers identified only 123 facilities that could capture carbon economically, even with full use of available federal subsidies and enhanced oil recovery. [28] Even at this fraction of industrial facilities only a portion of greenhouse gas emissions could feasibly be captured.

The petroleum refining industry is the largest source of industrial emissions other than fossil fuel production itself, yet less than 19 percent of refinery emissions were amenable to carbon capture. For metals processing, including steel, only a quarter of process emissions were amenable to CCUS.[29] In total, the researchers identified only 68.5 metric tons of CO_2 per year from industrial process emissions that could be economically captured,[30] representing just 8 percent of all industrial emissions in the US.

CCUS Perpetuates Fossil Fuel Systems and Impacts

Carbon capture fundamentally exists to prolong the life of fossil fuel burning infrastructure, and in doing so extends the fossil fuel era. CCUS also presents new and additional serious environmental, public health, and safety risks.

CCUS allows polluting facilities that already harm fenceline communities to continue operating, rather than close and be replaced by less harmful infrastructure. This concern is neither abstract nor hypothetical but borne out in operating facilities. The Boundary Dam Power Station, the sole remaining coal-fired power plant with carbon capture operating in North America, would have been shut down but for its retrofit with carbon capture.[31] Instead, its owner and operator hope to extend its operating life an additional thirty years.[32] A similar plan to extend the life of a coal plant in North Dakota, rather than retire it, is currently underway.[33] Prolonging the use of coal and other fossil fuels is not only inconsistent with the imperative to avoid catastrophic levels of warming; it is also at odds with protecting public health and the environment.

Although CCUS is often touted as pollution abatement, the process itself is a source of pollution. Carbon capture is detrimental to the health of nearby communities—something even major companies have recognized. As noted above, CCUS incurs a significant "energy penalty. The resulting increased fuel consumption also increases the production and potential release of several criteria pollutants, such as particulate matter, volatile organic compounds, and nitric oxides, in proportion to the additional fuel consumed.[34] Amine-based carbon capture units (the most common type) also use large amounts of chemicals for the capture process, leading to additional releases of ammonia.[35] Notably, several companies—including Chevron Phillips,[36] Dow Chemical,[37] and ExxonMobil,[38]—have cited the increased pollution load with CCUS as a reason *not* to incorporate CCUS into industrial facilities.

CCUS therefore not only entrenches polluting activities but exacerbates their impacts, contrary to the principles of environmental justice. Polluting activities are already disproportionately concentrated in Black, Brown, Indigenous and low-income communities, and these same communities are again being targeted as sites for CCUS deployment. CCUS proponents have targeted Southern Louisiana for what would be among the largest CCUS projects in the world, despite those areas being heavily overburdened by decades of toxic pollution and ongoing industrial accidents.[39] In Texas, ExxonMobil is leading a consortium of companies planning to develop a large-scale carbon capture and storage zone along the Houston Ship Channel,[40] a zone that already suffers from some of the worst air pollution in the country, which is "disproportionately shouldered by people of color, people living in poverty, and limited-English households."[41] Project developers are reportedly eyeing both onshore and offshore storage sites for the captured carbon,[42] but have identified the Gulf of Mexico as holding the largest potential for CO_2 storage.[43] California's Central Valley is also being targeted for CCUS, despite already having the state's worst air quality.[44]

Carbon Dioxide Transportation and Injection - Whether Onshore or Offshore - Threaten Communities & the Environment

Transporting and injecting captured carbon dioxide, whether onshore or offshore, pose growing and poorly understood threats to communities and the environment. Those risks are borne disproportionately by marginalized communities, such as those in the Gulf South, already subject to environmental racism and heightened toxic burdens from the fossil fuel, petrochemical, and agriculture industries, now targeted for CCUS buildout.

Transportation Risks

Transporting carbon dioxide by pipeline between the point of capture and the site of use, injection, or storage presents environmental, health, and safety risks. Carbon dioxide is a hazardous substance and an asphyxiant that can be fatal at high concentrations.[45] To facilitate mobility, captured carbon dioxide is compressed and transported in a supercritical state, at pressures far higher than natural gas pipelines.[46] Depending on the source of capture, compressed CO_2 may be mixed with other contaminants such as hydrogen sulfide, increasing the risks of pipeline corrosion, leaks, and rupture, and compounding the resultant health risks from exposure. Carbon dioxide leaks from pipelines pose a potential hazard for people and other animals. "CO_2 is denser than air and can therefore accumulate to potentially dangerous concentrations in low lying areas," displacing oxygen, and "any leak transfers CO_2 to the atmosphere."[47] These risks became reality in February 2020, when a CO_2 pipeline rupture in Mississippi led to the evacuation of hundreds and hospitalization of dozens of residents,[48] with harms including extreme disorientation, unconsciousness, and seizures.[49]

Until now, most of the approximately 5000 miles of CO_2 pipelines in the United States have been in relatively sparsely populated areas, primarily designed to service oil and gas fields.[50] But the CCUS buildout plans under discussion today project the massive expansion of the pipeline network into populous areas, magnifying the safety and health risks. One study calls for the development of a 65,000-mile CO_2 pipeline system in the United States, with a throughput capacity greater than that of the country's existing oil network, which has taken a century to build.[51] These projections are both unrealistic and risky.

The existing federal regulatory framework for pipelines is already failing. As Congresswoman Jackie Spier observed, the Pipeline and Hazardous Materials Safety Administration ("PHMSA") "does not have the teeth—or the will—to enforce pipeline safety in this country."[52] Beyond weak enforcement, the regulatory framework itself is insufficient. A recent report by the Pipeline Safety Trust concluded that "existing federal regulations do not allow for the safe transportation of CO_2 via pipelines" because "[t]he way regulations currently consider and mitigate for the risks posed by hydrocarbon pipelines in communities are neither appropriate nor sufficient for CO_2 pipelines."[53]

The inadequate regulatory framework and enforcement regimes applicable to CO_2 pipelines are particularly concerning given proposals to retrofit existing gas pipelines, such as those in the Gulf, for use in transporting CO2. Such retrofits would create additional hazards, as gas pipelines are typically not built to withstand the intense pressure and corrosive nature of compressed CO_2.[54] Moreover, the hazard risk of CO2 released affects larger areas than the typical gas pipeline explosion, and the location of existing pipelines if retrofitted for use in CO2 transportation could present significant new risks for those in the surrounding areas.

Storage risks

Storing CO2 underground is far from a simple, permanent fix. Injecting CO_2 underground in depleted oil and gas reservoirs or saline formations, whether onshore or offshore, involves complex pressure management to prevent leakage, displacement, and other disruptions to the geologic formation. As carbon dioxide is stored in underground saline reservoirs, it increases the pressure in the geologic formations. The pressure buildup is an important source of risk and a limitation on storage capacity, often overlooked in projections of potential sequestration sites.[55] If not properly managed, this excess pressure can lead to earthquakes ("induced seismicity"), create fractures that could release the carbon dioxide back into the environment, or cause CO_2 and displaced brine to leak into shallow freshwater aquifers.[56] Managing that pressure requires the removal of displaced brine, also known as "produced water."[57] But such brines, which can be saltier than seawater and may contain toxic metals and radioactive substances, have to be reinjected into the subsurface or otherwise disposed of properly, to prevent adverse impacts to local aquifers, soils, and ecosystems. Reinjection and disposal of brines is costly and adds a further challenge to CCUS buildout.[58] The pumping, transportation, treatment and disposal of the produced brine also can be "environmentally challenging".[59]

These challenges apply with equal if not greater force to offshore storage. The complexity of that management and the difficulty of monitoring sites for leakage or other disturbances is only magnified when CO_2 is injected underwater, particularly at great depths.

Offshore Carbon Dioxide Storage Presents Additional Risks

The above risks and hazards are especially acute in the context of offshore storage, particularly in the Gulf of Mexico, where risks are magnified by the extreme difficulty of the engineering environment and the preexisting footprint and ongoing impact of oil and gas production.

Storing carbon dioxide under the Outer Continental Shelf would require the development of a new system of offshore CO_2 pipelines. Even in the best of circumstances, the construction and operation of these pipelines could have a significant adverse impact on ocean ecosystems and the coastal communities that depend on and are affected by them. At worst, they present significant risks of rupture and leakage.

The poor track record with monitoring and maintenance of existing offshore oil and gas pipelines and wells raises concerns about capacity to ensure that offshore CCUS would not face similar issues. The Government Accountability Office has identified problems with pipeline integrity and weakness in oversight of existing offshore oil and gas infrastructure.[60] Monitoring injection sites and managing underground pressure are substantially more difficult undersea than on land, and the dynamics are largely untested and unknown. The deeper the injection sites, the lower the likelihood of detection and the more difficult repair. Experience with leaking pipelines in the Gulf demonstrates that undersea pipelines face significant risks of corrosion and failure.[61] The external risks to offshore infrastructure will only be magnified as climate impacts accelerate.

Leakage from offshore CO_2 injection and storage could have a profound effect on the surrounding marine environment, such as making seawater more acidic and threatening sensitive marine species. Both the U.S. Bureau of Ocean Energy Management (BOEM) and the IPCC have recognized that the marine impacts of CO_2 leakage could be significant, from acidification to increased salinity, and that they remain poorly understood. Knowledge gaps about the risks of leakage and prospects for their prevention must be filled before any offshore CO_2 storage is deployed.

In a 2018 report, BOEM identified diverse risks that CO_2 leakage from a reservoir via an injection well or a preexisting plugged and abandoned oil or gas well could pose to "(1) other sub-seabed resources, (2) the ocean water column, (3) environmental resources in the water column and on the seafloor, or (4) platform workers, and result in emissions to the atmosphere."[62] The IPCC has recognized that deliberate offshore injection of CO2 could alter ocean chemistry, exacerbating ocean acidification: "Injection up to a few GtCO2 would produce a measurable change in ocean chemistry in the region of injection, whereas injection of hundreds of $GtCO_2$ would eventually produce measurable change over the entire ocean volume."[63] Beyond the adverse biological impacts that dissolved CO_2 may have on ocean bottom and marine organisms,[64] if leakage of CO_2 from offshore storage sites reaches the ocean surface, it could pose a hazard to offshore platform workers, particularly in the event of a large or sudden release, and may reach the atmosphere, undercutting climate impacts.[65] Moreover, as discussed above, improper management of displaced brines could increase seawater salinity, which may present another environmental shock to marine organisms.[66]

The greatest risk of leakage from offshore storage sites comes from their interaction with existing oil and gas wells. As BOEM notes, there is "widespread consensus that the highest risk for CO_2 migration from a reservoir zone to the shallow subsurface or atmosphere is associated with previously existing wellbores."[67] This risk also applies to containment failure in offshore settings.[68] The Gulf, which has been heavily targeted for offshore CO_2 storage, is pock-marked with legacy wells and dry well bores from decades of drilling and extraction. This raises significant concerns that subsea storage of CO_2 in the Gulf may be particularly susceptible to leakage.

Last week was the twelfth anniversary of the Deepwater Horizon spill. It's a stark reminder that when things go wrong offshore it's hard to fix. While the risks of transporting CO_2 are distinct from those associated with oil and gas, they are significant and must be thoroughly assessed, and adequate mitigation measures, monitoring systems and requisite financing in place before any permits are granted.

Conclusion

The IPCC has issued a clear warning that humanity must cut global emissions of CO_2 and other greenhouse gases by roughly 50% in the next decade to have any chance of keeping planetary warming below 1.5C. The production and combustion of fossil fuels for energy, transport, and industrial processes is the overwhelming driver of the climate crisis. Ending reliance on fossil fuels is thus the fastest, cheapest, most effective way to reduce emissions. Far from contributing to that critical goal, the proposed massive deployments of publicly subsidized CCUS projects threaten to delay urgently needed climate action, undermine emission reduction efforts, squander limited resources, lock-in fossil fuel infrastructure, and expose communities across the Gulf Coast and throughout the United States to new and potentially catastrophic health, safety, and environmental risks. In so doing CCUS threatens to compound the already heavy burdens the fossil economy has imposed for decades on people of color and low-income communities. CCUS is a false solution, a dangerous distraction, and a new but completely avoidable chapter in this country's long history of environmental injustice and systemic racism. The Congressional response to CCUS must reflect and respond to that reality.

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