THE OPPORTUNITIES AND RISKS OF OFFSHORE CARBON STORAGE IN THE GULF OF MEXICO

OVERSIGHT HEARING

BEFORE THE

SUBCOMMITTEE ON ENERGY AND MINERAL RESOURCES

OF THE

COMMITTEE ON NATURAL RESOURCES
U.S. HOUSE OF REPRESENTATIVES

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Thursday, April 28, 2022
U.S. House of Representatives
Subcommittee on Energy and Mineral Resources
Committee on Natural Resources
Washington, DC

The Subcommittee met, pursuant to notice, at 9:33 a.m., in room 1324, Longworth House Office Building, Hon. Alan S. Lowenthal [Chairman of the Subcommittee] presiding.

Present: Representatives Lowenthal, Porter; Stauber, Herrell, and Graves.

Dr. LOWENTHAL. Good morning everyone. The Subcommittee on Energy and Mineral Resources will come to order.

We are meeting today to hear testimony on the opportunities and the risks of storing carbon dioxide offshore in the Gulf of Mexico.

Under Committee Rule 4(f), any oral opening statements at hearings are limited to the Chair and the Ranking Minority Member, or their designees. This will allow us to hear from our witnesses sooner and help Members keep to their schedules.

Therefore, I ask unanimous consent that all other Members' opening statements be made part of the hearing record if they are submitted to the Clerk by 5 p.m. today or at the close of the hearing, whichever comes first.

Hearing no objection, so ordered.

Without objection, the Chair may also declare a recess, subject to the call of the Chair.

Without objection, we may have other Members, which we will hear from later on today, to ask questions of witnesses in today's meeting.

As described in the notice, statements, documents, or motions must be submitted to the electronic repository at HNRCDocs@mail.house.gov. Members physically present should provide a hard copy for staff to distribute by e-mail.

Please note that Members are responsible for their own microphones. As with our fully in-person meetings, Members can be muted by staff only to avoid inadvertent background noise.

Finally, Members or witnesses experiencing technical problems should inform Committee staff immediately.

With that, I will begin my opening statement.

STATEMENT OF THE HON. ALAN S. LOWENTHAL, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF CALIFORNIA

Dr. LOWENTHAL. It is, for me, a very interesting hearing. I will start with the Biden administration has set goals for the United

States to reduce greenhouse gas emissions by at least 50 percent by 2030 and to reach net-zero emissions no later than 2050. According to the international scientific community, if countries worldwide reach net-zero emission by mid-century, we can prevent the worst impacts of climate change from occurring.

We have no time to waste and reaching these goals will take a whole-of-government approach. We need to eliminate greenhouse gas pollution from every sector of the U.S. economy, including heavy industries that are critical to our economy but are very difficult to decarbonize. I am talking about heavy industries like manufacturing, chemical processing, and refining.

One potential tool for these hard-to-decarbonize industries is carbon capture and storage. But capturing the carbon dioxide before it enters the atmosphere is just one side of the equation, and a complicated one at that. That carbon must then be stored and monitored for decades to come, which brings us to the subject of today's hearing.

The Outer Continental Shelf of the Gulf of Mexico has tremendous potential to permanently store large amounts of carbon dioxide that would otherwise be emitted into the atmosphere. State governments, industry, and academics have all expressed interest, thanks to the Gulf's unique geology and close proximity to heavy industries that emit significant amounts of carbon pollution.

The Gulf region is also home to a highly trained offshore oil and gas workforce whose skills and expertise are directly transferable to this emerging industry.

And it makes sense. Instead of pumping oil out of the seabed, they would be pumping carbon dioxide into it.

However, offshore carbon storage is most certainly not without risk, and it is no silver bullet climate solution. Carbon capture and storage does not give highly polluting facilities a license to increase emissions of carbon dioxide or the many other dangerous pollutants that they can spill into the air.

The Gulf region is home to over 1,000 industrial facilities that disproportionately impact minority and low-income communities. These types of facilities emit enormous amounts of pollution that are harming our planet and hurting human health.

We must also gain a better understanding of the impacts of offshore carbon storage on marine environments and the safety hazards posed by carbon dioxide pipelines, which will be essential for moving carbon from where it is captured and into the undersea storage reservoirs.

In 2020, a ruptured carbon dioxide pipeline in Mississippi led to the evacuation of 200 residents and the hospitalization of 45 people. That is why the Bipartisan Infrastructure Law directed the Department of the Interior to issue new safeguards for development of carbon storage projects on the Outer Continental Shelf, in addition to other provisions to support this industry.

It is critical that these regulations developed by the Department of the Interior prioritize the health and safety of Gulf communities, set strong industry standards, and provide protections for taxpayers.

Before I turn it over to Ranking Member Stauber, I want to emphasize that carbon capture and storage could be one piece, albeit a small piece, of our overall efforts to reduce pollution that is destroying our planet and harming the health of fellow Americans.

However, I would like to say usually when we have Majority witnesses, they all agree, generally, on the topic, and the Minority witnesses are usually in opposition. But this hearing, our Majority witnesses have different takes on this, on carbon capture and storage.

One esteemed scientist says that carbon capture and storage in the Gulf is not a want, but a need. It has to be done, really.

Another one says that carbon storage is not a silver bullet. And that before we do it, we really must take into account that lots of issues must be solved.

And our third witness says carbon capture and storage is a false solution.

So, I look forward to an exciting hearing and one that I hope will educate me greatly. I want to hear how realistic some of these carbon capture and storage projects really are in the near term.

I personally remain cautiously optimistic, but I also still believe that transitioning away from fossil fuel is the most effective strategy for saving the planet for our children and for our grandchildren, and it is going to remain a focus of this Subcommittee. Although, this is a very fascinating subject that we also need to look at.

[The prepared statement of Dr. Lowenthal follows:]

PREPARED STATEMENT OF THE HON. ALAN S. LOWENTHAL, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF CALIFORNIA

The Biden administration has set goals for the United States to reduce greenhouse emissions by at least 50 percent by 2030 and reach net-zero emissions no later than 2050. And according to the international scientific community, if countries worldwide reach net-zero emissions by mid-century, we can prevent the worst impacts of climate change from occurring.

We have no time to waste, and reaching these goals will take a whole-of-government approach. We need to eliminate greenhouse gas pollution from every sector of the U.S. economy, including heavy industries that are critical to our economy but very difficult to decarbonize. I'm talking about heavy industries like cement, manufacturing, chemical processing, and refining.

One potential tool for these hard-to-decarbonize industries is carbon capture and storage. But capturing the carbon dioxide before it enters the atmosphere is just one side of the equation, and a complicated one at that. That carbon must then be stored and monitored for decades to come.

Which brings us to the subject of today's hearing. The Outer Continental Shelf of the Gulf of Mexico has tremendous potential to permanently store large amounts of carbon dioxide that would otherwise be emitted into the atmosphere.

State governments, industry, and academics have all expressed interest thanks to the Gulf's unique geology and close proximity to heavy industries that emit significant amounts of carbon pollution. The Gulf region is also home to a highly trained offshore oil and gas workforce whose skills and expertise are directly transferable to this emerging industry.

And it makes sense. Instead of pumping oil out of the seabed, they would be pumping carbon dioxide into it.

However, offshore carbon storage is most certainly not without risk, and it is no silver bullet climate solution. Even if carbon capture and storage moves forward in some manner, that does not mean that highly polluting facilities should get a free pass to increase their carbon emissions or the many other dangerous pollutants that they spill into the air.

The Gulf region is home to over 1,000 industrial facilities that disproportionally impact minority and low-income communities. These types of facilities emit enormous amounts of pollution that are harming our planet and hurting human health.

We must also gain a better understanding of the impacts of offshore carbon storage on marine environments and the safety hazards posed by carbon dioxide pipelines, which will be essential for moving carbon from where it is captured and into the undersea storage reservoirs.

In 2020, a ruptured carbon dioxide pipeline in Mississippi led to the evacuation of 200 residents and the hospitalization of 45 people.

That is why the Bipartisan Infrastructure Law directed the Department of the Interior to issue new safeguards for development of carbon storage projects on the Outer Continental Shelf, in addition to other provisions to support this industry.

It's critical that these regulations developed by the Department of the Interior prioritize the health and safety of Gulf communities, set strong industry standards, and provide protections for taxpayers.

Before turning it over to Ranking Member Stauber, I want to emphasize that carbon capture and storage could be just one small piece of our overall efforts to reduce pollution that is destroying our planet and harming the health of fellow Americans.

Transitioning away from fossil fuels is still the most effective strategy for saving the planet for our children and grandchildren, and it will remain a focus of this Committee.

I also hope to hear from our witnesses today about just how realistic some of these carbon capture and storage projects really are in the near term. Carbon capture technology has been researched for years, and a decade ago was pushed aggressively by coal companies to prop-up polluting power plants. But the practice never took off, mainly because removing carbon dioxide from smokestacks is so incredibly expensive and uneconomic.

If capturing carbon doesn't make financial sense—and to my knowledge, it currently doesn't without generous tax incentives—we need to be careful about supporting just another fossil fuel industry boondoggle.

However, while I have concerns with the capture technology and cost side of this issue, today's hearing is more generally about storing carbon offshore in the Gulf of Mexico.

With that, I look forward to the testimony from our witnesses.

Dr. LOWENTHAL. With that, I look forward to the testimony of our witnesses, and I now recognize Ranking Member Stauber for his opening statement.

STATEMENT OF THE HON. PETE STAUBER, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF MINNESOTA

Mr. STAUBER. Thank you very much, Chairman Lowenthal. I look forward to being with you in person at the next hearing. And as you know, I value our friendship.

Today, I am excited to discuss an exciting new branch of the Energy and Minerals Resources Subcommittee jurisdiction: carbon capture, utilization, and storage. CCUS involves capturing carbon dioxide from emissions streams, whether it be right at the point of emission or from the air. Carbon is then condensed and stored underground, or reused in other applications.

This technology has the potential to revolutionize the industrial sector. It is a great example of innovation that is already deployed by firms in energy generation, steelmaking, and many others.

For starters, various forms of carbon capture and storage are already in effect and development in the United States on land. Meanwhile, the Gulf of Mexico provides opportunities for CCUS development offshore, where the favorable geology under the sea floor offers just the right situation for storage. We will therefore today explore the potential for offshore carbon capture and sequestration.

But first, I would be doing a disservice to the American people if I did not again discuss the damage inflicted on the livelihoods of Americans by Joe Biden's policymaking, or lack thereof. Just last week, I was able to join my close friend and colleague, House Minority Whip Steve Scalise, to an offshore oil rig off the Louisiana coast, the Appomattox. I saw firsthand how the oil and gas workers value safety and environmental responsibility, while developing the resources we need to keep energy affordable, reliable, and clean for American families.

The issue is clear: the Administration must offer oil and gas lease sales both onshore and offshore. The only offshore lease sale held, Lease Sale 257, was directed by a Louisiana court and was a resounding success. It would have generated record revenues for the United States and would generate even more over the life of the lease, which we would deposit into conservation funding. However, it was predictably challenged by activists, fundraising, and legal organizations, who were able to win an unlawful pause.

And to make matters worse, we are only 64 days from BOEM's current 5-year plan expiring, with no replacement in sight. This Administration needs to follow the law and complete a replacement plan by the July 1st deadline.

Meanwhile, onshore, the Administration was dragged kicking and screaming into offering one single lease sale. I am happy for the roughnecks in the West who may get a little relief, but it does come at a cost: a higher royalty rate and an 80 percent reduction in land offered, as the Interior Department bragged in a recent press release.

This is what Joe Biden envisioned when he promised to end fossil fuels as a candidate: less American resources, more foreign imports, more expensive lives for Americans, especially as the summer driving season is upon us. But don't take my word for it. The White House Press Secretary recently said that the President's policy is, and I quote, "to ban additional leasing." This is unacceptable. Joe Biden must get on the side of American energy.

With that being said, I can now turn back to the core of the hearing today. There are several Federal policy issues in the offshore CCUS space for us to consider.

Last November, Interior was authorized to lease lands and grant rights-of-way and easements for carbon storage on the Outer Continental Shelf. The law requires regulations to be issued within a year of enactment, and we are now only 7 months away. As the Administration develops this framework, we have several issues to consider.

For example, we need to ensure lease terms and long-term viability. Carbon has the potential to be stored permanently. Therefore, what will happen to the leased area? How will we monitor for safety, long term? How can we ensure the waters remain viable for multiple use?

And just like any industrial application, leasing and regulatory certainty is paramount. We need to ensure operators know their lease terms so they can plan, raise capital, and invest. Unlike other sectors, carbon storage doesn't create a commodity that can be bought and sold on a market. Firms cannot be expected to make these massive investments without having a baseline expectation of liability and certainty.

And lastly, we need to have a robust pipeline infrastructure to transport carbon from point source to sequestration. We therefore need a thoughtful and forward-thinking policy on ocean pipelines.

Given the general attitude toward pipelines by this Administration and the Committee Majority who, for example, advance short-sighted legislation like the Offshore Pipeline Safety Act, it is imperative we build consensus-driven, bipartisan solutions.

In closing, I look forward to diving into the prospect of capturing, transporting, and storing carbon offshore.

I look forward to the testimony. Thank you, Mr. Chair, and I yield back.

Dr. LOWENTHAL. Thank you, Ranking Member Stauber.

I believe that Ranking Member Westerman will not be making an opening statement.

Mr. STAUBER. That is correct, Mr. Chair.

Dr. LOWENTHAL. Then I am going to now introduce today's witnesses.

Dr. Tip Meckel is a Senior Research Scientist for the Bureau of Economic Geology at the University of Texas at Austin.

Mr. Carroll Muffett is the President and CEO of the Center for International Environmental Law.

Ms. Nichole Saunders, who is joining us remotely, is the Director and Senior Attorney for Energy Transition at the Environmental Defense Fund.

And Mr. Erik Milito is the President of the National Ocean Industries Association.

Let me remind the witnesses that under our Committee Rules, they must limit their oral statements to 5 minutes, but that their entire statement will appear in the hearing record.

When you begin, the timer will begin, and it will turn orange when you have 1 minute remaining.

I recommend that Members and witnesses joining remotely pin the timer so that it remains visible.

After your testimony is complete, please remember to mute yourself to avoid any inadvertent background noise.

I will allow the entire panel to testify before questioning the witnesses.

The Chair now recognizes Dr. Meckel for 5 minutes.

STATEMENT OF TIP MECKEL, SENIOR RESEARCH SCIENTIST, BUREAU OF ECONOMIC GEOLOGY, THE UNIVERSITY OF TEXAS AT AUSTIN, AUSTIN, TEXAS

Dr. MECKEL. Thank you. Subcommittee Chair Lowenthal, Ranking Member Stauber, and Subcommittee members, thanks for the invitation today to provide testimony related to the opportunities and risks of offshore carbon storage in the Gulf of Mexico.

I serve as a Senior Research Scientist at the Gulf Coast Carbon Center at the Texas Bureau of Economic Geology at the University of Texas at Austin. My expertise is in geology and geophysics, with a specialty in carbon dioxide storage.

During my 15 years working full-time on carbon capture and geologic storage, I have worked closely with the U.S. Department of Energy National Energy Technology Laboratory under the Office of Fossil Energy and Carbon Management. My colleagues and I have led a half dozen CCS demonstration projects, utilizing over $70 million in Federal funding. Our center has also interacted with many companies that are actively developing CCS projects, including offshore, both in the United States and internationally.

Beginning in 2010, I initiated a research program to evaluate the offshore Gulf of Mexico for carbon capture and storage. I have completed three multi-year, offshore CCS storage research projects to date, with one ongoing for the western Gulf of Mexico.

We now have the first example of a successful state lease in Texas for offshore CO_2 storage, indicating commercial market interest and viability of IRS Section 45Q tax credits for accelerating project deployment.

Lastly, my colleagues and I at the Center are currently in regular dialogue with the Bureau of Ocean Energy Management and the Bureau of Safety and Environmental Enforcement on topics related to offshore CCS.

In the United States and globally, we are faced with the unprecedented challenge of providing abundant, affordable, and reliable energy, while simultaneously mitigating the effects of climate change associated with industrial emissions.

Both the International Panel on Climate Change and the International Energy Agency have stated repeatedly over the last decade that trying to address our energy needs and associated industrial emissions will be both more expensive and less effective without carbon capture and geologic storage. Simply put, CCS is not a want, it is a need.

But it is important for the Subcommittee to recognize that while CCS is a relatively new topic for the offshore in the United States, it has been active internationally for over a decade, and there are over 20 years of experience in developing and deploying CCS technology in the United States, a recognized leader in CCS. Multiple examples of successful industrial projects exist. The primary technology components needed are at a very high technology readiness level, and projects can proceed safely and effectively today.

With regard to subsurface storage capacity, the Offshore Continental Shelves represent the national end-game for effective CCS deployment at the scale needed to mitigate existing and future emissions. In particular, the Gulf of Mexico Basin is one of the most studied geologic regions in the world. Currently available subsurface data are sufficient to initiate storage projects today. Multiple technical studies identify hundreds of gigatons of storage capable of addressing national emissions for decades.

Considering the opportunities that offshore CCS affords, it is important to recognize the following:

An offshore CCS industry would facilitate the mitigation of significant quantities of CO_2 emissions from industrial point sources and would increase the nation's ability to reach stated greenhouse gas emissions reduction targets.

The development of a successful offshore CCS industry will both retain, as well as create, significant long-term, diverse, and high-paying jobs.

Development of offshore CCS will lead to international competitiveness in a rapidly evolving global energy transition.

Offshore CCS can be an important part of addressing environmental justice issues related to the energy transition.

The opportunity exists to repurpose existing infrastructure nearing the end of its production cycle for CCS and avoid decommissioning costs.

Considering the risks that CCS presents, the following points are critical to understand:

CCS science is mature, and subsurface injection of CO_2 for emissions abatement is demonstrably safe and effective.

Primary risks include migration of buoyant fluids toward the surface and marine environment via legacy wellbores or geologic pathways.

The management of induced pressure in the subsurface associated with CO_2 injection is important for understanding the project location and adjacent proximity, while minimizing potential for induced seismicity.

The technologies needed for effective monitoring of subsurface CO_2 injection projects are mature and exist today.

The costs of CCS are currently quite high. Current IRS tax credits, valued at $39 a ton, are capable of initiating some projects, but tax credit values closer to $85 a ton would generate a significant additional increase in project development.

Public perception of CCS is uneven, although many have become more supportive once they are provided additional information on benefits and risks.

In conclusion, I believe the Gulf of Mexico represents the single best opportunity for developing a CCS industry in the United States that can effectively address national emission reduction strategies at the required scale. The opportunities are economically impactful, can significantly mitigate emissions for reaching our national targets, and the risks are manageable and monitoring is mature. We are ready to proceed.

I encourage the Subcommittee to recognize the ability to simultaneously address future abundant, affordable, and reliable energy needs, while reducing industrial emissions and addressing climate change by establishing permitting and regulations needed for safe and timely development of an offshore CCS industry in the OCS, specifically in the Gulf of Mexico.

Thank you for the opportunity to provide these perspectives, and I am happy to field any questions as time allows.

[The prepared statement of Dr. Meckel follows:]

PREPARED STATEMENT OF DR. TIMOTHY A. 'TIP' MECKEL, SENIOR RESEARCH SCIENTIST, CCS EXPERT, GEOLOGY AND GEOPHYSICS
BUREAU OF ECONOMIC GEOLOGY, THE UNIVERSITY OF TEXAS AT AUSTIN

Subcommittee Chair Alan Lowenthal, Ranking Member Pete Stauber, and Subcommittee Members: Thank you for inviting me today to provide testimony to the House Subcommittee on Energy and Mineral Resources oversight hearing titled: "The Opportunities and Risks of Offshore Carbon Storage in the Gulf of Mexico."

I serve as a Senior Research Scientist at the Gulf Coast Carbon Center at the Texas Bureau of Economic Geology at The University of Texas at Austin. My expertise is in geology and geophysics, with a specialty in carbon dioxide storage.

During my 15 years working full time on Carbon Capture and Geologic Storage (CCS), I have worked closely with the U.S. Department of Energy—National Energy Technology Laboratory under the Office of Fossil Energy and Carbon Management. My colleagues and I have led a half dozen CCS demonstration projects utilizing over $70 million dollars in Federal funding. Our Center has also interacted with many companies that are actively developing CCS projects, including offshore, both in the United States and internationally.

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Lastly, my colleagues and I at the Center are currently in regular dialog with the Bureau of Ocean Energy Management (BOEM) and the Bureau of Safety and Environmental Enforcement (BSEE) on topics related to offshore CCS.

In the United States, and globally, we are faced with the unprecedented challenge of providing abundant affordable and reliable energy, while simultaneously mitigating the effects of climate change associated with industrial emissions.

Both the International Panel on Climate Change (IPCC) and the International Energy Agency (IEA) have stated repeatedly over the last decade that trying to address our energy needs and associated industrial emissions will be both more expensive and less effective without carbon capture and geologic storage. Simply put, CCS is not a 'want', it is a 'need'.

It is important for the subcommittee to recognize that while CCS is a relatively new topic for the offshore, there are over 20 years of experience in developing and deploying CCS technology in the United States, a recognized leader in CCS. Multiple examples of successful industrial projects exist. The primary technology components needed are at a very high Technology Readiness Level (TRL), and projects can proceed safely and effectively today.

With regard to subsurface storage capacity, the Offshore Continental Shelves (OCS) represent the national end-game for effective CCS deployment at the scale needed to mitigate existing and future emissions. In particular, the Gulf of Mexico basin is one of the most studied geologic regions in the world. Currently available subsurface data are sufficient to initiate storage projects today. Multiple technical studies identify hundreds of gigatons of storage capable of addressing national emissions for decades.

Considering the ***opportunities*** that offshore CCS affords, it is important to recognize the following:

- An offshore CCS industry would facilitate the mitigation of significant quantities of CO_2 emissions from industrial point sources, and would increase the nation's ability to reach stated greenhouse gas emissions reduction targets.
- The development of a successful offshore CCS industry will both retain and create significant long-term, diverse, and high-paying jobs.
- Development of offshore CCS will lead to international competitiveness in a rapidly evolving global energy transition.
- Offshore CCS can be an important part of addressing environmental justice issues related to the energy transition.
- The opportunity exists to re-purpose existing infrastructure nearing the end of its production cycle for CCS and avoid decommissioning costs.

Considering the ***risks*** that CCS presents, the following points are critical to understand:

- CCS science is mature and subsurface injection of CO_2 for emissions abatement is demonstrably safe and effective.
- Primary risks include migration of buoyant fluids toward the surface and marine environment via legacy wellbores or geologic pathways.
- The management of induced pressure in the subsurface associated with CO_2 injection is important for understanding project location and adjacent proximity, while minimizing potential for induced seismicity.
- The technologies needed for effective monitoring of subsurface CO_2 injection projects are mature.
- The costs of CCS are currently quite high. Current IRS tax credits (similar in structure to those for solar and wind development) valued at $39/ton are capable of initiating some projects, but tax credit values closer to $85/ton would generate a significant additional increase in project deployment.
- Public perception of CCS is uneven, although many become more supportive once they are provided additional information on the benefits and risks.

In conclusion, I believe the Gulf of Mexico represents the **single best opportunity for developing a U.S. CCS industry that can effectively address national emission reduction strategies at the required scale**. The opportunities are economically impactful, can significantly mitigate emissions for reaching our national targets, and the risks are manageable and monitoring is mature. We are ready to proceed.

I encourage the subcommittee to recognize the ability to simultaneously address future abundant affordable and reliable energy needs while reducing industrial emissions and addressing climate change by establishing permitting and regulations needed for safe and timely development of an offshore CCS industry in the OCS.

Thank you for the opportunity to provide these perspectives, and I am happy to field any questions you may have as time allows.

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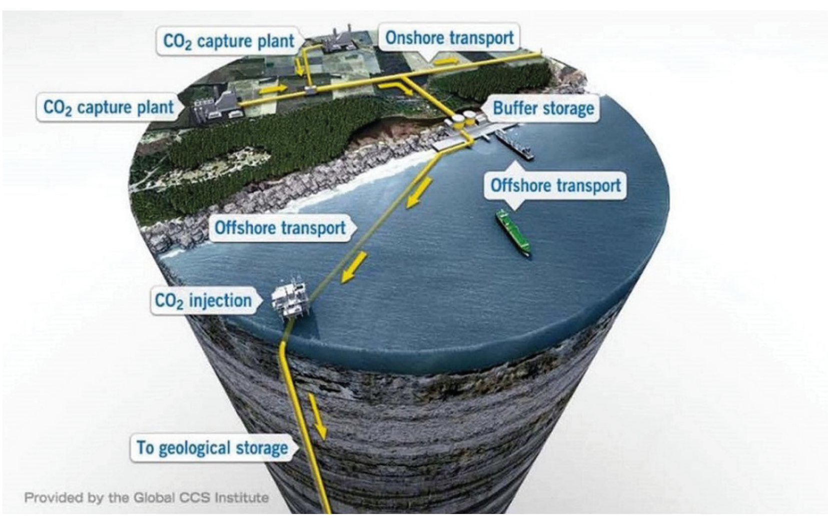
SUPPLEMENTARY MATERIAL

CONCEPTUALIZATION—Offshore storage components related to CCS project development are shown below. Not all projects will have all these components, but this image provides a sense of what types of infrastructure can be involved. Image courtesy of the Global CCS Institute.



JOBS

The Gulf of Mexico offshore oil and natural gas industry is estimated to support around 370,000 jobs per year. In 2019, the Gulf of Mexico oil and natural gas industry contributed an estimated $28.7 billion of to the U.S. economy. Developing a CCS industry in the Gulf of Mexico will maintain and expand similar employment levels and provide similar impact to the national economy. Throughout the Gulf, the offshore energy industry employs thousands of surveyors, engineers, geologists, technicians, and scientists and indirectly supports thousands of contractors and support service employees. The CCS industry is expected to rival the size of the current hydrocarbon production industry.

INTERNATIONAL COMPETITIVENESS

Many countries have already undertaken offshore CO_2 capture and geologic storage projects, most notably Norway, UK, Brazil, and Japan. Other countries are actively developing capabilities, including Indonesia, Malaysia, Australia, Netherlands, and South Africa. Energy development in these countries is currently strongly linked to emissions abatement in service of national stated targets for 2030 and 2050.

In the Gulf Coast, we have already seen some LNG export shipments rejected from European ports due to their high environmental impact. Many of these export companies are now positioning to provide LNG exports (as well as hydrogen and ammonia) that have reduced carbon intensity, which they see as a competitive advantage. The technologies associated with development in these export industries are internationally significant, including development of offshore CO_2 storage.

Many industrial ports are currently recognizing the importance of incorporating CCS into their future port competitiveness. For example, the Port of Corpus Christi in Texas (the largest energy port in the US) is actively developing CCS, and has established Memoranda of Understanding with international ports such as Rotterdam, to rapidly provide CCS to the port's industrial tenants.

INTERNATIONAL COMPETITIVENESS

We are already witnessing a transition to lower carbon intensity in the LNG export industry, but the associated patents and technology development have global significance. US companies can lead in this new technology landscape.

The Gulf of Mexico can become the lowest-cost and largest-scale storage province in the world, establishing a dominant role for CCS similar to its hydrocarbon production history.

ENVIRONMENTAL JUSTICE

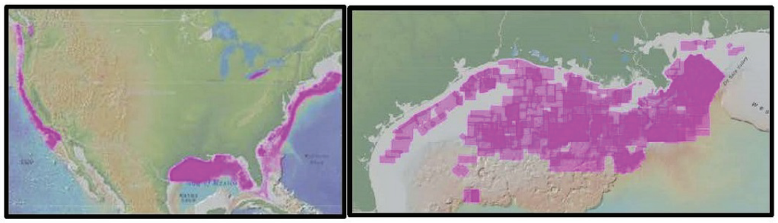
Environmental justice issues have become an important focal point for all aspects of the energy transition. Many of the communities directly affected by current unabated CO_2 emissions will benefit from CCS activities that improve local air quality while reducing greenhouse gas emissions to the atmosphere. The development of CCS will have additional benefit of improving emissions attainment targets for many of the local communities most affected by industrial emissions. In addition, by developing offshore storage, project development will not directly impact local communities, while providing additional jobs to those areas.

REPURPOSING EXISTING INFRASTRUCTURE

The Gulf of Mexico is one of the largest infrastructure decommissioning markets in the world. The possibility to re-purpose existing infrastructure (pipelines, rights-of-way, and platforms) would avoid costly decommissioning, while allowing for accelerated CCS deployment. This topic is rapidly developing, but provides a potential opportunity to leverage existing infrastructure in rapidly developing CCS in offshore settings.

DATA AVAILABILITY

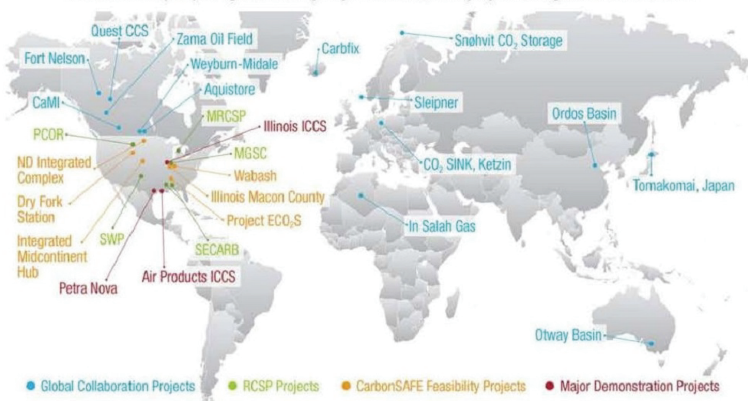
There is a significant amount of current data availability on the OCS that can be leveraged for developing CCS projects. The pink areas in the maps below show data available in the continental US (left) and in the Gulf of Mexico (right). These data cover hundreds of thousands of square miles.



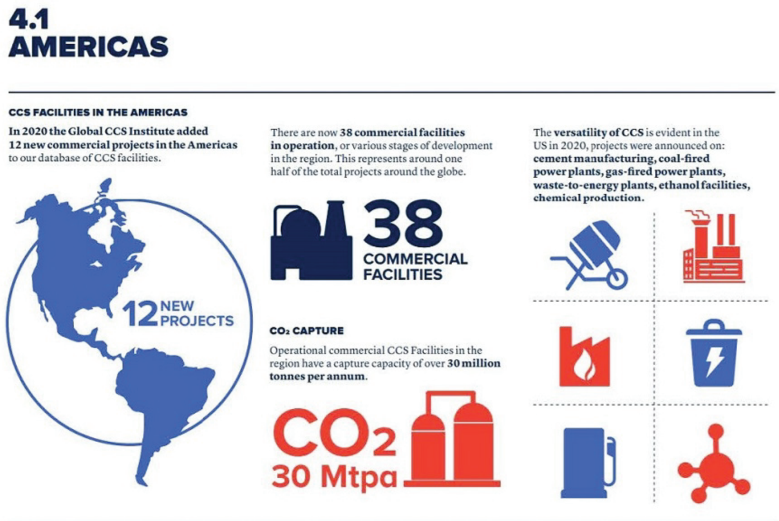
EXPERIENCE

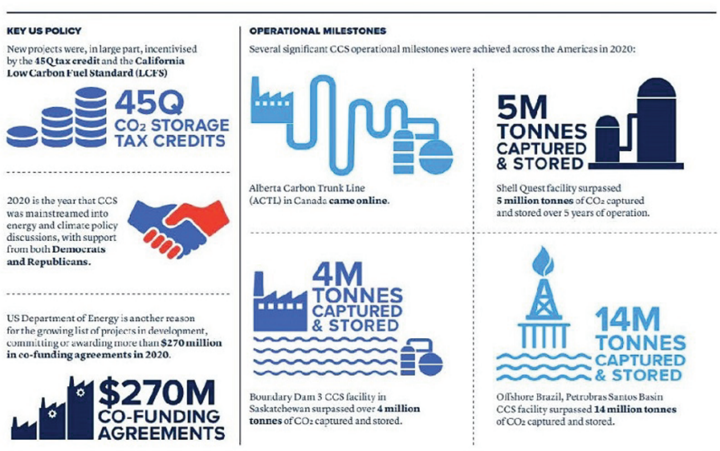
Over the last 20 years, the US Department of Energy has spent billions of dollars developing CCS technology, which is now at a high technology readiness level and ready for widespread deployment.

Exhibit 2-2. Map depicting locations of major U.S. DOE/NETL projects and global collaborations



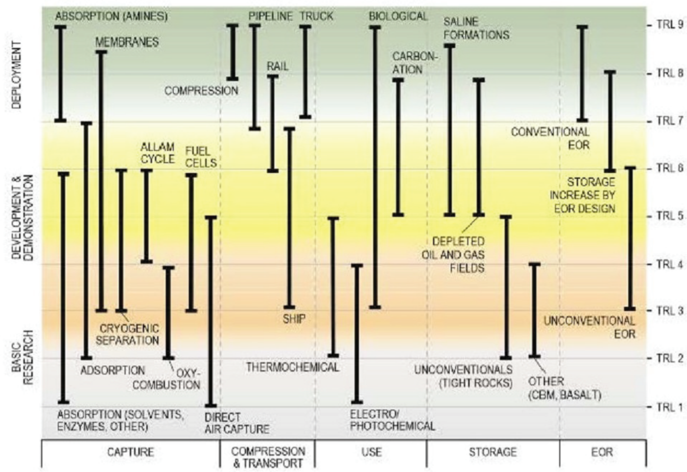
The summary images below illustrate the current state of CCS in the Americas as determined by the Global CCS Institute.





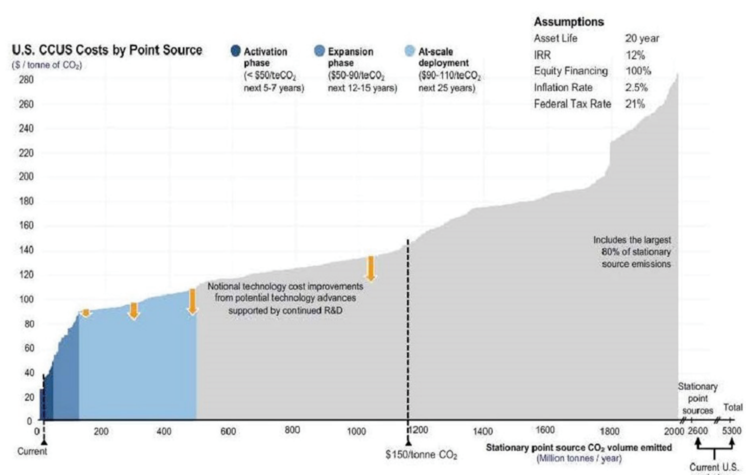
All of the components of CCS currently have some technologies at high Technology Readiness Level (TRL) in the deployment phase. Each component also has many technologies at lower TRL level that will continue to be developed for fit-to-purpose projects. The image below is from the National Petroleum

Council Report: Meeting the Dual Challenge—A Roadmap to At-Scale Deployment of Carbon Capture, Use, and Storage. The report was provided to the Secretary of Energy in 2019.



COSTS

The costs of CCS are high, mostly related to emissions capture engineering, but also including transport and subsurface storage. The costs of capture technology are falling, as is typical for all technologies as they move from demonstration to commercial deployment. The National Petroleum Council study provides the graphic below for considering the amount of CO_2 abatement possible (horizontal axis—millions of tons of CO_2), and the approximate costs for mitigating incremental amounts of CO_2 emission. The current IRS Section 45Q tax credit is around $39/ton and consideration is underway to raise that to $85/ton. At $85/ton credit value, NPC estimates that approximately 150 million tons of CO_2 could be abated. Currently, companies are paying as much as $600/ton for carbon offsets, suggesting the value of carbon may eventually rise to allow for mitigation of billions of tons of CO_2, which would be a significant portion of the national targets by 2050.



INDUCED PRESSURE

Decades of wastewater injection in the onshore counties of the Gulf of Mexico geologic basin indicate that risks of induced seismicity in Gulf of Mexico geology are low and unlikely to replicate our onshore experience in older and more brittle onshore geologic basins.

Examples of giga-ton scale storage are illustrated by this wastewater injection experience, illustrating the value of Gulf of Mexico geology (and OCS in general) as a CO_2 storage resource.

MIGRATION OF BUOYANT FLUIDS

The offshore region has lower density of legacy wells than onshore, and those wells are generally younger with better documented engineering.

Prior experience onshore managing CO_2 retention has been accomplished in projects involving hundreds of CO_2 injection wells. Offshore projects will benefit from this experience.

MONITORING

Using Department of Energy funding, I have personally led the deployment of 3D seismic subsurface imaging technology for CCS monitoring both in the Gulf of Mexico and in Japan. New technologies will evolve, but we know how to monitor injection sites for safe operation today.

European experience with CO_2 monitoring of both offshore subsurface and marine ecosystems provides a strong background for work in the US offshore.

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Dr. LOWENTHAL. Thank you, Dr. Meckel.

The Chair now recognizes Mr. Muffett for 5 minutes.

STATEMENT OF CARROLL MUFFETT, PRESIDENT AND CEO, CENTER FOR INTERNATIONAL ENVIRONMENTAL LAW, WASHINGTON, DC

Mr. MUFFETT. Chairman Lowenthal, Ranking Member Stauber, members of the Subcommittee, thank you for the opportunity to address you today.

Since 1989, the Center for International Environmental Law has used the power of law to protect the environment, promote human rights, and ensure a just and sustainable society. Carbon capture and storage advances none of those objectives.

Opposition to CCS is growing rapidly. The White House Environmental Justice Advisory Council says CCS will not benefit communities. Climate Action Network International, the world's largest network of climate organizations, says CCS is not a viable solution to the climate crisis.

Last summer, hundreds of organizations urged congressional leaders to reject CCS as a false and dangerous solution to climate change. In its latest report, the Intergovernmental Panel on Climate Change recognized the heavy reliance on CCS in many climate plans, but warned of its serious risks and limitations and identified CCS as among the highest cost, lowest potential of all climate mitigation options.

And communities across the Gulf Coast, the Midwest, the Ohio Valley, and beyond are mobilizing and litigating to stop CCS projects. Why? Because CCS is not a climate solution.

Despite decades of industry experience, existing CCS projects capture less than 1⁄10 of 1 percent of CO_2 emissions and have been marked by repeated and conspicuous failures.

CCS is energy intensive, making facilities that use it more costly and less efficient.

When renewable energy is already the cheapest source of new energy for most people, CCS just makes the bad economics of fossil fuels even worse.

The industry's only economical carbon storage solution is using captured carbon to produce even more oil. More than 95 percent of U.S. CCS capacity and development is designed to increase oil production, not reduce emissions.

Nor can the need to decarbonize industries justify massive new CCS infrastructure. An analysis of the CCS potential at more than 1,500 industrial facilities in the United States found CCS technically and economically feasible at only 123 of them, just 8 percent of the total. Even if CCS worked, building a massive new infrastructure for CCS would raise profound environmental, health, and safety risks for communities across the United States, with disproportionate impact on communities of color.

The roughly 5,000 miles of existing CO_2 pipelines are heavily concentrated in remote oil fields. CCS proponents call for 65,000 miles or more of new pipelines, including in heavily populated areas, putting communities at significant risk.

Compressed CO_2 is highly corrosive, increasing the risks of leaks and pipeline ruptures. Co2 is also an intoxicant, an asphyxiate. At high concentrations, it can result in unconsciousness, coma, and death. A CO_2 pipeline rupture near Satartia, Mississippi sent dozens to the hospital, with first responders reporting people frothing at the mouth and wandering around like zombies.

The Gulf Coast of Texas and Louisiana are among the few places that combine large-scale CO_2 storage potential with a dense concentration of high-emitting facilities. As a result, risky CCS infrastructure is being heavily targeted on communities that have already suffered decades of environmental injustice. CCS will only increase the burdens on those communities.

When CO_2 is injected into saline aquifers, failure to manage reservoir pressures can cause earthquakes, contamination of drinking water, and the potential failure of storage sites, resulting in CO_2 leaks into the environment and atmosphere. Managing these pressures may require pumping enormous amounts of saline brines from CO_2 storage reservoirs, creating a massive and potentially hazardous new waste stream.

These risks are compounded when CO_2 is injected below the ocean. Experience with natural gas demonstrates that offshore pipelines are at higher risk of failure than those onshore. Eighty years of drilling has left the Gulf of Mexico pockmarked with 27,000 abandoned oil and gas wells. The Bureau of Ocean Energy Management acknowledges that it does not know how many of those wells are already leaking, and leakage from old wells is one of the most likely failure points for offshore CO_2 storage.

Keeping global warming below 1.5 degrees requires cutting global CO_2 emissions in half by 2030. Publicly subsidized CCS will undermine emission reduction efforts, squander resources, lock in fossil fuel infrastructure, and expose communities in the Gulf Coast and beyond to potentially catastrophic health, safety, and environmental risks, compounding the environmental injustice borne by people of color and low-income communities.

CCS 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.

Thank you.

[The prepared statement of Mr. Muffett follows:]

Prepared Statement of Carroll Muffett, President and CEO, Center for International Environmental Law

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

[1] Global CCUS Institute, Global Status of CCUS (2021), at 12 (describing the current installed capacity of CCUS as 40 Mtpa), https://www.globalccsinstitute.com/wp-content/uploads/2021/10/2021-Global-Status-of-CCUS-Report_Global_CCUS_Institute.pdf. Global CO2 emissions from energy combustion and industrial processes were approximately 36.3 billion tons CO2 in 2021. International Energy Agency (IEA), Press Release, Global CO2 emissions rebounded to their highest level in history in 2021 (Mar. 8, 2022), https://www.iea.org/reports/global-energy-review-co2-emissions-in-2021-2.

[2] White House Environmental Justice Advisory Council, Justice40 Climate and Economic Justice Screening Tool & Executive Order 12898 Revisions: Interim Final Recommendations at 57, 59 (May 13, 2021), https://www.epa.gov/sites/default/files/2021-05/documents/whiteh2.pdf.

[3] CAN Position: Carbon Capture, Storage, and Utilization, Climate Action Network Int'l at 9 (2021), https://climatenetwork.org/resource/can-position-carbon-capture-storage-and-utilisation/.

[4] Letter from Center for International Environmental Law et al. to Joseph Biden, Nancy Pelosi & Chuck Schumer re: Carbon capture is not a climate solution (July 19, 2021), https://www.ciel.org/wpcontent/uploads/2021/07/CCUS-Letter_FINAL_US-1.pdf.

[5] See *Production of Pure Carbon Dioxide*, www.smokeandfumes.org, https://www.smokeandfumes.org/documents/61 (last visited Apr. 26, 2022); Production of Pure Carbon Dioxide, U.S. Patent No. 2,665,971 (issued Jan. 12, 1954). See also *Method for Recovering a Purified Component From a Gas*, www.smokeandfumes.org, https://www.smokeandfumes.org/documents/48 (last visited Apr. 26, 2022); *Petroleum Recovery With Inert Gas*, www.smokeandfumes.org, https://www.smokeandfumes.org/documents/62 (last visited Apr. 26, 2022); Process For The Removal of Acidic Gases From a Gas Mixture, www.smokeandfumes.org, https://www.smokeandfumes.org/documents/49 (last visited Apr. 26, 2022).

[6] Imperial Oil, *Review of Environmental Protection Activities for 1978–1979*, at 2 (available at https://www.climatefiles.com/exxonmobil/1980-imperial-oil-review-of-environmental-protection-activities-for-1978-1979/) (internal document of Esso (now ExxonMobil) subsidiary Imperial Oil acknowledging that there is "no doubt" that fossil fuel usage was "aggravating the potential problem of increased CO2 in the atmosphere"; and stating that "Technology exists to remove CO_2 from stack gases, but removal of only 50% of the CO2 would double the cost of power generation."); see also, Anthony Albanese & Meyer Steinberg, *Environmental Control Technology for Atmospheric Carbon Dioxide*, Energy Vol, 5 (7) (July 1980) 641–664 (available at https://www.sciencedirect.com/science/article/abs/pii/0360544280900444).

[7] See *Petroleum Recovery With Inert Gas*, www.smokeandfumes.org, https://www.smokeandfumes.org/documents/62 (last visited Apr. 26, 2022); Petroleum Companies with Inert Gas, U.S. Patent No. 3,193,006 (issued July 6, 1965).

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 life cycle greenhouse gas emissions and criteria pollutants due to the increased energy needed to operate the energy-intensive capture equipment. Energy

[8] See Global CCUS Institute, Global Status of CCUS 2021 62–63 (2021), https://www.globalccsinstitute.com/wp-content/uploads/2021/10/2021-Global-Status-of-CCUS-Report_Global_CCUS_Institute.pdf.

[9] Center for International Environmental Law, Confronting the Myth of Carbon Free Fossil Fuels: Why Carbon Capture is Not a Climate Solution 8 (2021), https://www.ciel.org/wp-content/uploads/2021/07/Confronting-the-Myth-of-Carbon-Free-Fossil-Fuels.pdf. Globally, 73% of the CO_2 captured globally each year is used for EOR projects. Global CCUS Institute, Global Status of CCUS 63 (2021).

[10] *See* Nichola Groom, *Problems plagued U.S. CO_2 capture project before shutdown: document*, Reuters (Aug. 6, 2020), https://www.reuters.com/article/us-usa-energy-carbon-capture/problems-plagued-u-s-co2-capture-project-before-shutdown-document-idUSKCN2523K8.

[11] *See* Carlos Anchondo, *CCUS 'red flag?' World's sole coal project hits snag*, E&E News (Jan. 10, 2022), https://www.eenews.net/articles/ccs-red-flag-worlds-sole-coal-project-hits-snag/.

[12] See Jonathan hettinger, Despite hundreds of millions in tax dollars, ADM's carbon capture program still hasn't met promised goals, Midwest Center for Investigative Reporting (Nov. 19, 2020), https://investigatemidwest.org/2020/11/19/despite-hundreds-of-millions-in-tax-dollars-adms-carbon-capture-program-still-hasnt-met-promised-goals/.

[13] See Graham Readfearn, Australia's only working carbon capture and storage project fails to meet target, The Guardian (Nov. 11, 2021), https://www.theguardian.com/australia-news/2021/nov/12/australias-only-working-carbon-capture-and-storage-project-fails-to-meet-target.

[14] The latest report from the Intergovernmental Panel on Climate Change (IPCC) indicates that models depicting deployment of CCUS assume a capture rate of 90–95%. IPCC, 2022: Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [P.R. Shukla, J. Skea, R. Slade, A. Al Khourdajie, R. van Diemen, D. McCollum, M. Pathak, S. Some, P. Vyas, R. Fradera, M. Belkacemi, A. Hasija, G. Lisboa, S. Luz, J. Malley, (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA. doi: 10.1017/9781009157926, available at https://report.ipcc.ch/ar6wg3/pdf/IPCC_AR6_WGIII_FinalDraft_FullReport.pdf [hereinafter, WGIII report], at n. 37, SPM-20 ("In this context, capture rates of new installations with CCUS are assumed to be 90–95% +") & n. 55, SPM-36 ("In this context, 'unabated fossil fuels' refers to fossil fuels produced and used without interventions that substantially reduce the amount of GHG emitted throughout the life-cycle; for example, capturing 90% or more from power plants, or 50–80% of fugitive methane emissions from energy supply.").

[15] See Benjamin Storrow, Big payout, more CO_2: Greens split over Dems' CCUS plan, E&E News (Dec. 16, 2021), https://www.eenews.net/articles/big-payout-more-co2-greens-split-over-dems-ccs-plan/.

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 life cycle 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 life cycle 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 CO_2 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

[16] See IPCC, WGIII, Ch. 6, at 6-38 (noting that the energy penalty from CCUS “increases the fuel requirement for electricity generation by 13-44%”); Budinis, S., Krevor, S., MacDowell, N., Brandon, N., Hawkes, A. (2018). An assessment of CCUS costs, barriers and potential. Energy Strategy Reviews, Vol. 22, November 2018, pp. 61–81, at 67–68 (discussing energy and efficiency penalty estimates for coal and gas), https://doi.org/10.1016/j.esr.2018.08.003.

[17] See also Clark Butler, IEEFA, Carbon Capture and Storage Is About Reputation, Not Economics at 4 (2020), https://ieefa.org/wp-content/uploads/2020/07/CCUS-Is-About-Reputation-Not-Economics_July-2020.pdf.

[18] Taylor Kubota, Stanford Study casts Doubt on Carbon Capture, Stanford News (Oct. 25, 2019), https://news.stanford.edu/2019/10/25/study-casts-doubt-carbon-capture/, citing Mark Z. Jacobson, The health and climate impacts of carbon capture and direct air capture, 12 Energy Envt. Sci. 3567 (2019), https://pubs.rsc.org/en/content/articlelanding/2019/ee/c9ee02709b/unauth#!divAbstract.

[19] Eye on the Market, Annual Energy Paper May 2021, p. 22 (2021), https://am.jpmorgan.com/content/dam/jpm-am-aem/global/en/insights/eye-on-the-market/future-shock-amv.pdf.

[20] See U.S. Government Accountability Office, Carbon Capture and Storage: Actions Needed to Improve DOE Management of Demonstration Projects (2021), https://www.gao.gov/assets/gao-22-105111.pdf.

[21] WGIII report, at Figure SPM.7, SPM-50.

[22] *Id*.

[23] WGIII report, Ch. 6, at 6-38.

[24] WGIII report, Ch. 6, at 6-39.

[25] Neil Grant et al., Cost reductions in renewable can substantially erode the value of carbon capture and storage in mitigation pathways, 4 One Earth 1588 (2021), https://doi.org/10.1016/j.oneear.2021.10.024.

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

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[26] Clark Butler, IEEFA, Carbon Capture and Storage Is About Reputation, Not Economics at 4 (2020), https://ieefa.org/wp-content/uploads/2020/07/CCUS-Is-About-Reputation-Not-Economics_July-2020.pdf; Mai Bui et al., *Carbon capture and storage (CCUS): The way forward*, 11 Energy & Envtl Science 1062 at 1062, 1132, 1138, 1193 (2018), https://pubs.rsc.org/en/content/articlelanding/2018/EE/C7EE02342.

[27] Food & Water Watch, *The Case Against Carbon Capture: False Claims and New Pollution* (2020), https://foodandwaterwatch.org/wp-content/uploads/2021/04/ib_2003_carboncapture-web.pdf; *Hydrogen's Hidden Emissions*, Global Witness (Jan. 20, 2022), https://www.globalwitness.org/en/campaigns/fossilgas/shell-hydrogen-true-emissions/ (Shell's CCUS fitted fossil fuel derived hydrogen plant produced more GHG emissions than it captured).

[28] See H. Pilorgé et al., Cost Analysis of Carbon Capture and Sequestration of Process Emissions from the U.S. Industrial Sector, 54(12) Envtl. Sci. Tech. 7524–7532 (2020), https://pubs.acs.org/doi/abs/10.1021/acs.est.9b07930.

[29] Id. at Supporting Information, S8.

[30] Id.

[31] Kevin Rives, Only still-operating carbon capture project battled technical issues in 2021, S&P Global (Jan. 6, 2022), https://www.spglobal.com/marketintelligence/en/news-insights/latest-newsheadlines/only-still-operating-carbon-capture-project-battled-technical-issues-in-2021-68302671.

[32] *Id*.

[33] Dan Gearino, Sale of North Dakota's Largest Coal Plant Is Almost Complete. Then Will Come the Hard Part, Inside Climate News (Jan. 15, 2022), https://insideclimatenews.org/news/15012022/sale-ofnorth-dakotas-largest-coal-plant-is-almost-complete-then-will-come-the-hard-part/.

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]

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[34] Carbon capture and storage could also impact air pollution, European Environment Agency (last modified Nov. 23, 2020), https://www.eea.europa.eu/highlights/carbon-capture-and-storage-could.

[35] Council on Environmental Quality, Report to Congress on Carbon Capture, Utilization, and Sequestration at 40 (2021), https://www.whitehouse.gov/wp-content/uploads/2021/06/CEQ-CCUSPermitting-Report.pdf.

[36] U.S. EPA, Archive Document: "PSD Greenhouse Gas Permit Application" at 11 (Mar. 19, 2012), https://archive.epa.gov/region6/6pd/air/pd-r/ghg/web/pdf/chevron_response031912.pdf.

[37] U.S. EPA, Archive Document: "PSD Greenhouse Gas Permit Application Revision" at 37 (Sept. 12, 2013), https://archive.epa.gov/region6/6pd/air/pd-r/ghg/web/pdf/dowchemical-lh9-app-09202013.pdf.

[38] U.S. EPA, Archive Document: "Exxon Mobile Baytown Olefins Plant Response" at 22 (Oct. 16, 2012), https://archive.epa.gov/region6/6pd/air/pd-r/ghg/web/pdf/exxonmobil-olefins-response.pdf.

[39] See, e.g., Gulf Coast Sequestration Makes Initial Filing to Obtain EPA Permit for CCUS Project, Gulf Coast Sequestration (Oct. 13, 2020), https://gcscarbon.com/media/gulf-coast-sequestration-makes-initial-filing-to-obtain-epa-permit-for-ccsproject/; see also Andrea Robinson, Wednesday's explosion marks second in four months for Westlake Chemical, KPLC (Jan. 27, 2022), https://www.kplctv.com/2022/01/28/wednesdays-explosion-westlakechemical-marks-second-four-months/; Heather Rogers, Erasing Mossville: How Pollution Killed a Louisiana Town, Intercept (Nov. 4, 2015), https://theintercept.com/2015/11/04/erasing-mossville-howpollution-killed-a-louisiana-town/.

[40] See Sabrina Valle, Exxon plans hydrogen and carbon-capture/storage plant near Houston, Reuters (Mar. 1, 2022), https://www.reuters.com/business/sustainable-business/exxon-plans-hydrogen-carbon-capturestorage-plant-near-houston-2022-03-02/; Heather Richard & Carlos Anchondo, CCUS in the Gulf: Climate solution or green washing?, E&E News (Jan. 31, 2022), https://www.eenews.net/articles/ccs-in-the-gulf-climate-solution-or-green-washing/; Press Release, ExxonMobil, Industry support for large-scale carbon capture and storage continues to gain momentum in Houston (Jan. 202, 2022), https://corporate.exxonmobil.com/News/Newsroom/News-releases/2022/0120_Industry-support-for-large-scale-carbon-capture-and-storage-gains-momentum-in-Houston.

[41] Yukyan Lam et al., Natural Resources Defense Council (NRDC) & Texas Environmental Justice Advocacy Services (TEJAS), *Toxic Air Pollution in the Houston Ship Channel: Disparities Show Urgent Need for Environmental Justice* (2021), https://www.nrdc.org/sites/default/files/air-pollution-houston-ship-channel-ib.pdf.

[42] Sabrina Valle, Exxon plans hydrogen and carbon-capture/storage plant near Houston, Reuters (Mar. 1, 2022), https://www.reuters.com/business/sustainable-business/exxon-plans-hydrogen-carbon-capturestorage-plant-near-houston-2022-03-02/.

[43] Heather Richard & Carlos Anchondo, CCUS in the Gulf: Climate solution or green washing?, E&E News (Jan. 31, 2022), https://www.eenews.net/articles/ccs-in-the-gulf-climate-solution-or-green-washing/ (quoting an ExxonMobil spokesperson who stated "ExxonMobil believes the greatest opportunity for CO_2 storage in the United States is in the Gulf of Mexico").

[44] See, e.g., State of the Air: Most Polluted Cities, American Lung Association, https://www.lung.org/research/sota/city-rankings/most-polluted-cities (last visited Apr. 12, 2022) (listing the nation's most polluted cities, where three of the top five are in California's Central Valley); see also Taylor Kubota, Stanford Study casts Doubt on Carbon Capture, Stanford News (Oct. 25, 2019), https://news.stanford.edu/2019/10/25/study-casts-doubt-carbon-capture/, citing Mark Z. Jacobson, The health and climate impacts of carbon capture and direct air capture, 12 Energy Envt. Sci. 3567 (2019), https://pubs.rsc.org/en/content/articlelanding/2019/ee/c9ee02709b/unauth#!divAbstract.

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 5,000 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

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[45] See U.S. EPA, Appendix B: Overview of acute health effects associated with carbon dioxide (2015), https://www.epa.gov/sites/default/files/2015-06/documents/co2appendixb.pdf. The Department of Transportation (DOT) lists and classifies the gaseous, liquid and solid forms of Carbon Dioxide as hazardous materials for purposes of transportation. See 49 CFR 172.

[46] See National Petroleum Council, Meeting the Dual Challenge 6-8, 6-11 (2021), https://dualchallenge.npc.org/files/CCUS-Chap_6-030521.pdf.

[47] IPCC, *Chapter 4: Transport of CO2, in* Special Report on Carbon Dioxide Capture and Storage (2005), at 188 (noting that CCUS "will require a large network of pipelines.").

[48] *Pipeline Ruptures in Yazoo County, Dozens Rushed to the Hospital*, Miss. Emergency Mgmt. Agency (Feb. 23, 2020), https://www.msema.org/news/pipe-ruptures-in-yazoo-county-dozens-hospitalized/.

[49] Sarah Fowler, *'Foaming at the mouth': First responders describe scene after pipeline rupture, gas leak*, Clarion Ledger, Feb. 27, 2020, https://www.clarionledger.com/story/news/local/2020/02/27/yazoo-county-pipe-rupture-co-2-gas-leak-first-responders-rescues/4871726002/; Dan Zegart, *The Gassing of Satartia*, Huffington Post (Aug. 26, 2021), https://www.huffpost.com/entry/gassing-satartia-mississippi-co2-pipeline_n_60ddea9fe4b0ddef8b0ddc8f.

[50] Congressional Research Service, Carbon Capture and Sequestration (CCUS) in the United States 8 (2021), https://sgp.fas.org/crs/misc/R44902.pdf.

[51] Eric Larson et al., Net-Zero America: Potential Pathways, Infrastructure, and Impacts 10 (2020), https://netzeroamerica.princeton.edu/img/Princeton_NZA_Interim_Report_15_Dec_2020_FINAL.pdf. See also Eye on the Market, Annual Energy Paper May 2021, p. 22 (2021), https://am.jpmorgan.com/content/dam/jpm-am-aem/global/en/insights/eye-on-the-market/future-shock-amv.pdf.

[52] Press Release, Congresswoman Speier Calls for Improved Pipeline Safety: "PHMSA is a Toothless Tiger" (Apr. 14, 2015), https://speier.house.gov/2015/4/Congresswoman-speier-calls-improved-pipeline-safety-phmsa-toothless.

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 CO_2. 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 CO_2 released affects larger areas than the typical gas pipeline explosion, and the location of existing pipelines if retrofitted for use in CO_2 transportation could present significant new risks for those in the surrounding areas.

Storage risks

Storing CO_2 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 signifi-

[53] Pipeline Safety Trust, CO2 Pipelines—Dangerous and Under-Regulated (2022), https://pstrust.org/wp-content/uploads/2022/03/CO2-Pipeline-Backgrounder-Final.pdf, citing Accufacts Inc., Accufacts' Perspectives on the State of Federal Carbon Dioxide Transmission Pipeline Safety Regulations as it relates to Carbon Capture, Utilization, and Sequestration within the U.S. (2022), https://pstrust.org/wp-content/uploads/2022/03/3-23-22-Final-Accufacts-CO2-Pipeline-Report2.pdf.

[54] *See* National Petroleum Council, Meeting the Dual Challenge 6-10-11 (2021), https://dualchallenge.npc.org/files/CCUS-Chap_6-030521.pdf.

[55] Steven T. Anderson and Hossein Jahediesfanjani, Estimating the net costs of brine production and disposal to expand pressure-limited dynamic capacity for basin-scale CO_2 storage in a saline formation, International Journal of Greenhouse Gas Control 102 (2020) 103161, at 1 of PDF.

[56] See, e.g., Thomas A. Buscheck et al, Pre-Injection Brine Production for Managing Pressure in Compartmentalized CO2 Storage Reservoirs, 63 Energy Procedia 5333, 5333 (2014), https://reader.elsevier.com/reader/sd/pii/S1876610214023807?token=1A5DFFA48E91CC072D4AEC9297 02C2253323F976B14AC07378B7C298D2FC87BC5F2FB2C7F1F0AD2B36DA3C61984A6D83& originRegion=us-east-1&origin Creation=20220424204627; see also Ernesto Santibanez-Borda et al., Maximising the Dynamic CO2 storage Capacity through the Optimisation of CO_2 Injection and Brine Production Rates, Int'l J. of Greenhouse Gas Control 80 (2019), 76-95, at 76, https://reader.elsevier.com/reader/sd/pii/S175058361830118X?token=A19D9EBFC6574B7FC4E74021E 6271F4FC3E3D96DD57CEB52BCCC93CBE8D536AFB3D1825B7FAB206D4D1AD379050CD4D6 &originRegion=us-east-1&originCreation=20220425200024.

[57] Anderson and Jahediesfanjani, at 1 of PDF ("Pressure management via production of in situ brine from saline formations could be necessary to safely increase CO_2 storage capacities to targeted levels.").

[58] See generally Anderson and Hossein, supra (discussing the costliness and challenges of managing brine (produced waters) to manage pressure in CO_2 storage sites).

[59] Santibanez-Borda et al, at 77.

cant 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 CO_2 could alter ocean chemistry, exacerbating ocean acidification: "Injection up to a few $GtCO_2$ 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

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[60] Government Accountability Office (GAO), Offshore Oil and Gas: Updated Regulations Needed to Improve Pipeline Oversight and Decommissioning (Mar. 2021), https://www.gao.gov/assets/gao-21-293.pdf.

[61] See Ian J. Duncan, Developing a Comprehensive Risk Assessment Framework for Geological Storage of CO2, Report to the US Dept. of Energy, National Energy Technology Laboratory (December 2014), at 240-41 and *passim* Section 10, https://www.osti.gov/servlets/purl/1170168.

[62] Bureau of Ocean Energy Management (BOEM), Best Management Practices for Offshore Transportation and Sub-Seabed Geologic Storage of Carbon Dioxide (2018), https://espis.boem.gov/final%20reports/5663.pdf, at 34.

[63] IPCC Special Report on Carbon Dioxide Capture and Storage (2005), Chapter 6: Ocean Storage, at 279, https://www.ipcc.ch/site/assets/uploads/2018/03/srccs_chapter6-1.pdf.

[64] IPCC Special Report, 279.

[65] IPCC Special Report on Carbon dioxide Capture and Storage, at 243, available at: https://www.ipcc.ch/site/assets/uploads/2018/03/srccs_chapter5-1.pdf.

[66] European Commission, Sub-seabed CO2 Storage: Impact on Marine Ecosystems (ECO2), Final Report Summary, at 16, https://cordis.europa.eu/docs/results/265/265847/final1-eco2-265847-final-publishable-summary-report.pdf.

[67] Bureau of Ocean Energy Management (BOEM), Best Management Practices for Offshore Transportation and Sub-Seabed Geologic Storage of Carbon Dioxide (2018), https://espis.boem.gov/final%20reports/5663.pdf, at 37.

[68] *Id*. (citing IPCC 2006).

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.

Dr. LOWENTHAL. Thank you, Mr. Muffett.

The Chair now recognizes Ms. Saunders for 5 minutes.

STATEMENT OF NICHOLE SAUNDERS, DIRECTOR AND SENIOR ATTORNEY, ENERGY TRANSITION, ENVIRONMENTAL DEFENSE FUND, AUSTIN, TEXAS

Ms. SAUNDERS. Chairman Lowenthal, Ranking Member Stauber, and members of the Subcommittee, thank you for the opportunity today to discuss carbon storage in the Gulf of Mexico with you. My name is Nichole Saunders, and I am a Director and Senior Attorney with Environmental Defense Fund in Austin, Texas.

I am echoing the Chairman now on this point, but carbon capture and storage is not a silver bullet climate solution. These projects are complex, highly technical, costly, and challenging. But most experts and models do agree we will need this tool in our toolbox if we are to meet emission reduction targets. And as much as 75 percent of captured carbon will likely need to be injected for long-term storage in deep underground reservoirs like those in the Gulf of Mexico. But this process cannot be done successfully by just anyone, or take place just anywhere.

There are three crucial minimum conditions that must be met to ensure this practice works for both the environment and society: First, these technologies cannot be a substitute for parallel work to lessen our dependence on fossil fuels; Second, and importantly, environmental justice and equity considerations must be central to decision making on projects, not only through thoughtful consultation and collaboration, but also through affirmative actions and solutions directly aimed at mitigating disproportionate burdens; and Third, policies, incentives, and regulatory programs must be designed to ensure the environmental integrity and safety of geologic storage projects, including the associated infrastructure and transport, minimizing the potential for leaks or other harms to both the climate and marine ecosystems.

In the absence of these conditions, the perceived opportunity of carbon storage may fail to overcome the risk that these projects do not live up to their climate promises. The United States has an opportunity to showcase global leadership on this complex issue if it can meet these conditions.

My testimony today centers on that third condition: ensuring the environmental integrity of carbon storage reservoirs in the Gulf. The technical issues surrounding this challenge are of a particular and timely relevance, given the Department of the Interior's active rulemaking on this issue.

As directed by Congress through the recent Infrastructure Investment and Jobs Act, Interior is currently developing regulatory programs for the purpose of long-term carbon sequestration on the Outer Continental Shelf. The agency has until November to do this, and it will be no easy task. In its report released just this month, the Intergovernmental Panel on Climate Change concluded with high confidence that if the geologic storage site is appropriately selected and managed, it is estimated that the carbon dioxide can be permanently isolated from the atmosphere.

And while that concept of site selection and management may seem straightforward, appropriately meeting these objectives is, in fact, immensely complex. Carbon storage projects can serve their role if, and only if, they are sited, designed, managed, and regulated in a manner that unequivocally and transparently ensures and demonstrates the long-term technical and environmental integrity of sequestration.

So, what exactly does that look like? Environmental Defense Fund has a long history of collaborative engagement on well integrity issues. Building on this experience and numerous domestic and international references, we work together with industry, academic, legal, and policy experts to build a set of initial principles we believe are core to demonstrating long-term secure storage offshore. They include the need to select and characterize good storage locations, including carefully assessing potential leakage pathways, safely construct and operate wells, conduct comprehensive testing and monitoring, develop data, modeling, and reports that demonstrate the carbon is securely stored and expected to stay there 1,000 years or more, ensuring proper plugging and closure processes, require accurate and transparent accounting of sequestration claims, and other details that are found more comprehensively in my written testimony.

Some may argue for reduced regulatory protections, given the remote offshore environment. But this argument simply does not hold water, as there remains much to protect in the Gulf. These standards are vital not only for the prevention of atmospheric releases, but also for the protection of marine ecosystems, water column chemistry, and other unique environmental, ecological, and biogeochemical features, fisheries, and economies.

In conclusion, the Gulf may offer a unique geologic opportunity to store large volumes of captured CO_2. Whether it can be done successfully, in a way that respects coastal communities, protects marine resources, prevents leaks and releases, and earns public trust as a valid solution remains to be seen. Ensuring that the United States is committed to developing oversight programs that address the principles for secure storage included in my testimony would be a good start.

[The prepared statement of Ms. Saunders follows:]

PREPARED STATEMENT OF NICHOLE SAUNDERS, DIRECTOR & SENIOR ATTORNEY, ENVIRONMENTAL DEFENSE FUND

Thank you for the opportunity to appear before you today to discuss offshore carbon storage in the Gulf of Mexico. Environmental Defense Fund (EDF) is a non-profit environmental research and advocacy organization working to identify science- and market-based solutions to major environmental challenges.

Capture of industrial and atmospheric carbon dioxide (CO_2) has been identified in numerous scientific reviews as a potentially useful and even essential tool in achieving timely de-carbonization. For it to work, however, safe and reliable sequestration methods, standards, and practices must be identified, implemented, and proven to ensure captured carbon stays where it's stored for a meaningful time.

Carbon storage in the Gulf may eventually serve a useful role in reducing emissions and in meeting net-zero objectives; *however*, there are three crucial, minimum conditions that must be acknowledged and addressed to ensure this practice is done responsibly,[1] and that it works for both the environment and society:

1. These technologies are utilized as only one of many possible tools for advancing de-carbonization and for cutting our heavy dependence on fossil fuels;
2. Environmental justice and equity considerations must be central to decision-making on projects, not only through thoughtful consultation and collaboration, but also through proactive actions and solutions directly aimed at mitigating disproportionate burdens; and
3. Policies, incentives, and regulatory programs must be designed to ensure the environmental integrity and safety of geologic storage projects in the ocean environment, including associated infrastructure and transport operations—minimizing the potential for leaks or other harms to the climate, marine ecosystems, and the economy.

In the absence of these conditions, carbon storage may fail to live up to its hoped-for promise. Currently, the U.S. has an opportunity to showcase global leadership on this complex issue if it can meet these conditions.

EDF's testimony today centers on one core component of the third condition—ensuring the environmental integrity of geologic carbon storage reservoirs in the Gulf. The technical issues surrounding this challenge are of particular and timely relevance, as is this hearing, as the Department of Interior (DOI) is actively considering a rulemaking on the issue.

Geologic Sequestration of CO_2 and Environmental Integrity—The DOI Rulemaking

As directed by the recent Infrastructure Investment and Jobs Act (IIJA) amendments to the Outer Continental Shelf Lands Act (OSCLA), DOI is currently developing regulatory programs "for the purpose of long-term carbon sequestration" on the Outer Continental Shelf (OCS) through processes that "prevent the carbon dioxide from reaching the atmosphere."[2]

The agency has until November to do this. It will be no easy task.

Recent models suggest that as much as 75% of carbon dioxide captured via carbon capture systems including direct air capture, will likely be sequestered in geologic reservoirs.[3] Moreover, the Intergovernmental Panel on Climate Change (IPCC), in its 2005 Special Report on CCS, concluded that well-selected, designed, and managed geological storage sites will likely exceed 99% retention of sequestered gases over 1,000 years.[4] In its recent 2022 report, IPCC built on additional research and went a step further to simply state with "high confidence" that "[i]f the geological

[1] White House Council on Environmental Quality: Carbon Capture, Utilization, and Sequestration Guidance, 87 FR 8808 (proposed Feb. 16, 2022).

[2] H.R. 3684 § 40307(a)(4) and 43 U.S.C. § 1337(p)(1).

[3] The Environmental Defense Fund (2021). *Summary for Policymakers: Carbon Management in Net-Zero Energy Systems*. https://www.edf.org/sites/default/files/documents/CM%20Summary%20for%20Policymakers_FINAL.pdf.

[4] IPCC (2005): IPCC Special Report on Carbon Dioxide Capture and Storage. Prepared by Working Group III of the Intergovernmental Panel on Climate Change [Metz, B., O. Davidson, H.C. de Coninck, M. Loos, and L.A. Meyer (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, p. 14. https://www.ipcc.ch/site/assets/uploads/2018/03/srccs_wholereport-1.pdf.

storage site is appropriately selected and managed, it is estimated that the CO_2 can be permanently isolated from the atmosphere."[5]

While the concept of site selection and management may seem straightforward, appropriately meeting these objectives is, in fact, immensely complex. Failure on this front can cause unexpected outcomes and compromise projects.[6] Geologic carbon storage projects can only serve a meaningful role in reducing emissions if—**and only if**—they are sited, designed, managed, and regulated in a manner that unequivocally and transparently ensures and demonstrates the long-term technical and environmental integrity of sequestration.

That is DOI's challenge.

Getting this right is paramount for U.S. leadership on emissions reduction and climate mitigation. A DOI rulemaking that does anything less than establish a leading global standard for the environmental and climate integrity of geologic sequestration offshore will not only increase the risk of failures that return carbon to the atmosphere and contaminate ecosystems, but it would also undermine and further weaken public faith in the validity and strength of the U.S.'s carbon sequestration capabilities and climate mitigation commitments, including the 45Q tax credit.

Finally, establishing a new regulatory program and implementing and enforcing that program comes with significant resource and human capital considerations. Agencies must not only have adequate staff and resources to complete reviews, but also the knowledge, expertise, and training to do their jobs effectively. This need has been made clear in EPA's experience onshore. It is vital that as DOI stands up this program, it has adequate resources and training—needs that could be met not only by funding, but also by more direct collaboration with other expert state and federal agencies. EDF supports the appropriation of necessary funds for this capacity building.

Marine Environments Offshore Must be Protected Just as Drinking Water Resources are Onshore

Onshore, geologic storage of CO_2 projects are regulated by EPA's Underground Injection Control (UIC) Class VI program[7]—an extensive regulation finalized by EPA in 2011 after years of technical analysis and stakeholder engagement. EPA's authority to adopt this rule derived from its responsibility to protect underground sources of drinking water (USDW), but the rule is fundamentally about secure storage of CO_2 and the prevention of disaster. Some may argue for minimal regulatory oversight offshore and a rollback of the advanced protections of Class VI due to the absence of USDWs and communities on the OCS, but this technicality does not equate to a lack of risk or a sound reason to reduce regulatory protections offshore. While the technical implementation of certain regulations and operational principles may require adaptation for the offshore environment, none of the below recommendations regarding secure storage are unique to the need to protect drinking water; rather, they are well-studied, foundational principles for ensuring *containment* in the intended reservoir.

A containment failure either from the reservoir, or in the transport or other handling of captured CO_2, would have likely implications not only with respect to a return to atmosphere and reversal of climate gains, but also for marine ecosystems and water column chemistry. In-depth study and peer-reviewed literature on this issue is limited, reducing current understanding of the environmental and climate consequences of water column CO_2 releases. What *is* known raises enough concern to know that consequences of both slow leaks and catastrophic releases during transport or other operations should be taken seriously. For example, a

[5] IPCC (2022): Summary for Policymakers. In: *Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* [P.R. Shukla, J. Skea, R. Slade, A. Al Khourdajie, R. van Diemen, D. McCollum, M. Pathak, S. Some, P. Vyas, R. Fradera, M. Belkacemi, A. Hasija, G. Lisboa, S. Luz, J. Malley, (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, p. 37. doi: 10.1017/9781009157926.001.

[6] *See e.g.*, White, J., Chiaramonte, L., Ezzedine, S., et al. (2014). Geomechanical behavior of the reservoir and caprock system at the In Salah CO2 storage project. *PNAS* 111(24), 8784–8752. https://doi.org/10.1073/pnas.1316465111 (presenting a case study of the In Salah CO_2 storage project, suggesting that operational injection pressures fractured the reservoir and lower caprock, allowing for pressure and likely CO_2 to move into the caprock. Although overall storage integrity wasn't compromised, the project stopped injection. The authors and many others underscore the field experience as a core example of the importance of careful site selection and monitoring.)

[7] *Class VI—Wells used for Geologic Sequestration of Carbon Dioxide*, EPA.GOV, https://www.epa.gov/uic/class-vi-wells-used-geologic-sequestration-carbon-dioxide.

catastrophic release of CO_2 directly into the ocean water column from a pipeline or ship—a hazard unique to geologic storage in the subseafloor—could temporarily acidify seawater to 100 times its natural levels, for tens of kilometers in all directions, with potentially dire consequences for fish and other components of marine ecosystems, including the industries and livelihoods that depend on those resources.[8]

The ocean environment itself comes with numerous additional and unique risk factors for geologic sequestration operations that are not present onshore. For example, while not covered by the scope of this testimony, in many cases, CO_2 will need to be safely transported through or upon the ocean by pipelines or ships before it can be injected, often at significant hydrostatic pressures that vary due to seabed depth. Indeed, comprehensive reviews[9] of scientific and policy concerns surrounding geologic storage have identified transport and initial injection as the phase of projects associated with greatest risk, underscoring further the need to cautiously address unique transport safety considerations in the ocean environment. Additionally, the 2020 Atlantic hurricane season brought a record-breaking eleven storms to the U.S. coastline, four of which came ashore in Louisiana alone.[10] The 2021 hurricane season was also above average.[11] It is predicted that a warming climate will result in more intense Atlantic hurricanes with higher rainfall rates.[12] This increasing risk[13] for industrial operations in the Gulf of Mexico must also be taken into consideration in establishing regulations regarding the infrastructure and operational requirements for carbon storage projects.

EDF strongly supports CEQ's recent recommendation that the Department of Energy, EPA, DOI, and National Oceanic and Atmospheric Association collaborate on studies "that are needed to better monitor and verify CCUS results and understand the impacts to living marine resources associated with geologic sequestration and monitoring efforts on the OCS."[14] In addition to this research and implementation of the below principles for secure storage, EDF also encourages these agencies to collaborate now on putting forth regulatory language that ensures proactive marine protections are in place in the currently active DOI rulemaking to the furthest extent of current scientific and technical knowledge. Work to understand and monitor these impacts cannot only occur long after DOI adopts and implements a leasing and permitting program. Where gaps exist, provisions requiring additional monitoring and study should be incorporated into the regulatory and permitting

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[8] *See, e.g.*, Siegel, D.A., DeVries, T., Doney, S.C., & Bell, T. (2021). Assessing the sequestration time scales of some ocean-based carbon dioxide reduction strategies. Environmental Research Letters, 16(10), 104003. https://doi.org/10.1088/1748-9326/ac0be0; Phelps, J.J.C., Blackford, J.C., Holt, J.T., & Polton, J.A. (2015). Modelling large-scale CO2 leakages in the North Sea. *International Journal of Greenhouse Gas Control*, 38, 210–220. https://doi.org/10.1016/j.ijggc.2014.10.013; Hofmann, G.E., Barry, J.P., Edmunds, P.J., Gates, R.D., Hutchins, D.A., Klinger, T., & Sewell, M.A. (2010). The Effect of Ocean Acidification on Calcifying Organisms in Marine Ecosystems: An Organism-to-Ecosystem Perspective. Annual Review of Ecology, Evolution, and Systematics, 41(1), 127–147. https://doi.org/10.1146/annurev.ecolsys.110308.120227; Jones, D.G., Beaubien, S.E., Blackford, J.C., Foekema, E.M., Lions, J., De Vittor, C., et al. (2015). Developments since 2005 in understanding potential environmental impacts of CO2 leakage from geological storage. International Journal of Greenhouse Gas Control, 40, 350–377. https://doi.org/10.1016/j.ijggc.2015.05.032; Rastelli, E., Corinaldesi, C., Dell'Anno, A., Amaro, T., Greco, S., Lo Martire, M., et al. (2016). CO2 leakage from carbon dioxide capture and storage (CCS) systems affects organic matter cycling in surface marine sediments. Marine Environmental Research, 122, 158–168. https://doi.org/10.1016/j.marenvres.2016.10.007; and Molari, M., Guilini, K., Lott, C., Weber, M., de Beer, D., Meyer, S., et al. (2018). CO2 leakage alters biogeochemical and ecological functions of submarine sands. Science Advances, 4(2), eaao2040. https://doi.org/10.1126/sciadv.aao2040.

[9] *See, e.g.*, de Coninck, H., & Benson, S.M. (2014). Carbon dioxide capture and storage: Issues and prospects. Annual Review of Environment and Resources, 39(1), 243–270. https://doi.org/10.1146/annurev-environ-032112-095222.

[10] U.S. National Oceanic and Atmospheric Administration (2020). *Record-breaking Atlantic hurricane season draws to an end.* https://www.noaa.gov/media-release/record-breaking-atlantic-hurricane-season-draws-to-end.

[11] U.S. National Oceanic and Atmospheric Administration (2020). *Active 2021 Atlantic hurricane season officially ends.* https://www.noaa.gov/news-release/active-2021-atlantic-hurricane-season-officially-ends.

[12] Tom Knutson, Geophysical Fluid Dynamics Laboratory (2021). *Global Warming and Hurricanes: An Overview of Current Research Results*. https://www.gfdl.noaa.gov/global-warming-and-hurricanes/.

[13] Marianna Parraga, *Explainer: Stronger storms test aging U.S. offshore oil facilities*, REUTERS, https://www.reuters.com/business/energy/stronger-storms-test-aging-us-offshore-oil-facilities-2021-09-07/.

[14] White House Council on Environmental Quality: Carbon Capture, Utilization, and Sequestration Guidance, 87 FR 8808 (proposed Feb. 16, 2022).

program, alongside a process for modifying permit conditions as new, actionable information about risks and risk control options arise.

EDF scientists are actively reviewing and synthesizing existing knowledge surrounding the possible ocean environment consequences that may arise from subseafloor geologic storage, and we look forward to the opportunity to share our findings on an ongoing basis.

Collaboratively Developed Proposed Principles for Demonstrating Secure Storage

Secure storage in the offshore environment demands a precautionary approach. The remainder of this testimony focuses on a set of technical principles EDF believes are vital to ensuring that injected carbon stays where it is put for a meaningful period of time—a thousand years or more. In fact, "long-term carbon sequestration" is now a statutory requirement for offshore geologic carbon storage projects.[15] Proof of this outcome is vital not only for prevention of atmospheric releases and public trust in carbon storage projects, but also for the protection of marine ecosystems, water column chemistry, and other unique environmental, ecological, and biogeochemical features that could be affected by a potential release of stored or transported CO_2 into seawater. The below principles are core to demonstrating the security of storage and reducing the likelihood of leakage and other impacts from subsurface reservoirs.

EDF developed these principles in consultation with leading industry, academic, policy and legal experts. The principles build on existing domestic and international regulations, standards, and guidelines designed to ensure and require documentation for safe, long-term containment of CO_2.[16] Where applicable, specific sections of these references are included as footnotes and can be consulted for both technical analysis as well as exemplary regulatory language.

EDF believes that Congress can and should monitor the development of the offshore storage regulatory program to ensure that each of these issues is addressed in DOI's active rulemaking. Recognizing the technical nature of these principles, we would welcome an opportunity to provide further briefing, and our experts would be happy to work with Members as you analyze and assess the forthcoming DOI proposal or relevant legislative issues.

EDF's Recommended (and Abbreviated) Principles:[17]

- **Limit Carbon Dioxide Stream Contents:** Section 40307 of the Infrastructure Investment and Jobs Act requires that a carbon dioxide stream consist overwhelmingly of carbon dioxide. We recommend consulting EPA's Class VI definition of carbon dioxide stream for language that will make sure that any other substances included are incidental and not added for the purposes of disposal.[18]
- **Select and Characterize Good Sites:** Proper site selection and site characterization is a fundamental step toward containment assurance. It is needed to confirm that sites have sufficient storage capability and trapping means to enable long-term containment. At each site, characterization must include a robust identification of potential leakage pathways in order to enable a site-

[15] H.R. 3684 § 40307(a)(4) and 43 U.S.C. § 1337(p)(1).

[16] References cited include: (1) EPA's Underground Injection Control Program for Carbon Dioxide Geologic Sequestration [hereinafter Class VI Rule], 40 C.F.R. pt. 146; (2) International Organization for Standardization (2017). *Carbon dioxide capture, transportation and geological storage—Geological storage* [hereinafter ISO Standard No. 7914:2017], *available at* https://www.iso.org/standard/64148.html; (3) International Organization for Standardization (2019). *Carbon dioxide capture, transportation and geological storage—Carbon dioxide storage using enhanced oil recovery (CO2-EOR)* [hereinafter ISO Standard No. 27916:2019], *available at* https://www.iso.org/standard/65937.html (relevant as an approved means for demonstrating secure storage to the Internal Revenue Service (IRS) for Section 45Q (86 FR 4728); (4) The European Parliament and the Council of the European Union (2009). *Directive 2009/31/EC of the European Parliament and of the Council of the European Union on the geologic storage of carbon dioxide and amending Council Directive 85/337/EEC, European Parliament and Council Directives 2000/60/EC, 2001/80/EC, 2004/35/EC, 2006/12/EC, 2008/1/EC and Regulation (EC) No 1013/2006.* [hereinafter EU Directive], *available at* https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0031; (5) U.S. Internal Revenue Service (2009), Notice 2009–83: *Credit for Carbon Dioxide Sequestration under Section 45Q*. https://www.irs.gov/pub/irs-drop/n-09-83.pdf.

[17] A full, technical version of the principles has been submitted to the Department of Interior.

[18] Class VI Rule 40 CFR 146.81(d) & 146.90(a); ISO 27914: 2017 3.7; ISO 27916: 2019 3.7; EU Directive 2009/31/EC 12.1.

specific monitoring program and set the stage for an eventual determination of whether long-term storage can be achieved with high confidence.[19]

- **Select and Characterize Good Reservoirs.** Storage should only be allowed in reservoirs that have sufficient areal extent, thickness, porosity, and permeability to receive the total anticipated volume of the carbon dioxide stream and that also have a confining zone and other necessary containment means sufficient to prevent loss of CO_2 from the storage reservoir.[20]
- **Identify and Assess Leakage Pathways:** An area of review (AOR) should be delineated using computational modelling that accounts for the physical and chemical properties of the injected CO_2 stream and displaced formation fluids, and should be based initially on available site characterization, monitoring, and operational data. Regulatory requirements should provide for adjustment of the area as each project and its site's characteristics are better understood. Using these data, the modelling should project the lateral and vertical migration of carbon dioxide and formation fluids in the subsurface from the commencement of injection activities until long-term containment is demonstrated and closure requirements are otherwise met. Regulations should require the identification and formal risk assessment of potential leakage pathways associated with the AOR.[21]
- **Safely Construct and Operate Wells:** Construction and completion requirements should prevent the movement of fluids into or between unauthorized zones. Wells should be spaced to avoid unplanned pressure interference from other injection wells. Older wells should only be allowed to transition to geologic sequestration purposes if they were engineered and constructed to fully prevent the movement of fluids into or between any unauthorized zones. For operations, regulations should ensure that injection does not initiate new fractures or propagate existing fractures in the confining zone and that internal and external mechanical integrity is appropriately maintained. Documentation of well monitoring should be required in order to track whether appropriate pressures and integrity are maintained. Operational requirements should include alarms, automatic down-hole shut-off systems, and procedures for rapid response in case of a shut-off.[22]
- **Require Comprehensive Testing and Monitoring Plans:** Permit applications should be supported by testing and monitoring plans based on formal risk assessments. They should be designed to detect potential unintended migration of CO_2 streams into unauthorized formations, the sea, or the atmosphere through potential leakage pathways. Monitoring should be risk-based and should adapt over time since monitoring needs will change during different phases of the project. Permitting staff should be equipped with tools and knowledge necessary to independently review and approve the monitoring plan and its amendments.[23]
- **Require Emergency and Remedial Response Plans:** Require an emergency and remedial response plan that is keyed both to deviations in project conformance and to monitoring network indications of leakage.[24]
- **Require and Define Post-Injection Site Care (PISC):** Post-injection monitoring and modelling should continue as long as necessary to confirm that CO_2 plumes are behaving as predicted and gather enough data to ensure secure storage. This process should reinforce: (1) understanding of the subsurface geologic storage system as measured by agreement between model forecasts and measurements of static and dynamic filed data, and (2) ability of the system to contain CO_2 while remaining within acceptable, projected risk thresholds.[25]

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[19] Class VI Rule 40 CFR § 146.83 (a); IRS Notice 2009-83 5.02(b)(i)(A); ISO 27914: 2017 5.1; ISO 27916: 2019 5.2 ; EU Directive 2009/31/EC Art. 4, Annex I.

[20] Class VI Rule 40 CFR § 146.83 (a)(1) & (2); ISO 27914: 2017 5.4; ISO 27916: 2019 3.10, 5.2; EU Directive 2009/31/EC Art. 4.3, Annex I.

[21] Class VI Rule 40 CFR § 146.84; ISO 27914: 2017 3.3, 4.2.3, 6.1; ISO 27916: 2019 6.1.1, 6.1.2; IRS Notice 2009-8 3.02(b)(i)(B).

[22] Citations for well construction: Class VI Rule 40 CFR § 146.86 (a); ISO 27914: 2017 Clause 7; ISO 27916: 2019 Clause 7; Citations for well operation: Class VI Rule 40 CFR § 146.88; ISO 27914: 2017 Clause 8; ISO 27916: 2019 Clause 6.

[23] Class VI Rule 40 CFR § 146.90; ISO 27914: 2017 8.5 & Clause 9; ISO 27916: 2019 Clause 6; EU Directive 2009/31/EC Article 13, Annex II 2.

[24] Class VI Rule 40 CFR § 146.94; ISO 27914: 2017 4.3.4, 4.5.3, 6.6(g), 8.3.5; ISO 27916: 2019 6.1.1(g).

[25] Class VI Rule 40 CFR 40 CFR § 146.93(a); ISO 27914: 2017 9.2.4; ISO 27916: 2019 Clause 10; EU Directive 2009/31/EC Article 17.

- **Demonstrating and Verifying Secure Storage.** Containment assurance should include preventing leakage of CO_2 from the entire storage complex (both the storage reservoir and the containment seals), thereby preventing leakage to both the water column and the atmosphere. There must also be assurance that formation fluids capable of harming aquatic life do not enter the water column. Demonstration of secure storage should include both the absence of detectable leakage and sufficient documentation to demonstrate with high confidence that injected CO_2 and formation fluids will be safely contained long-term—it's EDF perspective that this should be at least 1000 [26] years. Regulations should require review and verification of this demonstration.[27]
- **Plugging the Well:** Prior to closure, wells should be required to be plugged in accordance with an updated approved plugging plan.[28]
- **Closure:** Site closure (the end of normal post-injection monitoring) should be approved only after an operator provides modelling backed by high-quality data that demonstrates long-term containment of CO_2 and provides assurance against migration of CO_2 or formation fluids to the sea or atmosphere. Closure authorizations should not relieve an operator from ongoing responsibility for leaks or other harms caused by an operator's failure to adhere to regulatory requirements or approved plans regarding construction, operation, or closure of the project.[29]
- **Financial Assurance:** Financial assurance requirements must be sufficient to cover updated estimated costs of emergency and remedial response, corrective action, well plugging, and post-injection site care and closure.[30]
- **Assure Safety:** Operations must be conducted in a safe manner to protect against harm or damage to life (including fish and other aquatic life), property, natural resources of the OCS (including any mineral deposits both in areas leased and not leased), the National security or defense, or the marine, coastal, or human environment. This includes protecting against potential harms resulting indirectly from CO_2 injection, such as the migration of CO_2 or subsurface brine to the sea floor that would harm sea life or lead to deleterious changes in water chemistry.[31]
- **Transparency and Reporting:** Ensure accountability for geologic sequestration claims and U.S. carbon accounting programs such as the Greenhouse Gas Reporting Program (GHGRP) by requiring public comment on completed applications and proposed permits and public reporting of both CO_2 volumes sequestered and associated documentation of their security. Further, it's EDF's belief that a plain reading of the EPA Greenhouse Gas Reporting Program (GHGRP) Subpart RR [32] makes clear that its provisions apply to all wells that inject a CO_2 stream for long-term containment in subsurface geologic formations, including offshore facilities that are not subject to the Safe Drinking Water Act. As such, reporting requirements as well as provisions regarding the proposal and review of Monitoring, Reporting, and Verification (MRV) plans should be applicable to geologic sequestration facilities authorized by DOI. EDF recommends that DOI and EPA coordinate in order to foster efficient compliance.

Conclusion

While carbon capture and geologic storage is a critically important building block in reducing emissions, it is not a silver-bullet climate solution. It is a complex, highly technical, costly, and challenging venture that if done correctly can help us address industrial emissions. But geologic carbon sequestration cannot be done successfully by *just* anyone or take place *anywhere*.

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[26] IPCC (2005): IPCC Special Report on Carbon Dioxide Capture and Storage. Prepared by Working Group III of the Intergovernmental Panel on Climate Change [Metz, B., O. Davidson, H.C. de Coninck, M. Loos, and L.A. Meyer (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, p. 14. https://www.ipcc.ch/site/assets/uploads/2018/03/srccs_wholereport-1.pdf.

[27] Class VI Rule 40 CFR § 146.84(c)(1) & (2); ISO 27914: 2017 6.5, 6.7.2.2, 9.1; ISO 27916: 2019 5.1, Clause 6, 10.4.

[28] Class VI Rule 40 CFR 40 CFR § 146.92; ISO 27914: 2017 9.2.4; ISO 27916: 2019 7.2.

[29] Class VI Rule 40 CFR 40 CFR § 146.93 (b)(2); ISO 27914: 2017 Clause 10; ISO 27916: 2019 Clause 10; EU Directive 2009/31/EC Article 18; Texas 81(R) HB 1796 § 382.508(a) (2009).

[30] Class VI Rule 40 CFR § 146.85(a); EU Directive 2009/31/EC Art. 9.9, Art. 19.

[31] 30 CFR § 250.400.

[32] 40 CFR pt. 98.

The Gulf of Mexico does potentially offer a unique geologic opportunity and capacity to store large volumes of captured CO_2. Whether it can be done successfully—in a way that respects coastal communities, protects marine resources, prevents leaks and releases, and earns public trust as a valid solution remains to be seen. Ensuring that the U.S. is committed to developing oversight programs that address the principles for secure storage included here would be a good start.

Dr. LOWENTHAL. Thank you very much, Ms. Saunders.

The Chair now recognizes Mr. Milito for 5 minutes.

STATEMENT OF ERIK MILITO, PRESIDENT, NATIONAL OCEAN INDUSTRIES ASSOCIATION, WASHINGTON, DC

Mr. MILITO. Chairman Lowenthal, Ranking Member Stauber, and members of the Subcommittee, thank you for inviting me to testify. My name is Erik Milito, and I am President of the National Ocean Industries Association (NOIA).

At NOIA, we represent all segments of the offshore energy industry. Our members include not just energy developers, but also the businesses, large and small, that do the work of building, supplying, and maintaining these projects. Hundreds of companies are involved in the construction and operation of offshore energy projects, providing high-paying jobs and ensuring reliable supplies of affordable energy for Americans.

The same U.S. companies in the supply chain that have built out the U.S. offshore oil and gas sector are already participating in the build-out of the U.S. offshore wind sector and will play a significant role in the emerging offshore carbon sequestration sector. Geophysical companies, engineering design firms, health and safety consultancies, offshore service vessels, marine construction companies, drilling contractors, and a myriad of other service and supply companies will be integral to U.S. leadership in offshore CSS.

Our industry recognizes the risks of climate change and the need for continued action. As innovators, our industry is committed to contributing solutions to optimally balance societal and environmental needs. Energy policy must incorporate principles of innovation, efficiency, conservation, mitigation, resiliency, and adaptation as part of a systematic approach to addressing climate change. To do that, U.S. energy policy should support the development of all forms of abundant, reliable, and affordable domestic energy supplies, while continuously driving down emissions.

U.S. energy policy should seek to achieve meaningful GHG reductions across all sectors of the economy and balance energy, environmental, economic, social, and national security needs. When it comes to mitigating emissions, which fundamentally must be the focus of climate policy, energy policy should support the advancement of emission mitigation technologies, and specifically carbon capture and storage.

The widespread deployment of CCS will be critical for achieving the climate ambitions and goals that have been established by a diverse group of stakeholders around the world.

According to the International Energy Agency (IEA), reaching net-zero emissions will be virtually impossible without CCS. The IEA also says CCS is the only group of technologies that contributes both to directly reducing emissions in critical economic sectors and to removing CO_2 to balance emissions that cannot be avoided, a balance that is at the heart of net-zero emissions goals.

According to Secretary of Energy Jennifer Granholm, "Some emissions sources, like cement plants, can't be phased out immediately, or they don't have non-fossil-fuel options even available . . . that is where carbon capture and storage comes into play."

The U.S. Gulf of Mexico offshore region provides tremendous advantages for an emerging U.S. CCS sector. The Gulf of Mexico is characterized by vast geologic prospects for CO_2 storage, extensive and established energy infrastructure along the Gulf Coast and throughout the Outer Continental Shelf, a proximity to industrial centers for capturing emissions, and an accessible engineering and energy knowledge base and workforce. The Gulf Coast region is distinctly situated to emerge as a global hub for CCS. The Gulf Coast is home to the full supply chain of energy companies with the engineering experience, expertise, and vision to deploy projects with the scale and efficiency necessary for success.

As with any capital-intensive industry, the U.S. CCS sector requires certainty and predictability in the regulatory system. Fortunately, Congress has provided Interior with authority to regulate the transport and sequestration of carbon dioxide in the U.S. Outer Continental Shelf. And the Department is currently working to develop the regulatory regime to provide for the safe storage of CO_2 in the offshore region.

We also urge Congress to expand the 45Q tax credit as a means of incentivizing and supporting a durable offshore CCS sector in the United States.

As stated by the National Petroleum Council, CCS is an essential element in the portfolio of solutions needed to change the emissions trajectory of the global energy system. The U.S. Gulf of Mexico stands out as a premier region for global leadership and success in the emerging CCS sector.

One thing I would like to add: an article by Columbia University Climate School makes the point that, based on data collected over the last several decades, there is a wide consensus among experts, engineers, and geologists alike that it is safe to permanently inject and store carbon dioxide.

Thank you, and I would be happy to take your questions.

[The prepared statement of Mr. Milito follows:]

PREPARED STATEMENT OF ERIK MILITO, PRESIDENT, NATIONAL OCEAN INDUSTRIES ASSOCIATION

"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) . . . [It] is likely to be especially important for decarbonizing the industrial sector, where high-temperature heat can be difficult and expensive to electrify and where there are significant emissions . . ."

—*The White House Council on Environmental Quality Report to Congress on Carbon Capture, Utilization and Storage. June, 2021* [1]

[1] https://www.whitehouse.gov/wp-content/uploads/2021/06/CEQ-CCUS-Permitting-Report.pdf.

I appreciate the opportunity to testify today on behalf of the National Ocean Industries Association ("NOIA"). Now in our 50th year as an organization, NOIA represents all segments of the offshore energy industry. We are the voice and advocate for offshore oil and natural gas, offshore wind, offshore carbon capture and storage, and offshore mineral mining. Critically, our members include not just project developers, but also the businesses large and small that do the work of building, supplying, and maintaining infrastructure and projects in the domestic marine environment. Our members are energy companies, and their work is essential for providing the investment and jobs to generate the technologies and energy necessary for the U.S. and global economies to maintain a high quality of life and reduce poverty. We represent countless thousands of blue-collar and white-collar employees across the nation, stretching from New England to the Gulf Coast and to the West Coast. Indeed, we have confirmed that our member companies not only create jobs in the states of every member of this Committee, but in every state in the Union.[2] Together, we are working toward an affordable, reliable, safe, and low carbon energy system.

Progress toward addressing the climate challenge will depend upon increased innovation, conservation, efficiency, resiliency, mitigation, and adaptation. Carbon capture and storage (CCS) is an innovative approach to mitigating greenhouse gas emissions. The wide-spread deployment of CCS will be critical for achieving the climate change ambitions and goals that have been established by a diverse group of stakeholders around the world. CCS can serve as an important tool for balancing environmental, economic, and energy needs. U.S. leadership in CCS will help ensure the availability of abundant, reliable, and affordable domestic energy, while continuously driving down emissions.

The Basics of CCS:

As its name suggests, CCS involves the capture of CO_2 from either large point sources—including power generation or industrial facilities—or directly from the atmosphere. The captured CO_2 is then compressed and transported to either be injected into deep geological formations which permanently trap the CO_2 or is used in a range of applications. CCS uses a robust supply chain and combines various technologies to effectively reduce the amount of carbon dioxide that is emitted into the air, thus mitigating against warming effects and the impacts of greenhouse gases in the atmosphere. Carbon dioxide is the most common greenhouse gas, and it is emitted through various industrial processes and the transportation sector, among others. Industrial processes include emissions from power plants, industrial furnaces and stoves, steel blast furnaces, cement plants, and others.

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[2] https://www.noia.org/wp-content/uploads/2021/08/The-Gulf-of-Mexico-Oil-Gas-Project-Lifecycle.pdf.

The below infographic[3] from the International Energy Agency does an excellent job of showing the basics of the concept and the ways in which carbon can be transported and ultimately used or stored.

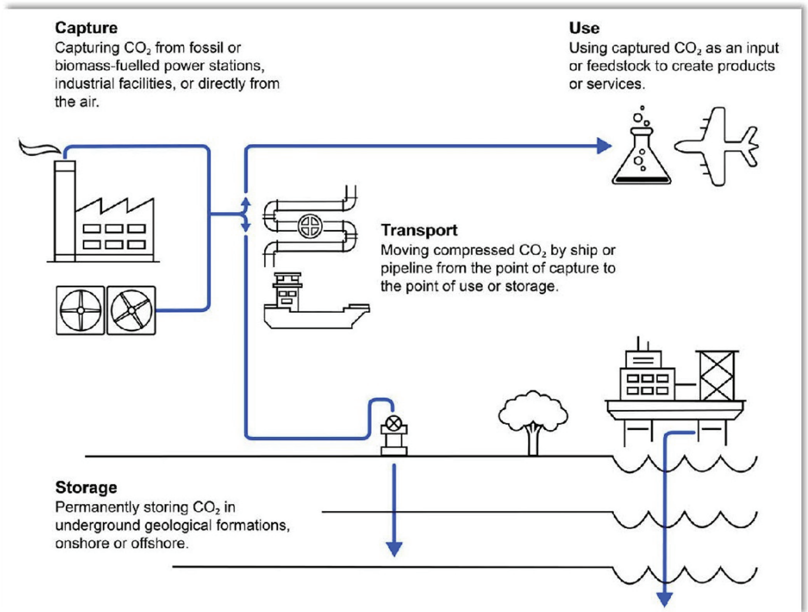

Figure 1: An IEA Infographic Explaining The Basics of CCUS

The Challenge and Opportunity

While we continue to reduce greenhouse gas (GHG) emissions throughout our economy and the energy system, CCS will be key to achieving our climate ambitions. As Secretary of Energy Jennifer Granholm has discussed with regard to transitioning the economy toward lower emissions, "Some emissions sources, like cement plants, can't be phased out immediately or they don't have non-fossil-fuel options even available . . . that is where carbon capture and storage comes into play."[4] In other words, CCS will play a critical role in further reducing carbon dioxide emissions from hard to decarbonize industries and meeting the challenge of climate change.

Importantly, as federal policymakers consider options for domestic CCS, we applaud the increasing recognition that the U.S. Gulf of Mexico's outer continental shelf offers tremendous advantages and can accelerate the emerging U.S. CCS sector and strengthen American leadership.

The Gulf aligns key drivers for success in CCS in the United States. First, the Gulf Coast is home to the full supply chain of energy companies with the engineering experience, expertise, and vision to deploy CCS projects with the scale and efficiency necessary for success. As the Greater Houston Partnership notes,[5] the Houston area alone is home to more than twenty energy-focused R&D centers, sixty-seven energy technology companies, six hundred exploration and production firms, 1,100 oilfield service companies, 180 pipeline transportation firms, and the fourth largest concentration of engineers. Likewise, neighboring Louisiana is also a key area for the Gulf's energy economy. In 2020, the energy sector provided some $73 billion in state GDP and nearly a quarter of a million jobs—almost one-ninth of

[3] https://www.iea.org/reports/about-ccus.
[4] https://twitter.com/secgranholm/status/1423023737289408512.
[5] https://www.houston.org/why-houston/industries/energy.

employment in the state.[6] Clearly, the region has a massive supply chain and a deep bench of technical expertise upon which to rely.

Second, the Gulf of Mexico is situated in close proximity to substantial industrial centers along the coastline for capturing emissions.[7]

Third, the Gulf is characterized by vast geologic prospects for CO_2 storage. As the National Petroleum Council reported, "One of the largest opportunities for saline formation storage in the United States can be found in federal waters, particularly in the Gulf of Mexico."[8] In fact, estimates have pointed to storage capacity along the Gulf Coast large enough for 500 billion metric tons of CO_2, which would equal about 130 years of industrial and power generation emissions in the U.S. as of 2018.[9]

Fourth, an extensive and established energy infrastructure along the Gulf Coast and throughout the outer continental shelf will enable logistical efficiencies for transporting CO_2 from emissions sources to storage locations.

Foreign Examples and Domestic Announcements Of Offshore CCS

Figure 2: The North Sea's Sleipner Field

The technical and commercial feasibility of large offshore storage projects is being proven on the global stage. For example, the *Sleipner* project, led by NOIA member company Equinor, has been in operation since 1996. It involves the capture of CO_2 from industrial sites onshore in Norway and then the transport and geologic storage in saline aquifers off the coast, in volumes of approximately one million tons per year.[10,11] By comparison, the average American car emits 4.6 tons of CO_2 each year.[12] There are other examples of offshore geologic storage as well, such as Equinor's second project—*Snohvit*—in the far-north of Norway, Chevron's Gorgon project in Australia, a project in Brazil's Santos Basin operated by Petrobras, and another in the South China Sea operated by CNOOC.

Projects with engineering transferability to the Gulf of Mexico are also underway. With operations beginning in 2024, *Northern Lights* is a new CCS project under construction that will initially store up to 1.5 million tonnes of CO_2 per year with the goal to achieve five million tonnes of CO_2 per year by 2027. The *Northern Lights* project is part of a larger carbon capture and storage initiative that will capture

[6] https://www.lmoga.com/assets/uploads/documents/LMOGA-ICF-Louisiana-Economic-Impact-Report-10.2020.pdf.

[7] https://www.colliers.com/en/news/houston/petrochemical-and-plastics-industry-2019-houston-economic-outlook.

[8] *Meeting the Dual Challenge: A Roadmap to At-Scale Deployment of Carbon Capture, Use, and Storage*, The National Petroleum Council, December 2019, p. 27.

[9] https://corporate.exxonmobil.com/News/Newsroom/News-releases/2022/0120_Industry-support-for-large-scale-carbon-capture-and-storage-gains-momentum-in-Houston.

[10] https://www.globalccsinstitute.com/wp-content/uploads/2021/11/Global-Status-of-CCS-2021-Global-CCS-Institute-1121.pdf.

[11] https://www.equinor.com/en/news/2019-06-12-sleipner-co2-storage-data.html.

[12] https://www.epa.gov/greenvehicles/greenhouse-gas-emissions-typical-passenger-vehicle#:~:text=typical%20passenger%20vehicle%3F-,A%20typical%20passenger%20vehicle%20emits%20about%204.6%20metric%20 tons%20of,8%2C887%20grams%20of%20CO2.s.

CO_2 from industrial sources within Norway, ship liquid CO_2 from capture sites to an onshore terminal on the coast, and then transport the CO_2 by pipeline to an offshore storage site below the North Sea in water depths of more than 300 meters and total depth to injection of 2,500 to 3,000 meters. In the U.S., the Gulf of Mexico is well suited for the development of projects like *Northern Lights*.

Fortunately, there have been recent decisions and announcements related to the emergence of a domestic CCS industry in the Gulf of Mexico. Talos Energy, a NOIA member company, has moved ahead with a joint venture called Bayou Bend CCS LLC, which has formally executed a lease from the State of Texas' General Land Office as part of an effort to undertake CCS projects off the coast of Texas in state waters near the industrial corridor around Beaumont and Port Arthur.[13] The lease covers some 40,000 acres and encompasses a formation which has the potential to store as much as 275 million metric tons of CO_2.

Further, fourteen companies have joined forces to establish Houston as a hub for large scale carbon capture and storage.[14] The group is forming a public-private partnership which could invest $100 billion to capture tens of millions of tons of CO_2 near the Houston ship-channel.[15] According to the consortium:

> With the appropriate government, industry and community backing, we believe we could help safely capture and store about 50 million metric tons of carbon dioxide a year from the area's petrochemical, manufacturing and power generation facilities by 2030, then double that to remove 100 million metric tons a year by 2040.
>
> We believe we could create tens of thousands of new jobs and protect existing ones that are important to Houston's economy while promoting long-term economic growth in Southeast Texas and beyond. We also believe carbon capture and storage could position Houston as a leader in future lower-carbon businesses like hydrogen, and help put the city well on its way to reaching its goal of being carbon-neutral by 2050.

The members of the group include Air Liquide, BASF, Calpine, Chevron, Dow, ExxonMobil, Ineos, Linde, LyondellBasell, Marathon Petroleum, NRG, Phillips 66, Shell, and Valero.

These are just examples, and there are countless companies with a history in the Gulf of Mexico exploring opportunities for offshore CCS. NOIA's membership alone includes dozens of companies throughout the supply chain with established experience or interest in participating in the build-out of the U.S. CCS sector.

Policy Action Necessary for Offshore CCS

As with any capital-intensive industry, the U.S. CCS sector requires certainty and predictability in the regulatory system, both at the state and federal level. Improvements must be made in U.S. laws and regulations to foster growth and enable success in U.S. CCS.

On January 12, 2022, NOIA released its Offshore CCUS Policy Paper, and this document included our public policy recommendations. This document is provided for your reference. The top priorities include:

1. Legislation to expand the 45Q tax credit, with direct pay option;
2. BOEM regulations for reasonable and predictable access to OCS geologic storage through leasing, permitting and approvals;
3. BSEE regulations for safety and environmental oversight of OCS transportation and sequestration;
4. Clear regulatory requirements for secure geologic storage in the OCS for purposes of qualifying for 45Q;
5. Prompt and thorough NEPA reviews for OCS storage program, leasing, projects, and infrastructure;
6. Consideration of related tax credits, such as 45X on hydrogen, and their interplay with 45Q; and

[13] https://www.offshore-mag.com/regional-reports/us-gulf-of-mexico/article/14241614/talos-energy-announces-formal-execution-of-carbon-capture-lease-site.
[14] https://houstonccs.com/.
[15] https://cleanenergynews.ihsmarkit.com/research-analysis/exxonmobil-unveils-vision-for-100billion-carbon-capture-hub.html.

Fortunately, the Infrastructure Investment and Jobs Act of 2021 (P.L. 117-58) included Sec. 40307, explicitly authorizing the Department to grant leases, easements, or rights-of-way on the outer continental shelf for the purposes of long-term storage. It also directed the Secretary to issue regulations to that effect within one year of enactment. NOIA understands that Interior is in the process of developing the regulatory framework for offshore sequestration as directed by the Infrastructure Investment and Jobs Act. It will be important for Congress to ensure adequate funding for Interior to fulfill its responsibilities for leasing and regulating the activity.

There is also a need for a stable tax credit environment, particularly in the early years. The 45Q tax credit has been vital in driving domestic onshore CCS, and it should be extended and expanded to ensure a runway toward a viable and durable offshore CCS program.

Safety and Environmental Protection

America's offshore energy industry, including the carbon capture and storage sector, is characterized by the continued advancement of technology and systems integrity, the application of extensive industry technical standards, and a robust regulatory regime. The industry continues to develop and improve upon technologies designed to ensure that a safety or environmental incident never occurs, and this includes everything from the materials used in offshore operations, the development of software and control systems to manage operations, the development, production, and deployment of modern vessels, drill ships, and facilities to drill wells and sequester carbon dioxide in the offshore environment, and the design and manufacture of monitoring equipment, subsea safety valves, and other safety equipment.

Furthermore, the vast experience of the oil and gas industry throughout the world, and specifically in the U.S. Gulf of Mexico, in the field of health, safety, and environmental will enable the U.S. government and industry to move forward, at the outset, with a strong foundation for safe and environmentally responsible offshore carbon capture and storage. As discussed by the Bureau of Ocean Energy Management in its 2018 OCS Study, "Since at least 2005, it has been recognized that storage of CO_2 in the offshore sub-seabed geological formations will use many of the same technologies developed by the oil and gas (O&G) industry." The industry's experience in risk assessments, project planning and execution, monitoring, mitigation, inspections, and response are transferable and will be applied in the offshore carbon and storage setting. In fact, the industry already has experience in developing and applying these practices in offshore carbon capture and storage projects throughout the world.

The United States, through its established regulatory oversight authorities within the Department of the Interior and other agencies within the federal family, is well positioned to develop a strong regulatory regime for leasing, permitting, oversight, and enforcement for carbon sequestration throughout the U.S. outer continental shelf. As discussed above, the success of a U.S. offshore carbon capture and storage sector will be contingent upon clear and predictable regulations that enable investment and protect the health and safety of workers, the public, and the environment. Interior has decades of experience in regulating offshore oil and gas operations and this established system of rules, along with institutional knowledge and practical application of engineering principles, is—in many respects—transferable to the development and execution of operational and regulatory requirements for offshore carbon capture and storage. As directed by Congress, Interior has begun the process for developing the regulations, and the industry remains committed to working with Interior and the entire federal family to establish a solid regulatory framework. Congress also should facilitate the necessary authorizations and funding for Interior to capably manage and oversee the safety and environmental requirements for offshore sequestration.

The combination of an experienced industry and an established regulator puts the United States in a unique position for confidently and effectively managing and overseeing safe and environmentally responsible carbon capture and storage in the U.S. outer continental shelf.

Continued Innovation and Development of Clean Energy Technologies

The Gulf of Mexico is a recognized energy center, with a vast ecosystem of companies and a workforce dedicated to developing all forms of abundant, reliable, and affordable energy, while continuously decreasing emissions. The offshore energy industry is uniquely situated to deploy energy projects at the scale and sophistication necessary to help lead the world in developing low carbon solutions. Many engineering projects and technologies can be integrated to provide a pathway to low carbon energy. This includes CCS and hydrogen. According to the International Energy Agency:

> Carbon capture, utilisation and storage (CCUS) technologies offer an important opportunity to achieve deep carbon dioxide emissions reductions in key industrial processes and in the use of fossil fuels in the power sector. CCUS can also enable new clean energy pathways, including low-carbon hydrogen production, while providing a foundation for many carbon dioxide removal (CDR) technologies.

Policy makers should recognize the homegrown expertise and the vast infrastructure throughout the Gulf of Mexico as we seek to secure the U.S. as a leader in global decarbonization efforts.

Conclusion

> *"CCUS is an essential element in the portfolio of solutions needed to change the emissions trajectory of the global energy system. In its Fifth Assessment Report, the IPCC concluded that the costs for achieving atmospheric CO_2 levels consistent with holding the average global temperature to 2 degrees Celsius—referred to as a "2 degree Celsius world"—will be more than twice as expensive without CCUS."* [16]*——The National Petroleum Council*

We have an opportunity to set the stage for a 21st century in which carbon is responsibly captured and transported for long-term geologic storage or beneficial use. The offshore, and particularly the Gulf of Mexico, present one of the most advantageous opportunities in the United States and the world. The success of this nascent industry will be closely connected to the development and implementation of clear and predictable leasing, permitting, and regulations, along careful coordination among federal, state, and local authorities. NOIA and its members stand ready to work with policy makers to establish this important industry.

Dr. LOWENTHAL. Thank you, Mr. Milito.

I want to thank all the panelists for their testimony. I think we now have a wide range of opinions on both the safety and the effectiveness of carbon capture and storage, although today we are talking more about the storage part.

I want to remind Members that Committee Rule 3(d) imposes a 5-minute limit on questions.

The Chair will now recognize Members for any questions they may wish to ask the witnesses.

I am going to recognize myself for 5 minutes of questions. My first question is to Dr. Tip Meckel.

Dr. Meckel, according to the Interior Department, most Gulf of Mexico storage potential is found in either depleted oil and gas reservoirs or saline aquifers. What is the difference between these two, and does one formation make a better storage location than the other?

And the second part of that question is, should the Interior Department consider slightly different rules and regulations for each type of formation, or would a one-size-fits-all approach work in this case?

[16] *Meeting the Dual Challenge: A Roadmap to At-Scale Deployment of Carbon Capture, Use, and Storage*, The National Petroleum Council, December 2019, p. 12.

Dr. MECKEL. Thank you for your question. The geology beneath depleted oil and gas reservoirs and the geology that is in a saline formation, or one that is filled with salt water, can be very similar. The geology doesn't care if it is full of saline water or oil and gas. I would say that each of those sites requires site-specific characterization to allow for safe and effective storage.

In a depleted oil and gas setting, what we are really talking about is an oil field or a gas field that has reached its productive end of life. That would be injecting CO_2 back into a depleted reservoir. So, to be clear, this isn't injecting CO_2 into currently productive reservoirs. Those depleted reservoirs do have a demonstrable geologic seal for retaining buoyant fluids in the subsurface, which is a huge advantage for understanding the ability to retain CO_2.

You do also have a lot of production experience, which can help you understand how fluids are moving in that subsurface geology in the past and, therefore, how they will likely move in the future.

Furthermore, there is some existing infrastructure there that might be leveraged to develop projects more effectively.

And the one issue with the depleted oil and gas fields is they tend to have quite a number of legacy wells. And legacy wells can be a weak point in the retention system.

On the saline aquifer side, this is a much, much larger proportion of the subsurface. Consider that oil and gas is only accumulated in a percent or less of the available subsurface. So, the vast majority of our storage potential is actually in saline reservoirs. They do have few or no legacy wells in their background, so they present less of a well risk.

They do have an untested seal in some regards, or retention interval. So, that may be one of the liabilities of developing a saline storage project that would require additional attention.

You asked if the rules should be the same, and I would agree that, overall, there doesn't need to be much of a distinction between these two. But they should perhaps have different emphases on these different risks that each presents, legacy well versus retention in a seal.

Dr. LOWENTHAL. Thank you, Dr. Meckel.

Ms. Saunders, onshore carbon storage has been happening for years in the United States. How should the Interior Department apply what we have learned from onshore carbon storage to offshore carbon storage in the Gulf of Mexico when writing these new regulations?

Ms. SAUNDERS. Thank you, Chairman. As an initial matter, I think I would say that it is absolutely in Interior's best interest to consult heavily with experts like those at the Department of Energy that have funded and led leading research on carbon storage for many years now through programs like Carbon Safe, and, of course, experts at EPA, who developed and now have the experience of implementing a fully parallel program through Class VI onshore.

There is not necessarily a need to fully reinvent the wheel here. Yes, adaptations are definitely going to be necessary for the unique conditions of the offshore environment. And there have also been important lessons learned in the process with Class VI. But I would hope and expect to see a rule from Interior that really closely parallels the protections that were developed onshore, and perhaps expands them in light of the unique circumstances and perhaps the scale of operations in the Gulf.

And I would also note that Interior can learn from international references on this point, as well, particularly those that have been utilized in active offshore projects like the EU's directive on carbon storage and the international standards out of ISO. Both of those are applicable in the offshore context and could provide useful information. They are also cited in the principles in my testimony.

Dr. LOWENTHAL. Thank you. I see I have run out of time. I am hoping that we will have a second round, or maybe even more, since many Members are not here.

I now turn to Representative Stauber for 5 minutes of questions.

Mr. STAUBER. Thank you very much, Mr. Chair.

Mr. Milito, great to see you. Thanks again for agreeing to be our witness.

As discussed in my opening statement, the 5-year leasing plan is set to expire on June 30, just 64 days from now. The clock is ticking. What could the impact on future investments in offshore CCUS be without a 5-year plan in place?

Mr. MILITO. That could be devastating. We have recently put out our own study that shows that if we do not have a leasing program in place, it could result in the average loss of 500,000 barrels a day through 2040. And if you think about the amount we were importing from Russia, it was about 500,000 barrels a day. So, if we don't produce it here in the United States, we have to get it from somewhere else. We will be looking at an average loss of 50,000 jobs.

And we have had our member companies, service companies who have facilities and operations along the Gulf Coast at several ports. They are now having to talk about whether or not to move those investments to other parts of the world. So, it is happening right now. It is having an impact, and it is going to really hurt our everyday Americans because the price at the pump is related to supplies, and supply is not keeping up with demand. And one way to increase supplies is through production of U.S. oil and gas.

Mr. STAUBER. Should no offshore lease sales be held, what happens to potential acreage for CCUS operations?

Mr. MILITO. That is a good question. The general understanding is that most of the CCS opportunities in the Outer Continental Shelf will be on the shelf in the shallower water. And the production in the Gulf of Mexico right now, 92 percent or more is coming from deep water. So, either way, you are likely going to have significant opportunities for carbon capture and storage projects in the Gulf of Mexico.

What could be a negative impact, though, is if we start to lose the talent and expertise, and they start to move to other parts of the world, because we need that workforce, we need that engineering expertise to be able to move forward, design, and implement those projects here in the United States, rather than lose that knowledge to other parts of the world.

Mr. STAUBER. And by your estimates, what is the potential for American job creation in the Gulf, if we were to scale up CCUS?

Mr. MILITO. We don't have any studies that have modeled the job impacts of that. We do have 370,000 jobs supported by the Gulf of Mexico oil and gas sector today. That is not just along the Gulf Coast. Every state in the country has companies and jobs that are supported by the Gulf of Mexico. As I said, the majority are along the Gulf Coast. Those are the types of jobs that would feed into the carbon capture and storage sector in the Gulf of Mexico.

So, it would be additive. Their high-paying jobs are generally paying 30 percent or more than the average wages across the country. A lot of blue collar jobs, and our membership, we have minority-owned companies, Native American-owned companies, companies led by women, and those are the types of companies that will play a role in the CCS build-out.

Mr. STAUBER. And in your testimony, you outlined the vast oil and gas operations and other long-standing industrial and commercial activities that occur in the Gulf of Mexico.

While the development of CCUS is promising, we need to consider ways to ensure multiple use of submerged lands in the OCS. We want it to continue.

How can we be sure that all uses of submerged lands are equally valued as BOEM considers regulations in the carbon capture sector?

Mr. MILITO. That is a great question and a great point. We have a lot of opportunities to do a lot of different things in the Gulf of Mexico.

We had our first approval for alternative use of an offshore facility recently for aquaculture. We know that hydrogen can be used in conjunction with CCS. We want to make sure that we can pursue that. We have to make sure we are continuing to pursue oil and gas opportunities, because it is a transition. We are talking about 2040, 2050. We are not talking about the transition to 2024. So, we have to make sure we are taking advantage of those opportunities. That can be done through the Federal agencies, the Federal family, to make sure that when we are doing environmental impact statements, we are minimizing conflicts.

But the Gulf of Mexico has a long history of compatible use. We have commercial and recreational fishing there. We have Rigs to Reefs. If you go around these facilities, these are ecosystems that are flourishing and that are now home to red snapper that wasn't there before. We have tourism, we have Department of Defense, and we have oil and gas and, hopefully, soon going to have wind. So, it all can work together, it is just a need to manage it from a multiple-use perspective, and do that through the NEPA process.

Mr. STAUBER. Thank you very much. I just have one last question to Dr. Meckel.

You had mentioned the pipes that are already on the ocean floor. Is that a viable use for transmission of CCUS?

Dr. MECKEL. So, if I understand your question correctly, you are thinking about the existing pipelines on the sea floor.

Mr. STAUBER. Yes.

Dr. MECKEL. Some of those are idle. Many of them are still moving fluids. The ones that are idle are up for consideration for repurposing for CO_2 transport. We do have examples of converting natural gas lines onshore into CCS lines. That was done in

Mississippi. So, there is some consideration for utilizing that infrastructure.

If it has been abandoned, it is probably unlikely that they will be re-utilizable. But the ones that are idle currently—and there are many—there is a huge opportunity to repurpose those going forward.

Mr. STAUBER. And then one last question. I know I am over time, Mr. Chair, just indulge me for a moment.

One of the questions that I have is about multiple use. Could you envision where there would be a carbon capture? Let's say there is an abandoned well, for example, on the ocean floor. You are putting the carbon in. Can you envision a law or a rule that would then say you couldn't drill for oil within a certain distance from that? In your professional conversations, is that part of it?

Dr. MECKEL. It is part of the conversation. But actually, what we are seeing in some of the state level considerations is that CCS is not developed at the expense of traditional oil and gas exploration. So, there are some considerations about the ability to drill through an existing CCS project to reach deeper hydrocarbons that may yet be undiscovered.

But in most cases, they are compatible activities. Again, they just need to be managed correctly in terms of their proximity.

Mr. STAUBER. Thank you very much.

Mr. Chair, I yield back.

Dr. LOWENTHAL. Thank you. I now recognize Representative Herrell for 5 minutes of questions.

Ms. HERRELL. Great. Thank you, Mr. Chairman. And thank you for having this hearing, and for all of our witnesses being here in person, I really appreciate that. And the timeliness of this hearing is amazing.

I mean, the carbon storage, it is important. It is an important issue, certainly important in southern New Mexico, where I am from. Obviously, we don't have any of the offshore drilling where I come from, but the companies that I represent are, obviously, looking at new technologies not only to store carbon, but to use it in such things as enhanced oil recovery.

But the biggest issue and hurdle that we have is the cumbersome permitting process by the Federal agencies. This is the biggest impediment we have, because now we are seeing wait times of up to 450 days to receive our Federal permits. And, obviously, we can all understand how that would prohibit business as usual, if you will.

I do have a question for Mr. Milito—and I hope I am saying that right.

Can you give the Committee a glimpse at what your members are experiencing? I mean, what are some of the wait times for off-shore operators and the experiences that they are having in terms of getting their permits approved?

And how do you think that will translate to permitting practices for offshore carbon storage?

Mr. MILITO. Yes. Generally, applications for permits to drill have continued to get processed and approved.

One area where there has been a huge backlog is in geophysical permitting, and that is kind of driven by the approvals that come out of the Department of Commerce through National Marine Fisheries Service. So, for companies to be able to pursue offshore oil and gas projects, they need to run the geophysical surveys to really understand the geology and the rock to make that happen. And that allows them to actually shrink the environmental footprint, because they are better to target the prospects, because these technologies are highly advanced.

I mean, you could really pinpoint where you want to target for producing oil and gas. Those same technologies will generally be required to be used for carbon capture and storage. So, we need to make sure that we are streamlining the ability to get permits to run geophysical surveys.

The other area is in leasing. There hasn't been a lease sale that has gone through finalization and issuance of the leases since late 2020. And as we have recognized and understand, in order to produce any kind of energy and to move forward with any type of energy project like CCS, you need acreage. To get acreage, you need leases. If you don't have lease sales, you can't do the activity, you can't produce energy, or you can't store carbon capture and storage. So, they do have some parallels, and we are highly concerned about the inability to get leases in the offshore.

Some of that production can come on-line rather quickly. If you have a lease that you would like to secure and it is close to an existing facility, you can bring that production on-line, sometimes within 12 months, which would help us in a situation like we are in today with high prices and the geopolitics of the Russian invasion of Ukraine. So, there are concerns.

I am confident that Interior is going to move forward and put together CCS regulations. They are working on it. We have had some engagement with them to let them have the opportunity to hear from our experts. But there are Federal laws and regulations in place that could hold things up.

Ms. HERRELL. OK, that is great. And you actually already answered the next question I was going to ask. It is kind of like did you have my notes? Because actually, I was going to ask how the lack of Federal lease sales also plays such an important role, and you just touched on that.

In New Mexico—obviously, again, not any of the offshore—but just to give an example of the slowdown or the kind of the process, in New Mexico, we have a 95 rig count. In Texas, where the land is largely private versus Federal lands, there are 249.

So, again, I just think the technologies could revolutionize the energy industry as a whole, and benefit the environment. I think it is timely, because many of our Committee hearings stem from environmental justice and what we can do to protect the environment. And certainly this is proof that technologies are moving forward to protect not only the industry, but the people that live in and around those industries and the company assets.

So, with that, those are all of my questions. Mr. Chairman, I yield back. Thank you for this hearing.

Dr. LOWENTHAL. Thank you.

Are there any Members who have not had their 5 minutes, or seek recognition to ask questions?

Not hearing any, I would like to have a second round to give us some more time, if that is OK with the other Members. Well, I am going to do it anyway. I am going to begin and recognize myself.

Mr. Muffett, it is critical to monitor the carbon dioxide injected into the earth to verify it doesn't leak back into the atmosphere or migrate into areas where it might cause damage. Tell me what you think about the Gulf of Mexico. Why don't the unique challenges that we are going to find there to monitoring and verifying that carbon dioxide injected into the deep—that monitoring will be able to successfully understand what is happening to the carbon dioxide?

And how should the Interior plan for such challenges about the damage that carbon dioxide might cause in their regulations?

Mr. MUFFETT. I think that there are a number of challenges to consider.

Analysis of experience with offshore natural gas pipelines has demonstrated that offshore pipelines pose a higher risk of failure than onshore pipelines, and the increased corrosion risk from CO_2 increased those risks of failure, even beyond the challenges of managing pressure in subsea storage.

With respect to managing and monitoring pressure, and monitoring leakage in subsea storage facilities in subsea reservoirs, I think the challenge is that the technologies are not yet developed. There are experimental measures. You read the scientific papers, and there are pilot projects that are in testing. But the means of doing this are not well understood. And it is important to recognize that our experience with abandoned oil and gas wells proves that point.

A document released by the Bureau of Ocean and Energy Management, just in 2021, covering the 2022 to 2023 research year, focuses on the Bureau's need to develop methodologies to determine whether existing abandoned oil and gas wells are leaking, because the Bureau does not know. And if the Bureau cannot tell you whether existing abandoned oil and gas wells are leaking, given the existing experience with those wells, I think the potential for monitoring leakage and monitoring pressure from CO_2 storage is even more complex and even more limited.

Dr. LOWENTHAL. Thank you.

Ms. Saunders, can you speak on the importance of involving the public, especially that live in the Gulf Coast region, in the Interior Department's carbon storage rulemaking in any future CCS activities and projects in the Gulf of Mexico?

Ms. SAUNDERS. Thank you, Chairman. I would be happy to.

I don't think that the importance of public involvement can really be overstated here. Our normal kind of rulemaking notice and comment processes just simply aren't going to be enough in this instance, given the weight of the decision at hand. So, proactive outreach is going to be very important.

EDF recently participated in a dialogue involving numerous interested environmental NGO stakeholders with Interior, and I also understand from that conversation that they are actively working to conduct similar outreach to environmental justice leaders and organizations, particularly those that are representing communities on the Gulf Coast.

From source to sink, we are talking about a lot of infrastructure, a lot of lives, a lot of land, a lot of ecosystems that might be touched and otherwise impacted by these operations. So, everyone in that chain, and in particular the communities that have already been disproportionately impacted and burdened by industrial development, really need a chance not only to be heard, but to be proactively involved in decisions that will impact them down the line.

I also believe, actually, that in guidance with EPA's Class VI program, there are numerous instances where public engagement and communication should occur both formally and informally in the actual individual project and permit process. So, I would hope that Interior would also look at those procedures and adopt something similar, as well.

Dr. LOWENTHAL. All right. I have one more question, and I am going to ask Mr. Muffett.

Does the track record of carbon capture projects in the United States make you optimistic or pessimistic that capturing carbon and storing it in the Gulf of Mexico will be an economical way to reduce carbon emissions?

Mr. MUFFETT. It is important to recognize that CCS is not a new technology. The oil industry invented and patented technologies to remove carbon from waste streams in the 1950s and 1960s. By 1980, ExxonMobil was acknowledging that it had the technology to remove carbon from waste streams, but that it was simply too expensive, and the industry didn't want to do it. Exxon said in an internal document, "We could remove 50 percent of the emissions from waste streams, but doing so would double the cost of the underlying industry."

So, the challenge for CCS is not one of technology on the capture side. The challenge has always been one of economics. And this has been demonstrated over and over again with CCS projects. The history of CCS projects in the United States and worldwide is a history where industry and proponents over-promise emission reductions and systematically under-deliver.

Chevron's Gorgon project in Australia is a case in point. It is one of the largest CCS projects in the world, and Chevron is currently having to repay massive fines to the Australian Government because it failed to capture remotely what it had committed to capture. And we have seen this happen again and again, and I think this is really important.

When rules were proposed——

Dr. LOWENTHAL. Can you make it brief. We are over in time.

Mr. MUFFETT. Oh, OK, thank you.

Dr. LOWENTHAL. Thank you.

I now recognize the Ranking Member for another 5 minutes of questions.

Mr. STAUBER. Thank you, Mr. Chair.

Mr. Milito, can you briefly explain the purpose of seismic surveying, and why it is needed to properly site locations for CCS or CCUS operations?

And what would happen if seismic permits weren't granted in a timely fashion?

Mr. MILITO. Well, seismic surveys are fundamentally scientific research. They are used to understand the geology, both onshore and offshore. They are used for a multitude of purposes for understanding the faults, the potential for earthquakes, the potential for any kind of activity within the geology itself. Seismic surveys are used for locating sand for beach renourishment. They are used for siting wind turbines. It is just fundamentally a scientific research activity.

But what it does, it allows you to obtain a very vivid image of the geology underneath the sea floor, so you can understand where and how best to either develop energy resources or to find the best sites for injecting carbon dioxide into a reservoir. It is really about delineating the reservoir and understanding which are the best locations for storing carbon dioxide when it comes to CCS.

Mr. STAUBER. Currently, is the Biden administration processing seismic permits in a timely and predictable fashion?

Mr. MILITO. No, and this has gone back several years. We have been looking for regulations to be in place. The regulations were finally put into place. And they are working contrary to the needs of Americans and for offshore energy development, because the permits are piling up. It relates to the incidental take authorizations, and companies are finding themselves in a real bind to be able to get these seismic permits, these geophysical permits, so they can do the geological work to best move forward with projects.

Mr. STAUBER. And then one of the long-term questions is about liability. Who is responsible for monitoring if carbon is stored forever?

Mr. MILITO. Well, the operator of the project is going to have the responsibility to monitor during the life of the project.

The question becomes about when you have a lease, whether it is wind, or oil and gas, or carbon capture and storage, at some point you are done using it. It goes back to the government. Leases have a fixed term, and they go back. Production ends, the lease goes back. So, when it comes to carbon capture and storage, this is still an open question.

The National Petroleum Council recommended that the government, through DOE, put together a forum to really have a discussion to consider all the issues around liability. And that is one approach we think should need to be taken, because companies aren't going to want to invest when they don't have the certainty around what the liability will be.

In Europe, at some point the liability transfers back to the government. That is one model. It is after you are able to demonstrate, after a certain number of years, that you have secured geologic storage permanently in place. So, different ways of looking at it, but it is something that must be sorted out.

Mr. STAUBER. Do any panelists have any ideas or recommendations to that question on how long should carbon storage lease terms be?

Doctor?

Dr. MECKEL. Yes, I have some opinions on that. Typically, if you are going to invest in a project of this scale, you are going to want the project to be active for anywhere from 15 to 30 years. So, a lease agreement needs to have that much flexibility.

Mr. STAUBER. And who should be responsible for the carbon storage after a certain period of time, in your opinion?

Dr. MECKEL. Well, under the current regulation in the United States onshore, it is under UIC Class VI well regulations, and you are required to monitor to demonstrate containment in order to be in compliance with your well permit. That, in turn, allows you to apply for the 45Q tax credit. So, the operator will always have the incentive to monitor the project, because it is tied directly to the economics of the project.

I agree with the former statement that understanding when that project ends and the timeline into transferring the liability back to a State or Federal Government is yet to be defined. But at least in the case of the state of Texas, in the state offshore, they are considering taking back over the CO_2 ownership at a given time. It is just not yet defined.

Mr. STAUBER. OK, thank you.

Ms. SAUNDERS. I could make some contributions, as well, Representative. I apologize, it is hard to jump in virtually.

Mr. STAUBER. Yes. Go ahead, ma'am.

Ms. SAUNDERS. I did want to kind of engage that this is an issue that EDF has been actively thinking about.

So, the traditional regulatory legal principles around liability, like those that apply in oil field operations, EPA has also indicated apply in the Class VI context. And they are designed to hold operators accountable when they fail to live up to their responsibilities, encouraging them to do as good of a job as possible.

And what we are concerned about is the potential for liability transfer done too early in the process or without the right characteristics to reopen it that might create a moral hazard, or create a situation where operators lack an incentive to decrease their exposure risk because they are not going to face significant consequences if projects eventually fail or have negative effects. For example, in the EU, there is a transfer of liability provision, but that framework also gives the authorities ability to reopen liability in the case of deficient data, negligence, failure to exercise diligence, and more.

So, I think an operator in Class VI EPA has also said, even though a transfer might occur, the operator might still be liable for regulatory non-compliance under certain circumstances, even after site closure is approved. For example, if they provided erroneous data to support approval, or it is necessary to protect health if a leak threatens USDW water.

I think there is some specificity here in terms of not wanting to create liability relief that lessens the motivation of operators to really do their due diligence in the name of helping for investment. Because, as we have seen in Texas, where the statute actually expressly provides that storage operators keep their liability for their mistakes offshore, we are still seeing projects and investment there, as well.

So, I think we have to be committed to the long game here and seeking early liability relief. And speaking at the same time to the safety and demonstrated safety of operations doesn't help public trust here. I think there is a solution that we need to find somewhere in the middle.

Mr. STAUBER. I thank you, ma'am.

My time is up. I yield back, Mr. Chair.

Dr. LOWENTHAL. Thank you, Ranking Member.

Before we conclude, I would like to ask each witness if there was one question that you were not asked today, but would have liked to have been asked by the Subcommittee, what is that question, and what would your answer have been?

Let's start with Dr. Meckel. Is there any question we should have asked, or you would have liked us to have asked you?

Dr. MECKEL. A question I am often asked by industrial entities considering pursuing these projects is how do I know that I can actually inject the CO_2?

And the answer is, we have existing examples of injecting billions of barrels of waste fluid into these similar geology for decades. And it has led to almost no incidents. So, we know today there are 1,500 wastewater injection wells in the Gulf Coast that are injecting the equivalent of a gigaton of CO_2—if you were to convert that water into a CO_2 equivalent—a gigaton, 1,500 wells. We know that those wells are capable of injecting a million tons a year equivalent today. We expect wells to be able to do even more of that.

So, we expect that the development of CCS to effectively address emissions will develop on the order of thousands of wells in the OCS that will be injecting gigatons of CO_2 by 2050. That is a significant reduction in the U.S. emissions profile.

Dr. LOWENTHAL. Thank you.

Ms. Saunders, I ask you the same question: What question were you not asked today, but would have liked to have been asked by the Subcommittee, and what would your answer have been?

Ms. SAUNDERS. Well, I have been fascinated and grateful to participate in this hearing because it represents a wide swath of perspectives on both the benefits and the most challenging risks and potential downsides of CCS in the Gulf. And the nuance here is exceptionally challenging.

So, at the moment, I want to share that the risk I am most focused on is that Interior has maybe 6 or 7 more months left to draft, propose, take comment, and finalize and complete a regulatory framework for offshore carbon storage on the OCS. It is absolutely imperative that those rules cut zero corners for the sake of expediency, not only on principles to demonstrate and secure storage of carbon, but also for many, many other aspects of a regulatory program, such as consulting and working with environmental justice communities and leaders on the Gulf Coast.

So, I am just really pleased that you have chosen to focus a hearing on this subject right now, because our current reality is that American companies are rapidly lining up to make decarbonization and net-zero commitments. Just this past week, we saw companies like Google and Meta committing massive sums of money to support ventures for carbon removal. All of this carbon, whether it is industrial capture, carbon removal, or otherwise has to go somewhere essentially permanently. And many experts direct much of those volumes to geologic storage.

And it is likely that carbon storage in geologic formations like those in the Gulf Coast may be part of meeting those targets. But before we roll out the red carpet and allow this practice at scale, we have to come to agreement on the conditions that need to be met to ensure that it will be done in a way that is not only safe, but can clearly demonstrate the permanence of storage.

So, that is why I am here. That is what I wanted to share my testimony about. And we desperately need more voices like all of yours here today focusing on how important that sequestration part is of this equation, and that we comprehensively monitor, report, and verify that we ensure our regulatory system holds carbon storage operations accountable for not just the safety of their operations, but the validity of their claims for sequestration. Otherwise, this whole process really fails to provide that benefit.

Dr. LOWENTHAL. OK, thank you.

Mr. Muffett, can you answer what question you were not asked today that you would have liked to have been asked, and what would your answer have been?

Mr. MUFFETT. I think the question we should all be asking is what conceivable rationale is there for investing untold billions of dollars of public money in a technology that will capture only a tiny fraction of emissions, even from industrial sources, when the most direct route to addressing the climate crisis is to accelerate the transition from fossil fuels?

We have the tools and technologies to do that right now. And increasingly, those tools and technologies are cheaper than fossil fuels.

And I would like to highlight that the fundamental lack of economics is demonstrated by the fact that the industry says they cannot do this without those massive public subsidies that they are asking again here today for the government to increase. And they are asking for further subsidies by asking the government and the American public to waive the liabilities that would result from potential accidents far into the future, which is what matters when we are talking about injecting CO_2 into the ground and keeping it there for decades, to centuries, to millennia. Thank you.

[Pause.]

Mr. MILITO. Sir, I think you are on mute. I guess it is my turn.

[Laughter.]

Mr. MILITO. OK, thank you. I think one of the leading questions here is, how do we put together a framework of regulation for the safe, secure, and permanent geologic storage?

I look at the EDF testimony from Ms. Saunders. I think it really lines up in a very excellent way the components of regulations that need to be put in place. We need to have a risk-based approach for the full life cycle design of these systems that looks at things like site characterization, characterization of reservoirs, assessing leakage pathways, constructing and operating wells, testing and monitoring response, post-injection site care, and demonstrating and verifying security. These are all elements that this industry has great experience doing, and we want to have regulations that put certainty around that to make sure it is done in that way.

One other thing I would add is, when it comes to monitoring, we have a long history of being able to monitor. If you look at the Sleipner project, offshore Norway, it has been around since 1996, over 25 years. It has captured over 20 million tons of carbon dioxide, and they have monitoring in place there. The monitoring is off the shelf. These are downhole instruments, gauges that allow companies to monitor pressures and temperatures to know if there is an abnormality.

So, our industry can do it, we are ready to do it. And we, as NOIA, are here to help and be a resource to Congress, to this Committee.

We thank you for allowing us to appear, and we look forward to further conversation on this key topic for addressing the climate challenge.

Dr. LOWENTHAL. Thank you. I want to thank the witnesses for their valuable testimony and Members for their questions.

This concludes our hearing. The members of the Committee may have some additional questions for the witnesses, and we will ask you to respond to these in writing. Under Committee Rule 3(o), members of the Committee must submit witness questions within 3 business days following the hearing, and the hearing record will be held open for 10 business days for these responses.

If there is no further business, without objection, the Subcommittee stands adjourned.

[Whereupon, at 10:54 a.m., the Subcommittee was adjourned.]

[ADDITIONAL MATERIALS SUBMITTED FOR THE RECORD]

Submission for the Record by Rep. Lowenthal

OCS Study
BOEM 2018-004

U.S. Department of the Interior
Bureau of Ocean Energy Management
Headquarters (Sterling, VA)

Best Management Practices for Offshore Transportation and Sub-Seabed Geologic Storage of Carbon Dioxide

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Available at: https://espis.boem.gov/final%20reports/5663.pdf

Statement for the Record

Carbon Capture Coalition

The Carbon Capture Coalition appreciates the opportunity to submit this statement for the record for the House of Representatives Natural Resource Committee's Subcommittee on Energy and Mineral Resources hearing on offshore carbon storage. Carbon management technologies are essential tools to achieving the nation's midcentury climate goals, while preserving and creating middle class jobs that pay family sustaining wages, providing environmental and other benefits to communities, and supporting regional economies across the country.

The Carbon Capture Coalition is a nonpartisan collaboration of more than 100 companies, unions, conservation and environmental policy organizations, dedicated to building federal policy support to enable economywide commercial scale deployment of the full suite of carbon management technologies, which includes carbon capture, removal, transport, utilization, and storage. Widespread adoption of carbon capture at existing industrial facilities, power plants and future direct air capture facilities is critical to **achieving net-zero emissions to meet midcentury climate goals, strengthening and decarbonizing domestic energy, industrial production and manufacturing, and retaining and expanding a high-wage jobs base**. Convened by the Great Plains Institute, Coalition membership includes industry, energy, and technology companies; energy and industrial labor unions; and conservation, environmental, and clean energy policy organizations.

This statement outlines the safety and effectiveness of secure geologic storage of captured carbon dioxide (CO_2) and its critical importance in realizing essential emissions reductions targets by midcentury. Carbon capture, transport and storage technologies have been proven at commercial scale in the United States for decades and industry has more than 50 years' experience safely transporting and permanently storing CO_2. Increased interest in using offshore resources in the U.S. among members of Congress and key stakeholders to enable a clean energy economy, along with recent federal investments in carbon management and industrial decarbonization through the Infrastructure Investment and Jobs Act, have provided a very near-term opportunity to scale commercial carbon capture, direct air capture and clean hydrogen projects, associated infrastructure, and geologic storage in the offshore environment.

Commercial interest in carbon management technologies and projects is growing rapidly, with nearly 90 publicly announced projects throughout the United States. More than 70 percent of these announced projects intend to store captured CO_2 deep underground safely and permanently in saline geologic formations. The potential for saline geologic storage is enormous and represents a long-term, scalable climate solution. While carbon capture and storage is only one piece of the climate solution, estimates of domestic saline storage capacity represent over 1,000 years' worth of U.S. CO_2 emissions.

What remains clear is that large-scale carbon management must play a central role in meeting midcentury global temperature targets, including through carbon capture at industrial facilities and power plants, and direct air capture facilities. In its' most recent WGIII *Climate Change 2022: Mitigation of Climate Change* report, the Intergovernmental Panel on Climate Change (IPCC) estimates that carbon capture, removal and storage technologies will account for up to 12 gigatons of CO_2 captured and stored annually by midcentury—further underscoring the urgent need to scale up carbon management technologies to capture and store CO_2 at scale by midcentury. Additionally, of the seven pathways that IPCC uses to reflect different decarbonization strategies, only one excludes deployment of carbon capture and removal technologies. This same scenario estimates that global energy demand will be cut in half over the next 30 years, which is unrealistic and unachievable in world where billions of people seek improved standards of living.

Safe and permanent injection and storage of CO_2 in deep geologic formations represent a well-understood and commercial practice in the U.S. and worldwide. In the U.S., EPA regulates and permits geologic storage projects using the Underground Injection Control Programs' Class II and Class VI wells. Through these programs, EPA and established state primacy programs maintain a robust system of monitoring, reporting and verification to validate secure geologic storage to claim the 45Q tax credit, the cornerstone policy enabling the scale up of carbon management projects. Furthermore, 45Q is a performance-based tax credit, meaning that projects must demonstrate that the captured carbon oxide (CO_2 or it's precursor, CO) is permanently stored or utilized to receive the credit. No other energy technology must prove carbon dioxide mitigation to receive a tax credit—wind, solar and other technologies receive federal tax credits based on production—regardless of total CO_2 emissions reduced.

While commercially practiced today, scaling up development and permitting of secure geologic storage at gigaton scale is key to getting industries on track to be able to reach net-zero emissions targets and midcentury climate goals. Domestically, the Great Plains Institute estimates that there is the potential to capture and store more than 300 million metric tons of CO_2 emissions per year from existing industry and power sources by 2035. To date, over a quarter billion tons of CO_2 emissions have been successfully stored globally in saline geologic formations. Commercial saline storage began with the Sleipner Project in Norway in 1996, which has stored approximately 1 million tons of CO_2 annually captured from natural gas processes and injected deep under the bed of the North Sea. In the U.S., the industry is capturing and storing 22 million metric tons of CO_2 per year. At the Archer-Daniels-Midland (ADM) in Decatur, IL annually stores approximately 1 million tons of CO_2 in captured from ethanol fermentation, in the first active Class VI well.

With more than 60 publicly announced carbon management projects declaring their intent to store CO_2 through dedicated saline storage, ensuring that EPA's Class VI permitting program, which provides specific regulations for dedicated geologic storage of CO_2, has adequate resources to properly and expeditiously permit projects is increasingly important. The anticipated increase in project applications to the Class VI Well program highlights the importance of federal and state efforts to provide key support for project development to meet midcentury climate goals. According to the Great Plains Institute, EPA has permitted two Class VI wells to date, with well permit applications for an additional four wells as pending.

While it's true that the offshore environment presents unique circumstances relative to the onshore environment, relevant federal agencies should support the same rigor of monitoring, verification and reporting for secure, long-term storage of CO_2 when promulgating rules governing the offshore environment. Additionally, these same agencies should ensure the same level of transparency through reporting, monitoring and verification and transparency measures required by Subpart RR of the EPA Greenhouse Gas Reporting Program in the onshore environment. Ensuring transparency and accountability mechanisms for the offshore storage environment are integral to maintain public confidence in the integrity of the 45Q tax credit.

Secure geologic storage is not only essential for reaching midcentury climate targets, but in enabling domestic industries to capture and manage their carbon emissions. In addition to playing a central role in decarbonizing domestic industry, manufacturing and energy, the deployment of carbon management technologies, coupled with the necessary development of CO_2 transport and storage infrastructure, will help safeguard current high-paying jobs at existing facilities, while creating tens of thousands of new jobs and generating tens of billions in capital investment, according to analysis conducted by the Rhodium Group. The deployment of carbon capture, direct air capture, carbon utilization and associated CO_2 transport and storage projects provide some of the most desirable clean energy, industrial and manufacturing jobs for American workers, as they consistently pay above-average local wages that support families and communities.

Federal policymakers have recently demonstrated their foresight and recognition of the essential role that CO_2 transport and storage infrastructure must play in putting our nation on a path to reaching net-zero emissions by midcentury with the enactment of the Infrastructure Investment and Jobs Act (IIJA). The bipartisan package included foundational investments in the buildout of regional CO_2 transport and storage infrastructure with the complete inclusion of the Storing CO_2 and Lowering Emissions (SCALE) Act. Much like the development of other vital infrastructure systems, the SCALE Act positions the federal government to partner with private capital to invest in both regional and national CO_2 transport and storage infrastructure networks.

The SCALE Act provisions enacted through the IIJA include funding for geologic storage permitting at $25 million during FY22–26 and $50 million during FY22–26 for state permitting program grants. Effective implementation of these modest but vital permitting resources could be transformative. These resources can provide the adequate federal and state permitting capacity required for a critical mass of carbon management projects to move forward over the next decade.

Enabling deployment at scale would ensure that the far greater federal investments in both the infrastructure bill and the 2018 bipartisan reform and expansion of the federal 45Q tax credit achieve their full climate potential. However, while these incremental gains remain important to realizing economies of scale, Congress now must deliver the broad portfolio of federal policy support for carbon management in forthcoming budget reconciliation legislation, including direct pay and multi-year extension of the 45Q tax credit, increased credit values for industry, power and direct air capture, and dramatically reduced annual capture thresholds. Combined with the investments made in the infrastructure law, these enhancements to the 45Q tax credit would result in an estimated 13-fold increase in carbon management capacity and annual CO_2 emissions reductions of 210–250 million metric tons by 2035 as well as creating hundreds of thousands of jobs in the carbon capture and direct air capture industries.

Conclusion

Carbon capture, removal, utilization, transport and storage technologies are essential tools to decarbonize the hardest-to-abate sectors, increase domestic energy production, protect and grow a high-wage jobs base, and fulfil our climate obligations. The groundbreaking provisions to scale deployment of associated CO_2 transport and storage infrastructure enacted as part of the bipartisan infrastructure law are essential to placing America's energy, industrial and manufacturing sectors on track to reach net-zero emissions by 2050. At the same time, these will ensure the long-term viability of vital industries that provide millions of existing high-wage jobs, which represent the lifeblood of American workers, their families and communities, and regional economies. Analyses by the Rhodium Group reveals the potential for creating tens of thousands and hundreds of thousands of jobs and generating hundreds of billions in investment from carbon capture and direct air capture deployment, respectively, if these technologies are deployed at levels needed to meet net-zero targets.

The Carbon Capture Coalition appreciates the opportunity to comment on the important topics of today's hearing and the Committee's support in advancing federal policies to enable greater deployment of carbon management technologies and infrastructure to meet midcentury climate goals. We look forward to working with the Committee in a bipartisan manner to participate in the rulemaking process for secure offshore geologic storage of CO_2.

Should you have any questions about anything outlined in this statement, please contact Madelyn Morrison, External Affairs Manager.

CLEAN AIR TASK FORCE

April 28, 2022

Hon. Alan Lowenthal, Chair
Subcommittee on Energy and Mineral Resources
U.S. House Committee on Natural Resources
1324 Longworth House Office Building
Washington, DC 20515

Re: Subcommittee Hearing: The Opportunities and Risks of Offshore Carbon Storage in the Gulf of Mexico, Statement for the Record of Clean Air Task Force, Inc.

Dear Chairman Lowenthal:

Clean Air Task Force (CATF) thanks you for holding today's Hearing on the important question of permanent subseabed geologic storage of industrial carbon dioxide in the Gulf of Mexico.

CATF is a global nonprofit organization working to safeguard against the worst impacts of climate change by catalyzing the rapid development and deployment of low-carbon energy and other climate-protecting technologies, including carbon capture and permanent storage and direct air capture and permanent storage technologies. CATF has offices in Boston, Washington D.C., and Brussels, with staff working virtually around the world. CATF's global carbon capture team consists of technology and policy experts and lawyers with decades of experience in carbon dioxide capture, transport, removal, and storage. The team's expertise stems from the regular contact we maintain with carbon capture project developers, investors, innovators, and regulators in addition to policy advocates and academic modelers. CATF's carbon capture team specializes in analyzing the effect of regulation and policy options, to discern the most cost-effective means to scale up carbon capture, transport, removal, and permanent storage technologies to achieve mid-century decarbonization goals.

CATF recognizes the critical role of carbon capture and permanent storage technologies in meeting mid-century decarbonization goals. IPCC Working Group III assessed 97 pathways to keep global warming to 1.5°C with limited or no overshoot and found an average of 665 gigatons (Gt) of carbon capture and storage will be needed between now and 2100, while emphasizing that carbon capture and storage is particularly vital for reducing hard-to-abate industrial emissions (e.g., cement, steel, and chemicals).[1] Many of these hard-to-abate industrial sources are located within the Gulf Coast region and have limited viable carbon dioxide emission mitigation options outside of carbon capture and storage. Injection of carbon dioxide deep below the seabed in areas offshore of these regions, both beneath state waters and on the Outer Continental Shelf (OCS) in the Gulf of Mexico represents a significant and viable gigaton-scale resource for permanent storage of captured carbon dioxide from industrial sources in the Gulf Coast region.[2]

Geologic storage, both onshore and offshore, is a well-understood and commercial practice in the U.S. and worldwide, with commercial operations dating back to the 1970s. To-date, in the United States alone, over 31 million metric tons (Mt) of CO_2 emissions have been safely and permanently stored in deep geologic formations regulated under the EPA's Subpart RR.[3] Commercial saline storage began with the Sleipner Project in Norway in 1996, which has stored approximately 1 Mt of captured CO_2 annually for over 20 years deep in the subseabed of the North Sea.[4] The Sleipner Project's multi-decade record of large-scale, safe and permanent storage of captured CO_2 provides precedent that subseabed geologic storage can be effectively and safely performed, provided that appropriate site characterization, design, monitoring, reporting and verification are undertaken. Additionally, the existence of naturally occurring, large hydrocarbon accumulations in the Gulf of Mexico provides

[1] Climate Change 2022: Impacts, Adaptation and Vulnerability, Working Group II Contribution to the IPCC Sixth Assessment Report (2022), https://www.ipcc.ch/report/ar6/wg3/.

[2] P.S. Ringrose & T.A. Meckel, *Maturing global CO_2 storage resources on offshore continental margins to achieve 2DS emissions reductions*, 9 Sci. Rep. 17944 (2019).

[3] 40 C.F.R. §§ 98.440–98.449 (subpart RR).

[4] Anne-Kari Furre et al., *20 Years of Monitoring CO_2-injection at Sleipner*, 114 Energy Procedia 3916 (2017).

evidence that this offshore region has appropriate subsurface geology and conditions for retaining large volumes of fluids over geologic time scales.

For permanent subseabed geologic storage to be implemented safely, a strong regulatory framework must be established. When properly characterized, deep [more than 1,000 ft below the seafloor][5] geologic reservoirs are ideal locations for permanent carbon dioxide storage and can ensure that injected captured carbon dioxide will not be released to the atmosphere. The operator must also demonstrate that injection and post-injection activities are sufficient to avoid releases, including through monitoring and reporting of amounts injected, pressures, and other specific parameters that should be included in regulatory requirements for this activity.

Existing rules under the Environmental Protection Agency's (EPA) Underground Injection Control program regulate geologic storage of CO_2 onshore and under the offshore seabed in state jurisdictions. The EPA also regulates the air monitoring of onshore geologic storage operations, under its Clean Air Act authority, to ensure that there is no release to the atmosphere. These regulations are based on the need for protections for underground sources of drinking water (USDWs). While USDWs are not present in the OCS, the key principles of EPA's UIC Class VI well regulations are otherwise still largely suitable for regulating subseabed storage activities beyond state jurisdiction in the OCS. Moreover, following the principles of EPA's UIC Class VI program will be equally imperative to prevent CO_2 releases to the ocean water column and the ensuing harm that could be caused to the ocean's flora and fauna.

The Infrastructure Investment and Jobs Act requires the Bureau of Ocean Energy Management (BOEM) to establish rules for deep subseabed storage of carbon dioxide under the OCS by November 15, 2022. BOEM and its sister agency the Bureau of Safety and Environmental Enforcement (BSEE) are working now to develop a robust regulatory framework for subseabed carbon dioxide storage. This effort will require close coordination and collaboration between EPA and BOEM/BSEE to ensure that any new rule adheres to existing key principles of EPA's UIC and Clean Air Act programs governing onshore geologic storage activities. BOEM and BSEE will also require financial support as they work to develop a suite of robust technical subseabed storage rules in a short time frame.

Sincerely,

CLEAN AIR TASK FORCE

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[5] U.S. Dep't of Interior, Bureau of Ocean Energy Management, OCS Study BOEM 2018-004, Best Management Practices for Offshore Transportation and Sub-Seabed Geologic Storage of Carbon Dioxide (Dec. 2017), https://espis.boem.gov/final%20reports/5663.pdf.