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U.S. Senate Date: Wednesday, April 11, 2018

Committee on Environment
and Public Works Washington, D.C.

LEGISLATIVE HEARING ON S. 2602, THE UTILIZING SIGNIFICANT EMISSIONS WITH INNOVATIVE TECHNOLOGIES ACT, OR USE IT ACT

Wednesday, April 11, 2018

United States Senate
Committee on Environment and Public Works
Washington, D.C.

The committee met, pursuant to notice, at 10:21 a.m. in room 406, Dirksen Senate Office Building, the Honorable John Barrasso [chairman of the committee] presiding.

Present: Senators Barrasso, Carper, Inhofe, Capito, Fischer, Ernst, Sullivan, Cardin, Whitehouse, Gillibrand, Booker, Markey, and Van Hollen.

STATEMENT OF THE HONORABLE JOHN BARRASSO, A UNITED STATES SENATOR FROM THE STATE OF WYOMING

Senator Barrasso. Good morning. I call this hearing to order.

Today we are here to discuss promising bipartisan legislation recently introduced by the Chairman, along with Senators Whitehouse, Capito, and Heitkamp.

The bill is called the Utilizing Significant Emissions with Innovative Technologies Act, or simply the USE IT Act. It is called the USE IT Act because the bill would encourage the commercial use of manmade carbon dioxide emissions. The bill supports the use of carbon capture technology and innovative research at sites with the captured CO2. The legislation also facilitates permitting for carbon dioxide pipelines in order to move the carbon dioxide from where it is captured to where it is either stored or used.

The USE IT Act complements and builds off of recently passed legislation that was introduced by the same bipartisan group of Senators. That one was called the FUTURE Act, the Furthering Carbon Capture, Utilization, Technology, Underground Storage, and Reduced Emissions Act, simply, the FUTURE Act. It expanded and extended the 45Q tax credit for carbon capture. Carbon capture can and does work.

The Committee heard testimony from David Greeson of NRG Energy last year. Their Petra Nova project outside of Houston is the largest carbon capture project of its kind in the world. That project has now captured and used more than a million tonnes of carbon. The FUTURE Act is going to spur investment in more additional carbon capture projects like Petra Nova.

In developing both the FUTURE Act and the USE IT Act, Senators on both sides of the aisle have found areas of common ground. I appreciate Senator Whitehouse's leadership as we work together to develop the USE IT Act. I am going to continue to work with Senator Whitehouse to ensure any amendments to this bill are built on bipartisan consensus as we work to move it through the Committee and ultimately to the President's desk.

In my home State of Wyoming, we are blessed with an abundant supply of coal, oil, uranium, and natural gas. These tremendous resources fuel our State economy and employ people in well-paying jobs; they provide affordable and reliable power to our Nation.

Coal, oil, uranium, and natural gas also make the United States more secure by making us less dependent on energy resources from other countries. We cannot afford to leave our resources stranded in the ground. That is why America must lead through innovation, and not regulation, as we continue to reduce emissions. This is the approach we take in the USE IT Act.

The bill will also allow coal plants in my home State of Wyoming to capture their CO2 emissions and turn them into valuable products. It will encourage the use and permanent sequestration of CO2. Greater use of these technologies, coupled with research support from the EPA, could lead to additional innovative technologies that will use CO2 emissions.

This is a market-driven approach. We are encouraging the development of markets for CO2. All of these actions will result in less carbon dioxide in the atmosphere.

The USE IT Act is important for Wyoming. The Sheridan Press recently published a front-page article titled Senate Bill Could Stimulate State Carbon Capture Projects. In the article, Jason Begger, who is the Executive Director of the Wyoming Infrastructure Authority, who has testified before this Committee, endorsed the USE IT Act. He explained how the legislation will allow Wyoming to diversify the use of its energy resources, and I ask that this article be entered into the record.

Without objection.

[The referenced information follows:]

Senator Barrasso. The USE IT Act has two sections, one that promotes research and the other to facilitate development of carbon capture products and CO2 pipelines.

The first title of the bill directs the EPA to conduct carbon dioxide research activities under existing authority in the Clean Air Act. Specifically, the EPA would provide technical and financial assistance to carbon dioxide utilization projects that use CO2 generated from industrial facilities. EPA would also administer a competitive prize program to promote another innovative technology: direct air capture.

The second title is all about creating a favorable environment for the permitting and development of the infrastructure needed to make carbon capture successful. In this title, the bill clarifies that carbon capture utilization and sequestration projects, as well as carbon dioxide pipelines, should be permitted in a timely and coordinated manner.

The bill will send an important signal to project developers that the Federal Government is committed to be a partner in the project development and in exploring new commercial uses for carbon dioxide.

The bill also establishes a process for stakeholders to work together to identify and develop models that facilitate the permitting and development of carbon capture projects and carbon

dioxide pipelines.

So, I look forward to working with members of the Committee to advance this critical legislation.

I will now turn to the Ranking Member, my friend, Tom Carper, for his opening statement.

[The prepared statement of Senator Barrasso follows:]

STATEMENT OF THE HONORABLE THOMAS R. CARPER, A UNITED STATES SENATOR FROM THE STATE OF DELAWARE

Senator Carper. Thanks, Mr. Chairman.

Delighted to see our witness, our first witness, our lead-off hitter, who is actually quite a good hitter, as I recall, and to welcome our other witnesses who will follow Senator Heitkamp.

Mr. Chairman, I want to thank you for this hearing today and I want to thank you, Senator Whitehouse, and others who have worked, along with our staffs, to craft this legislation for our consideration. It is really a pleasure to participate in a hearing that focuses on solutions to climate change, as opposed to a hearing that focuses and fuels the debate over the science of climate change.

Since the founding of our Union, our Country has faced daunting challenges that at first seem impossible to overcome. With support from Federal, State, and local governments, Americans have found ways to innovate and craft solutions to overcome these challenges.

I believe the same can and must be true when it comes to addressing climate change. Smart policies at the Federal, State, and local levels have spurred a clean energy revolution in this Country and we have achieved real results. $507 billion

have been invested in the clean energy sector over the past 10 years and our Country is the leader in exporting clean air and clean energy technology, a leader.

Thanks in part to these investments in clean energy and energy efficiency, American consumers are paying less for energy today, not more; jobs, some 3 million of them, in fact, have been created here at home to produce these clean energy technologies.

However, if our Country and, quite frankly, all countries, are going to address the challenge of climate change, we must do more to spur clean energy technology. That is why I have long believed that the Federal Government should foster and support the deployment of carbon capture, sequestration, and utilization technologies, and I have been, as a Congressman, as a Governor, and as a United States Senator, a strong advocate of doing just that.

Wide deployment of carbon capture, sequestration, and utilization could significantly reduce climate pollution emissions in this Country and abroad, and could be a real win-win for coal communities, for manufacturing, and for our climate.

But just as with other coal-related technologies, the barriers to carbon capture, utilization, and storage are largely financial, largely financial, not environmental. The reluctance

of investors to invest in CCUS is not because we require these operations to meet other basic and important environmental requirements. Instead, investors have shied away from expensive, large-scale carbon capture projects because energy prices are low. This Country has struggled to put a price on carbon usage and, as a result, we are well on our way to ceding the economic opportunities of carbon capture technology to other countries, like China, which only hurt the very coal communities that our President says he wants to help. And a couple of us actually grew up in those coal communities.

American ingenuity has always been our best tool in meeting the challenges our Country has faced, so it just makes sense that we would harness the same innovative spirit in order to find smart ways to spur CCUS in America.

Today we will hear, beginning with our lead-off witness, Senator Heitkamp, much about such innovative efforts occurring at the University of Delaware that, if successful, would make carbon capture a no-brainer, no-brainer, for businesses in the future.

This legislation before us, as the Chairman has said, is intended to spur more innovation in projects in CCUS like the one at the University of Delaware that we will hear about in just a moment. So, for that, I applaud the underlying effort and the Chairman and co-sponsors for your work.

Having said that, however, I do have one concern that I want to mention with the legislation which explains why I am not yet a co-sponsor. For one, I am concerned that the legislation may be handing over a program to an already burdened EPA to oversee what may be better suited for the Department of Energy to administer.

I am also a bit weary of discussing any additional streamlining provisions for this technology, when in the past two transportation bills we have established streamlining provisions to help these types of projects move through the permitting process more easily. I believe that before we consider a lot more streamlining measures, we ought to prioritize implementing the ones we have already put in place. Most importantly, I want to make sure that this effort is not connected with other efforts that may weaken the Clean Air Act.

In closing, let me reiterate that we don't need to scrap our environmental standards to provide a nurturing environment for American innovation and economic investment in carbon sequestration technologies; they are not mutually exclusive.

With that, we look forward to hearing from our lead-off witness and our other witnesses. Thank you all for being here with us today.

Thank you. And for your leadership, thank you, Mr. Chairman.

[The prepared statement of Senator Carper follows:]

Senator Barrasso. Thank you, Senator Carper.

Senator Capito.

STATEMENT OF THE HONORABLE SHELLEY MOORE CAPITO, A UNITED STATES SENATOR FROM THE STATE OF WEST VIRGINIA

Senator Capito. Thank you, Mr. Chairman and Ranking Member. I am glad to see Senator Heitkamp here and Senator Whitehouse.

Senator Barrasso and I are the major authors of this bill. I said it is good to have the team back because we had a major victory at the end of last year with everybody's help; we passed the FUTURE Act, which Senator Barrasso referenced in his opening statement, which reauthorized and really improved the 45Q tax credit for CCUS. It was a huge milestone for all of us because we had a bipartisan group of Senators, a diverse coalition of coal and oil industry, environmental groups, and the labor organizations that were supporting us, so we are now looking to the second phase and making sure that this technology can make it out into the field.

Beyond the economics, we need to have adequate R&D into CCUS, some of that is being done at Nettle in Morgantown and at our universities, and that our regulatory structures aren't so onerous so as to prevent CCUS projects and carbon dioxide pipelines from being permitted.

I think there is an issue that we try to address in here, and that is on the carbon dioxide portion of the pipelining,

which brings a different flavor to pipeline regulating than we have seen in the past. So, we are in the process of bringing together another coalition of stakeholders like the one that supported the FUTURE Act, and today's hearing is part of that process.

So, with all of us pulling together, I hope we can get another pro-CCUS bill. It is a win-win; it is an energy bill, it is a carbon emission reduction bill, and it will benefit all of us economically.

Thank you, Mr. Chairman.

[The prepared statement of Senator Capito follows:]

Senator Barrasso. Thank you, Senator Capito.

Senator Whitehouse.

STATEMENT OF THE HONORABLE SHELDON WHITEHOUSE, A UNITED STATES SENATOR FROM THE STATE OF RHODE ISLAND

Senator Whitehouse. Thank you, Chairman. It is good to be working on this bill again and trying to advance the cause of carbon capture, utilization, and sequestration. Obviously, if you are going to capture and utilize carbon dioxide, it is helpful to have a way to distribute it to the ultimate users, and that is where the pipeline piece comes in; it is a very sensible adjunct to the bill that we got passed.

I would like to make two points. One is that pretty much everybody on the Republican side of the aisle who has thought the climate change problem through to a solution, whether it is former Senators, former Representatives, former Treasury secretaries, former EPA administrators, former presidential economic advisors, they all more or less come to the same place, which is that there needs to be a market price on carbon dioxide emissions.

I think we agree with that. There is usually the view that it ought to be revenue-neutral, it shouldn't be revenues used to build more government, we don't need to have that fight on this issue; and it needs to be border adjustable so a cement plant in Texas doesn't face unfair competition from the same cement plant across the border in Mexico.

All of that is very doable, but it is going to take a little bit more leadership from our friends in the fossil fuel industry before we get there.

I want to make it clear that, from my experience here in the Senate, when our oil majors say they understand that climate change is real, they understand that their product is causing it, and they support a price on carbon emissions, that that is not a truthful statement. At the end of the day, their entire political and electioneering apparatus remains fully dedicated to making sure that there is no price on carbon.

How they are going to explain to the future and to their shareholders why they say one thing publicly and direct their political and electioneering efforts in a completely different direction I leave up to them, but I am here as witness to the fact that there is zero political and electioneering support from those industries for the serious price on carbon they claim to support. So, in the meantime, we can do things to move things forward, and this is one of those ways to move things forward.

The second point I would like to make is that we need to be very careful about making sure that when we are talking about regulatory efficiencies, we are really talking about regulatory efficiencies. When that becomes a code for undoing environmental protections, I am out.

We have seen regulatory efficiencies pay off in big ways. Rhode Island has steel in the water and electrons flowing into the grid from the first offshore wind turbines in the United States because we designed a better regulatory process than Massachusetts did. Cape Wind in Massachusetts died over more than a decade of regulatory process. We did it faster, smarter, and right in Rhode Island, and the payoff is we got the first offshore wind in the Country.

So, there in fact are ways to make regulation achieve its purpose in the most efficient way. We have to guard against that being a screen for undoing the underlying protections, and that is a principle that I am going to bring into this bill and into all of my oversight efforts on this Committee.

I appreciate the opportunity I have had to work with so many friends on this Committee on this and on the previous bill, and I am delighted to see my distinguished Dakotan colleague here.

[The prepared statement of Senator Whitehouse follows:]

Senator Barrasso. Thank you very much, Senator Whitehouse.

Now to the distinguished Dakotan colleague, Senator Heitkamp. Welcome to the Committee. Thank you for joining us and for your support of the bill.

STATEMENT OF THE HONORABLE HEIDI HEITKAMP, A UNITED STATES SENATOR FROM THE STATE OF NORTH DAKOTA

Senator Heitkamp. Thank you, Mr. Chairman, and hello to all my friends on the Environment and Public Works Committee.

I think Sheldon occasionally says that because he can't remember if it is North or South Dakota.

[Laughter.]

Senator Whitehouse. It is not east or west?

[Laughter.]

Senator Heitkamp. Good morning, Chairman Barrasso.

Senator Barrasso: If it is a road or if it is an island, yes.

[Laughter.]

Senator Heitkamp. Or soon to be.

Good morning, Chairman Barrasso.

Senator Whitehouse. No fair all you westerners ganging up on me.

[Laughter.]

Senator Heitkamp. I am going to start over now.

[Laughter.]

Senator Heitkamp. Good morning, Chairman Barrasso, Ranking Member Carper, and all of my friends and colleagues on this Committee. I want to thank you so much for the invitation to

testify on this USE IT Act, Utilizing Significant Emissions with Innovative Technologies Act.

I just want to make a point that for generation after generation we have seen CO2 as a pollutant, and the efforts that this Committee, in a very bipartisan way and our group of four have really tried to turn the page and start looking at CO2 as an opportunity and as a legitimate and valuable by-product.

So, Senator Barrasso, I want to thank you so much, and your staff, for your incredible work on this and making it a priority of your office, and inviting me and allowing me to be part of that work.

Senators Whitehouse and Capito, your continued work and partnership in these efforts on carbon capture, utilization, and storage initiatives, that leadership continues beyond the work that we did on our FUTURE Act, and we know that these new policies can create an environment in which innovation and implementation of CCUS technologies and processes are allowed to thrive and grow.

Much has already been said about the FUTURE Act. It was one cog in that wheel, and we know that we need to make sure that we can commercialize the work that is being done that we can continue to drive the technology in ways that will amaze and astonish people out in the Country.

When we talk about the challenges of how to implement the

policies that would encourage CCUS in this Country, it was clear that closing the financing gap through the FUTURE Act was critical, but merely doing that one piece wasn't enough.

It was before this very same Committee last year where the FUTURE Act was being discussed during a hearing on expanding and accelerating the deployment and use of CCUS and questions were posed to the witnesses about what additional challenges existed and what further policies we needed to promote CCUS. The response was clear: there needed to be a comprehensive approach that looked across the entire Federal and State regulatory policies to better coordinate and establish an environment where CCUS projects are not burdened by long lead times or duplicative and unnecessary regulations, and that we needed to build out the infrastructure necessary to move the CO2 from the source to those areas that are best able to utilize it as a by-product.

As a result of that hearing, Chairman Barrasso took the lead on addressing some of those very concerns, and I happily joined him and my colleagues, Senators Whitehouse and Capito, in that effort.

The USE IT Act directs EPA and CEQ to prioritize and take lead roles at the Federal level in supporting CCUS and direct air capture research, and establishing guidance for project developers and operators that will allow better coordination and facilitation of these projects. It also clarified that existing

policies facilitating the buildout of infrastructure projects are applicable to CCUS projects and CO2 pipelines.

While I will admit I am biased when it comes to advancing this bill and these policies, North Dakota is at the forefront of developing CCUS projects if the right conditions are met. As of yesterday, we are the first State in the Country that has been authorized by EPA to regulate Class 5 injection wells. We have three CCUS projects at various stages of planning. Red Trail Energy in Richardton is looking to capture and store CO2 from an ethanol plant. Project Tundra is looking to add carbon capture equipment to the back end of an existing coal-fired power plant in the Allam cycle project that could be fueled by synthetic gas produced at our great lignite coal resource in our State. It is really quite amazing.

All of these projects are not what we called in the old days vaporware. They are real, they are being developed every day, they are being invested in by the State and by private entities in the State of North Dakota, so we are ready to go. We are ready to go if the conditions are right.

To that point, I would like to submit several records or several letters in support of the USE IT Act. I want to make this point because I think sometimes we talk a lot about saving jobs and doing what we can to make sure people stay working. These employers represent thousands of jobs in my State, and

even more jobs if we look at the indirect benefit of this value-added industry to my State. So, I would like to submit these letters in support.

Senator Barrasso. Without objection.

Senator Heitkamp. Thank you.

[The referenced information follows:]

Senator Heitkamp. The impressive panel of witnesses that you have assembled to follow me are in a much better position to get further into the details of why this bill addresses some of those challenges laid out in the September hearing. What I can tell you is that I am certain that these efforts will lead to breakthroughs that provide for economic and employment benefits to our Country and provide long-term technological solutions that will allow for the continuation of an all-of-the-above energy policy, all while addressing climate challenges by greatly reducing carbon emissions.

I want to make one final statement. I think that when we are looking back at our legislative careers and we are thinking how did we do, did we just stand in our corners and shout across the void and across the divide? Occasionally something will come up where we will say we walked across, we sat down, we figured it out, and we did something that actually made a difference in the United States Congress.

I think this effort is exactly that and I think all of us who have worked on this, especially the four of us who have been particularly engaged, will have something to talk about. We will have an example of the kind of leadership that we have exhibited while we are here, and I think this not only has been a wonderful piece of policy, it has been a wonderful example of

how friends and colleagues can get together to actually move important policy for the people of this Country.

So, I proudly join and support all of my co-sponsors and I encourage a quick resolution out of this Committee and hard work on the Floor of the Senate to get this thing passed in the United States Senate.

Thank you, Mr. Chairman, for this opportunity.

[The prepared statement of Senator Heitkamp follows:]

Senator Barrasso. Thank you very much, Senator Heitkamp. Glad you could join us today. Appreciate it.

Senator Heitkamp. Thank you.

Senator Barrasso. At this time, I would like to call our four witnesses to the table.

We will now hear from our witnesses, and I am pleased to introduce Dr. Mark Northam, who is the Director of the University of Wyoming's School of Energy Resources. Prior to his service at the University, he has had extensive research experience in the private sector. Additionally, he has worked as a research science consultant in the areas of carbon management and technical intelligence at the Research and Development Center at Saudi Aramco. Dr. Northam also worked at Mobil and Exxon Mobil for over 20 years, where he held a variety of research operations and managerial positions.

I want to thank you for your willingness to testify today.

Additionally to Dr. Northam we have Dr. Julio Friedmann, who is the CEO of Carbon Wrangler, LLC.

It is good to see you again. Welcome back to the Committee. We appreciate your insightful testimony at the hearing last September on carbon capture and we look forward to hearing your insights today.

Next is Noah Deich, who is the Executive Director of the Center for Carbon Removal; and Dr. Feng Jiao from Senator

Carper's home State of Delaware.

Senator Carper, would you like to add any few words of introduction?

Senator Carper. Isn't that a great name, Feng Jiao? It means common sense. No, it doesn't really, but it could, because this is very much a common-sense approach, I think.

After finishing his post-doctoral research at the Lawrence Berkeley National Laboratory, Dr. Jiao joined the faculty at the University of Delaware I think in 2010. Was it 2010?

Mr. Jiao. Yes, 2010.

Senator Carper. Chemical and Biomolecular Engineering Department. Today he is still at that department at the University of Delaware, serves as an Associate Professor. He is also the Associate Director for the Center for Catalytic Science & Technology. His current research focuses primarily on converting carbon dioxide into valuable chemicals.

Dr. Jiao has published more than 50 articles.

Is that true?

Mr. Jiao. Yes, that is true.

Senator Carper. Okay. More than 50 articles in leading scientific journals, such as the Journal of American Chemical Society, regarding his work in electro chemistry and nano materials. Just last year he was awarded $1 million by the Department of Energy to further his work on carbon capture and

utilization. In addition, Dr. Jiao started a company called CO2 Energy LLC specializing in carbon capture and utilization.

We welcome you, Dr. Jiao. It is great to see you. Happy that the First State is represented on both sides of the dais. Thank you.

Senator Barrasso. I want to remind the witnesses that your full testimony will be made part of the record of the official hearing today, so we please ask you to keep your statements to five minutes so that we have time for questions. Look forward to hearing your testimony.

Dr. Northam, please begin.

STATEMENT OF MARK A. NORTHAM, EXECUTIVE DIRECTOR, SCHOOL OF ENERGY RESOURCES, UNIVERSITY OF WYOMING

Mr. Northam. Thank you. Chairman Barrasso, Ranking Member Carper, and members of the Senate Committee on Environment and Public Works, thank you for inviting me to testify on the Utilizing Significant Emissions with Innovative Technologies Act, or USE IT Act.

Senator Barrasso, thank you for the introduction. You took away the first 10 minutes of my testimony.

For those of you who are here to see the other Mark, I think he was here today and he is over in the House today, so sorry if you are disappointed.

I came to the University following 26 years in the oil and gas industry. I have had the privilege of working on carbon dioxide utilization and storage issues, technologies and policies for the bulk of my career.

For example, I was a technology leader with the Sleipner CO2 Storage Project in the Norwegian offshore from its inception. Sleipner CO2 Storage Facility was the first in the world to inject CO2 into a dedicated subsurface reservoir for the purpose of storage. The Sleipner facility has captured CO2 at the Sleipner area gas development since 1996. The captured CO2 is directly injected into the offshore sandstone reservoir.

Nearly a million tonnes of CO2 is injected per annum, and over 17 million tonnes has been injected since inception.

My work with carbon capture, utilization, and storage continues through the present day at SER, the School of Energy Resources. We continue to conduct important research related to the geologic storage of CO2 in saline aquifers, and to improve carbon dioxide-motivated enhanced oil recovery operations.

The State of Wyoming is an ideal jurisdiction to advance research and projects related to capturing and utilizing emissions of CO2. For example, the Wyoming legislature provided for the development of an integrated test center to serve as an operational test site for CO2 capture and utilization technology developers. The Wyoming Infrastructure Authority led the development of the site with the support of many private- and public-sector entities in Wyoming.

The ITC will soon host five semifinalists of the coal-track of the $20 million NRG COSIA Carbon XPRIZE, a global competition to develop breakthrough technologies that convert CO2 emissions from fossil fuel combustion into products with the highest net value. Competitors in this program are developing processes that utilize CO2 in the production of, for example, enhanced concrete, biofuels, nanotubes, and fertilizers. In fact, the Carbon XPRIZE finalists were announced Monday evening in New York City, and five of these finalists will be operating by the

end of this calendar year in Wyoming.

Wyoming is also one of a handful of States with existing CO2 pipeline infrastructure to serve an active enhanced oil recovery industry. The State has also planned for future expansion of the network through ongoing efforts of the Wyoming Pipeline Corridor Initiative, primarily for providing CO2 to parts of the State with significant demand for supply.

I am pleased to testify today in support of the USE IT Act. My testimony focuses on carbon dioxide utilization section of Title I, which amends section 103 of the Clean Air Act to authorize the U.S. Environmental Protection Agency to support certain CCUS-related research and development activities by the States, institutions of higher education, and others.

Title I of the USE IT Act, in part, authorizes the EPA to carry out a research and development program for carbon dioxide utilization to promote technologies that transform carbon dioxide generated by industrial processes into a product of commercial value, or as an input to products of commercial value. The bill defines carbon dioxide utilization as technologies or approaches that lead to the use of carbon dioxide through fixation of CO2 through photosynthesis or chemosynthesis, such as through the growing of algae or bacteria; the chemical conversion of CO2 to a material or chemical compound in which the CO2 is securely stored; and the

use of CO2 for any other purpose for which a commercial market exists.

The EPA is to provide technical and financial assistance to certain eligible CO2 utilization projects, with the eligibility criteria including access to an emissions stream from a U.S.-based stationary source that is capable of providing not less than 250 metric tonnes of CO2 per day.

I support these provisions. Not only do they create another source of critically needed funding for the CCUS-related research and technologies, but also they apply to a broad swath of potential CCUS technologies. Eligible technologies include the use of CO2 for any other purpose for which commercial markets exist, which I interpret to include CO2-EOR.

Moving to Title II, the USE IT Act first explicitly makes certain CCUS-related projects, including CO2 pipelines, subject to the 2015 Fixing America's Surface Transportation Act, or FAST Act. The FAST Act seeks to streamline Federal environmental review and permitting, reducing bureaucratic redundancies for certain large infrastructure projects and, second, directs the Chair of the White House Council on Environmental Quality, in consultation with EPA, DOE, and others, to prepare guidance to facilitate reviews associated with the deployment of CCUS projects and CO2 pipelines.

I support these provisions as well. In addition to

financial challenges, CCUS projects face unfortunate headwinds caused by well-intended, but nonetheless, arguably, counterproductive Federal policies. These policies include time-consuming reviews under NEPA, which is a specific challenge for States such as Wyoming that have significant areas of Federal lands. The Underground Injection Code under the Safe Drinking Water Act also arguably stands as an impediment to CCUS projects due to aspects of the Class VI CO2 injection storage regulations that are difficult, if not impossible, for the private sector to utilize. Title II of the USE IT Act should go some way towards ameliorating these and related challenges facing CCUS projects and technologies.

This concludes my testimony. I am pleased to testify today in support of the USE IT Act. The ongoing Federal role in supporting CCUS research at institutions of higher education is imperative.

Mr. Chairman, Ranking Member Carper, and members of the Committee, I would be pleased to answer any questions that you may have. Thank you.

[The prepared statement of Mr. Northam follows:]

Senator Barrasso. Thank you so much, Dr. Northam, for being here today.

Dr. Friedmann.

STATEMENT OF S. JULIO FRIEDMANN, CHIEF EXECUTIVE OFFICER, CARBON WRANGLER, LLC

Mr. Friedmann. Mr. Chairman, Ranking Member Carper, all the distinguished members of the Committee, thank you so much for inviting my testimony. I am honored to return. I believe last time I was here I was pleased and proud to serve as a Minority witness. Today I am pleased and proud to serve as a Majority witness.

My name is Julio. Until recently, I served as the Senior Advisor for Energy Innovation at the Lawrence Livermore National Laboratory. Prior to that, for about two and a half years, I was the Principal Deputy Assistant Secretary at the Office of Fossil Energy and happy to serve under Secretary Moniz there. I have spent 17 years working on clean energy technology and development, most of that focused on CCUS, and mostly from Lawrence Livermore National Lab.

My testimony last September focused on CCUS as a technology set. Since then, a sea change has occurred regarding this critical and important technology. Much of this is the result of the passage of the FUTURE Act. In my own travels around the world, we are the talk of the town and carbon is the new black.

The Act will greatly enhance the ability of commercial CCUS projects. It will attract financing and it has already

reaffirmed the United States unambiguously as the leader worldwide in CCUS development, deployment, and policy.

Because of that financial support for the FUTURE Act, the rate of CCUS deployment is now limited by a different set of issues. Some of those issues are associated with the cost of technology; some of them are associated with the use of carbon dioxide itself; some of them are associated with regulatory issues and permitting issues.

As such, I am pleased to see the USE IT Act bill. I am pleased to testify in support of it. I believe that the USE IT Act will ultimately lower hurdles to investment; it will lower barriers to deployment; and ultimately it will serve the development, deployment, and export of this important clean energy technology.

I just want to speak very briefly about direct air capture. This is something I have spent a lot of time working on and believe that this is an underserved and important technology option.

There are simply some sources of carbon dioxide that mankind emits that are hard to manage, and, in doing so, dealing with those will prove to be very expensive. Direct air capture technology today already beats the cost of many of those options, and those costs are coming down fast. There are at least three companies that are developing and deploying this

technology worldwide, and I have been very impressed by the rate of progress. That said, there remains substantial technical challenges, which is part of the reason to have substantial focus on the research and development of them.

The same thing can be said about the use of carbon dioxide and conversion to valuable products. We are seeing, again, a lot of interesting technologies developed and a lot of interesting companies out there. The venture community, the equity companies, the banks that are looking at these companies have uniformly said, gosh, these are cool; wish we had 100 more like them behind it. There are simply not enough shots on net, there are not enough companies being fielded and deployed, and there needs to be a larger innovation thrust in order to get those technologies to market.

In that context, Title I of this bill I think provides a pathway to doing so. In my own experience at the Department of Energy, we fielded a solicitation in this arena. We would love to see more work of that kind. It would be my hope that if the EPA has this research program and begins it, that they would actually partner with the Department of Energy in thinking about a good way to structure and execute such a program.

With respect to CO2 infrastructure otherwise, in many ways the United States has already demonstrated its prowess in fielding and managing CCUS infrastructure. The current network

of about 5,000 miles of CO2 pipelines, the creation of class II and class VI statutes under the EPA and under the Safe Water Drinking Act, and, in fact, programs like the long-lived regional Carbon Sequestration Partnerships have all been important to actually get this infrastructure up and running.

However, there are still shortcomings to these programs. The infrastructure elements that are out there limit deployment in the market in many ways. These are in my written testimony and I ask for you to review those.

Many groups have acknowledged that there is a shortage in this infrastructure and that they prevent a limitation. These pipelines, these storage sites are going to be anchors for commercial development; they are going to be anchors for future manufacturing in a new carbon economy; they are going to be anchors for communities who want to preserve jobs or have growth.

Among other things, the Department of Energy's Quadrennial Energy Review volume 1.1, the work from the Global CO2 Initiative, the State CO2-EOR Working Group have all identified the critical issue of pipeline permitting and pipeline deployment in order to get this technology up and running. The most important of these pipelines will actually have to be built in States that don't have an EOR opportunity, which are unused to the permitting and deployment of these. So, having pathways

that will make it faster and easier for investors to look at the risks and say, yes, we understand that we want to build this thing and that the risks and the costs associated with it are realistic and manageable is an important outcome of a bill like the USE IT Act.

I could go on, but the punchline here is if we want to get beyond 10 or 20 million tonnes of deployment, if we want to get to 50 to 100 million tonnes of deployment of CCUS, we will need to get this kind of infrastructure up and running.

[The prepared statement of Mr. Friedmann follows:]

Senator Barrasso. Thank you very much, Dr. Friedmann. Always a pleasure to have you here.

Mr. Deich.

STATEMENT OF NOAH DEICH, EXECUTIVE DIRECTOR, CENTER FOR CARBON REMOVAL

Mr. Deich. Good morning to the members of the Committee, and thank you for your invitation to testify.

I am the Executive Director of the Center for Carbon Removal, a nonpartisan, nonprofit organization based in the Bay Area of California. Our mission at the Center is to build what we call a new carbon economy. The essential feature of the new carbon economy is the pursuit of strong economic growth fueled by innovative strategies for cleaning up carbon from the air in a way that protects the environment. The essential strategies for achieving a new carbon economy include the carbon capture technologies advanced in the USE IT Act, as well as other forestry, agriculture, and industrial approaches for transforming carbon pollution back into a valuable resource.

In my testimony today, I will share why I believe the goals of the USE IT Act and other Federal policy efforts to advance a new carbon economy are so valuable and why bipartisan improvements to the USE IT Act could help it achieve greater positive economic and environmental impact.

To begin, the co-sponsors of the USE IT Act, Chairman Barrasso and Senators Capito, Heitkamp, and Whitehouse, deserve immense credit for designing this bill to support innovative

carbon capture technologies that will be essential for future American economic competitiveness and climate leadership.

In my work, I see businesses, investors, and climate champions alike increasingly embrace both the direct air capture technologies, which use clean energy to filter carbon from ambient air, and the carbon use systems, which harness CO2 to produce valuable products like building materials or clean fuels that are supported by this Act. We need these technologies to halt climate change.

And if we support research development and demonstration of these technologies domestically today, exactly like the USE IT Act does, we can ensure that the U.S. exports, not imports, direct air capture and carbon use systems in the decades to come, creating good jobs and wealth creation in geographies across America.

In addition, the USE IT Act is highly complementary to the 45Q tax credit, which was reformed earlier this year to include both direct air capture and carbon use systems.

Just as Julio has mentioned, I have seen 45Q improve the investment outlook for carbon capture technologies nearly overnight. But for this policy to advance, the full suite of carbon capture solutions, additional Federal investment in R&D across agencies is needed to make new solutions like direct air capture and carbon use more economically competitive.

The bipartisan nature of 45Q also provides an important model for advancing this legislation. I see bipartisanship as essential, as the investors and companies that we work with need to have confidence that any legislation will endure through routine political transitions.

The main concerns that I have heard about this legislation come from environmental groups, who primarily worry that components of this bill could lead to the erosion of foundational environmental loss. Ensuring that the amendment process for the USE IT Act is done in a bipartisan manner and that the language in the bill is bolstered to ensure that it will not be used to weaken valuable environmental laws will be essential for building support for this bill from those environmental constituencies.

I am actually very hopeful that the bipartisan process exemplified by 45Q can be a model for addressing concerns about the USE IT Act swiftly. Congressional legislation aimed at building a new carbon economy can steer us towards a future where we solve climate and economic challenges hand-in-hand.

I applaud this Committee for its leadership in pioneering the next generation of these carbon capture technologies, and I would also like to use this opportunity to invite the members of the Committee to join us at the Center for any future events related to building a new carbon economy, and I hope that we can

be a resource to you all moving forward.

Thank you for the opportunity to testify today, and I look forward to your questions.

[The prepared statement of Mr. Deich follows:]

Senator Barrasso. Thank you so much for your thoughtful testimony.

Dr. Jiao.

STATEMENT OF FENG JIAO, ASSOCIATE PROFESSOR OF CHEMICAL & BIOMOLECULAR ENGINEERING AND ASSOCIATE DIRECTOR FOR THE CENTER FOR CATALYTIC SCIENCE & TECHNOLOGY, UNIVERSITY OF DELAWARE

Mr. Jiao. Thank you, Mr. Chairman, and thank you, Senator Carper, and the rest of the Committee. My name is Feng Jiao. I am Associate Professor of Chemical and Biomolecular Engineering at the University of Delaware. I also serve as the Associate Director for the Center for Catalytic Science and Technology.

My research group currently raised support from NASA and Department of Energy, as well as the National Science Foundation to develop new CO2 utilization technologies.

As a critical component in CCUS, carbon utilization holds the key to generate revenues which can offset the capture cost, as well as the initial investment. An example is CO2 enhanced oil recovery technology, a most successful approach to utilize CO2 and generate revenues. To fully utilize this kind of technology, additional capital investment in CO2 pipelines and infrastructure are often required. In principle, the carbon capture facility could be built right next to the utilization site.

A good example is a Swiss company called Climeworks, who built the first commercial plant to capture carbon dioxide directly from air and sells locally to greenhouse for profit.

The facility actually can capture up to 900 tonnes of CO2 per year. The concept is very appealing, of course. There are some technical challenges for these kinds of technologies. One of them is the capture cost is still high compared to other carbon capture technologies.

At the University of Delaware, we are actively developing alternative approaches to utilize CO2. Thanks to the recent award from the Department of Energy National Energy Technology Laboratory, we are able to develop an electrochemical system which can convert carbon dioxide into useful chemicals. The so-called CO2 electrolyzer can produce useful chemicals, such as ethanol, ethylene, and syngas, from CO2 and water.

The technology is intrinsically scalable and ideal for distributed systems at CO2 point sources. If powered by low-cost renewable electricity, the CO2 electrolysis technology could provide a profitable approach to use CO2 as the carbon source for commodity chemical production.

At Delaware, we also established a start-up companied called CO2 Energy LLC to commercialize the CO2 electrolyzer technology. Large international energy companies, such as Shell and TOTAL, are also actively involved in developing this kind of technology. Because of these efforts, the performance of CO2 electrolyzers have been rapidly improved recently. Of course, the technology itself is still premature for commercial

deployment, so more R&D efforts and more investment is urgently required in the United States to further this technology so that we can be the global leader in this clean air technology.

Again, innovations in CO2 utilization are much needed because this is the only way to generate revenue streams for CCUS. Any CCUS operation fully relying on government subsidies is not sustainable. I fully support further investment in advanced CCUS technologies and I will be happy to answer any questions you may have. Thank you.

[The prepared statement of Mr. Jiao follows:]

Senator Barrasso. We are very grateful for your testimony. Thank you for joining us today from Delaware.

We will start with rounds of questions for five minutes, and I will start with Dr. Northam, if I could.

The State of Wyoming's leadership in carbon capture and utilization is very impressive. Through the University's work and initiatives like the Integrated Test Center in Gillette, Wyoming has already established itself as an innovative hub. The recent passage of the FUTURE Act has spurred interest in investment in carbon capture projects.

Do you think the USE IT Act's focus on permitting capture projects and pipelines is going to increase the interest that you are seeing, and can you explain why?

Mr. Northam. Thank you, Mr. Chairman. There is a large demand for carbon dioxide for enhanced oil recovery in the State of Wyoming, a demand that cannot be met by traditional supply. For example, in the Big Horn Basin, where there is no supply of CO2 today, there is easily a billion barrels of incrementally recoverable oil if we had access to CO2.

Infrastructure is certainly a large obstacle. The FUTURE Act has great potential for incentivizing anthropogenic CO2 availability. The USE IT Act's impact on easing the development of infrastructure --

Senator Carper. What is anthropogenic?

Mr. Northam. I am sorry. Anthropogenic CO2 is carbon dioxide that has been captured from some source that is created by man, combustion of coal, fossil fuels, or some industrial process, as opposed to natural CO2 which we use today, which is carbon dioxide that is stripped from natural gas where the two are comingled in the reservoir.

Senator Carper. The Chairman and I knew this. We just wanted to make sure our colleagues did, so thank you very much for your clarification.

Mr. Northam. Yes, I assumed that you knew that.

[Laughter.]

Mr. Northam. But I apologize. I will be more careful.

Senator Barrasso. That was for the record only. Everybody here knew it. Everyone here on the panel knew it.

Mr. Northam. It comes from the Latin. No, never mind.

[Laughter.]

Mr. Northam. The USE IT Act's impact on easing the development of infrastructure is the next step in the process of developing infrastructure, so I would say that, absolutely, yes, the USE IT Act has a great potential for not only spurring the carbon capture and utilization side of the process, but will have an economic impact on the State of Wyoming.

Senator Barrasso. Dr. Friedmann, if I could go to you. What I want to point out is you mention in your written

testimony the current scale of CO2 pipelines is inadequate, inadequate to support widespread carbon capture projects.

Don't we need a coordinated and rapid buildout of CO2 infrastructure in the Country to meet the projected needs, and would the USE IT Act address that need?

Mr. Friedmann. Thank you. Yes, this is not the first time this question has been asked or studied. Back in 2008, Pacific Northwest National Lab did a fairly comprehensive study to figure out how much CO2 pipeline network we needed in this Country, and their estimate was, to hit our goals by 2030, we needed something on the order of 20,000 to 30,000 miles of CO2 pipelines; and we also needed them in areas that are not traditional EOR provinces.

We needed them in places where they could provide access to sale and formation storage, and a lot of those are actually in the Midwest, in particular, Illinois, Indiana, Ohio, West Virginia, Pennsylvania, Michigan. These are States that currently lack CO2 infrastructure, but would benefit from the ability to store CO2.

As I said earlier, and I want to underscore this point, that infrastructure, like any other substantial shared infrastructure, becomes a magnet for industry; becomes a magnet for development; becomes an opportunity for economic growth, so I see these things as highly complementary and positive.

Senator Barrasso. Dr. Northam, you talked about carbon dioxide being used in enhanced oil recovery. Part of the purpose of the bill is also to promote research in additional uses of carbon. It is going to allow carbon dioxide to have commercial purposes even in areas across the Country that aren't blessed, like we are in Wyoming, with oil resources.

Can you talk a little bit about how this bill could encourage research in those other areas as well?

Mr. Northam. Thank you, Mr. Chairman, yes. Wyoming's Integrated Test Center is an example of how this bill will encourage research into other uses. It provides a facility with adequate space for research and access to significant emission stream; it provides space for scale-up of successful projects, which I would say is our most critical need at this time; and it provides for competitive funding to be put to work.

All of these elements, especially the stated support for scale-up, are critical to the success of CO2 utilization schemes. The ITC went from concept to reality rapidly, but there is still a need for additional programs like the ITC to expand and sustain this effort, and I believe that that is a critical deliverable from the USE IT Act.

Senator Barrasso. Dr. Friedmann, section 202 of the bill I think is critical. This section brings stakeholders together to promote the development of capture projects in CO2 pipelines

across the Country. How would this part of the USE IT Act address the need for better State and Federal coordination, a point that you raised in your written testimony?

Mr. Friedmann. Thank you for asking, and happy to discuss. One of the things that is the case is that we haven't actually deployed a lot of CO2 storage wells. We haven't deployed a lot of carbon capture facilities in this Country. As a consequence, we haven't actually tested or coordinated the existing regulatory base that is out there; and in many cases what we have there we recognize can be an impediment.

Just as one example, there has only been one class VI well permitted in this Country. There haven't been a whole bunch of people asking to permit them, but there has been one request and one permitted. It took 54 months. It took a very, very long time, and that is a hurdle to investors.

If people are looking at this and say it is going to take six years to get the pipeline built, while it is going to take five years to get the well permitted, then it makes it much harder for them to make the investment decision to build whatever needs to be built, including this kind of infrastructure.

And I mention this specifically because the wise individuals who put together the FUTURE Act also put together a fuse on it. You have to have projects begin construction by

January 1st, 2024; and that timeline is actually a very good one, it creates an incentive for people to get busy and get moving.

However, if people can overcome the financial hurdle and then see a regulatory hurdle behind it that they think will limit the chance for them to take advantage of those tax credits or take advantage of the opportunities that CCUS projects and technologies provide, then it will just limit the pool of applicants, it will limit the projects, and it will limit deployment.

Senator Barrasso. Thank you.

Senator Carper.

Senator Carper. Thanks, Mr. Chairman. Again, our thanks to all of you. Every now and then we ask unanimous consent to enter for the record a question or series of questions, and I would ask unanimous consent, Mr. Chairman, a letter from 14 environmental groups that have some concerns about Title II of the legislation.

Senator Barrasso. Without objection.

Senator Carper. Thanks very much.

[The referenced information follows:]

Senator Carper. Let me start off, if I could, with Dr. Jiao. Thank you so much for your work at the University of Delaware. You make us proud every day. Is anybody here with you from the University of Delaware, like anybody from Angie's List over your left shoulder? Angie, welcome. And for others who might be here who are also part of Blue Head Nation. Thank you.

Dr. Jiao, in your opinion, what is the smartest way we could be investing Federal dollars to ensure that carbon capture and utilization become mainstream? And why is your work at the University of Delaware so important for a carbon-free future?

Mr. Jiao. Thank you, Senator. So, I think the key to get people onboard, particularly the people from industry, is to make CCUS profitable. So, I think I concur with some of the earlier points by made by Senator Whitehouse, as well. In the past, the investment in CCUS was mostly on the capture side and storage. Although such technology is fantastic and we definitely need it, I don't think it can generate any revenue, which becomes the problem because this is not a sustainable business by itself.

So, I believe we should pay more attention to the utilization side, particularly I think the USE IT Act actually creates a lot of efforts in moving towards that direction, which

I am really glad to see.

We work on universal data which is actually kind of motivated by this motion. We are trying to make the utilization more favorable or economically more favorable compared to other technologies on the market, and if we can find a way to make CO2 into some valuable chemicals, that will potentially disrupt the current chemical production process. Mostly, we use derived carbon source, but now we can move away from that using CO2 instead, and I think that will actually help us to reduce the CO2 emissions.

Senator Carper. All right, thank you.

I want each of you to answer this question very briefly, and if you say no way, that would be okay too.

Almost every piece of legislation I have introduced, and sometimes with colleagues that are here today on this Committee, it is rare that I introduce legislation that is perfect. Maybe never. I would just say, Dr. Jiao, if you had to pick maybe one area that we could improve this legislation, very briefly, what might that be? Then I am going to ask our other witnesses to do the same. Just one area where you think we can actually make an improvement, please. Just briefly.

Mr. Jiao. I think my work quite recently is mostly funded by DOE, so I think DOE has a lot of experience investing in these carbon capture utilization technologies, so the bill

actually is going to ask EPA to administer these efforts, so I think probably they should coordinate across the agency somehow so they then will make the investment more efficient.

Senator Carper. Thank you.

Mr. Deich?

Mr. Deich. Thank you, yes. I think section 202, with the Task Force, can be strengthened, both to build on what Dr. Friedmann said, around the environmental integrity for storing carbon long-term, as well as for understanding really what the frontier of the regulations need to look like, especially around carbon use and the carbon accounting there. I think the National Academies are a great resource, so coordinating with them for implementing this task force would be very valuable.

Senator Carper. Good. Thank you.

Dr. Friedmann? Do you pronounce your name Julio?

Mr. Friedmann. Yes, sir, Julio.

Senator Carper. Good, the right way.

Mr. Friedmann. Super quickly, a different variant on what Dr. Jiao said, it would be great to have DOE engagement in this process because they understand how to do this and it has been a while since the EPA has executed research of this type. They would be strengthened by having that joint partnership.

I would also agree with Mr. Deich about the opportunity to try to strengthen and clarify the purpose of section 202, that

you want to ensure that you do in fact find ways to amend and improve the permitting and the regulatory aspects of this without actually endangering key environmental provisions. And if there is some way to add language that would strengthen and clarify those goals, I think that would probably be valuable.

The last point I would just make is there is in fact a need to have improved lifecycle analyses and understanding of the true carbon emissions associated with all of this work. Having that maybe under NIST, maybe some other organization, maybe the EPA, but trying to find a way to formalize the standards around these kinds of technologies would be helpful.

Senator Carper. Okay, good. Thanks.

Same question, Dr. Northam.

Mr. Northam. Thank you very much. So, I would cite two simple ways that I think this could be improved. Title 101 that focuses on air capture, I would love to see it expanded to focus on any type of capture of CO2. Capture from point sources is critically important. The technologies are farther along in terms of their development, so supporting the deployment of that I think would be an important improvement.

The second would be to not only focus on research, but one of the most critical needs for technology developers is funding for the development and scale-up process, and that is the valley of death that tends to be very difficult for inventors and

innovators to overcome, so some addressing that part of the process would also, I think, improve this Act.

Senator Carper. Great. Thank you all for those responses.

Thanks, Mr. Chairman.

Senator Barrasso. Thank you, Senator Carper.

Senator Inhofe.

Senator Inhofe. Thank you, Mr. Chairman.

Let me just make an observation here that I don't think anyone has made yet, and it has to do with fossil fuels. I can remember nine years ago, when President Obama first came in, he had this commitment to do away with fossil fuels, and I can remember going back to Oklahoma. I remember it so well because it was Shattuck, Oklahoma. I doubt any of you have ever been to Shattuck, Oklahoma. Someone said, Senator Inhofe, I don't quite understand. We have a president who is against fossil fuels, coal, oil, and gas, and yet that is accountable for 80 percent of the energy it takes to run this machine called America. He said, now, if he is successful in doing away with it, how do we run the machine called America?

That was a logical question and we dealt with that for a long period of time. Now, today, we have an answer, and I think this is really exciting. This is something that is a recognition that we will have to continue to use fossil fuels as a major part of our energy supply in a way that satisfies

everyone. So, it is one of these rare cases where you have a lot of agreement from people who have disagreed in the past.

Dr. Friedmann, I was here for the opening statements. We go back and forth because we have nine members in common between this Committee and the Commerce Committee, so you are seeing people come and go. But I remember you made recognition in your opening statement to the FAST Act permitting reform, and I think more people need to talk about that, because we can get things done. The FAST Act is a good example. We did the FAST Act primarily because of that permitting reform. We are able to do things on a timeline that can be enjoyed by all Americans, so I appreciate your bringing that up.

Dr. Friedmann, your testimony illustrates a problem that exists regarding the need for CO2 pipeline infrastructure and its effect in deploying the CCUS in the United States. Now, specifically, I will read the quote that is the basis of my question: "Ambiguities in the process or delays in permitting directly affect the financial viability of projects and their ability to attract investors."

What are the roadblocks that you see out there that are in the development of the CO2 pipeline?

Mr. Friedmann. Thank you for asking.

Senator Inhofe. You know, I think about it, it might have been --

Mr. Friedmann. Dr. Northam.

Senator Inhofe. -- Northam who brought up the question on permitting, so I am sorry. Either one of you guys.

Mr. Friedmann. You want to talk about section 201?

Mr. Northam. You go ahead.

Mr. Friedmann. All right, I will go.

It is sad, but true, pipelines are orphaned in this whole discussion. A lot of people are happy to run storage projects, EOR projects, even capture projects on industrial plants, power plants. Not a lot of people want to build or operate the pipelines, so it is hard to gather the financing to build them. So, it is born problematic; it is just one of those parts of the system that is hard to get done.

So, if people look at the setup and say, wait a second, I am not sure if the permit will go through, or I think it will take a very long time and I am going to be paying interest on capital before anything gets built, it just chills the investment environment. It is just that simple. It is hard to pull together an investment of that scale and size. Many of these pipelines will cost hundreds of millions of dollars to build, and that is not easy to pull together.

Senator Inhofe. Yes, good.

Dr. Northam, the Integrated Test Center in Wyoming will be used to test different ways to repurpose carbon dioxide from a

coal-fired power plant. I am really interested in the repurposing element of this and I would like to have you elaborate on your feelings how successful this could be and what we need to do to give you the resources you need to make this happen.

Mr. Northam. Thank you for the question. So, the chemistry of converting carbon dioxide into anything else is very difficult. It is a very energetically stable molecule, so we need research to understand how to go from an energetically stable molecule into other products. A lot of what we use today is carbon-based products, plastics, petrochemicals, fuels, so it is entirely doable. The question is can we do it efficiently and at a cost that competes with other sources of carbon.

Integrated Test Center has overcome some of the big hurdles for people who are working in this arena by providing not only an emission stream, but space for them to work. And then enterprises like the XPRIZE and some of the competitions that are promised in the USE IT Act are going to spur people to take on these difficult problems because the prize at the end of the pipeline, if you will, is significant.

Senator Inhofe. My time has expired, but I would be interested, for the record, in any of the rest of you who have ideas and thoughts on the repurposing element of this, and I would like very much to have the benefit of that, if you don't

mind doing it. Any comments right now, but my time has expired.

Mr. Deich. I will volunteer quickly that I think there is an important role of sequestering carbon in building materials, whether that is cements, roads, et cetera; and that the Federal Government can play a large role in being a first customer and a driver of those markets. So, the extent to which we can build on the first title of this bill to support those utilization technologies in our built environment will be very valuable.

Senator Inhofe. Good.

Any other comments for the record.

Thank you, Mr. Chairman.

Mr. Friedmann. I would agree that building materials, in particular concrete and cement, is very important. We move 55 billion tons of concrete every year around the world. That is a big sink; and actually adding CO2 to it improves the performance and makes it heavier and makes it more durable. There are a lot of good things that come from it.

Eventually, we will also reach a day when we will directly convert carbon dioxide into fuels. Right now that costs about twice or three times what a conventional liquid fuel would cost, but if in fact you can pull carbon dioxide out of the air and you can upgrade it to a fuel, then you have a circular economy.

What I do believe is every major oil and gas company is looking at that. They are not going to deploy it anytime in the

next five or ten years, but they all see that that is something that they need to track and would like to figure out a way to offer something like that to their customers. CCUS technology is helpful.

Senator Inhofe. That is fascinating.

Thank you, Mr. Chairman.

Senator Barrasso. Thank you very much, Senator Inhofe.

Senator Whitehouse.

Senator Whitehouse. Thank you, Chairman. I appreciate being here today on a matter where, to quote Senator Inhofe, we have agreement from people who have disagreed in the past; and indeed disagree in the present; and indeed will continue to disagree in the future about many things.

Senator Inhofe. But every time we have agreed it has been very successful. You look at the chemical act, the FAST Act.

Senator Whitehouse. I have learned that when we agree, Senator Inhofe is perhaps the most effective legislator in the Senate. Certainly, I have seen nobody produce more. So, we just need to find out how to agree on more. But I really appreciate this and look forward to working with my colleagues.

I guess what I would ask in my time is the record be clear what the sort of baseline proposition is here, why it matters to reduce our emissions of carbon dioxide, our anthropogenic emissions of carbon dioxide, starting with Dr. Northam.

Why are we doing this? Why does it matter? What does this help?

Mr. Northam. Senator Whitehouse, thank you very much. On Saturday I was on a panel with the ambassador from the EU to the United States, and one of the statements he made was Europe got over the hurdle of recognizing that carbon dioxide was contributing to global warming 20 years ago and has a very effective set of policies and procedures for reducing the CO2.

I think it is important because time is ticking. Most of the scientific community recognizes that CO2 is contributing to global warming; we are starting to see the impacts of it. These solutions are extremely technically difficult and expensive, and if we don't start actually making some progress, the progress we do make could be too late for staving off these major impacts.

Senator Whitehouse. Plus, other countries might steal a march on us technologically.

Mr. Northam. Absolutely.

Senator Whitehouse. Same question, Dr. Friedmann.

Mr. Friedmann. Thank you, Senator. All of this actually flows back in a real politic context; not in a scientific context, but in a real practical politics concept back to the Paris Agreement, and this is completely independent of whether or not the United States remains in it, although I personally think that would be a lovely thing.

First of all, the punchline is that greenhouse gases emissions represent a threat to national security of the United States; they represent a threat to our --

Senator Whitehouse. And carbon dioxide.

Mr. Friedmann. Sorry?

Senator Whitehouse. Carbon dioxide is one of those greenhouse gases?

Mr. Friedmann. Carbon dioxide is the most important of those.

Senator Whitehouse. Got it.

Mr. Friedmann. We emit 38 billion tonnes over the year, and that is an issue; we meaning the globe, not the United States.

It represents an environmental threat. We have extinctions, we are losing species, we have sea level rise, coral bleaching, all those other sorts of things, which are directly attributable to greenhouse gas emissions.

In addition to that, we are starting to have economic impacts that are associated with that that are rather grim and problematic.

That, however, as important as that is and as much as I spend my time on it, it is not the most important thing. The most important thing is actually 197 countries have all said that they care about it, which means the entire global market is

organized now. The entire global market is organized now to figure out ways to reduce emissions and to turn carbon dioxide into value.

Senator Whitehouse. And putting aside everything else, participating in that global market has economic value for the United States.

Mr. Friedmann. Indeed. As export technologies to the United States, both in terms of product and in terms of heavy equipment.

Senator Whitehouse. Mr. Deich? Did I pronounce your name right? If I didn't, I apologize.

Mr. Deich. You did. Thank you, Senator.

Senator Whitehouse. Great. Thank you.

Mr. Deich. So, I think the bottom line here is this is going to be the economy of the future, figuring out how to take the carbon that is already in the air and pulling it back in a way that improves the economy and the environment.

Senator Whitehouse. And we need to get the carbon dioxide out of the atmosphere because of what?

Mr. Deich. Because of both the environmental harm that could come from climate change, as well as all of the other changes to our society. But I really see this as an opportunity. There are 2 trillion tonnes of CO2, trillion with a T, that have been put into the atmosphere. All of that can

come back out as a valuable resource, and that is the biggest business opportunity that we have ever seen. So, if we can figure out how to do that across the economy, that is a huge opportunity that simultaneously solves these massive global challenges on hand.

Senator Whitehouse. Hard to do any of that if there is no price on carbon, though, because then there is no revenue stream, correct?

Mr. Deich. I would actually argue that there is now a price on carbon in not a clean way, as an economist like myself would want, but we do have, both with 45Q, a price on sequestering carbon --

Senator Whitehouse. Precisely.

Mr. Deich. -- and through a series of other --

Senator Whitehouse. Precisely. That is what we did in that bill, was to create a very narrow specific version of it, correct?

Mr. Deich. The extent to which we can expand on that and make sure that there is a robust market, and that that market happens here first is essential.

Senator Whitehouse. Dr. Jiao, the reason we want to or benefit from reducing carbon dioxide anthropogenic emissions into the atmosphere is?

Mr. Jiao. So, I think much has been said about the

potential climate impact when we emit tremendous amount of CO2 into the atmosphere. I also concur with some of the points made before. I see this as an opportunity to generate profitable pathways to utilize CO2. We definitely have an abundant source of CO2. If we can figure out a way how we can make CO2 into valuable chemicals or fuels, probably, and in an efficient way, then this will solve our issue, I think.

Senator Whitehouse. Thank you.

Thank you, Chairman.

Senator Barrasso. Thank you, Senator Whitehouse.

Senator Capito, again, thank you so much for your co-sponsorship and your hard work on this piece of legislation.

Senator Capito. Thank you. I want to thank everybody on the panel, too, and I want to start out talking again on the pipeline issue because I think this is a concern if we are going to move forward. In the answers you gave to the previous question, obviously, this is a stumbling block.

I have a figure here that says 4,500 miles of CO2 pipelines are in this Country now, but are any of those interstate, do any of them cross State lines, as far as you know?

Mr. Northam. Yes. The quick answer is yes. There are pipelines that deliver CO2 that is produced in Colorado to West Texas for enhanced oil recovery. There are others as well, but, yes, there are interstate.

Senator Capito. Okay. My point being there, obviously, is the permitting interstate obviously is a part of this bill, it is critically important.

The next question I have is on what we were talking about just a few minutes ago. I think you all have done a really nice job talking about why CCUS is important for the environment, for our economy, and for job creation and others. I come from, obviously, a heavy coal State. This is very important to us in terms of being able to have the longevity in the coal industry, but also the environmental benefits are important to us, as well.

So, in our experts' opinion, would you say that the United States is a leader now in CCUS technologies? I think you have already mentioned, I am just going to throw this up to anybody, what other countries are really forward-thinking here? I know you mentioned the European Union. Are there other countries that we should be looking at who are developing this technology at a more rapid and more advanced state?

Dr. Friedmann.

Mr. Friedmann. So, I am pleased to say that the United States is now the unambiguous leader in carbon capture and storage technology, and in no small part, again, because of the passage of the FUTURE Act.

I would say that there are many countries that are working

to catch up. Canada is most notable in this regard. Also, Norway has been an international class leader. In the context of both carbon capture, but even more importantly for CO2 conversion and use, China is coming on strong, for real.

I would point, among other things, to the Strategic Applied Research Institute, SARI, in Shanghai Technical University. They have built a building there that has 100 scientists; they are gearing up to 1,000 scientists. It is underwritten by the Chinese Academy of Sciences. All of that is focused on carbon capture and utilization.

The same thing can be said about Japan. Again, the same thing can be said about Canada. Out of the 10 finalists for the NRG COSIA XPRIZE, four of them are Canadian. Not a knock on Canada, we love Canada, but it would be lovely to see America's unambiguous leadership in this arena.

Senator Capito. Well, obviously, there would be tremendous economic benefits to us, and I would like to see that as well.

Do the two of you have anything to add on that?

Mr. Deich. Thank you, Senator. I think one of the things where we have not seen a leader emerge yet is in the direct air capture field. I think there are many places that are positioned to do that, and the United States is one of them, but unless there is action from policymakers, that leadership could easily go somewhere else right now. So, I think that figuring

out how to be that leader is essential today.

Senator Capito. Dr. Jiao?

Mr. Jiao. Regarding the technology I am working on, actually, Canada, Europe, and even China, they are actually very aggressive in this area, so if we don't act now, I think we will lose the leadership.

Senator Capito. We just had a discussion in your answers about global warming and the threat that you all perceive there. Is there any realistic way for the world to stay below the commonly identified 2-degree Celsius global mean temperature in increase target this century without broad CCUS? Can we do it as a Nation without this development of this technology and utilization of the technology?

Mr. Northam. My opinion, but the simple answer is no, we cannot.

Senator Capito. Dr. Friedmann?

Mr. Friedmann. Doubling down on that, actually, we are, instead, poised to massive overshoot, and every credible scenario not only has large-scale CCUS deployment in the next 20 years, but also large-scale carbon removal after 2050, which requires carbon capture and storage and things like direct air capture.

Senator Capito. Did you have a comment?

Mr. Deich. I would agree.

Senator Capito. Right.

Mr. Jiao. Yes, I agree.

Senator Capito. All right. Thank you all very much.

Senator Barrasso. Thank you, Senator Capito.

Senator Van Hollen.

Senator Van Hollen. Thank you, Mr. Chairman.

Thank all of you. Sorry I missed the testimony; I was in another committee, but I have had a chance to look it over and I strongly support this legislation. I should mention that in Maryland we have a company called AES. It is the Warrior Run power plant in Cumberland, Maryland where they capture 4 percent of the carbon dioxide generated and sell 150 tonnes per day to beverage-grade carbon dioxide in the food and beverage industry. So, I support this legislation.

But I do want to pick up on some of the comments Senator Whitehouse made and responses that you all made, which is that the reason we are doing this, the reason we are actually spending taxpayer dollars to do this is that there is a public good to be had from reducing carbon and, therefore, trying to address the problem of climate change.

Just a yes or no from each of you.

Mr. Northam. Yes.

Mr. Friedmann. Oh, yes.

Mr. Deich. Yes.

Mr. Jiao. Yes.

Senator Van Hollen. So, I am looking at a lot of the projects that have been funded by DOE, and all of these projects for carbon capture, at least at this point in time, have required some public financing in order to be economically viable, right?

Mr. Northam. Yes.

Mr. Friedmann. Yes. Happy to talk more about that, too.

Mr. Deich. Yes.

Mr. Jiao. Yes.

Senator Van Hollen. And the FUTURE Act that was just passed is another tax incentive, right? So, I just want to be clear with my colleagues; we are spending taxpayer money to reduce carbon dioxide, and the only reason I can see for spending taxpayer money on doing that is if we have a benefit from reducing carbon dioxide. That benefit, as the witnesses have said, is trying to address climate change and making sure we are well positioned in a global economy where the rest of the world recognizes we need to head in that direction.

As of today, as of today, we are trying to change that, what is the cost per tonne in terms of the public subsidy to make carbon removal economically viable?

Mr. Friedmann. To ask a clarifying question, are you asking what is required or what is it today?

Senator Van Hollen. What is required today, in terms of a public subsidy, to make a carbon capture enterprise economically feasible? I mean, the FUTURE Act was part of that, right?

Mr. Friedmann. Yes. So, when I was working in the Department of Energy, I worked with the White House and the Treasury, and we put forward a specific proposal for something about the order of $60 per tonne as essentially like a production tax credit, along the lines of the FUTURE Act, and we also suggested a 30 percent investment tax credit. You need some capital treatment as well as some operating treatment.

Senator Van Hollen. So, you need a public subsidy on both pieces there.

Mr. Friedmann. It is worth noting that that incentive on the order of $60 a tonne is about the same as the wind production tax credit. It is along the lines of other incentives we have made for other kinds of clean energy.

Senator Van Hollen. And you made the important point, Dr. Friedmann, all of you said that carbon capture needs to be part of the solution to climate change, but, Dr. Friedmann, you mentioned all the scenarios there. Those scenarios, to make sure we are under the 2 percent Celsius, they also require reduction in carbon emissions, do they not?

Mr. Friedmann. That is in fact their primary constraint. The scenarios all say we have to stay to a 2-degree world, so we

have to deeply reduce our carbon dioxide and other greenhouse gas emissions.

Senator Van Hollen. Right. So, I am glad that we are spending some public dollars for this public good, to sequester carbon and to reduce carbon that is generated, but, when you look at those models, how much of the reduction has to come, Dr. Friedmann, from actually reducing the overall emissions?

Mr. Friedmann. So, in order to hit a 2-degree target by 2020, you have to have something on the order of 85 percent reduction in greenhouse gas emissions. There are many pathways to do that; it requires efficiency improvements, deep deployment of renewable power, as well as carbon capture and storage.

Senator Van Hollen. Appreciate it.

I would just say, Mr. Chairman, to all my colleagues, and this is an appeal, what we are doing here is using taxpayer dollars for the purpose of helping the market toward carbon sequestration, and that is putting a price implicitly on this project; and, as of today, for quite a smaller price, you can actually generate some reductions today. So, I would just hope, if we are going to be taking this public policy direction as a Committee, that we not look at just this very important piece, and it is an important piece, but that we look at everything else at the same time.

I appreciate all of you for being here today and thank you

for your efforts in this particular area.

Senator Barrasso. Thank you, Senator Van Hollen.

Senator Markey.

Senator Markey. Thank you, Mr. Chairman, very much.

I would just note this at the top. I see that this is a bill ultimately that is $25 million that would be going to the EPA administrator for Direct Air Capture Technology Advisory Board and then another $50 million for the USE IT Act, and I just want to stipulate this once again, that back in 2009, in the House of Representatives, we passed the Waxman-Markey bill, and Henry Waxman and I put in $200 billion for carbon capture and sequestration, $200 billion. And the coal industry turned it down cold, $200 billion they turned down.

So here we are now and they are asking for this money, and I step back and I keep saying to myself you missed your shot; it was there. The $200 billion would have done the research, would have had the advisory boards, could have given the money to each one of the utilities or to oil companies or coal companies to be able to do the job; and they said they didn't want it. And that is fine, okay, that is a decision they made.

And, again, I am looking at this now and I am saying, okay, I believe in research and I believe in advisory committees, but I just think it is important to understand that, again, a vision without funding is a hallucination. So, I just don't want

anyone to get false hope from this, that the magnitude of this funding in any way affects the trajectory of this technology; it is just not real. We put in a real number based upon what all the experts told us in the utility industry to deal with it, it was $200 billion, and it was turned down, just absolutely, we don't want that money, 2009-2010, by the way, in this Committee. No, don't want it.

So, that is where we are, and again I definitely want to make sure that we do the research, but I also want everyone here to understand that there is another vision which is taking place. There are 109,000 new clean energy jobs in Massachusetts that have been created, most of them over the last decade, 109,000.

The United States installed 10,000 new megawatts of solar last year and 7,000 new megawatts of wind. That is 17,000 new megawatts. We now have 89,000 megawatts of wind capacity and 53,000 megawatts of solar installed in the United States, so that is about 140,000 wind and solar megawatts now installed in our Country; and globally, in 2016, in one year, globally, 74,000 new megawatts of solar and 52,000 new megawatts of wind capacity were installed. Overall, renewables now represent 55 percent of all new electrical generating capacity over the past 10 years, 55 percent, just so we get it all out here on the table.

And, again, the $200 billion in the Waxman-Markey bill that passed the House of Representatives was turned down over here in the Senate. Didn't want the money.

So, again, I believe in research and am happy to work in a bipartisan fashion to support new technologies for our future low-carbon economy, but I also want to have everyone understand where this whole thing is headed. It is all heading in the direction that now they realize they need the money.

Now they say, oh, is there any way you can help us? We turned that down and now what is left over that you can help us with that is kind of a penny on the dollar of what was being offered just six or seven years ago. And as long as we understand that, then I feel better about it.

So, I guess my concern is, and I would ask you this question, Mr. Deich, is they need financing, but we are opening up the Clean Air Act here. What is the fear that you might have if we open up the Clean Air Act in terms of other changes that might take place? On this, I would support it. I just want to make that clear, I do support the bill. I just want to put it in its total context. But I do have some apprehension about whether or not the Clean Air Act then becomes vulnerable for other purposes in the course of deliberation.

Can you give me that answer?

Mr. Deich. Thank you, Senator. That is something that we

are very sensitive to. We work closely with environmental groups, as well as startups and other investors in this space, and recognize that the Clean Air Act has not been amended in nearly 30 years at this point.

And what I think the environmental groups are looking for from this Committee is insurance that the bill will move forward in a bipartisan way to achieve the spirit that we have heard here at this hearing, and not to use it as a way to weaken or otherwise erode the foundational environmental law.

Senator Markey. That is good.

Do we have that commitment, Mr. Chairman?

Senator Barrasso. That was in my opening statement.

Senator Markey. Oh, I am sorry.

Senator Barrasso. I referred to that, that we are going to move forward, Senator Whitehouse and I, in a bipartisan way on not allowing --

Senator Markey. As Senator Inhofe mentioned over in the Commerce Committee, there are nine of us on two committees, the Commerce Committee and this simultaneously, so he and I have been running back and forth.

Senator Barrasso. Thank you.

Senator Markey. So, thank you for that statement, Mr. Chairman.

Senator Barrasso. Thank you. Appreciate your questions.

Senator Markey. Thank you.

Senator Barrasso. Before turning to Senator Inhofe, I would point out that the Clean Air Task Force is writing in support of this piece of legislation. I am going to introduce that as part of the permanent record. Without objection.

[The referenced information follows:]

Senator Barrasso. Senator Inhofe.

Senator Inhofe. I just want, now that this hearing is about to be over, to repeat something that I said in my questioning, that it is a relief to know that we have come to the point not where we were nine years ago, when the solution was you have to do away with fossil fuels, but now we recognize fossil fuels is going to be a part of our energy mix, a very important part; most likely, at least for the next few years, the same percentage as it has been in the past.

Now, I know that you folks, the response that you gave on the science. I know it is still mixed. You guys know it too. I always enjoy using the quote from Richard Lindzen, when he said, "Controlling carbon is a bureaucrat's dream. If you control carbon, you control life." So I would just like to hope that we can get beyond this discussion, because it is no longer necessary; we now are going to have this as a part of our energy mix. For the record, okay?

Senator Barrasso. For the record, absolutely.

And to follow up on your statement about the percentage being the same, what I have been reading is that 20 years from now, with the overall need of increased energy, and we need it all, that 20 years from now we will be using a significant more amount of coal than we are right now, planet-wise, so that we

need to come to the solutions involved here.

I have a number of letters in support of the legislation I am going to ask to be made part of the record, but I do want to thank all the witnesses for being here. I appreciate your time and your testimony. The record is going to be open for a couple weeks so that you may get some written questions from some other members who weren't able to be here, because there are a number of members on multiple committees, and everybody can't be at all committees at all times. But I appreciate all of you being here.

With that, the hearing is ended. Thank you.

[Whereupon, at 11:55 a.m. the committee was adjourned.]