CURC CARBON UTILIZATION RESEARCH COUNCIL
ADVANCING FOSSIL ENERGY SOLUTIONS

Written Testimony of Shannon Angielski

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Before the

Senate Energy and Natural Resources Committee

Hearing to "Examine Development and Deployment of Large-Scale Carbon Dioxide Management Technologies"

CURC Testimony:

Policies in Support of the Carbon Capture, Utilization and Storage Ecosystem

Washington, D.C.

July 28, 2020

INTRODUCTION AND BACKGROUND

The Carbon Utilization Research Council (CURC) is an industry coalition focused on technology solutions for the responsible use of our fossil energy resources in a balanced, low-carbon generation portfolio. CURC's members include electric utilities and power generators that rely upon diverse sources for their electricity production, equipment manufacturers and technology innovators, national associations that represent the power generating industry, labor unions, fossil energy producers, and state, university and technology research organizations. Members of CURC believe that American fossil fuels and ingenuity in technology innovation will satisfy the world's growing appetite for affordable energy, improve energy security, improve trade through increasing exports of U.S. resources and manufactured energy equipment, create high-paying jobs, and improve environmental quality. To meet these important objectives, members of CURC are at the forefront of their industries and partnering with the Department of Energy to develop and commercialize technologies that will transform the way the world uses fossil fuels. Successfully achieving these objectives will require a robust and sustained set of policies to incentivize the development and deployment of low and zero-carbon fossil energy technologies that are necessary to achieve global climate targets and that can also contribute to a robust U.S. economy.

On behalf of CURC, I am pleased to testify before the Senate Energy and Natural Resources Committee to discuss efforts to develop and deploy large-scale carbon dioxide management technologies in the United States. Given the nature of CURC and our mission, my testimony will focus on technology innovation efforts in the power sector, particularly with respect to carbon capture, utilization and storage (CCUS), and how those efforts can be leveraged with other industrial uses of fossil fuels. Throughout my testimony, note that I refer to carbon capture, utilization, and storage as either "CCUS" or "carbon capture", and carbon dioxide as "carbon" or "CO_2.".

ROLE OF CARBON MANAGEMENT TECHNOLOGIES IN A DECARBONIZED FUTURE

The reason we are participating in this hearing today is because international authorities recognize that fossil fuels, due to its lower cost and widespread availability, will continue to be used both here in the U.S. and globally. It is how we manage the carbon dioxide produced from the use of fossil fuels that will determine whether we are able to cost-effectively achieve midcentury emissions reduction goals and simultaneously enable all nations to benefit from economic growth and energy security.

Fossil fuels will continue to play an essential role towards reaching a decarbonized future. The U.S. Energy Information Administration (EIA) projects that fossil fuels will still account for 50% of U.S. power generation[1] and 77% of total U.S. energy consumption in 2050 under current policies.[2] Moreover, EIA

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[1] U.S. Electricity Information Administration. 2020 Annual Energy Outlook, Electricity and Renewable Fuel Table #54

[2] U.S. Electricity Information Administration. 2020 Annual Energy Outlook, Energy Consumption by Sector and Source

projects that, despite substantial projected renewable energy deployment, fossil fuel consumption will more than double globally by 2050, as fossil fuels are low cost, abundant and widely available in emerging economies.

The imperative and economic impact for building out carbon management technologies is clear. The United Nations Intergovernmental Panel on Climate Change (IPCC) has run several models for stabilizing emissions by 2050. Many models cannot limit warming to below 2°C above preindustrial levels if bioenergy, CCUS and their combination are limited.[3] In scenarios that could meet that objective without CCUS, mitigation costs rise by 138% compared to those with CCUS (IPCC AR5 report, 2014 table 3.2).

Mitigation cost increases in scenarios with limited availability of technologies [percent increase in total discounted mitigation costs (2015-2100) relative to default technology assumptions]				
Year 2100 CO_2 concentrations (ppm CO_2 – eq)	No CCS	Nuclear phase-out	Limited solar/wind	Limited bioenergy
Price increase to reach 450 (430-480)	138% (29 to 297%)	7% (4 to 18%)	6% (2 to 9%)	64% (44 to 78%)
Number of models that can achieve climate objective with the limitation of the technology	4	8	8	8

Figure 1: Summary of table 3.2 from IPCC AR5 Report showing that omitting CCS from the mitgation portfolio causes orders of magnitude higher costs than limiting other technologies. In addition, some models cannot even reach climate goals without CCS

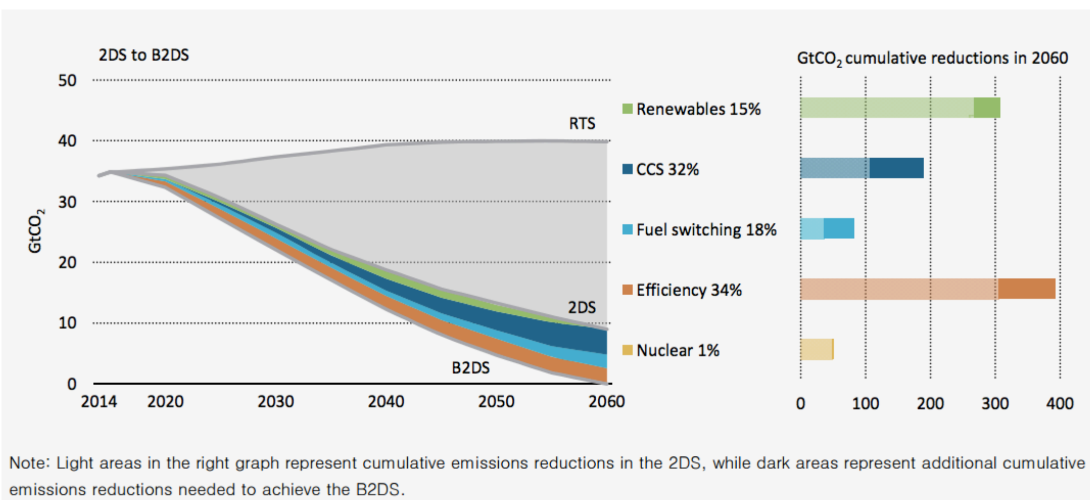

Figure 2: Technology Area Contribution to Global Cumulative Carbon Dioxide Reduction (Source: International Energy Agency)

[3] IPCC, 2014: *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Core Writing Team, R.K. Pachauri, and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.

Figure 2 above shows the results of International Energy Agency (IEA) modeling and the contributions of different technologies towards achieving the emissions reductions required under IPCC modeling for a 2°C scenario and a below 2°C scenario. The graphic on the left shows the emissions reductions by a percentage total of each technology's contribution to achieving emissions reductions necessary to meet the below 2°C scenario. The solid bands in the graphic on the right show the emissions reductions measured in metric tons that would be achieved from each technology area to meet the 2°C target. CCUS accounts for approximately 100 gigatons of global CO_2 emissions reductions required to meet the goals of the 2°C scenario by 2060. To put this into perspective, this amount of emissions reductions would be achieved by the installation of 1,100 carbon capture systems on 500 MW coal-fired units or 3,200 natural gas combined cycle units by 2030 and operating those systems for the next 30 years.[4] At higher capture rates and/or when combined with sustainable biofuels or plastics, power generated from fossil fuels can achieve net-zero or even negative carbon emissions, which is important to the broader discussion of achieving deep decarbonization from dispatchable grid technologies.

The applications for CCUS also extends beyond the power sector. CCUS has a substantial role to play in the reduction of CO_2 emissions in the industrial sector, one in which fossil fuels will still account for 77% of U.S. energy consumption by 2050.[5] While some of these industrial processes can be electrified, many (e.g. steel production, some chemicals production, etc.) will continue to require the use of fossil fuels or other low- or zero-carbon sources of hydrogen. This is because the energy requirement for these industry sectors is high-temperature heat, for which there are currently few cost-effective and available alternatives to the direct use of fossil fuels. Moreover, certain manufacturing processes (e.g., cement production) release CO_2 as a byproduct of the materials used and apart from energy production. CCUS technologies are one in a limited set of technologies with the potential to dramatically reduce industrial sector emissions by capturing the emissions associated with these processes, helping to decarbonize a traditionally difficult-to-decarbonize sector.

IPCC modeling also shows that in order to achieve deep decarbonization goals, CCUS is required with carbon dioxide removal (CDR) technologies such as bioenergy with carbon capture and storage (BECCS) or direct air capture (DAC).[6] Importantly, both BECCS and DAC must be coupled with geologic storage of CO_2.

The U.S. is well-positioned to take a leadership role in the development of these CDR technologies. CCUS processes for bioenergy are similar to those used in conventional fossil fuel applications, and DOE has already incorporated BECCS into its traditional CCUS programs. While global deployment of projects

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[4] This calculation assumes the coal plant operates at 75% capacity factor, the natural gas combined cycle plant at 60% capacity factor, and each with a 90% capture rate.

[5] U.S. Electricity Information Administration. 2020 Annual Energy Outlook, Energy Consumption by Sector and Source

[6] IPCC, 2018: Summary for Policymakers. In: *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty* [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. *World Meteorological Organization, Geneva, Switzerland, 32 pp.* https://www.ipcc.ch/site/assets/uploads/sites/2/2019/05/SR15_SPM_version_report_LR.pdf

utilizing BECCS is limited at this time, there is a commercial-scale demonstration project currently in operation in Decatur, Illinois (the Illinois Industrial Carbon Capture and Storage Project). There are also technology pathways by which biomass can be co-fired with coal (directly or gasified) or natural gas to create net-negative fossil fuel-fired power generation when combined with CCUS. Through its Coal FIRST program, DOE recently issued a funding opportunity soliciting proposals that evaluate technology pathways for co-firing of coal and biomass with carbon capture to create electricity and zero-carbon hydrogen at a competitive cost.

The U.S. is also making progress in the development of DAC technologies. Last year, Oxy Low Carbon Ventures and Carbon Engineering announced that they would partner to construct the first U.S. DAC demonstration facility in Texas, and DOE also continues to advance DAC technology research and development activities. Importantly, both traditional point source carbon capture, combined with NETs like BECCS and DAC, provide opportunities to leverage existing oil and gas industry expertise and infrastructure for CO_2 transport and storage, which together will enable us to achieve national and global decarbonization objectives.

<u>INFRASTRUCTURE SCALE OF CARBON CAPTURE, UTILIZATION, TRANSPORT, AND STORAGE</u>

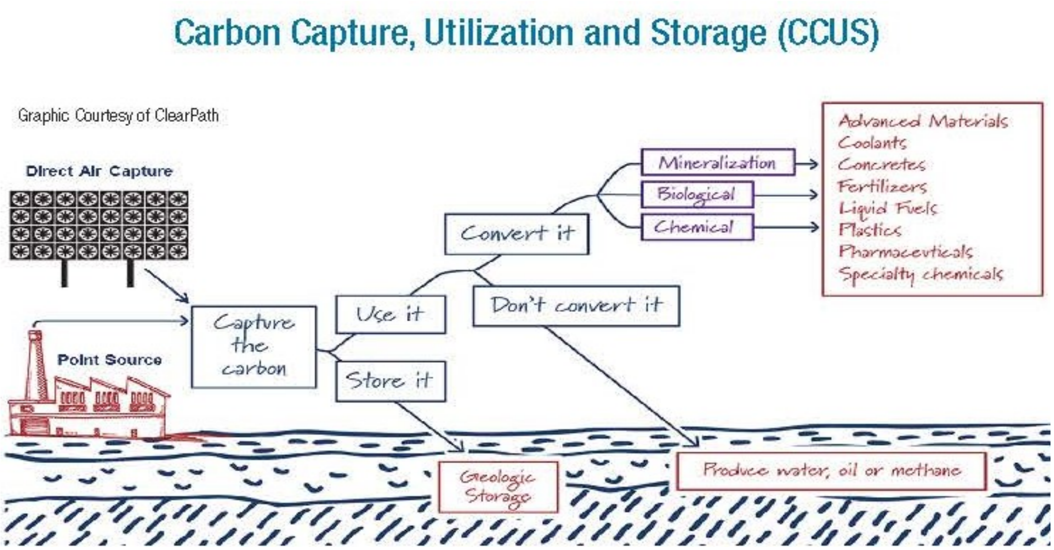

Figure 3: Carbon Capture, Utilization, and Storage (Source: ClearPath)

CCUS is an ecosystem of several distinct processes, each of which are necessary to prevent CO_2 from being released or to capture it directly from the atmosphere for permanent storage. It is therefore important to recognize the scale of infrastructure comprising an entire CCUS project – this includes the source at the site of capture, the transport method to move the carbon dioxide to the site of storage, and the storage facility – whether the captured CO_2 is used for enhanced utilization of oil, converted to other valuable products, or stored in a saline reservoir.

Ideally, CO_2 capture sites will be nearby, adjacent to, or co-located with the site of the CO_2 utilization or storage reservoir. This could be a distinct advantage for direct air capture facilities, which have more siting flexibility. While many industrial sources of CO_2 are close to feasible storage sites, a large majority are not. That is why innovation must take place to identify new methods for converting carbon dioxide into useful products, such as cement, where the carbon dioxide is permanently stored in the product. It is important to recognize that the development of a CCUS industry is dependent on more than capture technologies. Large-scale storage sites for captured CO_2 and the infrastructure to deliver that CO_2 from source to sink are critical to the success of a CCUS industry.

As many CCUS projects cannot be co-located with large-scale storage reservoirs, the majority of CO_2 will be transported by pipelines to storage sites. For example, the Petra Nova project had to build an 82-mile pipeline to transport its CO_2 to the enhanced oil recovery (EOR) fields where the CO_2 is permanently stored. CO_2 is already being transported throughout the country for CO_2 use in EOR, with over 4,500 miles of CO_2 pipelines in operation. To access other industrial sources of CO_2 and transport it to geologic storage locations, it will be necessary to permit and construct additional miles of pipelines. Having streamlined and coordinated pipeline permitting will be important for CO_2 pipelines and large-scale deployment of CCUS.

Legislation has been introduced in both chambers of Congress, and cosponsored by Members of this Committee, that would authorize agency coordination for streamlined permitting of CO_2 pipelines. S. 383, the Utilizing Significant Emissions with Innovative Technologies (USE IT) Act, would ensure that CO_2 pipelines and other CCUS infrastructure are eligible for permitting review processes established by the FAST Act of 2015 and would direct the White House Council on Environmental Quality (CEQ) to establish guidance to assist projects developers and operators of that infrastructure. Adding CO_2 pipelines to the ten other industry sectors covered by the FAST Act is particularly important, as it would allow for early consultation and enhanced interagency coordination towards satisfying environmental reviews and meeting statutory deadlines.

The 2015 FAST Act also created the Federal Permitting Improvement Steering Council (FPISC). The FPISC is an independent oversight council to oversee the cross-agency Federal environmental review and authorization process. Currently, the FPISC oversees 21 current and prospective projects covering conventional energy production, electricity transmission, pipelines, renewable energy production, and water resources. These projects total $58.5 billion in current investment and project to provide 52,050 temporary construction jobs. Unfortunately, authorization for the FPISC under the FAST Act expires in 2022. Congress should permanently authorize the FPISC to ensure that these and future CCUS projects are best positioned to navigate complicated federal permitting processes.

As mentioned, there are also niche opportunities to convert CO_2 into other products, including chemicals, fuels, and cement. Figure 4 below illustrates most of the current and potential uses of CO_2. However, many of these uses are smaller in scale in terms of the volumes of CO_2 that are utilized and stored. Some of the more significant current and potential uses of CO_2 are highlighted in the research underway in this focus area, shown below.

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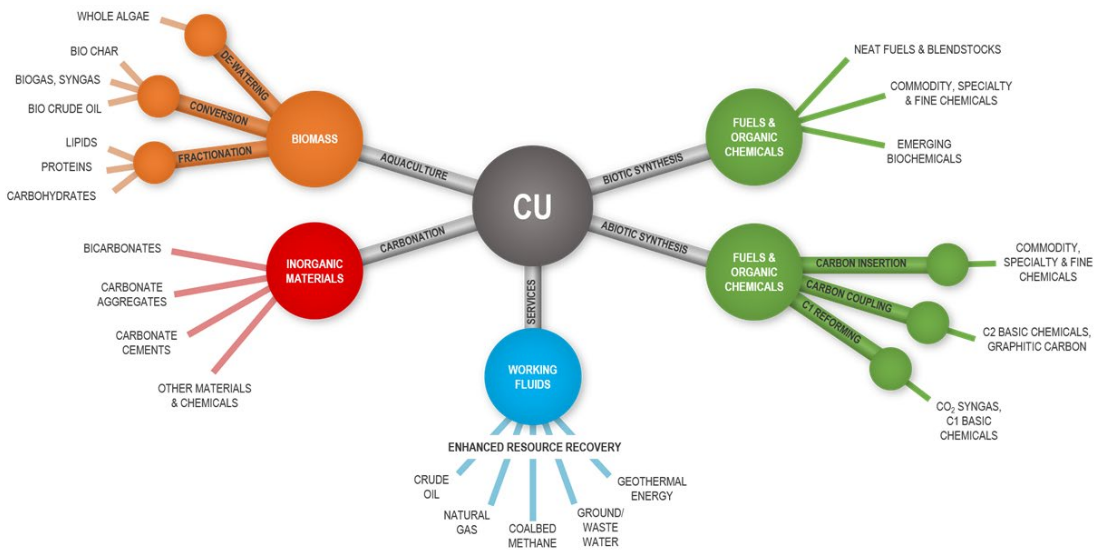

Figure 4: Carbon Utilization Pathways (Source: National Energy Technology Laboratory)

Solutions for large-scale storage underpin the entire CCUS ecosystem. Without large-scale CO_2 storage, the climate benefit of CCUS – including with DAC and BECCS – will not be realized. This is why the CURC-EPRI Roadmap recommends a broad program for CO_2 storage in geologic reservoirs in partnership with DOE.

The U.S., through DOE, is recognized as a global leader in the development of CCUS technology, aided by the DOE's world class carbon storage program. Over the nearly 20 years of the DOE carbon storage program, the United States has stored more than 10.5 million metric tons of CO_2 in a variety of geologic reservoirs to prove out the capability of safe and effective CO_2 storage[7]. The Regional Carbon Sequestration Partnerships (RCSPs) and the Carbon Storage Assurance Facility Enterprise (CarbonSAFE) initiative are two key components of the DOE program recommended and advocated by CURC and being implemented by DOE that will enable broad scale geologic storage in the U.S.

The RCSPs have established a solid foundation for the success of CCUS deployment. Through R&D and a successful history of large-scale pilot tests across the country, the RCSPs have developed – and continue to develop – the geologic framework and infrastructure standards needed to validate carbon storage within each region of the U.S. The RCSPs focus on technology evaluation, resource assessment, regulations, and infrastructure needs working with industry and public stakeholders. The RCSPs have provided regional and technical expertise to identify a regional network of qualified sub-regions and locations for CarbonSAFE and commercial projects. The RCSPs also play a key part in characterizing CO2

[7] Sullivan, M, Rodosta, T, Mahajan, K, Damiani, D. An overview of the Department of Energy's CarbonSAFE Initiative: Moving CCUS toward commercialization. *AIChE J*. 2020; 66:e16855. https://doi-org.proxygw.wrlc.org/10.1002/aic.16855

storage resources and reserves, which is essential for locating projects with long-term storage certainty and creating increased business confidence.

Figure 5: DOE CarbonSAFE and RCSP Projects (Source: National Energy Technology Laboratory)

Early on, CURC members recognized the critical need for large-scale storage necessary to store the volumes of CO_2 anticipated to be captured from industrial processes, which is why prior CURC-EPRI Roadmaps recommended advancing carbon storage efforts that led to the CarbonSAFE Initiative. Building on the foundation and utilizing the expertise of the regional partnerships, this program is designed to advance large-scale carbon storage resources through development of integrated storage complexes that will characterize, monitor, and develop the data necessary for storage sites to apply for Class VI permits and be constructed for operation. These facilities will be designed to have high storage capacity potential in excess of 50 million metric tons of CO_2 over 30 years per storage site and will serve as regional repositories of CO_2. In alignment with the Roadmap, the CarbonSAFE initiative also takes into account the efforts for storage management (e.g., stacked storage, pressure management, storage hubs), storage complex modeling data, site development plans, regulatory issues, and public outreach, as well as efforts to transition to future commercial ventures. Importantly, the CarbonSAFE initiative will be synchronizing the sources of industrial CO_2 with the storage reservoir, as well as identifying, evaluating, and assisting in the permitting of the transport of CO_2 to the storage facility.

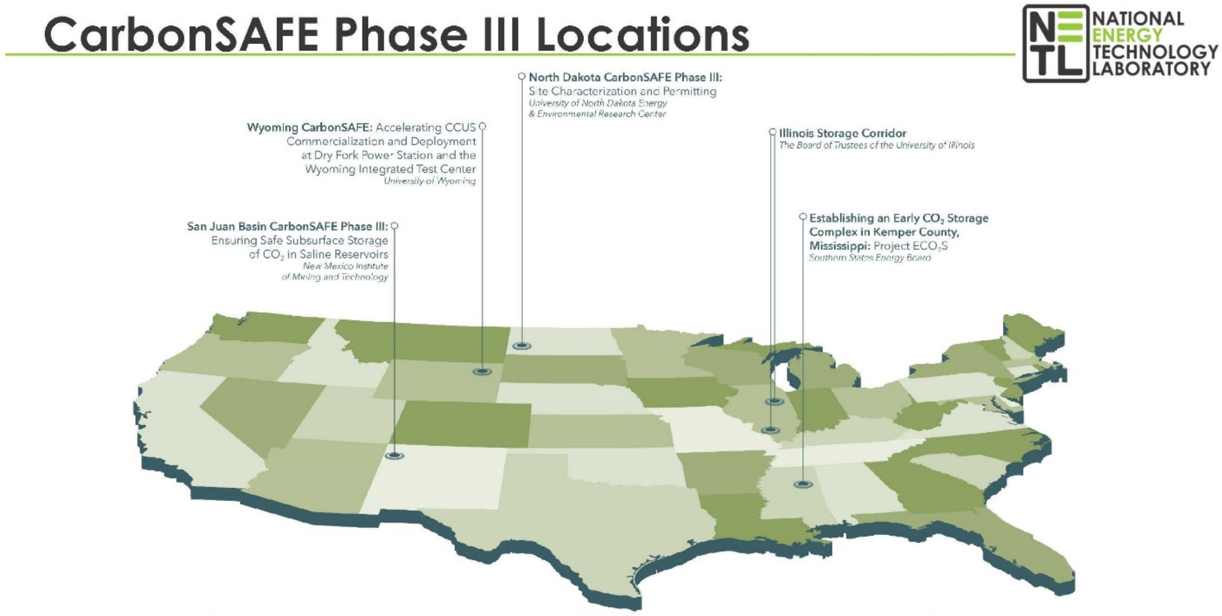

Figure 6: CarbonSAFE Phase III Locations (Source: National Energy Technology Laboratory)

CarbonSAFE Phase I awarded thirteen projects to undertake pre-feasibility and feasibility studies. Phase II awarded six projects to collect data, analyze the geology of the reservoirs including subsurface modeling and risk assessment, analyze contractual and regulatory requirements, and undertake public outreach. Phase III will undertake detailed site characterization, obtain Class VI permits for site injection wells, assess CO_2 capture systems, and obtain necessary NEPA approvals. Phase IV will obtain Class VI permits to inject, drill and complete injection and monitory wells, and complete construction of the sites.

There are currently five Phase III projects (See Figure 6). Due to limited funding, DOE was only able to select four Phase III projects, and a combined Phase II and III project. Increased federal funding would not only enable these projects to be accelerated but would also allow additional projects to be funded in other regions of the country. Funding for projects should be prioritized based on proximity of industrial sources to available geologic storage capacity, both onshore and offshore, to advance the commercial opportunities for CO_2 storage in the near term.

Policy Support for the CCUS Value Chain

CURC commends the Committee for advancing legislation that would support the entire CCUS ecosystem. The American Energy Innovation Act (AEIA), which includes the Enhancing Fossil Fuel Energy Carbon Technology (EFFECT) Act cosponsored by Chairman Murkowski and Ranking Member Manchin, will accelerate improvements to each of the critical components discussed above through increased funding and new program direction for the Department of Energy. Specifically, the bill would provide a much-needed reauthorization of DOE's Fossil Energy Research and Development program, authorizing funding for a coal and natural gas carbon capture technology program that includes new research and development activities, establishes a large-scale pilot project program, provides significant funding to support commercial demonstration projects of new CCUS technologies, and accelerates CCUS project development by authorizing a front-end engineering and design (FEED) study program. Coal, natural gas, and negative emissions applications like co-firing of coal and biomass are all included in the program. The bill also includes funding and program direction for a new Carbon Storage Validation and Testing program which directly aligns with the CarbonSAFE initiative, the success of which will underpin all carbon capture efforts including BECCS and DAC. Finally, the bill would authorize first-of-a-kind Carbon Utilization and Carbon Removal programs at DOE, centralizing research on those technologies within the Office of Fossil Energy, where the appropriate expertise is currently housed.

CURC encourages the Senate to pass the AEIA as well as the USE IT Act. When taken as a whole, these pieces of legislation would make a dramatic impact on the entire CCUS ecosystem and spur the development of a CCUS industry in the United States, along with the jobs that would come with it. Enactment of the 45Q carbon sequestration tax credits is another key policy tool for catalyzing a carbon capture industry in this country, as seen by the number of CCUS projects in development. This policy is designed to lower the cost of implementing carbon capture by providing a tax credit for every metric ton of CO_2 that is captured from industrial processes or through DAC and stored in geologic reservoirs including oil reservoirs, or when the CO_2 is converted into other products like chemicals or used in cement production.

Project developers as well as investors are encouraged by the recent issuance of proposed regulations by the Department of the Treasury to understand how to be eligible for the Section 45Q tax credits. While there are still some outstanding issues that have yet to be resolved, the proposed regulations provide the guidance needed for investment to flow into projects and meet the commence construction deadline to claim the 45Q tax credits. For the record, there remain concerns that project developers are already up against the commence construction deadline, particularly in a post COVID-19 environment. To ensure this tax credit can be used in the way it was intended by Congress, it will be necessary to extend the deadline.

<u>CCUS PROJECTS IN DEVELOPMENT</u>

Several projects are in development due to the tax credit market established by the 45Q tax credits and DOE program support. The graphic below identifies nine projects that are developing FEED studies supported grants provided by DOE with federal funding appropriated by Congress in 2019. Many of these projects are being designed as the source of CO_2 that will be stored in the Phase III CarbonSAFE projects, including Project Tundra and the North Dakota CarbonSAFE project; the Basin Electric Dry Fork Station project that will be coupled with the Wyoming CarbonSAFE project, and the Prairie State Generating Station project that will be coupled with the Illinois Geologic Storage Corridor CarbonSAFE project, to name a few (a full list of CarbonSAFE projects are included in Appendix A to this testimony). Each FEED study project is an electric power sector project. Five projects will retrofit carbon capture on existing coal units, and four projects will retrofit carbon capture onto existing natural gas combined cycle units.

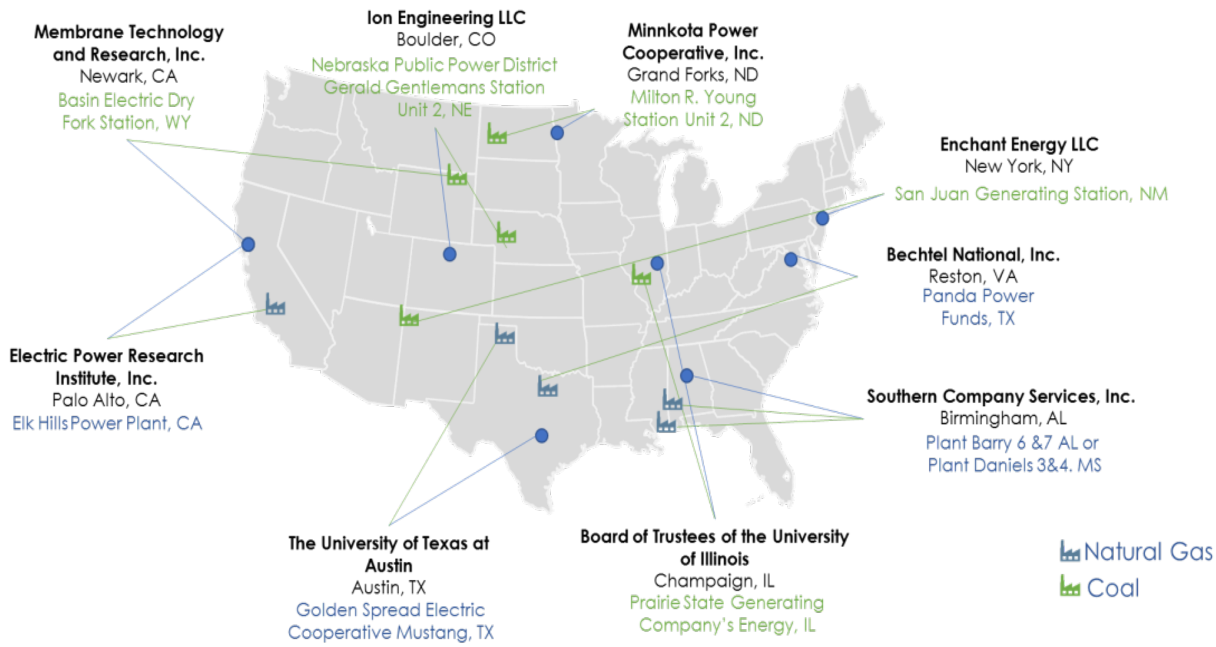

Figure 7: Existing FEED Study Projects (Source: U.S. Department of Energy)

At least 14 non-power projects have been announced that are in various stages of development and cover other industries, including ethanol and other biofuel production, petrochemical production, low-carbon hydrogen production, cement, and natural gas processing. The Wabash Valley Resources Project in Terre Haute, Indiana, for example, will capture and sequester approximately 1.75 million tons of CO_2 annually from their gasification plant and will store the CO_2 in the Wabash Valley CarbonSAFE reservoir. The project will produce zero-carbon hydrogen that will be used to generate electricity and produce ammonia with a zero-carbon footprint. This was the first U.S. investment made by the Oil & Gas Climate Initiative (OGCI). Several other projects are supported by OGCI as well as other investors including Oxy Low Carbon Ventures, which has several projects in development, and is an investor in new technologies such as CURC member NET Power's Allam cycle. A full list of U.S. projects in development is included in Appendix B.

FEDERAL POLICIES THAT CAN PROMOTE CCUS DEPLOYMENT AMIDST THE COVID-19 PANDEMIC

The COVID-19 pandemic has slowed global economic activity, leading to a drop in energy demand and prices. Quarantine conditions in nearly every country around the globe has also reduced manufacturing capacity, creating significant lags in supply chains. This is creating uncertainty in financial markets, where investors are less willing to make investments in first-of-a-kind projects that may have construction delays.

Direct Pay

Many owners of energy development projects do not have tax liability that enables the owner of the project to benefit from tax credits. For example, rural electric cooperatives and public utilities do not pay federal income taxes and therefore cannot benefit from tax credits themselves, though several rural electric cooperatives and public utilities are developing CCUS projects. In such situations, project developers typically employ tax equity structures that create a revenue stream to the owner of the credit in return for tax equity investment into a tax equity partnership. Under these structures, tax equity investors take on a significant portion of the tax credit value in return for equity investment. Under normal circumstances, this is not an ideal financial arrangement. Implementing an elective direct pay mechanism would enhance monetization of the 45Q tax credits for CCUS project developers by allowing tax credit recipients to elect to receive a direct cash payment from the Treasury instead of resorting to the tax equity market to provide a discounted tax credit. This may be necessary as the COVID-19 pandemic may result in reduced tax liability and appetite for investors, which could dry up equity markets, making even tax equity partnerships difficult to secure. This would also open up CCUS project developers to the world of capital markets. Importantly, the COVID-19 pandemic is not impacting investment capital, so providing access to private sector investment capital can be achieved with direct pay.

There is precedent for providing a mechanism similar to direct pay for energy projects from the Recovery Act in 2009, which provided a grant in lieu of a tax credit, but these grants were provided only for renewable energy projects. The Congressional Research Service estimated that the cost of the Treasury Grant in Lieu of Tax Credit program was $31.4 billion between 2008 and 2017 (in 2018 dollars). Given that CCUS is still an emerging technology and in early stages of developing an industry in the U.S., providing treatment equivalent to the wind and solar industry could act to stimulate needed investments in CCUS and achieve similar results over the next decade.

Extension of Commence Construction Date for 45Q

CCUS has only had a significant financial incentive in federal law since passage of the FUTURE Act in February 2018. Moreover, IRS did not propose regulations related to the implementation and guidance of the 45Q credits until June 1, 2020. What was originally considered to be a six-year window for CCUS projects to begin construction to qualify for the credit has now been reduced to less than four.

Other low and zero-carbon technologies have benefitted from substantial federal support for decades. The Production Tax Credit (PTC) for wind energy was first enacted nearly 30 years ago in the Energy Policy Act (EPACT) of 1992, and the Investment Tax Credit (ITC) for solar energy became law 15 years ago as part of EPACT 2005. According to Congressional Research Service, the total tax expenditure for the ITC, PTC, and the Recovery Act grant in lieu of tax credit program from 2000 thru 2018 is $74.15 billion (2018 dollars). This does not include the robust federal investments in research and development that were made in renewables or the state and regional policies that helped by requiring purchases of renewable power over that same period. While CCUS is further along in the cost and deployment curve than wind generation was 15 years ago, it has not had the benefit of similar support until the enactment of the 45Q tax credits in 2018. The successful commercialization of renewable energy technologies offers powerful evidence for the critical role that government incentives play in scaling up needed technology deployment when given sufficient time to leverage private capital in the marketplace.

Extending the commence construction deadline for eligibility for the 45Q tax credits by another five years will greatly enhance project deployment, particularly in a post-pandemic environment, and will come at a fraction of the cost of the wind and solar tax credit extensions. The Moving Forward Act (H.R. 2), which was passed by the House of Representatives on July 1, included a two-year extension of the 45Q commence construction date championed by Representative Terri Sewell (D-AL) coupled with direct pay. These provisions have a revenue estimate of only $493 million. A similar provision was included in the Growing Renewable Energy and Energy Efficiency Now (GREEN) Act (H.R. 7330) developed by the Democratic majority on the House Ways and Means Committee.

Senators Shelley Moore Capito (R-WV), Sheldon Whitehouse (D-RI), John Barrasso (R-WY) and Kevin Cramer (D-ND) also introduced a bipartisan amendment (S. Amdt. 1374) to the American Energy Innovation Act (S. 2657) to extend 45Q for five years, which was supported by CURC.

Section 48A Tax Credits

In 2005, Congress authorized $1.3 billion in investment tax credits designed to significantly improve coal generation efficiency, which in turn reduces emissions. Another $1.25 billion in tax credits were added to this program by Congress in 2008 but, to be eligible, a project had to install CCUS. Congress did not edit the underlying 2005 efficiency requirements for existing coal plants when it added the requirements for CCUS, so the tax credits have been ineffective for retrofit projects. As a result, there are approximately $2 billion of tax credits that have been reallocated by IRS and that remain available in the program. As there are no plans to build new coal plants in the U.S. today, the only opportunity to use these tax credits will be to retrofit existing coal plants. If changes are made to the statute and the tax credits are unlocked for use in retrofit projects, these tax credits could support six or more projects and could significantly reduce emissions of CO_2 from the existing fleet.

Bicameral and bipartisan legislation, the Carbon Capture Modernization Act (S. 407 / H.R. 1796), has been introduced that would remove the efficiency requirement and make some other technical changes to the eligibility criteria for effective utilization of the tax credits. This legislation was introduced in the Senate by Senators John Hoeven (R-ND) and Tina Smith (D-MN) and is cosponsored by Members of this Committee including Ranking Member Manchin (D-WV), John Barrasso (R-WY), and Steve Daines (R-MT). Enacting this legislation will unlock the nearly $2.0 billion in tax credits that remain in the program and support the application of carbon capture retrofits on existing coal plants.

Federal Grants

The federal government can also provide grant funding to deliver needed, up front capital investment for large-scale CCUS demonstration projects. As noted, the global market impact of the coronavirus pandemic will limit markets from financing several large, capital-intensive CCUS projects, putting them at risk of not being able to access private sector capital. Providing grants from the federal government will act as a substitute to the private sector capital that will be needed to finance CCUS projects. Federal grant support should also be provided to fully fund CarbonSAFE projects through Phase IV and provide additional funding for new projects, as the CarbonSAFE projects will act as the sink for the CCUS and NET demonstration projects, as well as provide continued funding for the Regional Partnerships to conduct relevant surveys and site characterizations to prepare regions for commercial CCUS deployment.

When combined with the 45Q tax credit, these projects will jump start a CCUS industry nationwide, assist the U.S. to meet its decarbonization objectives, and position the U.S. as a world leader in an emerging CCUS industry. Congress should consider enacting elements of the American Energy Innovation Act that would provide the necessary funding for these activities as an economic stimulus measure. There is existing precedent from the American Recovery and Reinvestment Act of 2009 that similar federal investments can spur economic growth and lead to job creation in the energy industry.

CONCLUSION

To date, CCUS and carbon dioxide removal technologies have not been deployed at the rate needed to achieve targets set out by the IPCC. The United States has taken a leadership role in the development of these critical technologies with a foundation already laid over the past 20 years. With sustained and robust policy support, particularly through legislation like the EFFECT Act and the LEADING Act, the U.S. can accelerate CCUS deployment and is doing so with the support of policies already enacted by Congress like the Section 45Q tax credit and targeted federal funding for a world-class research and development program at the Department of Energy (DOE).

IEA Executive Director Fatih Birol testified before this very Committee last year that U.S. leadership on CCUS is “extremely important”. Passage of the AEIA, coupled with the Section 45Q tax credit model, will allow the U.S. to maintain this leadership and deploy CCUS technologies that can be used around the world.

APPENDIX A – CarbonSAFE Projects*

Phase I

1. Nebraska Integrated Carbon Capture and Storage Pre-Feasibility Study
2. Integrated Pre-Feasibility Study for CO2 Geological Storage in The Cascadia Basin, Offshore Washington State and British Columbia
3. Integrated Mid-Continent Stacked Carbon Storage Hub
4. Integrated Carbon Capture and Storage in The Louisiana Chemical Corridor
5. Northern Michigan Basin CarbonSAFE Integrated Pre-Feasibility Project
6. CarbonSAFE Rocky Mountain Phase I: Ensuring Safe Subsurface Storage of Carbon Dioxide in The Intermountain West
7. Integrated Pre-Feasibility Study of a Commercial-Scale Commercial Carbon Capture Project in Formations of The Rock Springs Uplift, Wyoming
8. Integrated Commercial Carbon Capture and Storage Prefeasibility Study at Dry Fork Station, Wyoming
9. CarbonSAFE Illinois East Sub-Basin
10. CAB-CS: Central Appalachian Basin CarbonSAFE Integrated Pre-Feasibility Project
11. Integrated Carbon Capture and Storage in Kansas
12. Integrated CCS Pre-Feasibility in The Northwest Gulf of Mexico
13. California CO2 Storage Assurance Facility Enterprise (C2SAFE)

Phase II

14. CarbonSAFE Illinois Macon County
15. Establishing an Early Carbon Dioxide Storage (ECO2s) Complex in Kemper County, Mississippi: Project ECO2S
16. North Dakota Integrated Carbon Storage Complex Feasibility Study
17. Wabash CarbonSAFE
18. Integrated Midcontinent Stacked Carbon Storage Hub
19. Commercial-Scale Carbon Storage Complex Feasibility Study of Dry Fork Station, Wyoming

Phase III

20. Illinois Storage Corridor
21. San Juan Basin CarbonSAFE Phase III: Ensuring Safe Subsurface Storage of CO_2
22. Establishing an Early CO_2 Storage Complex in Kemper County, Mississippi: Project ECO_2S
23. North Dakota CarbonSAFE Phase III: Site Characterization and Permitting
24. Wyoming CarbonSAFE: Accelerating CCUS Commercialization and Deployment at Dry Fork Power Station and the Wyoming Integrated Test Center

Source: National Energy Technology Laboratory

APPENDIX B – U.S. Carbon Capture Projects in Development*

Projects in Early Development

Panda Energy
Facility Category: Large-scale CCS facilities
Operational: DOE FEED grant awarded
Facility Industry: Power – NGCC

California Resources Corporation / OGCI
Facility Category: Large-scale CCS facilities
Operational: DOE FEED grant awarded
Facility Industry: Power – NGCC

City of Farmington, NM / Enchant Energy
Facility Category: Large-scale CCS facilities
Operational: DOE FEED grant awarded
Facility Industry: Power – Coal

Nebraska Public Power / Ion Engineering
Facility Category: Pilot and demonstration CCS facilities
Operational: DOE FEED grant awarded
Facility Industry: Power – Coal

Basin Electric Dry Fork Station
Facility Category: Large-scale CCS facilities
Operational: DOE FEED grant awarded
Facility Industry: Power – coal

Minnkota Power
Facility Category: Pilot and demonstration CCS facilities
Operational: DOE FEED grant awarded
Facility Industry: Power – coal

Mustang Station of Golden Spread Electric Cooperative (GSEC)
Facility Category: Pilot and demonstration CCS facilities
Operational: DOE FEED grant awarded
Facility Industry: Power – NGCC

DTE Energy
Facility Category: Large-scale CCS facilities
Operational: N/A – multiple projects
Facility Industry: Industrial – biorefinery

Pacific Ethanol
Facility Category: Large-scale CCS facilities
Operational: N/A – pre-FEED, multiple sites
Facility Industry: Industrial – ethanol

Source: Clean Air Task Force

Elysian / Starwood Energy Group
Facility Category: Pilot and demonstration CCS facilities
Operational: N/A – unavailable
Facility Industry: Unavailable

Clean Energy Systems
Facility Category: Pilot and demonstration CCS facilities
Operational: N/A – pre-FEED
Facility Industry: Power - BECCS

Glenrock Petroleum
Facility Category: Large-scale CCS facilities
Operational: N/A – unavailable
Facility Industry: Power - BECCS

Great River Energy Coal Creek Station
Facility Category: Large-scale CCS facilities
Operational: DOE FEED grant awarded
Facility Industry: Power – coal

Blue Flint Ethanol
Facility Category: Large-scale CCS facilities
Operational: DOE FEED grant awarded
Facility Industry: Industrial – ethanol

Red Trail Energy
Facility Category: Large-scale CCS facilities
Operational: DOE FEED grant awarded
Facility Industry: Industrial – ethanol

Illinois Clean Fuels
Facility Category: Large-scale CCS facilities
Operational: N/A – unavailable
Facility Industry: Industrial – BECCS

LafargeHolcim Cement Carbon capture
Facility Category: Large-scale CCS facilities
Operational: Mid 2020s
Facility Industry: Cement Production

OXY and Carbon Engineering Direct Air Capture and EOR Facility
Facility Category: Large-scale CCS facilities
Operational: Mid 2020s
Facility Industry: N/A

OXY and White Energy Ethanol EOR Facility
Facility Category: Large-scale CCS facilities

Operational: 2021
Facility Industry: Ethanol Production

Project ECO_2S: Early CO_2 Storage Complex in Kemper County
Facility Category: Large-scale CCS facilities
Operational: 2026
Facility Industry: Under evaluation

Velocys' Bayou Fuels Negative Emission Project
Facility Category: Large-scale CCS facilities
Operational: 2024
Facility Industry: Chemical Production

Project Under Construction

The ZEROS Project
Facility Category: Large-scale CCS facilities
Operational: Late 2020s
Facility Industry: Power Generation

Projects in Advanced Development

Cal Capture
Facility Category: Large-scale CCS facilities
Operational: 2024
Facility Industry: Power Generation

CarbonSAFE Illinois – Macon County
Facility Category: Large-scale CCS facilities
Operational: 2025
Facility Industry: Various

Dry Fork Integrated Commercial Carbon Capture and Storage (CCS)
Facility Category: Large-scale CCS facilities
Operational: 2025
Facility Industry: Power Generation

Fuel Cell Carbon Capture Pilot Plant
Facility Category: Pilot and demonstration CCS facilities
Operational: ?
Facility Industry: Power Generation

Gerald Gentleman Station Carbon Capture
Facility Category: Large-scale CCS facilities
Operational: Mid 2020s
Facility Industry: Power Generation

Integrated Midcontinent Stacked Carbon Storage Hub

Facility Category: Large-scale CCS facilities
Operational: 2025 - 2035
Facility Industry: Various

Lake Charles Methanol
Facility Category: Large-scale CCS facilities
Operational: 2022 (Institute estimate)
Facility Industry: Chemical Production

Mustang Station of Golden Spread Electric Cooperative Carbon Capture
Facility Category: Large-scale CCS facilities
Operational: Mid 2020s
Facility Industry: Power Generation

Plant Daniel Carbon Capture
Facility Category: Large-scale CCS facilities
Operational: Mid 2020s
Facility Industry: Power Generation

Prairie State Generating Station Carbon Capture
Facility Category: Large-scale CCS facilities
Operational: Mid 2020s
Facility Industry: Power Generation

Project Tundra
Facility Category: Large-scale CCS facilities
Operational: 2025 - 2026
Facility Industry: Power Generation

San Juan Generating Station Carbon Capture
Facility Category: Large-scale CCS facilities
Operational: 2023
Facility Industry: Power Generation

Supercritical CO_2 Pilot Plant Test Facility
Facility Category: Utilization Facilities
Operational: 2020
Facility Industry: Power Generation

Wabash CO_2 Sequestration
Facility Category: Large-scale CCS facilities
Operational: 2022
Facility Industry: Fertilizer Production