CARBON CAPTURE COALITION

To: Department of Energy
From: Carbon Capture Coalition
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Re: DE-FOA-0002660-RFI

EXECUTIVE SUMMARY

Members of the Carbon Capture Coalition (the Coalition) have prepared this Request for Information in response to DE-FOA-0002660-RFI. **In addition to this RFI response, the Coalition will be preparing specific, actionable recommendations on implementing key carbon management areas to the Department of Energy (DOE) over the coming months, as DOE works to implement the historic bipartisan Infrastructure Investments and Jobs Act (IIJA)**.

Carbon capture, direct air capture, carbon utilization, transport and storage projects and associated infrastructure must be deployed quickly to reach a critical mass by 2030. Doing so will establish new benchmarks in technical maturity, ease of construction, affordability, and effective and timely permitting processes. Meeting these benchmarks will enable the industrial, power, and CO2 transport and storage sectors to make the massive carbon capture investments necessary for achieving net-zero emissions economywide by 2050.

The Department of Energy has a critical role to play in putting innovative industries on a pathway to meet 2030 commercialization targets through enabling pilot scale to commercial demonstrations, lowering technology risk and attracting private capital in the process. If we fail to commit to a broader federal policy portfolio now to enable significant carbon capture deployment by 2030, the U.S. and other countries risk being left without essential options needed to avoid the worst impacts of climate change.

At the beginning of the 117th Congress, the Coalition updated its Federal Policy Blueprint, which laid the groundwork for a broadly bipartisan federal carbon management policy portfolio that enhances and builds upon the landmark 45Q tax credit. It is estimated that the provisions enacted by the Infrastructure Investments and Jobs Act, in tandem with proposed bipartisan enhancements to the 45Q tax credits in pending climate and energy legislation, would result in an estimated 13-fold increase in carbon management capacity and annual CO2 emissions reductions of 210-250 million metric tons by 2035.[i]

ABOUT US

The Carbon Capture Coalition is a nonpartisan collaboration of more than 90 businesses and organizations building federal policy support to enable economywide, commercial scale deployment of carbon capture technologies, which includes carbon capture, removal, transport, utilization, and storage from industrial facilities, power plants, and ambient air.

Economywide adoption of carbon capture technologies is critical to **achieving net zero emissions to meet midcentury climate goals; strengthening and decarbonizing domestic energy, industrial production and manufacturing; and retaining and expanding a high-wage jobs base**.

Convened by the **Great Plains Institute**, Coalition membership includes industry, energy, and technology companies; energy and industrial labor unions; and conservation, environmental, and energy policy organizations.

AREA 1: POINT SOURCE CARBON CAPTURE TECHNOLOGIES

The United States leads the world in the commercialization of carbon capture, removal, transport, utilization and storage (or carbon management), and there is broad bipartisan support among members of Congress to enact policy mechanisms to support capturing, storing and utilizing CO2 and CO. The U.S. currently has 13 commercial-scale carbon capture facilities, with the capacity to capture about 25 million tons of CO2 annually, representing approximately half of the 27 commercial-scale carbon capture projects worldwide.[ii]

In the four years since Congress revamped the federal Section 45Q tax credit, project developers and investors have announced over 84 carbon capture projects to date, with more than half of those project announcements in 2021 alone.[iii] They span multiple industry sectors, electric power, transportation fuels, and direct air capture technologies. These publicly announced carbon capture projects represent an essential early down payment on long-term deployment to meet midcentury climate goals. If these projects all proceed to commercial operation, it will put us on the pathway for a seven-fold increase in operating carbon capture projects in the U.S. in the next decade.

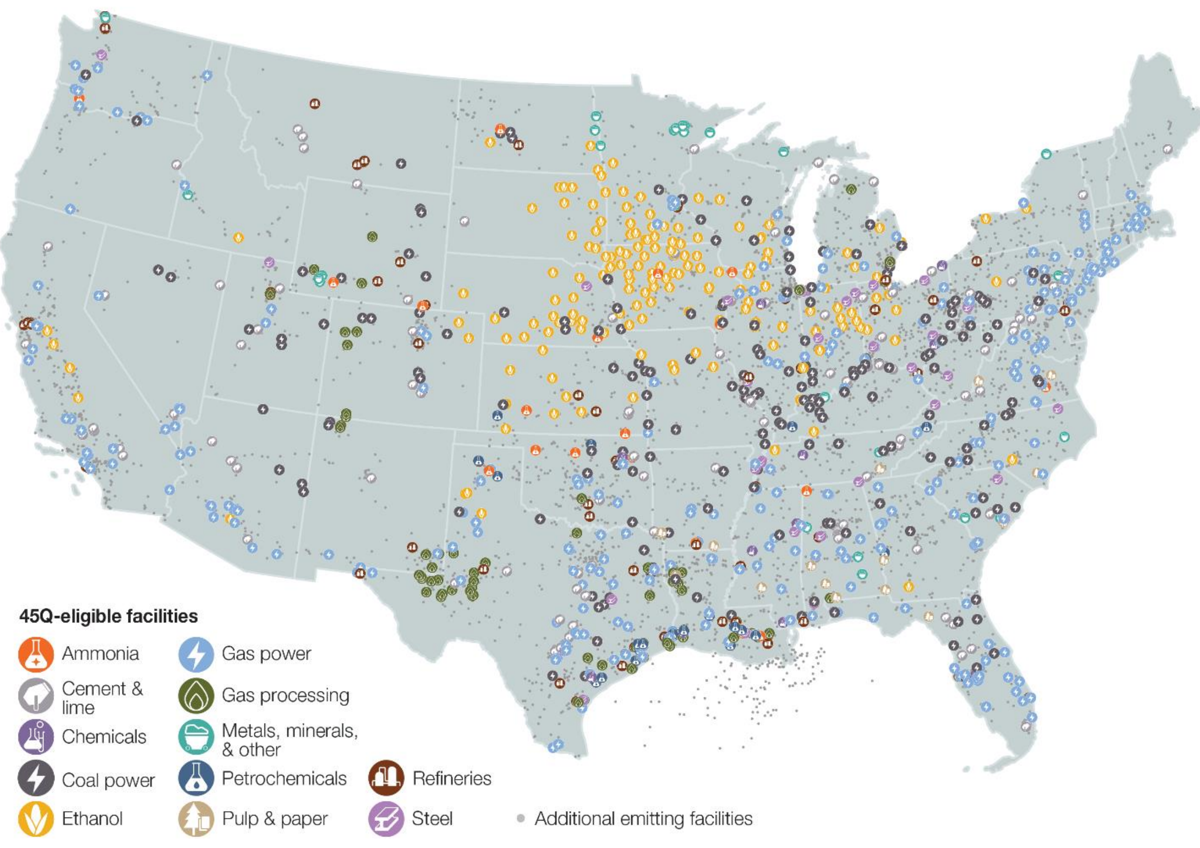
Of the 84 publicly announced projects, 71 percent of them are planned in the industrial sector, which includes hard-to-decarbonize steel, cement and petrochemical industries. Nineteen facilities are in the power sector (28 percent of all publicly announced projects), including 11 natural gas plants, 6 coal plants, 1 biomass and 1 waste-to-energy plant. There is currently one publicly announced direct air capture plant at full commercial scale in the United States.[iv] Beyond those facilities that are 45Q-eligible, there are a number of new technology applications that utilize or store CO2, and DOE should take an expansive view of available technologies to fund through RDD&D activities.

To meet midcentury emissions reduction goals, preserve and create high-wage jobs and maintain U.S. technology leadership, a broad suite of enabling policies will be required to accelerate commercial deployment of carbon capture projects.

The largest sources of carbon emissions in industrial production include carbon-intensive industrial sectors such as steel, cement, basic chemicals and refining. These sectors also directly emit CO2 through physical or chemical conversion of materials to end products and in these cases, there are limited decarbonization options beyond carbon capture.

Heavy industry, as well as coal, natural gas and biomass power generation feature lower concentrations of CO2, thus increasing the per-ton costs of capture. In addition, direct air capture that separates CO2 from ambient air, the most dilute source of CO2, has the highest per-ton costs of capture.[v]

Figure 1: 45Q eligible facilities[vi]



Within the United States, there are 1,197 facilities whose emissions meet minimum eligibility requirements for the current iteration of the 45Q tax credit. Based on analysis from the Great Plains Institute, 542 of these facilities have been identified as good opportunities for carbon capture retrofit over the next 15 years, based on a number of factors. This includes numerous facilities in the industrial sector.[vii]

The largest price sensitivity in deploying carbon management technologies is the cost of capture. The cost of transport and storage is relatively fixed per mile of CO2 pipeline.

Table 1: Cost of CO2 Capture by Application[viii]

Concentration of CO2	Application	US $ per MT captured/compressed	Transport/ Storage cost
Pure CO2 emissions	Ethanol, natural gas processing, ammonia	$15 – 20/metric ton	$25/ton
CO2 emissions @ 16 – 50% concentration	Hydrogen, cement, refining, steel	$40 – 60/metric ton	$25/ton
CO2 emissions @ ~13 – 15% concentration	Coal power	$55 – 65/metric ton	$25/ton
CO2 emissions @ ~4%	Natural gas power	$65-75	$25/ton
CO2 emissions @ <1%	Direct air capture	>$100	$25/ton

Policy

Legislative accomplishments over the past two years include the groundbreaking provisions for carbon management contained within the Fiscal Year (FY) 2021 Omnibus, containing a two-year extension of the 45Q tax credit and robust authorizations for federal research, development and demonstration programs, as well as crucial reforms to the Department of Energy loan program office, enabling DOE to draw on $8 billion in currently available funds to provide loans and loan guarantees to carbon capture projects.

Additionally, the Internal Revenue Service (IRS) which finalized the 45Q rulemaking in January 2021 after a three-year delay, together with the 45Q extension provided by the FY21 funding bill, provides long overdue regulatory and investment certainty to unlock billions of dollars in private capital for carbon capture projects, which can now complete the planning, engineering, permitting and financing required to begin construction by the end of 2025 in order to qualify for the credit.

The recently-enacted IIJA marks a major step forward in fostering economywide deployment of carbon management technologies and includes full funding for 2020 Energy Act authorizations to support commercial-scale demonstrations, pilots and engineering studies for carbon capture, direct air capture and carbon utilization technologies and investments in the development of regional direct air capture and hydrogen hubs. Large-scale pilot and demonstration projects are key to achieving our emissions reduction objectives and to driving near-term job creation and economic activity, while spurring additional project development. The infrastructure bill contains $8.6 billion in funding over five years for 2020 Energy Act authorizations for pilot, demonstrations and other deployment facing initiatives.

The 45Q tax credit is the cornerstone federal policy for enabling economywide deployment of carbon management technologies. Further enhancement of the 45Q tax credit is crucial to providing investment certainty, additional incentive value and the flexibility needed to drive greater private investment in carbon management projects. Several 45Q enhancements contained in pending legislation in the U.S. Senate would reduce the cost gaps between the current level of support provided by 45Q, enabling deployment of carbon capture technologies in a greater number of sectors, particularly those with higher costs of capture.

Measures to close the cost gaps between current 45Q and economywide commercial deployment include multiyear extension of the tax credit, direct pay at full value of the tax credit, increased credit levels for industry, power and direct air capture projects, as well as significant reduction of arbitrary thresholds contained in the statute.

Table 2: Thresholds in Current Law Versus Proposed Changes in Build Back Better Act

45Q Annual Carbon Capture Thresholds in metric tons of CO_2/CO per year		**Build Back Better Act** Proposed 45Q Reduced Annual Carbon Capture Thresholds in metric tons of CO_2/CO per year	
Direct air capture facilities	100,000 or more	**Direct air capture facilities**	1,000 or more
Carbon utilization projects	25,000 – 500,000	**Carbon utilization projects**	Carbon utilization projects are subject to the individual project thresholds
Industrial facilities (e.g., ethanol, steel, cement, and chemicals)	100,000 or more	**Industrial facilities** (e.g., ethanol, steel, cement, and chemicals)	12,500 or more
Electric Generating Units (i.e., coal, natural gas and biomass-fired powered plants)	500,000 or more	**Electric Generating Units** (i.e., coal, natural gas and biomass-fired powered plants)	18,750 or more

Table 3: Current Credit Amounts Versus Proposed Increases in the Build Back Better Act

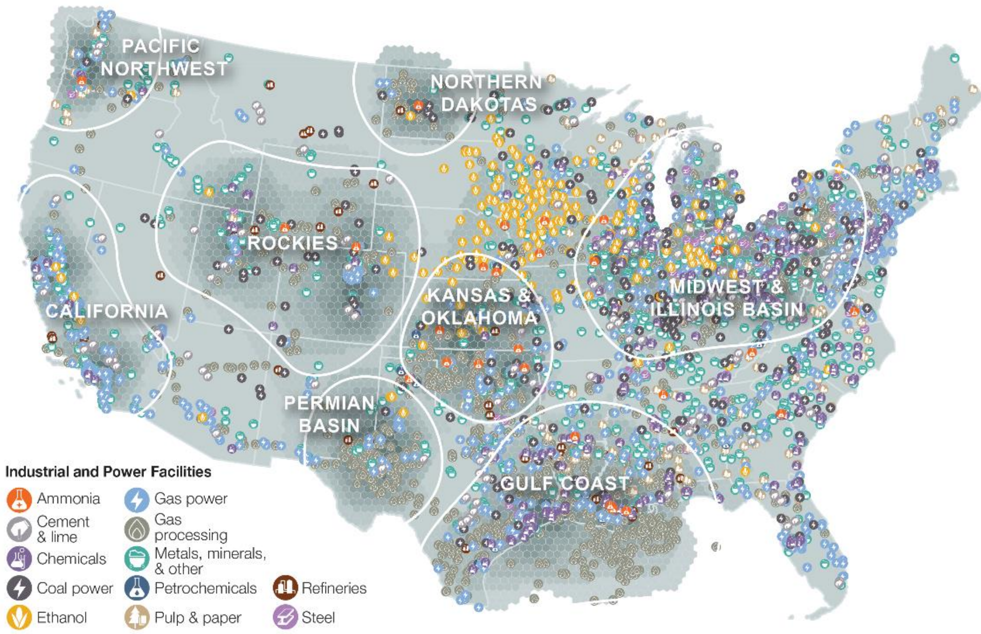
Current 45Q Tax Credit Amounts		Proposed 45Q Credits: Industry & Power	Proposed 45Q Credits: Direct Air Capture
For dedicated secure geologic storage of CO2 in **saline or other geologic formations**	$50 per ton	$85 per ton	$180 per ton
For **carbon utilization projects** to convert CO or CO2 into useful products (e.g., fuels, chemicals, products)	$35 per ton	$60 per ton	$130 per ton
For secure geologic storage of CO_2 in **oil and gas fields** through enhanced oil recovery	$35 per ton	$60 per ton	$130 per ton

Area 2: Carbon storage resources for commercial development

Carbon capture, transport and storage has been demonstrated at scale since 1972 in the United States, beginning with CO2 captured from natural gas processing and used in enhanced oil recovery in West Texas. .[ix] Of the 84 carbon capture projects publicly-announced since the reauthorization of 45Q in the 2018 FUTURE Act, 71 percent of all projects are planning to store in dedicated saline storage sites, indicating a strong and growing preference among project developers and investors for dedicated geologic storage.[x] Today, the majority of facilities where carbon capture is cost-effective are located either above or in close proximity to geologic formations that are suitable for saline geologic storage.[xi]

To reach economywide deployment, the industry must move from a single source-sink model to one where large-scale carbon storage sites serve as hubs for multiple capture sources. Regional analyses of 45Q eligible facilities shows several clusters or “hubs” that are excellent opportunities for shared carbon management infrastructure that are in close proximity to suitable long-term storage options (see figure 2).

Figure 2: Regional Opportunities for Hub Development[xii]



Policy

At the federal level, the Environmental Protection Agency (EPA) has permitted two Class VI wells with an additional four wells pending. Of the 84 carbon capture projects that have been publicly announced, 72 percent have declared their intent to store CO2 in saline formations and will require Class VI well permits. Additionally, the EPA reports that they have received more than 50 inquiries regarding Class VI well permits.[xiii,xiv]

Increasing the capacity at EPA to both permit Class VI wells and review state Class VI primacy applications in a timely manner will be critical to achieving economywide scale of carbon management technologies and meeting both net-zero emissions in the power sector by 2035 and midcentury climate goals. Already, EPA is taking steps to increase capacity to respond to the anticipated need, thanks in part to a $3 million increase in appropriations to the Class VI program for FY21.[xv]

Additionally. the recently-enacted Infrastructure Investment and Jobs Act fully funds the Storing CO2 and Lowering Emissions (SCALE) Act, which provides $25 million to support permitting of Class VI wells at EPA and $50 million for state activities including a grant program for states to establish their own Class VI permitting programs. To date, North Dakota and Wyoming have achieved primacy, with Louisiana's final determination from EPA expected soon. Texas, Arizona, and West Virginia in the pre-application phase, and several other states exploring Class VI primacy.[xvi] North Dakota has permitted two Class VI wells under its state primacy program.

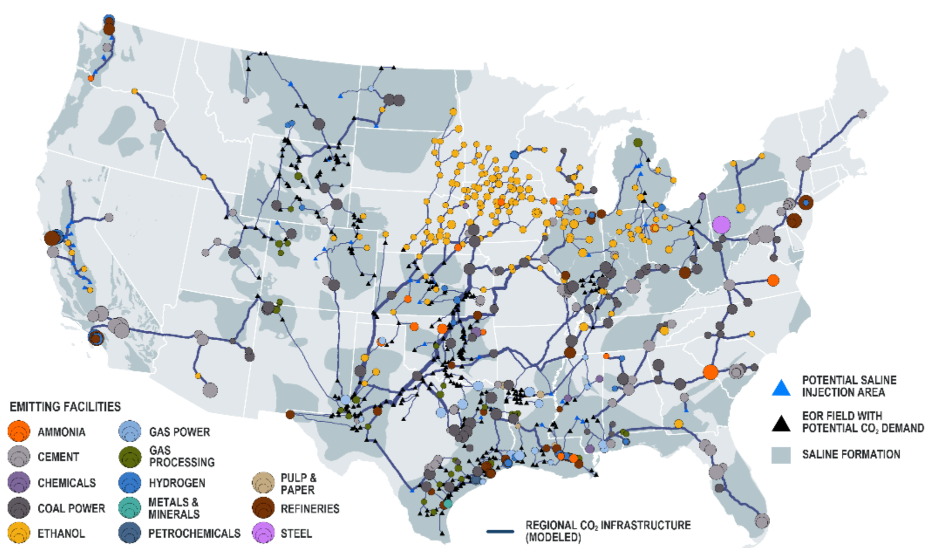
Area 3: CO2 pipeline infrastructure at regional/national scale

Under today's policy context, which includes the Section 45Q tax credit, it is already a positive economic proposition in some areas and industry sectors to finance regional CO2 transport infrastructure. However, the costs of transporting captured carbon from emitting facilities can pose barriers to deployment. Many of the industrial and power facilities in the United States are located in regions without significant deep saline or hydrocarbon geologic formations. Long distance transport infrastructure can unlock the economic potential for these facilities to sell captured CO2 and earn tax credits for storage under Section 45Q.[xvii]

There are currently about 5,000 miles of CO2 transport pipelines in the United States. Economywide deployment of regional CO2 transport infrastructure will require significant buildout of this network. Developing shared transport infrastructure connecting emitting sources to storage and utilization sites will minimize overall costs and land use impacts of deploying technologies[xviii]

Over the near term, as CO2 pipeline networks are being developed, barge waterways and freight highways can play an important role in carbon transport networks. Like railroads, interstate routes and freight waterways are well-established modes of transport for bulk commodities such as energy products and fuels. Trucks, barges, and trains can connect local facilities to one another, as well as facilitating connection to distant markets. These multi-modal transport options also offer flexibility, enabling routes to evolve over time and the frequency of transport to adapt in line with the volume of material being transported.

Figure 3: Optimized transport network for economy-wide CO2 capture and storage[xix]



Optimized CO_2 transport and storage modeling from the Great Plains Institute finds that, under the federal 45Q tax credit, a shared, interconnected CO_2 transport and storage system could capture, transport and store 300 million metric tons of CO_2 per year by 2035 from industrial facilities and power plants.

Areas that host concentrated industrial activity, geologic storage and existing conventional fossil fuel distribution infrastructure are candidates for carbon hubs, can act as early launching points for the development of carbon management hubs. Developing shared transport infrastructure can reduce costs when multiple sources collaborate in developing transport infrastructure.[xx]

The coordinated development of major new CO_2 transport infrastructure remains a logistical and financing challenge. Using authority and funding provided in IIJA, by prioritizing regional hubs that contain a high concentration of producers and consumers, DOE can reduce financial and logistical barriers to development of key transport infrastructure.[xxi]

Policy

The new infrastructure law includes the bipartisan SCALE Act to support the buildout of the regional CO_2 transport and storage infrastructure network needed to enable commercial deployment of carbon capture, direct air capture and carbon utilization.

Similar to the buildout of other forms of infrastructure to support deployment of low- and zero-carbon technologies over the next 30 years, scaling a national CO_2 transport and storage system is a necessary component to meeting medium-term and midcentury climate goals. Much like the development of other infrastructure systems, the SCALE Act positions the federal government to partner with private capital to invest in both regional and national CO_2 transport and storage infrastructure networks.[xxii]

By creating economies of scale, shared CO_2 transport and storage infrastructure can lower costs. Aggregating more CO_2 from more sources decreases transport and storage costs, which in turn enables more carbon capture deployment. Additionally, shared infrastructure will decrease the risk shouldered by any one individual carbon capture, utilization or storage project, reducing the total costs of carbon capture.

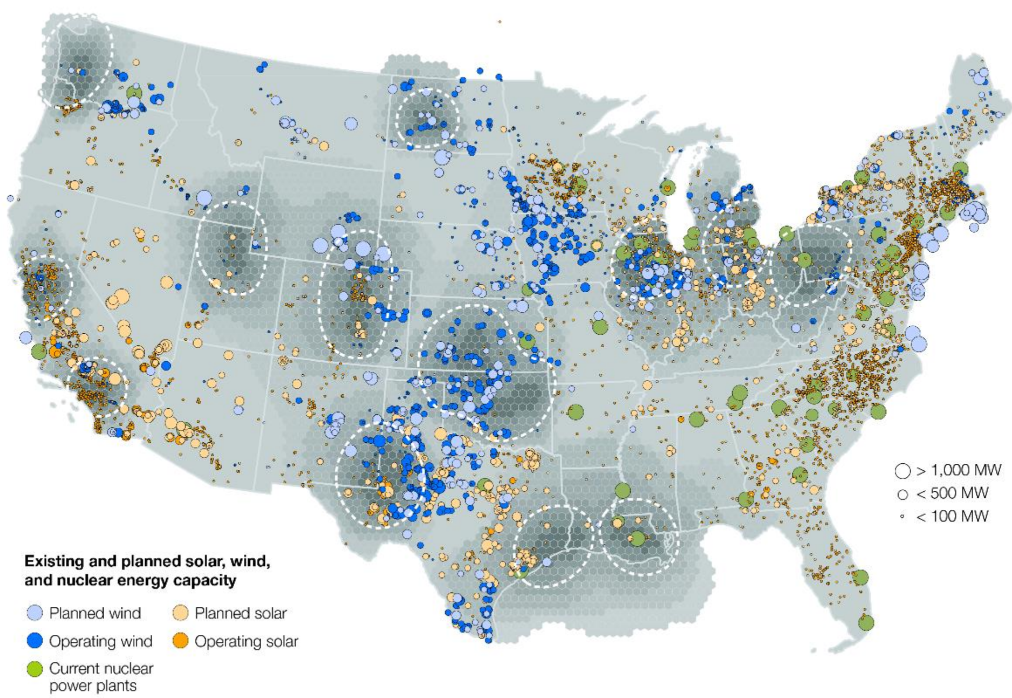
Area 4: DAC technologies and regional deployment opportunities

The International Energy Agency estimates that the global carbon management industry will need to scale up to well over 2,000 facilities, capturing 2.8 gigatons of CO_2 per year to limit warming to 2°C. For the more ambitious 1.5°C scenario, under conditions where further emissions reduction measures are taken, the International Panel on Climate Change estimates that on average, between 8 to 15 gigatons of annual emissions reductions will come from carbon capture technologies, more than half of which must come from negative emissions technologies. Direct air capture and other negative emissions technologies will play an increasing role in managing emissions from hard-to-abate sectors and from diffuse mobile sources, as well as offsetting any remaining anthropogenic emissions.[xxiii]

There are numerous areas of concentrated industrial activity within the vicinity of geologic storage formations throughout the United States that, along with existing commodity transport infrastructure, form potential carbon and hydrogen “hubs”. These hubs would act as early launching points for investment in carbon dioxide removal that can minimize financial and logistical barriers to market development.[xxiv]

In addition to considering the location of geologic storage, potential and existing areas for CO2 transport and storage, and existing 45Q-qualifying facilities, the siting of direct air capture hubs must consider existing or potential renewable and zero-electricity generation, as well as water resources (See Figure 4).[xxv]

Figure 4: Renewable Energy and Biomass Energy Availability for Hydrogen and Carbon Dioxide Removal[xxvi]



To meet the statutory requirements of the DAC hubs over the five-year period, DOE must select projects that have a high level of project readiness, including technological readiness, access to low- and zero-emissions power, water supply, and the state regulatory environment (Class VI wells, pore space ownership).

Carbon utilization entails the beneficial use of CO_2 or CO captured from gaseous waste streams in the manufacture of a valuable product that results in a net reduction of greenhouse gas emissions as compared to an incumbent process or product. Carbon utilization may involve the production of a wide variety of commodities or products sourced from waste gases or direct air capture, including low- and zero-carbon fuels, chemicals, plastics, advanced materials, industrial gases and fluids, building materials and even feedstocks for food and animal feed. The marketplace for eligible commodities and products produced from carbon utilization should not be constrained, so long as the production and use of captured CO_2 or CO offsets anthropogenic CO_2 emissions on an established lifecycle basis.

Increasingly, carbon utilization is seen as an important complement to large-scale carbon storage, as it provides value-added markets for carbon capture operations and constitutes an important component of a circular carbon economy. Taken together, the National Academies of Science has estimated that globally, utilization pathways could take up to 1 gigaton of CO_2 per year. The growing carbon-to-value market could be worth an estimated $800 billion annually by 2030.

High-volume products sourced from carbon utilization, including concrete, aggregates and fuels could drive both significant carbon utilization and market value. The cement and concrete sectors alone contribute 8 percent to annual global emissions; carbon capture and mineralization pathways have the potential to permanently store CO_2 and reduce the emissions footprint of the global cement and concrete industry on a gigaton scale.

However, scaling carbon utilization pathways will require a range of market development policies including pilot and demonstration scale projects to further provide insights regarding cost, efficacy and scale, federal procurement, and buildout of CO_2 transport infrastructure, as well as continued breakthroughs in carbon utilization technologies and processes enabled by federal RD&D. Similar to carbon capture retrofits, direct air capture and CO_2 transport and storage projects, regulatory and permitting issues for carbon utilization will require considerable attention from project developers, government and stakeholders.

The federal government can take steps to incentivize commercial production of products sourced from carbon capture, including developing standards and disclosures regarding the embodied carbon content of carbon recycled products. As corporations and other entities begin to look towards procurement of electricity, liquid fuels and products sourced from carbon capture processes, the federal government can play a central role in developing standards for what is needed to track, account for and verify carbon reductions from the manufacture of such products.[xxvii]

Workforce Development

Deployment of carbon capture, removal, transport, utilization, and storage technologies will retain and grow domestic high-wage industrial, energy, and manufacturing jobs. Carbon capture projects at industrial facilities and power plants provide some of the most desirable clean energy and industrial jobs since employment associated with heavy industry (refining, chemicals, cement, steel, etc.) and power plants pay higher than average local wages, while preserving important facilities and infrastructure.[xxviii]

In addition, new and innovative high-skilled and high wage industries will play a role in commercializing carbon capture and carbon removal, including jobs associated with new negative emissions and carbon utilization technologies. In many cases, the skills required for jobs in newly developing sectors such as carbon utilization and direct air capture require similar skill sets to those of the mining and oil and gas sectors. As a result, a well-trained labor pool may already exist in many regions. Additionally, carbon capture retrofits will reduce carbon emissions from existing facilities, preventing their retirement and loss of associated high-wage jobs.

Figure 5: Employment Potential of Near- and Medium-term CCS Deployment[xxix]

According to a Rhodium Group analysis commissioned by the Great Plains Institute, carbon capture deployment at industrial facilities and power plants and buildout of associated CO_2 transport infrastructure can create hundreds of thousands of high-wage jobs. Up to 107,000 jobs can be created over a period of 15 years through investment in retrofits and retrofit operations, with additional jobs occurring in the long-term.[xxx]

Separate analysis from Rhodium Group shows that a typical direct air capture plant capturing one million metric tons of CO_2 per year can generate roughly 3,500 jobs across the various sectors in the supply chain. The construction, engineering and equipment manufacturing sectors combined could see at least 300,000 new jobs associated with full scale direct air capture deployment.[xxxi]

The administration can leverage existing federal apprenticeship and workforce training programs to expand support for jobs training undertaken in partnership with community colleges, trade unions and other local institutions in affected communities.

Environmental Justice

In addition to realizing the essential reductions in carbon emissions from widespread adoption of carbon capture technologies, there is a need to ensure that benefits from deployment of the suite of carbon management technologies flow to affected communities and workers. The communities that are most vulnerable to climate change also typically suffer the greatest impact from criteria air and other pollutants; carbon capture has the potential to play a role in addressing these concerns.

Carbon capture retrofits in many instances may significantly reduce conventional pollutant emissions for several reasons. First, prior to CO_2 separation and capture, flue gas must undergo pretreatment to remove criteria air pollutants, including sulfur oxides, particulate matter, and nitrogen dioxide, to protect the capture solvent. Additionally, utilization of pre-combustion industrial gases removes criteria pollutants as part of the utilization process. Finally, installation of carbon capture may result in facilities having to meet more current and usually stricter emissions standards. However, the specific impact of individual carbon capture retrofits on conventional pollutants will vary depending on the emissions and carbon capture technologies deployed at individual cement, refining, iron and steel, and power plants.

Because carbon capture retrofits are capital intensive, there is little risk of old, inefficient, and polluting facilities extending their lives by adding carbon capture. Younger and relatively more efficient plants with significant remaining economic life pose the most serious challenge to climate change; without capture, they will emit CO_2 unabated, potentially for decades. While carbon capture will likely provide air quality benefits, further analysis is needed to quantify air quality impacts from carbon capture retrofits at different types of facilities in different industries and develop appropriate measures to ensure and optimize benefits.

DOE has the technical expertise to coordinate an interagency study to assess and quantify potential benefits and risks to local criteria air and other pollutants from carbon capture retrofits at industrial and power facilities across different technologies and industry sectors.

CONCLUSION

In summary, economywide deployment of carbon capture, removal, transport, use and storage is not optional if we are to achieve the decarbonization necessary to meet midcentury climate goals. We must implement lessons learned from our successful experiences commercializing wind, solar and other low and zero-carbon technologies to implement a broader policy framework for economywide carbon capture deployment.

Deployment of carbon management technologies also provides a viable pathway for the decarbonization and continued operation of industrial, manufacturing and energy facilities, thereby avoiding plant closures and the loss of jobs and livelihoods. This must be accompanied by additional job training, environmental policy and other measures to ensure that reductions in carbon emissions are accompanied by economic, public health and other benefits at the community level.

The U.S. is the world's leader in the capture, use and storage of carbon emissions, with nearly 50 years of successful commercial and operational experience across multiple sectors to leverage in building new industries and associated high-wage jobs. Building on the deeply bipartisan success of the 2018 FUTURE Act and now passage of the bipartisan Infrastructure Investment and Jobs Act, the Administration has the opportunity to put the carbon management industry on a commercialization pathway that enables meeting net-zero emissions targets and midcentury climate goals.

The Carbon Capture Coalition looks forward to providing additional feedback and input as the Department of Energy begins to implement the historic carbon management provisions in the Infrastructure Investment and Jobs Act.

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[i] Fact Sheet: Bipartisan Infrastructure Investment and Jobs Act, Carbon Capture Coalition
[ii] Global Status Report 2021: Policy Fact Sheet, Global CCS Institute, 2021.
[iii] U.S. Carbon Capture Activity and Project Table, Clean Air Task Force, 2021
[iv] Ibid
[v] 2021 Federal Policy Blueprint, Carbon Capture Coalition, 2021
[vi] An Atlas of Carbon and Hydrogen Hubs for United States Decarbonization, Great Plains Institute, 2022.
[vii] Transport Infrastructure for Carbon Capture and Storage, Great Plains Institute, 2020
[viii] Transport Infrastructure for Carbon Capture and Storage, Great Plains Institute, 2020
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[xiii] Class VI Wells Permitted by EPA, EPA, 2021
[xiv] U.S. Carbon Capture Activity and Project Tracker, Clean Air Task Force, 2021
[xv] Class VI Wells: Permitting & Primacy for Secure, Long-Term Storage of CO2, Carbon Capture Coalition, 2020.
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[xxx] The Economic Benefits of Carbon Capture, Rhodium Group, 2021
[xxxi] Capturing New Jobs and New Business: Growth Opportunities from Direct Air Capture Scale-Up, Rhodium Group, 2020