United States House of Representatives
Select Committee on the Climate Crisis

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"Solving the Climate Crisis: Reducing Industrial Emissions Through U.S. Innovation"

Questions for the Record

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1. **In this committee, we've talked, often with frustration, about how China has cornered key parts of the clean energy market, such as batteries and solar panels. Has China cornered the market in carbon capture for industrial emissions, or is this an opportunity for the United States to take the lead and export critical technology to China and other countries?**

According to the Global Carbon Capture and Storage Institute (GCCSI), China has commenced construction of one large-scale carbon capture and storage facility and another seven large-scale projects are in different stages of development. By contrast, the U.S. has 13 operating commercial-scale facilities that capture carbon dioxide (CO_2) from a variety of industrial and power generation sources and have a combined annual capture capacity of over 25 million metric tons. Thus, the U.S. remains the clear leader in the deployment of carbon capture, the commercial use of captured carbon and its safe and permanent geologic storage in oil and gas fields and saline formations, and we have the potential to expand that global leadership role. GCCSI recently updated its database of large-scale carbon capture and storage projects under development globally by adding ten new projects, eight of which are in the U.S.

The U.S. oil and gas industry has globally unmatched experience and expertise with large-scale CO_2 injection and storage that dates back to 1972. Multiple other U.S. industries collectively have decades of experience capturing and managing CO_2 at commercial scale. And American innovators, entrepreneurs and investors are on the cusp of a technological and economic transformation in the beneficial use of captured CO_2 and carbon monoxide (CO) to produce low and zero-carbon fuels, chemicals, advanced materials, and products.

However, if we are maintain and strengthen America's global leadership position, Congress must build on last year's landmark bipartisan reform and expansion of the Section 45Q tax credit by enacting a broader portfolio of federal incentives and other policies for carbon capture, much as has successfully been done for other low and zero-carbon technologies, such as wind and solar. The 70-plus companies, unions and NGOs that participate in the Carbon Capture Coalition recently reached consensus on just such a policy portfolio for American leadership on carbon capture. The Coalition's *Federal Policy Blueprint* was submitted to the Committee for the record at the hearing.

2. Several labor unions are members of your coalition. Why is the topic of industrial efficiency and carbon capture so important to them?

Carbon capture technologies can enable the decarbonization of critical economic activities, while avoiding the closure of existing industrial and manufacturing facilities and power plants and helping to achieve the emissions reductions needed to meet midcentury climate goals. Key sectors of our economy suited to carbon capture deployment support a high-wage, highly-skilled jobs base vital to the livelihoods of working Americans and to the stability and well-being of entire communities and regions that depend on them. Therefore, economywide deployment of carbon capture represents a central and necessary objective of a broader federal climate strategy and policy framework for labor unions, and it is the reason why unions have participated actively in the Coalition since its founding in 2011.

3. What is the biggest challenge for industrial carbon capture and what policy would make the greatest impact?

While industrial carbon capture from high-purity industrial sources of CO_2 such as ethanol, natural gas processing and ammonia production have now become economically viable under the reformed federal 45Q tax credit, many industrial processes produce less pure streams of CO_2 and have higher costs of capture. These industries also tend to produce low-margin commodities that are vulnerable to global competition, and they are thus highly sensitive to any increases in costs of production associated with implementation of emissions reduction technologies such as carbon capture. Moreover, some of the most carbon-intensive industrial sectors, such as refining, chemicals, cement, and steel production, have deployed few and, in some cases, no examples of carbon capture and utilization technology at full commercial scale, which means that the first large-scale projects in these industries will be more costly and involve more commercial risk to project developers and their investors who are the early adopters.

Following last year's reform and expansion of the Section 45Q tax credit, there is no longer one single policy that would have the greatest impact, but rather we now need to take a page from the policy success of wind and solar by enacting a broader portfolio of federal policies to enhance and build on 45Q as noted in the response to question 1 above. The first component of this broader federal policy portfolio includes technical fixes and enhancements to 45Q and other existing incentives, as well as new incentives to reduce the cost of capital in financing carbon capture projects (see response to question 10 below for more detail). Second, now that we have the revamped 45Q credit as a cornerstone federal incentive for deployment, it is crucial that federal policymakers devote attention to ensuring that CO_2 transport infrastructure becomes an important element of broader federal infrastructure policy to ensure that we have robust infrastructure in place across the country to transport CO_2 from where it is captured to where it can be geologically stored and put to beneficial use (see response to question 9 for more detail.) Finally, Congress can help ensure that the next generation of carbon capture and utilization technologies with lower costs and improved performance make their way into the marketplace by continuing to advance bipartisan RDD&D legislation such as the USE IT Act, Clean Industrial Technology Act and the Fossil Energy R&D Act, which would provide dedicated federal funding for research, development and demonstration of capture and utilization technologies in key industrial sectors.

4. You mentioned that Federal procurement policies will play an important role for creating early markets for industrial carbon capture projects. Could you expand upon which types of industrial products would be best suited for government procurement? Which of these have potential for carbon utilization?

The Carbon Capture Coalition has identified as a priority the development of federal procurement policy for low, zero and even carbon-negative electricity, liquid fuels and products produced through carbon capture, utilization, removal and storage. While the Coalition has yet to develop specific policy recommendations, Coalition participants recognize the important role that federal procurement policy has played in providing demand-side support for other low and zero-carbon technologies, complementing the role of tax credits and other financial incentives on the supply side to help drive private investment in commercial technology deployment.

Carbon capture and utilization in industrial settings is multifaceted, so federal procurement policies not only need to support market development for different non-energy products, but also for electricity and a wide range of liquid fuels. For example, utilization of waste steel plant CO emissions to produce low carbon ethanol, jet fuels and chemicals is currently being commercialized in China and Europe and could readily be deployed in the U.S. with the right mix of policy support. Also, low and zero carbon-electricity and hydrogen are critical to decarbonization of industrial sectors, and government procurement policies can help stimulate deployment of carbon capture in power generation and in hydrogen production for industrial heat and other applications.

In addition, key industrial commodities such as steel and cement lend themselves to government procurement policies. Infrastructure and construction constitute a significant component of market demand for such commodities, and federal funding for projects plays a major role in these markets. Because the purchase of these commodities represents a small percentage of total project costs, the federal government can provide a meaningful premium in the marketplace for lower-carbon steel, cement and other commodities manufactured with carbon capture and/or incorporating carbon utilization, without significantly increasing the total federal contribution to such projects.

Finally, federal procurement policies can play an especially important role in establishing markets for products derived from the utilization of captured CO_2 and its precursor CO that have a smaller carbon footprint than their traditional counterparts. Considering both technological maturity and potential market size, building materials, fuels, chemicals and plastics produced from captured carbon are examples of promising areas where procurement policy could make a real difference in fostering deployment. Beyond reductions in carbon emissions, there are additional benefits to many of these technologies, including military readiness. Direct air capture-to-fuels applications, for example, could enable the military to produce fuels around the world through the capture of CO_2 from ambient air.

5. Are there environmental, health, safety, or other risks and tradeoffs to pursuing carbon capture utilization and storage? How can they be mitigated?

Carbon capture, pipeline transport and geologic storage of CO_2 have been undertaken at scale for nearly a half century in the U.S., and over a billion tons of CO_2 have been injected into geologic formations over that time period without significant environmental incidents. Industry currently purchases and manages on the order of 65-70 million metric tons of CO_2 annually for injection. Environmental, health and safety risks are known, minor, well-managed and regulated. The transport,

use and geologic storage of that CO_2 is enabled by just over 5,000 miles of existing CO_2 pipelines in 11 states, the operation of which over decades has involved no fatalities or major environmental accidents. Few industries on this scale have a comparable safety and environmental record.

6. You mentioned the importance of the 45Q tax credit for carbon capture projects. Beyond 45Q, what policies does the Carbon Capture Coalition recommend for creating markets for industrial carbon capture?

This question is already addressed in responses to questions 1, 3, 4, 9 and 10, especially questions 4 and 10.

7. You mentioned in your testimony visiting two overseas demonstrations of CCUS at steel production facilities. Could you talk about what you learned from these visits that could be applied to facilities in the United States? Why do you think these innovative applications were demonstrated in other countries and not in the United States? What made these countries better environments for testing these technologies?

U.S. state and federal officials and representatives of industry, labor, NGO and philanthropy recently had the opportunity to visit the world's only large-scale carbon capture facility at a steel plant in the United Arab Emirates and a commercial-scale carbon utilization project under construction at a steel mill in Belgium and to consider how these technologies and business models could be applied here in the U.S. The direct reduction ironmaking process used by Emirates Steel in the UAE is widely deployed in the U.S. The specific HYL technology from Energiron produces a pure stream of CO_2 that can be readily configured for capture and compression, and it is currently installed at a steel plant in Louisiana, potentially creating a near-term opportunity in the U.S. In Belgium, the "Steelanol" project under development between the U.S. company LanzaTech and global steel producer ArcelorMittal to produce ethanol from steel mill CO emissions could also be pursued in the U.S. under the right policy circumstances.

In both the UAE and Belgium, the commitment of resources by Abu Dhabi (through the Abu Dhabi National Oil Company) and the European Union, respectively, and the economic opportunity to add value to existing energy and industrial production through carbon capture and utilization provided the impetus to these projects and made their development feasible. Here in the U.S., the existing 45Q tax credit, coupled with targeted federal resources and incentives for early commercial technology demonstration in key industrial sectors such as steel, cement, chemicals, etc., would enable similar steel and other large-scale industrial carbon capture projects to move forward. Specifically for carbon utilization-to-fuels pathways such as LanzaTech and ArcelorMittal's CO-to-ethanol process, incentive support for low-carbon fuels through the Renewable Fuels Standard or some comparable federal policy would be needed for deployment to proceed.

8. Are there ways that carbon capture can help industrial facilities with reliability and resilience?

Many types of industrial facilities are very energy-intensive and require cost-effective, reliable electricity and industrial heat on a 24/7 basis. Installing carbon capture on coal and natural gas power generation can decarbonize electricity inputs to industrial production without impacting supply or system reliability. Similarly, steam methane reforming of natural gas with carbon capture currently

provides the lowest-cost source of zero-carbon hydrogen, thus enabling cost-effective, on-demand provision of near zero-carbon heat to industrial processes.

9. You mentioned that expanding infrastructure for the transport of carbon dioxide will be crucial for bringing down the costs of deployment of CCUS. Can you describe the existing carbon dioxide pipeline infrastructure in the United States and how and where it would need to be expanded to accommodate the volumes projected for deep decarbonization?

Currently, the U.S. has just over 5,000 miles of existing CO_2 pipelines in 11 states, and CO_2 has been safely transported and injected for injection and geologic storage at scale since 1972. The bulk of today's CO_2 transport infrastructure is concentrated in several pipeline networks, with the largest centered on the Permian Basin of Texas and New Mexico and other smaller networks on the Gulf Coast and in the Northern Plains, with the remainder consisting of single source-to-sink pipelines in several states.

For carbon capture to realize its full potential to contribute to midcentury emission reductions as borne out in modeling by the International Energy Agency (IEA) and Intergovernmental Panel on Climate Change (IPCC), a national system of CO_2 transport infrastructure will need to be developed on a scale comparable to systems now in use to transport oil and gas. This will entail scaling up existing regional CO_2 infrastructure hubs substantially, establishing new hubs in areas of concentrated industrial and energy-related emissions and geologic storage potential (e.g. Louisiana Gulf Coast and industrial Midwest), and developing new long-distance, large-volume CO_2 trunk lines and associated feeder lines to regions not currently served by infrastructure for carbon management, including the Upper Midwest, Midwest and coastal regions.

The Carbon Capture Coalition has urged Congress to make CO_2 transport infrastructure a core component of broader federal infrastructure policy, specifically recommending a federal role in leveraging private capital investment through:

- Low-interest federal loans to finance extra pipeline capacity and realize economies of scale;
- Support for large-volume, long-distance CO_2 trunk line demonstration projects to support development of key regional hubs; and
- Encouragement to state and local governments to designate anthropogenic CO_2 pipelines as "pollution control devices" to enable tax abatement.

The Investing in Energy Systems for the Transport of CO_2 Act of 2019 (INVEST CO_2 Act) recently introduced in the House incorporates the Coalition's recommendations for a federal role in helping to finance the buildout of national CO_2 transport infrastructure.

10. You mentioned that carbon capture projects are difficult to finance due to the high cost of debt and equity and the risk involved in the investment. Which government financing mechanisms would best lower these costs and risks?

As noted above, the Coalition recommends a portfolio of policies to expand the pool of eligible investors and projects, reduce investment risk, and make capital available to projects on more favorable terms. The following policies involve technical fixes and enhancements to the existing 45Q tax credit, improvements to other existing complementary incentives and new financial incentives.

First and foremost, Congress should extend now the authorization of 45Q beyond the current deadline for beginning construction at the end of 2023 in order to provide the kind of longer-term planning and investment horizon that has helped spur private investment, commercial deployment and cost reductions for other low and zero-carbon technologies. The newly-reformed 45Q credit provides a foundational incentive for early commercial carbon capture deployment, but significant delays by the IRS in providing guidance have reduced the time period available to plan, engineer, permit and finance large-scale, capital intensive carbon capture and utilization projects from six years to just four.

In addition, technical fixes and new policy options to enhance and complement 45Q would further incentivize private investment in the deployment of carbon capture technologies. The technical fixes identified below offer many potential near-term deployment benefits to the carbon capture industry:

- Eliminating the 25,000-ton minimum annual capture threshold in 45Q that inadvertently risks precluding most carbon utilization projects from eligibility;
- Preventing the disallowance of 45Q and the 48A tax credit under the Base Erosion and Anti-Abuse Tax--BEAT (a technical fix already afforded investors claiming the Production Tax Credit for wind energy and the Investment Tax Credit for solar energy), which otherwise risks reducing the pool of available investors in carbon capture projects; and
- Enabling developers of power plant carbon capture retrofit projects to access available 48A tax credits by incorporating needed technical fixes provided for in the Carbon Capture Modernization Act. (The legislation would address a conflict in current law that makes the tax credit unworkable for potentially eligible projects.)

The Coalition also recommends several new policy options to help the carbon capture industry achieve economywide deployment:

- Providing enhanced transferability for the 45Q credit in statute by including additional taxpayers who are involved in the carbon capture transaction to be allowable as transferees (modeled on the transfer provision in Section 45J(e) of the Advanced Nuclear Tax Credit);
- Establishing a revenue-neutral refundable option for 45Q to enable a greater diversity of companies and business models to benefit from the tax credit; and
- Creating an "American Energy Bond" option to allow project developers to make interest payments in the form of tax credits, if they invest bond proceeds in qualified energy infrastructure projects, including carbon capture and utilization.

Providing for the eligibility of carbon capture and utilization eligible for federal financial incentives that have proven effective in other industries can further reduce the cost of capital and complement and reinforce the deployment potential of the 45Q credit. The Carbon Capture Improvement Act would make carbon capture and utilization projects eligible for tax-exempt private activity bonds, and the Financing Our Energy Future Act would also allow carbon capture and utilization projects to become master limited partnerships, thus affording the tax advantages of a partnership coupled with the benefit of being able to raise equity in public markets.

Finally, ensuring the widespread availability of infrastructure to transport CO_2 from where it is captured to where it can be stored or put to beneficial use will reduce costs and increase investor confidence in proposed capture and utilization projects. As referenced in the response to question 9, the Investing in Energy Systems for the Transport of CO_2 Act of 2019 (INVEST CO_2 Act) would provide for a federal role in providing low-cost financing to support the deployment of CO_2 transport

infrastructure and ensure that such infrastructure is built with sufficient capacity to stimulate private investment in ongoing development of capture and storage projects over time.

11. **You mentioned that there is potential for using biomass as a feedstock for power generation and capturing the carbon dioxide on the back end to create negative emission energy for industry. Could you expand upon what issues need to be considered when determining whether sources of biomass are appropriate for power generation with carbon capture to reduce greenhouse gas emissions? Taking into account land-use considerations and the multiple uses of biomass, what is a reasonable scale for using biomass for power generation with carbon capture?**

While IPCC modeling indicates that deploying atmospheric carbon removal strategies at significant scale—including bioenergy with carbon capture to achieve negative emissions—is necessary to meet midcentury climate goals, the Carbon Capture Coalition does not take a position regarding the appropriate future scale and scope of biomass utilization in bioenergy production with carbon capture relative to other negative emissions strategies, including direct air capture deployment. However, existing biofuels production and biomass power generation in U.S. provides ample opportunity to deploy carbon capture, use and geologic storage of biogenic CO_2 emissions to demonstrate the commercial potential for larger-scale negative emissions energy systems—without expanding beyond current levels of biomass feedstock use in energy production. If we are even to have the option of scaling up negative emissions energy systems in the post-2030 period, it is important that federal policymakers support commercial demonstration of bioenergy with carbon capture now at biofuels and biomass power facilities using existing feedstock supplies. In the meantime, federal policymakers and stakeholders can and should continue to work to forge agreement on policies that can help ensure long-term sustainable biomass utilization in the context of midcentury decarbonization.

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