Institute of Clean Air Companies
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TO: Office of Fossil Energy and Carbon Management, U.S. Department of Energy
FR: The Institute of Clean Air Companies (ICAC)
RE: **Department of Energy's (DOE) Request for Information: Deployment and Demonstration Opportunities for Carbon Reduction and Removal Technologies (#DE-FOA-0002660)**

The Institute of Clean Air Companies (ICAC) appreciates the opportunity to offer comments in response to Department of Energy's Request for Information on deployment and demonstration opportunities for carbon reduction and removal technologies.

ICAC is the national trade association of companies that supply greenhouse gas management and air pollution control and monitoring systems, equipment and, services for stationary sources. For over 60 years, ICAC member companies have helped to clean the air by developing and installing reliable and cost-effective control and monitoring systems.

ICAC's response will focus on the importance of the scaling process and the need for continued DOE funding; standards, codes, and validation requirements; conversion of CO_2; and direct air capture technologies. We support technology-neutral and flexible policies that enable cost-competitiveness and a diverse set of technologies to compete in the market.

Again, ICAC appreciates the opportunity to offer input to DOE and we look forward to answering any further questions or provide additional information.

Sincerely,

Clare Schulzki
Executive Director, ICAC

I. Introduction

The Institute of Clean Air Companies (ICAC) appreciates the opportunity to respond to the Department of Energy Office of Fossil Energy and Carbon Management's RFI on Deployment and Demonstration Opportunities for Carbon Reduction and Removal Technologies. ICAC is a trade association headquartered in Arlington, VA, and represents more than 30 companies in the air pollution control, greenhouse gas management, and emissions measurement industry. ICAC members have successfully developed and deployed solutions to address emissions challenges for more than 60 years and are uniquely positioned to provide their expertise on emerging clean technologies and advancing clean technology markets.

ICAC members have successfully commercialized solutions for the industrial, power, oil and gas, manufacturing and maritime sectors, and have worked alongside policymakers, regulators, and other industry stakeholders to address challenges that emerge at the nexus of air and water pollution management. Pollutants managed by member technologies include mercury, acid gases, PM, NOx, SOx, VOCs, HAPs, GHGs, HCl, and coal ash. Additionally, ICAC members are working at the forefront of the energy transition on innovations in clean hydrogen production and use, carbon capture, and other solutions to tackle the next set of emissions challenges through equitable, cost-effective, and collaborative work. Our members have operations in all 50 states and range from multi-national corporations with thousands of employees to small businesses focused on local emission challenges. ICAC is recognized as a trusted, unbiased technical resource for government and other stakeholders by providing information on what is technologically achievable, and the relevant costs associated with technologies.

ICAC members' experience in meeting emissions challenges equips our organization with valuable insights that can help inform the development of successful policies, regulations, and other mechanisms to support the advancement of clean technologies ready to deploy now and those needing further development. ICAC believes policies should be technology-agnostic and flexible to enable cost-competitiveness. Many solutions will be needed to meet the anticipated clean energy demand and to reach our mid-century decarbonization goals. ICAC members stand ready to provide information to help inform DOE and the Administration as it looks to help enable the development and deployment of carbon reduction and removal technologies and would welcome the opportunity to further discuss our industry's perspectives.

II. Continued DOE Funding, Scaling Process and Market Incentives

Any business case for deploying carbon capture, utilization, and sequestration (CCS) technologies must rely on ongoing monetization (e.g., the Section 45(q) tax credit) or producing a sellable product (e.g., Monolith with carbon black production). Emerging clean energy technologies cannot only rely on commodity markets, because such markets do not provide adequate long-term revenue guarantees that are required to secure project financing.

Though production, integration, design and construction all happen rapidly (between 2-4 years), the technology development of low-carbon process technologies does not mimic the evolution of "computer tech" types of production. Maturing a process technology typically will require incorporating the lessons-learned of three completed and successful projects. DOE should focus

on continued, long-term funding to see projects all the way through this 4–6-year process. The successful scale-up of flue gas desulfurization (FGD) and selective catalytic reduction (SCR) markets, driven by EPA regulation of coal plants, are great examples of quick market reaction and deployment of technology solutions.

Until the cost of carbon emissions is fully internalized, DOE must address the gap between the cost of low-carbon commodities and their market value. This requires an appropriate government and business cost-sharing model. New types of facilities are needed at scale and demand uncertainty is high in early-stage development. Full Front End Engineering Design (FEED) studies are required, as well as new commercial arrangements and integration with early infrastructure in the hub and cluster approach.

ICAC believes DOE should consider its approach to technology advancement within the energy sector. Successful projects, albeit fewer, should become the norm for DOE project involvement. This will ultimately facilitate additional Congressional funding for more aggressive investments. Projects like Petra Nova could have been supported by making Section 45(q) tax credits available or by employing another long-term cost-sharing model (e.g., the "Contract for Difference" approach utilized in the United Kingdom for clean hydrogen energy hubs). DOE should assume ongoing responsibility so prior investments can continue to be realized commercially.

III. Opportunities for Carbon Conversion Technologies and Grant Program

The conversion of CO_2 into useful and cost-effective products is a critical pathway towards reducing carbon emissions. Unlike many markets where relatively few technologies will dominate the market space, these opportunities are usually very specific and fragmented. For example, CO_2 can be used in various chemical pathways, but the conversion to an ultimate final product may require many unique technologies.
Conventional production of many chemicals (e.g., methanol) involves fossil feedstocks, such as natural gas or coal. Moving these products forward will require a pathway that uses captured CO_2 and low-carbon hydrogen to ensure sustainable production. ICAC members have many examples of the following activities as examples:

- Methanol catalysts which turn CO_2 into methanol helps meet the urgent need to remove carbon emissions in hard-to-decarbonize sectors of the economy.
- Low-carbon hydrogen can be used to create sustainable aviation fuels.

ICAC members understand the importance of carbon abatement technologies. Many of our members have strong interests in the use of CO_2 as an emerging feedstock for sustainable fuels and chemicals and are continuously looking for solutions to do even more. No single company can do it alone, so most are working through collaborative partnerships to lead the transition to a net-zero carbon economy. Ensuring DOE support is inclusive of technologies that abate carbon, in addition to those that capture carbon, will be critical to maximize overall emissions reductions and avoidance.

ICAC member companies are excited about the opportunity to contribute to the development of emerging companies with disruptive ideas on capturing and converting CO_2 by working in

collaboration with the DOE. As noted above, since many of these technologies are still in development, even with corporate partnerships, it is difficult for the private sector to bring these technologies through to full commercial deployment without government support to mitigate the risks. While private partnerships can help to advance the development of technologies, government support can create demand so that a market is ready and waiting for these products. Such support is the best way to accelerate the development and deployment of CO_2 conversion technologies.

What permitting and validation requirements should be implemented?

Validation requirements are needed to be able to compare the performance of processes for producing very different products from CO_2. First, field verification of CO_2 conversion requires precise and comparable measurement of CO_2 inputs and outputs with appropriate QA/QC and documentation. Second, individual processes may have dramatically different costs, chemical inputs, utility requirements and output products. Thus, attempting to compare the ability of different carbon capture and utilization (CCU) processes to utilize CO_2 must be thoughtfully done.

For example, in the NRG Canada's Oil Sands Innovation Alliance (COSIA) Carbon XPRIZE competition, prizes were awarded to teams that could convert the most CO_2 from flue gas into products with the highest value. However, determining whether a team was economically converting the most CO_2 into useful and valuable materials and comparing teams against each other was challenging for the reasons described above.

Independent testing and verification of emerging technologies are vital parts of the technology commercialization process. With the rapid development of CCU technologies, where existing standards and certifications do not exist, independent verification approaches and guidelines can provide a means to obtain credible information for an emerging market. The ISO 14034:2016—Environmental Management: Environmental Technology Verification (ETV) standard can serve as a foundational platform to ensure the consistency, quality, and credibility of data on CCU technology performance, enabling direct comparisons between technologies and reducing risk to decision-makers regarding potential investment, future deployment, and ultimate impacts of CCU innovations. The ISO 14034 standard was written specifically to facilitate the verification of technologies that are commercial or approaching the commercial-ready phases of development [typically for technology readiness levels (TRLs) from 6 to 9].

The NRG COSIA Carbon XPRIZE utilized the verification approach established in ISO 14034 as a foundation for its assessments of the nine technologies that participated in the pilot-scale testing finals of the competition during 2019 and 2020. The fundamental principles of ISO 14034 were applied to ensure that the evaluation of competitors was of high quality, consistent across technologies and met the information needs of the XPRIZE judges responsible for selecting winners.

In addition to process verification with ISO 14034, verification of economic benefits was required in the XPRIZE competition. Therefore, a Standards Data Set was created to set a standard economic value to components of the scoring and judging of teams' prize applications.

The data set was developed to establish a fair measurement protocol, backed by credible market data, to evaluate the potential net value of technologies that turn CO_2 into useful product and was a key input into a high-level equation, the 'net value score', which included three top-level variables: product value (p, in $/metric ton of product), cost of inputs (c, in $/metric ton of product) and global market size (M, in metric megatons of CO_2 per year). Without such a Standards Data Set, it would have been impossible to compare the results of process for producing such diverse products as concrete and cement, concrete admixtures, and syngas.

Identify if the commercialization of relevant technologies and products requires standards/certifications and the applicable federal agencies or standard-setting organizations for it?

EPA, through its Environmental Technology Verification program, has developed testing protocols and verified the performance of new environmental technologies. This program could serve as a template for verification of the technical performance of CCU technologies.

DOE has developed CO_2-emissions life-cycle assessment (LCA) guidelines as well as techno-economic assessment (TEA) guidance for projects implemented using DOE funding. Such tools must be sufficiently flexible to evaluate CCU processes that use a variety of inputs and produce a variety of products. DOE is encouraged to examine existing LCA and TEA tools to ensure they can meaningfully evaluate the wide range of CCU technologies.

IV. Direct Air Capture Technologies and Regional Deployment Opportunities

The Infrastructure Investment and Jobs Act (IIJA) was clear in its intent for direct air capture (DAC) hubs to be focused on the deployment of industrial-scale DAC projects. The focus on commercial-scale deployment is an essential complement to the DOE programs for research, development, and demonstration support which are directed at the earlier stages of DAC development.

For this program to result in climate-relevant volumes of removals and to facilitate scaling of these removals, DOE should consider the following when selecting DAC proposals:

Regionality

- In order to allow the proposals with the most promise of execution success, scalability, and cost-effectiveness to come forward, DOE should not apply location constraints other than those naturally occurring based on access to renewable electricity, pore space, or CO_2 utilization opportunities.
- DOE should favor projects proposed in regions with demonstrated scaling potential, including being in the vicinity of large-scale geological storage and proximity to potential or existing point-source capture projects to enable shared use of transport and injection infrastructure.

Technology

- DOE should focus on selecting projects with a high likelihood of success, this includes projects with both technological maturity and a high degree of project maturity.

- Project maturity includes well-defined and understood supply chains for at-scale technology deployment, experience developing projects of similar size and complexity, proven access to essential project elements (e.g., suitable wells for sequestration) as well as the financial strength to withstand some cost overruns.
- Evaluation of the performance of the technology should be based on a rigorous Life Cycle Analysis (LCA) that includes all upstream inputs (including energy and consumables), downstream emissions, and any fugitive emissions from the facility itself.
- Comparison of projects on a levelized cost of removals basis will be possible if verified net carbon removals are provided in the form of a third-party LCA. Should such an assessment not be possible for a specific technology due to insufficient project or technological maturity, this project should be considered for funding through pilot and demonstration programs rather than the deployment-focused DAC hubs program.

Partnership Structures and Business Models

- The existing programs incentivize the private sector to deliver DAC solutions (e.g., Section 45Q tax credits and the DOE Loan Program). These programs remain the most effective approach to delivery of commercial-scale carbon removals. Success in this model can be aided by:
    - Ensuring that minimum thresholds in the areas of technology readiness, project maturity, and environmental integrity are set.
    - Issuing calls for proposals iteratively, such that future DAC hubs can learn from the initial DAC hub(s). This structure will also improve the likelihood that carbon removal targets are met once the full value of the funding is received.

Permitting and Regulatory

- DAC facilities are very similar in construction and operational activity to existing industrial processes and therefore the existing EH&S and National Environmental Policy Act (NEPA) are well equipped to handle commissioning and permitting of a DAC facility.

Community Engagement, Benefits, and Impacts

- A single megaton DAC facility is expected to result in over 300 ongoing operational jobs and over 3000 construction jobs.[1]
- There are clear environmental benefits of removing CO_2 to reduce the pace of and prevent global warming. Although no single facility will have a measurable impact on local air quality, liquid-DAC facilities are based on closed chemical loops and therefore do not result in new pollutants being introduced into the local environment.

V. Direct Air Capture Prizes and Requirements

A DAC prize will be most effective at catalyzing full-scale commercial deployment if it is structured in the form of a long-term offtake agreement for a portion of a plant's removals. This revenue certainty and stability will complement tax incentives and the small but growing market for purchases of technological removals, thereby greatly reducing risk and allowing for project

[1] The Rhodium Group. "Capturing New Jobs". June 23, 2020.

financing. Designing this style of DAC prize should be based on the same technological maturity and project readiness as is outlined above.

VI. Conclusion

ICAC member companies offer a wide range of skill, talent and assets that can help provide unmatched access to industry stakeholders, strategic advice, marketing and branding support, investor networks, and a community of like-minded founders. Working with DOE, we can lead the way to a more sustainable world by connecting people, capital, and purpose to advance market-ready solutions to address climate change.

ICAC looks forward to working with DOE on bringing together thought leaders to push the boundaries on advancing low-carbon and clean energy products in support of DOE's efforts to combat climate change. The roadmap and support of the new cohort will help change the landscape on innovative solutions and build a trajectory for products that help us achieve economy-wide carbon neutrality and foster cleaner, healthier communities.

Again, ICAC would like to thank DOE for the opportunity to respond to this Request for Information. We welcome an opportunity to further discuss these thoughts with you and are happy to answer additional questions or clarify any points made.

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