June 24, 2024

TO: Industrial Efficiency and Decarbonization Office, U.S. Department of Energy
FR: Institute of Clean Air Companies
RE: DE-FOA-0003363: Request for Information on Transforming Industry – Strategies for Decarbonization

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The Institute of Clean Air Companies (ICAC) appreciates the opportunity to respond to DOE's Office of Industrial Efficiency and Decarbonization Office (IEDO) Request for Information (RFI).

ICAC, a trade association in Arlington, VA, represents 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 provide solutions for the industrial, power, oil and gas and maritime sectors, and have worked to address challenges that emerge at the nexus of air and water pollution management. ICAC member companies' experience can help provide valuable insight on what is technologically achievable now as well as where further development and policy support is needed.

ICAC hopes that its responses will help inform DOE as it develops a new study, *Pathways for U.S. Industrial Transformations*: *Unlocking American Innovation*. ICAC believes that the U.S. industrial sector can play a lead role as technology innovators in developing the clean energy economy and to help create global demand for U.S. environmental technologies. We welcome the chance to participate in additional conversations or answer any clarifying questions that may arise in this response.

Best regards,

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Category 1A: Questions on Primary Challenges and Barriers to Decarbonization

1A.1 What feedback do you have on the primary industrial decarbonization challenges and barriers summarized above? Please list any additional barriers that you think are important.

In addition to the cross-sector barriers outlined by DOE in the RFI, some of the key challenges to deploying decarbonization solutions in the industrial space include high costs and permitting approval. On permitting, the process for receiving a Class VI carbon sequestration permit is very lengthy and only a few have been approved to-date, making CCS projects more challenging to achieve and delaying GHG reduction benefits.

On constraints within industrial entities, ICAC would underscore the role that risk avoidance in making capital investments plays in creating barriers to decarbonization. Entities must factor in the ability to compete in a market following implementation of a clean energy project. Any company that voluntarily chooses a decarbonization path would incur higher costs than its competitors. Especially for public companies with fiduciary responsibilities to shareholders, this is problematic and deters companies from such action more than not.

In order to keep competition fair and also drive emission reductions, government must act to support companies seeking to be proactive on decarbonization. Tariffs or other tools would have to be in place to prevent unfair competition from foreign companies not subject to U.S. emission reduction requirements.

Another barrier that we see is that currently, there is insufficient government support for funding bridge technologies on the way to net-zero. For industrials to successfully decarbonize, there must be a matching policy framework in other markets and jurisdictions, along with long-term policy signals that can support projects.

1A.2 Which barriers do you feel are most important to address first?

For companies to invest, they must see an opportunity for a return on the stockholder funds. Unless it is a venture capitalist with a higher risk profile, companies are reluctant to embark too far into industrial decarbonization without sufficient policy and market signals. Most industries do not have the funding available to proceed with a costly decarbonization project unless there is a viable pathway for a return on investment. Projects requiring capital with no return will not be supported, and therefore there needs to be a mechanism to monetize emission reductions to offset capital expenditures.

1A.3 How would you recommend government engage to address these (or other) industrial decarbonization barriers?

The government has and continues to provide a large focus on supporting novel technologies, but there is limited to no funding made available for shorter-term ready-to-deploy solutions. For example, replacing older or less efficient kilns at industrial sites with the latest existing technology could have an immediate beneficial GHG impact, but most funding programs require a novel or innovative technology component. Likewise, fuel switching from coal to natural gas has an immediate impact and will enable blending with hydrogen in the future, but there are no incentives available to support that transition.

Furthermore, ICAC also encourages measures that provide sufficient support over the long-term to cover the cost delta between traditional technologies and practices and emerging clean technologies. Any business case for deploying large-scale decarbonization technologies must rely on ongoing monetization or producing a sellable product. 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 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.

For example, the successful scale-up of flue gas desulfurization and selective catalytic reduction markets, driven by EPA regulation of coal plants, are fitting 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. Cost-sharing will be needed to allow project owners to share some of the technology, schedule, and performance cost risks until the technology is proven enough for U.S. companies to take on the risks themselves.

1A.4 Aside from cost, what vulnerabilities/challenges do facilities face when adopting new technologies?

Access to financing is a critical issue as the industrial sector has plenty of examples of failed adaptation of new technologies. Financial markets have become very keen to recognize these risks and avoid taking them. If the technology does not perform as intended with much higher O&M expenses, the company can find that they just priced their industrial product out of being competitive in the market.

Most industries have unique applications and so they most likely will be the first to attempt it. This risk taking could place them in a vulnerable situation relative to competition not willing to venture into decarbonization until it is proven. Implementing decarbonization projects risks changing the competitive landscape for an industry.

Additionally, for many decarbonization projects, expensive associated infrastructure is required. CCS installation is challenging, as the future of CO2 pipelines and other transportation and storage infrastructure is highly uncertain, as permitting processes are very lengthy and stakeholder support in communities and local governments may be low.

1A.5 What are the blind spots or unknowns when transferring technology from the bench scale to commercial scale?

Technology scale-up stresses the design conditions in ways that cannot be recognized at benchtop-scale or even early demonstration units. This experience is unavoidable and presents an opportunity for DOE to facilitate this effort through initial project cost-shares and longer-term support signals. For example, employing a long-term cost-sharing model like the "contract for difference" approach utilized in the UK and elsewhere can make projects more feasible and decrease risk.

1A.6 What are the current and future gaps/barriers in workforce needs and availability?

The current infrastructure spending is critically impacting the availability of construction craft workers. Most projects cannot meet their workforce cost curves and thus incur losses that impact future projects. This mismatch was a key root cause evidenced in the recent bankruptcy of one of the largest non-union contractors in the U.S. market for industrial and utility construction.

Category 1B: Questions on Cross-Cutting Decarbonization Strategies

1B.1 What are the most impactful cross-cutting and systems-wide strategies needed to decarbonize industry and why?

Combined heat and power solutions can provide significant, cross-cutting value across industrial sectors. Combined heat and power present an immediate beneficial opportunity leap-frogging the efficiency of steam production. It is also adaptable to future low-carbon fuels in a longer term retrofit strategy. This strategy can provide real, near-term progress on reducing industrial emissions, as newer or earlier stage strategies are de-risked and commercialized.

1B.3 Given the breadth of available and emerging technologies, which cross-cutting technologies are most in need of RD&D funding?

Though not a sector of focus in DOE's recent reports and research on industrial sectors, ICAC encourages the agency to consider solutions within the natural gas transmission market. In this market, many decarbonization efforts have focused on easier and lower CAPEX mitigation measures, such as pneumatic valves, sealing, blowdowns, etc., Going forward, the incremental abatement solutions will become more expensive and challenging, due to low exhaust temperatures which are below that required for methane oxidation, as well as the presence of sulfur species that specifically deactivate catalysts designed for methane destruction.
Several ICAC members are working with gas transmission companies on catalytic solutions for both rich and lean burn engines with some success in the early development stages. It is important that this work continues to determine if recent innovations can be part of a control pathway for at least some of the engines. DOE can support these efforts through funding and efforts to derisk trials to validate performance.

1B.5 Which barrier(s) do you think is most important to address?

Policy barriers are the most important challenges that need to be addressed to move the needle on industrial decarbonization. Unfortunately, there are few, if any, silver-bullet decarbonization technologies for many industrial applications. The available and emerging solutions are expensive and typically carry much higher operational costs.

In addition to the policy and incentive measures discussed in our response to 1A.3, there must be trade protection to limit competition against products produced in a high-carbon environment. Market adjustments (likely tariffs) need to be based on total Scope 1, Scope 2 and Scope 3 emissions. Without a robust policy framework, it will be challenging for DOE to even find willing participants to engage in a business strategy that could price themselves out of an industrial market.

In addition, the risk of stranded capital, the lack of a market for CO2, and the low price for carbon credits are also critical issues that, once addressed, would substantially support pathways toward achieving industrial decarbonization.

1B.6 Which barrier(s) do you believe to be most difficult to overcome and how might you do so?

Demand for CO2 is a difficult barrier. While enhanced oil recovery (EOR) is currently the primary market and has potential for significant growth, this market remains challenged from a permitting perspective as associated with oil production. Low-carbon fuels production has potential for creating a limited demand for CO2, but not in the significant utilization volumes associated with EOR.

1B.7 What approaches are needed to reduce or overcome the risk of deploying new crosscutting technologies, catalyze uptake, and accelerate technology adoption?

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 shortcoming requires an appropriate government and business cost-sharing model. New types of facilities are needed at scale the demand uncertainty is high in early-state development. Full Front-End Design (FEED) studies are required, as well as new commercial arrangements and integration with early infrastructure in the hub and cluster approach.

Category 2: Questions on Framework for Industrial Decarbonization Pathways

2.2 Given the uncertainty around considerations like cost and regulations, how does your organization make decisions under such uncertainty?

The financial performance of 1st-, 2nd-, or 3rd-of-a-kind projects for any emerging technology is seldom positive. This is an area where DOE support can make a real difference, but this assistance needs to be more closely focused on the "Fund at Scale Deployment." As many of these 1st projects are considered failures, industrial users will require DOE financial and technical support to pursue fleet-focused deployment. If the 1st project is the only focus, then technologies, such as gasification in the 2000s, get demonstrated in the U.S. market only to realize full commercialization in foreign markets, like China, through a fleet deployment mentality.

2.4.3 Is anything missing in the decision tree?

The decision tree has to consider cost competitiveness in the world market. The tree does not matter if the decision is to simply move production to a less decarbonized environment. This decision is going to be made based on a viable long-term pro forma. Temporary incentives, including Inflation Reduction Act tax credits, are important for short-term performance but cannot be relied on for long-term industrial market competitiveness.

2.5 How can we differentiate "bridge" investments that produce emissions savings in the near/medium-term but are at least neutral for the path to net-zero emissions (e.g., installing new electrified equipment) versus the "dead-end" investments that produce emissions savings in the near/medium-term but delay or deviate from the path to net-zero emissions (e.g., efficiency improvements to fossil-fuel based systems), often causing stranded assets?

Any "bridge" investment needs a 20-year operational pathway, plus 5-years development and deployment. Investments in combined heat and power are a notable example of a "bridge" investment with future optionality to further decarbonize.

Category 4: Net-Zero Emissions Decarbonization Pathways for Specific Industrial Subsectors; 4D: Iron and Steel Questions

4D.3 What do you think are the primary production routes needed to decarbonize the iron and steel subsector between now and 2050? For each route for which you have knowledge or expertise, please share the following information. Please also provide any supporting references (if available).

Steel is relatively simple to decarbonize through the pathway to Electric Arc Furnace (EAF) production utilizing scrap and Direct Reduced Iron (DRI). Decarbonizing the power supplied to the facility and producing DRI with low-carbon fuels is going to be one of the primary challenges for the iron and steel sector in the U.S.

4D.3.1 What are the primary solutions/technologies necessary for that production route?

It is not the carbon regulation that most threatens Integrated Steel production, it is the environmental rules for other criteria pollutants. Many of the current grades are achievable with EAF production, but there will need to be further adaptation to those grades.

4D.3.3 What are the main factors that influence choice of this production route at the facility level?

Emissions from the coking process and blast furnace will continue to be ratcheted down through ongoing EPA regulatory policy rulemaking process. Fortunately, EAF steel production has a history of being cost-competitive with predictable profits indexed to the scrap market against the Integrated Steel production which experiences much more volatility.

4D.3.4 What are the primary barriers/challenges faced by this route and how can they be overcome?

DRI is a pathway to higher grades. Substituting a low-carbon fuel for natural gas is likely to see an incremental cost increase. The use of a temporary hydrogen production tax credit will not provide a long-term solution that is financeable and maintains cost-competitiveness. This also requires policy to avoid unfair advantage for imported steel competition.

4D.5 What technical and/or technology solutions does the subsector need that are not currently available?

Cost competitive low-carbon DRI production though hydrogen or other low-carbon fuel will likely require significant tax credits to be an economic production pathway.