Industrial Innovation Initiative

a partnership between Great Plains Institute and World Resources Institute

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Re: DE-FOA-0002697-RFI

Background

The Advanced Manufacturing Office has a crucial role to play in advancing the full scope of cross-cutting strategies key to achieving industrial decarbonization by midcentury. This task, however, cannot be accomplished alone and there is a critical need for cross-agency coordination if the US is to decarbonize the industrial and manufacturing sectors effectively and efficiently. In response to the Request for Information regarding Industrial Decarbonization Priorities (DE-FOA-0002687-RFI), the Industrial Innovation Initiative (I^3) has prepared the following document.

About I^3

The Industrial Innovation Initiative (I^3) is an ambitious coalition which aims to advance solutions key to decarbonizing the industrial sector through policy development and implementation, technology demonstration and adoption, and demand-side market development. The Initiative builds on years of stakeholder engagement and extensive work by its co-conveners, Great Plains Institute and World Resources Institute (WRI), to collaborate with government officials and advance decarbonization solutions important to the industrial sector.

I^3 values a stable climate, a safe and healthy environment, thriving livelihoods for American workers, and a strong US economy. Therefore, I^3 supports policies that will put American industry on a path to net-zero emissions, retain and create high-wage jobs, and advance technology leadership and economic competitiveness. The Initiative convenes key industry, environmental, labor, and other stakeholders, to advance cross-cutting strategies, policies, and programs for achieving industrial decarbonization by midcentury.

Category 6: Crosscutting Industrial Decarbonization Opportunities

C6.1 What emerging decarbonization technologies could have the most impact in the industrial sector over the next 5-10 years, and 10-20 years?

While each industrial sector possesses unique opportunities for emissions reductions, I^3 has identified several solutions in our recent Policy Blueprint which cut across industries to advance

industrial decarbonization. Emerging technologies such as carbon management (here meaning carbon capture, utilization, and storage/sequestration), low- and zero-carbon hydrogen, and advanced nuclear reactors have significant potential to decarbonize the hardest to abate industrial processes.[i]

These solutions possess the greatest potential impact in the near and medium term because substituting clean hydrogen can reduce on-site fuel combustion and process emissions, while carbon management enables the capture of the emissions most challenging to avoid. Carbon management is especially useful for mitigating process emissions which are the product of chemical reactions within an industrial process itself. The substitution of fossil fuels for clean hydrogen is ideal for processes which require on-site fuel combustion to generate high-temperature heat, or in certain sectors, as a feedstock. I^3 sees carbon management and clean hydrogen as the emerging decarbonization technologies with the most promise over the coming decades.

This is in line with the establishment of direct air capture carbon and clean hydrogen hubs across the US under the recently passed Infrastructure Investment and Jobs Act (IIJA). The hydrogen hubs will demonstrate viable production through a diversity of feedstocks, including nuclear energy, renewable energy, and fossil fuels with carbon capture. The development of these hubs marks a significant investment in the future of these technologies and the infrastructure necessary to transport captured carbon and low-carbon hydrogen from the production facility to the end user or storage site. Great Plains Institute, a convener of I^3, recently published a Carbon and Hydrogen Hubs Atlas, which provides analysis on a range of siting factors for carbon dioxide removal, carbon capture retrofit, and new zero-carbon hydrogen production.[ii]

Another solution to consider is advanced nuclear energy. Advanced nuclear reactors will leverage a wide range of technologies capable of deep decarbonization beyond just electricity. The heat produced from nuclear fission can be applied to different applications ranging from power production to district heating and industrial process heat to hydrogen production and petroleum refining. By directly using heat and avoiding conversion loses, advanced nuclear energy promises to be a competitive carbon-free energy source that can help decarbonize all sectors. Advanced reactors can come in smaller sizes that are more suitable for industrial applications than conventional reactors.

That is not to overlook the significance of existing solutions, or the importance of continued funding for their research, development, demonstration, and deployment. Decarbonization solutions such as the electrification of low- and medium-temperature industrial processes and opportunities to increase energy and feedstock efficiency are examples of technologies which, while not “emerging” should not be disregarded. The Industrial Research Assessment Centers and Smart Manufacturing Leadership programs included in the IIJA are an encouraging indicator of the United States’ continued prioritization of these effective solutions.

C6.4 What limiting factors or challenges do these crosscutting technology areas face regarding broad deployment in the United States? And **C6.5 What DOE resources would be most beneficial to accelerate decarbonization?**

The primary challenges to broad deployment of these solutions are the costs and insufficient markets for both these technologies and the low-carbon products they create. Additionally, the deployment of these decarbonization solutions will require enhancements to US infrastructure and a specially trained workforce to construct, install, and maintain the relevant systems.

Tax Credits and Financial Incentives

The first challenge to building the market for these solutions is the upfront cost and potential competitive disadvantage more costly, low-carbon products face on the market. Enhancements to tax credits, like the 45Q credit, have the potential to build upon the momentum that has ramped up since the credit was updated in 2018. Such enhancements include direct pay, extending the program for up to 10 years, increasing the credit value, and eliminating capture thresholds. Even modest improvements to a suite of existing federal incentives can create complementary benefits that enable additional carbon capture, direct air capture, and carbon utilization projects to achieve financial feasibility.

Low- and zero-carbon hydrogen production and investment tax credits would greatly defray the upfront and operating costs of low-carbon hydrogen production, particularly when paid directly to the producer of that hydrogen and stacked with other incentive programs like the renewable production and investment tax credits and the 45Q credit. Tax credits should be neutral towards the type of hydrogen production technology, chosen energy feedstock, and end use once a minimum standard of emissions reduction relative to conventional production methods has been met. Additionally, higher credit amounts that reward technologies with lower carbon intensities compared to conventional hydrogen production are powerful tools to incentivize newer, cleaner technologies.

For technologies that exist in the market but require support for further commercialization, such as electrification, the federal government can provide incentives such as tax credits, grants, loans, or loan guarantees to encourage their uptake. These financial incentives can be particularly effective to accelerate the replacement of equipment having large capital costs in areas such as process heat (e.g., replacing boilers and steam systems with large service industrial or distributed heat pumps) at opportunities of equipment turnover.

One of the barriers that many facilities face when implementing energy efficiency upgrades is the high upfront cost of the investment, particularly for small to medium sized companies. Tax credits for companies that meet energy efficiency targets or help them offset the cost of efficiency upgrades will help drive the deployment of efficiency technologies. Having economic incentives such as tax credits can strengthen the emissions reduction potential of other policies

like strategic energy management efforts. Further, tracking and monitoring of energy use is integral to strategic energy management by helping facilities understand and improve their energy performance. These efforts can include hiring energy managers, creating efficiency targets, or implementing new technologies or processes. The DOE should expand programs to provide education and technical assistance for strategic energy management efforts, including through the Better Buildings' Better Plants program.

Additionally, the federal government can expand block grant funding for states to support industrial efficiency, with increased funds for states that establish procurement programs to help build market demand for low-carbon products. State grants to increase industrial efficiency would support manufacturers to cover the upfront costs of energy-efficient retrofits. States could apply for additional funding contingent on establishing programs that help build state-level market demand for low-carbon products, such as the development of state-level low-carbon procurement standards.

Advanced nuclear energy would also benefit from tax credit enhancements, including eliminating the current capacity cap, increasing the amount of the credit, and allowing direct pay. The creation of tax credits for emerging clean energy technologies with low market penetration that are more generous than current tax credits for conventional clean energy technologies can help in their deployment. These "boosted" tax credits can help with the funding gaps nascent technologies typically face due to being perceived as higher risk.

While tax credits are perhaps the most powerful direct financing tools, additional financing mechanisms can provide the final push to make a project viable by incentivizing capital investment or enhancing revenue. These tools include the option to convert tax credits into a cash payment (direct pay), contracts for differences to ensure producers receive a minimum price, tax-exempt private activity bonds, and master limited partnerships. A project's eligibility for these mechanisms and their relative contribution will likely vary by project type, but their availability provides more optionality for financing projects and increases developer and investor confidence.

Procurement Policies

To support market development of the technologies and products using carbon management, low- and zero-carbon hydrogen, electrification, and energy efficiency solutions to decarbonize, the US can develop procurement programs, product standards, and purchasing agreements.

A clear and comparable data set is a necessary starting point for setting meaningful emissions intensity benchmarks for any voluntary or mandatory industrial procurement policy. Given the low level of comparable data in many industrial sectors, disclosure of emissions intensity data through environmental product declarations (EPDs) or other independently verified reporting mechanisms, following a consistent scope and methodology, should be the first step to build

towards other procurement policies at the federal or state level. Because completing EPDs or other reporting mechanisms can have a significant cost—especially for small and medium-size manufacturers—technical assistance and grants for companies to develop EPDs or other reporting mechanisms are critical to putting in place mandatory disclosure policies.

Concurrent with information and disclosure policies, the US may put in place procurement bonus policies that encourage companies to outperform each other on low-carbon innovation. A procurement bonus provides a cost discount to a company's bid if it has lower carbon intensity than its competitors. Additionally, there could be a fund that covers the cost differential (if any exists) between the winning low-carbon bids and the bids that use conventional technologies. This enables agencies or departments to use low-carbon options without having to cover any additional costs through their operational budgets.

Public sector procurement standards should be established to create a required carbon intensity benchmark for public purchasing at the federal or state level. It is critical to set an appropriate threshold, focused on specific product and material types, that is somewhat more ambitious than the market average. It is also critical to increase stringency over time to encourage continued innovation towards midcentury decarbonization. This type of policy, therefore, builds on information and disclosure policy and can be planned to come into effect after a few years of collecting comparable emissions intensity data. Robust direct public investment in research, development and deployment is also crucial to the success of this policy. As standards increase in stringency, investment could also be increased.

A high achiever's program would provide a voluntary certification to manufactured materials that meet a defined specification for lower greenhouse gas emissions intensities (similar to the EnergyStar approach for energy efficiency). This type of voluntary certification could then be used as a requirement for some percentage of federal or state purchasing, and as a voluntary benchmark for private sector procurement and consumer-facing programs. When additional market differentiation would be useful, a tiered approach could be developed to highlight categories even within lower-emissions materials. This approach would allow different actors to use different tiers as their procurement threshold. As with procurement standards, a high achiever's program would rely on initial policies around information and disclosure for a set of clear and comparable data and would aim to align with relevant existing certification schemes to avoid duplication of effort. It would also be important to increase the ambition of emissions intensity thresholds over time to continue lowering the emissions of products that meet the high achiever's certification criteria.

Grid and Infrastructure Enhancement

Scaling up electrolytic hydrogen powered by renewable or nuclear energy will require a vast expansion of available zero-carbon electricity. The federal government should work with states and regional grid authorities to enact policies that facilitate expansion and hardening of transmission and distribution infrastructure. In areas with abundant renewable resources,

incentives that allow excess renewable capacity generation to be moved via transmission infrastructure to areas with less abundant renewable resources for hydrogen production via electrolysis would increase confidence in additional renewable resource development and in the viability of low- and high-temperature electrolysis projects. The establishment of hydrogen hubs should allow for co-location of hydrogen production and renewable energy resources. However, to scale up this solution to the degree necessary for midcentury decarbonization of this challenging sector, reliable transmission of low-cost, zero-carbon electricity will be critical.

Additionally, regional transmission expansion can support affordable electrification of industrial processes by connecting regions of the US with ample and excess renewable capacity to large industrial customers.

Workforce Development

As industrial processes transition to electro-technologies, switch to low- and zero-carbon power, fuels, and feedstocks, and add carbon management technologies to their facilities, federally created workforce training programs can minimize worker displacement, encourage development of new worker capabilities, and avoid stranded assets. This is critical to the installation, operation, and maintenance of industrial systems and retaining high-wage jobs at industrial facilities. In preparation for these workforce training programs, the federal government can convene utilities, companies, trade groups, education providers, and labor organizations to ensure that training programs are appropriately targeted to meet the needs of all stakeholders.

C6.6 Provide any additional information relevant to the energy efficiency and GHG reduction opportunities/challenges in crosscutting technology areas within the industrial sector that do not fit into the previous questions in this Category.

Methane Emission Transparency and Reduction Efforts

It is worth noting the importance of monitoring and disclosures to validate reductions of both carbon and methane emissions. Methane emissions are particularly relevant to the industrial sector given the primary role of natural gas as a source of industrial heat and power and as a raw material for chemicals, fertilizer, and hydrogen. Methane is a potent gas with a global warming potential 86× that of carbon dioxide over a twenty-year period.

In the latest Global Methane Tracker report, the International Energy Agency found that methane emissions have increased and continue to be undercounted by various global governments including the US.[iii] The Biden administration's global pledge to reduce 30 percent of methane emissions by 2030 was a major first step in curbing this potent greenhouse gas. Investments in Industrial Assessment Centers and efforts to work with companies and universities to increase transparency and identify opportunities to address methane emissions that are associated with use of natural gas in industrial processes should be expanded. The AMO should coordinate with the Environmental Protection Agency to account for all possible

industrial methane emission sources and enhance and standardize industrial methane emission disclosures. Additionally, developing and deploying solutions that minimize methane emissions through increased research and innovation, technology standards and making more methane emissions reduction grants available for manufacturers will aid in near-term greenhouse gas reductions.

Section 8: Industrial Decarbonization Workforce, Community, and Equity Considerations

C8.1 In what ways, if any, do you anticipate decarbonization processes could impact your workforce?

The industrial and manufacturing sectors, which includes the production of metal, mineral, chemical, and petroleum products, among others, employs millions of Americans and supports state and local economies. Decarbonization must occur in a way that preserves industries, their contributions to the US economy, as well as the direct and upstream jobs they provide.

Deployment of carbon management 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 as 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.

A Rhodium Group analysis, commissioned by Great Plains Institute, found that the anticipated industrial sector deployment of carbon capture, storage, and buildout of associated CO_2 transport infrastructure is expected to create up to 17,000 annual project-related jobs and 13,000 jobs for ongoing annual operations, with nearly $52 billion in capital investments through 2050.[iv] Many additional high-wage jobs are created locally and across supply chains through the sector-wide deployment of carbon management technologies. 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.[v]

Further, scaling up a US hydrogen economy could lead to about $140 billion in annual revenue and support 700,000 jobs throughout the hydrogen value chain by 2030, and $750 billion in annual revenue and up to 3.4 million jobs by 2050.[vi]

The same principle that explains the preservation and creation of good industrial jobs (as well as jobs throughout the supply chain) through the deployment of carbon management and hydrogen technologies can be applied across solutions to facilities which seek to decarbonize. With proper financial incentives and workforce training programs, American industry can emerge as a global leader in the clean energy and manufacturing transition.

C8.4 As the industrial sector decarbonizes, what are the challenges in delivering equitable outcomes? What DOE resources or actions could support improvement of areas surrounding industrial facilities, particularly those in areas of historical environmental injustice?

A significant challenge to equitable decarbonization lies in the quality of public and community engagement. Communities should be contacted, educated, and solicited for comment early and frequently throughout the process of a project's development. Requiring robust community engagement and public participation is critical for building project and technology support, as the people living and working in the area will better understand what is changing and how it will impact them. Public studies of the local environmental, economic, and community benefits of cleaning up the industrial sector through decarbonization solutions can help build understanding and support among the impacted communities. The public comment period should not be seen as a rubber stamp requirement, but instead be treated as an opportunity to understand, respond, and act to resolve any concerns of the community.

I^3's coalition of industry stakeholders are here to connect

The information contained within this document represents a small fraction of the collective knowledge and expertise of our participants. Members of I^3 are ready and willing to connect with the Department of Energy and the Advanced Manufacturing Office to provide key industry, labor, environmental, and business perspectives from our stakeholder group. The Initiative meets monthly and is happy to schedule ad hoc meetings to facilitate vital discussions such as these. If you would like to connect with us directly, please reach out to I^3 Project Manager, Gabrielle Habeeb, at ghabeeb@gpisd.net, and we will gladly arrange a meeting.

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[i] Industrial Innovation Initiative, *Decarbonizing Industry by 2050: A Federal and State Policy Blueprint*, published November 9, 2021, https://www.industrialinnovation.org/blueprint.

[ii] Dane McFarlane and Elizabeth Abramson*, An Atlas of Carbon and Hydrogen Hubs for United States Decarbonization*, published February 2022, Great Plains Institute, https://www.carboncaptureready.org.

[iii] IEA 2022, *Global Methane Tracker 2022*, https://www.iea.org/reports/global-methane-tracker-2022

[iv] John Larsen, Whitney Herndon, Galen Hiltbrand, and Ben King, *The Economic Benefits of Carbon Capture: Investment and Employment Estimates for the Contiguous United States* (Rhodium Group, April 20, 2021), commissioned by the Great Plains Institute, https://rhg.com/research/state-ccs/.

[v] Rhodium Group, *Capturing New Jobs and New Business: Growth Opportunities from Direct Air Capture Scale-Up*, published June 23, 2020, https://rhg.com/research/capturing-new-jobs-and-new-business/

[vi] Fuel Cell and Hydrogen Energy Association, *Road Map to a US Hydrogen Economy*, published 2020, https://www.fchea.org/us-hydrogen-study.