Industrial Innovation Initiative

a partnership between Great Plains Institute and World Resources Institute

From: Industrial Innovation Initiative, I^3
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Re: Request for Information (RFI) on Transforming Industry: Strategies for Decarbonization (DE-FOA-00033663_MOD0001)

About I^3

The Industrial Innovation Initiative (I^3) is an ambitious coalition that 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, 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.

I^3 convenes key industry leaders, environmental organizations, organized labor, and other stakeholders to advance cross-cutting strategies, policies, and programs for achieving industrial decarbonization by midcentury.

Background

Thank you for the chance to respond to this Request for Information to share strategic and technical feedback on decarbonizing America's industrial sector and positioning the United States as a leader in the global clean energy economy. Since I^3's founding in 2020, we have advocated for a suite of policies and technologies that reduce industrial emissions, including our most recent 2024 Federal Policy Blueprint, which recommends additional policies required to support the significant industrial decarbonization investments contained in the Bipartisan Infrastructure Law (BIL) and Inflation Reduction Act (IRA). The support for the recommendations outlined in the blueprint demonstrates the commitment of key private sector actors to reducing industrial emissions. However, the private sector needs additional

assistance from the federal government to build the infrastructure, workforce, and business climate required to rapidly advance industrial decarbonization.

Given the expansive nature of this RFI, with many questions focusing on the perspectives and actions of individual companies, we have responded to the questions that relate most directly to I^3's priorities. We did not respond to any questions in Category 4, as these questions relate to specific industrial subsectors, and many individual I^3 members will also submit their own responses. I^3's response represents the collective knowledge of the diverse, consensus-based Initiative. We are grateful to be presented with this significant opportunity to shape the Department of Energy's (DOE) overall strategy for industrial decarbonization.

Category 1: Industrial Decarbonization Challenges, Barriers, and Cross-Cutting Strategies

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.

The listed challenges are well-considered and recognized by industrial stakeholders as the quintessential barriers that policy and the private sector must work towards overcoming. Another key barrier to progress in industrial decarbonization is the lack of a price on carbon. Carbon pricing or market mechanisms (e.g. cap and trade) that levy a cost on emissions would incentivize more private sector action on climate. Far too many companies and facilities have not taken meaningful steps to curb their emissions because they do not bear a direct cost for their emissions. This transcends all other barriers because the underlying business case for making GHG reduction investments is distorted, relying on other factors (such as energy costs) as proxies. It is important to recognize the industries and facilities that are working to reduce their emissions, regardless of if that is primarily guided by business opportunity or climate motivations. That said, if more industries and facilities do not have a financial incentive to significantly reduce "business as usual" emissions, critical technological innovations that will improve efficiency and global competitiveness in the long-term could be delayed or lost. A means for the market to properly value the costs and benefits emissions versus reductions is foundational to surmount many other challenges.

There is insufficient demand for low-carbon products sold at a premium to justify sufficient capital investment in projects and as a result, fewer industrial decarbonization projects will reach Final Investment Decision (FID). Companies need to be rewarded for producing low-carbon products. While the government has developed historic supply-side policy via tax credits, grants, hubs, and prizes, demand-side policy has not kept pace. New policies that induce offtakers to purchase low-emission industrial products or that serve to aggregate demand would further stimulate market action. This includes policies that net out "green premiums" associated with low-carbon products as well as those which provide longer-term

financial commitments to purchase low-carbon products, such as advanced market commitments.

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

Although all these barriers are significant, I^3's members are particularly concerned about the pace of progress in developing decarbonization infrastructure, especially linear infrastructure including transmission and carbon dioxide pipelines. The Federal Policy Blueprint that we released in January of 2024 highlights the need for rapid expansion of the electricity grid and construction of a robust carbon dioxide and hydrogen pipeline network.

In the absence of rapid buildout of this infrastructure, only select facilities in certain industries will realistically have the capacity to significantly reduce emissions in the short term. To underscore this point, it is worth considering one of the awards that the Office of Clean Energy Demonstrations (OCED) announced in March through its Industrial Demonstrations Program. Heidelberg Materials was selected for award negotiations to receive up to $500 million to implement a carbon capture, utilization, and storage (CCUS) project at its Mitchell, Indiana, plant. According to OCED, "this project would capture at least 95% of the carbon dioxide from one of the largest cement plants in the nation and store it in a geologic formation beneath the plant property."

The availability of large volumes of pore space at the site makes this a viable project. However, most of the 90-plus cement plants in the US do not have the option to inject captured carbon dioxide on site because of unfavorable geology. Without access to carbon dioxide pipelines, these plants will struggle to achieve large emissions reductions.

In addition, the federal government needs to support expansion of commercially available decarbonization solutions across sectors, particularly for small-to-medium-sized enterprises for which the cost of decarbonization is high relative to their cash flow. Coupled with investments in expansion of large critical infrastructure referenced above, support for bottom-up investment helps move the entire economy along the decarbonization curve.

For electrification to scale, there must be adequate supply of clean electricity, which will require an all-hands-on-deck approach from players across the value chain: utility regulators must plan and futureproof their expansion to accommodate the growing load; manufacturers and original equipment manufacturers (OEMs) must address and overcome barriers like long-lead times for component parts while building out their own domestic supply chain; engineers, technicians, and workers must be trained and skilled through workforce development to build and maintain new systems; researchers must continue to optimize and develop clean technologies to achieve greater energy efficiency; and so forth.

The need for additional federal support to remove barriers thwarting construction of this decarbonization infrastructure is essential. This included the rapid permitting of C

lass VI wells and primacy applications. DOE should continue to assist the Environmental Protection Agency (EPA) in this effort.

EPA has already taken steps to accelerate its review of Class VI applications, but there remains a critical need for EPA to further streamline its processes. The IIJA increased funding for Class VI injection well permitting by $25 million between FY 22 and FY 26. These funds have supported additional full-time federal employees working on permit applications from just a handful to 25, distributed both at the national headquarters and at regional offices. EPA officials have committed to reviewing Class VI permits pending before them "as expeditiously as possible." DOE also works with the National Laboratories to review subsurface modeling portions of permit applications. Building on these developments, EPA should aim to shorten the timeline for obtaining a construction permit from two years to one, aligning with the faster review timelines observed in states with Class VI primacy. This can most likely be achieved by shortening the timeframe of the technical review, which is expected to become more efficient over time through experience.

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

While transformative infrastructure reform would most likely fall under Congressional jurisdiction, DOE can still play a role by leading or proposing infrastructure coordination and planning. For example, designing and periodically updating a national CO_2 infrastructure network can guide project proposals and infrastructure corridors. Additionally, hubs policy, such as the Federal Hydrogen Hubs Program, can deliberately concentrate infrastructure, which should be a priority if DOE receives authority and funding for such a program.

As the RFI recognizes by highlighting inefficient information flows as an important barrier, the knowledge base about decarbonization across industries, companies, and facilities is highly uneven. There is a pressing need for more case studies and straightforward educational materials, particularly for small- and medium-sized manufacturers. Pilots and demonstrations of key technologies should be used as the subject matter of such case studies and materials, showcasing the successful efforts and what is needed to achieve project goals.

Government can take several steps to improve the flow of information. One would be to require grant recipients to provide publicly available updates on their industrial decarbonization projects, including lifecycle data. Although recipients should not be compelled to disclose proprietary information, it is reasonable for the government to require grant recipients to provide updates on their projects. With guidance from the DOE, grant recipients should provide non-proprietary information in easy-to-understand language that similarly situated firms can use as they seek to reduce emissions. DOE should then take the final step of distributing these materials to trade associations and individual emitters. To address concerns around data-sharing, DOE can anonymize data and publish overall local and regional impact reports that are public-facing, which will help nearby communities understand the project(s) progress. Having

additional focused data or informational details will also help with accountability and build stronger trust between industry and the community.

Technical Assistance Partnerships (TAP) and Industrial Assessment Centers (IAC) should carefully document their projects. Some of the materials created by the IACs are woefully out of date. The IACs should produce updated materials likely to be of use to plant managers and others considering facility upgrades, and these materials should apply to a wide range of facility sizes and capacities. Producing broadly accessible written materials and accounts of successful industrial decarbonization projects will serve as learning tools and encourage firms and facilities that have not prioritized reducing emissions to do so. IACs offer a key pathway to help build the workforce of tomorrow to support the advanced technologies being deployed for decarbonization, especially for small to medium-sized manufacturers who make up the majority of the supply chain.

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

One daunting challenge facing facilities is embracing new technologies that they may be forced to subsequently discard when economic or political conditions change. (Question 2.5 addresses this challenge of stranded assets.) Facilities can adopt so-called “no regrets” strategies but such strategies do not generally provide a realistic pathway to net zero emissions. Fear of investing in technologies that may one day become stranded assets deters some facilities from implementing new technologies.

There is also a perceived risk that new technologies will not actually perform as expected due to lack of data, which leads to low uptake and continues the cycle of uncertainty. With more public-facing data and case studies, greater awareness of successful vendors and successful projects can help mitigate some of the perceived risks by increasing the number of respected companies with a proven track record. This will provide evidence upon which other firms hesitant to join can base their decision-making. Furthermore, case studies offer a way to better understand technology applications within clearly defined contexts, thereby improving replicability in other similar facilities.

One other factor is political uncertainty, which makes it more challenging for tax credits for industrial decarbonization to be viewed as ‘bankable’ by the finance sector. The tax credits in IRA expire in 2034, leading to a ‘revenue cliff’. Decarbonization projects that do not have a revenue stream other than tax credits are therefore treated as higher-risk investments, increasing the cost of capital. As a result, fewer projects will reach FID.

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

One concern is geographic misalignment of the workforce. This problem can be greatly exacerbated when project developers fail to prioritize use of local workforce, and instead rely almost exclusively on travelers who take their paychecks and skills home with them. In some

markets, this practice contributes to a vicious cycle where local workers are unable to gain the skills needed to help deploy the technologies of the future because they are never given a chance.

If businesses are uncertain about which technologies to embrace as they seek to decarbonize in a financially prudent manner, then the institutions that train workers will struggle in their efforts to align training programs with industry demand. Workers may lack the requisite skills for positions that turn out to be critical to the energy transition. This challenge highlights why workforce pathways that support development of broad skill sets which can be applied to diverse technologies are preferable to pathways that narrowly target specific technologies. For example, a union journeyman worker who has completed a construction craft laborer apprenticeship can be put to work on projects that range from Direct Air Capture to a wind farm to a hydrogen pipeline to bridge reconstruction, making the worker more flexible and efforts to build local skilled workforce more sustainable. On the other hand, someone trained as a "solar installer" will be vulnerable to variations in the solar development cycle, making it more difficult to develop and retain a skilled workforce.

The best way to ensure that workers throughout the country possess the requisite skills is for industry to engage early with labor unions. With thousands of training centers across the country, unions are equipped to train new workers in the locality of the project. In rare cases where there is a shortage of local workers, unions can draw on their networks to bring in skilled workers from other areas. This applies to both the buildout and operations of these facilities. I^3 strongly supports DOE's efforts to ensure union participation in decarbonizing America's industrial base. We noted that more than half of the awards made through the Industrial Demonstrations Program committed to working with union labor. Union projects are more likely to be completed on time and on budget, helping build momentum for similar projects in the future.

There are also concerns from older generations of workers who have become familiar with fossil fuel technologies and may not want to spend the last 5-10 years of their careers re-training to acquire new skillsets. DOE programs like the IACs can help fill this gap by advocating for more updated curricula as they interact with companies looking to use newer, decarbonized technologies and can be a resource for skilling future generations of engineers and ensuring that small to medium-sized manufacturers are not left out of the transition.

1A.7 What are the differences in workforces across industries/across the country related to the availability of skillsets, staff, training, etc.?

Workforces generally reflect the employment opportunities available in a particular location. As the economy shifts, the risk of a mismatch between employment opportunities and workers skills increases. This is especially true in areas where the nature of employment changes dramatically, for example from traditional manufacturing to renewables deployment or from manual labor to jobs that require computer skills in 'smart manufacturing.

The solution to this problem is the same as in the previous question: industry must involve unions in the early stages of planning and implementing new projects to ensure that unions train enough workers to meet the forecasted demand. If industry and union form these partnerships, unions are confident that they can supply the workers required to help decarbonize a range of industries.

While mismatches can exist in some exceptional circumstances, in most geographic markets, there's an adequate supply of workers whose skill sets could be successfully deployed to build and operate emerging technologies with minimal additional training or none at all. It is worth recognizing where the workforce has existing skills that could be redeployed, such as the wealth of knowledge in areas with a long history of employment in legacy energy industries, but also worth remembering that many of the core skills (e.g. placing concrete or fitting pipes) are present across the United States.

Community colleges and vocational training programs offer local options that may be leveraged within communities closer to workers. Community colleges frequently serve as transitional educational options for students on the way to 4-year colleges or for students who do not wish to pursue 4-year non-vocational options, yielding a key demographic to target who may benefit from being introduced to new technologies and engaged in the new green economy.

1A.9 What other resources are needed to identify and address workforce needs?

There is a pressing need for improved communication between industry, government (local, state, federal), primary schools and academia, and organized labor to align expected jobs with the skills of the workforce.

It is also important to recognize that workforce needs extend beyond the workplace. One obvious example is a lack of affordable housing, a challenge in communities across the country. Some projects may generate a demand for employment that cannot be met locally. In such cases, companies will need to recruit workers from outside the area. Workers who might be tempted to move by the availability of steady employment may choose not to move if they cannot secure reasonably priced housing.

Business and government must work together to ensure an adequate supply of housing, especially in locations where there is an acute shortage. Building new housing takes time and is expensive. DOE should collaborate with project developers, local officials, and the Department of Housing and Urban Development to identify "underutilized" housing in areas where industrial decarbonization projects are likely to notably increase demand for housing.

The same is true of lack of access to personal transportation (driver's license and working vehicle) or childcare, which can be barriers to participation in construction and other fields relevant to the transition. DOE should work with state and local authorities and business communities to identify existing resources and support development of new resources to lower these barriers.

Other examples include options for education, and other regional considerations like climate, demographics, or political alignments; some of these needs will be based on individual preference while others should be addressed as we envision the equitability of the energy transition.

1A.10 How can government broaden the reach of energy management education and training programs to engage a diverse audience, including outside the traditional sphere?

The percentage of high school graduates attending college has dipped sharply in recent years. Making these students aware of the training and employment opportunities in energy-related fields before they graduate is critical. Working closely with guidance counselors, school boards, Parent Teacher Associations (PTAs), and other such stakeholders can extend opportunities to students. Counselors in particular play an outsized role in working with students of color and others who have traditionally been underrepresented in the energy field.

Tailoring digestible and relevant materials to these counselors will allow them to confidently direct students to union apprenticeship programs, community colleges, and other training opportunities. The various pieces of the workforce development puzzle must fit together. Counselors may be reluctant to recommend training programs to students if such programs are not available locally.

It is worth highlighting one program that clearly demonstrates the potential of collaboration between industry, unions, and schools. Capturing Better Futures, which began in the 2023-2024 school year is a collaborative partnership between Vernon Parish School Board, CapturePoint Solutions LLC and United Association. The 2-year Career Technical Education (CTE) welding program will serve 30 students (15 juniors and 15 seniors) from 9 high schools. The program will provide underserved high school students with content knowledge and applied trade skills associated with pipeline construction. The 2-year (CTE) program will prepare students with the training and skills to enter the workforce and to pursue employment either through the private or public sector or through United Association's continued apprenticeship program. Students will be given credit towards the five-year apprenticeship program and can transition from high school to a high-demand career while earning a fair family wage, medical benefits and retirement.

Demand for the CTE program has far exceeded the number of available positions. This is a strong indication that students are eager to learn skills that they can deploy to help American industry transition away from fossil fuels. Expanding CTE opportunities in areas with high concentrations of industry is a "no-regrets" decision. Providing public funding for similar training programs in high schools is a prudent investment that will more than pay for itself through increased economic activity and higher tax payments.

In parts of the country with a dense concentration of energy-related jobs such as the Gulf Coast, government support for innovative programs can expand opportunities to those who

have not traditionally been able to access energy-related jobs. Replicating successful programs such as Better Futures is one way to increase the diversity of the energy workforce.

Colleges and vocational training programs offer local options that may be leveraged within communities closer to workers. These programs may also consider working with industrial facilities within their immediate geographic areas to design and offer targeted, tailored and integrated skills training that directly apply to workers in these facilities while building a deeper worker pool from surrounding communities for the industrial facilities.

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?

Increasing the availability and affordability of clean power will be pivotal in decarbonizing industry. Its applicability as an energy carrier for power and heat can unlock a substantial, if not majority, portion of emission reductions. Importantly, making its price competitive with and eventually cheaper than incumbent fossil fuels will increase its uptake.

There are multiple aspects of increasing production and consumption of clean power. Enhancing the transmission network within and across grids is fundamental to this process. Making better use of the electrical networks that we already have in place will also be critical. Energy efficiency can help on the margins, but we also need a national goal of eliminating curtailment of low-carbon electricity.

Because industry consumes large volumes of electricity, the sector is well-positioned to absorb and store electricity in the form of heat through thermal batteries. Ensuring that we capture and use as much renewably generated electricity as possible by encouraging adoption of thermal storage will reduce the need to generate heat and power from fossil fuels and enable industry to purchase clean power when prices are lower. Thermal batteries combine extreme load flexibility with large capacity storage systems, allowing for scheduling charging load during periods of low power demand and cost. Thermal batteries can align with the needs of grids and grid operators to only consume electricity at times when it is most advantageous for the system.

Adding large, new industrial loads onto the electricity system via the deployment of thermal storage can help meet grid balancing needs -- improving system resiliency; increasing the amount of variable renewables grids can sustain; and improving overall system efficiencies without affecting peak loads and, depending on location, with minimal or no new system transmission or distribution costs. Adding thermal batteries to the grid under a framework that incentivized locational and time- sensitive charging will bring significant grid benefits- while also decarbonizing industrial heat.

As renewable capacity increases, so does the scale of curtailment. Last year in California, grid operators curtailed nearly 700,000 megawatt hours of electricity. Putting this electricity to productive use in the industrial sector will make it easier to meet midcentury climate goals by curbing the demand for new solar and wind installations. This also reveals the need to support the development of thermal storage and batteries, allowing these technologies to continue moving up in the technology readiness (TRL) and adoption readiness (ARL) scales and provide viable options to store off-peak generation.

Carbon utilization for process emissions (CCU) can also help create virtuous circular supply chains and phase out linear virgin fossil-based systems, essential for long-term decarbonization (or defossilization). Deploying CCU in industrial applications can help reduce emissions from facilities in hard-to-abate sectors, while providing alternative feedstocks for carbon-containing fuels, chemicals and products. Such projects can valorize carbon emissions, creating a market-based incentive to capture—rather than emit—carbon oxides. This also creates a symbiotic relationship between sectors, where the co-product or waste of one process can become the feedstock for another, maximizing the productivity, efficient use and value-add of limited resources. During the transition to a clean energy economy, CCU technologies can provide an immediate GHG mitigation option for currently unavoidable carbon oxide production, while being flexible enough to take advantage of clean power and direct air capture when infrastructure and technology readiness and costs have been further developed. As there will be a need to remove carbon from the atmosphere for many decades, carbon utilization represents a long-term emerging sector in which the United States can be a global leader. Support of carbon distribution networks and systems must recognize that carbon utilization can be in a wide range of volumes, including in small, modular processes, and can occur anywhere across the country.

Expanding CCU represents a major opportunity to deploy low-carbon fuels, feedstocks, and energy sources, one of DOE's four industrial decarbonization pillars.

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

Electrified heating technologies and energy storage mechanisms should take priority. Scaling up deployment of these technologies would potentially transform virtually every major industrial sector, leading to a potentially significant decrease in emissions. Electrified heating and energy storage, particularly in conjunction for high temperature uses, do not benefit from the same technological maturity or level of production incentives.

The Industrial Efficiency and Demonstration Office (IEDO) can develop competitions and prizes with ambitious performance criteria that require a transformational change to achieve emissions reductions. The prizes could consist of commitments from purchasers (particularly the private sector) for products that meet the criteria, a financial award and recognition, or connect prize winners to opportunities for demonstration projects and support.

1B.4 Some example barriers to cross-cutting strategies are provided in this section. Are there additional barriers you believe hinder cross-cutting strategy/technology adoption?

One additional barrier involves the complexities around lifecycle accounting. Establishing ways to encourage emissions reductions across sectors by developing broadly accepted standards for allocating responsibility for emissions and credits for reductions is an important task. Establishing standards and uniform methodologies could allow new third-parties to be involved in the monitoring, reporting, and verification of life cycle assessments (LCAs), taking some of the onus off the federal government and speeding up project planning.

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

I^3 appreciates that DOE identified inefficient information flow as a significant barrier. DOE should do more to encourage early adopters of technologies to share their experiences with other facilities interested in implementing similar projects. Executives and plant managers need access to their counterparts at other organizations who can share their experiences designing and implementing emissions reductions projects.

OCED should conduct webinars with recipients of the Industrial Demonstrations Project (IDP) funding to disseminate more detailed information about these projects. In particular, I^3 encourages OCED to collaborate with colleagues at EPA overseeing the Climate Pollution Reduction Grant (CPRG) program. Dozens of industrial facilities will likely apply for funding as sub-grantees through the CPRG program. These facilities would benefit immeasurably from hearing from and interacting with IDP recipients. Facilitating this type of information exchange can stimulate the adoption of cross-cutting technologies.

Category 2: Questions on Framework for Industrial Decarbonization Pathways

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?

Industrial electrification clearly illustrates these distinctions. In parts of the country where industries rely on electrical grids in which coal still provides a substantial share of generating capacity, electrification of industrial processes could potentially increase emissions in the short term. But a combination of market pressures and government regulations at both the federal and state level mean that the share of electrical generation derived from fossil fuels will decrease over the next few decades. Given the inexorable greening of the grid, facilities that electrify can be confident that their emission intensity will decrease over time.

2.10 Are there current policies or interventions that are hindering implementing different decarbonization pathways?

There is substantial uncertainty surrounding the rules for tax credits such as 45Q (carbon capture and utilization), 45V (clean hydrogen production), and 45Z (transportation fuels.) Until the details of these credits are finalized, industry will be reluctant to make large investments that might not be financially justifiable under certain regulatory conditions. IRA and BIL are generating both unprecedented interest in industrial decarbonization but also a substantial degree of apprehension as industry awaits definitive regulatory rulings that will shape the future of these pathways.

Industry is also concerned about the procedures it must follow to access these tax credits. Lifecycle analysis requirements in the 45Q program for some carbon utilization pathways are an excellent example of cumbersome procedures that could be streamlined to encourage broader participation. DOE must approve a qualifying project's lifecycle analysis before the IRS may issue a tax credit under the 45Q program. This is a clunky and protracted process. Instead, DOE and the Department of Treasury should consider adopting a similar approach to one used in California that relies on third-party reviewers to certify LCAs rather than on an interagency process. Congress passed these tax credits because it understood the need to incentivize industry to decarbonize. Agencies must ensure the integrity of these programs but can implement them more straightforwardly to ensure broader uptake by multiple industrial sectors.
There are also challenges associated with New Source Review (NSR) for industries such as cement manufacturers when considering emissions reduction projects. Facilities must go through time-consuming and expensive analysis, a situation that is compounded when they are in a nonattainment area. NSR rules act as a deterrent to facilities considering upgrades likely to reduce emissions. Although the EPA is responsible for NSR under the Clean Air Act, these regulations have a direct impact on the ability of industry to pursue emissions reductions projects. Federal agencies should coordinate their efforts to ensure that regulations achieve maximum emissions reductions.

Category 3: Impacts and Evaluation Criteria for Industrial Decarbonization Pathways

3.5 Which criteria do you recommend government prioritize in quantifying the societal impacts of different net-zero pathways?

The RFI identifies several important dimensions that fall under social criteria. It is difficult to prioritize these social impacts in part because communities will have various perspectives on the relative importance of these goals.

There is no simple formula for balancing these competing goals. Government should use broad sustainability metrics such as jobs created; jobs preserved by enhancing economic

competitiveness; GHG LCA/carbon-intensity; water use; energy use; and other environmental impacts (positive and negative, including air emissions). Government should also consider how a pathway fits into a net-zero plan and whether it can realistically be implemented with existing policies. If a pathway has the potential to create extensive negative externalities and relies on optimistic assumptions regarding policy and economic developments, government should be leery of supporting it. On the other hand, if a net-zero pathway is realistic in the medium term but is likely to result in short-term negative externalities, government should be open to supporting it. To use a previous example, if electrifying a facility causes short-term emissions to increase as the grid transitions to cleaner fuels but will reduce emissions and air pollution in the medium term, government should view such retrofits positively.

With respect to employment and career opportunities created or preserved by diverse net-zero pathways, it is important to assess how available those opportunities will be to local workforce, including workers from industries that could be negatively impacted by the transition as well as members of Justice 40 communities that have historically been underrepresented in these fields. Pathways and projects that maximize local job creation and access for workers from legacy industries and underrepresented communities may deliver much larger socioeconomic benefits than pathways that rely on non-local workforce or fail to provide opportunities to legacy workforce or underrepresented communities.

3.8 How could DOE confirm that it is on the right path in measuring/assessing decarbonization success?

The number of large-scale first of a kind and second of a kind projects, including both those funded by DOE grants and those funded without government funding is a revealing indicator. Furthermore, DOE should track the number of announced projects that reach FID. In addition, making steady progress on cross-cutting strategies and technologies is essential. Carefully monitoring production and installation of industrial heat pumps and thermal batteries is one way to assess progress on industrial electrification, a critical cross-cutting strategy.

Another important consideration is strategic flexibility. DOE has identified multiple pathways to decarbonize industry. Some that look like remote possibilities today will become central to reducing industrial emissions. Others that appear promising today may not achieve widespread adoption. In almost all cases, supportive infrastructure is also measurable and indicative of the likelihood of success for technology pathways (e.g. clean power production, transmission and distribution installed in more near-term (less than 8-10 year) timeframes; CO_2 pipelines and geologic sequestration sites; the passage of incentives to support carbon utilization besides storage/sequestration clean hydrogen production and transport options; etc.)

At the same time, it is important to recognize that pathways will proceed at different rates. I^3 members are hopeful about the prospects for green hydrogen, but we recognize that it will likely take several years before the Untired States begins to produce and deploy green hydrogen at a meaningful scale. In such cases, DOE can use alternative metrics or intermediate metrics (not annual emissions reductions) to gauge progress. These would include statistics

such as number of electrolyzers manufactured, pipeline miles constructed or rehabilitated, new transmission and distribution infrastructure miles constructed, and offtake commitments.