Industrial Innovation Initiative

a partnership between Great Plains Institute and World Resources Institute

From: Industrial Innovation Initiative, I³
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Re: DE-FOA-0002664-RFI

Background

The Department of Energy's Hydrogen Program (and the Energy Efficiency and Renewable Energy Offices, the Hydrogen and Fuel Cell Technologies Office, the Office of Fossil Energy and Carbon Management, the Office of Nuclear Energy, and the Office of Clean Energy Demonstrations) have a crucial role to play in advancing the full scope of clean hydrogen strategies key to achieving industrial decarbonization by midcentury. This task cannot be accomplished alone and there is a critical need for cross-agency coordination if the US is to leverage hydrogen resources to advance decarbonization priorities effectively and efficiently. In response to the Request for Information regarding Regional Clean Hydrogen Hubs Implementation Strategy (DE-FOA-0002664-RFI), the Industrial Innovation Initiative (I³) has prepared the following document.

About I³

The Industrial Innovation Initiative (I³) 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, to collaborate with government officials and advance decarbonization solutions important to the industrial sector.

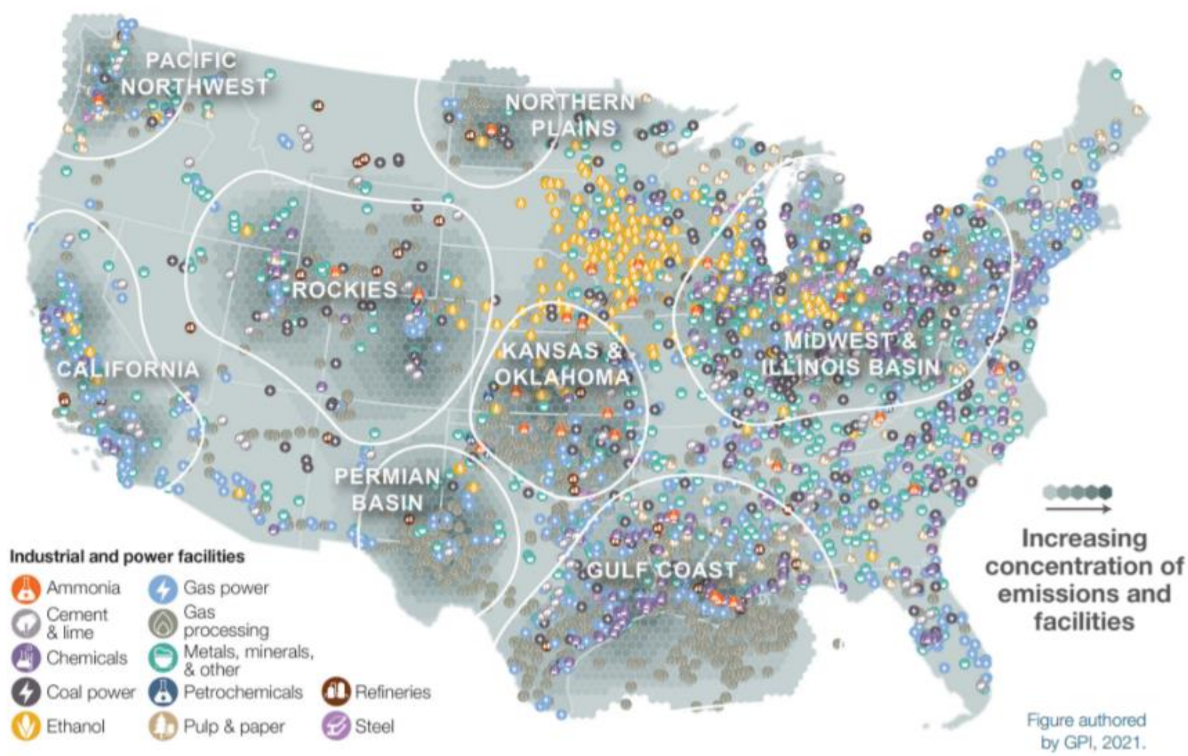
I³ values a stable climate, a safe and healthy environment, thriving livelihoods for American workers, and a strong US economy. Therefore, I³ supports policies that will put American industry on a path to net-zero emissions, retain and create high-wage jobs, and advance technology leadership and economic 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 1: Regional Clean Hydrogen Hub Provisions and Requirements

1-1.b. What existing facilities and infrastructure, including pipelines and storage facilities, could be most easily leveraged by the H2Hubs?

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 new zero-carbon hydrogen production.[i] The hubs identified in the atlas provide an opportunity to co-locate new hydrogen facilities in areas with existing hydrogen and ammonia distribution infrastructure, natural gas pipelines, biomass feedstock resource, and permanent geologic CO_2 storage potential. The following response relies heavily on this report.

Figure 1 – Regional Opportunities for Hub Development[ii]



Existing Industrial Facilities

When produced with zero- or low-carbon energy, hydrogen is a powerful decarbonization solution for multiple sectors and numerous end uses that are difficult to electrify or rely on fossil feedstocks, such as industrial process heat or iron and steel production. Hydrogen use can displace fossil-based medium- and high-grade heat in industrial applications that may be hard to electrify.[iii]

There are eight regions where concentrated industrial activity coincides with unique advantages that can facilitate the near-term development of a low carbon hydrogen economy. With distinct industrial profiles and networks of existing commodity transport infrastructure, each region can play to its strengths in the development of hydrogen hubs. The Gulf Coast and

Midwest and Illinois Basin regions currently lead in total stationary fuel consumption and in total emissions.

The regions identified in Figure 1, above, include a total of 3,332 facilities across 12 primary sectors. Industrial sectors with a high total number of facilities across study regions include gas processing; metals, minerals, and other; and ethanol production. The Midwest and Illinois Basin and the Gulf Coast are home to a particularly high concentration of industrial and power facilities, with over 1,000 facilities in each region.

Existing Renewable and Zero-Carbon Electricity Availability

The use of hydrogen as an energy carrier will require large amounts of zero-carbon electricity for water electrolysis. The capacity of regional balancing authorities and electric generation dispatch markets to take on new load must be considered. Transmission constraints and the projected retirement of nuclear and other baseload power plants are also important considerations. Data from S&P Global Market Intelligence[iv] and the US EIA[v] are used in Figure 2, below, to show the nation's potential for electricity generation from wind and solar, as well as existing nuclear power plants.

Figure 2 – Renewable and Zero-Carbon Electricity Availability[vi]

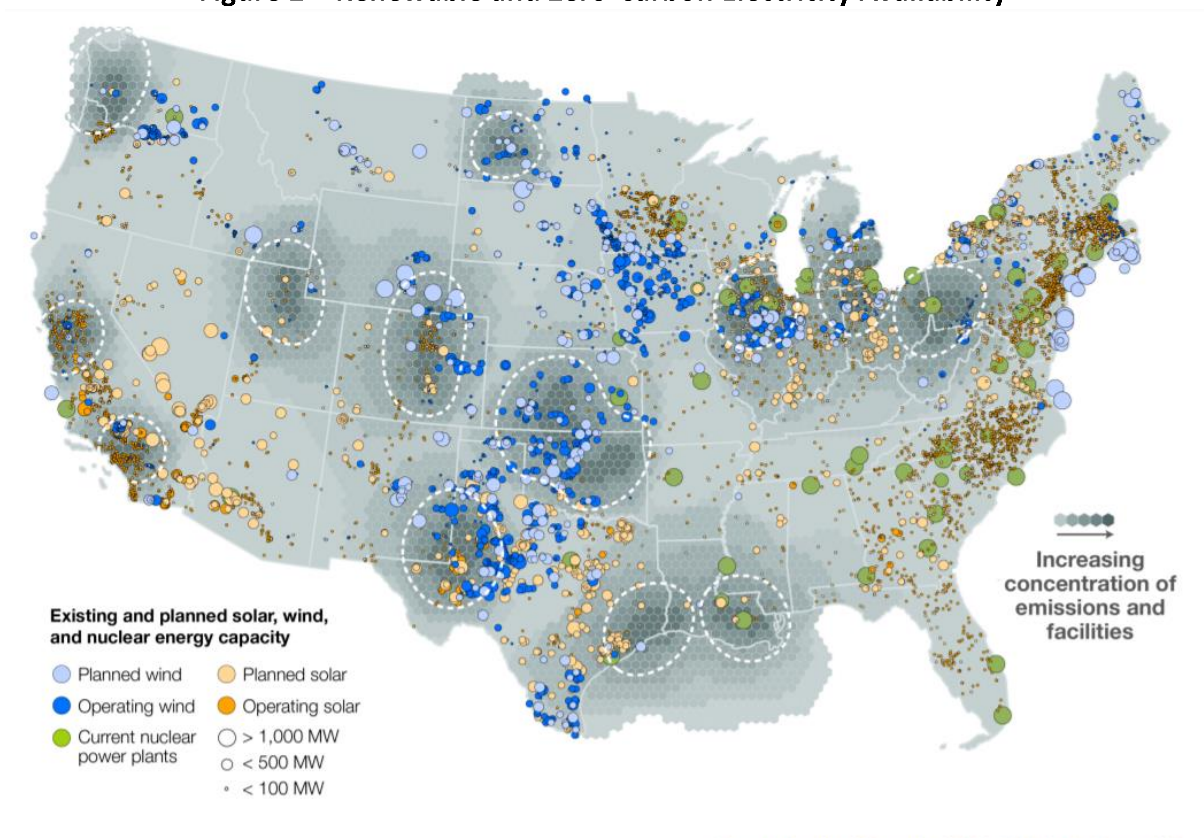
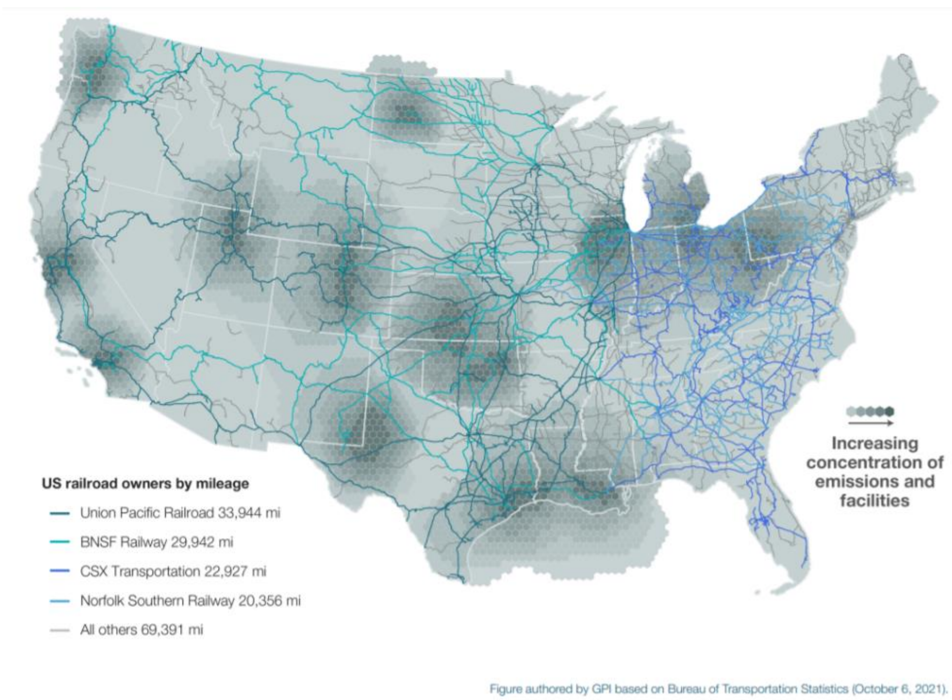


Figure authored by GPI based on S&P Global Market Intelligence; S&P Capital IQ (December 2, 2021); EIA Power Plants (July 10, 2020).

Existing Multimodal Transportation

Before regional hydrogen pipeline networks are built, existing multimodal transport networks, such as railroads, will play an important role in transporting hydrogen to sites of utilization or storage. An extensive network of freight rail lines runs throughout the US, connecting ports, manufacturing hubs, and other areas of economic activity. These rail lines are widely used for long-distance transport of bulk commodities, including energy products and chemicals.[vii] With many transport nodes intersecting waterways and interstates, commodities may travel by a combination of rail, truck, and water.

Figure 3 – Transport Infrastructure: Railroads[viii]



Barge waterways and freight highways can play an important role in near-term hydrogen transport networks. Like railroads, interstate routes and freight waterways are well-established modes of transport for bulk commodities, such as energy products and fuels. Trucks, barges, and trains can connect local facilities to one another, as well as facilitating connection to distant markets. These multimodal transport options also offer flexibility, enabling routes to evolve over time and the frequency of transport to adapt in line with the volume of material being transported.

Figure 4 – Transport Infrastructure: Barge Waterways & Freight Highways[ix]

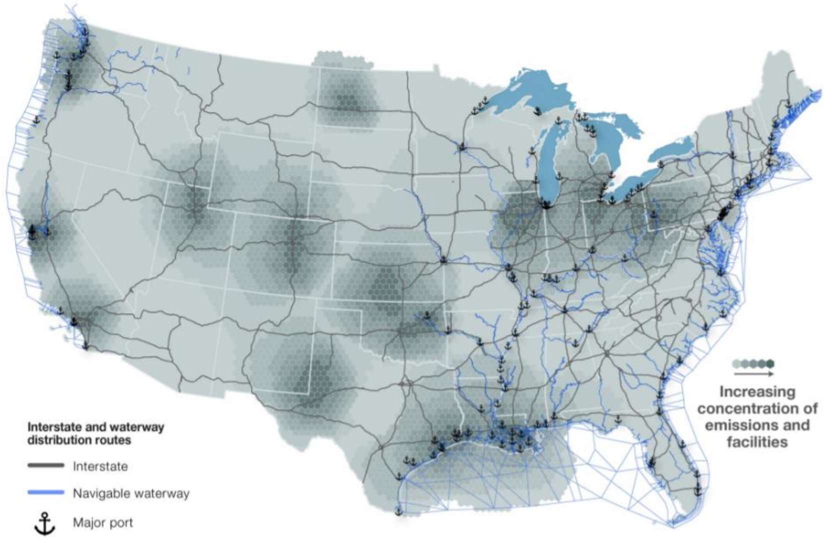


Figure authored by GPI based on Tele Atlas (October 6, 2021); National Transportation Atlas Database (Major Ports; December 17, 2019; Navigable Waterway Lines; June 26, 2019).

The nation's existing pipeline networks can serve multiple purposes in the development of hydrogen transport networks. Routing new hydrogen pipelines along existing pipeline routes can maximize efficiency in infrastructure buildout, as existing natural gas and other pipelines can provide an adjacent right-of-way that reduces land use, logistical challenges, and planning costs for new hydrogen transport infrastructure. To a certain extent, hydrogen can also be blended into the existing natural gas distribution system for co-firing. However, greater utilization of existing pipeline infrastructure may not be feasible due to hydrogen's unique pressure and corrosive qualities.

Figure 5 – Transport Infrastructure: Natural Gas Pipelines[x]

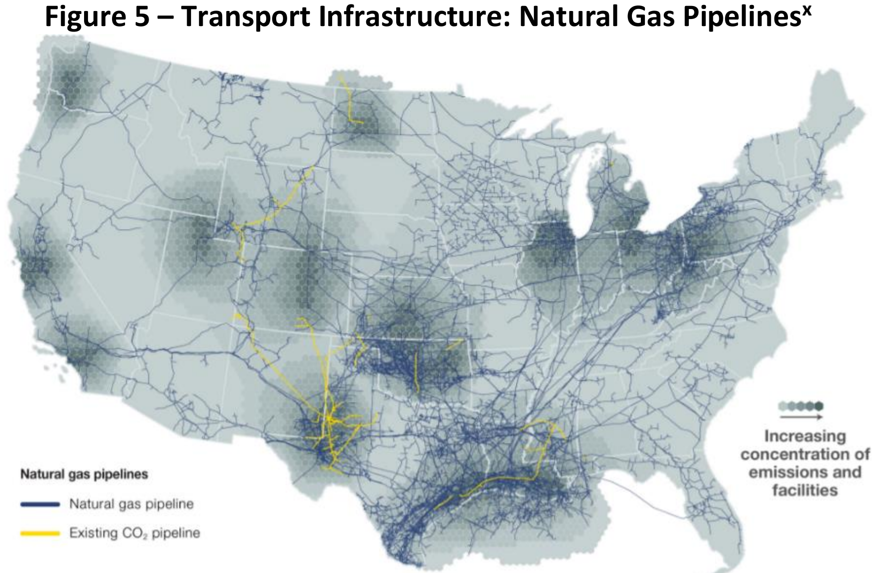


Figure authored by GPI based on EIA Natural Gas Interstate and Intrastate Pipelines (April 28, 2020).

Oil pipelines, like natural gas lines, can provide an adjacent right-of-way that maximizes efficiency in infrastructure buildout and minimizes land use for new hydrogen infrastructure. The regions prime for hubs, as identified in Figure 1, are often already operating as major interchanges of petroleum, fossil fuel, and other chemicals transmission. Figure 6, below, highlights their position as central nodes of connection and distribution for fuel and commodity markets.

Figure 6 – Transport Infrastructure: Petroleum Pipelines[xi]

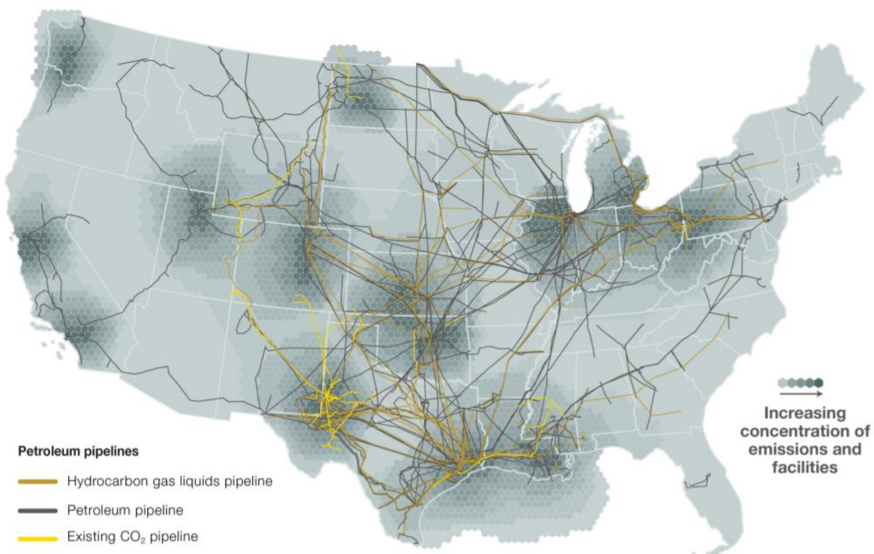


Figure authored by GPI based on EIA (Crude Oil Pipelines; April 28, 2020; HGL Pipelines; April 28, 2020; Petroleum Product Pipelines; April 28, 2020).

1-1.c. What types of new 'connective infrastructure' will be needed by the H2Hubs (e.g., pipelines, storage, etc.)?

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. Hydrogen hub developments 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 the industrial sector, reliable transmission of low-cost, zero-carbon electricity will be critical.

1-1.d. What supportive activities would make the hydrogen hubs successful and sustainable (e.g., workforce development, community-based organization engagement, domestic manufacturing, labor standards, etc.)?

Workforce Development
As industrial processes switch to low- and zero-carbon hydrogen for heat, fuel, and feedstocks, federally created workforce training programs can minimize worker displacement, encourage and develop new labor skills, and avoid creating many stranded assets. Developing this workforce is critical to install, operate, and maintain industrial systems and retain high-wage jobs at industrial facilities. In preparation for potential 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.

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, and the direct and upstream jobs they provide.

Scaling up the US hydrogen economy could yield 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.[xii] Deploying clean hydrogen technologies will retain and grow domestic high-wage industrial, energy, and manufacturing jobs. 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.

Community-based organization engagement
A significant opportunity for equitable development of clean hydrogen hubs lies in the quality of public and community engagement. Communities should be contacted, informed, and solicited for comment early and frequently throughout the process of a project's development to determine and secure the social license to build. Requiring robust community engagement, education, 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.

1-2. The Bipartisan Infrastructure Law (BIL) states that H2Hubs must (1) demonstrably aid the achievement of the clean hydrogen production standard developed under Section 822(a) [defined as 2 kg CO2e/kg H2 at the point of production]; (2) demonstrate the production, processing, delivery, storage, and end-use of clean hydrogen; and (3) can be developed into a national clean hydrogen network to facilitate a clean hydrogen economy.

The discourse around hydrogen has been dominated by ambiguous definitions of hydrogen under different color schemes like green, blue, gray, and pink hydrogen. The color of hydrogen, however, says very little about the emission profile of a hydrogen production pathway. The emission profile of a hydrogen production process depends on the system boundary and the constituent processes used to produce the end-product. Unclear and non-standardized definitions for clean hydrogen fail to convey the emissions impacts for a broad range of hydrogen production pathways and creates an uneven marketplace for hydrogen production and end-use that doesn't reward performance accordingly.

The BIL defines the term 'clean hydrogen' as hydrogen produced with carbon intensity equal to or less than 2kg of CO_2-equivalent per 1kg of hydrogen at the site of production—excluding upstream emissions associated with material acquisition and transportation. The 2021 working paper from the International Partnership for Hydrogen and Fuel Cells in the Economy defined the emission analysis system boundary for hydrogen to cover a "well-to-gate" boundary, inclusive of emission associated with raw material acquisition, raw material transportation and hydrogen production.[xiii] While the working paper does not include storage considerations in their valuation, hydrogen storage options should be factored into a holistic carbon intensity definition, given its role in industry and overall emission reduction. Inconsistencies in the formal definition of clean hydrogen will hamper fair market competitiveness. Hydrogen can be produced from various feedstocks, with different technologies and varied emission profiles. Therefore, standardized definitions for clean hydrogen and associated accounting protocols are needed to weigh the performance of these varied pathways to clean hydrogen. The Department of Energy should take immediate steps to collaborate with the Environmental Protection Agency and create a robust definition and standardized protocol to assess the emission profile of hydrogen production inclusive of upstream emissions.

Category 4: Market Adoption and Sustainability of Hubs

4-32. What mechanisms (e.g., tax/other incentives, offtake structures, prizes, competitions, alternative ownership structures for hydrogen production bundling demand, contracts for difference, etc.) would be valuable to incentivize market-based supply and demand?

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.

Zero-carbon hydrogen production energy would also benefit from advanced nuclear technology 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 costs of developing a hydrogen transport infrastructure network may be prohibitive for an individual facility to develop alone, costs can be shared when multiple facilities or states in a hub collaborate on developing shared infrastructure. Industrial facilities in a hydrogen hub can take advantage of their proximity to one another to develop shared transport infrastructure and achieve the associated financial benefits. Properly supported, the establishment of hydrogen hubs can sustain and create local economic investment, enabling the scale of development and deployment required for low-carbon technology and decarbonization solutions.

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’s Hydrogen Program and the aforementioned Offices to provide key industry, labor, power, 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.

NOTES

[i] 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.
[ii] Ibid.
[iii] IPCC, “Summary for Policymakers,” *in Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty*, ed. Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, et al. (Geneva, Switzerland: World Meteorological Organization, 2018), https://www.ipcc.ch/sr15/ chapter/spm/; IEA, Net Zero by 2050 (Paris: IEA, 2021), https://www.iea.org/ reports/net-zero-by-2050.
[iv] S&P Global Market Intelligence; S&P Capital IQ (Power Plant Summary; accessed December 2, 2021).
[v] US EIA Layer Information for Interactive State Maps (Power Plants; July 10, 2020), https://www.eia.gov/maps/layer_info-m.php.
[vi] Dane McFarlane and Elizabeth Abramson*, An Atlas of Carbon and Hydrogen Hubs for United States Decarbonization*.
[vii] “Freight Rail Overview,” U.S. Department of Transportation Federal Railroad Administration, accessed January 5, 2022, https://railroads.dot.gov/rail-networkdevelopment/freight-rail-overview.

[viii] Dane McFarlane and Elizabeth Abramson*, An Atlas of Carbon and Hydrogen Hubs for United States Decarbonization*.
[ix] Ibid.
[x] Ibid.
[xi] Ibid.
[xii] Fuel Cell and Hydrogen Energy Association, *Road Map to a US Hydrogen Economy*, published 2020, https://www.fchea.org/us-hydrogen-study.
[xiii] International Partnership for Hydrogen Fuel Cells in the Economy (IPHE), *Methodology for Determining the Greenhouse Gas Emissions Associated With the Production of Hydrogen*, Version 1 – October 2021, https://www.iphe.net/_files/ugd/45185a_ef588ba32fc54e0eb57b0b7444cfa5f9.pdf.