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The Atlantic Council Hydrogen Policy Sprint Brief 1: Has Hydrogen's Time Come in the United States?

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TAKEAWAYS

- Hydrogen has enormous potential to decarbonize hard-to-abate sectors such as heavy industry and parts of the transportation sector in the United States. Substituting hydrogen into these sectors would also yield significant environmental justice benefits by enhancing local air quality.

- The debate over the 'color' of hydrogen that policy and investment should support—whether 'green' hydrogen produced from renewable electricity, 'blue' hydrogen from methane with carbon capture, or any of the other 'colors' that signify different production processes—misses the point. Policy and investment should instead prioritize low lifecycle carbon intensity, regardless of the production method.

- The United States has rich opportunities to build a self-sustaining hydrogen economy with both production and demand centers and has the resources—inexpensive and abundant energy resources for production and existing pipeline infrastructure—to lead the world in hydrogen development. Regional hydrogen clusters that can scale clean hydrogen production and that can already host hydrogen demand centers—such as the port of Los Angeles and its associated transportation hubs and the Texas Gulf Coast—should be the focus of initial investment and deployment. But in order to unlock hydrogen's potential, more public-private coordination and policy guidance is critical to provide regulatory certainty, reduce risk for investments, and ensure that clean hydrogen production and demand increase in tandem.

This is the first paper in a series of Atlantic Council Global Energy Center hydrogen 'policy sprint' briefs. Each paper identifies major challenges and opportunities for building a hydrogen economy in the United States and addresses the policy framework that the US hydrogen economy will require.

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Why hydrogen?

Hydrogen has gained significant momentum in recent months, particularly in Europe, as governments and private sector leaders have announced new policies, projects, and investments. Hydrogen will be critical to the world's ability to reach net-zero by midcentury, as renewables on the grid and electrification alone cannot achieve that target, especially in hard-to-abate sectors like heavy industry and parts of the transportation sector.[1] Hydrogen combustion or use in fuel cells produces only water as a byproduct, and it can be produced cleanly through a number of methods listed below. Preparing infrastructure for hydrogen and scaling production now can help avoid stranded asset concerns across the energy industry as resources traditionally used for oil and gas can be retooled for the clean fuel.

But development of clean hydrogen production, infrastructure, and applications is not yet at the scale necessary to realize its decarbonizing potential globally, which may require ten times the current production capacity by 2050.[2] The United States, in particular, is lagging behind countries in Europe and Asia in political support, market certainty, and new project development for clean hydrogen.

However, despite trailing in hydrogen policy and ambition, the United States' technological and infrastructure advantages make it perhaps the best-positioned country to lead on hydrogen development. With abundant renewable resources and inexpensive natural gas that can be used for clean hydrogen production, millions of miles of existing pipeline infrastructure that could carry blended hydrogen or potentially be retrofitted to carry pure hydrogen, and a plethora of hydrogen demand opportunities from heavy industry to transportation, the United States has a unique opportunity to create a self-sustaining domestic hydrogen economy. This could also lead to significant job growth: the "Road Map to a US Hydrogen Economy" report found that a robust hydrogen economy in the United States could support 700,000 jobs by 2030 and 3.4 million jobs by 2050.[3] However, more policy support and investment will be essential to catching up with Europe and East Asia and to unlocking hydrogen's decarbonization potential.

A self-sustaining hydrogen economy? Opportunities in the United States

The United States can take a lesson from the European Union's approach to hydrogen development by focusing on regional clusters that offer especially rich opportunities for hydrogen production and deployment. There are several opportunities for such clusters in the United States, which are centered around major demand centers such as ports, transportation hubs, and industrial centers. Focusing initial hydrogen deployment in these clusters can help build scale while demonstrating the fuel's broader potential as long-distance infrastructure is built.

One such opportunity is the port of Los Angeles and its associated transportation hub; California has the renewable resources to produce green hydrogen at scale, and substituting hydrogen in the port's operations, including by replacing diesel trucking, would have immediate decarbonization impacts without the need for long-distance hydrogen infrastructure.

The Houston metropolitan area offers an equally promising opportunity; the Texas Gulf Coast already boasts about 900 miles of hydrogen pipelines, low-cost methane and significant hydrogen production that can be cleaned by implementing carbon capture, excellent geological storage for hydrogen or for captured carbon dioxide, and existing hydrogen demand.

Other early opportunities for clusters exist around the country, particularly in the Midwest and in the Ohio-Pennsylvania-New Jersey corridor. Production resources—whether abundant renewable generation, low-cost methane and carbon storage potential, or another resource—paired with a potential hydrogen demand center can unlock short-term hydrogen decarbonization impact while enabling a deeper role for hydrogen in the future. And even in regions without potential demand hubs, hydrogen can be blended into existing natural gas infrastructure to reduce emissions immediately without the need for major new infrastructure development.

1 Thomas Koch Blank and Patrick Molloy, "Hydrogen's Decarbonization Impact for Industry," Insight Brief, Rocky Mountain Institute, January 2020, https://rmi.org/wp-content/uploads/2020/01/hydrogen_insight_brief.pdf.

2 Hydrogen Council, "Hydrogen: Scaling Up," November 2017, https://hydrogencouncil.com/wp-content/uploads/2017/11/Hydrogen-scaling-up-Hydrogen-Council.pdf.

3 "Road Map to a US Hydrogen Economy," Fuel Cell & Hydrogen Energy Association, ushydrogenstudy.org.

Importantly, hydrogen's impact can go far beyond reducing carbon emissions and supporting deep decarbonization. For communities that host major industrial centers or transportation hubs, it can also provide immediate local air quality benefits that are particularly important from an environmental justice perspective. For instance, replacing diesel with hydrogen in heavy trucking—a transportation sector that cannot be easily electrified due to the current energy density of lithium-ion batteries—can immediately reduce both carbon emissions and the emissions of harmful local pollutants, even if that hydrogen is 'grey' and produced from natural gas without carbon capture. Trucking is an industry in which hydrogen development can advance rapidly, even as clean hydrogen production continues to come online. Reducing the deleterious health and quality of life impacts of diesel trucking hubs in particular should be an environmental justice priority, and it can be accomplished by switching to hydrogen now.

Carbon is key, not 'color'

As hydrogen has gained momentum, production method has become a focus of debate in the United States and abroad. Almost all hydrogen today is 'grey,' produced using natural gas, and is a major source of emissions; but even that 'dirty' hydrogen is cleaner—in a well-to-wheels analysis—than diesel in heavy transport. But hydrogen can also be produced cleanly through a variety of methods: using renewable electricity ('green'), using natural gas with carbon capture ('blue'), using nuclear electricity ('pink,' 'red,' or 'yellow'), among a number of other methods, including using biomass (which is sometimes called 'green' and sometimes excluded from that category).

The debate between 'green,' 'blue,' and the other 'colors' of hydrogen misses the point, however; the key question is how to make the biggest decarbonization impact as quickly as possible. Policymakers and industry should instead focus on minimizing carbon, and they should use hydrogen from any production method that can cut carbon emissions. For example, low-carbon production of hydrogen from sources like methane pyrolysis or nuclear energy should be prioritized along with hydrogen production from renewables. The only valuable differentiator between hydrogen molecules is the carbon intensity of their production, not their method of production.[4] If, instead, policymakers require 100 percent renewable hydrogen on day one, they will preclude the significant decarbonization and environmental justice benefits that other proven clean hydrogen production methods can provide, leading to more emissions in the short and medium terms and slowing the development of the broader hydrogen economy.

The 'Colors' of Hydrogen: Hydrogen Production Methods

Grey	Steam reforming of natural gas
Brown	Lignite coal gasification
Black	Black coal gasification
Green	Electrolysis using renewable electricity
	Biomass to hydrogen*
Blue	Steam reforming of natural gas with carbon capture and storage
Pink	Electrolysis using nuclear-generated electricity**
Turquoise	Pyrolysis of natural gas with solid carbon byproduct
Yellow	Electrolysis using power from the grid (mixed origin)

* Some categorize hydrogen produced from biomass as 'green' while others exclude it from the category. It is worth noting that some biomass-to-hydrogen pathways are net-negative CO_2 emissions—a better outcome than hydrogen produced from renewable energy—again pointing to the need to focus on emissions and not production method.

** Hydrogen produced with nuclear power has also been classified as 'yellow' or 'red,' further demonstrating the inconsistencies of using 'colors' to differentiate between production methods.

4 An additional consideration should be the level of criteria air pollutants (CAP) emitted in production, which, even for grey hydrogen, is far lower than that of diesel over its life cycle, though may have different local impacts that need to be considered. This issue could be addressed by independent environmental regulations, which would further incentivize cleaner forms of hydrogen production without precluding early, meaningful wins from fuel-switching to hydrogen.

The role of policy: Converting ambition into reality

Has hydrogen's moment arrived, or is it still a decarbonization pipe dream with more distant potential? This time, the hype—with companies investing in low-carbon hydrogen production, and hydrogen demand cases beginning to come online across the country—is real. But the industry and the broader US hydrogen economy will continue to lag behind their targets, potential, and competitors unless they are given policy support that can help clean hydrogen compete. These projects rely upon long-term markets, and—without an established hydrogen economy or any policy support—the inability to rely upon long-term stability may be prohibitive for many projects.

To commit to a hydrogen-powered future, policy needs to provide regulatory certainty that can reduce the risk of investing in clean hydrogen production, infrastructure, and applications. The issue is no longer whether hydrogen will work. The issue is now how to reach scale quickly enough to realize hydrogen's decarbonization potential, before it is too late.

Despite the need for policy to spur hydrogen development and de-risk investment, the United States currently has no policy support in place for hydrogen production or investment. Concentrating on regional clusters for development is low-hanging fruit that can make a significant difference in clean hydrogen's viability and development without requiring a large-scale reshaping of infrastructure.

Policy must also help create the market conditions to accelerate hydrogen development through incentives and by clarifying the industry's future. Investment or production tax credits would help to spur investment in clean hydrogen and would improve the fuel's competitiveness with grey hydrogen and other alternatives. Even more simply, production or consumption targets at the federal, state, or local levels would reduce uncertainty and give companies a time frame for development that would allow both the supply and demand sides to develop with confidence that a market will exist for their products.

By helping to set the market and continuing to support innovation through the Department of Energy, national labs, and other agencies such as the Department of Transportation and the Environmental Protection Agency, the government can support technology and capacity building in regional clusters that lay the groundwork for a national hydrogen economy. Making technology and innovative manufacturing a central piece of this strategy can also play to US domestic advantages and help the United States better compete with China, avoiding a replication of China's dominance in the solar industry.

A path forward: Coordination to unlock opportunity

A coordinated strategy will be essential to the United States successfully scaling a clean hydrogen economy across the country. First, the supply and demand sides of the market need more regulatory certainty in order to commit to long-term investments, which will require both coordination between those sides of the market and with the government to help set targets for what the market will look like in the future. Coordination across levels of government will also be critical: state and local governments—particularly those in regions with the potential to serve as clean hydrogen development clusters—must work together and with the federal government to concentrate resources, create a consistent and efficient policy framework to support clean hydrogen development, and further clarify the market conditions.

Because the United States trails Europe and East Asia in hydrogen policy and deployment, coordination with allies and partners in those regions can help develop a global hydrogen economy while also creating fora to share best practices, collaborate on technological innovation, and drive global investment. Hydrogen's moment may have finally arrived, but government and industry must work together for it to reach its potential to meet net-zero.