ISSUE BRIEF

The Economics of Demand-Side Support for the Department of Energy's Clean Hydrogen Hubs

The Council of Economic Advisers

July 5, 2023

Introduction

Clean hydrogen has the potential to play an important role in decarbonizing the U.S. economy by reducing emissions in some of the most difficult-to-decarbonize sectors, including industrial and chemical production as well as heavy-duty transportation, and in the power sector through low-emission power generation. It could also be used as a form of long-duration energy storage to support the expansion of renewable power. As the clean hydrogen industry matures, initial projections suggest it will experience rapid cost declines through learning-by-doing. Near-term support on both the demand- and supply-side can accelerate this outcome. To this end, today, the Department of Energy is issuing a notice of intent for a demand-side support mechanism to complement supply-side investments made through the Regional Clean Hydrogen Hubs program.

The Department of Energy's National Clean Hydrogen Strategy and Roadmap lays out how clean hydrogen production could increase from almost zero today to 10 million metric tons by 2030. A range of early-stage technologies, which could be employed at hydrogen hubs—from electrolysis to steam methane reforming with carbon capture and storage—can contribute to this goal. In addition to the development of production technologies, hubs that are sited where production and end-use are not co-located will need to make essential investments in mid-stream infrastructure to store and transport hydrogen.

At the same time, without policy intervention, hubs may face innovation-related market failures that risk slowing the scaling of the industry. These market failures could include financial frictions, positive externalities from knowledge spillovers, and negative externalities from the emissions associated with fossil fuel-based hydrogen production.

Supply-side incentives—like production tax credits and public funding of research and development and demonstration projects—can drive down the cost of hydrogen production technology and are complementary to the development of the hydrogen hubs. There are now multiple supply-side "push" mechanisms for clean hydrogen in law. For example, the Inflation Reduction Act included a new hydrogen production tax credit for up to $3 per kilogram of clean hydrogen. The Inflation Reduction Act also provided the Department of Energy's Loan Programs Office with over $300 billion of additional loan authority to help finance clean energy projects, including hydrogen production. Meanwhile, the Bipartisan Infrastructure Law included $1.5 billion to support hydrogen electrolysis and $8 billion to fund a broad Regional Clean Hydrogen Hubs program. These hubs will create networks of co-located ecosystems for clean hydrogen production, distribution, storage, and end-use. By building out the underlying infrastructure for clean hydrogen, these investments help lower the cost of production while maximizing technological knowledge spillovers.

These supply-side investments can be complemented by programs that mitigate the risk of demand-side market challenges, which could inhibit developers from accessing financing to further scale up production. The combination of high upfront capital expenditures and projected declining cost curves make it difficult for producers participating in the hubs to secure long-term offtake contracts that provide revenue and cash flow certainty—an important consideration for securing project financing. As of late 2022, there have been announcements for roughly 12 million metric tons per annum of clean hydrogen capacity, yet only around 10 percent of this capacity has reached the Final Investment Decision stage where major financial commitments are made. Lack of near-term demand certainty can make clean hydrogen projects a riskier investment, inhibiting the flow of private capital into production and mid-stream infrastructure. This underscores the importance of demand-side policies in accelerating the early-stage development of this industry.

Thus, the hydrogen hubs would benefit from a combination of both supply- and demand-side policies. This Brief lays out how demand-side policies can complement existing supply-side incentives to hasten the rate at which the clean hydrogen industry can grow and compete with carbon-intensive hydrogen production.

The Economic Case for Demand-Side Support

Economic research suggests that market failures on the demand-side, if they emerge, can slow the development of innovative technologies. While many traditional economic policies aimed at spurring innovation and new technological investments are grounded in supply-side mechanisms, demand-side tools can be a valuable complement. For example, the development of new vaccine technology has been kick-started by a mix of supply-side and demand-side policies.

Despite the importance of large capital inflows into industries like clean hydrogen, perverse economic incentives and market failures can hinder the ability of firms to receive financing from private credit markets. Real or perceived risks around clean energy projects can raise the cost of accessing capital, which could slow the rate at which projects like those in the hydrogen hubs program achieve commercialization. Asymmetric information between developers and capital investors as well as the high fixed cost for investors to acquire the necessary knowledge to properly assess newer technologies can result in underinvestment from private financing institutions before an industry fully scales up.

A second consideration for potential investors in hydrogen hubs stems from uncertainty about future demand and future technology cost trajectories. Generally, project developers can use long-term contracts to help secure debt financing—these contracts provide certainty around stable future cash flows that are important to investors. For instance, as other clean energy industries such as solar developed, governments and the private sector relied greatly on Power Purchase Agreements (PPAs), long-term contracts where developers would install (and own) solar power equipment and sell the electricity to end-users. PPAs provided the developers a consistent, guaranteed source of revenue that was essential for becoming bankable.

At the same time, if rapid declines in technology costs are expected, the willingness of private sector end-users to seek out such contracts with clean energy developers will be limited. As they deploy, rapidly scaling industries like clean hydrogen will move down the cost curve through mechanisms like learning-by-doing. With clean hydrogen, the cost of production using renewables and electrolyzer technology is expected to fall by roughly 50 percent by 2030. This makes end-users and consumers more reluctant to sign long-term contracts that would effectively lock them into paying higher prices than they otherwise would. This could create a significant hurdle in the near term for the clean hydrogen hubs—technology costs can only come down if projects are built, but the expectation of falling technology costs constrains the market's willingness to finance projects now, in the absence of demand-side support. These demand-side challenges are particularly relevant in the cases of newer end-uses of clean hydrogen that are called for in the hydrogen hubs program, including in the industrial and transportation sectors, such as clean steel production and sustainable aviation fuels.

The hesitation from the private sector to make long-term demand commitments creates opportunities for the government to use demand-pull mechanisms to support newer industries of strategic or social importance. These include advance market commitments, prizes, and contract for differences agreements—policies which have already have been used in biomedical and pharmaceutical industries, among others. The economic literature has repeatedly demonstrated how effective these demand-pull tools can be in encouraging rapid innovation for products like vaccines, particularly in low- and medium-income countries.

Though a very different market setting, some of the fundamental economics that made demand-pull tools so essential for new vaccine development also shape the economics of new clean energy and climate technologies. This is why economists have argued that policy tools like advance market commitments that provide additional demand certainty can be highly effective for clean energy industries. Moreover, economic research illustrates how in certain clean energy industries, incentives tied to output can even be more cost-effective than purely providing subsidies on the supply side.

In addition to direct demand support, regulations can also create industry confidence that large-scale demand sources will materialize as costs come down. EPA's proposed greenhouse gas emissions standards for both natural gas power plants and heavy-duty vehicles could be met using clean hydrogen technologies. Although these would not come into force for several years, allowing much of the expected cost declines to materialize beforehand, finalizing these rules would provide regulatory certainty for developers that a large market for clean hydrogen will emerge over time.

Other Examples of Clean Energy Demand-Pull Policies

Within the United States, some private sector entities are already exploring opportunities to use demand-pull mechanisms to hasten the deployment of clean energy technologies. For example, Frontier is a coalition of private companies that are using advance market commitments for carbon removal technologies. As of May 2023, the group has already committed almost $60 million for carbon removal-related products at various stages of technological readiness.

Other countries are also testing demand-side mechanisms for clean and renewable energy. For instance, the European Union is proposing an auction-based model through a European Hydrogen Bank, and Japan is exploring a contract for differences scheme to fill the gap in price between green and grey hydrogen (clean hydrogen produced using water and renewable electricity versus carbon-intensive hydrogen produced using methane).

Some countries have already begun implementing these demand-pull programs for renewables and clean hydrogen. The United Kingdom has been using a contract for differences model for clean energy projects through the Low Carbon Contracts Company (LCCC). This mechanism facilitates an auction process where low-carbon electricity producers bid for a long-term contract that guarantees a fixed "strike" price. Winning projects sell their low-carbon electricity on the market, but they are shielded from market price fluctuations through a commitment from the LCCC to pay the difference between the market and strike price. The United Kingdom is actively developing a Hydrogen Production Business Model mechanism to provide demand-side support to clean hydrogen projects. The German government has also invested €900 million in a similar auction-based mechanism called H2Global. This program—which will be carried out by Hintco, a subsidiary of the H2Global Foundation—helps meet the gap between supply- and demand-side prices, guaranteeing demand for clean hydrogen at a certain price.

Conclusion

There is a recognized need for expanded clean hydrogen capacity if the United States is to meet its net zero emissions goals. Clean hydrogen may play a large role in mitigating emissions from otherwise hard-to-decarbonize industries. Given its importance, reducing the risk of market failures can help accelerate the rapid scaling needed.

Historically, innovation policies have centered around supply-side economic tools like investments in basic research; however, economic evidence supports the role that demand-side support can play, in conjunction with capacity-expanding investments, to mitigate the risk of market failures and accelerate market scaling. In the case of clean hydrogen, the economic evidence suggests that mechanisms like a contract for differences and providing regulatory certainty can play a key role in unlocking the full potential of supply-side investments like the Regional Clean Hydrogen Hubs and accelerating market maturation.