# Growing Opportunities in Clean Hydrogen

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09 / 21 / 22

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**This article was published in the September 2022 issue of *Insights*.**



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**Key Points**

- The U.S. government plans to invest billions in tax credits, loans and grants to help make clean hydrogen an environmentally friendly alternative to fossil fuels in transportation and industrial and refining processes.
- Achieving this objective requires developing and commercializing clean hydrogen technology; building out vast hydrogen production, transportation and distribution infrastructure; and developing and producing transportation vehicles and other end-use products designed to utilize hydrogen as an energy source and as input in production and manufacturing.
- To make hydrogen production cleaner, the energy industry is pursuing two basic approaches: adding carbon-capture systems to existing methane-based production methods and developing hydrolysis production techniques relying on renewable and other nonfossil fuel-generated electricity.
- Because the clean hydrogen industry and technology are still emerging, developers and financiers must consider additional project risks relative to projects with existing mature technology.
- Despite the additional risks, investment in clean hydrogen — backed by aggressive government subsidies — is expected to expand dramatically.

Hydrogen fuel has long been considered a potential clean alternative to fossil fuels because the only byproduct from the combustion of hydrogen is water. However, traditional methane-based hydrogen production methods cause large amounts of greenhouse gas emissions, hindering hydrogen's adoption as a fuel to combat climate change.

Momentum is building for using renewable and nuclear energy instead of fossil fuels to power electrolyzer systems in the production of hydrogen, and using carbon-capture technologies to reduce emissions caused by traditional hydrogen production methods. This shift is bolstered by the federal government's renewed focus on supporting the technological development needed to make these production methods economically feasible: The recently passed Inflation Reduction Act (IRA) contains a number of tax incentives designed to support clean hydrogen projects, most notably a new 10-year production tax credit (PTC) that subsidizes production costs to the point of near parity with traditional production methods. The Infrastructure Investment and Jobs Act (IIJA), passed in November 2021, includes $9.5 billion for clean hydrogen technology development, and the IRA expands Department of Energy (DOE) loan and grant programs relating to hydrogen.

Recent geopolitical turmoil — namely, Russia's invasion of Ukraine and the sanctions on Russian oil imports and gas price instability that followed — have also highlighted the importance of energy alternatives, including hydrogen, in promoting energy security and resilience. In March 2022, the U.S. and European Commission announced the formation of a joint task force to reduce Europe's dependence on Russian fossil fuels, with clean hydrogen a key part of the task force's REPowerEU Plan that sets clean hydrogen investment and production goals.

## Market Outlook

Currently, hydrogen is primarily used as a component in industrial and refining processes (such as ammonia fertilizer production), with ammonia production facilities extracting hydrogen from fossil fuels and combining it with nitrogen to produce

ammonia. Replacing hydrogen produced by such traditional methods with clean hydrogen would permit the production of decarbonized ammonia, commonly referred to as green ammonia, which could itself serve as a future alternative fuel source. Hydrogen can also be used as a fuel for the generation of electrical power and in vehicles, including through the use of fuel cells. However, except in limited circumstances (such as to power forklifts and for space station hydrogen fuel cells), these uses are still in early stages of development.

Hydrogen cannot be broadly used yet as a clean alternative to fossil fuels because the technology for the efficient production, distribution, storage and use of hydrogen has not been developed to the point of economic viability. Additionally, there is a lack of infrastructure — such as hydrogen gas pipelines — supporting the production, distribution and consumer utilization of hydrogen fuel. As an initial step in promoting the expansion of hydrogen uses, proponents are focused on making the production of hydrogen for current and future uses more environmentally friendly by modifying existing production methods to include carbon-capture systems and introducing new hydrogen production processes powered from sources other than fossil fuels. The energy industry uses a color-coded system to describe the cleanliness of various hydrogen production methods based on their extraction process and energy source. The colors range from black (the least environmentally friendly) to green (the most).

Producing green hydrogen involves using renewable power to split water into hydrogen and oxygen through electrolysis. Electricity constitutes approximately 70-80% of the costs of green hydrogen production. Therefore, ensuring the availability of a reliably affordable nonfossil fuel-generated electricity source and developing energy-efficient and cost-effective electrolysis technology are crucial in producing more green hydrogen. Green hydrogen developers are concentrating on projects in geographic areas with both large amounts of renewable energy and access to water for electrolysis, such as Australia and regions of the Middle East. Depending on the water source, some of these developers must contend with an energy-intensive desalination process before electrolyzation.

## Recent Legislative and Policy Developments

### Inflation Reduction Act

The IRA contains a number of tax incentives designed to further support investment in blue and green hydrogen projects, most notably the new 10-year PTC that provides up to $3 per kilogram of clean hydrogen produced at a qualifying facility that commences construction before 2033.

The value of the new PTC for clean hydrogen is being widely hailed by the energy industry as a game-changer, as it would help close the gap between current costs of green and gray hydrogen production in the U.S. (According to S&P Global Commodity Insights, as of August 2022, green hydrogen costs roughly $5.5-$9.5 per kilogram, depending on the technology and the location, while gray hydrogen costs roughly $1.80-$2.4 per kilogram for steam methane reforming without carbon capture and storage, depending on the location.) The PTC is also anticipated to cover all or a large portion of the costs of carbon capture to convert gray to blue hydrogen.

The per-kilogram amount of the credit will be adjusted for inflation annually and will be determined for any given facility on a sliding scale based on the greenhouse gas that remains after the hydrogen production process at that facility. Importantly, producers must meet certain prevailing wage and apprenticeship requirements during both the construction of the project and the relevant credit period in order to claim the full amount of the credit.

Blue hydrogen producers claiming (or that have claimed) carbon-capture credits for a project cannot also claim the new clean hydrogen PTC for the same project; however, the clean hydrogen PTC can be claimed for a clean hydrogen project that is powered by a renewable energy facility for which tax credits are also claimed. The IRA also creates significant additional monetization options for the clean hydrogen PTC by allowing the credit to be transferred to unrelated parties for cash, subject to certain requirements, and making the credit eligible for "direct pay" for up to five years of the credit period.

In lieu of the PTC, clean hydrogen producers may choose to claim an investment tax credit (ITC), which is a one-time credit based on the producer's investment in the facility rather than 10 years of credits based on the production of the facility itself. In addition to the tax incentives available for clean hydrogen production, qualifying hydrogen storage facilities that commence construction prior to 2025 may claim a new stand-alone energy storage project ITC.

The legislative landscape is still developing around clean hydrogen, with new rules expected to further define how clean hydrogen will be measured, and with proposals for new tax incentives gaining traction. Of course, there is always a risk that future administrations could trigger a shift in policy that would unwind some of these incentive programs, but the growing global focus on clean hydrogen is expected to endure in some capacity.

### Infrastructure Investment and Jobs Act

The IIJA identifies clean hydrogen as important for promoting energy security and resilience. It includes $9.5 billion for directly funding the development of clean hydrogen technology across different platforms through grants, cooperative agreements and other legislatively authorized agreements. The law includes $8 billion for building four regional hydrogen hubs,

$1 billion for developing electrolyzer systems and $500 million for establishing clean hydrogen manufacturing and recycling programs to support a domestic supply chain.

The IIJA defines clean hydrogen as "hydrogen produced with a carbon intensity equal to or less than two (2) kilograms of carbon dioxide-equivalent produced at the site of production per kilogram of hydrogen produced." This definition encompasses green hydrogen (produced using renewable electricity) as well as blue hydrogen (which relies on fossil fuels and carbon-capture technology) and pink hydrogen (produced using nuclear-powered electrolysis).

The hubs called for by the law will be networks of clean hydrogen producers, potential consumers and connective infrastructure located nearby, with at least one hub for each type of clean hydrogen from the three different power sources: fossil fuels, renewable power and nuclear power. These hubs are intended to aid the advancement of clean hydrogen technology and prove the viability of the production, processing, delivery, storage and end use of clean hydrogen on a commercial basis that would assist and accelerate the development of a national hydrogen network.

Both the IIJA and the IRA contain new funding for the Title 17 Innovative Energy Loan Guarantee Program and the Advanced Technology Vehicles Manufacturing (ATVM) Program. This has led to the first DOE loan guarantee for a new clean energy technology project since 2014. The $504.4 million loan guarantee was issued in June 2022 for the Advanced Clean Energy Storage project in Utah, which will produce green hydrogen for use as part of a fuel blend with natural gas for electricity production, which will reduce emissions. In addition, the DOE announced it has offered a conditional commitment for a $1 billion loan guarantee for the Monolith Olive Creek clean hydrogen and industrial decarbonization project. Under the ATVM, the DOE may make loans to support the manufacture of hydrogen fuel-cell electric vehicles.

## Considerations When Structuring Clean Hydrogen Projects

Developers and financiers of clean hydrogen projects need to consider development issues and risk factors similar to other energy projects, but in the context of technology and an industry that is still in the early stages of commercial development.

One of the major issues for financing is securing off-take agreements for the sale of clean hydrogen from production plants to midstream distributors and end users. Long-term, fixed-price off-take agreements to provide hydrogen for industrial and refining applications likely offer the most stable financial structure for a project. However, opportunities for such agreements providing for the large-scale sale of hydrogen are currently limited to instances where there are local industrial partners with a high demand for hydrogen in their manufacturing processes and for operators of hydrogen refueling stations in areas comprising a hydrogen transportation hub. This could change with the development of the regional clean hydrogen hubs planned under the IIJA and with the potential to establish grid blending, which is the mixing of hydrogen with natural gas in the existing natural gas infrastructure grid. Regardless of the off-taker and off-take volume, developers and financing entities should be wary of conditional pricing or contingencies that shift supply risks from off-takers to project companies.

Additionally, projects need to account for risks in using technology still in the early stages of development, such as methane pyrolysis, a process that breaks down methane gas into hydrogen and solid carbon, and alkaline electrolysis, a type of electrolysis using a liquid alkaline solution or solid alkaline exchange membrane to split hydroxide ions. Investors and financiers will need to scrutinize engineering, procurement and construction contracts, operation and maintenance agreements, manufacturer warranties, insurance requirements and availability guarantees to ensure adequate contractual and risk protection. For example, the prototypical technologies used in clean hydrogen production pose increased risks due to their unproven reliability and lack of a long-term operating track record, and these risks require specialized engineering analysis by underwriters.

Electricity supply and cost are major considerations for any green hydrogen project, given that they are the largest cost input in the production of green hydrogen and have a significant impact on project competitiveness and economic viability. For blue hydrogen projects, the carbon capture components essentially present project-on-project risks and require the diligence of risk allocation generally associated with carbon capture projects.

However, many of the other risks inherent in clean hydrogen production and transportation — such as fire and the risk associated with transporting pressurized explosive gases — are well known to investors, financiers and insurance companies familiar with the oil and gas industry. Insurance companies have started developing detailed underwriting approaches specific to the hydrogen industry to account for the unique aspects of clean hydrogen production. Developers may want to enter into strategic partnerships with industry participants experienced in the clean hydrogen space to mitigate risks and establish themselves within the industry.

## Conclusion

Clean hydrogen is positioned to be one of the next major waves of environmentally beneficial energy projects, with government policy and legislation weighing in heavily to reduce financial uncertainty and encourage technological innovation. But much of the technology is still nascent, and investors and developers must pay close attention to each project's development and financing agreements to manage significant project risk.