Hydrogen Takes Center Stage

BLACK & VEATCH

3 Ways Hydrogen Can Transition Our Economy Away From Carbon

From the largest producers of energy and power to those pursuing advances in technology, healthcare and agriculture, many of the world's largest and most influential organizations have declared bold and ambitious environmental and sustainability targets. To decarbonize our economies, powerful words must be met with powerful action. How will the world's energy systems, supply chains and heavy industries overcome what is often described as an addiction to fossil fuels? The answer is increasingly hydrogen.

The world's most abundant element is also a clean-burning, energy-dense alternative fuel ready to serve as the gateway to decarbonization.

Hydrogen has uses as a zero-carbon fuel for heating, transport, the production of green chemicals and fertilizer, storage of renewable energy and electricity generation. It is not without challenges, however, as infrastructure is required to ensure that hydrogen can be purified, stored and used in a safe and economic manner.

While full predictions of a hydrogen economy are premature, there are already signs of hydrogen's growing application across electricity generation and storage, vehicle charging and as a replacement for fossil fuels in the chemical industry. Black & Veatch, already working across the hydrogen value chain, has been pioneering these emerging infrastructure solutions. How these sectors will mature and gain prominence will depend greatly on market forces; regulatory incentives; technological innovation and investments; partnerships; and many other social, economic and political forces. And these drivers will vary from location to location.

What seems most certain is that hydrogen will play an important role in the new energy mix, offsetting, and in time, even replacing our dependence on fossil fuels. Given the nature and scale of the infrastructure required, here are three areas that could feasibly kick-start a hydrogen economy because either progress is already underway or existing infrastructure could be repurposed.

1. Green Hydrogen Power Generation at Existing Gas-Fired Facilities

As electric utilities continue to close down and reduce their reliance on base-load coal-fired generation plants, questions around natural gas-fired assets now loom large on the horizon. In our relative early years of ramping up renewable energy, gas-fired power plants have proven to be important grid management tools complementing intermittent sources like wind and solar. The ability to ramp up and down quickly adds crucial stability to the grid, and high performance and efficiency make coal-fired generation hard to relinquish and replace in the mid-term.

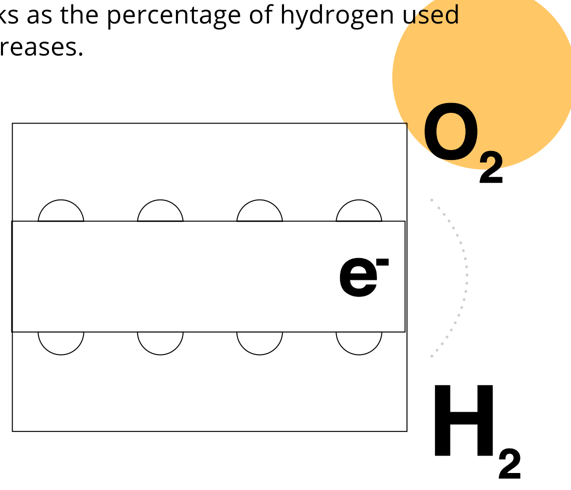
However, hydrogen has potential as a transition fuel while making use of existing infrastructure.

Hydrogen could replace in part, or eventually in full, natural gas at modified or new facilities.

Today, gas turbines are capable of up to approximately 50-percent hydrogen fuel content. What's more, each of the major gas turbine manufacturers are making substantial progress on a path to firing 100-percent hydrogen fuel within this decade. In fact, large gas turbine plants can fire more hydrogen than current supply generally allows. The latest advanced-class gas turbines, and multiple older models, will be retrofitted with newer hardware to realize higher hydrogen content, up to 100 percent.

The Intermountain Power Agency (IPA), a major U.S. electric utility, laid out plans to be one of the earliest large-scale users of combustion turbine technology designed to use a high percentage of green hydrogen. Green hydrogen is the production of hydrogen via the electrolysis of water, powered by a renewable energy source or by nuclear power. Such a transition will see IPA make progress decreasing its carbon footprint across Utah, Nevada and California.

Of course, challenges remain, such as driving down the cost of promising technologies like proton exchange membrane (PEM) electrolysis as well as managing and overcoming embrittlement risks as the percentage of hydrogen used increases.



The New Flyer Xcelsior CHARGE H2™ is a battery-electric vehicle that uses compressed hydrogen as an energy source to extend the range while remaining emission-free.

Image courtesy of New Flyer.

2. Hydrogen Fuel for Heavy Transport and Commercial Use

Hydrogen fuel cell vehicles (FCEVs) are gaining traction, particularly for commercial use. FCEVs have the same battery train as an electric vehicle but use hydrogen to produce electricity in addition to the battery. Benefits such as fast refueling time, long range performance, and lighter weight make FCEVs an attractive zero-emission option.

Mostly powered by diesel today, heavy-duty vehicles emit high levels of particulates, nitrogen oxides, and other pollutants. Freight vehicles, given their mileage and fuel consumption, tend to be the highest contributors to greenhouse gas emissions and pollution at street level. Commercial applications could also include hydrogen fuel cell electric buses; railways; and machinery and materials handling equipment, such as forklift trucks and high-torque construction and excavation equipment for mining or other specialized uses.

Building the infrastructure will remain the challenge, perhaps less so for long-haul freight vehicles, given that they have more predictable and standardized routes than general automobiles. The development of hydrogen fueling stations will likely depend on regulatory incentives; for example, the progressive zero-emission regulations in places such as California. Black & Veatch has deployed more than 25 hydrogen stations for light-duty vehicle application in California and in the Northeastern United States region.

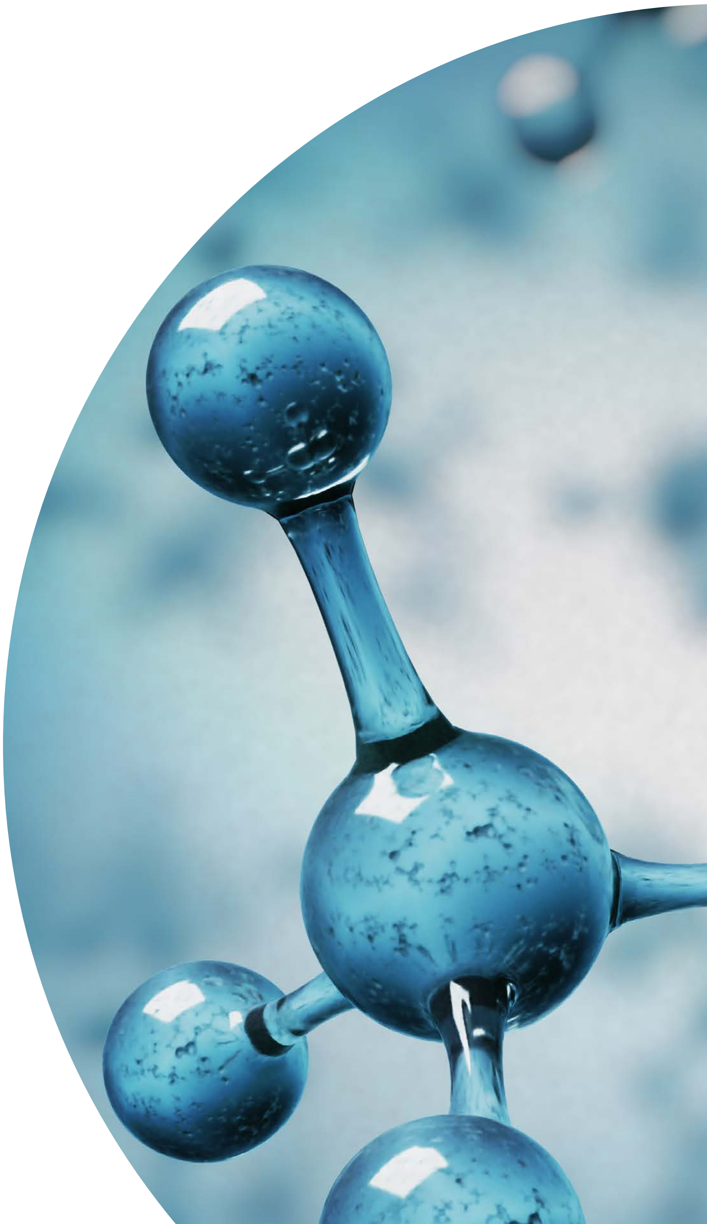
As of 2020, Nikola Motor has more than 14,000 pre-orders for its battery electric and hydrogen-fuel-cell electric vehicles.

Image courtesy of Nikola.

3. Green Ammonia for Energy and Other Green Chemical Production

Ammonia is a common chemical produced today, primarily as fertilizer. Composed of one-part nitrogen and three-parts hydrogen, ammonia is easier to store, ship and distributed than elemental hydrogen, making it a potential vehicle for hydrogen storage. As it doesn't contain carbon, it will not release CO_2 when used in gas turbines or in fuel-cell systems where it can provide high power density.

Even more promising, hydrogen for ammonia production can be produced through electrolysis and renewable energy sources rather than a hydrocarbon process. But in the short- to medium-term, it looks more likely that regulations will encourage the production of "blue hydrogen" or "blue ammonia" using the cost-effective steam methane reforming (SMR) production process. Plus, the SME process can be paired with additional carbon capture, sequestration and utilization for green chemical production. This would help reduce the carbon footprint of the historically challenging chemical industry while also creating a pathway to more pervasive decarbonization — a win-win solution.



Hybrid facilities that mix both technologies could pave the way to large-scale adoption of electrolysis processes and help drive down the cost of technology over time.

Black & Veatch has more than 80 years' experience covering all commercial ammonia process equipment and technologies, and building and revamping new and existing facilities at scale. As a technology integrator, Black & Veatch works across the hydrogen value chain to help accelerate the development of new sustainable ammonia treatment facilities, while providing proven experience in carbon capture, renewable and water technologies.

For more information visit [https://www.bv.com/solutions/hydrogen.](https://www.bv.com/solutions/hydrogen)