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Green Hydrogen's Role in Energy Transition

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Green hydrogen is an emerging yet credible technology used to lower carbon emissions where electrification is less effective—and we believe its growth could be among the highest of any area of the energy transition, creating niche opportunities for companies and investors.

Hydrogen Goes Green

Hydrogen itself is a colorful gas, but can be described using a veritable rainbow of hues, starting with the less desirable browns and grays, and expanding into the more appealing blues and greens.

Gas that is generated from coal or lignite is referred to as brown, while gas that is generated from steam methane reformation (which typically uses natural gas as the feedstock, or raw material used in production) is considered gray. Neither of these processes is carbon-friendly, so governments and industries have pursued cleaner options.

One such option is blue hydrogen, where gas is produced by steam methane reformation but emissions are curtailed using carbon capture and storage. This process can roughly halve the amount of carbon produced, but is far from emission-free.

Enter green hydrogen: a hydrogen-produced fuel obtained from electrolysis of water with electricity generated by low-carbon power sources. It could almost entirely eliminate emissions using renewable energy.

Electrifying Difficult Areas

As concerns about climate change drive the energy transition, green hydrogen will likely be the solution of choice across a number of high-emission sectors.

While the majority of emissions can be reduced using electrification generated by renewable power, other emissions are hard to electrify, due either to greater technical challenges or the nature of the production process.

Two areas that are hard to electrify are heavy industry and heavy-duty transportation. Both have high energy demands, and in many cases, high heat requirements or particular feedstocks with strong emission profiles in and of themselves (including the steel production process, petrochemicals, and manufacturing aluminum).

Hydrogen's Strengths

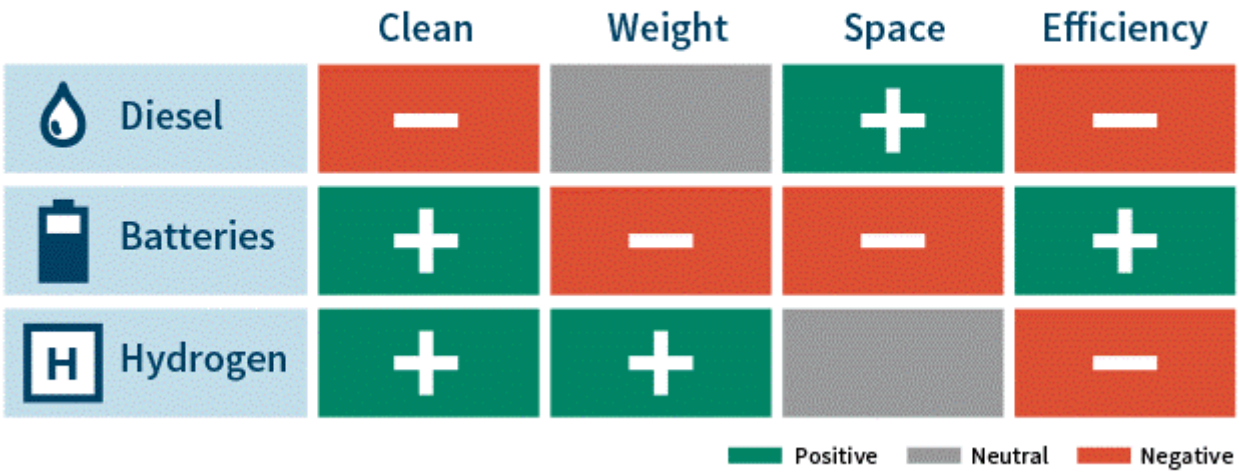
The matrix below shows the relative tradeoffs between green hydrogen, batteries, and conventional diesel fuel in heavy industry and heavy-duty transportation.

Diesel's advantage, setting aside cost, is the space it requires relative to its energy content. That's why it's the standard fuel across the trucking, rail, and global marine shipping industries (which also require quick refueling, another strength of diesel).

Batteries are clean; their main shortcoming is their weight. They take up significant space relative to their energy density, so are not ideal in applications that require hauling large amounts of cargo. Additionally, batteries can take a significant amount of time to recharge, which is not ideal for highly utilized assets such as trucks. Batteries are better suited to personal vehicles: When you drive your car just a few hours a day, it has plenty of time to recharge.

Green hydrogen, meanwhile, is clean. It also solves the problems presented by batteries in that it has a much better energy density and can quickly be refueled. Its weakness is that it must use fuel cells to convert hydrogen into usable power. While that is not as efficient as batteries, hydrogen does have very high latent energy density—meaning it will be some time before batteries catch up to green hydrogen.

Tradeoffs Between Green Hydrogen, Batteries, and Diesel



Source: William Blair, as of November 2021.

Electrifying Difficult Areas

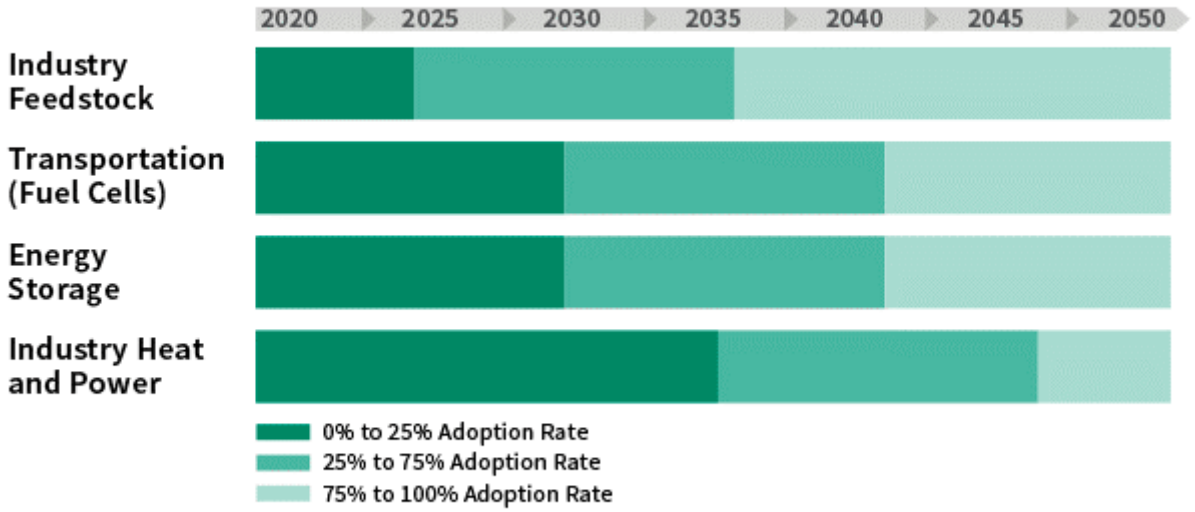
How quickly green hydrogen penetrates heavy industry and heavy-duty transportation depends on the market. We break these two industries into four main areas: industry feedstock, transportation (fuel cells), energy storage, and industrial heat and power. Let's look at them one at a time.—

We expect industry feedstock and transportation to be the earliest adopters of green hydrogen. Industry feedstock begins as a replacement market for existing hydrogen, which is considered gray hydrogen, because, as noted above, it is produced via natural gas. Examples of this include ammonia, which is used for fertilizers, as well as methanol. In transportation, heavy-duty trucks are a natural market for green hydrogen, but we expect adoption to progress to rail and marine applications.

Energy storage is likely the next market for green hydrogen. Long-duration storage is critical to lowering emissions because the need for it increases with the use of renewable energy (such as wind and solar). Batteries can only handle short-duration storage (in the hours). Given the heavy seasonality in wind and solar generation, however, we must be able to harvest excess power and store it in a form that allows us to use it later when power demand increases. Green hydrogen can bridge that gap.

The last market we expect green hydrogen to penetrate is decentralized heat and power. Think of this as remote industry, where the power grid is less developed or less reliable, and energy intensity is high. A related market involves blending green hydrogen with natural gas for heating in residential and commercial settings.

Green Hydrogen Markets and Estimated Adoption Dates



Source: William Blair estimates, as of November 2021.

Considering the scale of these markets, what kind of growth rates can we expect? We anticipate that these markets will expand by roughly six times by 2050, equating to a similar increase in total hydrogen demand globally. As the need to decarbonize the global energy system becomes more urgent to avoid the worst effects of climate change, we believe the growth of green hydrogen will be much higher relative to fossil fuel-derived gray hydrogen.

Risks

Up to this point, we have discussed green hydrogen's potential, but it is also important to consider what could slow adoption or be a barrier to commercialization.

The main cost components of green hydrogen are renewable power and equipment (58%); electrolyzers, which use electricity to break water into hydrogen and oxygen (22%); and storage (10%). As renewables and electrolyzers combined account for 80% of the total cost of green hydrogen, it is critical that these component costs decline in order for green hydrogen to be economic across the markets we discussed above. We would need the price of green hydrogen to reach $2 a kilogram versus roughly $5 a kilogram today in order for this to happen.

Renewable power prices have certainly decreased dramatically, and there is a visible road map for those costs to continue decreasing, but electrolyzers have more uncertainty. Multiple technologies are used, and the companies producing them are generally smaller and have short track records.

Providing some level of comfort regarding the electrolyzer cost trajectory are the rates of decline for batteries over the past decade. Batteries and electrolyzers have some overlapping features, so looking at the cost declines of batteries gives us some line of sight into the cost hurdles that must be overcome for electrolyzers to be cost-effective. Moreover, we don't need to see the same level of improvement in electrolyzers that we saw in batteries to achieve price points that make green hydrogen competitive.

The Green Hydrogen Potential for Growth Investors

As an emerging yet credible technology that can lower emissions where electrification is less effective, green hydrogen has the potential to be a silver bullet for key parts of the energy transition.

Industry, as discussed, will likely be a key area of growth, creating niche opportunities for companies. Moreover, the diversity of the end-markets green hydrogen serves should help mitigate volatility of growth through the transition.

Backstopping this transition is favorable policy support. The European Union wants hydrogen to meet 14% of its energy needs by 2050, and we should see policy support more broadly around the world. China has undertaken significant research and development in green hydrogen, with pilot facilities opening in key cities. Momentum has been building in Japan. And discussion in the United States could eventually result in more concrete policy.

All things considered, we believe hydrogen's percentage of the total energy mix could be in the mid-teens by 2050, translating into a total addressable market of greater than $1 trillion. As growth investors, we will be looking to identify the best opportunities in this market.

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