HYDROGEN FOR LIGHT-DUTY VEHICLES

Prospects

TERRIBLE

This fact sheet is part of an Energy Innovation paper assessing clean hydrogen's value for cutting climate pollution from 12 end uses. The full report includes context, analysis, policy recommendations, and citations—see QR code or link at bottom.

Electric vehicles have insurmountable advantages over hydrogen fuel cell vehicles.

NOTE: *This should be compared with the "Heavy-Duty Vehicles" overview.*

CONTEXT: Manufacturers, governments, and researchers have spent decades developing hydrogen fuel cell electric vehicles (FCEVs) in pursuit of clean vehicles that operate similarly to internal combustion engine vehicles (ICEVs)—that is, promising long ranges and fast fueling times. However, battery electric vehicles (BEVs) have improved dramatically over this time, closing the gap on these metrics and taking off in sales and infrastructure deployment. Even so, a desire to keep all options open has kept interest in FCEVs alive. For example, California is dedicating substantial funding to FCEVs despite very low sales and a booming BEV market.

INFRASTRUCTURE NEEDS: Supporting hydrogen light-duty vehicles (LDVs) at scale would require building out an expansive network of refueling stations, tanker trucks (to deliver hydrogen), and—when demand is sufficiently high—dedicated hydrogen pipelines. Given that hydrogen is a much less energy-dense (but more volatile) fuel than gasoline, refueling stations require large storage tanks, compression or liquefaction equipment, and safety systems.

As of 2023, there was a massive gap in the number of U.S. public BEV charging stations (more than 100,000) and hydrogen refueling stations (60). BEVs have a clear path to growth, as they allow for recharging at home; public charging stations can also be built in a modular manner while using the existing distribution system, which can be gradually upgraded over time.

By comparison, FCEV refueling stations represent a big risk. Not long ago, policymakers were pursuing compressed natural gas (CNG) vehicles to help clean up the transportation sector; however, CNG stations peaked in 2016 and have been closing due to "high repair and operating costs, and fleets transitioning away from CNG." As BEVs have taken off, CNG stations are being stranded, hurting consumers who took on the risk of buying CNG cars. This same situation is likely to play out with FCEV stations—a risk consumers shouldn't have to bear.

SOCIAL IMPACTS: FCEVs are generally a net benefit for reducing local pollution, as ICEVs cause health-harming smog while fuel cells emit only water vapor. However, if electrolytic hydrogen production is dirty, this benefit risks coming at the cost of communities near fossil fuel power plants that will run more often to supply the power. Unlike with BEVs, dirty electrolytic hydrogen can wipe out or reverse FCEVs' climate benefits—an impact that can be worsened by the high rates of hydrogen leakage at refueling pumps, given that hydrogen has approximately a 12 times greater warming impact than CO_2 over a 100-year period.

Building out a hydrogen distribution system to refuel FCEVs will also raise transportation costs for consumers (or result in two sub-par systems in FCEV and BEV infrastructure). While BEVs

are taking off and have a path to self-sufficiency, FCEVs would likely only grow with heavy and sustained policy support, which would raise taxes and electricity rates (or cut support for BEVs).

COMPETING TECHS: FCEVs' key roadblock is that **battery electric vehicles** outperform them on many key metrics and are closing the gap on the others. BEVs are much more efficient, requiring two to three times less clean electricity than FCEVs using electrolytic hydrogen. They cost less than FCEVs—on sticker price, fuel costs, and maintenance—and this will remain true over time. They have better acceleration, better handling, and more cargo space.

FCEVs currently outperform BEVs on range and refueling speed. However, 96 percent of LDV trips are less than 125 miles, meaning BEVs can complete most trips on a single charge. BEV ranges also continue to improve (with the latest Tesla Model S surpassing 400 miles), as do the quality and availability of fast chargers (now able to get BEVs back to "80 percent charge in 30 minutes" and with much shorter times on the horizon). Further, BEVs can be charged at homes and businesses, meaning most consumers likely already spend far less idle time refueling with BEVs than with FCEVs or ICEVs. This all points to a vanishingly small use case for hydrogen LDVs, making it extremely costly to build an enabling FCEV refueling network.

Markets and analysis both reveal BEVs' superiority. BEVs are already reaching cost parity with ICEVs, with 1.1 million cars sold in the U.S. in 2023—up 48 percent year-over-year and capturing 7 percent of the market. Studies show current policies may see U.S. electric LDV sales rise to 56 to 67 percent by 2032, and reaching 100 percent sales by 2030 would help save $2.7 trillion through 2050. By contrast, analysts expect FCEVs will remain "a very small portion" of LDV sales through 2044, and fewer than 3,000 FCEVs were sold in 2023—down from 2021's peak.

TAKEAWAY: BEVs have an enormous lead in vehicle sales and charging station deployment, fundamental efficiency and performance advantages, and a clear path to mitigate range and refueling speed concerns. This reality makes hydrogen LDVs not only unnecessary for realizing a clean transportation system but also counterproductive to achieving this goal in a timely and cost-effective manner. BEVs will require significant public investment to reach maturity—including for charging stations, fleet purchases, and staff for city and highway planning. Using limited resources on duplicative hydrogen infrastructure risks raising consumer costs, leading to stranded assets, and hindering BEVs' growth. Private companies should be welcome to take risks in investing in FCEVs, but policymakers should prioritize scaling BEVs' proven success.

FURTHER READING:

- Amol Phadke et al., "2035 The Report – Transportation: Plummeting Costs and Dramatic Improvements in Batteries Can Accelerate Our Clean Transportation Future," University of California, Berkeley, April 2021, https://www.2035report.com/transportation/wp-content/uploads/2020/05/2035Report2.0-1.pdf
- John O'Dell, "In Hydrogen vs. Electric Cars Comparison, Who Wins?" Edmunds, March 25, 2024, https://www.edmunds.com/electric-car/articles/hydrogen-vs-electric-cars.html
- Jasper Jolly, "Will hydrogen overtake batteries in the race for zero-emission cars?" *The Guardian*, February 13, 2024, https://www.theguardian.com/business/2024/feb/13/will-hydrogen-overtake-batteries-in-the-race-for-zero-emission-cars
- **Featured story:** Eric Wesoff, "Why is California wasting millions on hydrogen fuel pumps?" Canary Media, March 7, 2022, https://www.canarymedia.com/articles/hydrogen/why-is-california-wasting-millions-on-hydrogen-fuel-pumps
- **Full report:** https://energyinnovation.org/publication/hydrogen-policys-narrow-path-delusions-and-solutions