Title

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Author

Fulton, Lewis, PhD

Publication Date

2024-10-01

DOI

10.7922/G25M642W

Institute of Transportation Studies | UNIVERSITY OF CALIFORNIA

Developing a Hydrogen Vehicle Market in California Will Require Significant Upfront Investment, but Should be Self-Sustaining Thereafter

Lewis Fulton, PhD
Director, Energy Futures Program, Institute of Transportation Studies, UC Davis

October 2024

Issue

While hydrogen fuel-cell electric vehicles (FCEVs) are seen as a part of California's efforts to decarbonize transportation, especially for the heavy-duty vehicle sector, their role remains unclear. This may change, however, with the launch of the California Alliance for Renewable Clean Energy Hydrogen Energy Systems (ARCHES)[1] developed by the California Governor's Office of Business and Economic Development (GO-Biz) as a public-private partnership. The U.S. Department of Energy and ARCHES recently signed a $12.6 billion agreement to build a clean, renewable Hydrogen Hub in California, including up to $1.2 billion in federal funding. The transportation sector will play a central role in this effort, including commitments to deploy 6,000 FCEVs, mainly trucks and buses, along with 60 refueling stations and other investments.

To support ARCHES and California's commitment to hydrogen, the UC Davis Hydrogen Program[2] evaluated the requirements and costs of building a network of hydrogen stations (including delivering hydrogen to those stations), and the costs of purchasing these vehicles, including light-, medium-, and heavy-duty vehicles. This work builds upon our prior studies[3] that developed two FCEV adoption scenarios through 2045: i) an ambitious but incremental Base Case scenario closely aligned with FCEV sales targets adopted by ARCHES, and ii) an even more ambitious High Case scenario that assumes robust light-duty and medium/heavy-duty vehicle markets by 2030, along with more rapid growth in refueling and hydrogen production capacities throughout the state. We used the two scenarios to estimate the level of investment and other costs for building out a hydrogen system to support road transportation (i.e., trucks, cars, buses), and examine how these investments and per-unit hydrogen costs play out over time (with 2030 and 2045 being key years) and across different types of hydrogen system components (e.g., hydrogen delivery systems and stations). We also looked at workforce and jobs impacts from the transition to hydrogen and FCEVs within the state.

Key Research Findings

To build out a transportation hydrogen system for cars, trucks, and buses by 2030 will cost between $4 to $12 billion over the next 6 years. This cost includes building out hydrogen distribution systems and refueling stations across California as well as the purchase of light-duty cars, trucks, and buses. This cost range includes hydrogen transmission, distribution, and station operation, as well as vehicles, but does not include hydrogen production. This wide range reflects different ways to measure this investment, in particular whether vehicle purchase costs are taken in their entirety, or just as the incremental costs over buying conventional (gasoline or diesel) vehicles, which is far lower. In any case, the needed investments further increase by a factor of eight between 2030 and 2045, given the on-going rapid rise in hydrogen vehicle sales over that period.

FCEV costs become manageable as prices come down over time. While the actual cost of purchasing FCEVs (both cars and

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trucks) to 2030 will be around $9 billion, based on their expected prices, their incremental costs over comparable gasoline or diesel vehicles is much lower, around $1.6 billion. For refueling stations, we did not consider incremental costs but simple the total investment cost of building these out for both light-duty and heavy-duty vehicles, which are estimated to cost on the order of $1.5 billion. Hydrogen delivery truck costs (i.e., trucks that deliver hydrogen from production sites to stations) are far lower, accounting for around $100 million over this period.

Economies of scale will help drive down costs. Building the system up to a certain scale will be needed to make it self-sufficient. Early investments in developing hydrogen stations and other infrastructure as well as subsidizing the purchase of FCEVs will help grow markets and drive down purchase price of FCEVs along with the cost of hydrogen sold to vehicles. By 2030 or soon after, the per-unit cost of hydrogen sold to vehicles needs to be cut by half or more from today's prices, and be in the range of $5 to $7 per kilogram. It will also help (for example, with vehicle production volumes and station construction costs), to have similar efforts elsewhere around the country, since this will create yet larger economies of scale, and reach a greater overall market size for these aspects faster.

Workforce impacts will likely be positive, with many new jobs created within the state. Including both constructing and operating this system, our Base Case creates 600 to 2,200 jobs by 2030, and rises rapidly thereafter as system growth rises rapidly. In 2045, the manufacturing and sales of FCEV transit buses within California are expected to generate between 200 and 300 in-state, full-time equivalent jobs (FTEs), depending on the scenario (Base vs High Case). In 2030, expenditures on hydrogen fuel, and the follow-on effects on the industries that produce and distribute it, are expected to produce between 629 and 2,193 FTEs, with this range growing to between 8,169 and 25,518 FTEs by 2045. Fuel consumption volume, and consequently system size, is the key factor in determining job creation.

Policy Implications

Federal and State investment early on will be critical. In many cases, the investments identified in our analysis may not be immediately profitable. In turn, there is an important role for government (i.e., ARCHES, with its state and federal funding) to assist in building out the infrastructure and making FCEVs more affordable (i.e., offering purchase incentives) as the system grows. If ARCHES (with its federal and state funding) were to cover half the cost of building out a system of stations (including delivering hydrogen to those stations) and purchasing FCEVs, then this would be about $1.6 billion over a 6-year timeframe.

Other existing programs and policies can help, including California's Low Carbon Fuel Standard, which helps cover some station infrastructure costs, and the Clean Truck and Bus Voucher Incentive Project, which helps cover some FCEV purchase costs. If needed, additional funding could be generated by, a small increase in the annual registration fees of gasoline and diesel cars and trucks. For example, a fee of $10 per vehicle per year for 6 years applied to the 25 million registered vehicles in California would be more than enough to cover all the investment costs identified in our analysis.

More Information

This policy brief is drawn from the report "Fuel-cell Vehicle and Hydrogen Transitions in California: Scenarios, Cost Analysis, and Workforce Implications" available at www.ucits.org/research-project/rimi-3o. For more information about findings presented in this brief, please contact Lewis Fulton at lmfulton@ucdavis.edu.

[1]https://archesh2.org/

[2]https://its.ucdavis.edu/research/uc-davis-hydrogen-fuel-cell-projects/

[3]https://its.ucdavis.edu/research/uc-davis-hydrogen-fuel-cell-projects/

Research presented in this policy brief was made possible through the Resilient and Innovative Mobility Initiative (RIMI) led by the UC Institute of Transportation Studies (UC ITS). RIMI is supported by the State of California through a one-time allocation in the 2021 State Budget Act. The UC ITS created RIMI as a living laboratory – bringing together university experts, policymakers, public agencies, industry stakeholders, and community leaders – to inform the state transportation system's immediate COVID-19 response and recovery needs, while establishing a long-term vision and pathway for directing innovative mobility to develop sustainable and resilient transportation in California. Established by the California Legislature in 1947, the UC ITS has branches at UC Berkeley, UC Davis, UC Irvine, and UCLA.

Project ID UC-ITS-RIMI-3O | DOI: 10.7922/G25M642W