

As transit agencies across the country consider the options to decarbonize their fleets, hydrogen fuel cell buses have emerged as a compelling option due to similar operational logistics and performance compared to incumbent technologies. This information sheet serves as a reference point for transit agency decision makers for further information on fuel cell buses and hydrogen infrastructure implementation.



Hydrogen Comes in a Variety of Ways

Each transit agency has different requirements and therefore will need to examine and determine the options for hydrogen supply and refueling station. Sometimes the best option is to produce hydrogen onsite, such as the case for Sunline Transit in the Coachella Valley, CA who has an abundance of land on a large property, by either electrolysis or small-scale reformation of natural gas or biogas. For other more urban transit agencies, such as Orange County Transit Authority (OCTA), delivered liquid hydrogen is the best option for a more space restrained infrastructure solution. The Center for Transportation and the Environment (CTE) produced the *Guidebook for Deploying Zero-Emission Transit Buses*, containing a thorough step-by-step guide for both battery electric and hydrogen fuel cell electric bus fleet implementation, which is available for download here: <http://nap.edu/25842>

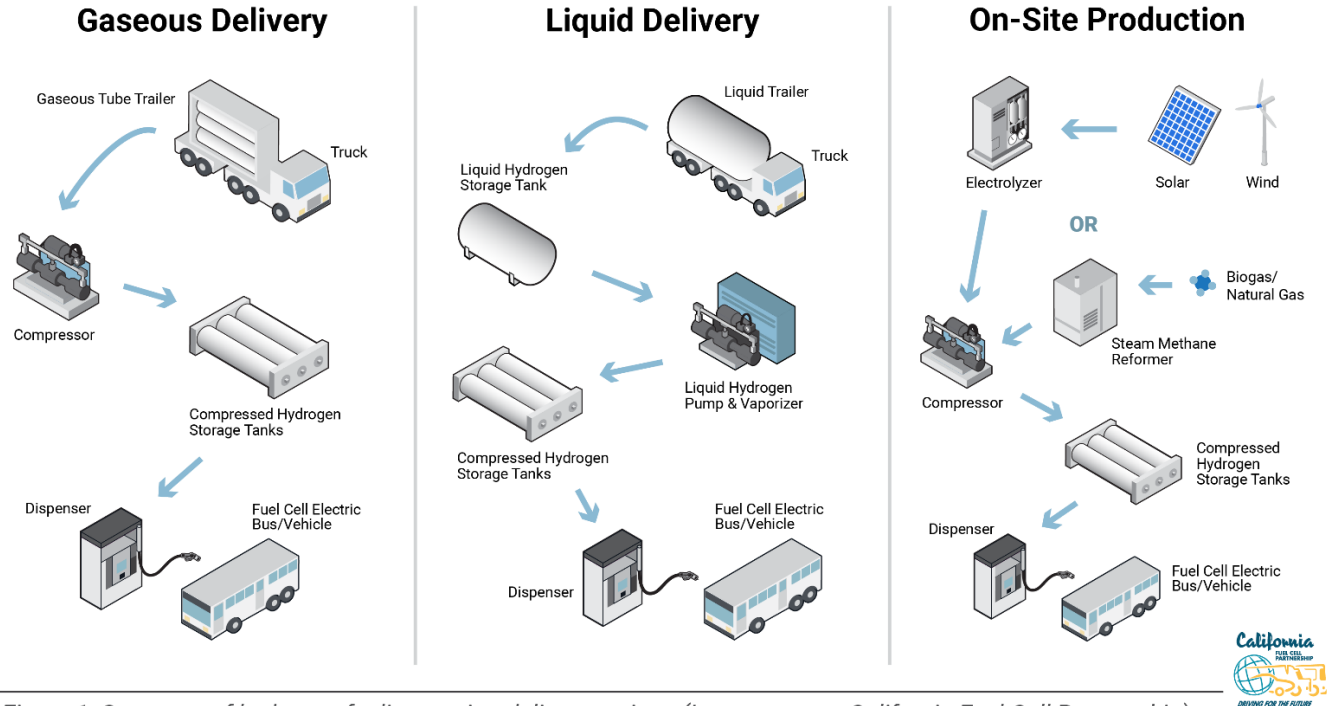


Figure 1: Summary of hydrogen fueling station delivery options (Image source: California Fuel Cell Partnership)



Performance: Fuel Cell Buses Operate the Same Way as Diesel & CNG Buses

Transit Agencies overall have had great experiences using fuel cell electric buses in their day-to-day operation. The National Renewable Energy Lab (NREL) has published data on fuel cell bus performance and maintenance over the past 10 years that can be found here: <https://www.nrel.gov/hydrogen/fuel-cell-bus-evaluation.html>

Price Comparison: At Scale, Hydrogen Infrastructure is Cheaper Than Electric

The price for electricity can vary widely throughout the day, while hydrogen pricing can be constant at a fixed price per kilogram contract with a supplier. In terms of an overall fleet bus and infrastructure price comparison, Foothill Transit performed an analysis on battery versus fuel cell buses over a 12-year period and determined a savings of \$12.9 million by using fuel cell buses with hydrogen infrastructure covering a 23-bus block. The full evaluation can be found here: <https://cafcp.org/sites/default/files/07-24-2020-Foothill-ZEB-Update-to-Board.pdf>

Funding Sources

Public/private partnerships are available for hydrogen infrastructure financing. As for public incentives, in California, the Air Resources Board offers zero emission bus funding through HVIP (<https://www.californiahvip.org/>) and VW Mitigation fund (<http://vwbusmoney.valleyair.org/>). On the federal level, each year funding is available through the Federal Transit Administration’s Low-No Program (<https://www.transit.dot.gov/funding/grants/lowno>).

Resilience: Zero-Emission Emergency Back-Up Power from Fuel Cells

Hydrogen fuel cells are already used for back-up power in critical operations such as hospitals and data centers. Transit agencies also have this option to further utilize hydrogen for back-up power through stationary fuel cells. This allows further use of the readily available hydrogen fuel. Learn more here: <http://www.casfcc.org/>

California Air Resources Board Innovative Clean Transit Rollout Plans

The Innovative Clean Transit (ICT) regulation (Cal. Code Regs. Tit. 13 § 2023.1(d)) requires each transit agency to submit a complete Zero-Emission Bus Rollout Plan (Rollout Plan), approved by its governing body, to CARB showing how it plans to achieve a full transition to zero-emission buses (ZEBs). Rollout plans for large transit agencies were due in July, 2020; small transit agencies are due June 30th, 2024. Rollout plans are posted on the CARB website: <https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit/ict-rollout-plans>

Below is a graphical representation of the rollout plans compiled by NREL.

