Fuel Cell Electric Bus Fact Sheet

Overview

- Fuel cell electric buses provide zero-emission transit with range and performance comparable to diesel and CNG, and significantly better fuel economy.
- More than 300 FCEBs have been deployed around the world and operated millions of miles in revenue service
- Transit agencies in the U.S. operate 27 FCEBs. The majority are at AC Transit and SunLine Transit in California.
- More than 30 additional buses planned for deployment in California in the next two years.
- FCEBs meet FTA's Buy America requirements.
- Transit agencies in the EU operate 87 FCEBs; 163 additional buses are planned for deployment in the next two years.
- China operates 20 FCEBs and has confirmed orders to operate 500 FCEBs in the next two years.
- Two transit bus manufacturers, New Flyer Industries & ElDorado National, supply fuel cell electric buses in the U.S.
- Ballard Power Systems and Hydrogenics are the primary suppliers of fuel cell systems for transit buses.
- Most of the hydrogen fuel used in transit bus applications is delivered from large-scale central production facilities or produced renewably on-site.
- Fuel cell technology developed for the transit bus market is beginning to diffuse into other heavy-duty applications like light rail, drayage trucks, and parcel delivery trucks.

SunLine Transit Agency

- First transit agency to completely convert to CNG
- Operates five FCEBs, expanding to 19 by EOY 2018
- FCEBs have traveled 762,000 miles (October 2016)

Alameda-Contra Costa Transit District

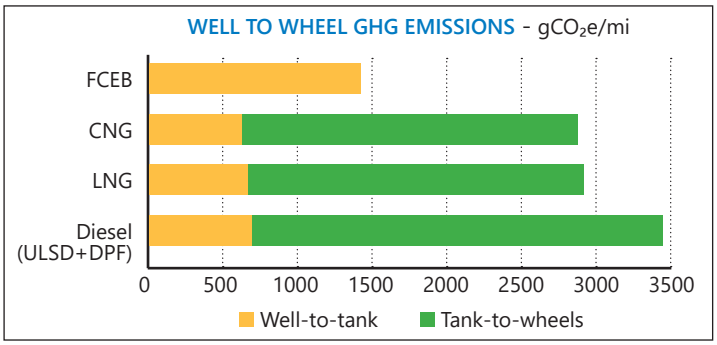
- Operates 13 FCEBs, the largest fleet in North America. Expanding fleet in next two years.
- FCEBs have traveled 1.6 million miles and carried 4 million passengers (October 2016)
- The fleet averages 36,000 miles/month
- The lead fuel cell has more than 23,000 hours—nearly the half-life of the bus.

Orange County Transportation Authority

- Took delivery of first FCEB in May 2016, an ElDorado National bus manufactured in Riverside, California
- Plans to add 10 New Flyer FCEBs in 2018

Environmental Benefits

Greenhouse gas modeling[1] shows that FCEBs running on hydrogen produced from natural gas reduce CO_2 by more than half compared to a diesel bus. When hydrogen is made from renewable sources—such as wind- and solar-power or biogas—GHGs are nearly zero.



From well to wheels, FCEBs have zero criteria pollutants (NOx, VOCs and PM). Whether hydrogen is made from natural gas or renewables at "upstream" central locations, emission control is more effective compared to fuels burned in a large number of individual transit buses with internal combustion engines.

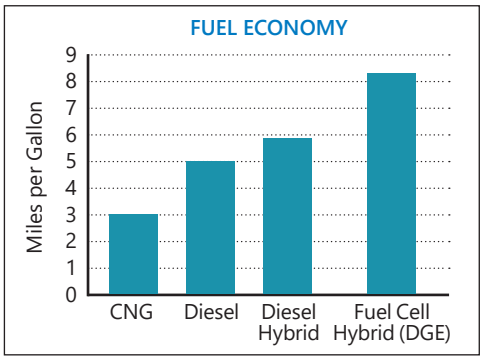
Zero-emission FCEBs are a benefit to riders and drivers, and to the communities in which they operate. Many of the early-market FCEBs are being placed in disadvantaged communities where clean buses can make the biggest impact on the health-related impacts of poor air quality.

1 CaFCP analysis using GREET model with support and verification by Argonne National Laboratory and CARB

Performance and Range

Zero-emission FCEBs offer the same full vehicle performance—air conditioning, gradeability, and highway speeds—on all types of transit routes. With range of 240-310 miles per fill, FCEBs are therefore a "one-to-one" replacement for conventional buses.

Because FCEBs are electric buses that make electricity from hydrogen, the are about twice as efficient than buses powered by combustion engines. By converting more of the fuel energy into motive power, fuel cell buses have the potential to reduce overall fuel costs.



Source: Public Transit Special Issue 2008 & NREL Reports

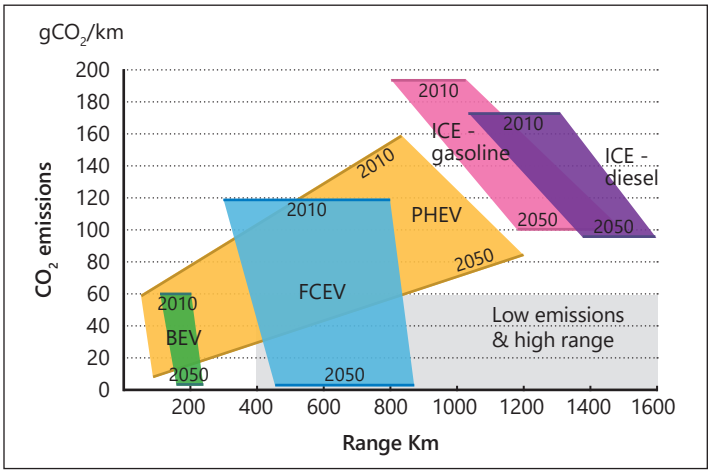
Costs

Capital - FCEB capital costs are about $1.3 million per bus, a reduction of more than 60% since 2008. In future years, manufacturers believe that costs will decrease to $900,000 per bus,[2] with a long-term target of $600,000[3].

Fuel - Hydrogen cost ranges from $5.00–$8.00/kilogram[4] at the three California transit fueling sites; approximately $0.71–$1.14/mile. As more buses are deployed, the increased fuel demand is expected to lower the fuel price more on a per-mile basis.

Maintenance - Costs of the SunLine and AC Transit fuel cell buses under warranty have been roughly the same as the agencies' conventional buses. In the long-term, however, there is significant potential for operational cost savings because fuel cell systems are solid-state devices without moving parts and the electric propulsion systems are far more durable and easier to maintain than conventional systems. Preventative maintenance and parts replacement is expected to be less than for diesel and CNG buses.

FCEBs fall within the "low emissions and high range" zone



Source: Urban buses: alternative powertrains for Europe report – FCH JU

Scalability

Hydrogen stations at transit yards are built to be scalable. The equipment is similar to a CNG station, and therefore a station can increase its capacity from 40 to 400 buses by upgrading the compression and storage equipment, and adding dispensers, while not entailing ten times the investment. Hydrogen stations do not typically need vast electrical or gas utility upgrades to scale up to a commercial level.

Disadvantaged Communities

FCEBs serve riders of necessity in disadvantaged communities throughout California. This interaction between Californians and clean transit technology is important in establishing a link between the State's investments and a broad demographic of riders.

2 May 2014 New Flyer letter to CARB, as referenced in www.arb.ca.gov/msprog/tech/techreport/fc_tech_report.pdf
3 US DOE 2012 FCEB targets at www.hydrogen.energy.gov/pdfs/12012_fuel_cell_bus_targets.pdf
4 When operating five or more FCEBs per site.