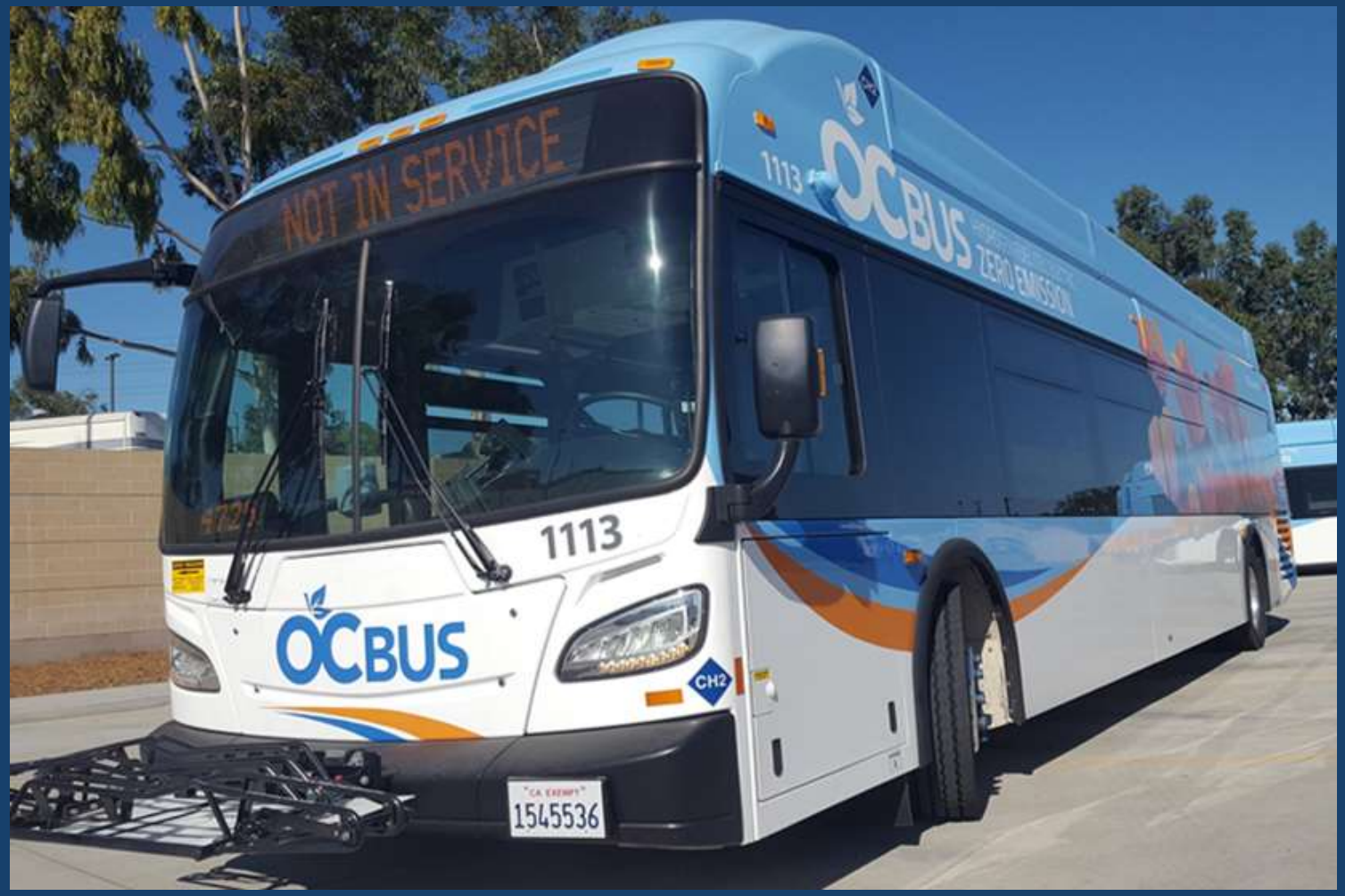
OCTA Hydrogen Buses Overview



California Transit Association 54th Annual Conference & Expo.

Monterey, CA. Nov. 2019

Bill Habibe. OCTA. Mngr. Transit Tech. Svcs

Fuel-Cell Electric Bus Demo – The beginning

- Demo H2 Fuel-Cell Electric Bus
  - Center for Transportation and the Environment (CTE)
  - Two-year demo at no cost to OCTA
  - Grant funded
  - 150 kW fuel cell
  - 200 KW battery
  - 50 Kgr. H2 fuel on board
  - 6.5 MPKgr.

OCBUS OCTA

ARB AQIP Fuel Cell Electric Bus Commercialization Consortium

- Partnership with CTE, AC Transit, OCTA & New Flyer
- OCTA 10 fuel cell buses, facility modification and new station
- Bus price - $1.235 Million plus tax

OCBUS

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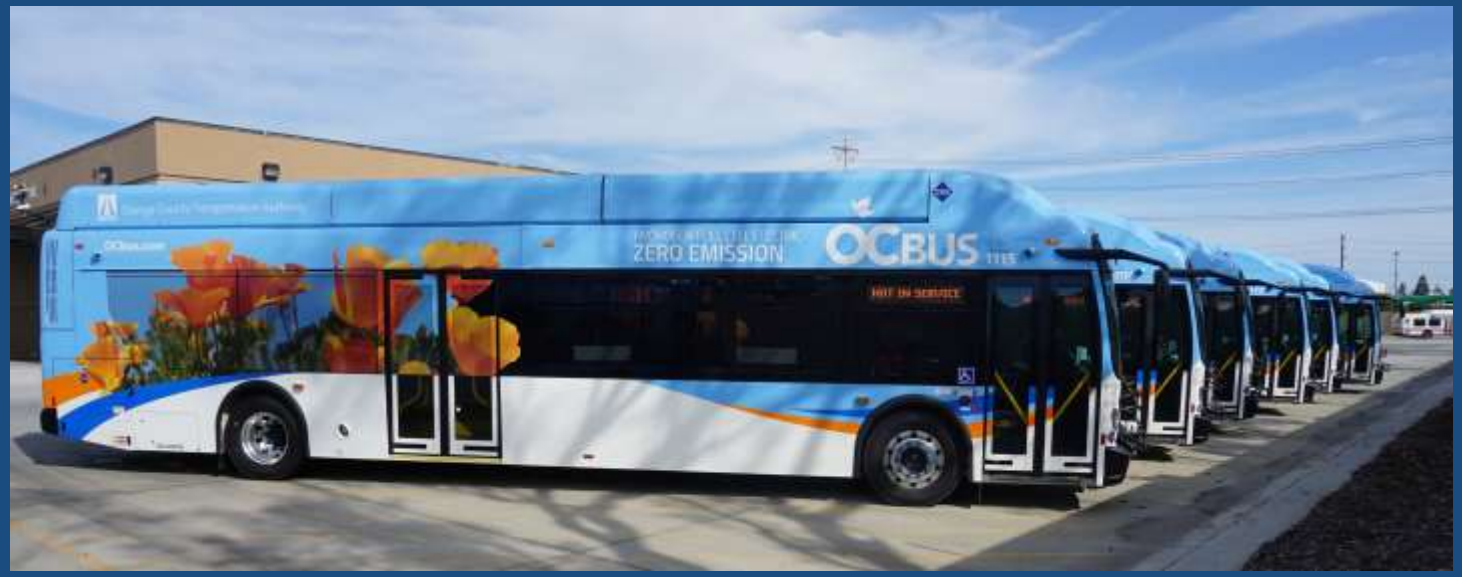
Hydrogen Powered Buses Overview



- 100 KW Battery Capacity
- 75 to 85 KW Fuel Cell
- High Torque Electric Motor. 210 KW / 986 Ft. Lb.
- 37.5 Kgr. H2 fuel on board
- Range per fill up has been tested to approximately 300 miles.

Hydrogen Station System Overview

- 18,000 gal, 4,536 kg liquid hydrogen tank capacity.
- Vacuum insulated tank maintains liquid hydrogen at -423°F.
- Target, on board pressure, is 350 BAR (~5,000 PSI)
- Fueling time 6-10 minutes

Operational/Technical Data

- Training
  - 640 Volt systems.
- Hydrogen is colorless and odorless - Detectors are needed
- Hydrogen flames are virtually invisible in daylight – Infrared detectors are needed
- Hydrogen Cost, $8.00 x Kgr.
- 1 Kgr of hydrogen has the same energy content as 1 gallon (3.2 kg) of gasoline. (DOE)
- Miles x Kgr , ~7 to 8

Technical Issues

- Control Systems: Coolant Temperature Across the FC
- Replacement of Traditional 300 Amp. Delco Alternator w/Vanner
  - DC to DC Converter low voltage output to batteries due to parasitic loads (HVAC, etc.) during high FC output demand.
- Pending Verification - Defroster heat too low (~118 F v/s ~165F).
- Traction motor leaking oil (1117).

Technical Issues (Cont.)

- Hydrogen fuel tank valves leaking (2 valves on 1112)
- Ending fueling pressures undergoing adjustments.
  - Temperature compensation – Fueling Station
- 75 to 85 KW Fuel Cell not rated for Express Service
  - E.g., FWY driving, 65 MPH sustained for long periods of time.
- 75 to 85 KW Fuel Cell sensitive to elevation gain. E.g., O.C to Riverside, CA

Operational Benefits

- Fueling Operation similar to LNG/CNG
- 6 Minutes Fuel Tank filled ups.
- After fueling (6-min.) bus can be taken to the shop for repairs
- 75 to 85 KW Fuel Cell performs well on “Stop n’ Go” traffic
  - OCTA Stops every ¼ mile
- Mileage Range can be extended by adding on board storage/Liquid H2/Higher fuel pressure.
- Does not need dedicated energy transfer points throughout the facilities.

Next Steps

- To continue service deployment of Hydrogen powered buses.
- Finalize H2 Fueling Station Commissioning.
- Acquire Zero-Emission Battery Powered Buses
- Evaluate Bus Performance
- Select Zero-Emission Compliance Path: 2023-2040

Thank you.

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