



**Power your fleet with US Hybrid's powertrain components
to provide cleaner, quieter, and lower cost operation**



www.ushybrid.com

www.magmotor.com

US Hybrid HQ: Torrance, CA

Year
Established

1999

Core
Competency

Electric Powertrain for
BEV, Hybrid and Fuel Cell
Heavy Duty Vehicles

US FuelCell Windsor, CT

Year
Established

2013

Core
Competency

Fuel Cell Power
Plant

Magmotor Corporation Worcester, MA

Year
Established

1876

(Acquired by US Hybrid in 2008)

Core
Competency

Servo Motors and Drives
Automation, Robotic and
Semiconductor Mfg.



Torrance, CA



Windsor, CT



Worcester, MA

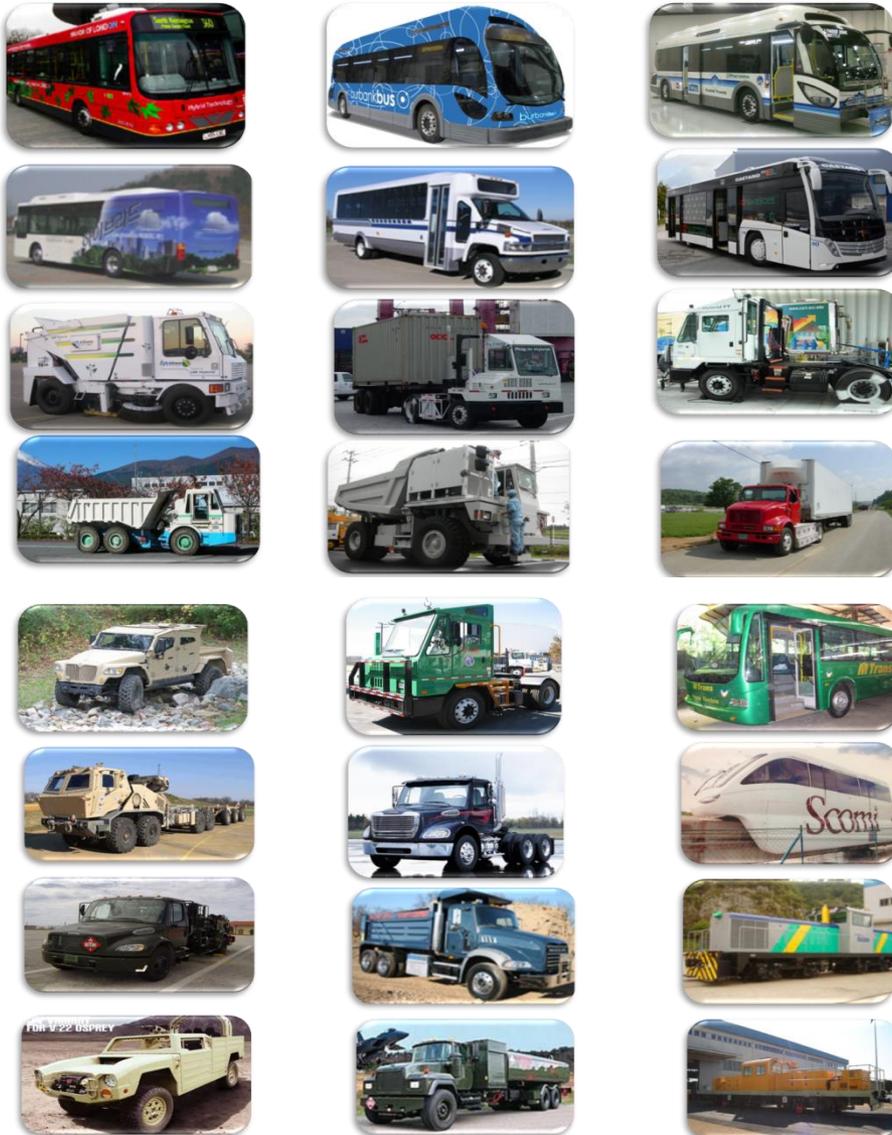


Torrance, CA

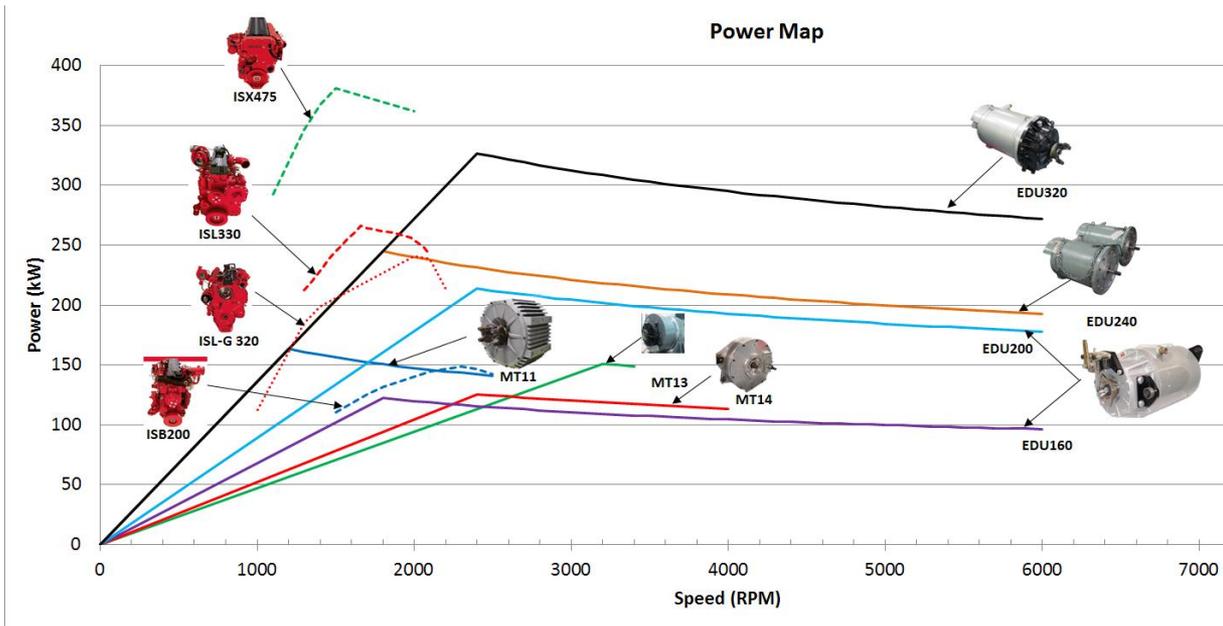


Honolulu, HI

US Hybrid's Business Focus is Heavy Duty Commercial Vehicles



Class	6	7	8
Category	Medium	Heavy	Heavy
Weight Range (GVWR)	19,501-26,000	26,001-33,000	>33,000
Examples	 Shuttle Bus  Bucket  Municipality Monorail Sao Palo Brazil KL Malaysia Mumbai, India	 Delivery  Constructions  Agriculture Mining	 Transit Bus  Drayage  Refuse 

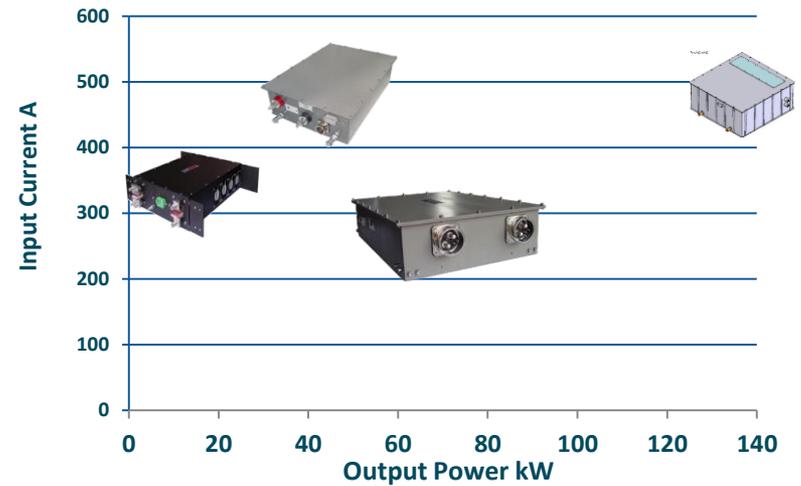
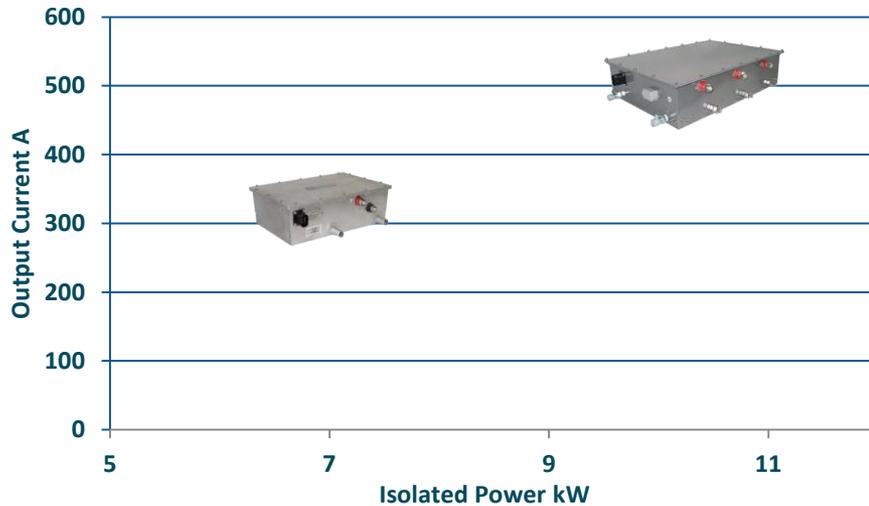


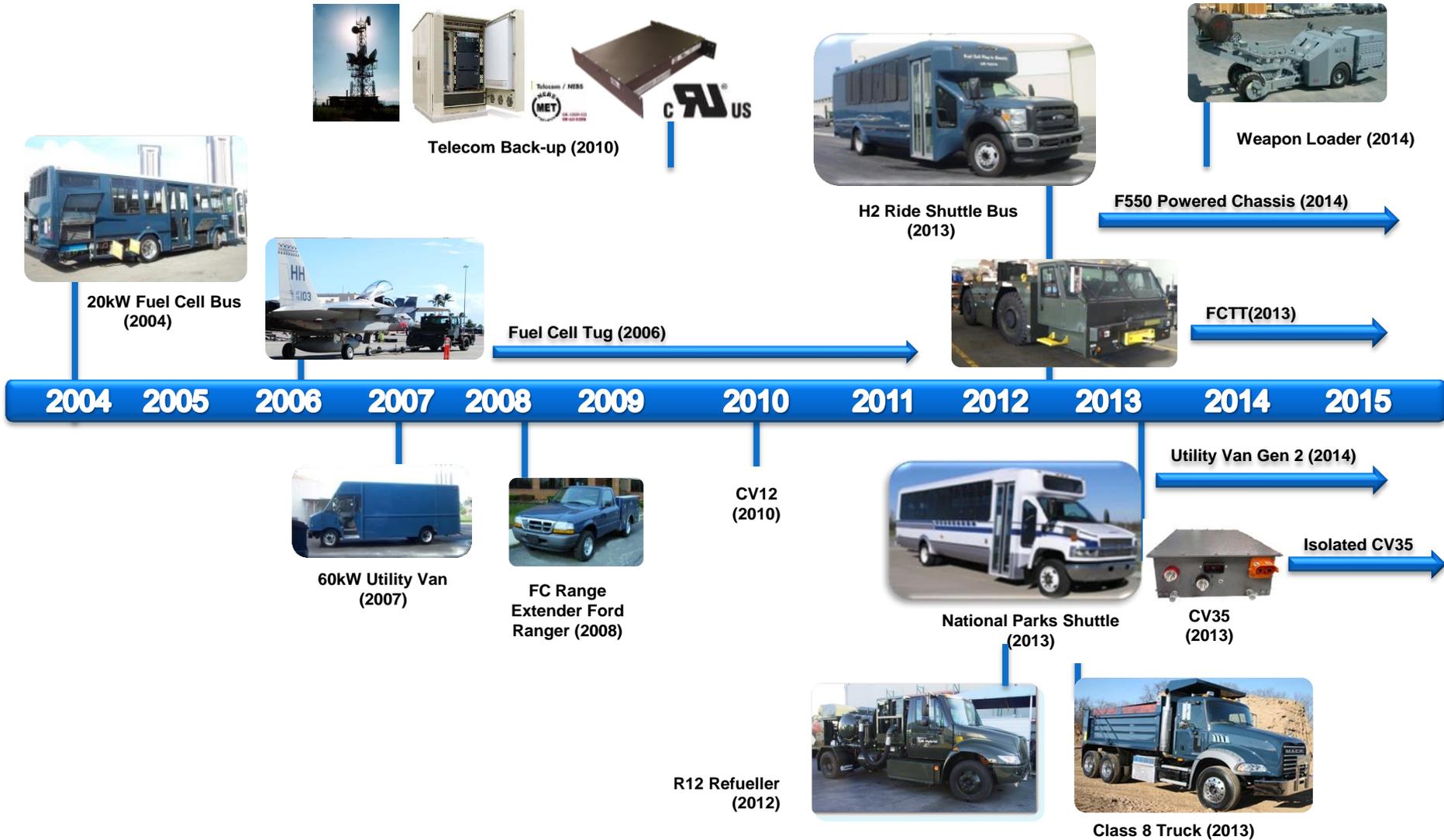
200kW

240kW

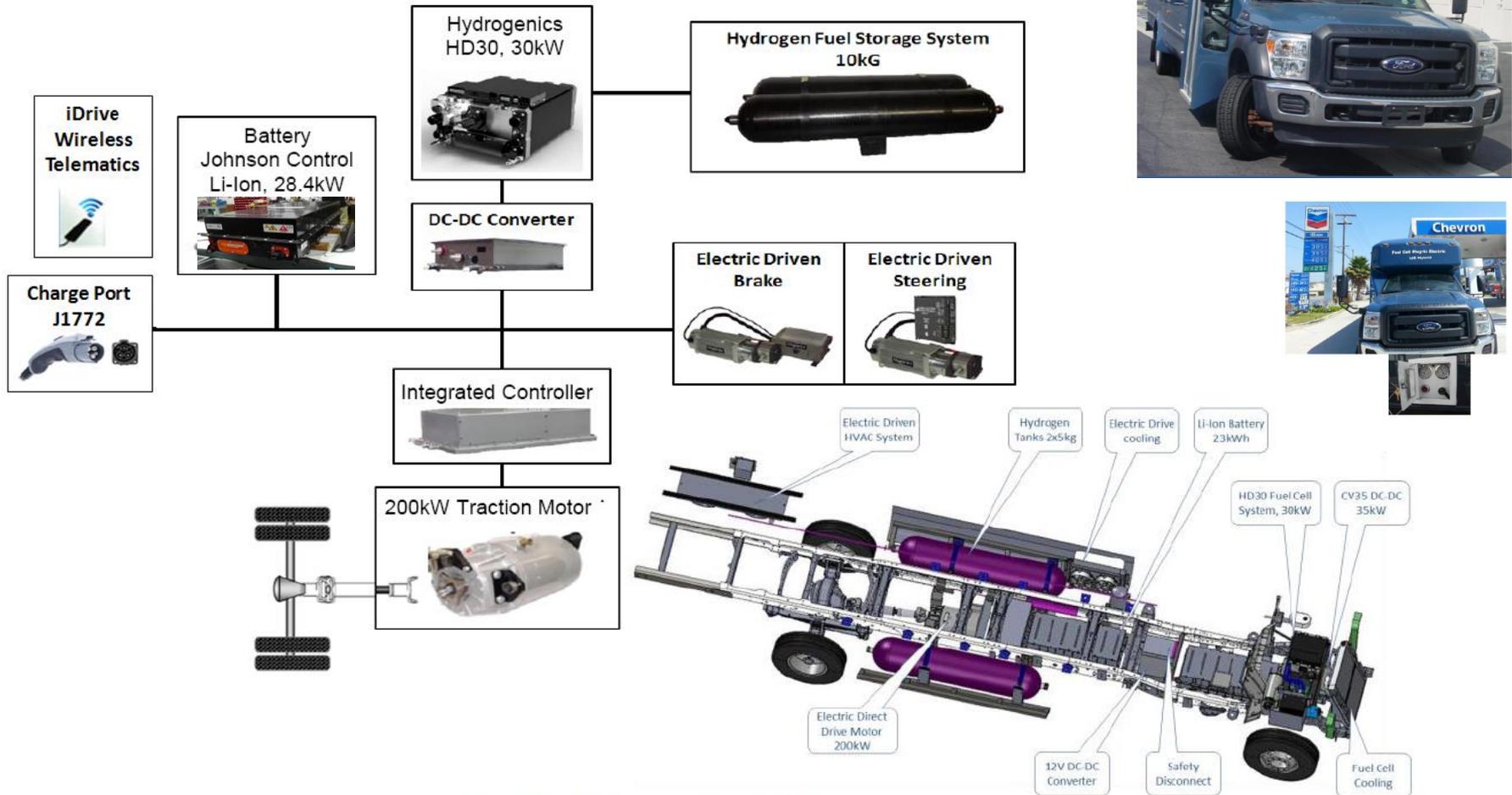
320kW

DC-DC Converters





Fuel Cell Plug-In Ford F-550 Powered Chassis 2014 Commercial Deployment



Fuel Cell Power Train Diagram

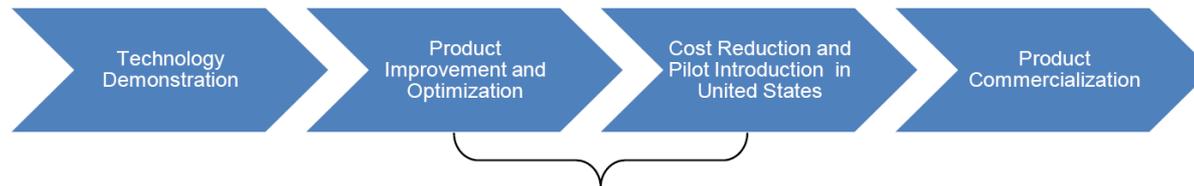
- **Diesel:** 37.1 kWh/gal, 15.16 kWh/kg, Engine Output: **4500 Wh/kg, 11kWh/gal**
- **Gasoline:** 32.9 kWh/gal, (11.8 kWh/Kg, Engine Output: **2800 Wh/kg**)
- **Hydrogen:** 39.7 kWh/kg,
(1kg H₂ =11 gal @5000 psi, or 11 gal @5000psi tank is same as 2 gal of diesel fuel)
Total Energy Density (Electric output power) per kg: **15,000 Wh/kg**
- **Mixed Fuels:**
 - Ethanol(E100) = 22.1 kWh/gal,
 - (M85) 85% Methanol, 15% Gasoline = 18.6 kWh/gal
- **Energy Storage Devices have much lower energy density:**
 - Ultra Capacitors 0.004 kWh/kg,
 - Lead Acid 0.025 kWh/Kg
 - NiMh 0.06 kWh/Kg
 - Li-Ion 0.11 kWh/Kg

1 Gallon of Diesel fuel has same net energy as 100 Kg of Li type Battery at 100% SOC

1kg of H₂ (7miles/kg) > 2-Gallons Diesel (3.8mpg)

US Hybrid has established *US FuelCell* division to support fuel cell transit bus commercialization

- US Hybrid has established the facility at former UTCPower plant
- Purchased the necessary development, testing and production equipment to complete the FTA project.
- Has established a development, test, validation and production team at Windsor, CT facility.

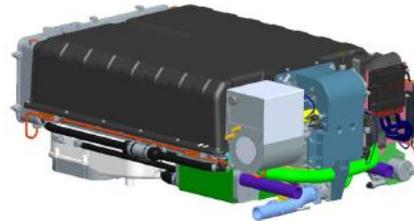


Task #	Task Description
1	FCPP Development
2	Advanced American Fuel Cell Bus Development
3	FCPS Development
4	Advanced CSA Development
5	Advanced American Fuel Cell Bus Procurement & Operation
6	Accelerated Operation

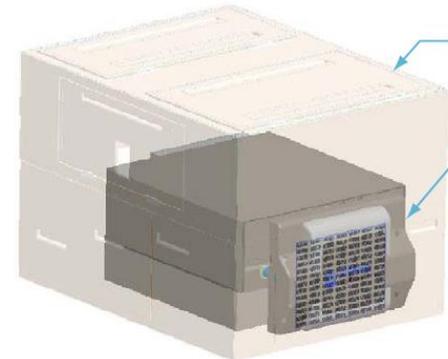
- PureMotion 120kW FC power plant is the most robust fuel cell for transit applications with millions of miles logged.
- Generation2 130kW Fuel Cell Power plant has the following advantages:



PC40

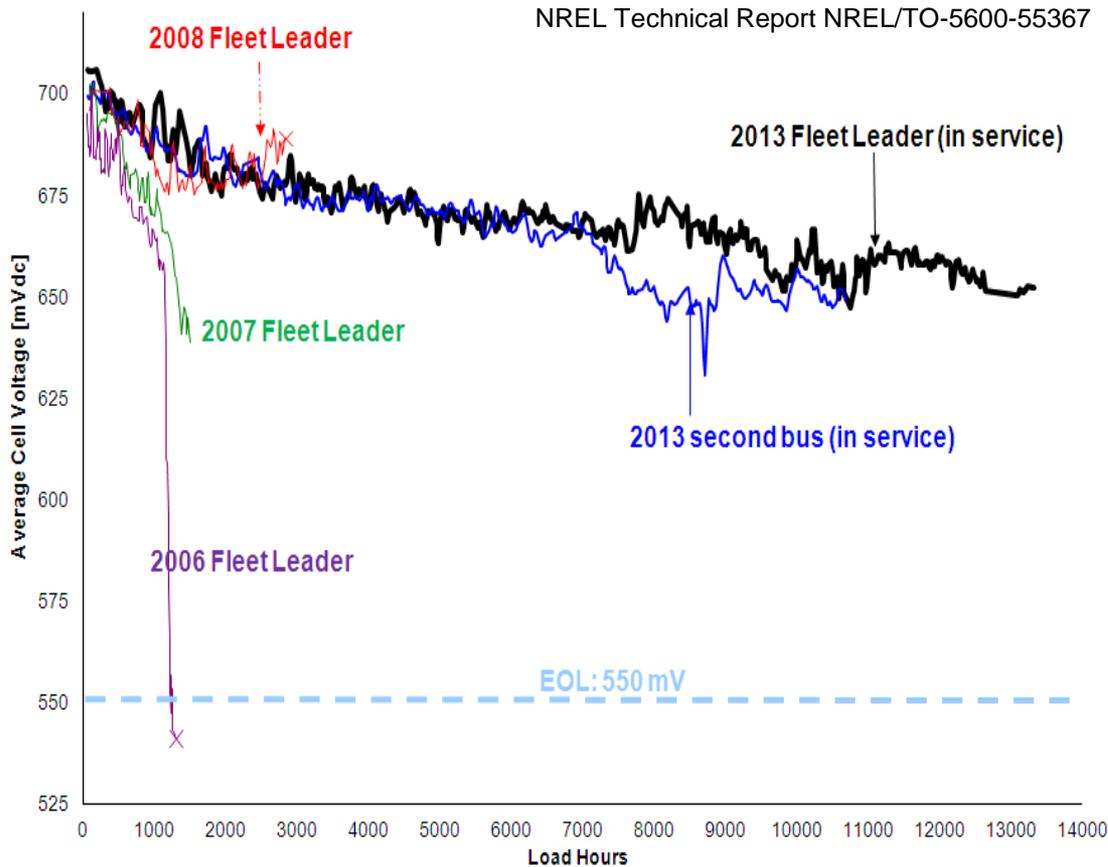


PC58



Requirement	PC40	FTA Requirements	PC58 NFCBP Status
Net Power (kW)	120	120	130
Durability (k hrs)	8 ⁽¹⁾	9.6 -12	12 – 16
F CPP Cost	\$X	60% to 75% of X	73% of X
F CPP Size (m3)	1.8	0.87 -1.22	0.57
Weight (kg)	840	420 - 588	530

(1) Demonstrated durability at time FTA proposal submittal



FCEB and Diesel Bus Comparative Availability

Category	FCEB # Days	%	Diesel # Days	%
Planned work days	1,943		631	
Days Available	1,087	56	498	79
Unavailable	856	100	133	100
Fuel cell propulsion	99	12		
Hybrid propulsion	30	3		
Traction battery issues	160	19		
Bus maintenance	557	65	133	100
Fueling unavailable	10	1		
Maintenance Cost \$/Mile	\$1.30	100%	\$0.79	60%

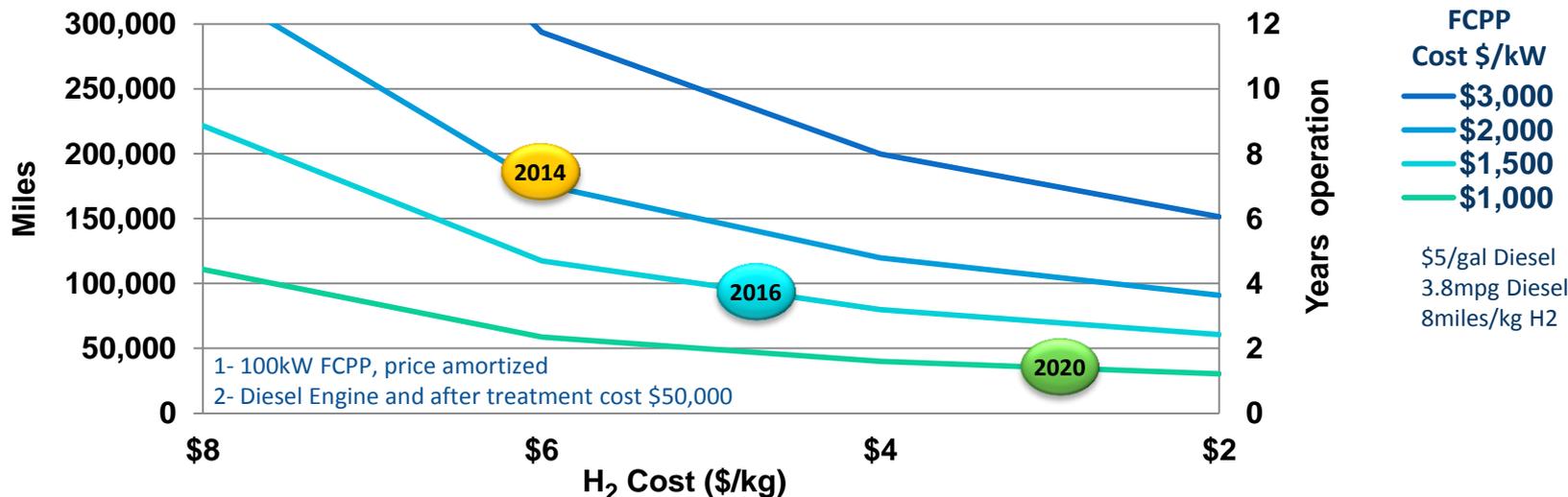
Comments: Most cost is due to learning curve
 Bus Maintenance and Battery are major items
 Fuel Cell Technician labor rate is higher than Diesel

Table 9. Maintenance Cost per Mile by System (Evaluation Period)

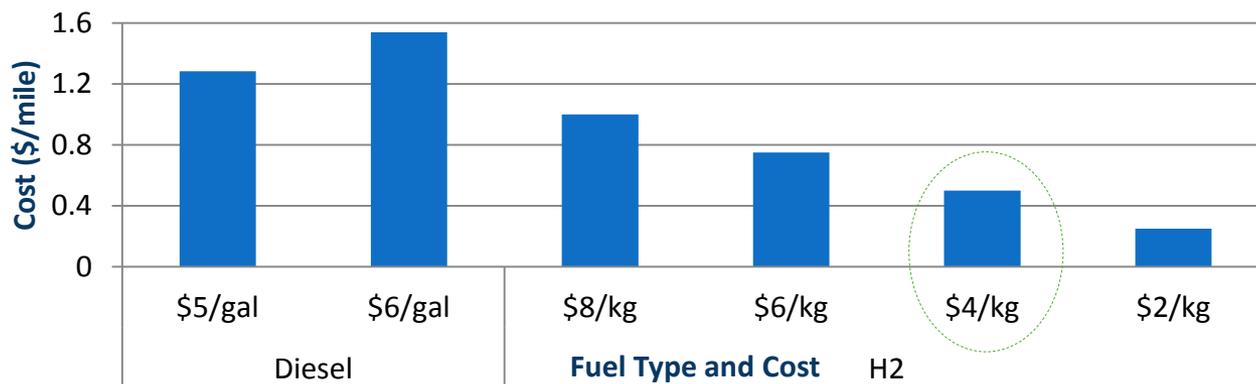
System	FCEB		Diesel	
	Cost per Mile (\$)	Percent of Total (%)	Cost per Mile (\$)	Percent of Total (%)
Cab, body, and accessories	0.56	42	0.26	33
Propulsion-related	0.39	30	0.22	28
PMI	0.23	17	0.09	11
Brakes	0.01	1	0.14	18
Frame, steering, and suspension	0.04	3	0.01	1
HVAC	0.01	1	0.03	4
Lighting	0.01	1	0.00	0
Air, general	0.05	4	0.03	4
Axles, wheels, and drive shaft	0.01	1	0.01	1
Tires	0.00	0	0.00	0
Total	1.31	100	0.79	100

Fuel cell power plants can provide better or comparable reliability and maintenance costs to Diesel engines with after-treatment.

Total cost of ownership FCPP Cost (\$/kW) vs. H₂ Price (\$/kg)



Operation Fuel Cost \$/Mile for various H₂ and Diesel pricing



Fuel Cell Power Plant (Fully Integrated) Transit Bus Commercial Viability and ROI

	Q3-2014	2016	2020
Price (\$/kW)	\$2,000	\$1,500	\$1,000
Quantities	10	100	250
Warranty ①	1 year	2 year	5 year
Extended Warranty ②	4 Years	5 Years	10 Years
Design Life ③	5 year	8 year	12 year

1kg of H2 => 2-Gallons Diesel

① Estimated operation at 4000 hr./year

② Extended Warranty price (\$/mile) comparable to Transit Industry

③ Design Life include scheduled Preventive Maintenance and FCPP rebuild.