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Sr. Product Manager



UTC Power

A United Technologies Company

United Technologies Corporation



UTC
Fire & Security



Pratt & Whitney



Carrier



Otis



Sikorsky



Hamilton Sundstrand



Research Center



UTC Power

\$42.7 B annual revenue

Transportation Fuel Cell Experience

Automotive



Public transportation



FUEL CELL BUS BENEFITS

- Air quality
- CO₂ emission reductions
- Low noise
- Energy security
- Lower operating costs
- Exportable power



Replacing a fleet of 4000 diesel buses with fuel cell hybrids buses avoids...

CO ₂		NO _x + NMHC		PM	
Tons	acres	tons	# cars	tons	# cars
492,000	378,000	5,900	308,000	70	51,000

Notes: On an annual basis. Using Fleet of 4000 buses and 50,000 miles per bus per year. Diesel emission data based on that reported in DART's LNG Bus Fleet Final Results (produced for D.O.E. by N.R.E.L., in October 2000). Each car is assumed to emit 38 lbm/year of NO_x [EPA]. Each car is assumed to emit 0.06 g/mile of PM per year [EPA]. "Nox" above includes NO_x, NMOG/NMOC's and CH₄ emissions... all ozone precursors. Ave. car assumed to run 21,000 mi/yr.

Prior Bus Learnings



2005

2004

EMT Madrid, ATM Torino

12 m Irisbus

60 kW S300 PEM

Hydrogen

FC/battery hybrid

2002

California transit agencies

9 m Thor "Thunder Power" Bus

60 kW S300 PEM

Hydrogen

FC/battery hybrid

1998

Georgetown University

12 m NOVA Bus

100 kW Phosphoric Acid

Methanol

FC/battery hybrid



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Advanced Fuel Cell Bus Program

- Hybrid electric configuration
- High efficiency (2-3x diesel bus)
- Near-ambient pressure fuel cell system
- Regenerative braking
- Quiet operation
- >480 km range
- Zero emissions



Advanced Fuel Cell Bus Configuration



**Electric
drive motor**



Batteries



Hydrogen tanks



**PureMotion™ 120
Fuel Cell Power System**



Inverter

**Auxiliaries
(lights, HVAC,
etc.)**

ISE ThunderVolt® Fuel Cell Hybrid Drive System

Photo credit VanHool, Dynetek, ISE



UTC Power

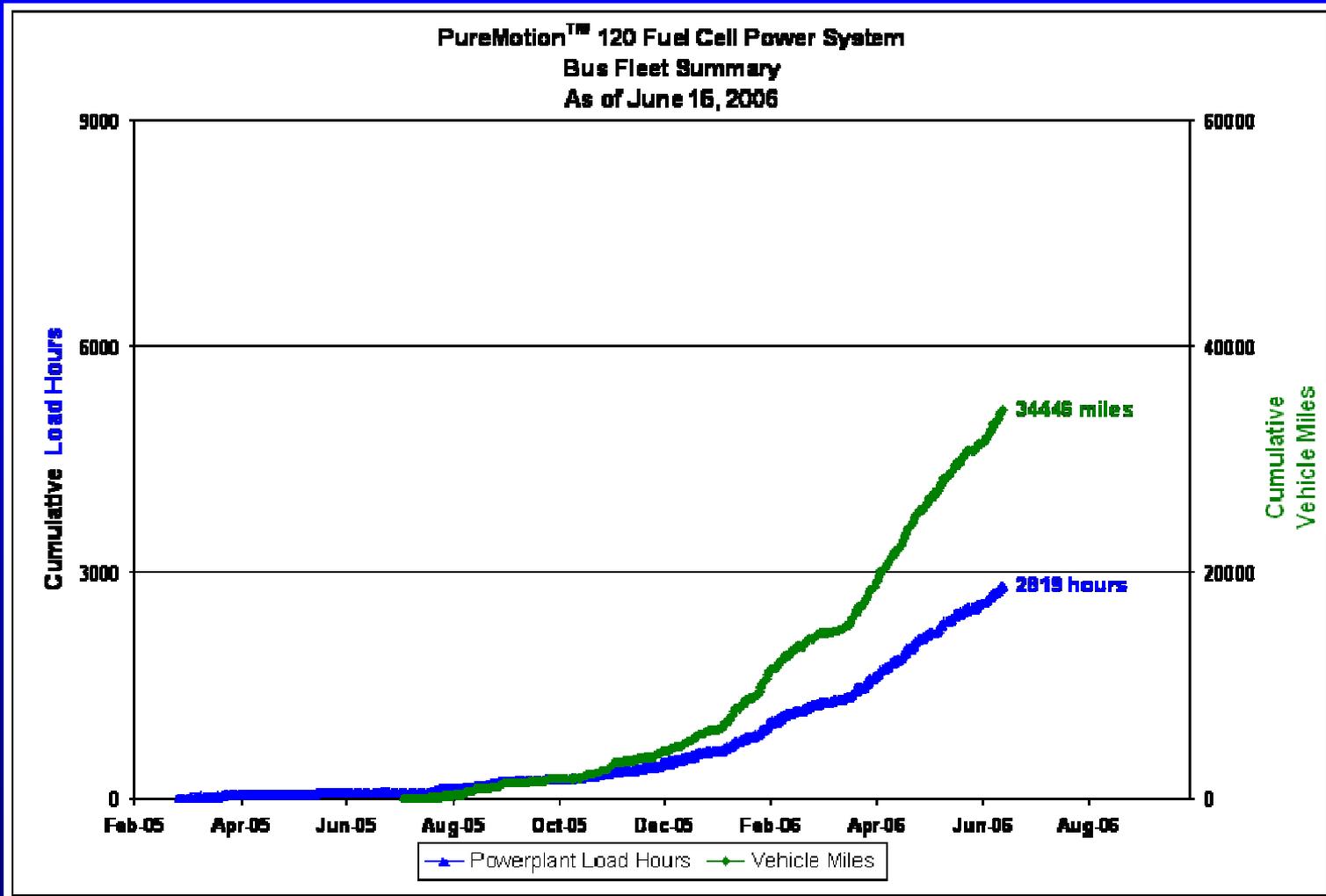
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PureMotion™ 120 Fuel Cell System

- 120 kW
- Compressor-free design
- Modular
- Self-contained
- Simplified interfaces
- Ease of maintenance
- Durable



PureMotion™ 120 Fuel Cell System Fleet Status

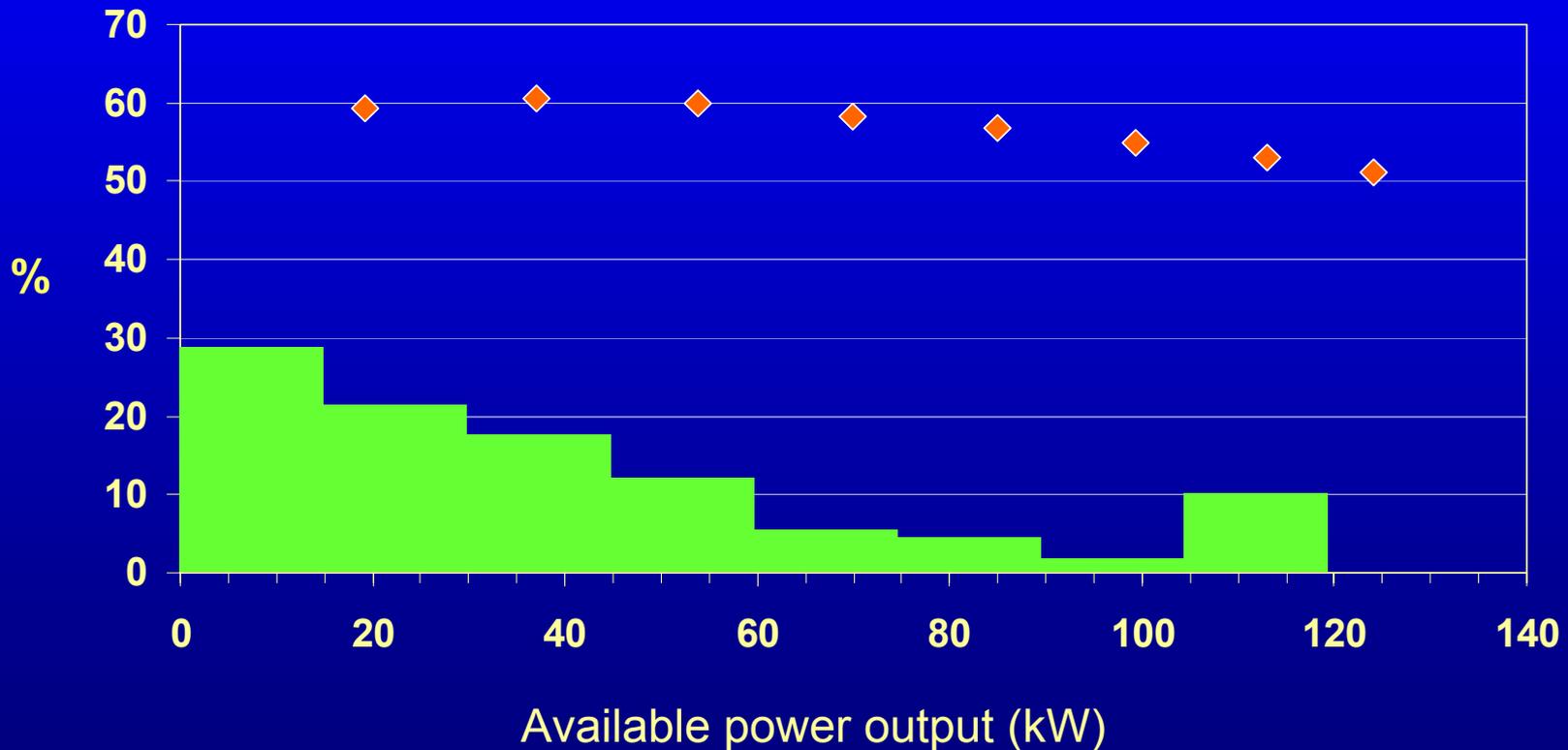


PureMotion™ 120 Fuel Cell System

Efficiency

power plant net efficiency (%)

frequency of power demand while in service (%)



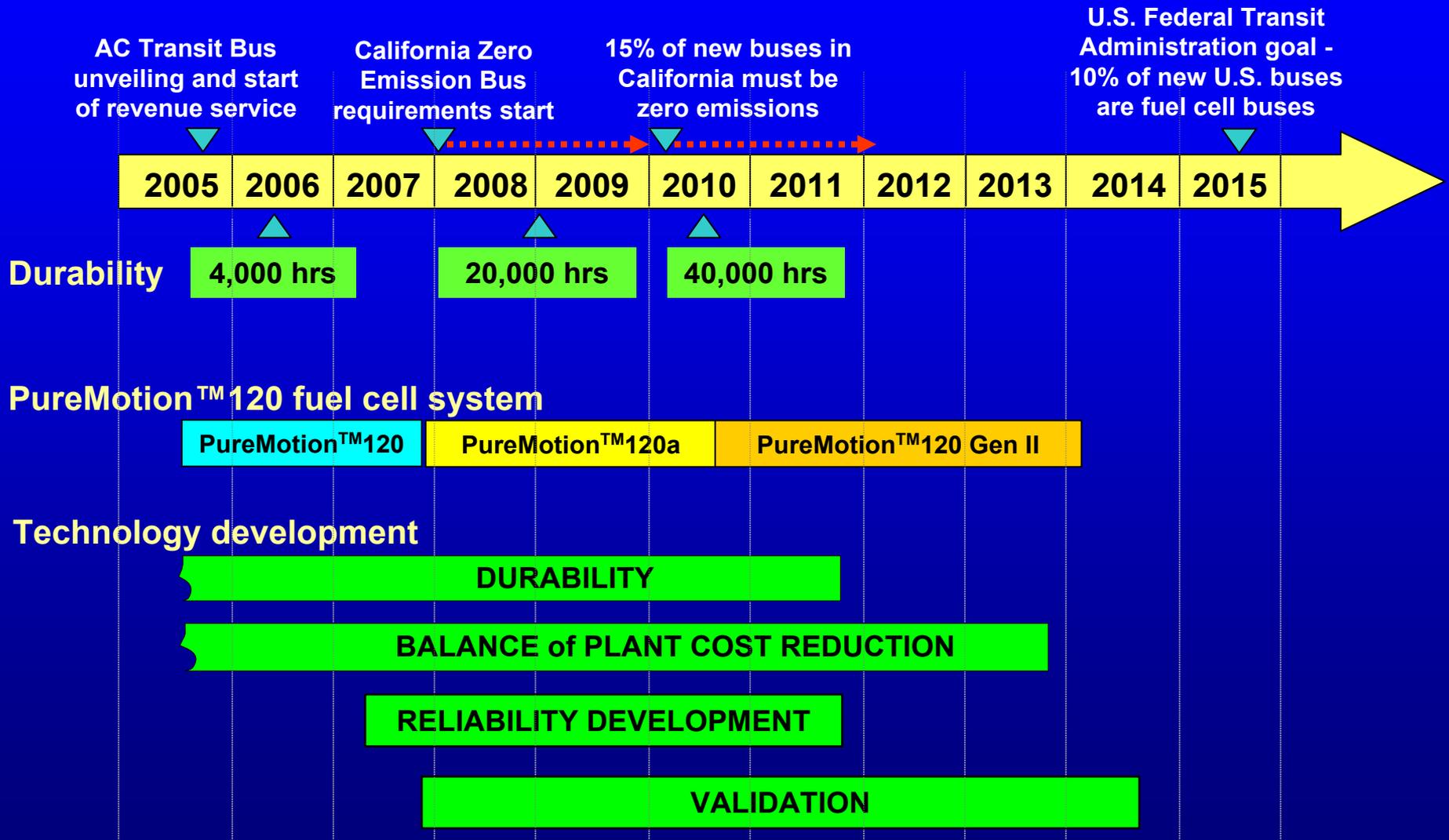
Transit Bus Comparison



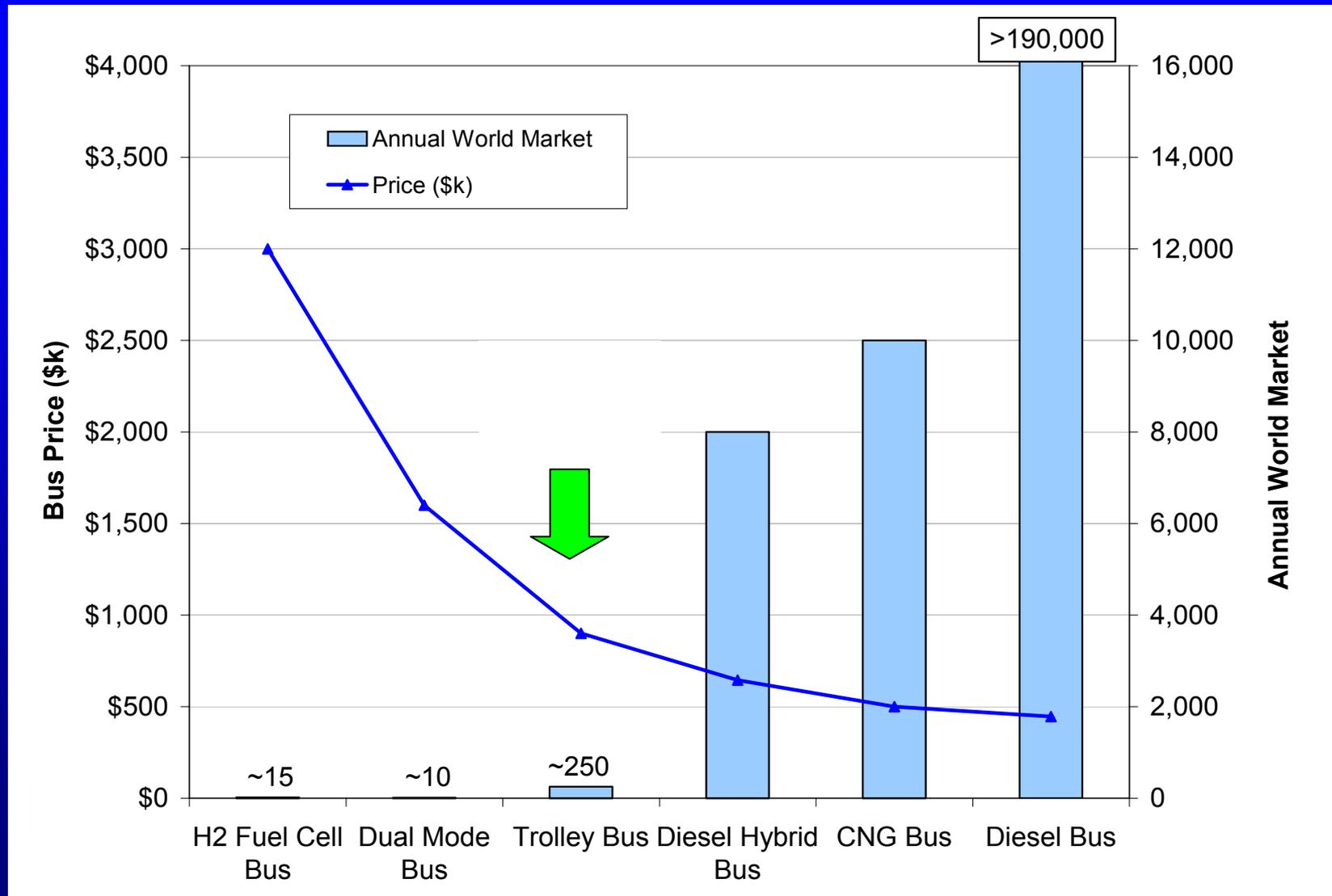
PARAMETER	VanHool A330 fuel cell bus *	Diesel bus
Acceleration (sec to 48 km/h)	15	20
Acceleration (sec to 80 km/h)	36	31
Weight (kg)	16,300	13,140
Interior noise (dB stopped)	56	72
Interior noise (dB @ 80 km/h)	69	78
Fuel consumption (kg/100 km)	8.2	16.9

* Preliminary Data from AC Transit/Sunline Transit *

Bus/Fleet Technology Roadmap



BUS/FLEET MARKETS



ZERO EMISSION COMMERCIAL BUS FLEETS

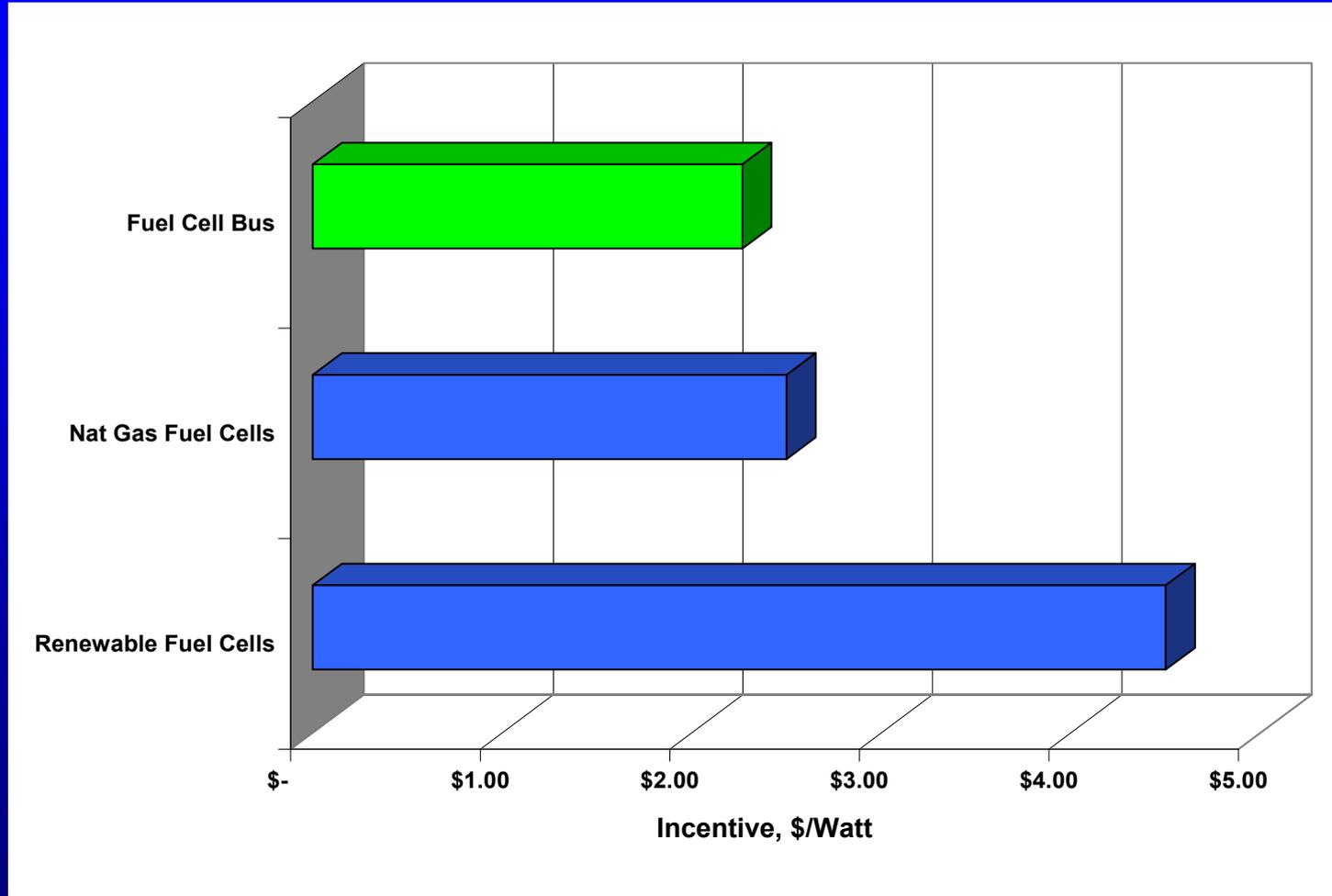
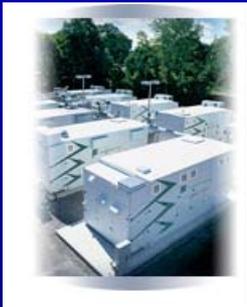
- Zero emission fuel cell hybrid buses lower operational life cycle costs
 - Efficiency = lower fuel costs
 - Fewer parts = lower maintenance costs
- Commercial business case with competitive capital cost
- Zero emission standards needed to drive larger orders resulting in lower capital cost



Aggregate orders will drive capital cost to competitive levels

100 + buses will drive bus cost to \$1M

COMPARISON OF CALIFORNIA INCENTIVES



SUMMARY

- The PureMotion™ 120 fuel cell system is on the road to commercialization
- We are leveraging our stationary fuel cell durability expertise
- ZEB rule:
 - 40 foot transit buses
 - Specify operating time and hours
 - Zero NO_x
- Aggregate bus orders
- Incentives

