

Heavy Duty Vehicles

Transit Demonstrations

by:

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Technology Demonstration

Current Projects

- Advanced Technology Fuel Cell Bus developed by ISE for Sunline Transit Authority
- Battery Electric Bus developed by ISE for LAMTA

Advanced Technology Fuel Cell Bus

Leading the way to cleaner air



Advanced Technology Fuel Cell Bus

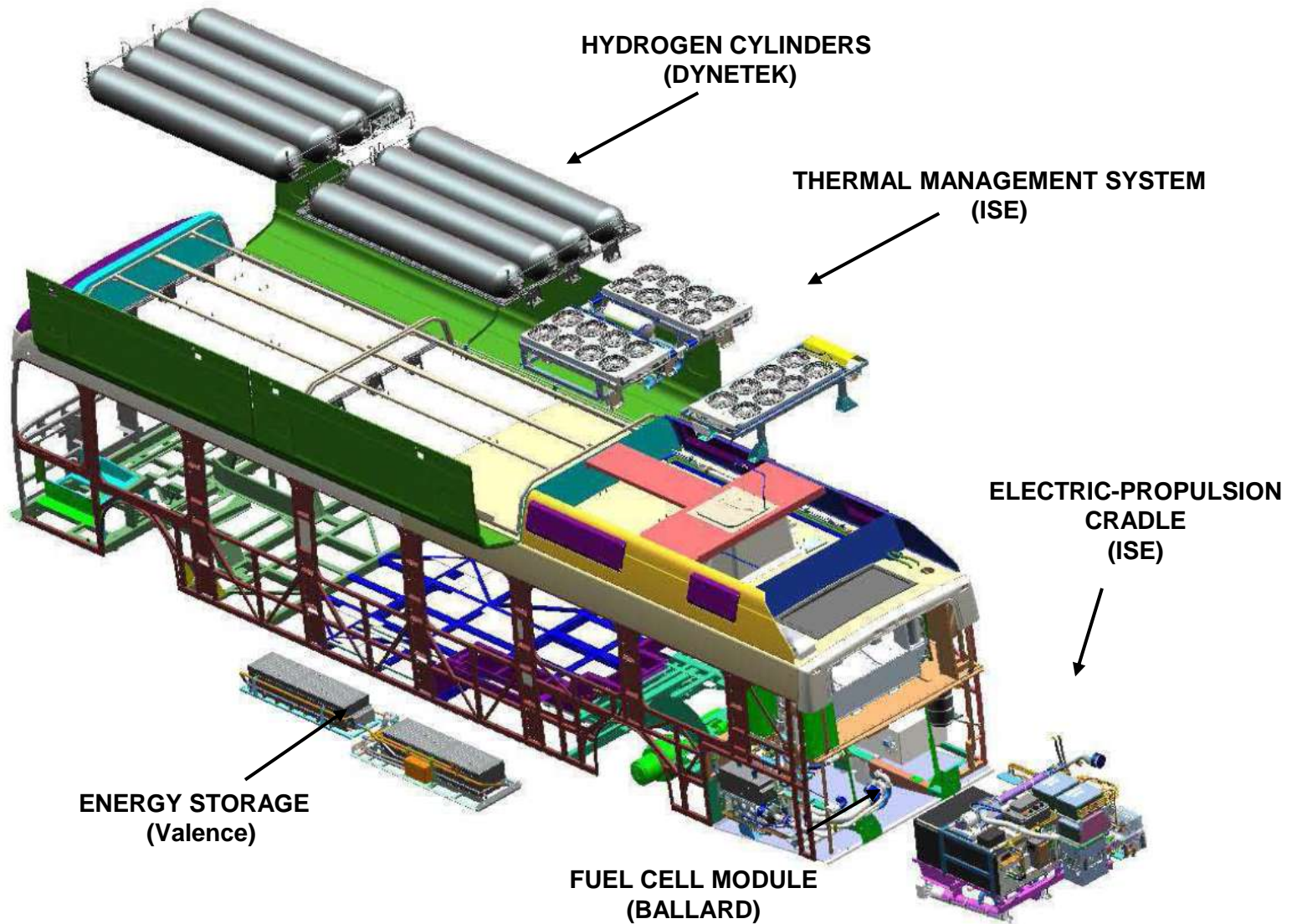
Features:

- Bus - New Flyer Industries
 - A low floor 41' – 37 passenger bus
- Drive System - ISE Corporation
 - “ThunderVolt” system with Siemens drive motors
- Fuel Cell - Ballard Power Systems
 - “HD6” 150 kW heavy duty fuel cell module
- Hydrogen storage - Dynetek
 - “DyneCell” Type 3, 5000 psi (350 bar) tanks
- Battery – Valance
 - 35 kWhr Lithium battery pack

Status:

- Final testing in progress and delivery to Sunline - 4th quarter 2009

System Modules



Ballard HD6 Fuel Cell

- Output Power 150 kW
- 6000 Durability Lifecycles
- Operating temperature -20 to 70 C
- Specific Power 422 W/kg



Performance Test Results

- Average fuel economy of 7 mi/kg
- Range over 310 miles
- Top Speed: 65 mph
- Acceleration: 0 – 30 mph in 18 seconds at Full Seated Load
- Maintains 20 mph and above on 8% grade climb at Full Seated Load
- Low Exterior Noise Levels: 76 dBA and below

Cost Share

- AQMD allocated \$2.1 Million for hydrogen and fuel cell technologies
- Allotment represents 13% of \$16.6 Million budget for 2009 and beyond

Advanced Technology Fuel Cell Bus Project

	Amount	Percent
AQMD	\$325,000	26%
Partners	\$950,000	74%
Total	\$1.275 M	100%

Battery Electric Bus Project

Features:

- North American Bus Industries (NABI)
 - A 40' Bus Chassis, MGW 43,420 lbs
- ISE electric drive system
 - With Siemens drive motors and other driveline components
- Lithium Battery
 - 150 mile range

Status:

- Battery, Management System, Software and packaging development continue

ISE Battery Bus



Battery Selection Criteria

- Safety – SAE J2464 EV Battery Abuse Testing
- Energy storage > 100 Wh/kg
- Pack size = 320 kWh for 150 mile range
- Reliability – uniform cell performance
- Cycle life > 6000 cycles
- Price $< \$1000/\text{kWh}$
- Availability

Battery Testing



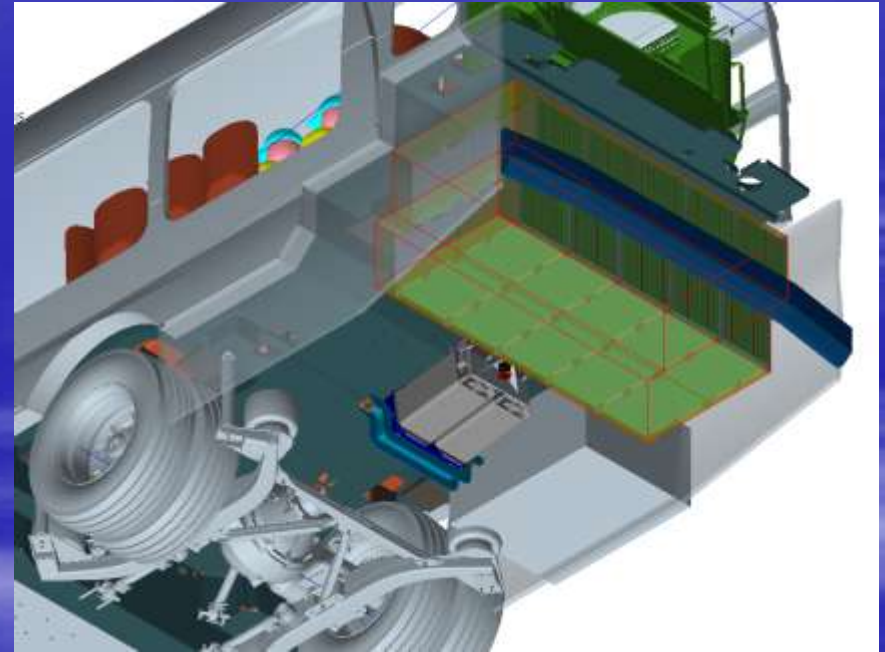
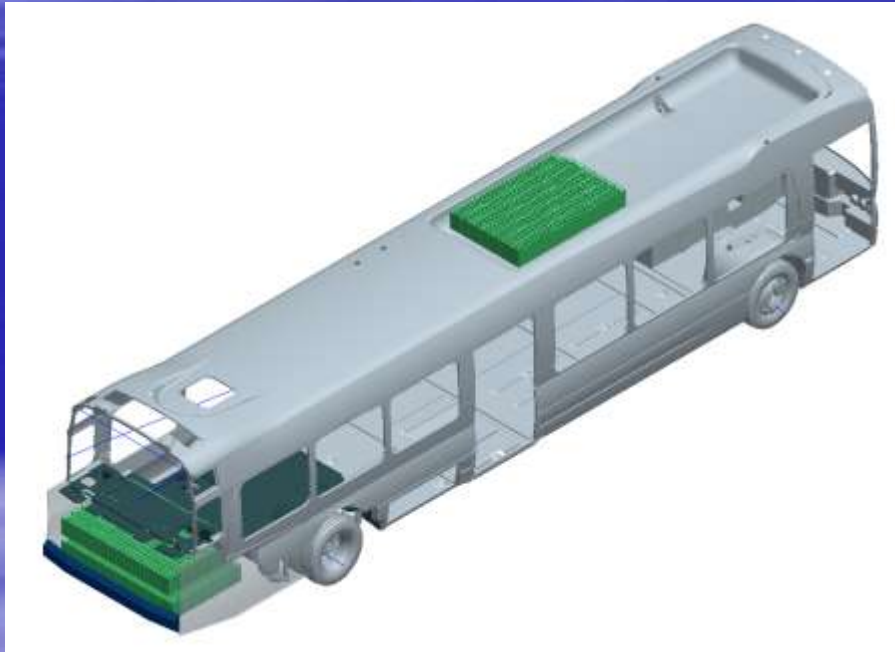
Battery Choices

- Lithium Titanate – lower energy density, high charge rates
- Lithium Phosphate – higher energy density, lower cost
- Lithium Ion – safety concerns, cooling capability, lower life cycles
- Lithium Manganese – much higher energy density, large scale cells, higher cost

Battery of Choice: Lithium Manganese

- Energy Density ~ 100 Wh/kg
- Life Cycles > 8000
- Pack = 320 kWh
- Cost > \$1200/kWh

Packaging Study



Cost Share

- AQMD allocated \$3.4 Million for Electric/Hybrid technologies
- Allotment represents 20% of \$16.6 Million budget for 2009 and beyond

Battery Electric Bus Project

	AMOUNT	PERCENT
AQMD	\$290,000	13%
Partners	\$1.995 M	87%
TOTAL	\$2.285 M	100%

Questions

