



Transportation recharged.™

HYBRID-ELECTRIC DRIVE SYSTEMS FOR HEAVY DUTY VEHICLES

March 2008

ISE Corporation
12302 Kerran Street
Poway, CA 92064

Mission:

To Develop, Provide, and Service Robust Hybrid-Electric Drive Systems for Market Segments where ISE can be the Recognized Leader

- ❖ ISE designs, develops, and supplies hybrid drive systems optimized to maximize the benefits for its customers

- ❖ ISE designs, develops, and supplies components for hybrid drive systems
 - One-Stop-Shop for heavy duty electric and hybrid drive system components
 - Develop and supply hybrid system components and subassemblies to vehicle OEMs for ISE and non-ISE designed systems

- ❖ Partner in vehicle service and support
 - Provide replacement components for in service vehicles
 - Provide maintenance support of hybrid vehicles at operator sites





ISE HYBRIDS CAN BE OPTIMIZED FOR MANY APPLICATIONS

Transit Buses



LBT Gasoline-Hybrid Bus



Opus Diesel-Hybrid Bus



Natural Gas-Hybrid Bus



SunLine Transit Fuel Cell Bus

Adjacent Markets

Short-Haul, Heavy Duty Commercial Vehicles



Kenworth Hybrid Electric Truck



SunLine Transit UCR Truck



Peterbilt Hybrid Electric Truck



Hybrid Refuse Truck

Specialized Military Vehicles



US Army FMTV Diesel-Hybrid Truck



25K Fuel Cell Aircraft Loader



US Army FMTV-HIMARS Variant Diesel-Hybrid Truck



USAF Hybrid Tow Tractor

Other Commercial Vehicles



MTA Flint Diesel-Hybrid Minibus



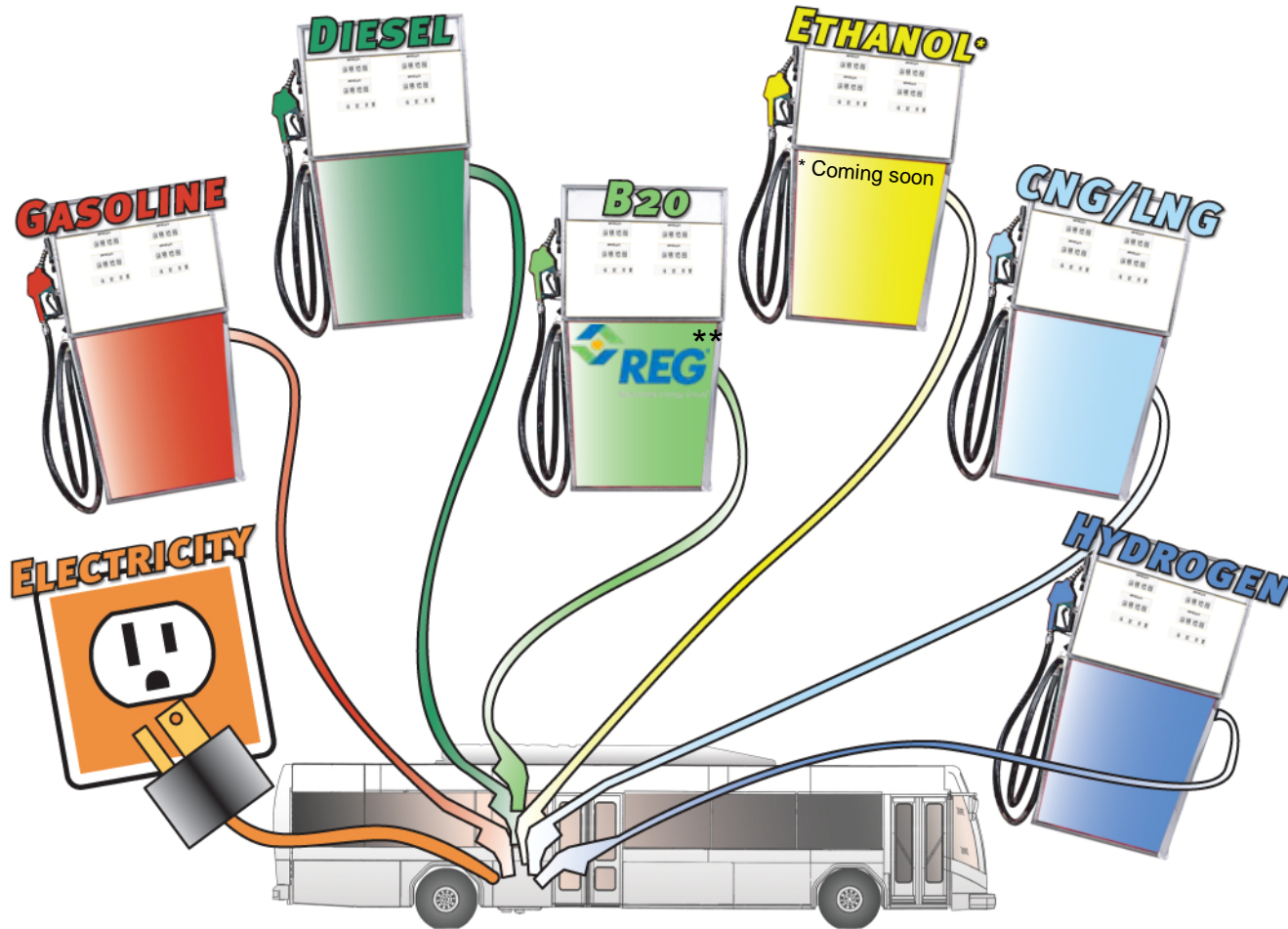
School Bus



Delivery Trucks



United Airlines Tow Tractor



ISE THUNDERVOLT® HYBRID DRIVE SYSTEM

** ISE/REG co-marketing agreement offering Biodiesel to ISE customers direct from the manufacturer

Gasoline Hybrid Bus



Diesel Hybrid Bus



Hydrogen Hybrid Bus



Hydrogen Fuel Cell Bus



- The only commercially available gasoline hybrid-electric drive for large transit buses
- ISE Gasoline Hybrid-Electric Drive System Advantages:
 - NOx emissions are virtually non-existent
 - Fuel economy is competitive with conventional diesel and superior to CNG
 - Reduced maintenance – brake life has exceeded 150,000 miles and projected at 300,000 miles
- California ARB certified as a qualified “alternative fuel”
- Over 300 firm & option orders with over 200 buses in commercial service
- Ethanol (E85) variant coming soon

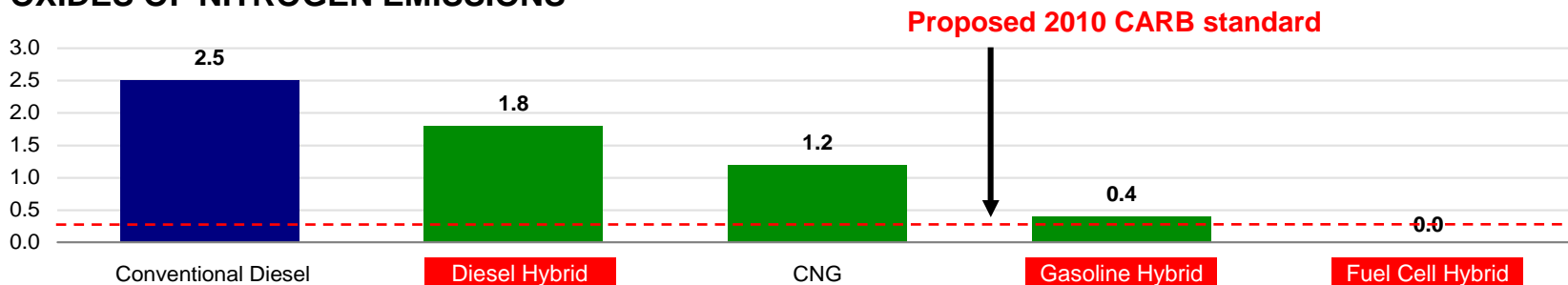




CARB CONFIRMS ISE HYBRID'S LOW EMISSIONS

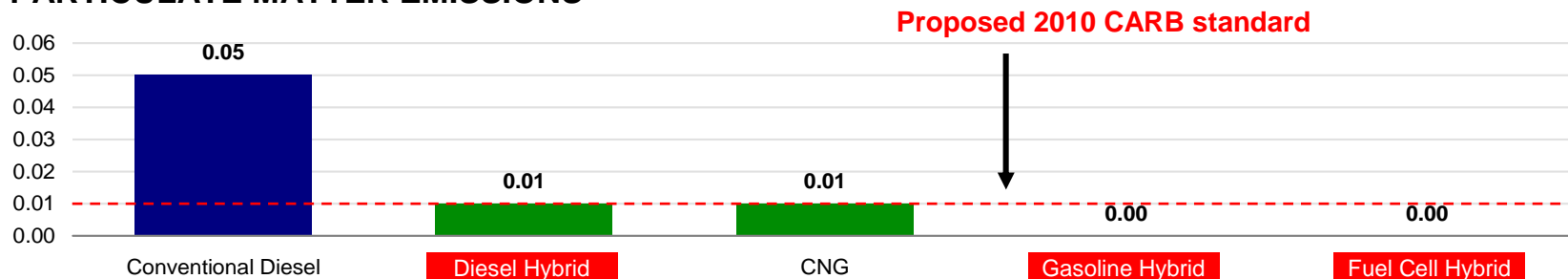
(grams/hp-hr)

OXIDES OF NITROGEN EMISSIONS



(grams/hp-hr)

PARTICULATE MATTER EMISSIONS

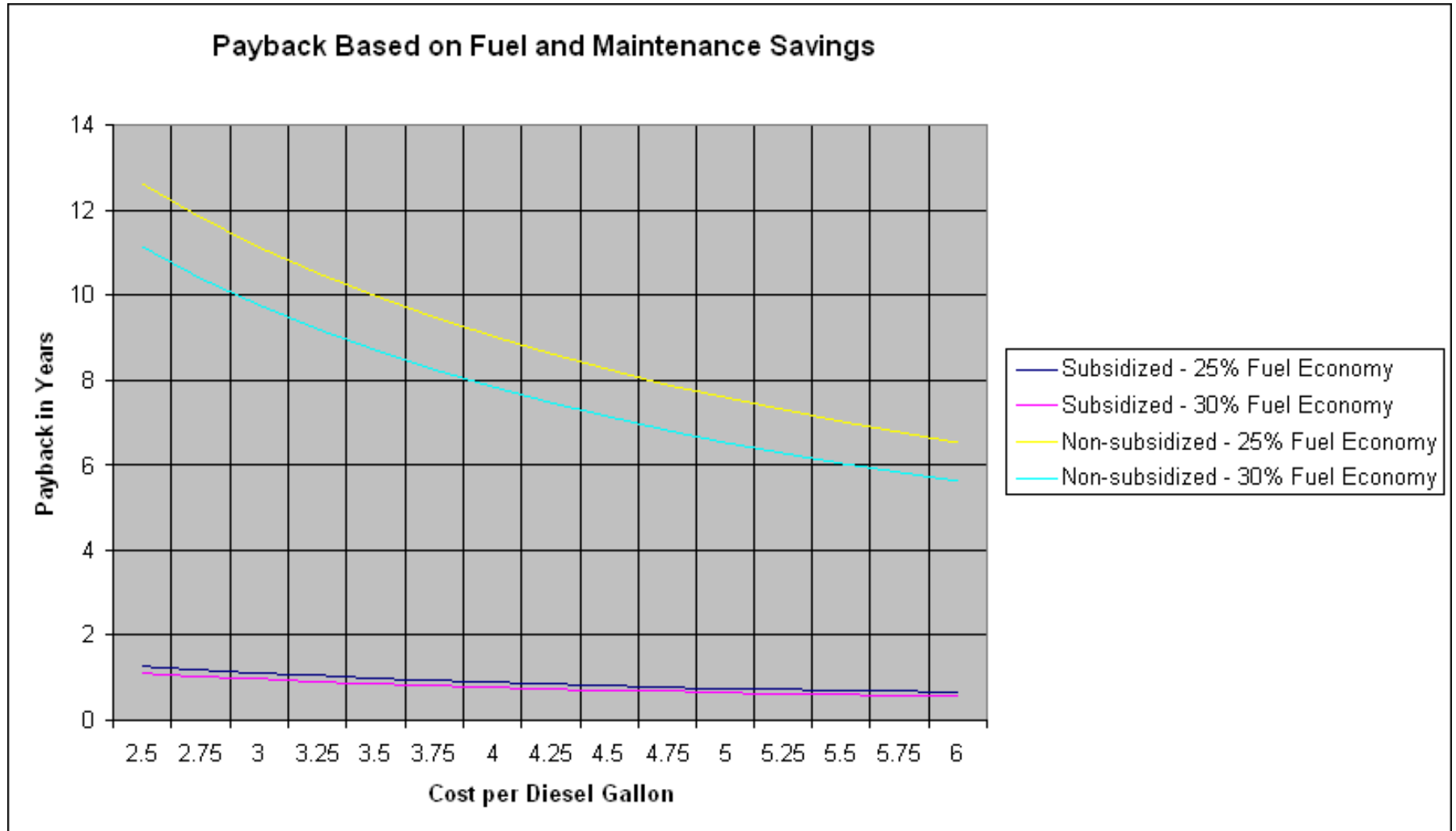


Source: California Air Resources Board (CARB) data.

 Denotes products manufactured by ISE.



Transit Payback Analysis for Gasoline Hybrid



- ❖ ISE Diesel Hybrid-Electric Drive System Advantages:
 - Uses Cummins 5.9 liter ISB 260H with standard ISE hybrid system
 - Significantly greater fuel economy improvement (21% vs. 13% for Allison over 17 mph average speed)
 - Reduced NOx emissions at least 25% better than the engine alone

- ❖ Several critically important features unique to ISE systems:
 - Electrically-driven power steering, braking and air conditioning accessories
 - An advanced control system featuring an automatic engine start/stop algorithm
 - Advanced energy storage



- ❖ New ISE Hybrid Electric System
 - Cummins ISL 330 Hp engine mated to 260 kW permanent magnet generator
 - New 260 kW Siemens permanent magnet motor with 4500 Nm torque
 - No gears required
- ❖ Base order of 50 diesel-hybrid buses, and options for 100 additional buses
 - 60' articulated hybrid Wrightbus Streetcar - A bullet train on rubber tires
 - Designed for BRT operation
 - High profile operating route on Las Vegas strip
 - Deliveries in 2007 and 2008



Hydrogen (“HHICE”)

- ❖ First commercially-viable near-zero emission drive system for 40'+ transit buses



Fuel Cell

- ❖ ISE is the most experienced integrator of fuel cells in North America
- ❖ Collaboration with UTC and Van Hool on 5 buses
- ❖ 40' Bus achieves 6-8.8 MPG
- ❖ 30' Bus achieved 9.5 mpg
- ❖ Extremely quiet operation
- ❖ Completely zero emission transportation system on renewable fuels



British Columbia (BC) Transit Fuel Cell Buses

- ❖ 20 hydrogen fuel cell buses for the 2010 Winter Games in Vancouver, BC
- ❖ Deliveries in 2008 and 2009
- ❖ Partnered with New Flyer and Ballard Power

"New Flyer looks forward to working with the most advanced hydrogen fuel cell technology and electric drive and energy storage systems, provided by Ballard and ISE, respectively. These transit vehicles will be more durable and efficient with a greater range of operation when compared to previous generations. We believe these highly-innovative, zero-emission vehicles will play a critical role in the future of transit." – John Marinucci, President and CEO of New Flyer

"The fuel cell buses will provide the cleanest and most efficient propulsion technology in the long term. This will help BC Transit improve British Columbia's quality of life by reducing greenhouse gas emissions and improving the rider's overall experience." – Kevin Mahoney, Chair, BC Transit



Recent London 2012 Bus Award Fuel Cell & HICE Buses

- ❖ 10 hydrogen-powered buses for Transport for London (TfL)
 - 5 hydrogen hybrid ICE buses
 - 5 fuel cell buses
- ❖ ISE is prime contractor with Wrightbus / Ballard Power
- ❖ Delivery to TfL by 2010
- ❖ Order is part of the Mayor's plan to have up to 70 hydrogen vehicles in operation in London by 2010



"The Mayor and Transport for London are committed to tackling climate change through cutting London's contribution to CO2 and other emissions." – Mike Weston, Operations Director for London Buses

"Hydrogen is a fuel of the future as it improves air quality and does not produce the harmful emissions which are causing catastrophic climate change. These ten new hydrogen vehicles will be clean and efficient, providing a smoother, quieter ride for passengers. London is now the first city in Europe to commit to a hydrogen bus fleet of this size, which will match traditional diesel buses in terms of performance. This is an important step towards my target of having five per cent of all public sector fleet vehicles powered by hydrogen by 2015." – Ken Livingstone, Mayor of London

❖ ISE CNG Hybrid-Electric Drive System Advantages:

- Uses Cummins 5.9 liter ISB 230 HP with standard ISE hybrid system
- Significantly greater fuel economy than standard CNG
- Reduced NOx emissions at least 25% better than the engine alone

❖ Several critically important features unique to ISE systems:

- Electrically-driven power steering, braking and air conditioning
- An advanced control system featuring an automatic engine start/stop algorithm
- DC-DC Converter (solid state alternator)



ISE Battery Electric Drive System Advantages:

- Uses large lithium battery pack with standard ISE drive system
- Zero Emissions
- Quiet operation
- No engine certs, no traps, no fuel, no filters
- Inexpensive operation (20% of operation on fossil fuels)
- Grid emissions cleaner than 2010 engine standards
- Grid power comes from largely domestic sources



Trash Trucks

- ❖ Most stop/go operation of any vehicle type
- ❖ Designed to meet demanding combinations of inner city and highway driving
- ❖ All-electric mode capability
 - Battery power can be utilized for quiet operation



Yard Hustlers

- ❖ Vehicles used to tow trailers in contained yards for distribution (Wal-mart, UPS, Coca-Cola), and at ports
- ❖ ISE is teamed with Kalmar which produces about 80% of US yard hustlers

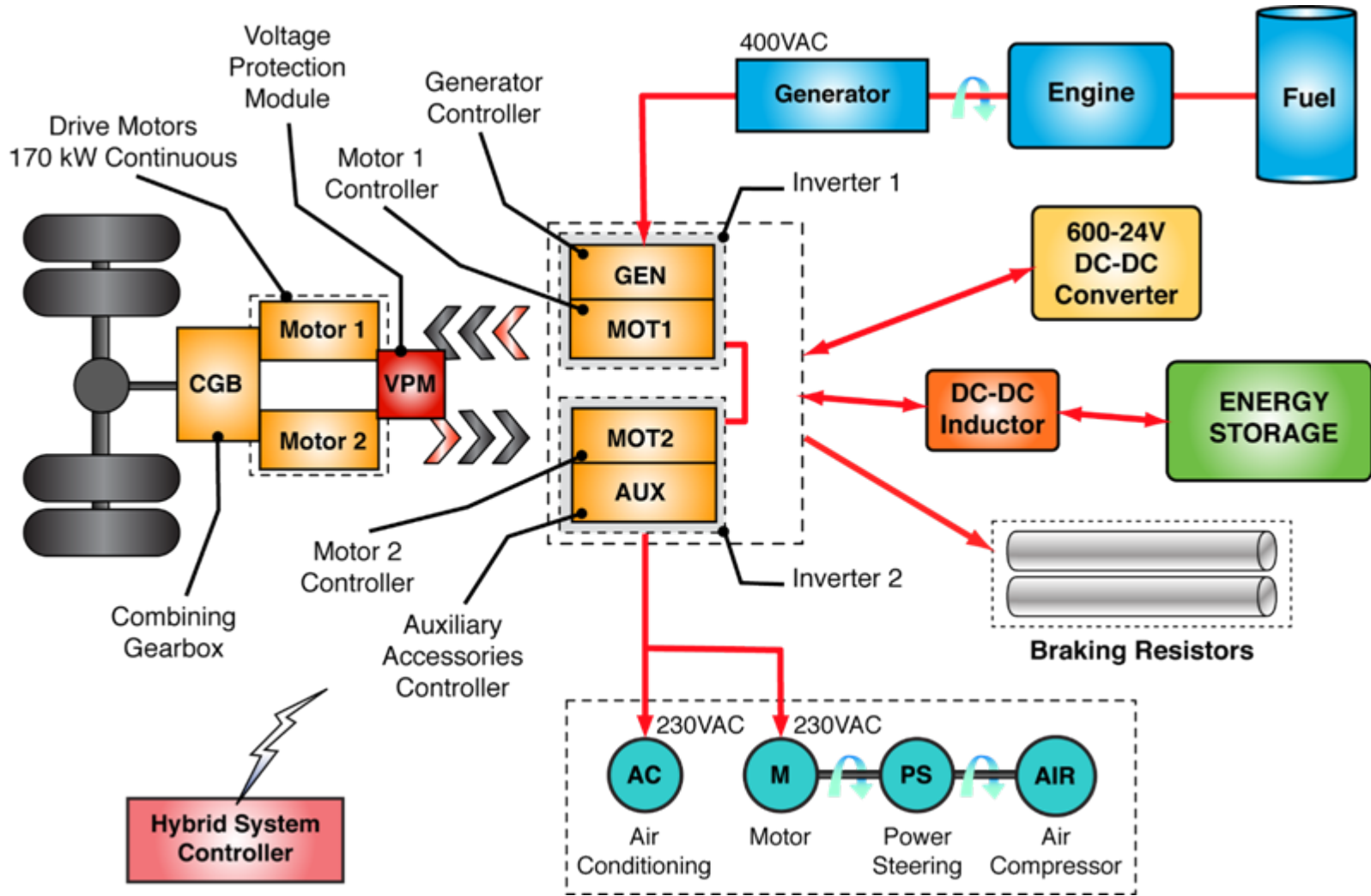


Drayage Trucks

- ❖ Class 8 tractors providing tow services in and around port properties (~5 miles proximity)
- ❖ Most stop/go operation of any vehicle type
- ❖ Battery dominant w/ range extender (short distances) or standard series electric hybrid (longer range)







❖ Broadest, most advanced product line in the business

Vehicle Control






Elec. Access.





AC 231 DL




Energy Storage








Motive Drive







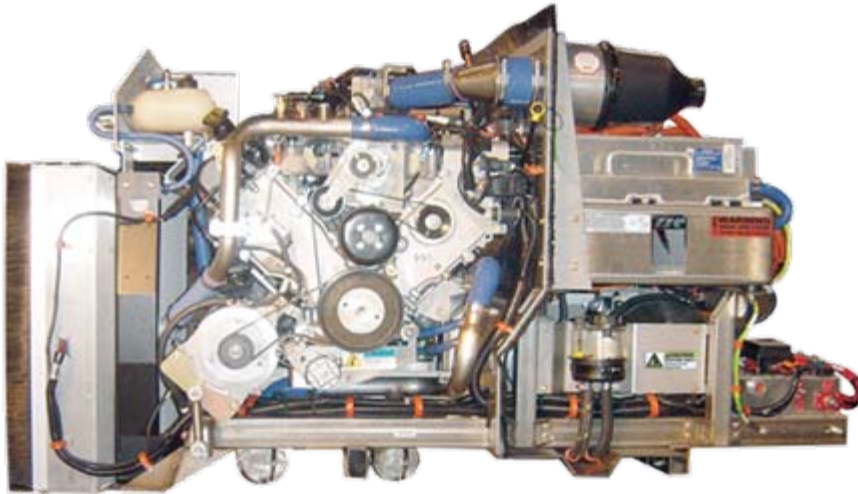
Aux Power Unit



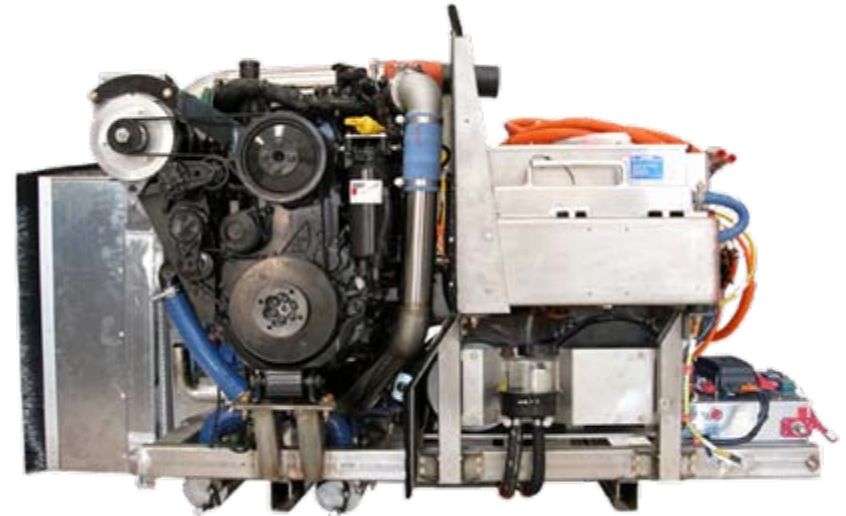






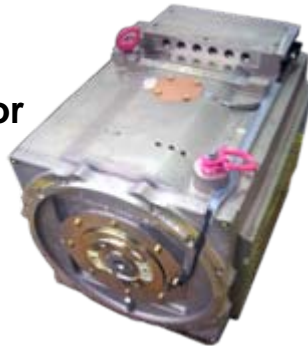
**Gasoline Hybrid
Cradle Assembly**



**Diesel Hybrid
Cradle Assembly**

- ❖ ISE is the US distributor of Siemens bus drive systems
- ❖ Siemens Systems have over 40 million transit miles
 - More than all other heavy duty hybrid systems combined
- ❖ 2 year warranty (5 year extended warranty available)

Single permanent magnet drive motor
260-400 kW (348-540 Hp)
4000-5000 Nm (2950-3690 ft-lbs)



Single Inverter
300kW (402Hp), 800V



Permanent Magnet Generators
30kW to 260 kW



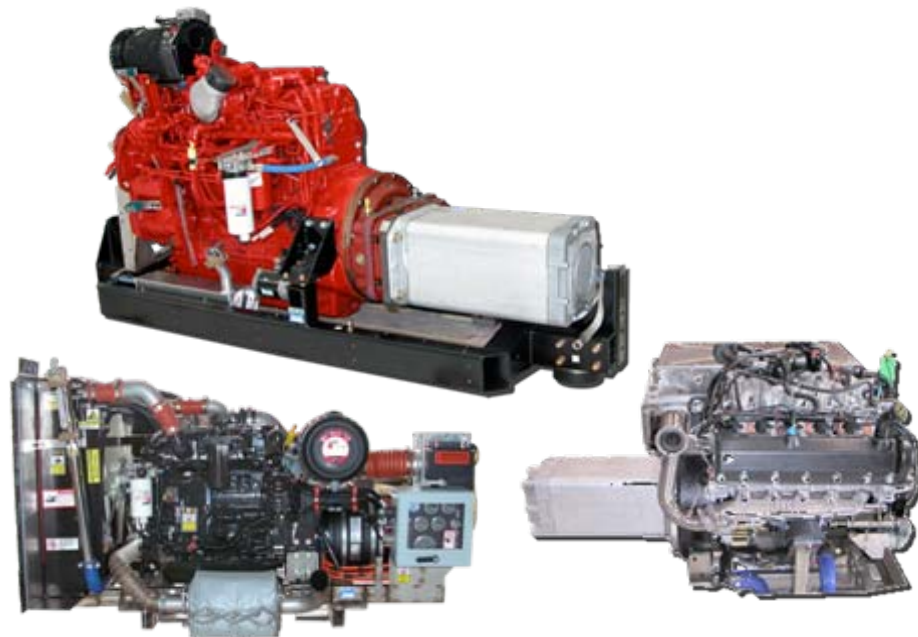
**Dual Motors with
combining gear box**
170 kW / 300 kW peak, 3200lb-ft



DUO Drive Inverter
2 x 175kVA, 720V

❖ Engine Driven Generators

- Otto Cycle Engines
 - Propane, CNG, Gasoline
 - Hydrogen
- Diesel Engines
- Engine Controllers
- Custom Generators to 260kW



❖ Fuel Cells

- Hydrogen Fuel
- Fuel Cell Controller
- DC-DC Converters



ISE-Altairnano Battery

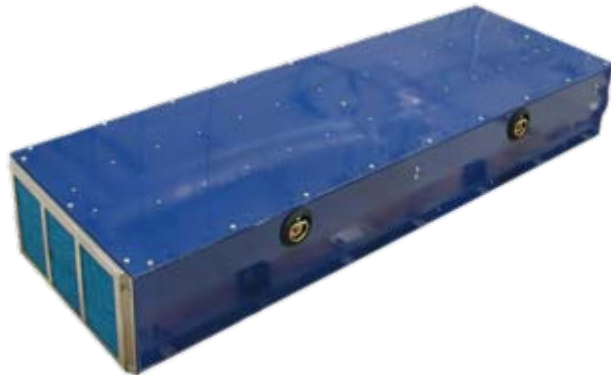
- 30kWh usable energy
- 200kW charge and discharge power
- -35°C to 60°C operating temperature
- Expected life 6-12 years
- 2 year standard warranty (extended options available)
- Uses Altair NanoSafe™ Technology

Cobasys LLC 4500 Series

- 14.6 kWh battery system
- 340kW, power rating 10 sec
- -10 °C to 55°C operating temperature, liquid cooling
- Expected life 4-6 years
- 3 year standard warranty (extended warranty available)
- Cycle life decreases with duty cycle depth

ThunderPack™II Ultracapacitor

- 0.5kWh usable energy
- 200 kW charge and discharge power
- -35°C to 65°C operating temperature
- Expected life 6 years
- 2 year standard warranty (extended options available)
- Cycle independent lifetime
- 94% average efficiency



❖ Power Steering & Braking

- Double shaft motor with integrated hydraulic pump and clutched scroll air compressor



❖ Heating, Ventilation, and Air Conditioning

- 230 VAC Scroll Compressor
- Heat Pumps
- Electric Heaters
- Fuel Heaters



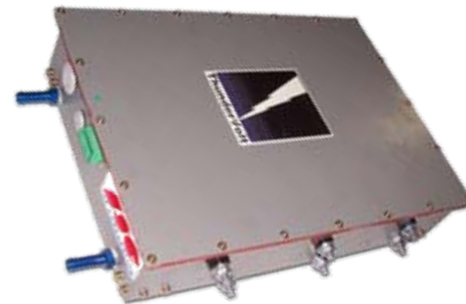
❖ Rooftop Cooling Modules

- Clean rooftop location
- High efficiency
- Quiet with variable-speed fans



❖ DC-DC Converter

- Efficient 600VDC-to-24VDC conversion
- Enable command
- CAN command, control & monitoring
- Over temperature protection
- Voltage control & current limiting
- Short circuit protection



❖ Inductors

- Peak voltage 800VDC
- Inductance 1 mH
- Capacitance 5mF
- Rated current 300A



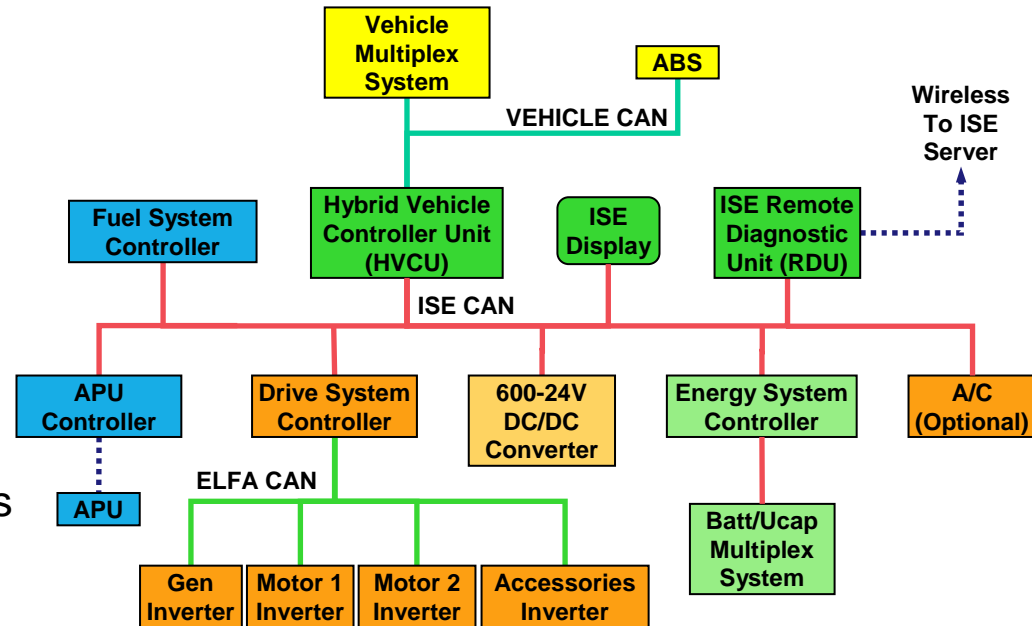
❖ PM Motor Protection

- Rated voltage 850VDC
- Clipping Voltage 800 VDC Nom., Adjustable
- Rated current 6 x 200A Continuous



Hybrid System Controller (EVControl™)

- ❖ CAN based network
- ❖ Network nodes monitor & control subsystems
- ❖ Allow future expansion for new components
- ❖ Diagnostic software allows easy troubleshooting to line replaceable units



All-in-One Distribution Platform

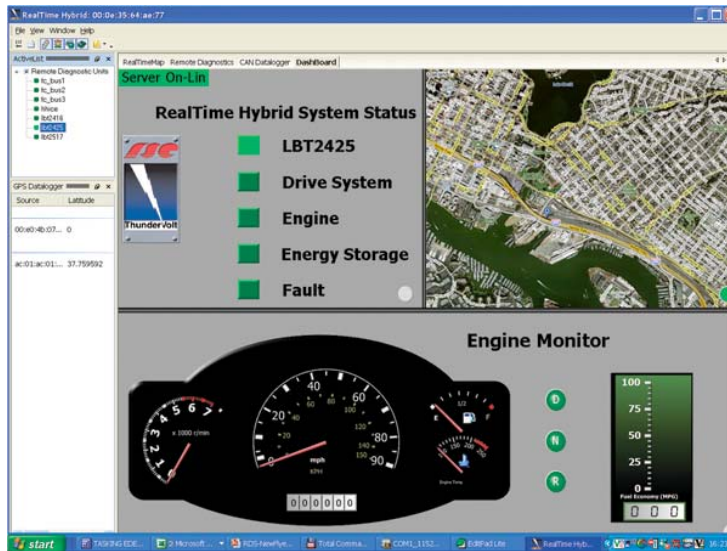
- ❖ Centralizes diagnostics/control signals
- ❖ Contains all fuses and breakers



Vehicle Subsystem Controller (Nodes)

- ❖ Vehicle rated computer - dual CAN ports
- ❖ Manufactured by STW
- ❖ Software by ISE





RDU

- Wireless link from vehicle allows real time data access via internet
- Experts can monitor operation and troubleshoot issues remotely
- Wireless Ethernet allows high data rate transmission at depot
- Master database maintained



Vehicle Operations Center

- Displays real time data directly from operating vehicles
- Can display calculated data such as Tons of Emissions Not Produced, Gallons of Fuel Saved, etc.
- First two installed at AC Transit and SunLine Transit



- ❖ ISE's 13 years of experience has resulted in the lowest emission and highest fuel economy hybrid drive systems verified in independent testing
- ❖ ISE's systems are modular and easily upgraded to more advanced technologies and new applications
- ❖ ISE offers a flexible series of Hybrid Drive System products optimized for customer requirements

