



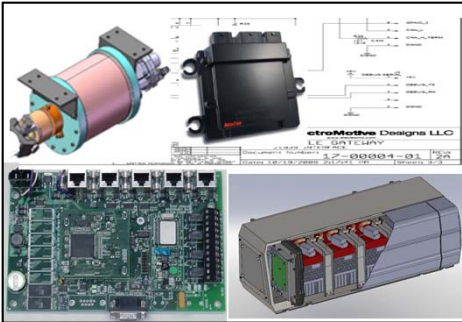
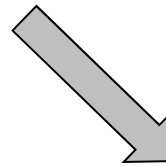
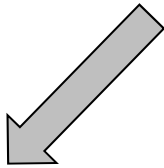
Advancing Clean Transportation

Electric and Hybrid Electric Conversion Systems for Trucks and Buses



What We Do

EMD **ElectroMotive** Designs LLC



Engineering and
Design Services



Propulsion Systems for
Class 3-8 Vehicles

Electric and Hybrid Vehicle Experience – 17 Years



Light Duty:

- Passenger
- Utility
- Fuel Cell
- All Electric



Medium Duty (Series Hybrid):

- Shuttle Buses
- Utility Trucks
- Recycling Collection
- Telecommunications
- Gas Service



Heavy Duty (Parallel Hybrid):

- Refuse Collection
- Bucket Trucks
- School Bus
- Dump Body



Hybrid Propulsion Systems

EMD has parallel hybrid conversion kit designs for Class 3 thru 8 trucks, buses and other specialty vehicles

 	 	 
GVW range: 10,001-16,000lbs pickup trucks large SUV's beverage & parcel delivery trucks shuttle buses school buses gas/electric utility trucks	GVW range: 16,001-26,000lbs - beverage & parcel delivery truck - shuttle buses - gas/electric utility trucks - school buses - panel/box trucks	GVW range: 26,001-80,000lbs - refuse collection trucks - school buses - transit style buses - gas/electric utility trucks - panel/box trucks - specialty vehicles (airport, military, construction, etc)

Feature	Benefit
Easy to install & service	• Low impact – can be installed & serviced by channel partners
Fuel agnostic	• Operates with gasoline, diesel, biofuels, CNG
Modular & scalable system	• Works on most types of vehicle vocations
Plug-in Capable	• Uses low cost grid power to supplement fuel

Medium and Heavy Duty Market – U.S.

- Number of Trucks and Buses – over 100M¹
- Miles Traveled – over 1B¹
- Large commercial fleets
 - Up to 50% operating costs go towards paying for fuel²
- Military
 - Uses 175% more, per soldier than 40 years ago³

1- Bureau of Transportation Statistics

2- Wal-Mart Study

3- Rand/Deloitte/DOD

Challenges in Energy Storage Systems

Battery Management

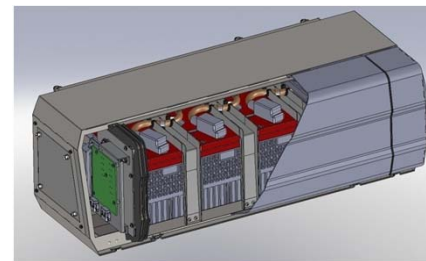
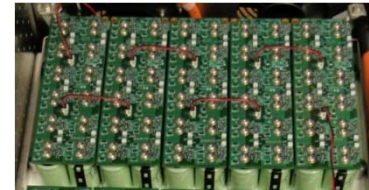
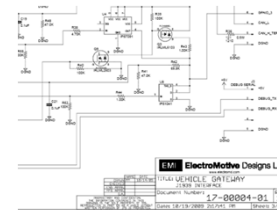
- ☐ Electrical
- ☐ Thermal

Getting Power and Capacity “Out”

- ☐ Battery
 - ☐ Voltage, current
- ☐ Capacitor
 - ☐ Voltage “swing”
- ☐ Hybrid Energy Storage Techniques
 - ☐ DC to DC conversion

Supply Chain Verification

- ☐ Sources
- ☐ Testing/Validation/Safety
- ☐ Real vs. Anecdotal vs. Generalized Information



Managing Expectations

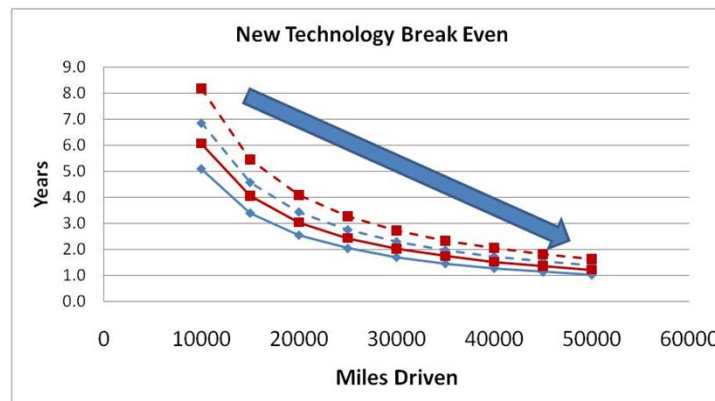
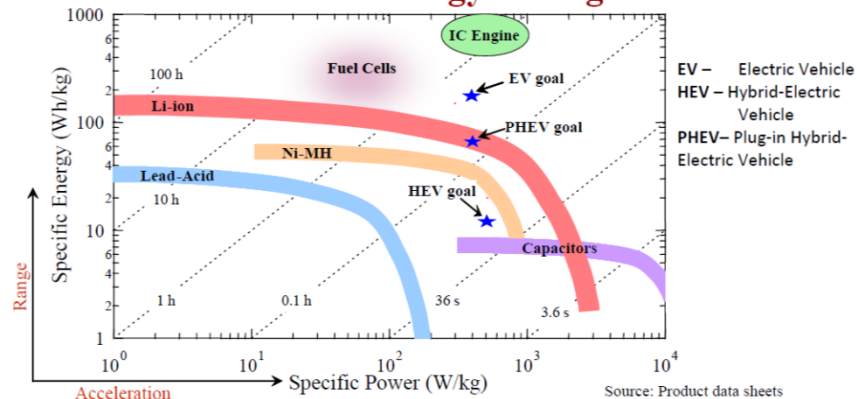
Energy Storage

- ❑ Self-Sufficient Designs
 - ❑ Passive and Active
 - ❑ Can't depend on plugging in
- ❑ Very Application Dependant
 - ❑ Energy, Power, Cycle Life
 - ❑ Variety of Configurations

Value Proposition

- ❑ Initial Cost vs. Life Costs
- ❑ Miles or Hours per year
- ❑ Do your homework upfront
 - ❑ Duty Cycle
 - ❑ Vocation
 - ❑ Location

Relative Performance of Various Electrochemical Energy-Storage Devices



Future Industry Requirements

Standards

- ☐ Safety, Testing
- ☐ Packaging



Emissions

- ☐ Vehicle Classes
- ☐ EV/HEV



Supply Chain

- ☐ Consistency – Dozens of Recipes and Configurations
- ☐ Tested and Validated Products and Designs

Applications

- ☐ Well understood by suppliers
- ☐ Time is needed to experience a variety of scenarios

MD's Approach to Market

- Work Closely with Customer
- “One size does not fit all”
- Consider Life Cycle Cost
- Don't Forget about Disposal Method and Costs
- Understand State/Capability of Technology
 - Keep an open mind during design phase
- Lead with solid Value Proposition
- Safety, Safety, Safety

Thank You.....

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