The University of Texas at Austin
Center for Electromechanics

2016 ADVISORY PANEL
ADVANCED VEHICLE TECHNOLOGIES

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Vehicle Technology is Changing

Electronics / Controls

IT / Wireless / GPS

Batteries

Alternative fuels

1965 Ford Mustang GT

2012 Ford Mustang GT

Tesla Model S

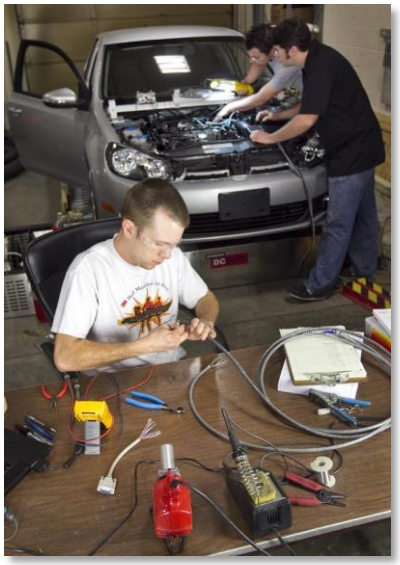
CEM's Role in Vehicle Research

Predictive modeling and simulation

Prototype vehicle design and testing

Advance technology demonstration and assessment

Outreach, Education, and Technology Transfer



Advanced Vehicle Research

Multitude of vehicle platforms - light-duty through heavy-duty

- NEVs, parcel delivery vans, terminal tractors, and transit buses

Vehicle design

- Electric and fuel cell hybrids
- Accessory electrification and anti-idling

Energy storage and fuel conversion

- Chemical batteries, flywheels, and high pressure tanks for natural gas and/or hydrogen
- Gas compressors

Partners and Sponsors

Government agencies and national labs

Non-profit agencies and research centers

Vehicle and component manufacturers

Others

Strengths / Niche

Highbay and machine shop

Skilled technicians and expert engineering staff

Access to UT professors and students

First and only permanent hydrogen fueling station in Texas

Dedicated hydrogen vehicle lab

Modeling / Simulation

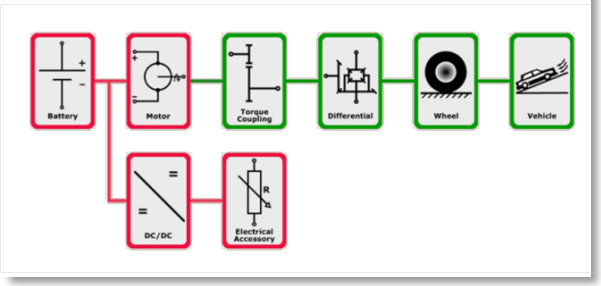
Dynamic power systems modeling

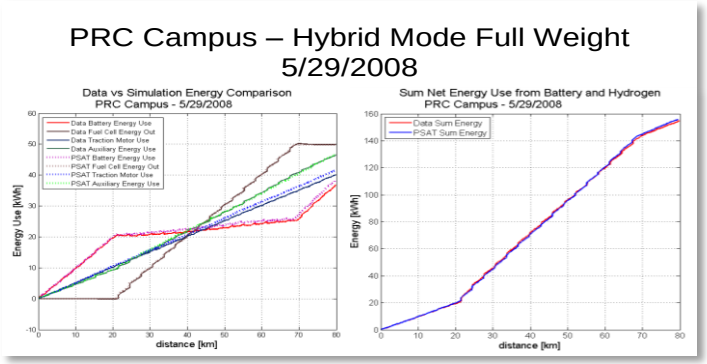
Quickly evaluate vehicle configurations and routes

Customizable components and controllers

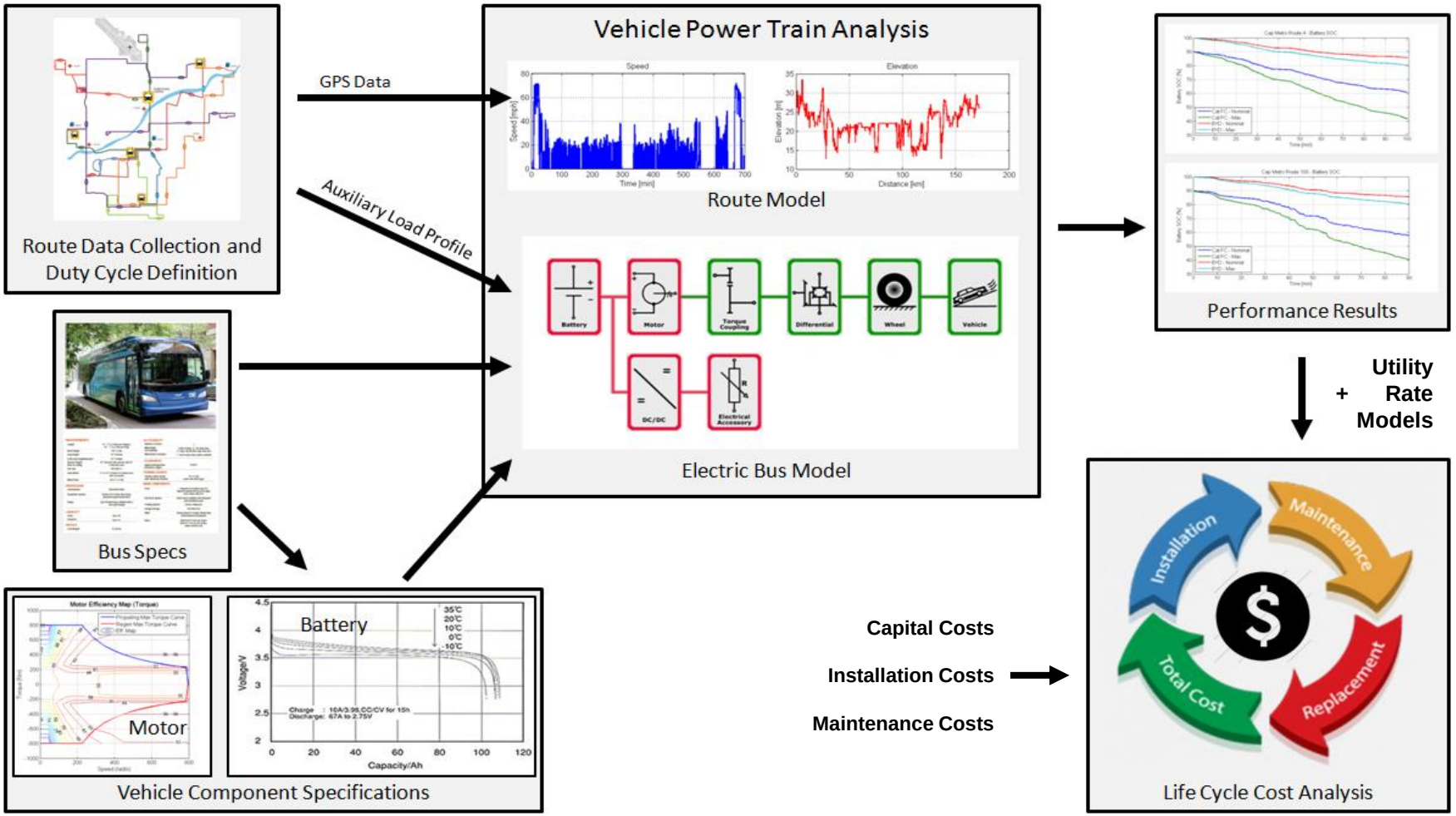
Avoid build and test approach

<u>Tools and methods are enabling adoption of electric transit buses</u>





Fleet Assessment Tools



For Example: Long Beach Transit

FTA TIGGER award for all-electric bus fleet

- Implement 10 electric buses for dedicated circulator route

CEM's modeling tools were critical to

- Formulating the initial bus RFP
- Evaluating bids and down selecting preferred bus and charging solution

Upcoming work will include validation and performance testing at LBT upon delivery of buses and charging infrastructure

Partnered with the Center for Transportation and the Environment

Advantages for Fleet Operators

Avoid the Build and Test Approach

Eliminate route planning and fueling logistics guess work

Perform “What If” Scenarios

Compare and evaluate multiple vehicles and service scenarios

Successful Deployment !

Know how your vehicles will perform before they ever hit the street

Diverse Project Portfolio

Extended Range, Hydrogen Fuel Cell, Hybrid Delivery Van

Paratransit Accessories Electrification

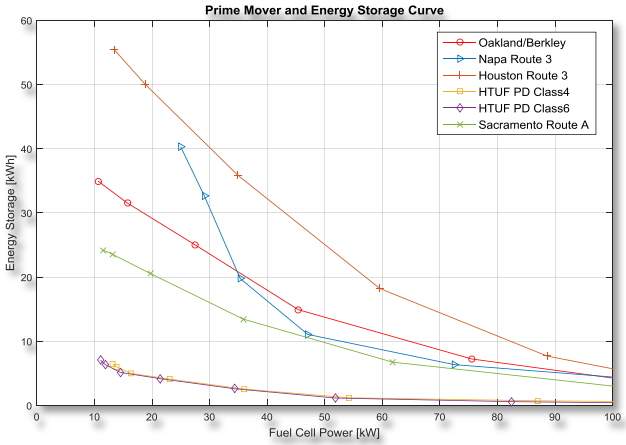
Advanced Conformable Hydrogen Storage

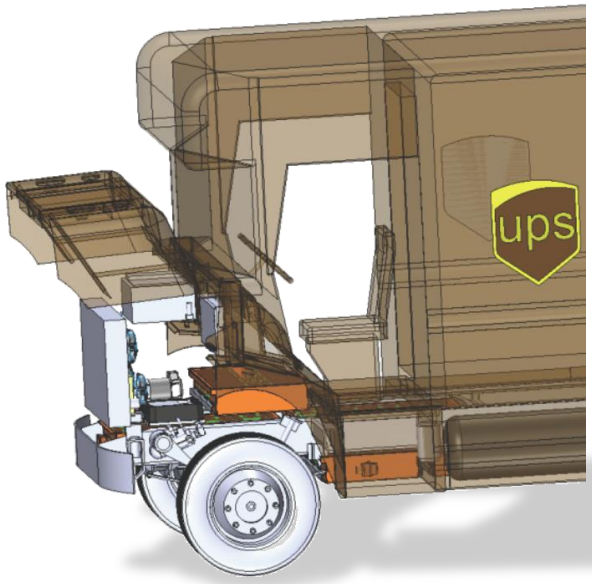
Bus Exportable Power Supply for Emergency Response

Linear Motor Compressor for Natural Gas Vehicles

Fuel Cell Delivery Van

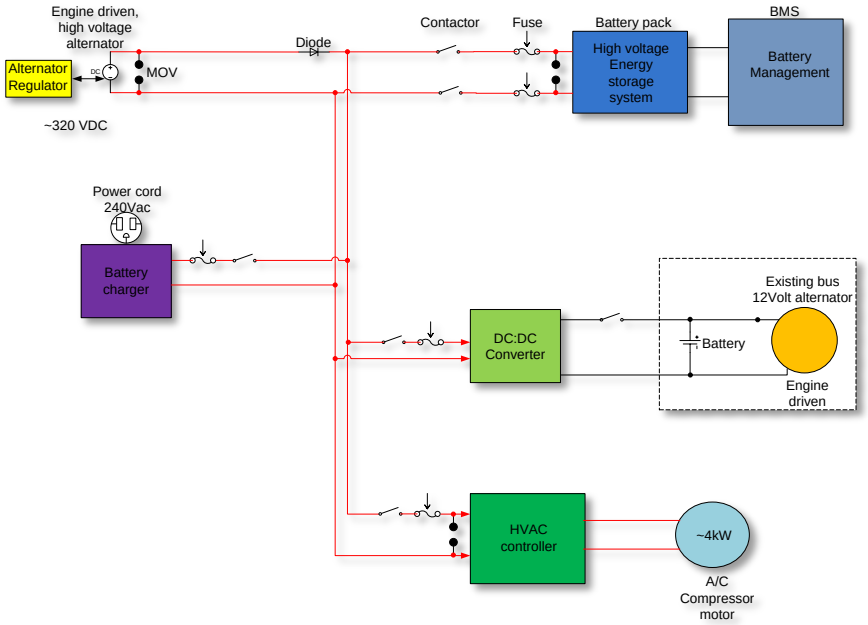
- Sponsors: DOE, CEC, SCAQMD
- Partners: CTE, UPS, USL, Valence, Hydrogenics, Luxfer
- Goal: Build and demonstrate commercially viable zero emissions delivery van that can service nearly all routes
- CEM Role: Phase 1 prototype vehicle design, build, and demo. Phase 2 technology transfer to USL.
- Status: Concluding design phase





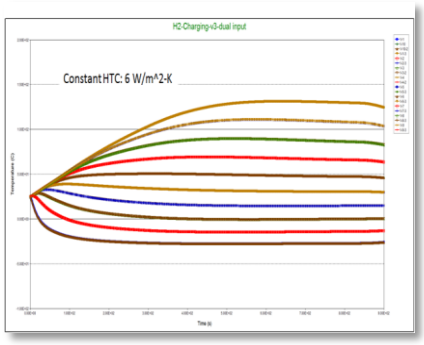
Paratransit Electrification

- Sponsor: FTA
- Partners: CTE, Utah Transit, Trans World Associates, Micro Climate Control
- Goal: Reduce fuel consumption and emissions and increase operational life of paratransit buses
- CEM Role: Vehicle #1 design, build, and demonstration. Vehicle #2 technology transfer.
- Status: Concluding design phase and component requirements definition and selection



Conformable Hydrogen Storage

- Sponsor: DOE EERE
- Partners: CTE, High Energy Coil Reservoir
- Goal: Develop low-cost 700 bar conformable hydrogen storage vessel to enable hydrogen vehicles
- CEM Role: Thermodynamic fueling simulation, low permeability resin selection, and permeability testing
- Status: Resins selected, beginning permeability testing, and concluding thermodynamic modeling



Bus Exportable Power Supply

- Sponsor: FTA
- Partners: CTE, Hagherty Consulting
- Goal: Enable use of transit assets for emergency response by providing exportable power
- CEM Role: Power system design, build, and test. Strategic planning partner.
- Status: Developing strategic plan and requirements definition

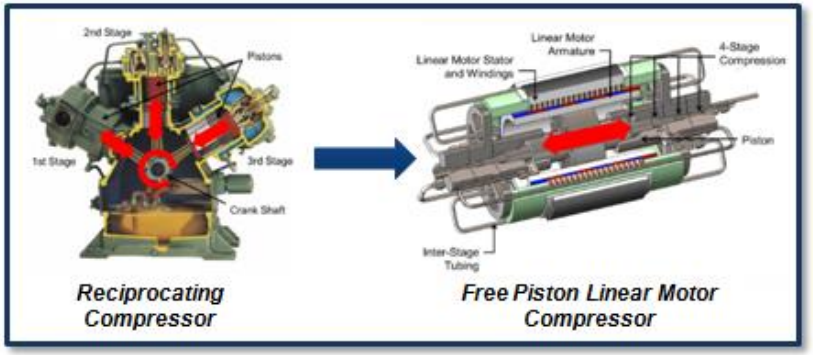
= 1 Bus

- Transit agencies have large amounts of raw horsepower and energy
- Single bus *could* power up to 160 homes for 8 hours
- Buses are maintained regularly, local, and readily deployable
- Technical aspects understood
- How, when, and where being investigated by expert panel

BEPS

CNG Linear Motor Compressor

- Sponsor: DOE ARPA-e
- Partners: GTI, Argonne
- Goal: Enable adoption of light-duty NGV through affordable and reliable at home refueling
- CEM Role: Linear motor design, compressor simulation, build and demo
- Status: Seeking commercial partners, ARPA-e project concluded with successful demo



Increased Efficiency
- Single moving part with no motion conversion
- Resonant frequency operation
- Dry, low friction seals with no oil carryover

Increased Life
- Reduced part count and serviceable design
- Near frictionless carbon seals with low wear

Metric	Current	MOVE	UT-CEM
Cost	$4,000	$500	*$2,000 **
Parasitic Load (kWh/GGE)	1.7	<1.7	*<1.7*
Flow Rate (GGE/hr)	0.5 - 1	1	*1*
Fill Pressure (bar)	250	250	250
Life (hrs)	<5,000	15,000	>>5,000
Weight (lbs)	150	50	100

Accomplishments / Insights

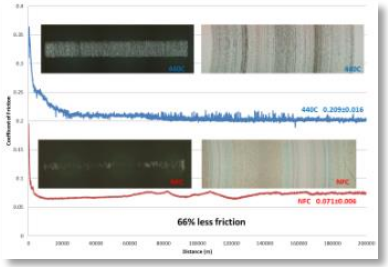
Seal and Coating Development
- Tested two dozen NFC seal and coating systems
- Achieved friction coefficient of 0.05
- Demonstrated >3,000 hr seal life and still counting!

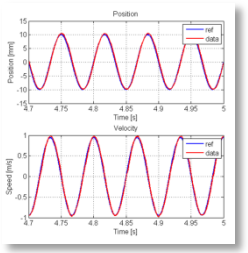
Linear Motor Design and Testing
- Studied 6 linear motor variants, balancing performance and cost
- Demonstrated resonant frequency operation and tight position control surpasses MOVE efficiency targets

Compressor Design and Testing
- Engineered and tested custom valves
- Optimized intercooler design for cost
- Designed compressor for serviceability

Patent Application Filed
- Covers free piston linear motor compressor system
- Separate filings being considered for subsystems

Seeking Commercial Partners and Pathways
- Alternative applications and scale-up are possible





What's Next?

Continue marketing Fleet Assessment Tool and **expand** capabilities to entire Transit Agency operations with potential on-site generation and energy storage

Continue technology transfer model for alternative fuel vehicle applications

Expand vehicle powertrain modeling to include benefits of new autonomous technologies and V2V communication

Explore alternative applications and commercial partners for linear motor compressor

Thank You!

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