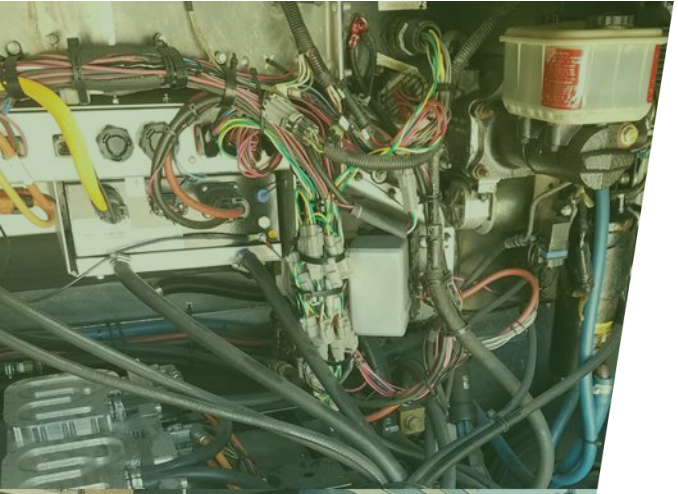
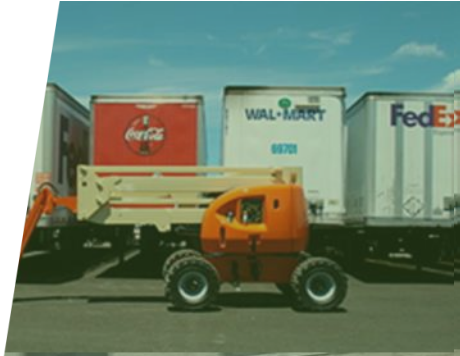
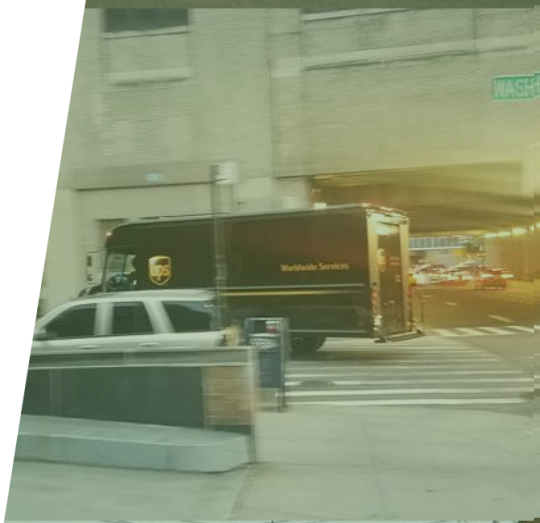


UES
UNIQUE ELECTRIC SOLUTIONS





DEPARTMENT OF ENERGY
H2@SCALE WORKSHOP
July 2018

Company Background

Unique Electric Solutions (UES) is focused on manufacturing electric and hybrid electric propulsion systems for Electric and Hybrid Electric Vehicles. UES is currently working with domestic and international Fleets and on development and demonstration programs for Medium Duty EV/HEVs for Package Delivery fleets and Bus markets operating in urban environments.

Team Background

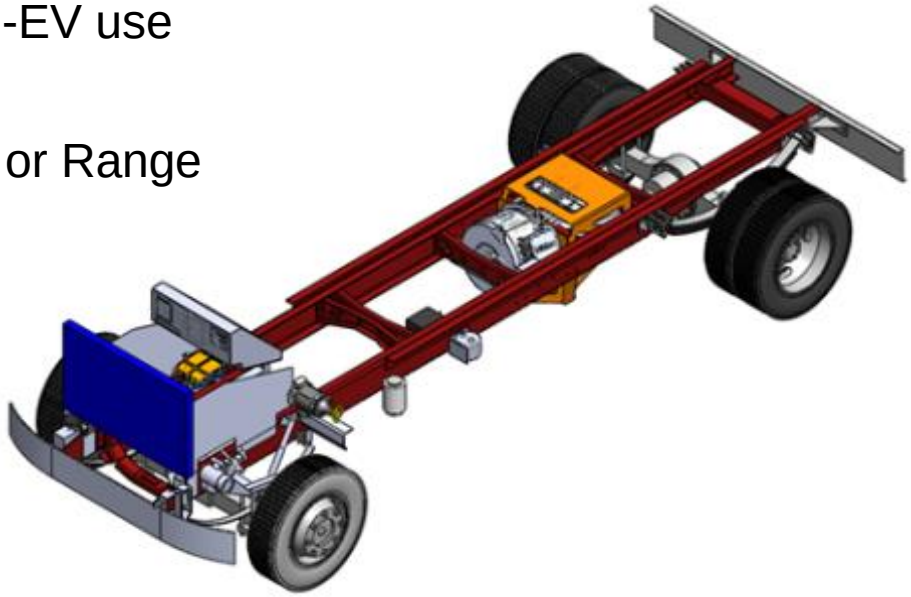
- UES MANAGEMENT TEAM – EACH WITH OVER 20 YEARS OF EV/HEV EXPERIENCE – MEDIUM/HEAVY DUTY TRUCK AND BUS INDUSTRY
  - **Design and Manufacture of propulsion systems, electrical and thermal battery management, controls and power electronics**
  - **Chassis structure, design analysis and manufacturing**
  - **LV/HV Electrical distribution system design, testing and manufacturing (high/low voltage)**
  - **Battery cell and complete energy storage system design, testing and manufacturing**
  - **Infrastructure development and deployment for national fleets and passenger car OEMs**
  - **Fuel Cell System Design, Integration and Repair**

Class 4 thru 7 Trucks and Buses

- IDEAL FLEETS
  - **Focus Area**
    - **Conversion or New Upfits**
    - ~100 miles per day
    - 8-12 hrs dwell time for charging
    - 7-20+ years vehicle life
    - Fleets size of 1000 or more
  - **Addressable vehicle market (US)**
    - 5M+ Installed based
    - 650K new per year
  - **Global Market**
    - 2X+ US Market (excluding China)

UES's "Base EV"

- GENERIC PLATFORM
  - **Electric "Skateboard" Approach for Trucks and Buses**
  - **Benefits**
    - Portable – can be assembled anywhere in the US with local sources of labor and suppliers – brackets, wiring, installation, service
    - Serviceable – Base EV Propulsion can be integrated into existing maintenance programs
    - Open Architecture - for all-EV use or HEV programs, using most any Energy Storage or Range extender



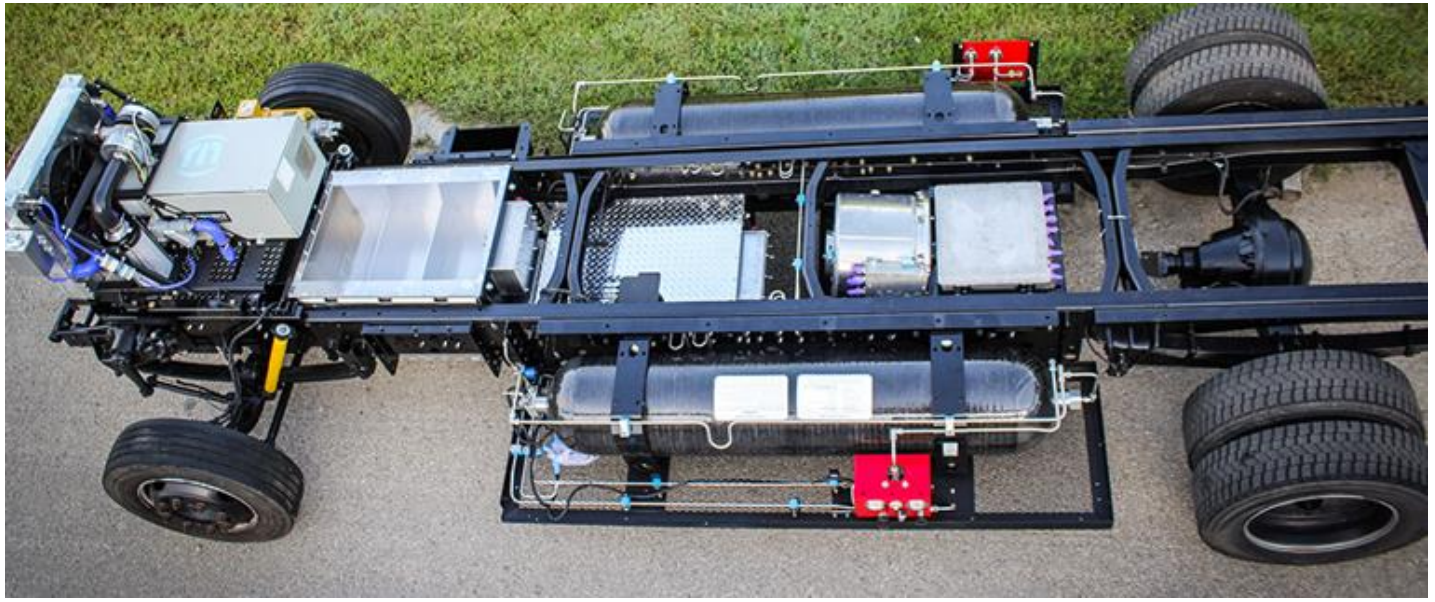
Work in Progress

- PROJECTS – MEDIUM DUTY EV/HEV'S
  - **Sponsored Demonstrations Work in Progress**
    - United Parcel Service (UPS), STS - FCEV/EVs
      - *US Department of Energy / California Energy Commission*
      - *New York State Energy Research Authority*
      - *South Coast Air Quality Management District*

FUEL CELL INTEGRATION

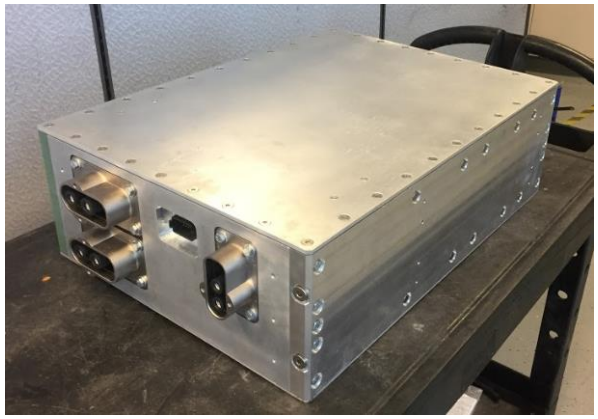
Fuel Cell Discussion – Focus Areas

- TALKING POINTS
  - **Overall System and Component Voltages**
  - **Varying Thermal Management Needs**
  - **System Integration Challenges**
  - **H_2 Storage and Fueling**
  - **Controls and Data Collection**



Systems Voltage Alignment

- VOLTAGE MISMATCH'S EXIST
  - **Medium and Heavy Duty EV/HEV 600VDC**
  - **Fuel Cells 35V to 120VDC**
  - **Lack of OTS DC to DC's – with Isolation**
- CURRENT MITIGATION STRATEGY
  - **Ground Up Design**
  - **High Efficiency**
  - **Optimized for aging and load**
  - **Modular 10-100kW**
- FUTURE CONSIDERATIONS
  - **Higher Voltage Fuel Cells**
  - **Manufacturing Cost Reduction Support**
    - Novel Power Electronics Cooling
    - Power Device Package Optimization

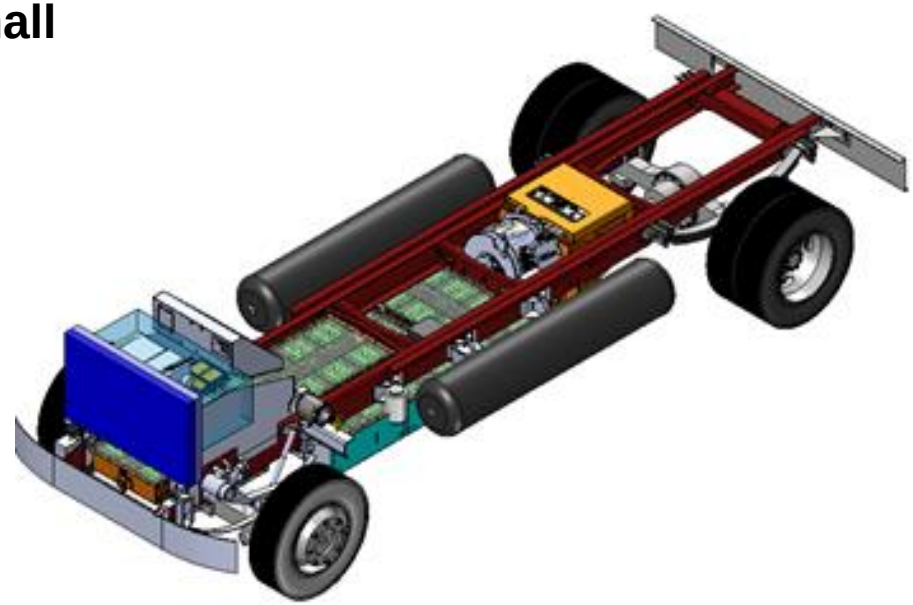


Thermal Management

- VARYING NEEDS
  - **PEM Fuel Cells**
    - 40-70C
    - Tight operating window
    - DI, DI/Glycol
  - **Traction and Power Electronics**
    - 70-100C
- MITIGATION STRATEGY
  - **Dual Cooling Loops**
    - Flow Controls
  - **PWM Fan Control**
- FUTURE CONSIDERATIONS
  - **Common coolants**
  - **Higher FC operating temps**

System Integration and H_2 Storage

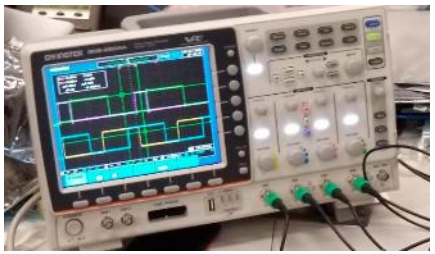
- ADDITIONAL EQUIPMENT / CHALLENGES
  - **Fuel Cell, Blower, Air Filter, Tanks, Lines, Filters**
  - **Multiple Fill Ports**
  - **Pushes equipment outside of frame rails**
  - **Manage additional Weight/Volume**
- MITIGATION STRATEGY
  - **Larger tanks vs Multiple Small**
  - **Side Barriers**
- FUTURE CONSIDERATIONS
  - **700bar + Station Upgrades**
  - **Conforming tanks**
  - **Lighter equipment**
    - Composite Tanks



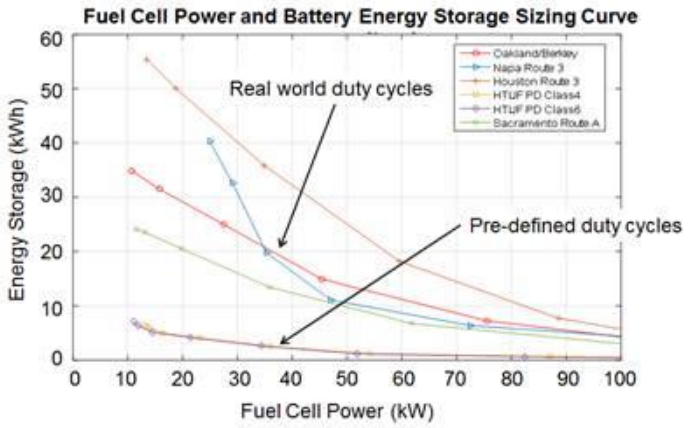
Composite Prototyping Center

THE COMPOSITES INSTITUTE

Controls and Data Collection



- OVERVIEW / CHALLENGES
  - **Assumptions and Model Validation**
  - **14 Different System and Manufactures**
  - **Mix of CAN, Digital and Analog I/O**
  - **Most Mission Critical**
  - **Varying IP and Data Collection Desires/Requirements/Restrictions from Project Sponsors/OEM/Fleet/Internal Groups**
  - **Data Bus Loading**
- MITIGATION
  - **Majority of Work in in this Area**
  - **Lots of Negotiation!**
  - **Mix of Telemetry, Memory Cards, Paper**
  - **Optimization of Data & I/O**
- FUTURE CONSIDERATIONS
  - **Standards Expansion SAE/IEEE/ETC**
  - **Creative Collaboration Agreements**



Conclusions

- MAKING PROGRESS
  - **Sponsored Research Helps Move the Ball Forward!**
  - **Optimization is Significant and Quick**
    - Address Human Factors
  - **Industry Interest/Support Growing**
  - **Exploring Off-shore Opportunities to drive Volumes**
  - **Cost Reduction**
  - **Size and Weight Reduction**
  - **Many Niche Vocations**
  - **Collaboration is Key!**

THANK YOU!

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