

# Sustainable Technologies: Finding Success the Second Time Around



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**Green Truck Summit**  
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# Lessons Learned: Applying Knowledge in Next Generation

**Project Startup: Evaluating Coca-Cola's Class 8 Hybrid-Electric Delivery Trucks**

Although the largest trucks – Class 8, with a gross vehicle weight rating (GVWR) above 33,000 lb.—make up only 1% of

**Advanced Technology Vehicles in Service**

**King County Metro Transit**

**DIESEL HYBRID ELECTRIC BUSES**

KING COUNTY METRO TRANSIT provides transit service in King County, Washington. Its 1,300 buses, trolleys, and streetcars are used by 300 million passengers each year. Metro has long been committed to providing efficient, environmentally friendly transportation. Since 1999, it has operated dual-mode transit buses in the Metro Bus Tunnel, a 1.7-mile route under-sea downtown Seattle. These 60-foot, articulated buses use diesel power on the surface streets. When they enter the tunnel, they connect via catenary poles to overhead wires and use electric power while underground. Using the tunnel shortens the buses' route times and reduces congestion aboveground. Running in electric mode reduces noise and fumes in the tunnel.

**Results: Evaluating Express Hybrid-Electric Trucks**

Renewable Energy Laboratory's (NREL) Fleet Test team evaluated the 12-month, in-service fleet of a gasoline hybrid electric delivery comparable conventional diesel trucks (Express) in Southern California. Its higher emissions and fuel economy of use of alternative fuel and advanced technology vehicles to test.

**Hybrid-Electric Transit Buses**

**NYCT Diesel Hybrid-Electric Buses Final Results**

www.nrel.energy.gov • April 2011

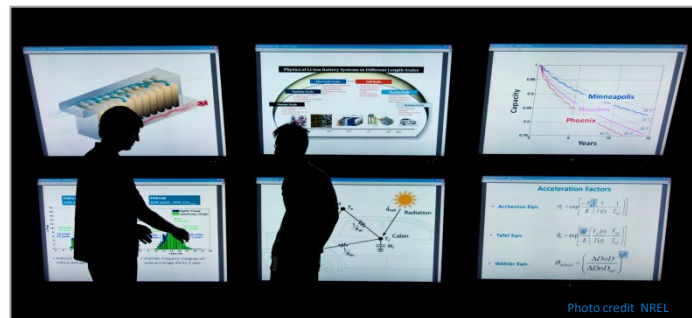
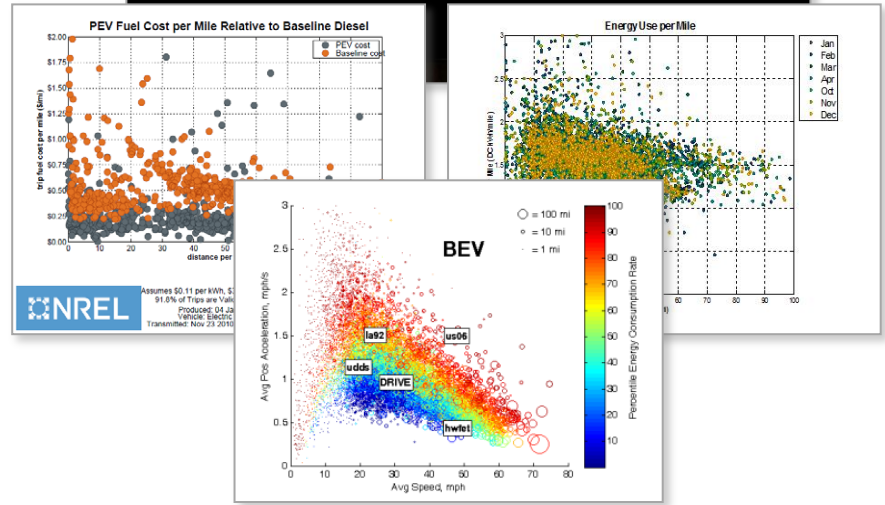


Photo credit: NREL



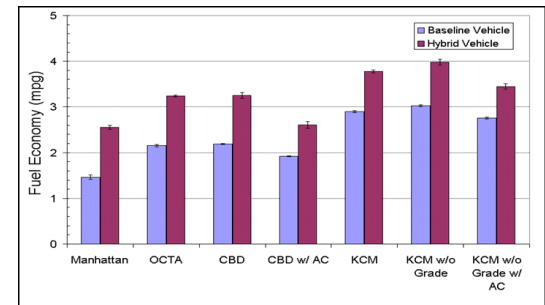
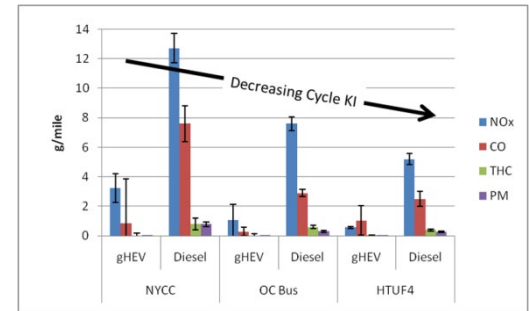
**Buy it. Then try it.**  
 Evaluations of newly deployed technology are useful if you use the lessons learned

**Optimize it.**  
 Good data, tools, and techniques for development of next generation, optimized systems

# Optimal Deployment 2<sup>nd</sup> Time Around

## Re-establish your goals/objectives:

- GHG Reduction
- **Criteria Pollutants (i.e., NO<sub>x</sub>)**
- Petroleum Use Reduction
- Alt Fuel Credits
- **Total Operational Cost Savings**
- Low Carbon Fuel Use
- Electrification Incentives
- **Idle Reduction, etc.?**



## Sometimes:

Success might mean negative consequences in non-objectives

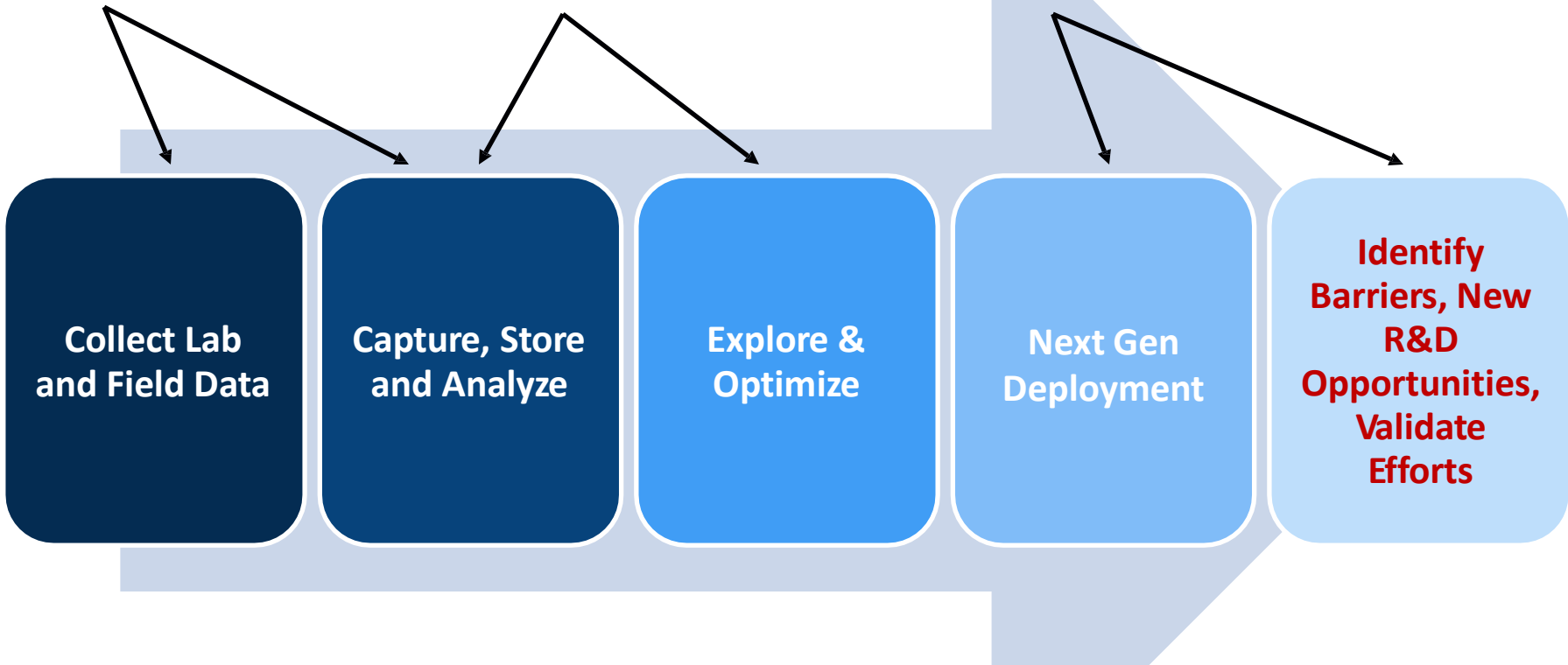
Re-assess and adjust

# Field Data & Analysis Tools: Process for Improving the Deployment

*Field data help build operational knowledge*

*Fleet tools (DRIVE, FASTSim, AFleet, etc.) used to analyze, investigate, and optimize impacts*

*Optimized system deployment: Vehicles, Facilities and Operations*



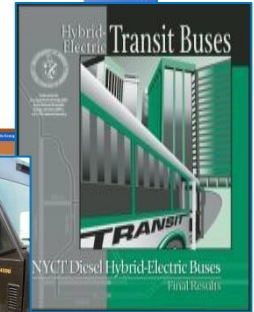
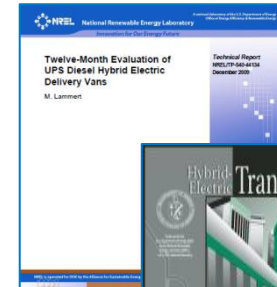
*Partnership between Fleets and Technology Providers = Relevant Analysis, Results & Optimized Solutions for Real World Applications*

# Fleet Evaluations Provide Lessons for Next Iteration

## Background:

Medium-duty (MD) and heavy-duty (HD) testing, aggregated data, and detailed analysis have resulted in:

- **3<sup>rd</sup> party unbiased data:** Provides data that would not normally be shared by industry in an aggregated and detailed manner
- Over 6 million miles of advanced technology **MD and HD truck data have been collected, documented, and analyzed** on over 300 different vehicles since 2002
- **Guiding R&D** for new technology development and identifying new opportunities for next generation deployments – where are the areas for improvement?



# 2<sup>nd</sup> Time Around Examples from NREL's Field Testing

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- Vehicle Placement – Optimizing vehicle vs. route
- Tuning – Understanding duty cycle and fine tuning
- New Features – Adding new features to optimize
- Integrated Operations – Vehicle demands vs. facility
- Battery State of Charge (SOC) Control – Understanding duty cycle vs. battery use

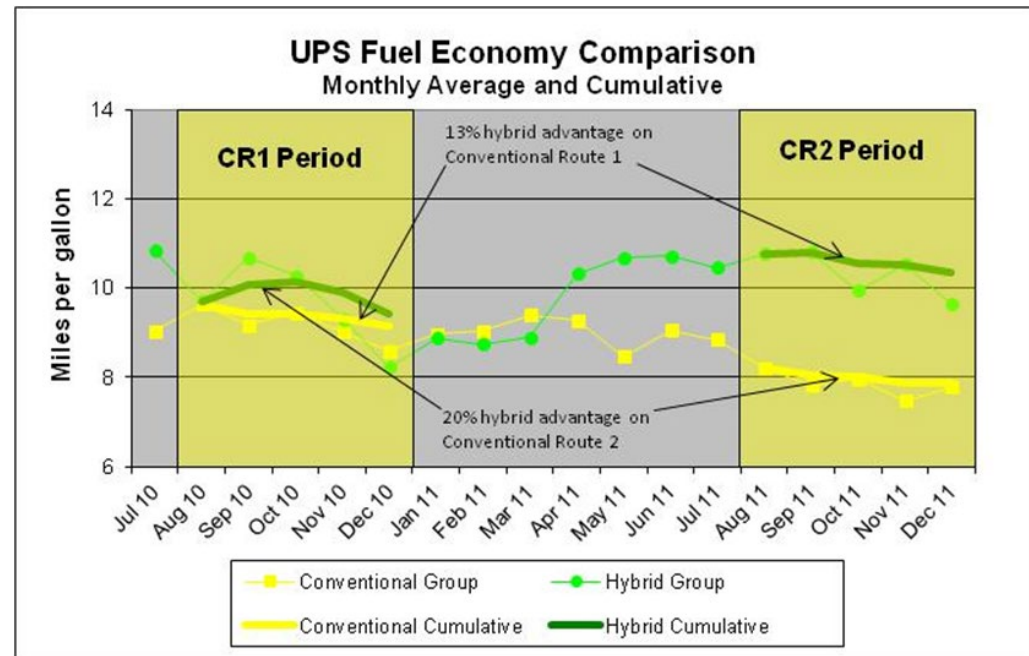
# Improvement: Vehicle Placement



## UPS Hybrid Electric Package Delivery Placement

- UPS has deployed hybrid electric vehicle (HEV) delivery vans in multiple locations around the United States and has learned to maximize success in its fleet by optimizing location / usage
- In its “2nd Gen” deployment, UPS placed HEVs in more “urban” drive cycles (higher “kinetically intense” routes) and maximized HEV advantage. NREL documented this improvement in a study in 2012 with its Minneapolis, MN fleet
- Optimized placement resulted in higher gal/day/vehicle savings over other route options

CR1 = routes where non-hybrids were placed  
CR2 = routes where hybrids were placed  
NREL study showed the “switch” between the two groups, which maximized hybrid advantage (20% vs. 13%) if HEVs were placed in CR1 routes

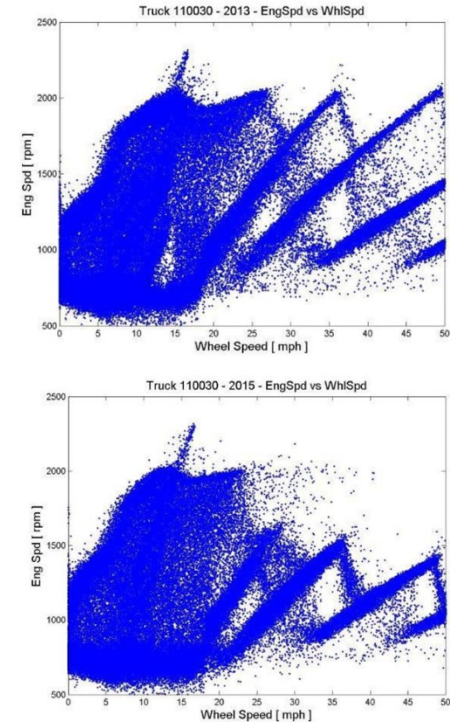


Full Report: <http://www.nrel.gov/docs/fy12osti/55658.pdf>

# Improvement: Tuning

## City of Indianapolis Transmission Tuning

- City of Indianapolis deployed 50 side-loader refuse trucks and roll-off recycling trucks
- Used drive cycle analysis techniques to investigate new powertrain options and determined that new transmission calibrations could drastically improve fuel economy while maintaining operational performance
- 11 % fuel economy improvement for roll-off recycler trucks by applying an improved calibration and a reduced road speed limit change
- 5.6 % side-loader fuel economy improvement by applying a new calibration including “Dynamic Shift Sensing” and “Neutral at Stop”
- 50 truck improvement = \$250k / yr



	2013	2015	Change
Fuel Economy [ mpg ]	1.93	2.09	+8% *
KI [ 1/mi ]	2.18	2.15	-1%

KI = kinetic intensity



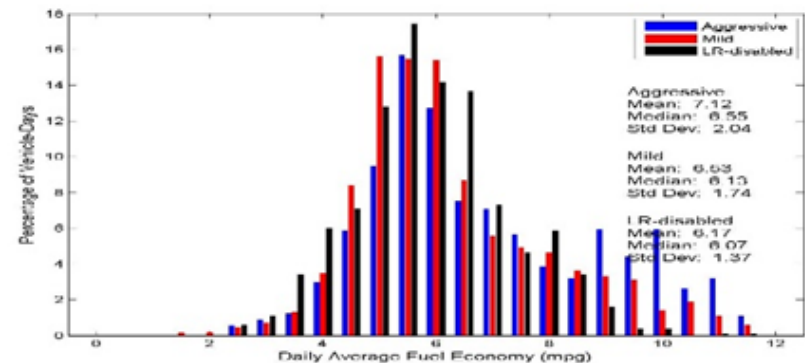
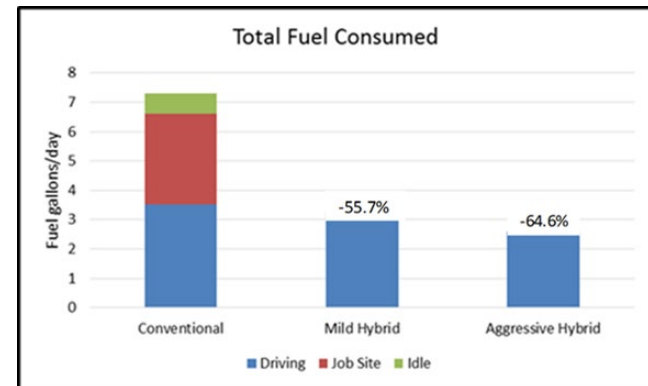
# Improvement: Same Hardware, New Features

## Odyne's Next Generation Energy Management System



- Odyne has delivered over 150 plug-in (charge depleting) hybrid electric systems for work trucks – some as part of the American Recovery and Reinvestment Act (ARRA)
- Customer use has been observed and measured and used to develop new control features
- The plug-in HEV system is capable of propelling the vehicle to and from the job-site or providing job-site electrification of PTO loads (or both)
- How to optimize where the energy is used is being explored – i.e., where and when to use the stored energy. Battery size vs. driving calibration vs. duty cycle

Two calibrations have been developed (Mild and Aggressive) to optimize route vs. job-site battery use

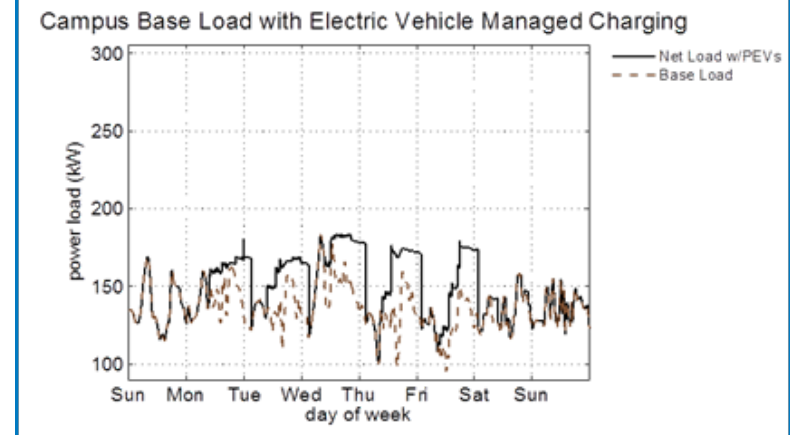
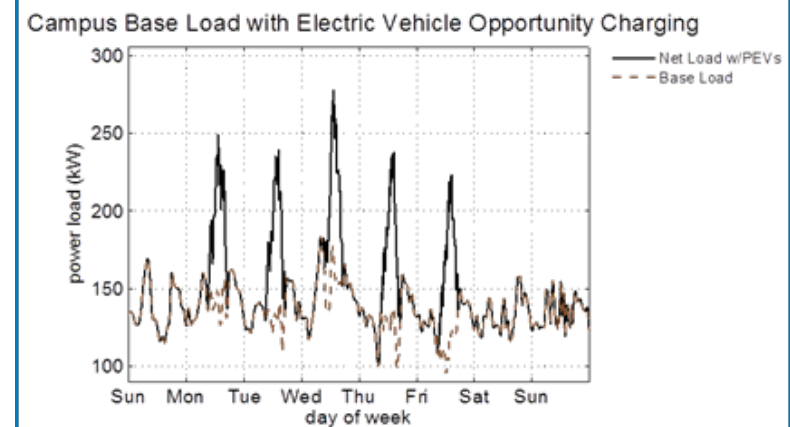


# Improvement: Integrated Operations

## EVs and Facility Management: Intelligent Charge Control

- Frito-Lay has deployed fully electric delivery trucks to its facilities.
- Demand charges can be as high as 30%–50% of a facility's utility cost (based on highest 15 mins) depending on location and rate structure
- EV charging strategies have been identified as a possible way to minimize facility cost and maximize vehicle utilization
- Understanding charging patterns of vehicles and energy demands of a facility can lead to an optimized charge strategy for a fleet of EVs

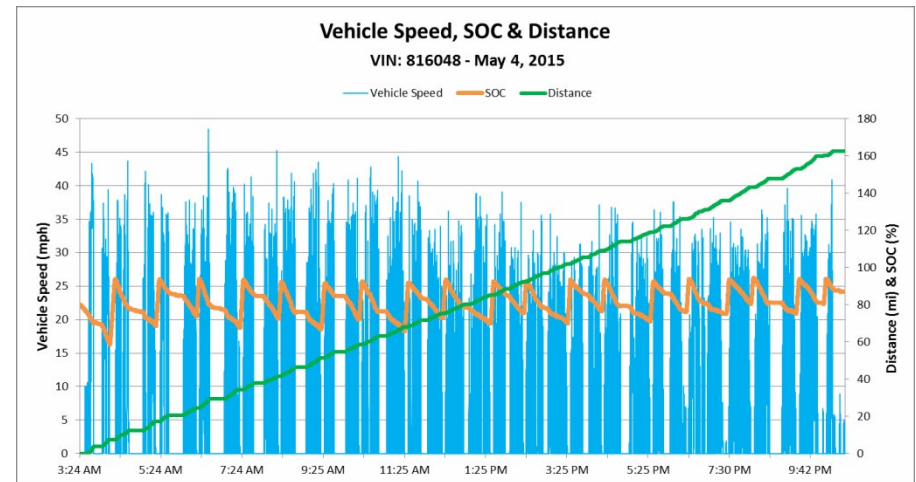
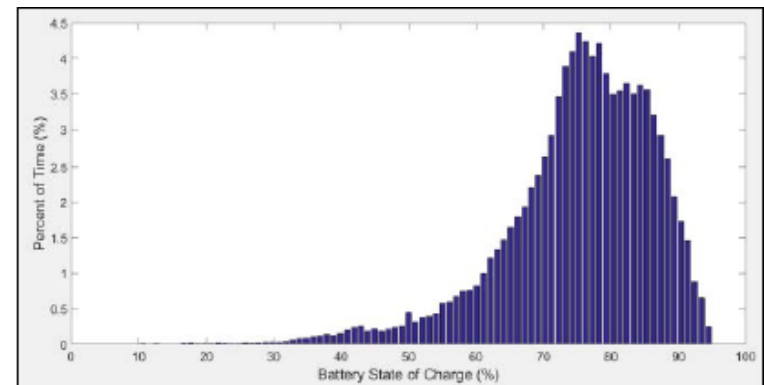
A strategy to manage EV charging could reduce facility demand charges by 20%



# Improvement: Battery SOC Control

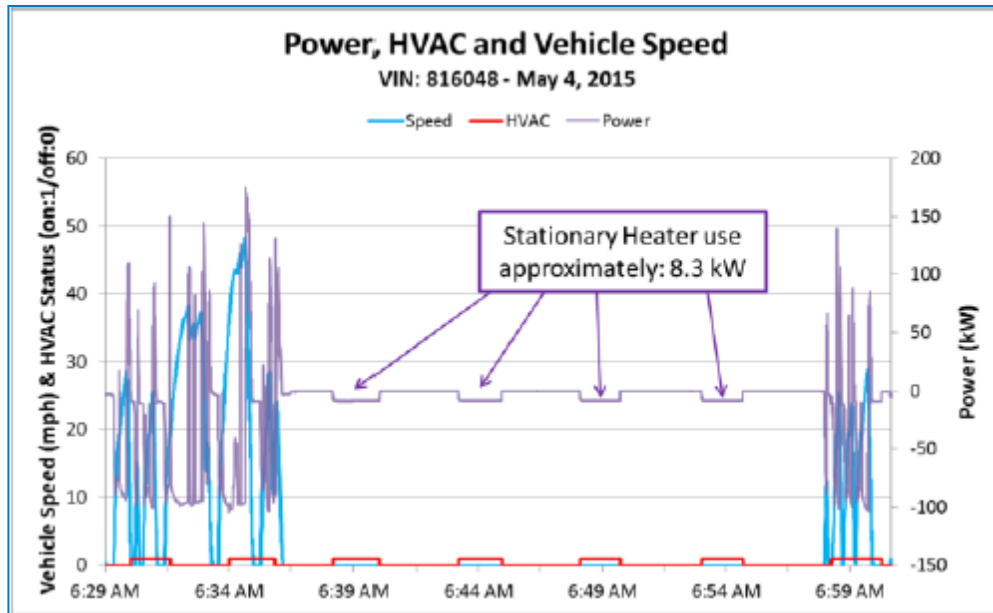
## Foothill Transit EV Optimization

- Foothill Transit in California has installed a DC fast charger to charge a fully electric transit bus while on route, minimizing battery size and reducing bus cost
- Battery SOC (along with other factors) has an effect on battery life
- Changes can be made to enable bus operation while maximizing battery life
- 75.4% of the time it is between 60%–90% SOC
- Opportunities for charge strategy change to prolong life of battery?

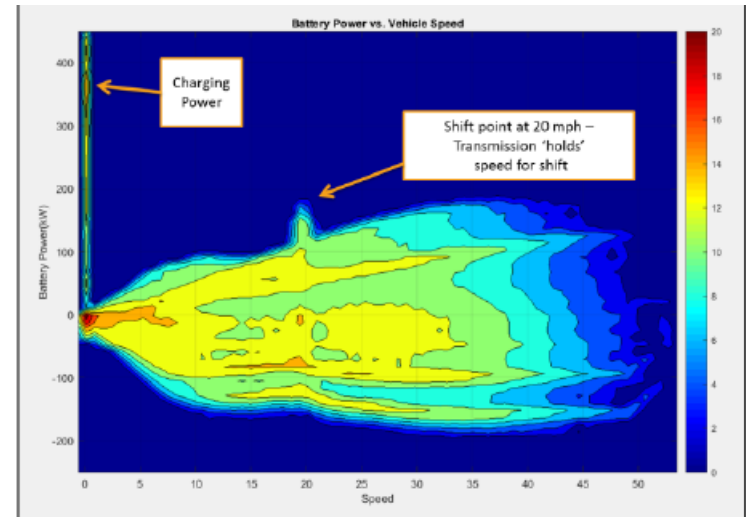


# In Process: Foothill EV Bus Project

Using power and HVAC analysis to look for next gen improvements?



**Auxiliary load analysis:** Power impacts of HVAC, can system be improved?



## Controls Calibration:

Understanding at what vehicle speed the power is being used; shows charge, regen and depletion characteristics, could possibly “tune” for better efficiency

## Special Thanks To:

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- United Parcel Service
- Foothill Transit
- City of Indianapolis
- Odyne Systems, LLC
- Frito-Lay North America

Questions?

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