Zero-Emission Drayage Truck Demonstration (ZECT I)



P.I. - Matt Miyasato
P.M. - Brian Choe (Presenter)
South Coast Air Quality Management District
2015 DOE Vehicle Technologies Annual Merit Review
June 11, 2015

This presentation does not contain any proprietary, confidential, or otherwise restricted information

South Coast
Air Quality Management District

Project ID#
VSS115

Overview

Timeline

- Project start date: Oct. 2012
- Project end date: Sept. 2015*

  * To be extended to Sept. 2017

Budget

- Total project cost: $9,251,003
  - ✓ DOE share: $4,169,000 (45%)
    - $1,268,335 expended
  - ✓ Cost share: $5,082,003 (55%)

Barriers & Targets

- Promote market acceptance
- Data collection and analysis

Partners

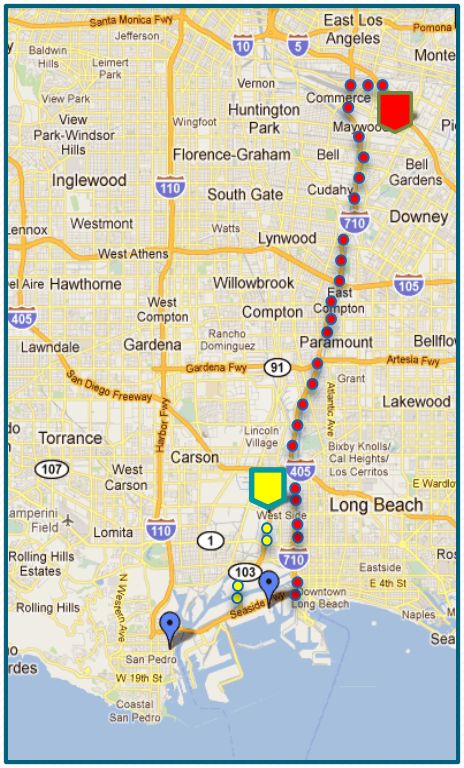
- Project Lead – SCAQMD
- TransPower
- U.S. Hybrid
- NREL
- TTSI
- SA Recycling

Objective/Relevance

- Demonstrate zero-emission heavy-duty truck technologies in real world drayage operations
- Promote market acceptance through demonstration with fleet partners
- Collect and analyze data on performance and O&M costs

Project Approach/Scope

- Initially to develop 13 Class 8 zero-emission drayage trucks consisting of:
  - ✓ Nine BETs - Balqon (3), TransPower (4), US Hybrid (2)
  - ✓ Four fuel cell range extenders by Vision Motors
- Balqon and Vision have dropped out
  - ✓ CNG PHEVs to be added
- Chassis dynamometer testing to validate and optimize vehicle performance
- Two-year demonstration in port drayage service with fleet partners (TTSI, SA Recycling)
- NREL to collect and analyze performance and O&M cost data against baseline trucks



Demonstration Technologies

	TransPower	US Hybrid
Architecture	BEV	BEV
Traction Motor	Dual Motor (300 kW Total)	Dual Motor (320 kW Total)
Transmission	Automated Manual	Automated Manual
Battery	215/269 kWh $LiFePO_4$	314 kWh Li-ion
Charger	On-board Two 150kW/70 kW ICUs	Off-board 120 kW
Recharge Time	3-4 hrs (70 kW ICU)	3 hrs
Range	70-100 miles	100 miles

* CNG PHEVs with 30-40 miles AER and 150-200 miles in operating range to be added

Technical Accomplishments
TransPower – EDD1

- Completed in 4/14
- Extensively road tested with over 3,000 accumulated miles
- Deployed with SA Recycling in 11/14
  - ✓ Heavy cargos (scrap metals)
  - ✓ Valuable lessons on real world operations and challenges
  - ✓ Limited operations due to issues with battery cells and BMS
  - ✓ 325 miles (303 miles w/trailer)
  - ✓ Averaging 2.4 kWh/mi efficiency

EDD1

EDD1 at SA Recycling

Technical Accomplishments
TransPower – EDD2

- System Improvements
  - ✓ More reliable battery cells
  - ✓ Improved battery pack design
  - ✓ New BMS
- Chassis dyno testing at UCR
  - ✓ DTP and UDDS Cycles
  - ✓ 2.06 - 2.42 kWh/mile (72,000 lbs)
  - ✓ 7% grade simulation
- Deployed with TTSI in late 1/15
  - ✓ More typical drayage service
  - ✓ Port gate access & queuing up
  - ✓ Reliable operations with positive feedback from drivers

EDD2 on Chassis Dyno at UCR

EDD2 at the Port Container Yard

Technical Accomplishments TransPower-EDD3 & EDD4

- EDD3
  - ✓ Completed in 12/14
  - ✓ Delivered to TTSI in late 3/15
  - ✓ Deployment in 4/15

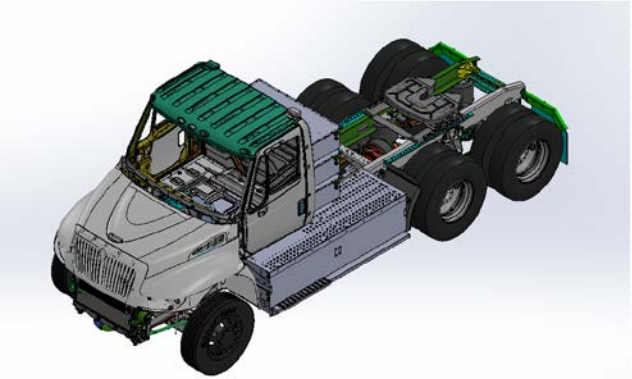
EDD3

- EDD4
  - ✓ Completed in 2/15
  - ✓ Undergoing on-road testing
  - ✓ To be deployed by 5/15
  - ✓ Reduced recurring labor hours for truck assembly from 4,200 hrs to 1,000 hrs

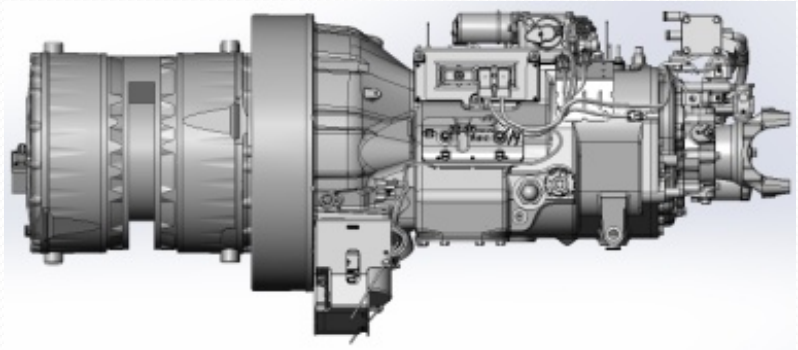
EDD4

Technical Accomplishments
US Hybrid

- Both trucks in assembly
- First truck to be completed in 6/15
- Chassis dyno testing in 7/15
- First truck deployment in 9/15
- Second truck to be deployed by 11/15



US Hybrid BET Design



320 KW EDU

US Hybrid Truck Assembly

Data Collection & Analysis

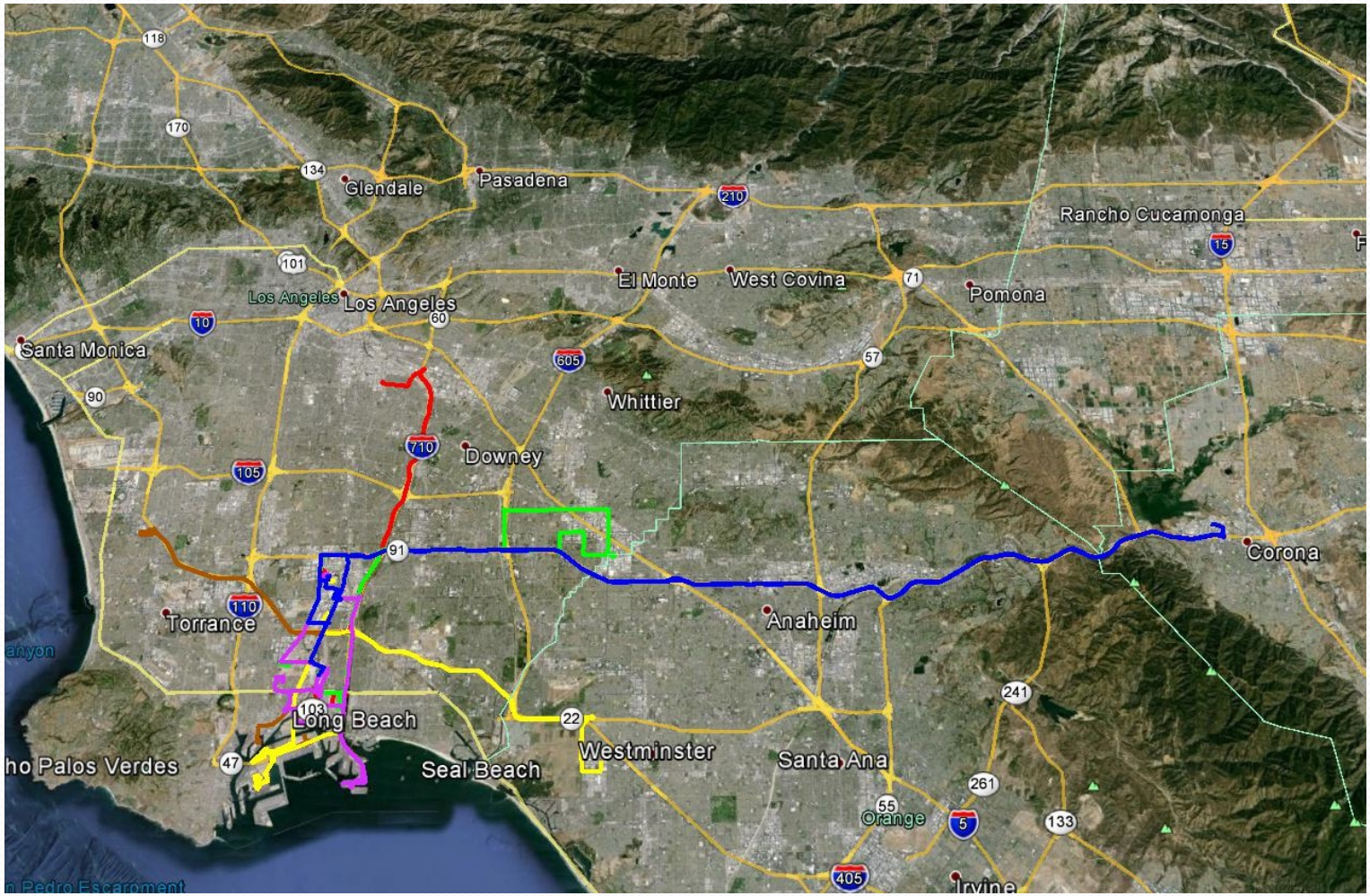
EDD2

- 1/15 through 3/15
- 26 days of operation
- 1120 miles traveled (680 miles with trailer)
- More local operations

Baseline Trucks

- 10/14 through 1/15
- Two diesel trucks
- Mack® 2013 – 12.8L
- 149 days of operation
- 22,660 miles traveled

EDD2 Sample Routes



South Coast
Air Quality Management District

Median Daily Use

	EDD2	Baseline Trucks
Operation Time	3.7 hrs	7.9 hrs
Idle Time	1.2 hrs	2.6 hrs
Distance	39.8 miles	124 miles
Trailer Distance	21.6 miles	
Average Speed	11.8 mph	16.5 mph
Fuel Consumption	2.0 kWh/mi	6.2 mpg
Ending SOC	68.1%	
Kinetic Intensity	1.3	0.7

Responses to FY2014 Reviewer Comments

- Several reviewers commented that the project won't be able to collect two years worth of demonstration data by September 2015.

  Response: We are in discussion with DOE to extend the project term to September 2017.

- One reviewer would like to see "fuel cell trucks go head to head with electric trucks." This would help narrow down the field for commercialization in the future.

  Response: 2014 ZECT demonstration project (ZECT II) includes several fuel cell electric trucks and hybrid electric trucks for demonstration in drayage service, providing a valuable opportunity to evaluate a wide range of zero-emission capable technologies between the two projects.

Collaboration and Coordination

- TransPower and US Hybrid each to develop battery electric drayage trucks for demonstration
- University of California, Riverside to perform chassis dynamometer testing to validate the performance of demonstration vehicles
- TTSI and SA Recycling to deploy demonstration vehicles in drayage service for two years
- TTSI is also providing two baseline diesel trucks
- NREL to analyze vehicle performance and O&M cost data during demonstration

Proposed Future Work

- Remainder of FY 15
  - ✓ TransPower to deploy EDD4 by May
  - ✓ US Hybrid to complete first demo truck by June
  - ✓ Chassis dynamometer testing for US Hybrid truck in July
  - ✓ US Hybrid to deploy first demo truck by September
  - ✓ Amend agreement with DOE to add CNG PHEVs and extend the project term to September 2017

- FY 16
  - ✓ US Hybrid to deploy second demo truck by Q1
  - ✓ Continue field demonstration
  - ✓ Deploy first CNG PHEV for demonstration by Q1 (if included)

Summary

Objective/Relevance

- Demonstrate zero-emission capable drayage trucks in real world drayage service to promote market acceptance and analyze performance and cost data

Approach

- Develop demonstration drayage trucks based on
  - ✓ Two types of BEVs (TransPower, US Hybrid)
  - ✓ CNG PHEVs to be added
- UCR to perform chassis dynamometer testing to validate vehicle performance
- Two-year demonstration in drayage service with TTSI, SA Recycling and other participating fleets
- Two baseline diesel trucks for comparison analysis
- NREL to collect and analyze performance and cost data

Summary (2)

Technical Accomplishments

- TransPower completed all four demo trucks
- TransPower deployed EDD1 with SA Recycling in 11/14
- EDD2 and EDD3 deployed with TTSI in 1/15 and 4/15 respectively
- EDD2 was chassis dyno tested at UCR in 10/14
- NREL is collecting and analyzing performance data
- US Hybrid completed system design and is working on vehicle integrations for both demo trucks

Future Work

- TransPower to deploy EDD4 in 5/15
- US Hybrid to complete first demo truck in 6/15 with a deployment plan in 9/15
- Second US Hybrid truck to be deployed in 11/15
- Amend agreement to add CNG PHEVs with 30-40 miles AER and 150-200 miles of operating range