Zero Emission Heavy Duty Drayage Truck Demonstration



Brian Choe
South Coast Air Quality Management District
May 16, 2013

Project ID#
VSS115

South Coast AQMD

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Overview

Timeline

- Project Start Date: Oct. 2012
- Project End Date: Sept. 2015

Barriers

- Risk Aversion
- Cost
- Infrastructure

Budget

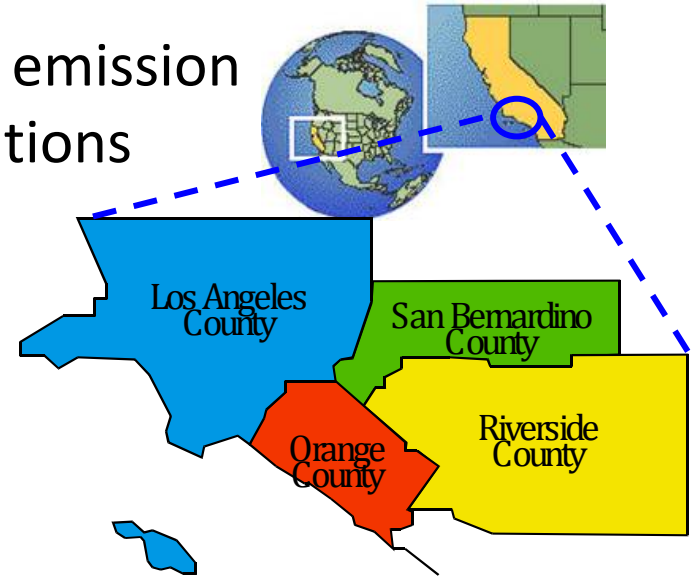
- Total Project Cost: $9,251,003
- DOE Share: $4,169,000
- Cost Share: $5,082,003

Partners

- Project Lead - South Coast Air Quality Management District
- Balqon
- TransPower
- U.S. Hybrid
- Vision Industries
- National Renewable Energy Laboratory (NREL)

Objectives

- Develop and demonstrate zero emission drayage truck technologies in real world cargo container transport operations
- Measure and analyze the performance of demonstration vehicles
- Accelerate the deployment of zero emission technologies in port drayage operations
  - 90% of NOx emissions from mobile sources in the South Coast Air Basin
  - Approximately 10,000 drayage trucks operating in Ports of Los Angeles and Long Beach



Project Relevance

- Risk Aversion - Promote market acceptance through demonstration in real world drayage service with partnering fleets
- Cost - Assess total cost of ownership for drayage truck applications (O&M cost savings vs capital costs)
- Infrastructure - Evaluate different charger technologies for more accommodating charging infrastructure and logistics

Project Milestones
FY 12 and FY 13

Month/Year	Milestones	Status
October 2012	DOE award agreement	Complete
January 2013	Agreement amendment	Complete
March - April 2013	Contract executions	Pending
April – June 2013	Drive system design	Pending
June 2013	Vehicle integration begins	Pending
September 2013	First demonstration vehicle completed	Pending

Project Approach/Scope

- One year to develop four different types of heavy-duty zero emission drayage truck technologies
  - Three types of battery electric trucks
    - Balqon (3), TransPower (4), US Hybrid (2)
  - Fuel cell hybrid electric truck (extended range)
    - Vision Industries (4)
- Chassis dynamometer evaluation to validate and optimize the vehicle performance
- Two-year demonstration in real world drayage service with partnering fleets
- Collect and analyze performance and cost data

Project Approach
Vehicle Development - Balqon

- Three Class 8 battery electric drayage trucks based on pre-commercial prototype model MX-30
- Specifications
  - 240 kW electric motor with automatic transmission
  - 380 kWh battery pack (Lithium Iron Phosphate)
  - 160 kW fast charger (3 hrs to charge)
  - 55-70 mph
  - 100-150 miles range
- Notable
  - 500 kWh energy storage unit with DC-DC fast charger
    - Rapid charge trucks in 1 hr
    - The energy storage unit to be charged during off-peak hours

MX-30

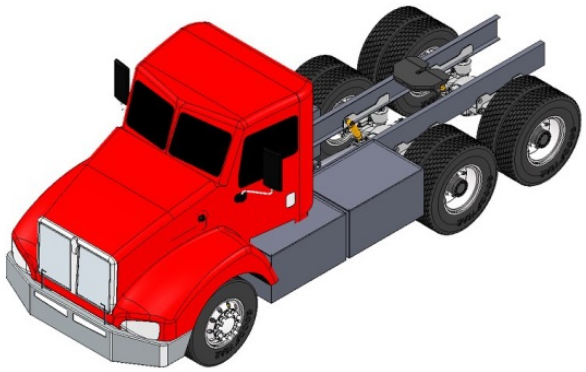
Project Approach
Vehicle Development - TransPower

- Four Class 8 battery electric drayage trucks based on pre-commercial prototype model ElecTruck
- Specifications
  - 300 kW electric motor with Automated Manual Transmission
  - 269 kWh battery pack (Lithium Iron Phosphate)
  - 60 mph top speed (65,000 lbs)
  - 70 - 100 miles range
- Notable
  - Inverter-Charger Unit (ICU)
    - Combines the function of inverter and battery charger
    - Simpler and more economical
      - No need for off-board charger; requires routine wiring of cable and plug
    - Charging time: 4 hours

ElecTruck

Project Approach
Vehicle Development - US Hybrid

- Two Class 8 battery electric drayage trucks
- Specifications
  - 320 kW electric motor with automatic transmission
  - 300 kWh battery pack (Lithium Nickel Cobalt Aluminum Oxide)
  - 120 kW DC fast charger
  - 6.6 kW on-board level 2 charger
    - Emergency backup
- Performance
  - 60 mph top speed (65,000 lbs)
  - 100 miles range
  - Charging time: 3 hours (120 kW FC)



Project Approach
Vehicle Development - Vision

- Four Class 8 fuel cell hybrid electric trucks based on pre-commercial model Tyrano
- Specifications
  - 320 kW electric motor
  - Direct drive w/ two-speed rear end
  - Parallel hybrid system with 33 kW PEM fuel cell
  - 130 kWh battery pack (Lithium Iron Phosphate)
  - 20kg hydrogen storage
  - Level 2 Charger (8 hrs)
- Performance
  - 60 mph top speed (65,000 lbs)
  - Extended range: 200 miles
  - Refuel time: 10-15 min. H_2 @ 6,250 psi

Tyrano

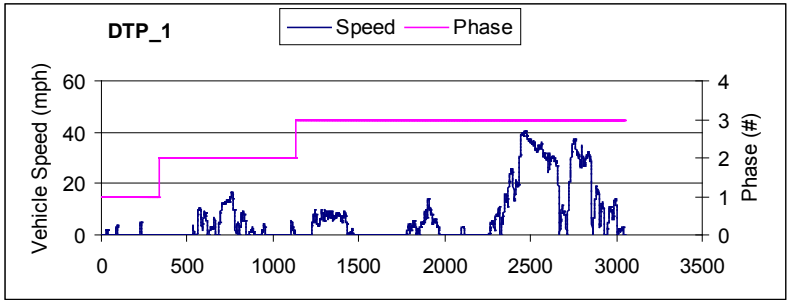
Zero Emission Trucks

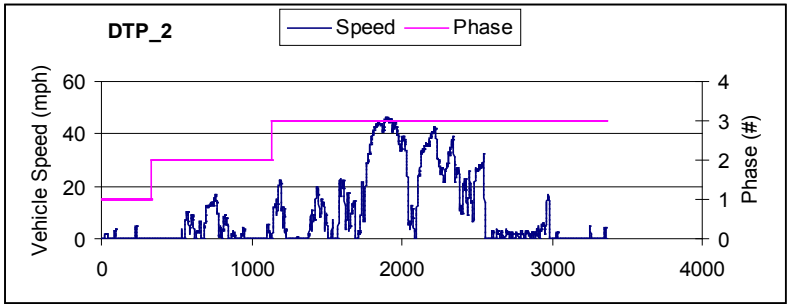
What are the differences?

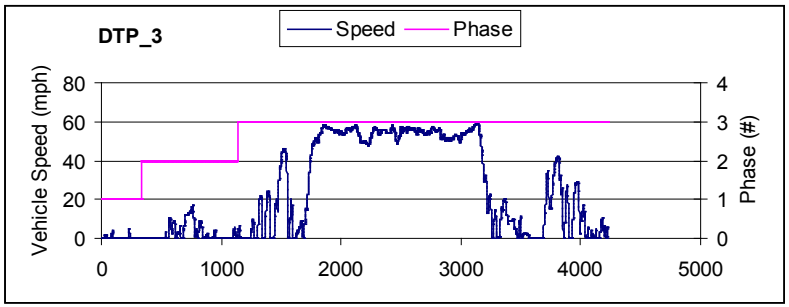
	Balqon	TransPower	US Hybrid	Vision
Transmission	Automatic (dual mode)	Automated Manual Transmission	Automatic	Direct Drive two-speed rear end
Battery Pack/ Fuel Storage	380 kWh $LiFePO_4$	269 kWh $LiFePO_4$	300 kWh Li-ion (NCA)	130 kWh $LiFePO_4$/ 20 kg H_2
Charger	160 kW FC; DC-DC FC with 500 kWh energy storage unit	Two 70 kW on-board Inverter-Charger Units (ICU)	120 kW FC; 6.6 kW on-board Level 2 charger (backup)	Level 2 charger
Recharge/ Refuel Time	3 hrs (160 kW) 1 hr (DC–DC FC)	4 hrs (70 kW ICU)	3 hrs (120 kW FC)	8 hrs (Level 2)/ 10-15 min H_2
Range	100-150 miles	70-100 miles	100 miles	200 miles

Project Approach
Chassis Dynamometer Evaluation

- Each manufacturer to test at least one demonstration vehicle on a chassis dynamometer to validate and optimize the vehicle performance
- Vehicles to be tested on the Drayage Truck Port Cycle
  - Simulate typical drayage truck operations
  - Consist of three modes:
    - Near dock (2-6 miles)
    - Local (6-20 miles)
    - Regional (20+ miles)
- University of California , Riverside or other approved institution to perform the testing UC RIVERSIDE CE-CERT







DTP Cycle: near dock (DTP_1), local (DTP_2), regional (DTP_3)

Project Approach
Field Demonstration

- Two-year demonstration in real world drayage service with partnering fleets in the South Coast Air Basin
  - Total Transportation Services and California Cartage Company
- Evaluate the performance of demonstration vehicles for drayage duty cycle
  - Battery electric trucks
  - Fuel cell hybrid electric trucks (extended range)
- Assess total cost of ownership for drayage truck applications
  - O&M cost savings to offset higher capital costs
- Evaluate different charger technologies for more accommodating charging infrastructure to support drayage operations
  - On-board charger (ICU)
  - DC–DC fast charger with 500 kWh energy storage unit

Project Approach
Data Collection and Analysis
National Renewable Energy Laboratory (NREL)

- Manufacturers to install on-board data loggers to collect and transmit required vehicle, charger and ambient data during the two-year demonstration
- Manufacturers or partnering fleets to provide maintenance and operational cost data on a monthly basis
- NREL to evaluate the in-use performance and O&M costs of demonstration vehicles and to provide quarterly and final reports

Collaborations and Coordination

- Four EV manufacturers, as subrecipients, to develop and demonstrate four different types of electric drayage trucks
  - Balqon, TransPower, US Hybrid, Vision Industries
- NREL, as subrecipient, to analyze the in-use performance data for demonstration vehicles
- University of California, Riverside to perform chassis dynamometer testing to validate the performance of demonstration vehicles
- Fleet partners, Total Transportation Services and California Cartage Company, to deploy demonstration vehicles in real world drayage service

Future Work

- FY 13
  - Complete drive system designs by Q3
  - Vehicle integrations to begin in Q4
  - Coordinate with NREL and manufacturers for data collection arrangement
- FY 14
  - Chassis dynamometer testing for performance validation
  - Field demonstrations to begin in Q1
  - Complete vehicle integrations by Q3
  - NREL to provide performance analysis reports on quarterly basis

Summary

- Objective of this project is to develop and demonstrate zero emission drayage trucks in real world drayage service to promote market acceptance and demand
- One year to develop four different types of heavy-duty zero emission drayage truck technologies
  - Three types of battery electric trucks (Balqon, TransPower, US Hybrid)
  - Fuel cell hybrid electric truck (Vision Industries)
- Chassis dynamometer testing for vehicle performance validation and optimization
- Two-year demonstration with partnering fleets in port drayage operations in the South Coast Air Basin
- NREL to analyze the performance and cost data for demonstration vehicles