PROJECT ID: ELT260

Improving the Freight Productivity of a Heavy-Duty, Battery Electric Truck by Intelligent Energy Management

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Overview

TIMELINE

Oct. 2019 — Dec. 2022

5% completion

BUDGET:

Total Project Funding: $4,869,889

- DOE: $3,799,536
- Industrial cost share: $1,070,353

Partners:

- University of Minnesota
- Greenlots
- HEB Companies
- Murphy Logistics

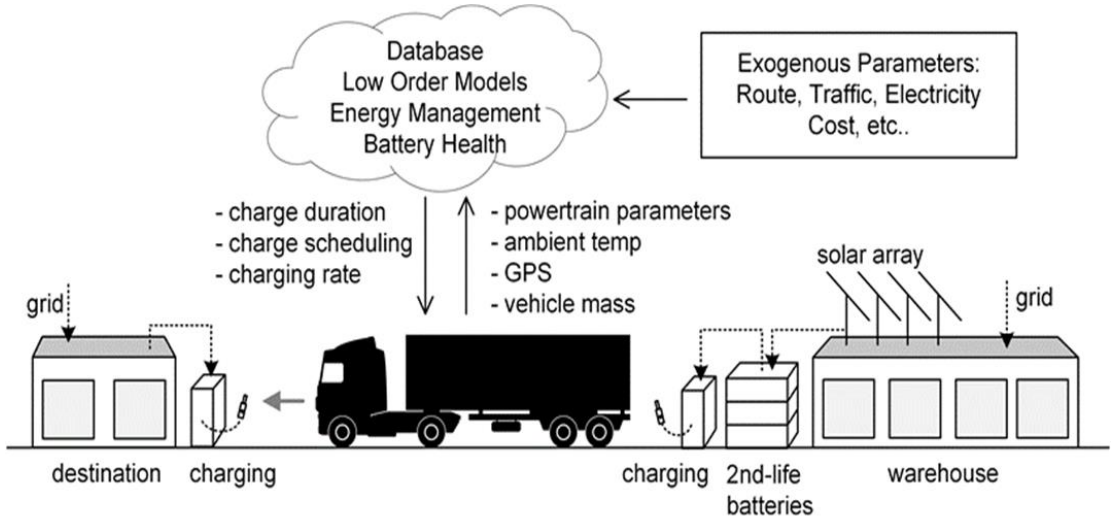
BARRIERS:

- Total cost of ownership:
  - High purchase price and range of charge and payload
- Performance Validation:
  - Fleets need better performance data on Battery Electric Trucks, (BEVs), in real-world usage to validate the reliability of the vehicles
- Infrastructure Needs:
  - Infrastructure cost and planning complications

Relevance

Impact:

Decrease the cost and time required for on-route charging, recommend energy efficient routing, and provide eco-driving recommendations to the operator.



Objective:

Research, develop, and demonstrate life cycle cost-effective Class 8 battery electric vehicles equipped with an intelligent Energy Management System (i-EMS) capable of commercial operations of ≥250 miles per day as well as increased efficiency and productivity when compared to baseline 2019 Mack and 2015-2020 Volvo heavy duty battery electric vehicle fleet performance.

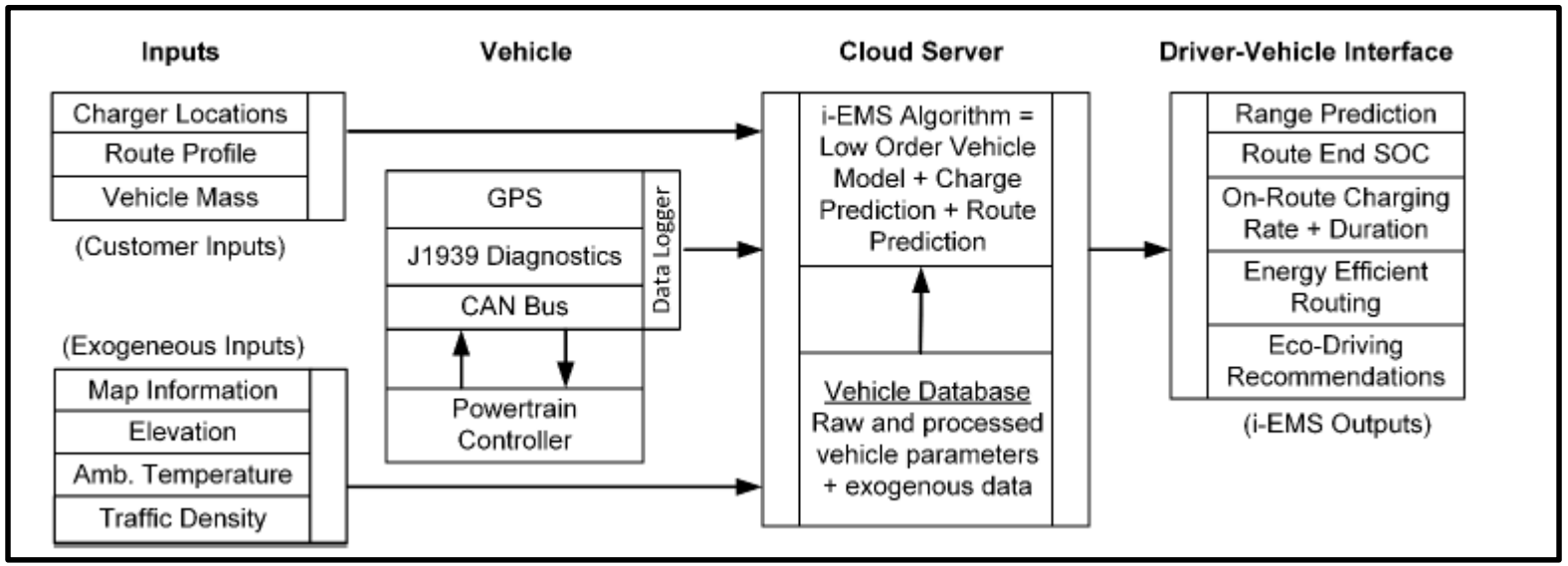
MILESTONES

FY	Milestone	Type	Description	Status
FY2020	Baseline database created	Technical	Baseline database is created for all vehicle data and representative duty cycles are defined for the project	In process
	Battery Electric Truck specification	Technical	Battery Electric Truck specification is ordered for build and delivery. Verified to Achieve Performance Measures, i.e., proper battery configuration.	In process
	Initial battery electric truck simulation model is complete	Technical	Initial, physics based battery electric truck model is complete	In process
	Begin development of machine learning algorithm	Technical	Initial data and discussion allows for development of core algorithm to begin.	In process
	Published verification plan and project requirement document completed	Go/No-Go	Published verification plan and project requirement documents outlining demonstration and evaluation plan is completed	
FY2021	Beta algorithms meet performance requirements	Technical	Beta algorithms meet performance requirements to enable initiating of software development, i.e., identify and minimize on-route charging cost.	
	Completed energy-efficient routing and driving algorithms	Technical	Completed energy-efficient routing and driving algorithms	
	Driver interface app	Technical	Complete driver interface app to install on test vehicles that communicates with vehicle and cloud server	
	i-EMS performance	Technical	i-EMS performance is verified with actual truck operation per duty cycle definition	
	On-route charging locations are defined	Go/No Go	Define necessary on-route charging locations for each customer site to accomplish the 250-mile range objective	

APPROACH

- Understand fleet partners' baseline operations and establish project duty cycles
- Combine physics-based truck model, battery information, utility demand charges and database parameters as inputs to a machine learning algorithm that will predict energy use, operational energy cost, and battery performance
- Implement i-EMS on 2 Battery Electric Vehicles, (BEVs), using a low-distraction screen to display charging and routing recommendations to operators
- Install vehicle charging locations at fleet partners
- Demonstrate i-EMS in daily operations with fleet partners covering both cold and hot-weather conditions

Schematic describing the flow of inputs and vehicle data



ACCOMPLISHMENTS

- Fleet partners' baseline operations:
  - 10 Vehicles have been identified at Murphy Logistics
    - VIN# information is being collected
  - Understand fleet partners' baseline operations and establish project duty cycles
- Physics-based truck model
  - University of Minnesota has identified all of the model parameters, their descriptions, and current values for the electric truck model
  - Volvo engineers are currently reviewing them based on:
    - Fuel/Drive System
    - Physical Specifications
    - Validation Data
    - Drive Train Specific

COLLABORATION

Organization	Key Contributions
Volvo	Principle Investigator, Contract Management, Project Management and engineering resources for truck operation, data collection and route simulation
University of Minnesota	Vehicle to cloud data management, algorithm development, data analytics, secondary driver display
Greenlots	Electric charging support, installation of chargers
HEB Companies	Fleet testing, operational data, driver feedback
Murphy Logistics	Fleet testing, operational data, driver feedback

PROPOSED FUTURE WORK

Continue with the project plan activities:

Task Name	Start	2020					2021			
		Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Task 1: REQUIREMENTS & PLANNING										
Task 1.2: Collect and analyze fleet customers' baseline duty cycles	Q12020									
Task 1.3: Create a baseline database using all collected parameters for chosen duty cycles and decide representativeduty cycles for the project	Q12020									
Task 1.4: Create the project verification plan	Q12020									
Task 1.5: Place purchase order for build of truck demonstrator	Q42020									
Task 2: TECHNOLOGY & ALGORITHM DEVELOPMENT										
Task 2.1 Create physics-based, battery electric truck model	Q32020									
Task 2.2: Create initial machine learning	Q22021									
Task 2.3: Define locations for on-route charging	Q32021									
Task 2.4: Determine optimal on-route charging locations for fleets	Q42021									
Task 2.5: develop driver-vehicle interface	Q42021									

Any proposed future work is subject to change based on funding levels

SUMMARY

- The project will develop an intelligent Energy Management System (i-EMS) for use with Volvo's electric heavy-duty tractors for use on regional haul freight movement routes that operate at least 250 miles a day.

- The developed i-EMS technologies will decrease the cost and time required for on-route charging, recommend energy efficient routing, and provide eco-driving recommendations to the operator.

- The developed i-EMS will be integrated onto two early production Volvo Electric Class 8 tractors and demonstrated in-service at the two partner fleets (winter in Minnesota and summer in Texas) to determine the performance and optimize the system.

- The full suite of vehicle analysis in the i-EMS will extend the vehicle's battery driving range by 20-30%. When combined with utility service cost savings, Volvo is projecting a vehicle operating cost efficiency improvement of 50%.