DAIMLER DAIMLER TRUCKS NORTH AMERICA

DTNA EMG INNOVATION ECASCADIA 2.0

Development and Commercialization of Heavy-Duty Battery Electric Trucks Under Diverse Climate Conditions

2020 DOE Vehicle Technologies Office Annual Merit Review

Principal Investigator: Marcus Malinosky

Organization: Daimler Trucks North America LLC (DTNA)

Project ID: elt259

Date: 6/3/2020

In partnership with

ups meijer South Coast AQMD

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OVERVIEW

TIMELINE

- Project Start: October 2019
- Project End: December 2022
- ~ 15% complete

BUDGET

- Total Project Budget: ~ 10 Million
  - DOE Funding: ~ 4.6 Million
  - DTNA Cost Share: ~ 5.56 Million
- Budget Period 1: ~ 4.56 Million
  - DOE Funding: ~ 2.2 Million
  - DTNA Cost Share ~2.36 Million

PARTNERS

- United Parcel Service (UPS)
- Meijer
- South Coast Air Quality Management District (SCAQMD)

BARRIERS

- The all-electric, medium- and heavy-duty (MD/HD) truck market is limited to short-range application
- All-electric HD trucks are produced by small volume manufacturers with limited ability to scale production, provide after-sales support or engage with dealers

TECHNICAL TARGETS

- Develop and bring to market a fully commercialized, all-electric Class 7/8 day cab tractor
- Increase range capabilities to 250 miles per charge and improve efficiency to achieve 2.0 kWh/mile through a redesigned 500-550 kWh battery back system and ultra-efficient integrated e-axles.
- Provide a life-cycle cost-effective and zero-emission freight movement solution for more than 70% of use cases

RELEVANCE

DTNA Freightliner eCascadia 2.0

IMPACT

- This project advances state-of-the-art heavy-duty electric truck technologies to full commercialization and provides a platform for the market to reduce:
  - fleet operation, maintenance and energy costs
  - diesel consumption
  - carbon, nitrogen oxides (NO_x), particulate matter (PM) and emissions.

PROJECT OBJECTIVES:

- Develop and demonstrate a fully commercialized Class 7/8 electric tractor with sufficient range and durability to meet the needs of 70% of U.S. freight movement

- Improve performance over baseline prototype eCascadia:
  - increased range
  - increased fuel efficiency
  - increased battery capacity
  - reduced curb weight
  - lighter battery packaging
  - enhanced motor design, software, telematics and diagnostic systems custom-designed for electric trucks.

MILESTONES

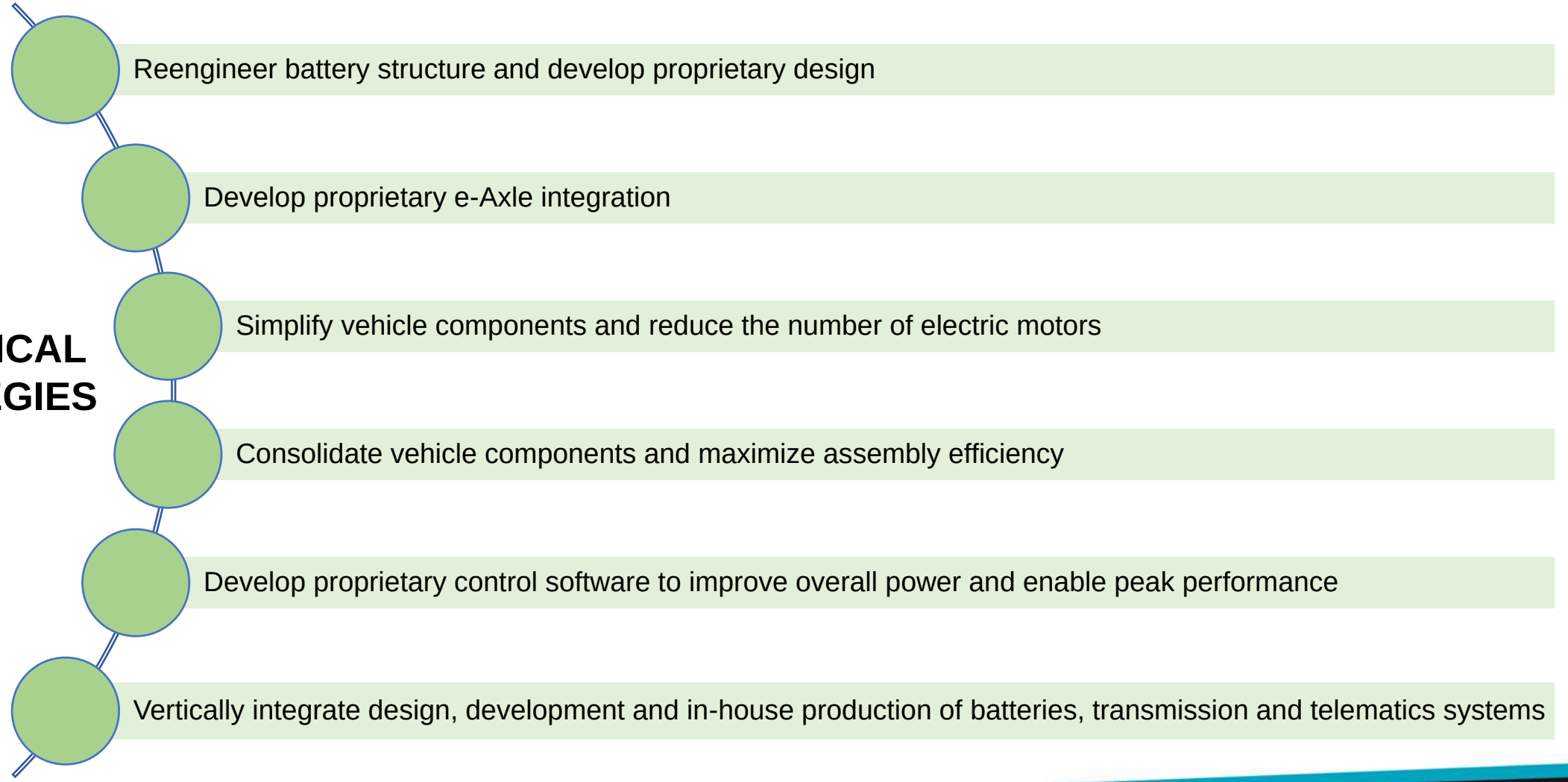
PHASE	DESCRIPTION	STATUS/COMPLETION DATE*
Phase 1a Research, Design, Building and Commissioning: Vehicle Design and Specification (Budget Period 1)	100% Finalization of Component Specifications	COMPLETE (July 2019)
	Feasibility Analysis of Series Development Confirmed *(Go/No-Go)*	COMPLETE (April 2020)
	Project Implementation Specifications Confirmed	COMPLETE (April 2020)
	Supplier Pre-Selection Confirmed	June 2020
	B-Sample Vehicle Specification Targets Achieved *(Go/No-Go)*	September 2020
Phase 1b Research, Design, Building and Commissioning: Commercial Scale Production Model (Budget Period 2)	Target Vehicle Metrics Achieved	November 2020
	Final Assembly of Test Vehicles Complete	June 2021
	Finalization of Data List to be Collected and Analyzed	June 2021
	Finalization of Design Elements	June 2021
	C-Sample Vehicle Specification Targets Achieved *(Go/No-Go)*	June 2021
Phase 2 Deployment and Demonstration (Budget Period 3)	Start of Production Tests/ 100% of Parts are Customer Ready	November 2021
	Start of Commercial Series Production	January 2022
	Vehicle Delivery and Demonstration Initiation	June 2022
	Data Evaluation, Measurement and Verification	December 2022

** Please note that this table reflects completion dates that may be impacted by the ongoing COVID-19 public health crisis.*

APPROACH

DTNA EMG is leveraging global design, engineering, sourcing and vertically integrated production capabilities to quickly achieve economies of scale and reduce product costs. Through a ‘co-creation’ approach with fleet partners, DTNA EMG will collect operator feedback and determine best practices for continuous improvement.

TECHNICAL STRATEGIES



TECHNICAL ACCOMPLISHMENTS AND PROGRESS

- B-sample build completed April 2020
- B-Sample vehicle testing in process
- C-Sample vehicle design and integration is in process with approximately 75% of the design documented
- C-sample vehicle simulation is ongoing.
- D-Sample vehicle design is in process
- D-Sample development supplier selection in process

Key Takeaway: The project team has made significant progress and achieved critical project milestones for Phase 1a: Research, Design, Building and Commissioning – Vehicle Design and Specifications, including completion of the B-sample build.

DTNA Freightliner eCascadia 2.0 B-Sample truck

Partner Organizations

- **Organization**: Meijer
- **Location** : Grand Rapids, MI
- **Contribution**: In-kind support, Fleet Partner for Vehicle Deployment & Demonstration in Meijer fleet operations in Michigan

- **Organization**: United Parcel Service (UPS)
- **Location** : Atlanta, GA
- **Contribution**: In-kind support, Fleet Partner for Vehicle Deployment & Demonstration in UPS fleet operations in Southern California

- **Organization**: South Coast Air Quality Management District (SCAQMD)
- **Location**: Diamond Bar, CA
- **Contribution** : In-kind support, Regulatory Guidance

REMAINING CHALLENGES AND BARRIERS

- **COVID-19**
  - The project team has experienced global supply delays for vehicle components due to the current COVID-19 public health crisis and DTNA has had to pause orders from suppliers that are currently unable to fill orders and/or perform deliveries.
  - DTNA has modified production protocol to comply with the public health guidelines calling for a 6 ft distance between individuals, which reduced the number of people able to work on a vehicle from the typical 10+ down to only 2 -3 at a time. This slightly delayed the completion of the B-Sample build as well as the progress of the C-sample build, however the project team is still making tremendous progress despite these limitations.
  - The COVID-19 public health crisis has impacted the project team's ability to travel and meet with fleet partners in order to access their infrastructure needs. Infrastructure evaluation for United Parcel Service (UPS) and Meijer is still planned but delayed due to travel restrictions.
- **Emerging Technologies and Prototype parts**
  - DTNA and suppliers are both working with new technologies which provides an opportunity to learn together about developing prototype equipment but also presents unique challenges. For example, DTNA experience leakage currents with DC/DC converters which required the project team send parts back/forth all over the world. This issue caused delays not typically seen in normal commercial production, as often-times even global suppliers will only have one plant where prototypes are produced.
- **Order Volumes**
  - The volume of parts orders for trucks, especially prototype/demonstration vehicles, are relatively low compared with the order volume for passenger cars, which can lead some suppliers to treat truck supply orders as a low priority. DTNA leverages its passenger car business to get supplies quickly and uses common parts whenever possible; but this leads to other issues with durability, as the range and environmental conditions seen with truck operations are drastically different than light-duty vehicles.

FUTURE RESEARCH

Remainder of Budget Period 1

- Continue B- Sample vehicle testing
- Complete C-Sample vehicle design, integration and simulation
- Begin C-Sample vehicle procurement
- Complete D-Sample vehicle development supplier selection
- Begin D- Sample tooling supplier selection to begin

Budget Period 2

- Continue C-Sample vehicle component procurement
- Build and Commission C-Sample test vehicles
- Procure D-Sample vehicle components
- Begin vehicle testing for integration, functionality, durability and reliability

Budget Period 3

- Complete vehicle testing
- Demonstrate technical and commercial market readiness
- Deliver first trucks to fleet customers
- Data evaluation, measurement and verification (EM&V)

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

SUMMARY

Key Takeaway: Despite the challenges and barriers outlined in this presentation, DTNA EMG remains on track to develop the fully commercialized, all-electric Class 7/8 day cab tractor with improved range, efficiency, durability and performance. The project team has passed critical milestones and technical progress to date is summarized in the table below.

PHASE	STATUS
Phase 1a: Vehicle Design and Specification	**In Progress**
B-Sample Battery Commissioning	Complete January 2020
B-Sample High Voltage (HV) Commissioning	Complete April 2020
B-Sample Engine Control Unit Commissioning	Complete April 2020
B-Sample Build Complete	Complete April 2020
B-sample Vehicle Testing	In progress
C-Sample Vehicle Simulation	In progress
D-Sample Vehicle Design	Started