

## Executive

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**Project Title:** Weight impacts of Heavy-Duty Zero Emission Vehicles

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## Weight Impacts of Heavy-Duty Zero Emission Vehicles

Assessing Impacts of Heavier Electric Trucks on Infrastructure, Safety, and Freight to Guide Caltrans Policy Decisions.

### WHAT IS THE NEED?

With Governor Newsom's Executive Order N-79-20 setting a mandate for 100% zero-emission (ZE) medium and heavy-duty vehicle operations by 2045, California is undertaking a major transition in its freight and transportation systems. However, this transition comes with a significant engineering and logistical challenge: ZE trucks (particularly battery electric trucks (BETs)) are substantially heavier than their diesel counterparts. These weight increases can accelerate wear and deterioration of pavements, strain bridge infrastructure, and potentially heighten road safety risks, especially in high-traffic freight corridors. Because California's infrastructure was not designed with these heavier vehicles in mind, there is an urgent need to evaluate the long-term structural and financial implications of this shift.

Moreover, although ZE technologies provide significant environmental and public health benefits by reducing greenhouse gas emissions, the transition to these technologies brings a number of complex and uncertain challenges. As ZE technologies evolve (such as advancements in battery types and hydrogen fuel cells), vehicle weights and axle configurations are expected to vary. These differences will also lead to changes in how and where the vehicles are used over time and across different regions. These variations must be understood to forecast the demands placed on pavement, bridges, and safety systems. Without clear data and modeling, state agencies such as the California Department of Transportation (Caltrans) risk underestimating the maintenance costs and safety challenges associated with the transition. Therefore, this research is necessary to develop evidence-based, actionable recommendations to help Caltrans prepare infrastructure and policy measures that support California's ZE future while mitigating adverse impacts on its highway system.



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## WHAT ARE WE DOING?

This study aims to evaluate the impacts of medium- and heavy-duty BETs on California's highway infrastructure and safety as the state transitions to zero-emission vehicles (ZEVs) through 2045. The first step is to quantify expected vehicle and axle weights of BETs, which depend on a wide range of evolving factors such as policy decisions, technology developments, and socioeconomic trends. These variables will be captured in a set of plausible modeling scenarios developed in Task 1. Two scenarios will be selected and used throughout the project to assess their impacts on freight movement, pavement performance, bridge integrity, and roadway safety.

Using these scenarios, the research team will translate projected vehicle weights into axle load distributions (Task 2), analyze how these loads affect freight patterns (Task 3), and evaluate infrastructure wear on pavements (Task 4) and bridges (Task 5). In parallel, Task 6 will assess how increased vehicle weights and new technologies could impact traffic safety, including crash characteristics and vehicle stability. Throughout the project, the team will use Caltrans tools and data such as Weigh-in-Motion (WIM) records, California Statewide Travel Demand Model (CSTDm) projections, and pavement/bridge modeling software. The culmination of these efforts will be a Final Report (Task 7), summarizing outcomes and providing guidance to support Caltrans' infrastructure planning during California's ZEV transition.

## WHAT IS OUR GOAL?

The goal of this research is to determine the potential impacts of increased vehicle and axle weights associated with medium and heavy-duty BETs on the degradation of pavement and bridges, freight operations, and roadway safety under different scenarios of BET technology evolution and market implementation, and to make recommendations for specific actions that Caltrans may undertake to address the potential impacts.

## WHAT IS THE BENEFIT?

The primary benefit of this project lies in its ability to equip Caltrans with the evidence-based insights and actionable recommendations necessary to navigate the infrastructure implications of California's mandated transition to 100% ZE medium and heavy-duty vehicles ZEVs by 2045. As BETs are significantly heavier than their diesel counterparts, their widespread deployment poses risks to pavement longevity, bridge integrity, and roadway safety, especially on heavily trafficked freight corridors. This research will quantify these impacts under realistic scenarios and provide a framework for data-informed decision-making regarding vehicle weight regulations, infrastructure upgrades, and policy adaptations.

By systematically modeling scenarios that reflect different levels of BET adoption and associated vehicle weight changes, the project ensures that Caltrans can proactively prepare for increased wear and safety challenges rather than reacting to infrastructure failures or safety incidents. Moreover, the research supports state climate goals while helping to balance environmental benefits against the cost and safety implications of heavier ZEVs. In doing so, it positions Caltrans to lead the way in building a more sustainable, safe, and resilient transportation network in the era of electrified freight.

## WHAT IS THE PROGRESS TO DATE?

The contract with the research team has been fully executed, and the project officially began on August 26, 2025.