



Caltrans Division of Research,  
Innovation and System Information

# Research

# Notes

Modal

AUGUST 2022

Project Title:  
Zero-Emission Rail Feasibility

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## Low- and Zero-Emission Rail Feasibility Study – Caltrans Intercity Passenger Services

Low- and Zero-Emission rail research and feasibility assessment of fuel propulsion technology alternatives for California inter-city rail services.

### WHAT IS THE NEED?

Railways are the most environmentally friendly mode of transportation on land per passenger-or ton-mile. Diesel provides the majority of the energy for rail transportation, both in the United States and California. Most of the fleet is older than 10 years and do not meet the latest emission standards, Tier 4.

Even where Tier 4 standards are met, (e.g., latest model of passenger locomotives) emissions are significantly higher than the 2010 onward standards for on-road heavy-duty diesel engines on a grams per brake horsepower-hour basis (e.g., oxides of nitrogen emissions are approximately seven times higher and particulate matter is approximately three times higher). Diesel exhaust is responsible for 70 percent of the cancer risk from airborne toxics and its combustion results in greenhouse gas (GHG) emissions.

California has a statewide goal to significantly reduce its GHG emissions and improve air quality while offering alternative modes of transportation. Rail is an essential part of the transportation mix to achieve the state's goals. The California Department of Transportation (Caltrans) owns large parts of the intercity fleet, which is usually operated by one of the joint power authorities.

Transitioning the state-owned fleet to low-and zero-emission options is essential to ensure contribution to overall state goals and for rail to remain as a credible alternative compared to other modes. Technology shift is enabled by state organizations taking the lead, so that private operators will follow.

### WHAT ARE WE DOING?

This research will identify and evaluate suitable technologies



DRISI provides solutions and  
knowledge that improves  
California's transportation system

for intercity passenger rail to reduce or eliminate airborne toxics and GHG emissions resulting from motive power, considering economic implications and implementation constraints. Technologies will include conventional options such as wayside electrification; different fuels/energy carriers such as renewable fuels, natural gas, and hydrogen; and hybrid options with on-board energy storage devices such as batteries. The emphasis will be on options that eliminate toxic exhaust gases at point-of-use.

Hydrogen fuel cell systems are capable of a zero emissions solution since the only by-products are water and oxygen. The energy supply chain and associated emissions will be considered in California's context including future emission reduction potential (e.g., more renewables in electricity generation), thereby providing a well-to-wheel assessment. Technological challenges and practicality of options for intercity services will be considered.

In a subsequent research project, similar work would be conducted for other railway services, such as streetcar/light rail and commuter, and for freight rail switcher, road-switcher, and line-haul. Beneficiaries of this research will be the operators of California Intercity Passenger Rail on behalf of the state and people of California and in accordance with the California State Rail Plan.

## WHAT IS OUR GOAL?

The proposed project will identify and recommend alternative potentially viable zero and near zero emissions technology options that Caltrans and Joint Powers Authorities can evaluate to apply for funding to convert/purchase rolling stock.

## WHAT IS THE BENEFIT?

This work will contribute to better-informed decision-making to help achieve California's goals of GHG and airborne toxic reductions while offering increased quality of life to the State's

residents through modal choice. This research will allow Caltrans and sister agencies to develop a cohesive policy and plan combined with targeted regulation and funding to ensure sustainable rail transportation while reducing the potential for stranded investment.

Joint powers authorities will benefit through avoiding duplication of effort, assistance with decision making, and technology selection. Furthermore, they benefit from the possibility of shared design, development, purchase, and deployment of zero-emission equipment with a stronger negotiation position with equipment suppliers. Changes in motive power technology will benefit everyone along rail corridors, passengers, and personnel. California could become a national and potentially global leader in zero-emission rail technology and innovation, similar to the success in the automotive sector.

## WHAT IS THE PROGRESS TO DATE?

### Tasks

1. Literature Review – almost complete (awaiting supplier data)
- 2.1 Data acquisition & collection
  - a. Secure data transfer, storage & retrieval (Caltrans standards) established and in use
  - b. Initial route data provided and under assessment
  - c. Other two routes' data still awaited
  - d. Identification of potential alternative data sources underway
4. emissions spreadsheet evaluation
- 2.2 Model Benchmark Simulation
  - a. Simulation build commencing for all three routes
  - b. Simulation tested and evaluated for first route
- 2.3 Model Hydrail Trains
  - a. Component sizing data in progress

The project initially faced some unexpected delays in bringing the sub-contractor on board and is currently facing further delays due to unavailability of data needed.