Analysis and Scenarios of Low-Carbon Options for Heavy Duty Trucks

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Background and Motivation

The trucking sector has historically been poorly represented in long-term models that are used to characterize **energy use and emissions and analyze technology adoption scenarios of low-carbon futures**.

•Many of these energy and scenario models only deal with highly aggregated heavy-duty and medium-duty trucks. These simplifications ignore differences in average driving distances, ownership models and other key variables that drive truck purchase decisions.

•We are developing a ***better set of cost and performance projections for trucks of different types and technologies*** in order to understand the potential role of alternative truck technologies and fuels to reduce emissions in the heavy- and medium-duty truck sectors.

•It is possible to characterize different truck types into many different vocational categories, such as shown in the table below. These all have different duty cycles, different average travel per year, and different fuel use and refueling profiles.

Truck Type	Description or example	Average Mileage/year	Relative fleet size
Long haul	Class 8 long distance travel	Very high ~100,000	Medium
Short haul	Class 7, 8 regional travel	High ~50,000	Low
Heavy-duty vocational	Refuse truck	Medium 20,000 – 30,000	Medium
Medium-duty vocational	Trash compactors, bucket trucks	Medium 20,000 – 30,000	Medium
Medium-duty urban	Delivery trucks (UPS, FedEx)	Medium 20,000 – 30,000	High
Buses	Transit buses, shuttles, coaches	Medium ~30,000	Medium
Heavy-duty vans and pickup trucks	Class 2B and 3 > 8,500 lbs. GVWR	Medium 20,000 – 30,000	Very high

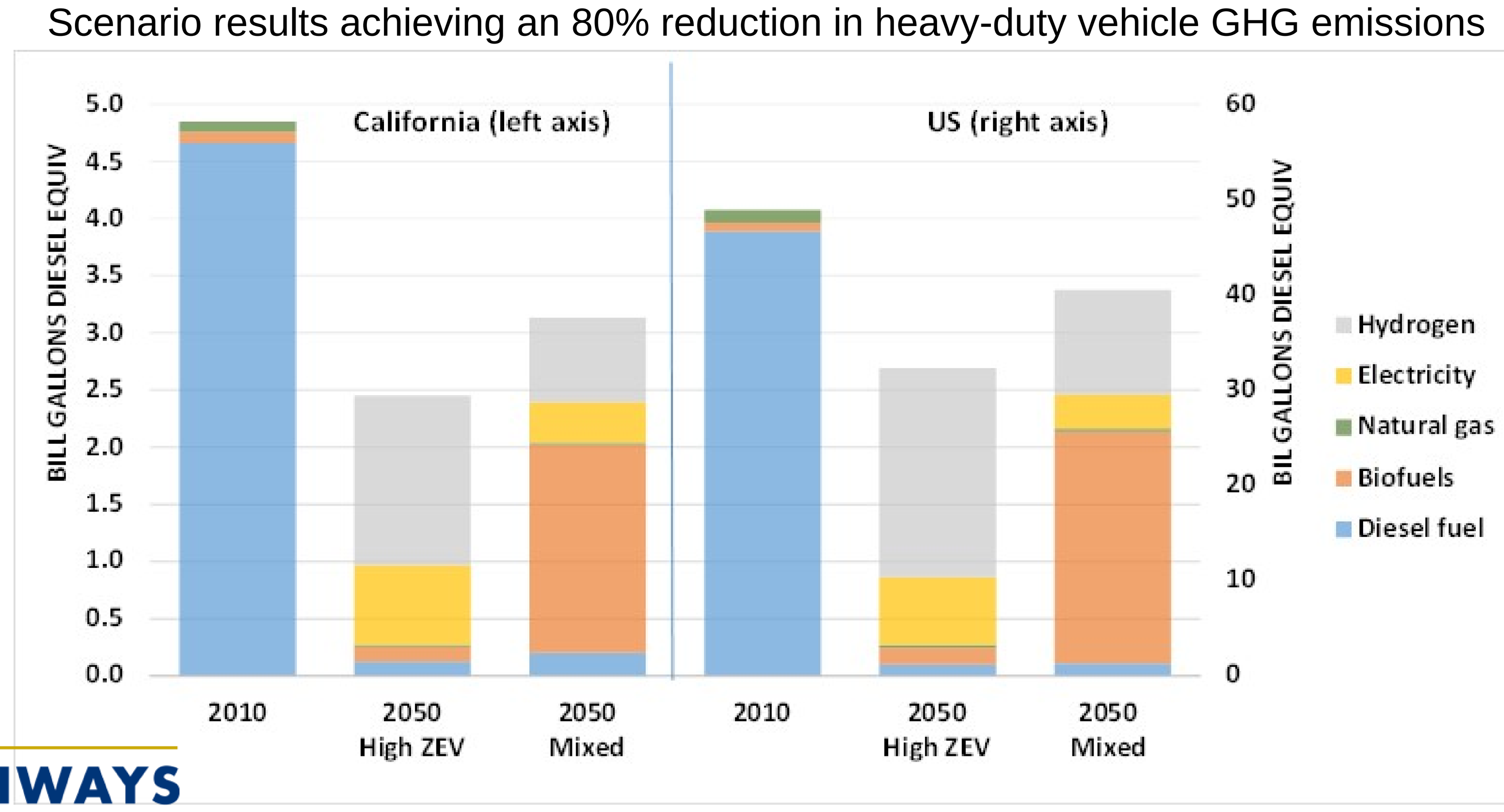
Heavy-Duty Truck White Paper

The starting point for this study is the forthcoming STEPS White Paper *Strategies for Transitioning to Low-carbon Emission Trucks in the United States,* which reviews estimates of truck CO_2 reduction potentials and costs and develops new scenarios to 2050 focused on achieving an "80- in-50" target. These scenarios indicate that a combination of strong uptake of zero-emission trucks and advanced biofuels will likely be needed to hit such a target, but even with this combination it is a very challenging target. It also finds that:

- The costs of deploying ZEVs and advanced biofuels to reduce truck GHG emissions may be substantial in the near term but should decline over time, relative to a baseline scenario.
- The number of ZEV trucks (and the sales trajectory) that could be needed by 2030 suggests that policies targeting the sales of ZEVs may be needed as a complement to fuel economy standards.
- Similarly, policies may be needed to ensure that sustainable, low-carbon hydrogen and diesel-replacement biofuels become available in large volumes in the coming decades.
- As shown in the figure below, the required volumes of fuels (hydrogen, biofuels) could be quite large, despite very strong improvements in fuel economy across truck types that reduces the overall demand for truck fuel considerably compared to 2010 or a 2050 baseline projection.

But more research is needed – how can such scenarios be achieved? The purchase behavior of trucking companies will be critical, and this will be explored in the new study.

Scenario results achieving an 80% reduction in heavy-duty vehicle GHG emissions



New STEPS3 Project

Modeling and Analysis of Emissions and Costs of Sustainable Truck Futures - Incorporating Decision Making into Future Scenarios

- A number of different models try to characterize truck technology and emissions in the future (e.g. CARB's VISION model and the CA-TIMES model).
- The goal is to combine many of the best elements of these models with a detailed **truck cost model** and a "front-end" **truck purchase decision-making framework** to assess the adoption of these technologies over the near and long-term.
- The truck cost model will develop truck costs for a range of truck classes and technologies based upon key component costs.
- The decision framework will consist of a discrete choice model taking into account the purchase behavior of a range of consumer types (large fleets, single owner operators, etc), a range of decision factors (vehicle purchase and operating cost, maintenance/reliability, resale value, refueling time, etc) to enable projections of future truck technology sales mix and explore the implication of technology evolution and policy initiatives.
- We will begin with long-haul, short-haul and delivery trucks. Over time we will add layers of detail such as more truck types, more users/owner heterogeneity, and potentially spatial representation to capture truck purchase behavior in non-attainment areas.

Key Research Questions:

- What factors do truck owners/operators consider when making decisions to purchase trucks?
- How do these factors influence the purchase of alternative fueled and advanced trucks?
- What are reasonable adoption rates for alternative truck technologies in the near-term and how does this influence how we achieve a low-carbon, low emissions fleet to meet longer-term air quality and greenhouse gas goals for transportation?
- What sorts of policy levers and incentives that can help bring about these changes to a sustainable truck fleet?

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