Truck Technology Choice Model: Overview

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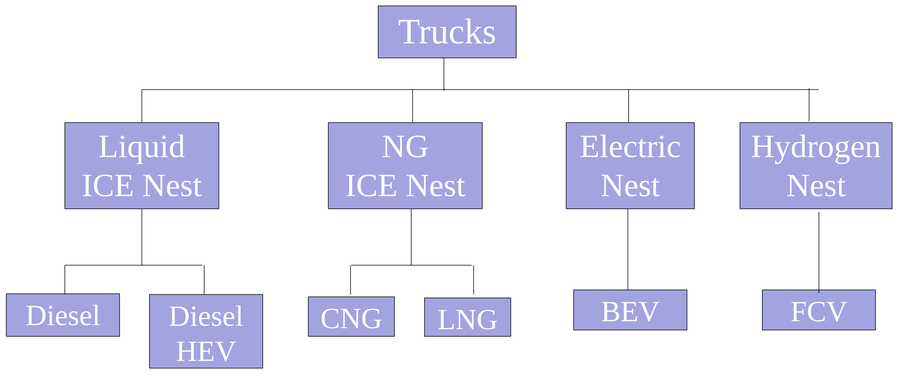
Background

Despite the relatively small number of vehicles, the trucking sector accounts for a disproportionately large and fast increasing percentage of GHG emissions and local criteria pollutants. However, historically the trucking sector has been poorly represented in energy and emission modelling due to its complexity. The objective of this project is to understand the technical characteristics of alternative fuel truck technologies and the barriers of adoption. This work focuses on the development of a detailed choice model that incorporates economic and non-economic factors influencing truck purchases, which is used to analyze scenarios for the future deployment of trucks.

Key Research Questions

- How do fleets and sub-categories (e.g. risk groups) of fleets, differ in their purchase decision making?
- What percentages of the fleet market do these various risk groups represent?
- How large must incentives or subsidies be to make a significant difference in purchase decisions?
- How stringent must a mandate (e.g. for ZEVs) be to have the desired effect on the entire trucking sector?
- What timescales must policy levers be implemented in order to meet climate change goals for 2030 and 2050?
- How does variation in uncertain parameters, such as truck technology costs and adoption in other parts of the world, influence fleet adoption?

The nested multinomial logit framework of the truck choice model



Discrete choice models attempt to explain and predict choices among discrete alternatives. Nesting the model allows correlations between choices.

Methods

- Trucks are disaggregated into several truck categories that encompass specific vehicle types and use patterns. These truck categories will then be segmented into risk groups that have different factors impacting truck purchases. The decision choice model is applied to each of these risk groups to generate the market shares for each vehicle technology.

Truck categories: Long haul, Short haul, Heavy-duty vocational, Medium-duty vocational, Medium-duty urban, Urban buses, Other buses, Heavy-duty pickups

Risk groups: Early adopters, Late adopters, In-betweens

Vehicle technologies: Diesel, Diesel hybrid electric, Compressed natural gas, Liquefied natural gas, Battery electric, Hydrogen fuel cell, Gasoline

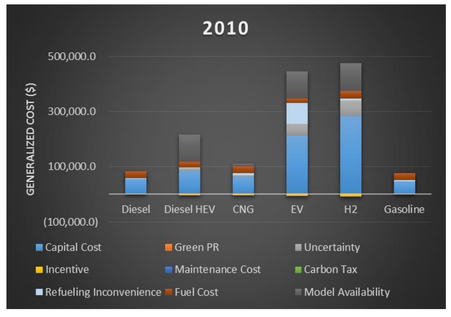
- The truck choice model is structured as a nested multinomial logit (NMNL) model. The model represents a discrete choice formulation that includes a number of important factors that will influence individual decision-makers' preferences among a suite of vehicle technology options. Nests represent groups of close substitutes for decision-makers as they consider the utility of various technology alternatives. The choice formulation assumes a variation in the utility of trucks for decision makers. The utility of each vehicle type is estimated for different truck purchase decision-makers and then translated to purchase probabilities.

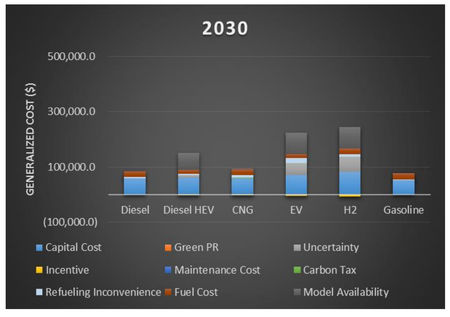
Factors: Capital cost, Fuel cost, Green public relations, Uncertainty, Incentives, Refueling inconvenience, Maintenance cost, Carbon tax, Model availability cost

- The calibrated model can then be used to develop projections, policy analysis, sensitivity analysis, and get a better sense of what would be needed to drive market adoption of different technologies over a given time frame.

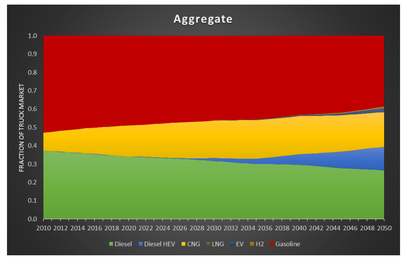
Model Outputs: Sample Results

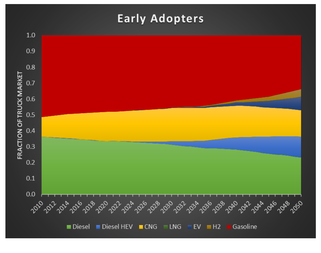
Generalized costs of medium-duty urban trucks for the in-between risk group at three time cross sections. 4-year analysis, low oil price, high carbon intensity, expected carbon tax, expected green PR, low incentives

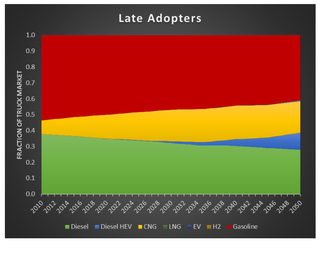


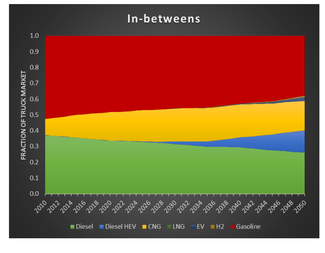


Market share by year of medium-duty urban trucks for three different risk groups and the aggregate. 4-year analysis, low oil price, high carbon intensity, expected carbon tax, expected green PR, low incentives









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