

Sustainable Transportation Energy Pathways (STEPS)

Truck Technology Transitions with a Decision Choice Model

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Work Status / Research Team

- *Work in progress*
- *Research team*
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Outline

- Project Outline
- Preliminary findings
- Decision choice model framework
- Decision choice model parameters/inputs
- Preliminary results
- Next steps

Project Outline

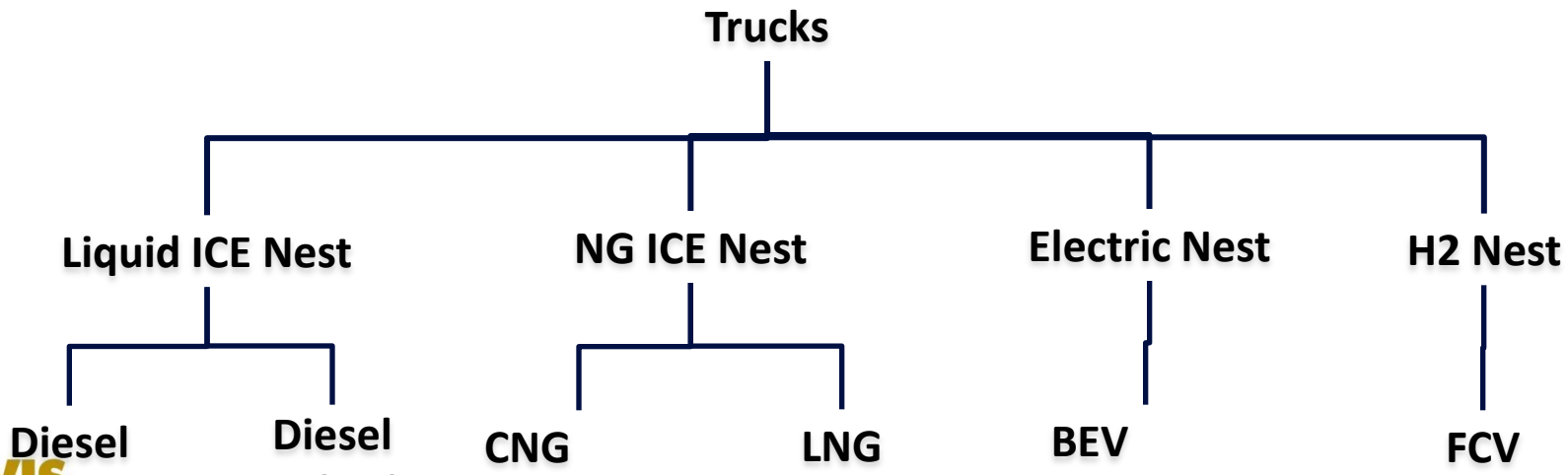
- Understand critical elements of transition to alternative fuels and technologies in MD and HD trucks to reduce GHGs and criteria pollutants through 2050 (Present work – CA, future add US)
- Develop decision choice model which utilizes important purchase decision factors for different truck fleet categories
- Incorporate choice model into ARB Vision model to project truck stock, fuel use, emissions
- Questions:
  - Which factors influence truck purchase decisions?
  - How do reasonable technology adoption rates influence achieving emissions goals?
  - How does infrastructure development influence truck purchases?
  - What policy levers and incentives best help achieve emissions goals?

Preliminary Findings

- Increase payback period, VMT => increase NG, BEV truck sales (vehicles with lower fuel/operating costs will benefit)
- Generalized truck costs converge over time (increased volume sales, green PR, carbon tax, lower risk, incentives all work to reduce spread in costs)
- Fleet purchase factors such as risk, green PR, fuel availability have large uncertainty
  - Major thrust for 2016
- Need more detailed data for specific truck fleet categories to better understand the potential for BEV and FC trucks.
  - Major thrust for 2016

Truck Decision Framework

- Based upon existing vehicle choice models (LDV):
  - Utility of decision-makers is dependent on direct costs as well as a number of other factors related to the technology, perceptions, and fuel infrastructure
- Nested Multinomial Logit Model
  - Used in many vehicle choice approaches based on work by Greene
  - Nests represent groupings of similar technologies that consumers consider close substitutes



Decision Choice Model Parameters

- Capital Cost
- Operating costs (fuel use, maintenance)
- Green PR (Environmental perception)
- Uncertainty (Risk)
- Incentives/Subsidies
- Vehicle Range
- Refueling Time
- Station Availability
- Carbon Tax

Truck Fleet Categories

- Fleet categories can strongly affect decision factors
- HD: Long haul, short haul, drayage (port)
  - Range, station availability
- Fleet size (large, medium, owner operator)
  - Risk
  - Payback period
- Private, For hire
- Challenge to understand how each fleet category makes purchase decisions

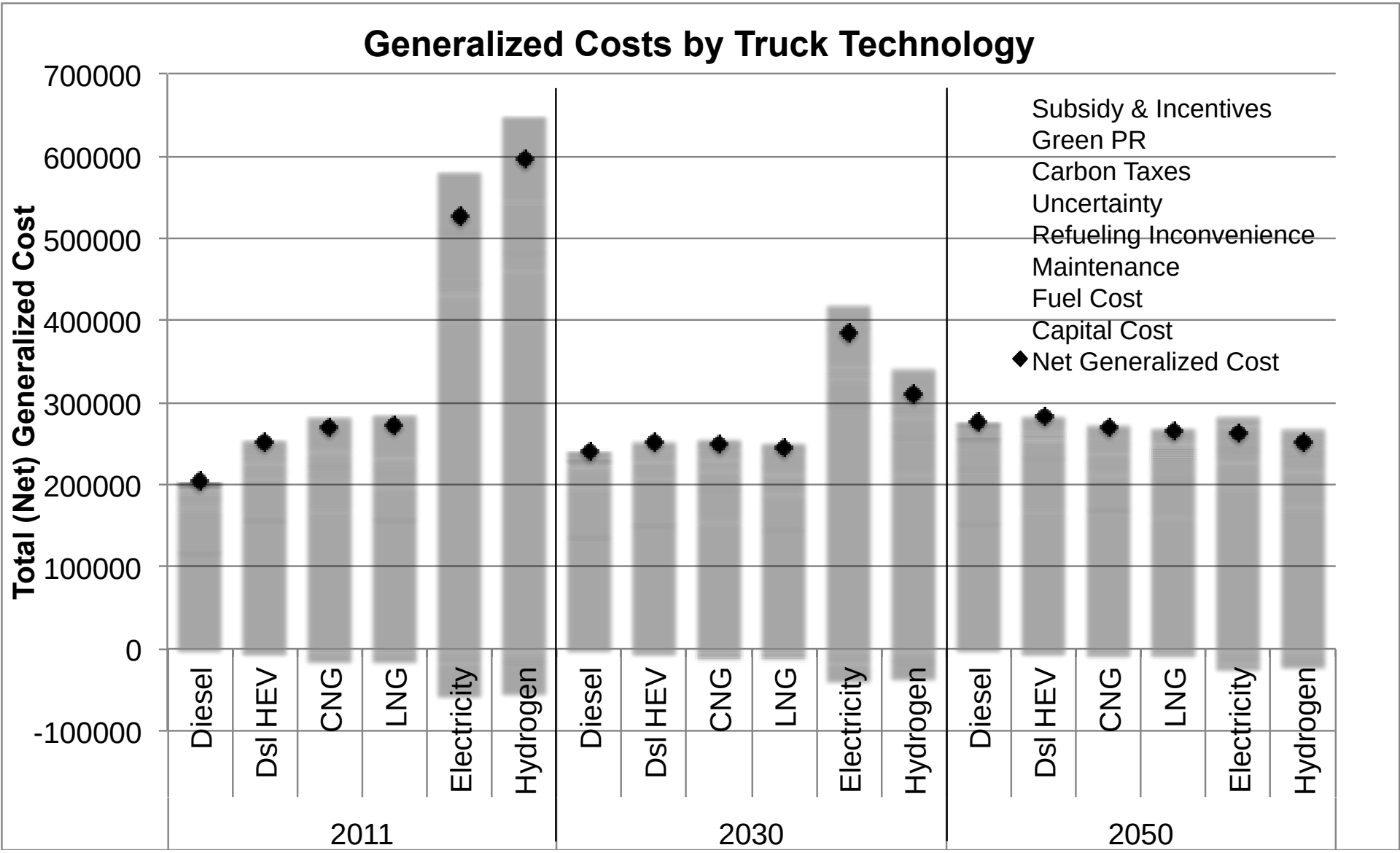
Decision Choice Model Inputs

- Determine weighting of decision factors (How important are factors for various fleet categories?)
  - Interviews with fleet operators and other experts
  - Surveys for fleets operators
- Example inputs (PoLB, PoLA drayage)
  - 2008 regulation: drayage trucks must meet 2007 engine standards
  - Incentives for retrofit diesel engines, LNG trucks
  - Owner operators only considered retrofits (risk, capital cost too high)
  - Some fleets purchased LNG trucks
    - Incentives
    - Fuel cost low
    - Could deal with reliability problems
    - Environmental perception: benefit with Lowes, Target, and other customers

Truck and Fuel Technology Inputs

Truck Segment	Long haul	Short haul	Port/drayage trucks	Heavy duty vocational	Medium-duty vocational	Medium-duty urban	Buses	Heavy-duty vans and pickup trucks
Truck Class	Class 8	Class 7, 8	Class 7, 8	Class 6-8	Class 3-5	Class 3-5	Class 6-7	Class 2B and 3 > 8,500 lbs. GVWR
Vehicle Examples	Tractor Trailer	Tractor Trailer	Tractor Trailer	Refuse truck	Trash compactors, bucket trucks	Delivery trucks	Transit buses, shuttles, coaches	Pickups and Vans
Avg Annual VMT	68,805	20,237	45,594	13,416	5,170	13,150		12,042
Avg Daily VMT	220	65	146	43	17	40		37
Fleet size	112,319	376,946	19,528	41,366	22,274	166,553		752,938
Avg Age	6.8	27.9	5.0	27.3	29.6	29.7		29.7
Avg MPG	5.8	7.1	5.5	4.6	8.0	12.6		14.2
Annual Fuel Consumption	1342.7	1077.1	163.0	120.6	14.4	174.3		637.9
% Fuel Consumption	38%	31%	5%	3%	0%	5%		18%
Vehicle Technology Commercialization								
CNG/LNG	Commercial/ Early Market	Commercial/ Early Market	Commercial/ Early Market	Commercial	Commercial	Commercial	Commercial	Commercial/ Early Market
Hydrogen	--	--	Demonstration	Demonstration	Demonstration	Demonstration	Commercial/ Early Market	Demonstration
Electricity	--	--	Demonstration	Demonstration	Demonstration	Demonstration	Commercial/ Early Market	Demonstration
Vehicle Range / Energy Storage Considerations								
CNG/LNG	Favorable	Favorable	Favorable	Favorable	Favorable	Favorable	Favorable	Favorable
Hydrogen	Challenging	Acceptable	Acceptable	Favorable	Favorable	Favorable	Favorable	Favorable
Electricity	Challenging	Acceptable	Acceptable	Favorable	Favorable	Favorable	Favorable	Favorable
Infrastructure Deployment								
Refueling Considerations	Truck Stops	Truck Stops / Central location	Near Port	Central Fleet Refueling	Central Fleet Refueling	Central Fleet Refueling	Central Fleet Refueling	Conventional Fueling Stations
CNG/LNG	Commercial/ Early Market	Commercial/ Early Market	Commercial/ Early Market	Commercial	Commercial	Commercial	Commercial	Commercial/ Early Market
Hydrogen	--	--	--	--	--	--	Early Market/ Demonstration	--
Electricity	--	--	--	--	Early Market/ Demonstration	Early Market/ Demonstration	Early Market/ Demonstration	--

Generalized Costs – Subsidy (2015, 2030, 2050)

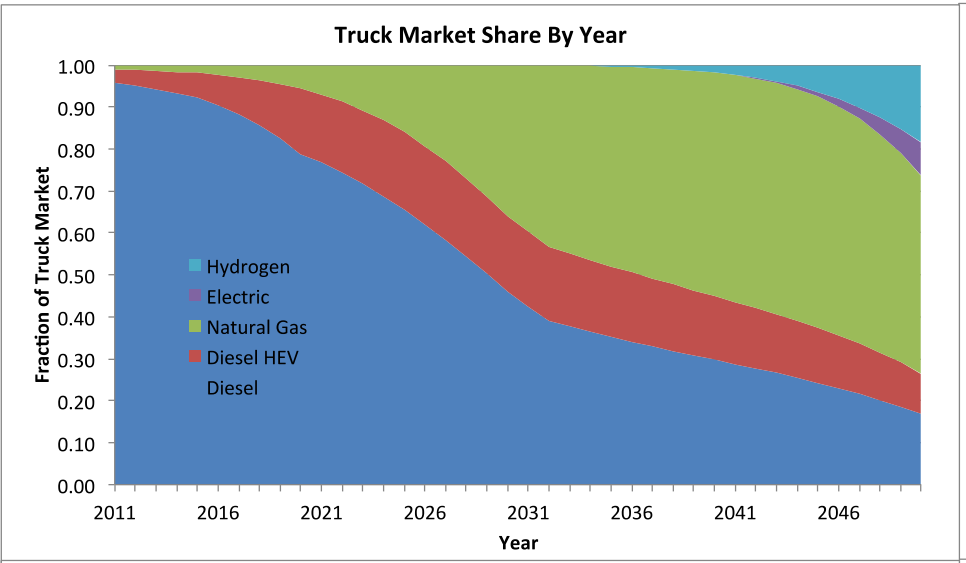


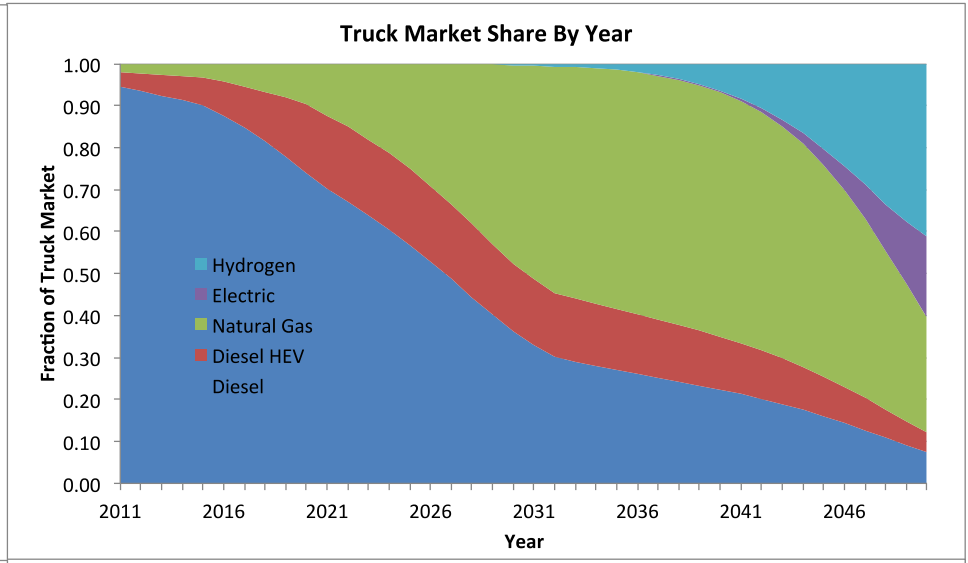
Truck Market and Fleet Shares

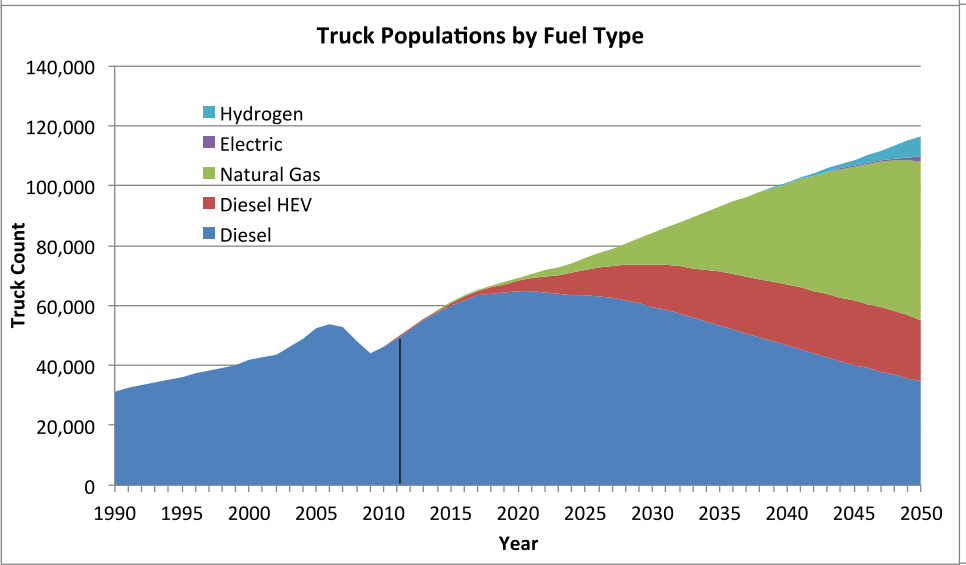
No Subsidy or Carbon Tax

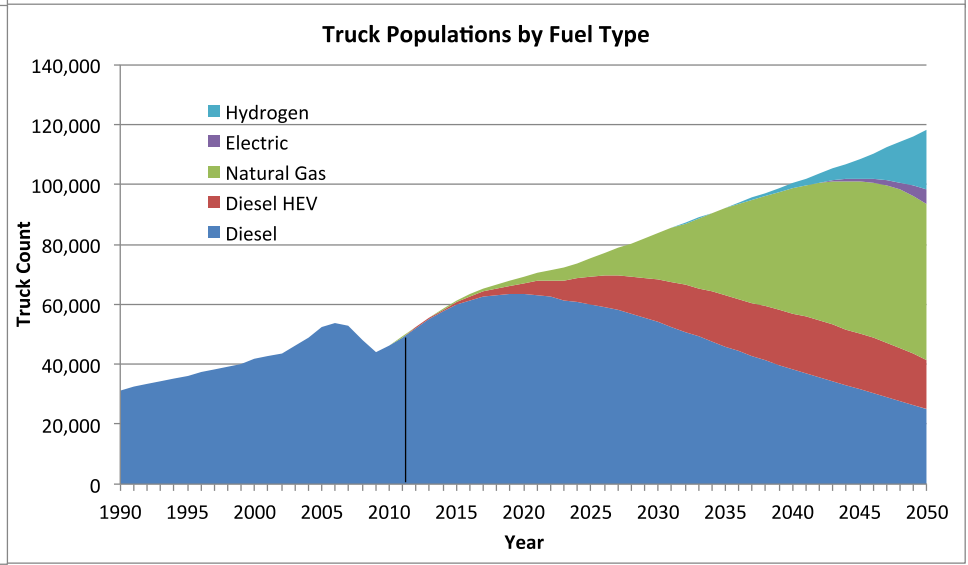
100k miles/yr
1 yr payback

Subsidy and Carbon Tax









Next Steps

- Conduct interviews and surveys with fleets to better understand model parameters
- Expand truck types to include fleet categories where useful (fleet size, private vs for hire, VMT, other segments?)
- Include more detailed data for each truck fleet category (stock, VMT, fuel economy, performance needs, choice factors, etc.)
- Create scenarios based on fleet purchase decisions for transitions to a low emissions truck sector
  - Understand critical factors and time periods for achieving emissions goals
  - Explore policy levers to achieve goals

Thank You