Institute of Transportation Studies | UNIVERSITY OF CALIFORNIA

UCI University of California, Irvine

Drayage Fleet Operator Perspectives on Zero-emission Trucks and Policies

November 20, 2024

Youngeun Bae, Ph.D.
Assistant Project Scientist, ITS-Irvine

Key Terms

- **Drayage trucks**: Class 8 heavy-duty (over 33,000 lbs GVWR) trucks transporting containers and freight between ports and other near-port locations

- **A fleet of vehicles**: A group of one or more vehicles belonging to an organization for business purposes

  A single truck ~ 100+ trucks

- **A fleet operator**: A person who owns and/or manages a fleet of vehicles and is solely or collaboratively involved in fleet procurement decisions for the organization

  Company presidents, CEO, CTO, COO, Fleet managers, Financial/operation dept, Truck drivers, ...

- **Zero-emission vehicles** (ZEVs): Battery electric trucks or Hydrogen fuel cell electric trucks, which produce no tailpipe emissions of criteria pollutants

*image source: https://ww2.arb.ca.gov/resources/fact-sheets/advanced-clean-fleets-regulation-detailed-drayage-truck-requirements

How Will Drayage Fleets Respond to ZEVs and California Truck Regulations?

- California's drayage fleets face strict targets under Advanced Clean Fleets regulations [(a)]:
  - **Starting Jan 2024:** All drayage trucks newly registered in the CARB online system must be ZEVs
  - **By 2035:** All operating drayage trucks entering seaports and intermodal railyards must be ZEVs
- **Critical knowledge gap:** What are the behavior and perspectives of fleet operators (*key demand-side players*) regarding ZEVs and related policies?

*(a) As of 10/25/2024, CARB will not take enforcement action until U.S. EPA either grants a preemption waiver or determines that no waiver is necessary. (https://ww2.arb.ca.gov/our-work/programs/advanced-clean-fleets/advanced-clean-fleets-regulation-advisories)

Presentation Overview

1. Under the ZEV mandate, what factors influence a fleet operator's truck choice if they are ***forced to choose*** between battery electric and hydrogen fuel cell electric trucks?

Fleet operator preferences *under the ZEV mandate*

2. When given a ***free choice*** between ZEVs and status quo alternatives (e.g., diesel and natural gas), what preferences do fleet operators form and by which influencing factors?

Potential reasons *fleets might avoid the policy, such as delaying adoption, if they still prefer diesel or natural gas trucks*

3. How do ***small and large fleets*** respond to the state policy in terms of their business plans?

Equity implications *on ZEV adoption between under-resourced vs more established fleets*

California Drayage Fleet Survey

Survey Design

- **Informed by previous research** (Bae et al., 2018; 2021; 2022; 2023a; 2023b)

✓ *Basic fleet information*
✓ *Truck choices (choice experiment)*
✓ *Fleet management*
✓ *Potential charging behavior*
✓ *Perceptions*

Pretesting

- Resolved errors
- Improved layout
- Ensured logical flow

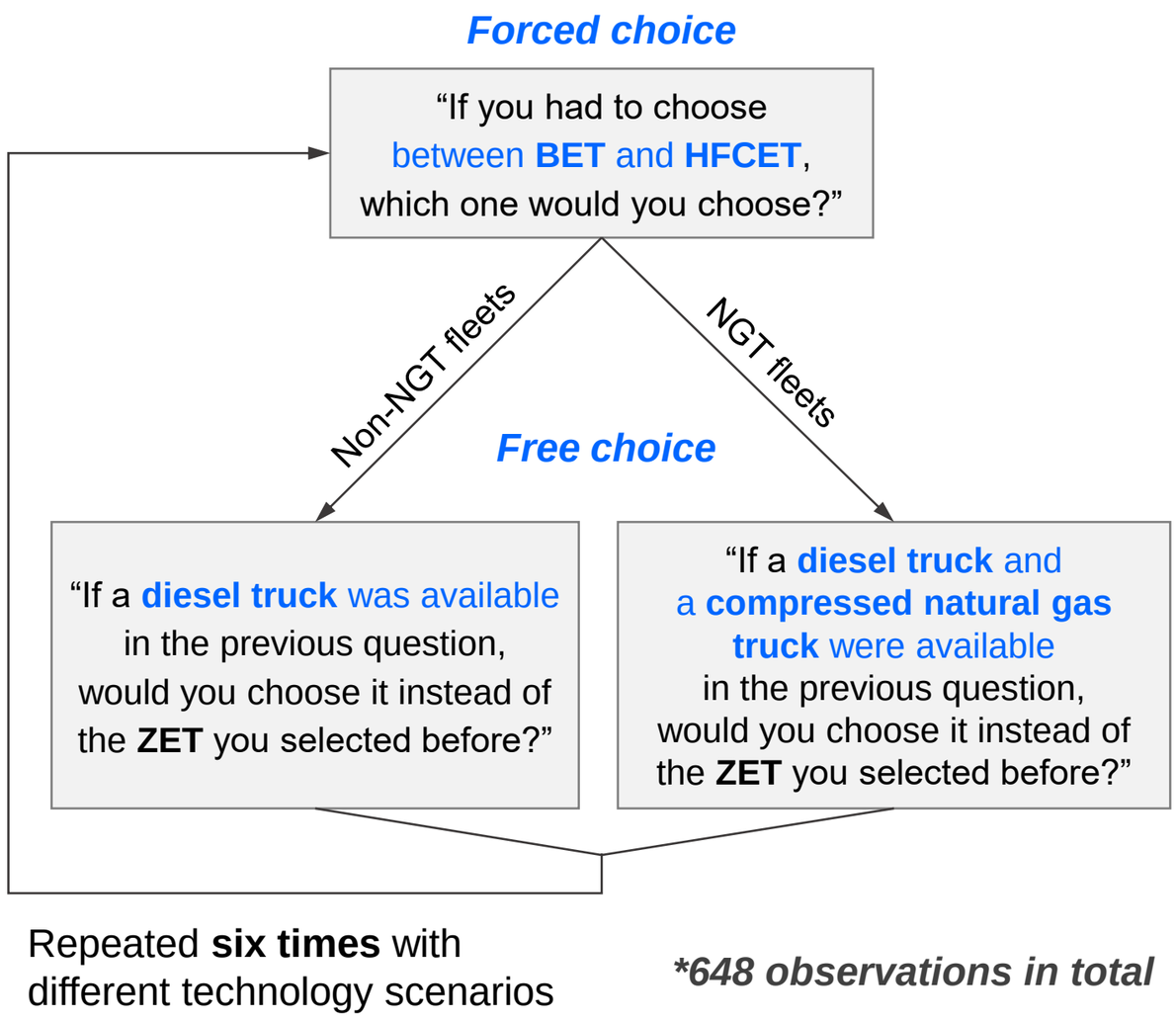
Pilot Survey

- **One-on-one meetings** (June 2023)
- Stratified random sampling
- **12 participants**
- **Obtained prior information** for choice experiment design
- **Tested** questionnaire from fleet operator viewpoints

Main Survey

- **Large-scale** online survey (Dec 2023 – Apr 2024)
- Census method (contacted all drayage companies at POLA/LB)
- **59 participants**
- Updated choice experiment design
- **English/Spanish** ver.

Truck Choice Experiment



Repeated **six times** with different technology scenarios

648 observations in total

Assume that the following hypothetical set of trucks are available, including a battery electric truck (BET) and a hydrogen fuel cell electric truck (HFCET).

	BET	HFCET	Diesel Truck
Purchase costs — Purchase costs (relative to Diesel)	**200** % (incentives unavailable) e.g., $300,000	**105** % (incentives applied) e.g., $158,000	**100** % e.g., $150,000
Operating costs — Operating costs (relative to Diesel)	**70** % e.g., 35 cents/mi	**115** % e.g., 57.5 cents/mi	**100** % e.g., 50 cents/mi
Driving range — Maximum driving range	**300** miles	**500** miles	**700** miles
Emissions — Emission levels (relative to Diesel)	**0** %	**0** %	**100** %
Off-site infrastructure — Shortest distance to off-site fueling/charging stations	within **10** min	Not available	within **5** min
On-site infrastructure — infrastructure construction costs	**100** % of total costs* (no incentives) e.g., $80,000 to $480,000 per charger	**25** % of total costs* (incentives cover 75%) e.g., $500,000 (fast-fill station)	Not applicable
Refueling/ charging time — Refueling/charging time	**31** min to **10** hr (1 MW to 50kW charger)	**10** min	**5** min

Click here for the information about the truck characteristics.

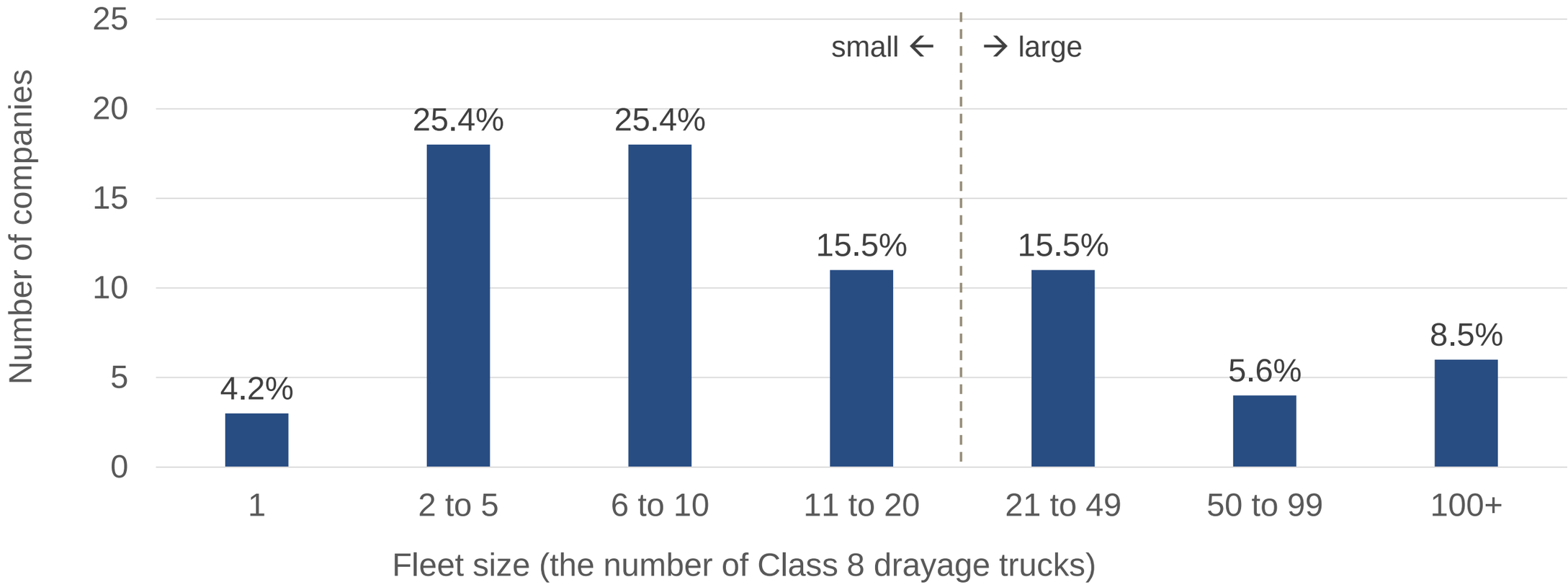
* The total costs for constructing the infrastructure include both the purchase and installation of fueling/charging equipment. Such construction costs vary depending on a scale of the facilities (e.g., the number of chargers or filling hoses). Approximate average costs are as follows:

- For BETs: 1) $80,000 per 50 kW charger; 2) $160,000 per 1
- For HFCETs: $2M for a fast-fill station.

An Example of Choice Tasks

Survey Participants

- 50 small fleets (≤ 20 Class 8 trucks) (70%) and 21 large fleets (30%)



Key Findings When Fleet Operators are Forced to Choose among ZEV trucks

- **Driving range is a critical factor**
  - Longer range increases likelihood of choosing that vehicle
  - BETs: 120-250 miles, HFCETs: 350-500 miles – fall short compared to diesel/natural gas trucks (700+ miles)
- **Offsite charging/fueling stations is crucial for small companies**
  - Small organizations (≤20 trucks, <$15M annual revenue)
  - Charging/fueling availability near their base impacts decisions more than a 100-mile range improvement
- **Vehicle purchase costs are another key driver**
  - Lower costs increase likelihood of the choice
- **Operating costs is also a significant factor for large fleets**
  - Large fleets with >20 trucks
  - Greater sensitivity likely arises from higher total mileage and/or more thorough cost calculations
- **Adopters of zero-emission trucks continue to prefer these vehicles**

Responses From Fleet Operators

“Is there anything you would like to share regarding the topics covered in this survey?”

“Even if the state and federal government were to subsidize every ZEV truck, we still have to make them work! **The limited payload, range, and time it takes to charge are such HUGE problems** […] My customers make money on every pound they ship overseas. They are not going to be ok shipping 10,000 less lbs by using a carrier that uses FCEV or 14,000 less lbs using a BET. […] **Make them with a 700 mile range and cut their weight by 14,000 lbs and I am ALL in. The cost is a barrier, but it is not the only barrier.** These trucks come with a host of issues that most small operations cannot easily overcome.” (Small fleet, 2-5 trucks)

“Operation costs nor price of the vehicle is not the criteria for us to choose which vehicle to purchase. **Refueling accessibility is most important factor for our operation**” (Small fleet, 6-10 trucks)

“What driver will be able to afford a 450k truck? The sales tax alone is 45k. […]” (Large fleet, 21-49 trucks)

Key Findings When Fleet Operators Choose Between ZEVs and Conventional Trucks

- **Driving range remains critical**
- **Construction costs of on-site charging infrastructure are particularly crucial**
  - Without financial incentives, high construction costs may deter fleets from making the switch
- **Strong disinclination for hydrogen fuel cell electric trucks**
  - Possibly due to unfamiliarity with hydrogen trucks and perceived technology unreadiness
- **Vehicle purchase costs remain a key driver**
- **Adopters of zero-emission trucks continue to prefer these vehicles**
- **Natural gas truck adopters were less deterministic in choices**
  - Compared to fleets only with diesel trucks (likely due to decision complexity involving multiple fuel options)

Responses From Fleet Operators

“Infrastructure is so new that **it costs too much** […]” (Small fleet, 11-20 trucks)

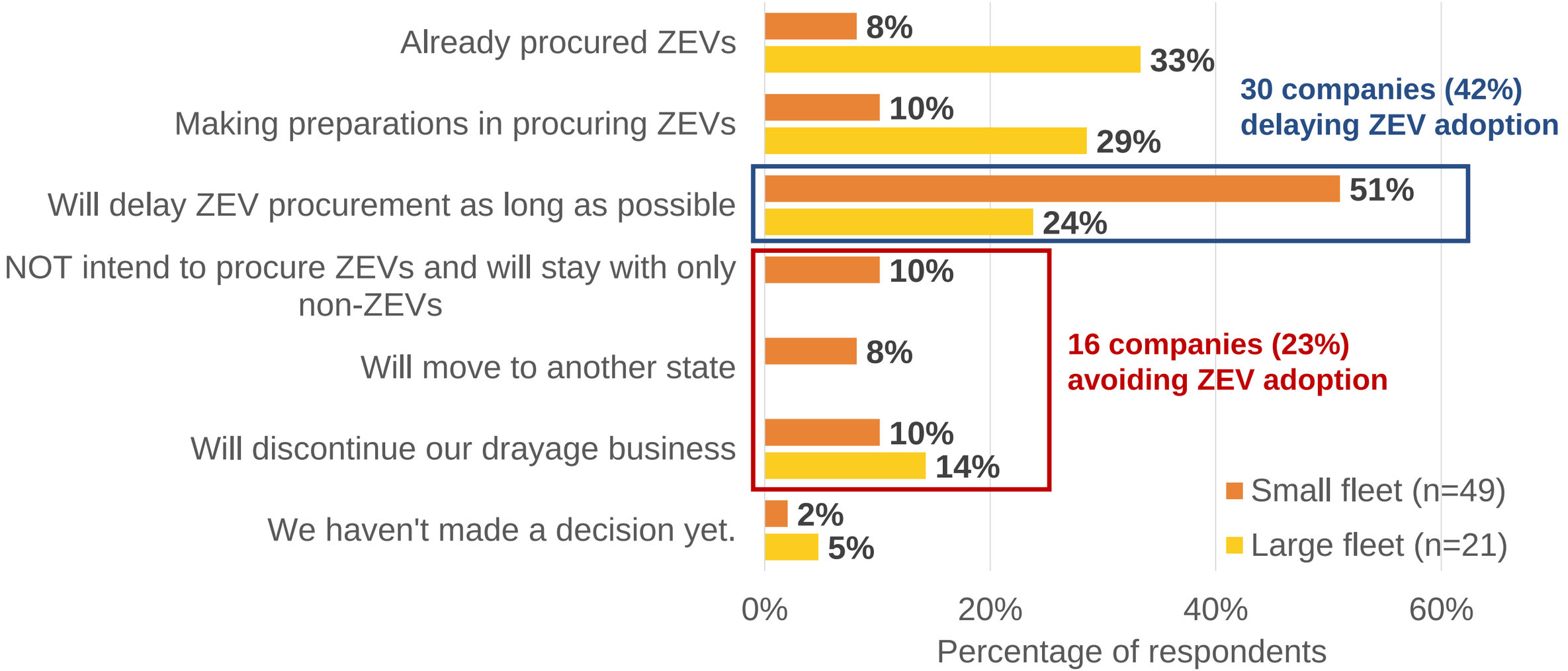
“ZEV infrastructure is hard to install. Even if we had fund, **electric company can’t install until they are ready**. I will have to [see…] how drayage market react.” (Small fleet, 6-10 trucks)

“Did you know that even a short haul guy like me **would need two/three EV trucks to replace a diesel trucks day**? […]**”** (Large fleet, 50-99 trucks)

“We see our cost tripling […] **acquisition costs** are significantly above those for a comparable diesel truck [...] **operational cost** will be very high due to the learning curve to familiarize with the true capabilities […] get towed back to base facility significantly initially [...] the worst part is that we would need to purchase **2 electric trucks to produce the same output as one diesel truck** (The true costs are: two registration fees, two insurance policies, two parking spots, […])” (Small fleet, 6-10 trucks)

“It is very hard for small fleet to afford the huge costs transferring to zero-emission. **Eventually, the very small fleets will be gone, and the drayage market will be shared by the big companies** which has the capital and land.**”** (Small fleet, 6-10 trucks)

How Are Small and Large Fleets Responding to ZEV Regulations?



Conclusions

- Understanding fleet operator perspectives is essential for achieving the ZEV transition
- Key adoption barriers: infrastructure limitations, high costs, operational incompatibility
- Small and large fleet perspectives highlight equity issues in ZEV adoption and policy
- Advanced Clean Fleet regulations impact differ by fleet size:
  - Small fleets tend to delay or avoid ZEVs, with some considering relocation
  - Large fleets are more proactive, with many already procuring ZEVs
- Both small and large fleets voice concerns about disproportionate impacts on small fleets

Policy Implications

- Continue policy support for infrastructure construction for all fleets
- Provide targeted infrastructure solutions for small fleets (e.g., offsite charging options, charging-as-a-service, truck-as-a-service)
- Extend ZEV driving ranges through R&D support for manufacturers
- Continue purchase incentives to reduce upfront cost gap with diesel trucks
- Provide tailored outreach for large fleets (highlighting operating cost benefits) and education for small fleets (improving approaches in cost evaluations)
- Expand ZEV trial programs for fleets new to these technologies
- Support more equitable adoption for small fleets

Acknowledgement

- **Funding**: University of California Institute of Transportation Studies Statewide Transportation Research Program
- **Major contributors & co-authors on related papers:**
  - Stephen G. Ritchie, Chancellor's Professor, UC Irvine
  - Craig R. Rindt, Assistant Director & Project Scientist, UC Irvine
- **Contributors:**
  - David Brownstone, Professor Emeritus, UC Irvine (Choice experiment design)
  - David S. Bunch, Professor Emeritus, UC Davis (Choice experiment design)
  - Marshall Miller, Co-Director, Sustainable Freight Research Program, UC Davis (Recruiting for pilot survey)
  - Michiel Bliemer, Professor, University of Sydney (Ngene developer)
  - Stephane Hess, Professor, University of Leeds (Apollo developer)
  - Andre Tok, Associate Project Scientist, UC Irvine (Survey testing)
  - Monica Ramirez Ibarra, Assistant Project Scientist, UC Irvine (Spanish version)
  - Blake Lane, PhD & Kate Forrest, PhD, APEP, UC Irvine (Attribute design)
  - Sara Forestieri, PhD, CARB (Attribute design)
  - Guoliang Feng, UC Irvine (Attribute design)
  - Montana Reinoehl, UC Irvine (Recruiting for pretesting)
  - Jared Sun, PhD and Cam Tran, UC Irvine (Incentive distribution)
- **Special Thanks to:**
  - Numerous drayage companies who participated in the survey!

More Information

Bae, Y.*, Ritchie, S.G., and Rindt, C.R. 2025. "**Choice Experiment Survey of Drayage Fleet Operator Preferences for Zero-Emission Trucks**." *The 104th Annual Meeting of the Transportation Research Board*. Washington, D.C.

Bae, Y.*, Rindt, C.R., and Ritchie, S.G. 2025. "**Charging Infrastructure Decisions by Heavy-duty Vehicle Fleet Operators: An Exploratory Analysis**." *The 104th Annual Meeting of the Transportation Research Board*. Washington, D.C.

Bae, Y.*, Ritchie, S.G., and Rindt, C.R. 2025. "**Small and Large Fleet Perceptions on Zero-emission Trucks and Policies**." *The 104th Annual Meeting of the Transportation Research Board*. Washington, D.C.

Bae, Y.*, Rindt, C.R., Mitra, S.K., and Ritchie, S.G. 2024. "**Fleet Operator Perspectives on Alternative Fuels for Heavy-duty Vehicles**." *Transportation Policy* 149: 36-48. https://doi.org/10.1016/j.tranpol.2024.01.023

Bae, Y.*, Rindt, C.R., Mitra, S.K., and Ritchie, S.G. 2024. "**Fleet Operator Perspectives on Heavy-duty Vehicle Alternative Fueling Infrastructure**." *Transportation Research Record* 2678.1: 490-506. https://doi.org/10.1177/03611981231171150

Bae, Y.*, Mitra, S.K., Rindt, C.R., and Ritchie, S.G. 2022. "**Factors Influencing Alternative Fuel Adoption Decisions in Heavy-duty Vehicle Fleets**." *Transportation Research Part D Transport and Environment* 102C: 103150. https://doi.org/10.1016/j.trd.2021.103150

Bae, Y.*, Rindt, C.R., Mitra, S.K., and Ritchie, S.G. 2021. "**Organizational Decision-making Processes of Alternative Fuel Adoption: An Empirical Study with Heavy-duty Vehicle Fleets in California**." *The 100th Annual Meeting of the Transportation Research Board*, Online conference.

Bae, Y.*, Mitra, S.K. and Ritchie, S.G. 2019. "**Building a Theory of Alternative Fuel Adoption Behavior of Heavy-duty Vehicle Fleets in California: An Initial Theoretical Framework**." *The 98th Annual Meeting of the Transportation Research Board*. Washington, D.C..

THANK YOU!

Youngeun Bae, Ph.D.

youngeub@uci.edu