Vehicle Data for Analysis of Medium- and Heavy-Duty Electrification

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Transportation and Mobility

Accelerating **sustainable mobility technologies and strategies** for passenger and freight transportation, with a focus on deeply **decarbonizing** the transportation sector, increasing **mobility equity**, and combating **climate change**.
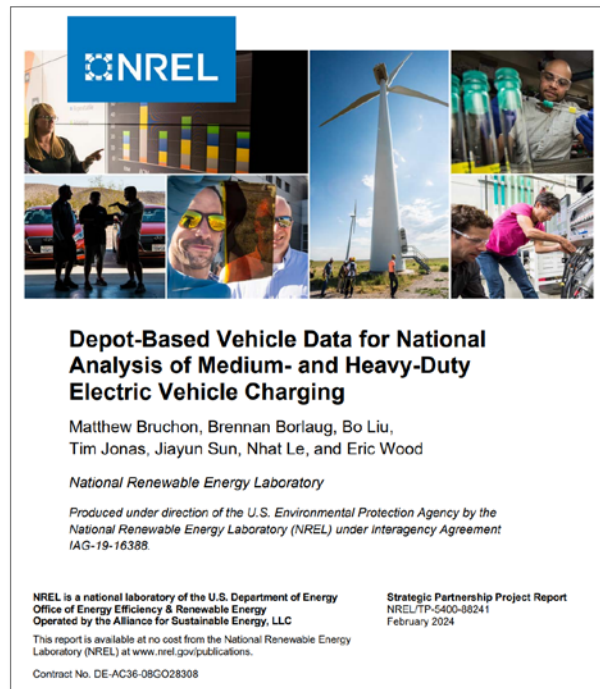
Successes

- Evaluating the energy, cost, equity, and time impacts of new mobility technologies when deployed at scale.

What's Next

- Advancing decarbonization solutions for hard-to-electrify on-, off-, and non-road transportation sectors
- Identifying advanced lithium-ion battery, power electronics, and high-power megawatt-scale charging technology solutions
- Expanding light-duty vehicle electrification via nationwide EV charging network

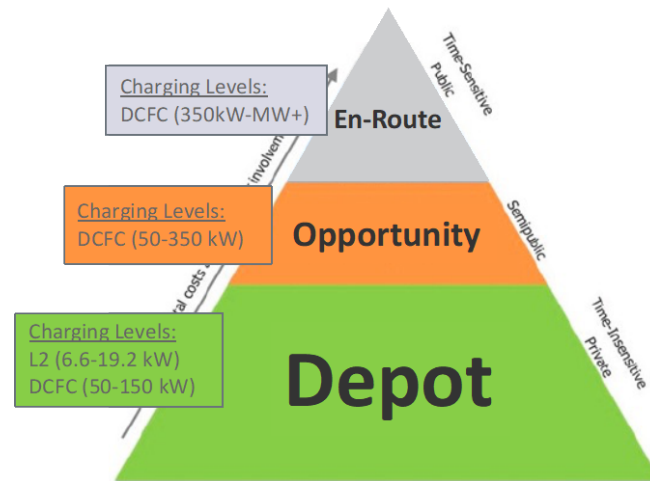# Data can inform medium- and heavy-duty vehicle (MHDV) electrification pathways

- **Challenge:**
  Uncertainties around MHDV electrification
  - How many MHDV can electrify "easily"?
  - How many may face more significant operational challenges?
  - Does the answer differ across varieties of vehicle?
- **Contribution:**
  Public dataset summarizing typical operations across varied types of MHDV
  - Dataset created by NREL with support and direction from EPA

Depot-Based Vehicle Data for National Analysis of Medium- and Heavy-Duty Electric Vehicle Charging

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Strategic Partnership Project Report
NREL/TP-5400-88241
February 2024

https://www.nrel.gov/docs/fy24osti/88241.pdf

The newly released dataset describes depot-based operations

- Our objective was to accurately model MHDV with **early electrification** potential:
  - **Depot-based** operations centered around a stable primary domicile location
  - Consistent operating schedules
- We modeled three categories of depot-based MHDV:
  - Transit buses
  - School buses
  - 20 categories of truck (5 vocational driving styles X 4 weight class groups)

Charging Levels:
DCFC (350kW-MW+)

En-Route

Charging Levels:
DCFC (50-350 kW)

Opportunity

Charging Levels:
L2 (6.6-19.2 kW)
DCFC (50-150 kW)

Depot

Matteo Muratori, Brennan Borlaug, Catherine Ledna, Paige Jadun, and Aravind Kailas. *Road to zero: Research and industry perspectives on zero-emission commercial vehicles.* iScience 26 (106751), 2023.

We applied three steps to model each vocation

	Trucks	Transit buses	School buses
Variability analysis: How variable are trends across regions?	• NHTS NextGen OD data • Census data	• National Transit Database	• NREL FleetREDI portal, Fleet DNA database
Operations modeling: How are MHDV used in representative regions?	• Geotab Altitude API • NREL modeling	• General Transit Feed Specification data • NREL EVI-Pro model	• NREL Fleet DNA database • NREL EVI-Pro model
National aggregation: What are national trends?	• Experian vehicle registrations data	• National Transit Database	• Experian vehicle registrations data

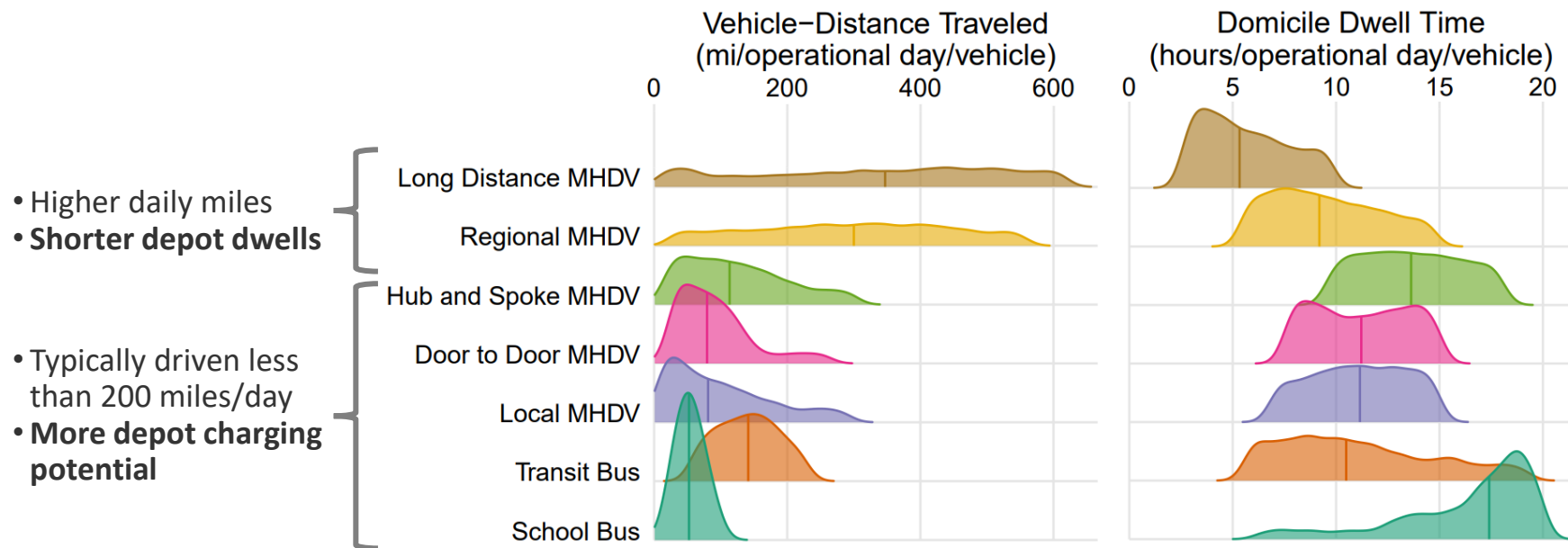Public data tables:
data.nrel.gov/submissions/231

We defined regional clusters using variables that affect operations

We collected data and modeled operations for representative regions in each cluster

Legend:

- ☐ TAF Boundary

Cluster
- ▨ Non-MSA, longer trips
- ▨ Non-MSA, medium trips
- ▨ Tier 1 density
- ▨ Tier 2 density
- ▨ Tier 3 density, longer trips
- ▨ Tier 3 density, medium trips
- ▨ Tier 3 density, shorter trips
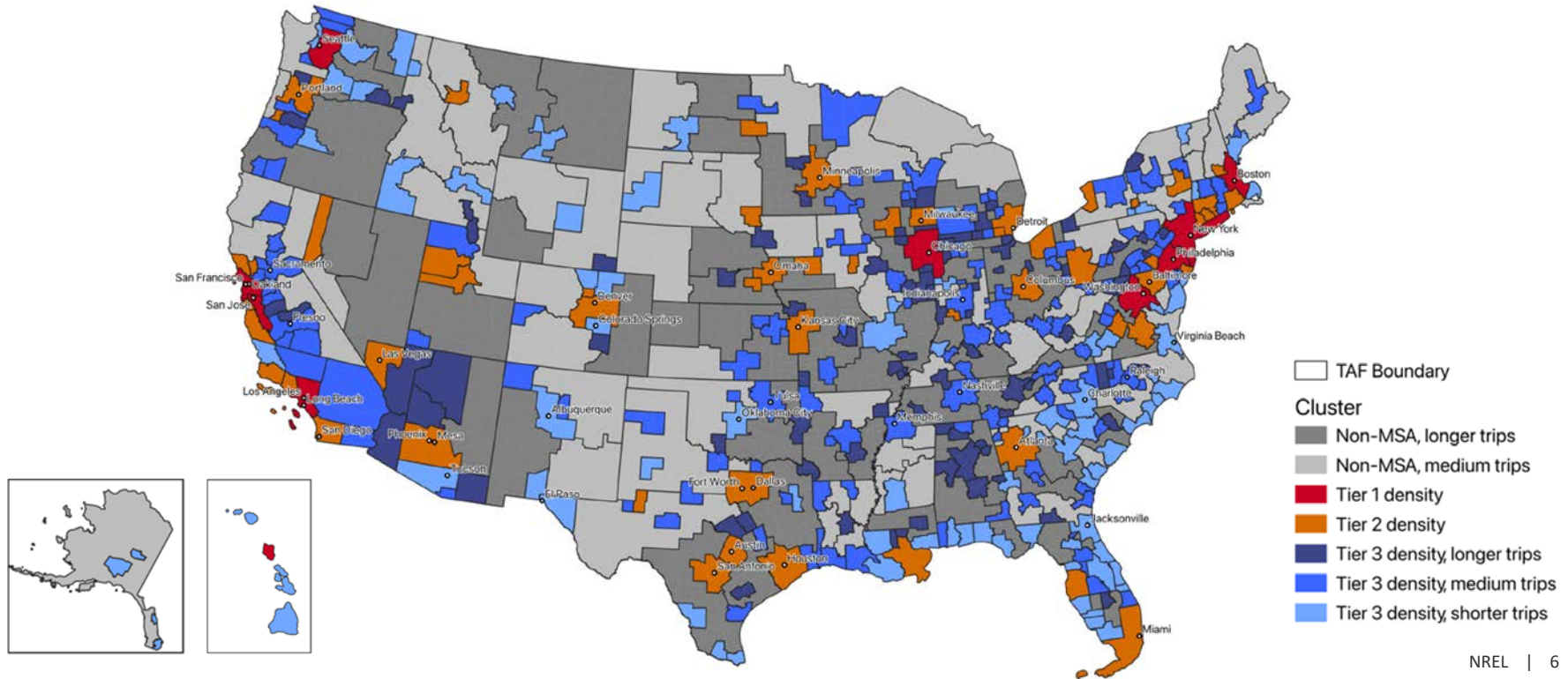
Regional results were aggregated into national summary statistics

Typical operations (10th-90th percentile)

- Higher daily miles
- **Shorter depot dwells**

- Typically driven less than 200 miles/day
- **More depot charging potential**

Bruchon, Matthew, Brennan Borlaug, Bo Liu, Tim Jonas, Jiayun Sun, Nhat Le, Eric Wood. "Depot-Based Vehicle Data for National Analysis of Medium- and Heavy-Duty Electric Vehicle Charging". National Renewable Energy Laboratory. NREL/TP-5400-88241. February 2024.

Dataset includes daily VMT, hours at depot, and charging load profile shapes

- For each of the 22 MHDV types, we provide national values for:
  - Percentiles for daily miles driven and hours at depot on weekdays vs. weekends
  - Percent of fleet operating on an average weekday vs. weekend
  - Normalized charging load profiles (assuming load is spread evenly across depot dwell)

Truck load profiles

School bus load profiles

Time of day

Transit bus load profiles

Time of day
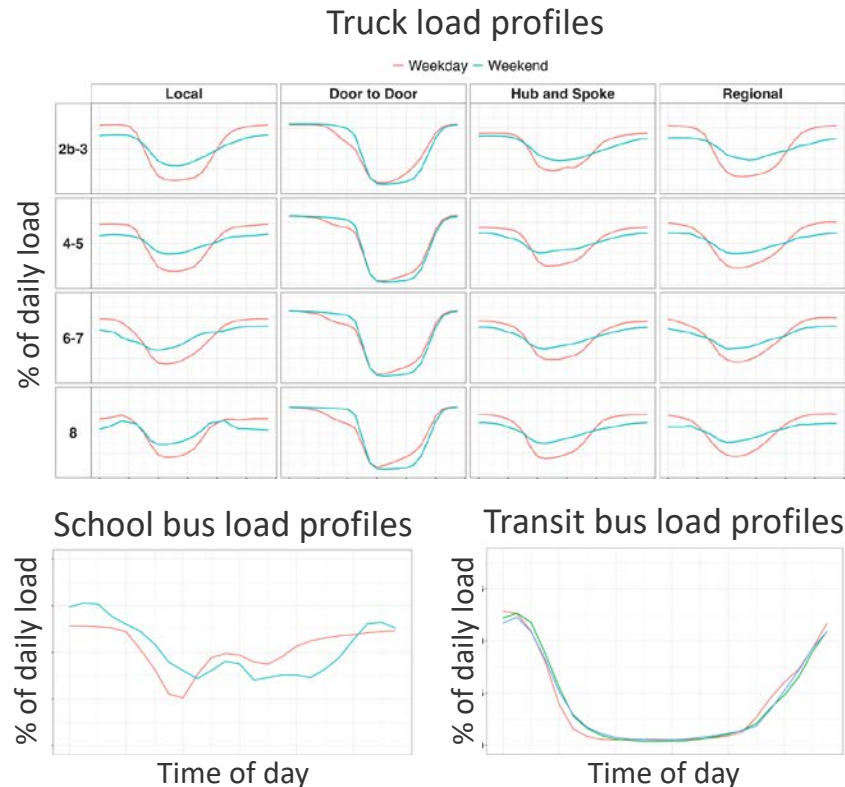
This data can inform policymaking, infrastructure planning, and investment

- Illustrative questions the data tables could help inform:
  - *How many school buses could rely entirely on depot charging given range constraints?*
  - *If community chargers were built for local trucks and delivery vans to use during the workday, what share of the fleet may want to use them?*
  - *How large would batteries need to be to electrify 50% of regional Class 8 tractors without public infrastructure buildout? What depot charging speeds are needed?*
- Dataset and technical report are publicly available at **data.nrel.gov**

Thank You!

Dataset: data.nrel.gov/submissions/231

Technical report: https://www.nrel.gov/docs/fy24osti/88241.pdf

Questions?

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