



Sustainable Freight Research for Accelerating Medium-Duty & Heavy-Duty Zero-Emission Vehicle Deployment

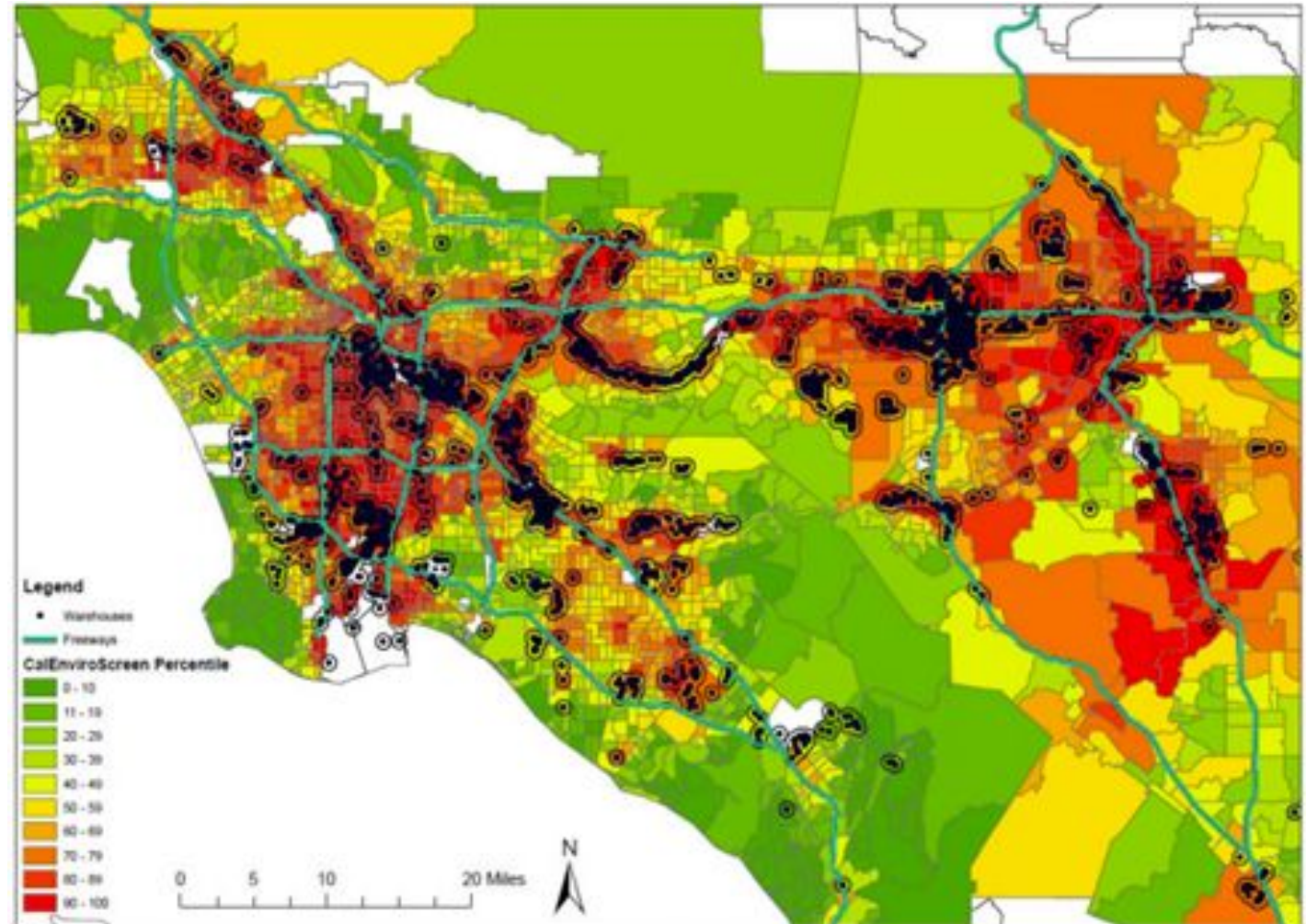
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Reducing emissions from trucks is critical

- **7.5%** of total U.S. GHG emissions come from medium-duty & heavy-duty trucks
- **31%** of total NO_x emissions in California are from these trucks
 - Public health impacts are higher near freight facilities

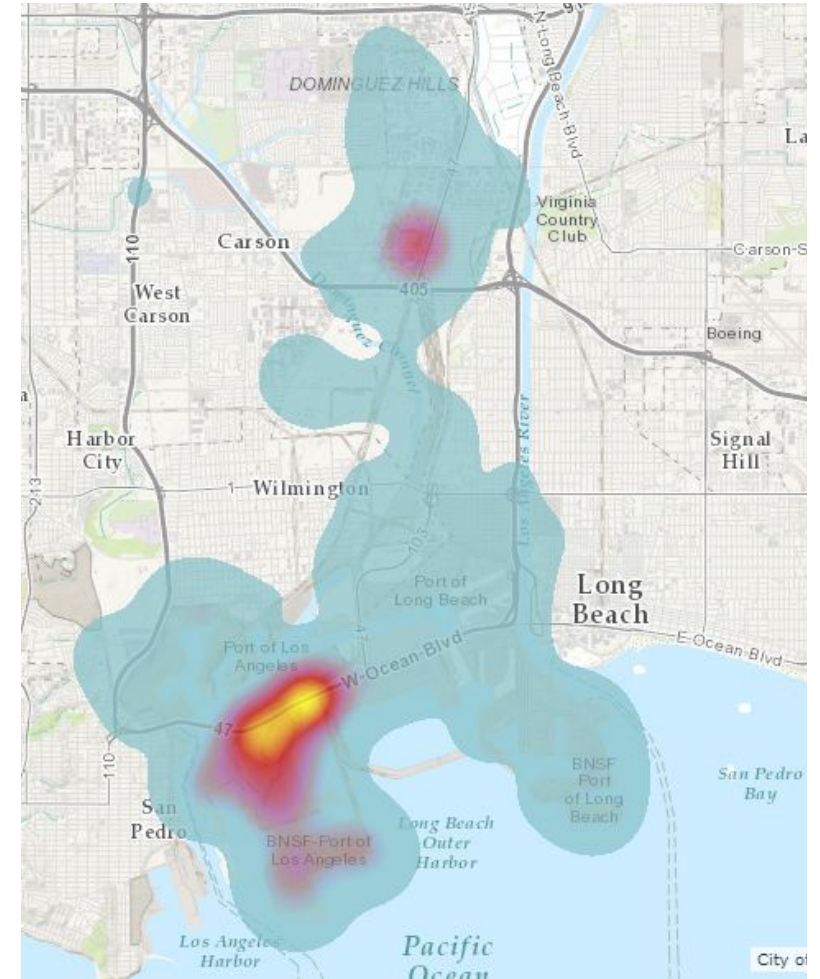


Source: SCAQMD (2021). Proposed Rule 2305 – Warehouse Indirect Source Rule.



Port drayage is an ideal early application for BETs

- Run **limited daily distance**
- **Return to home base** every night
- Spend a large amount of time **creeping and idling**
- Tend to operate in **environmental justice communities**





There are many operational barriers to the adoption of battery electric trucks (BETs)

- **Range** is relatively short
 - 250 miles for commercially available model
- **Charging time** is too long
 - 90 minutes or longer
- **Charging infrastructure** is very limited
 - Public charging stations almost non-existent





Several technological solutions can help

- Zero-emission trucks with **longer range**
- **Faster chargers** to cut down charging time
- **New charging technologies** that enable more opportunities for charging
- **Advanced fleet management tools** that consider unique characteristics of BETs



Source: Hwang et al. (2018).



We are studying innovative opportunity charging

- Provide opportunity charging **where and when BETs would normally idle** such as queuing at terminal gates and loading/unloading at warehouses
 - Reduce deadhead miles
 - Keep BET productivity high
- Analyzing **real-world operation data** of drayage trucks serving Ports of Los Angeles & Long Beach





Preliminary results are promising

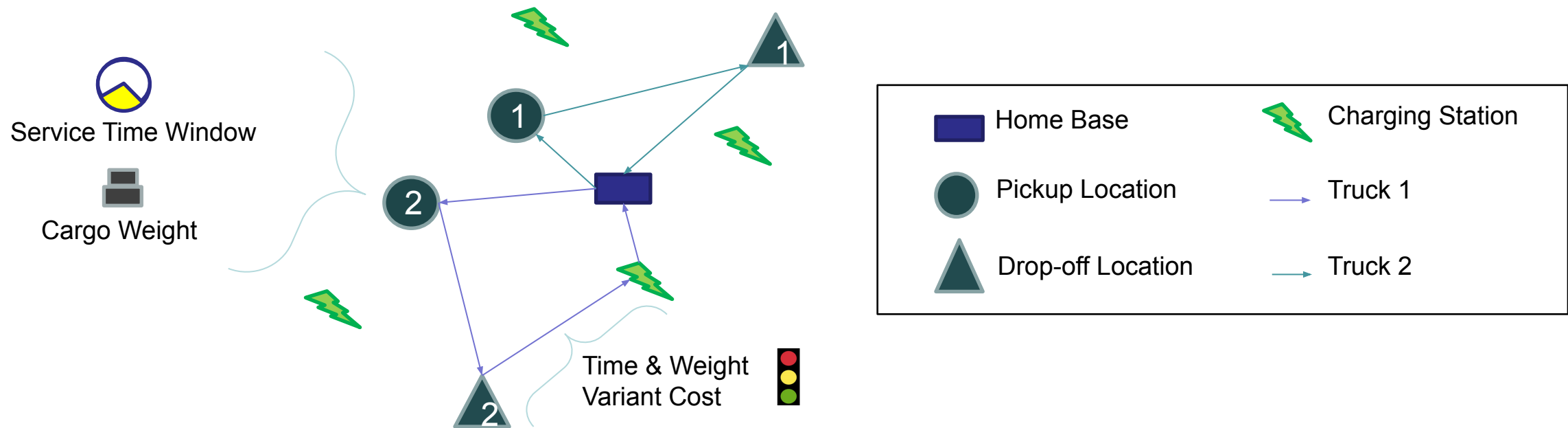
- **14%** of operating time is spent in extended idling areas (red polygons)
- **84%** of the tours can be completed if trucks receive wireless charging in these areas
 - **79%** without wireless charging





BET fleet requires new way of dispatching

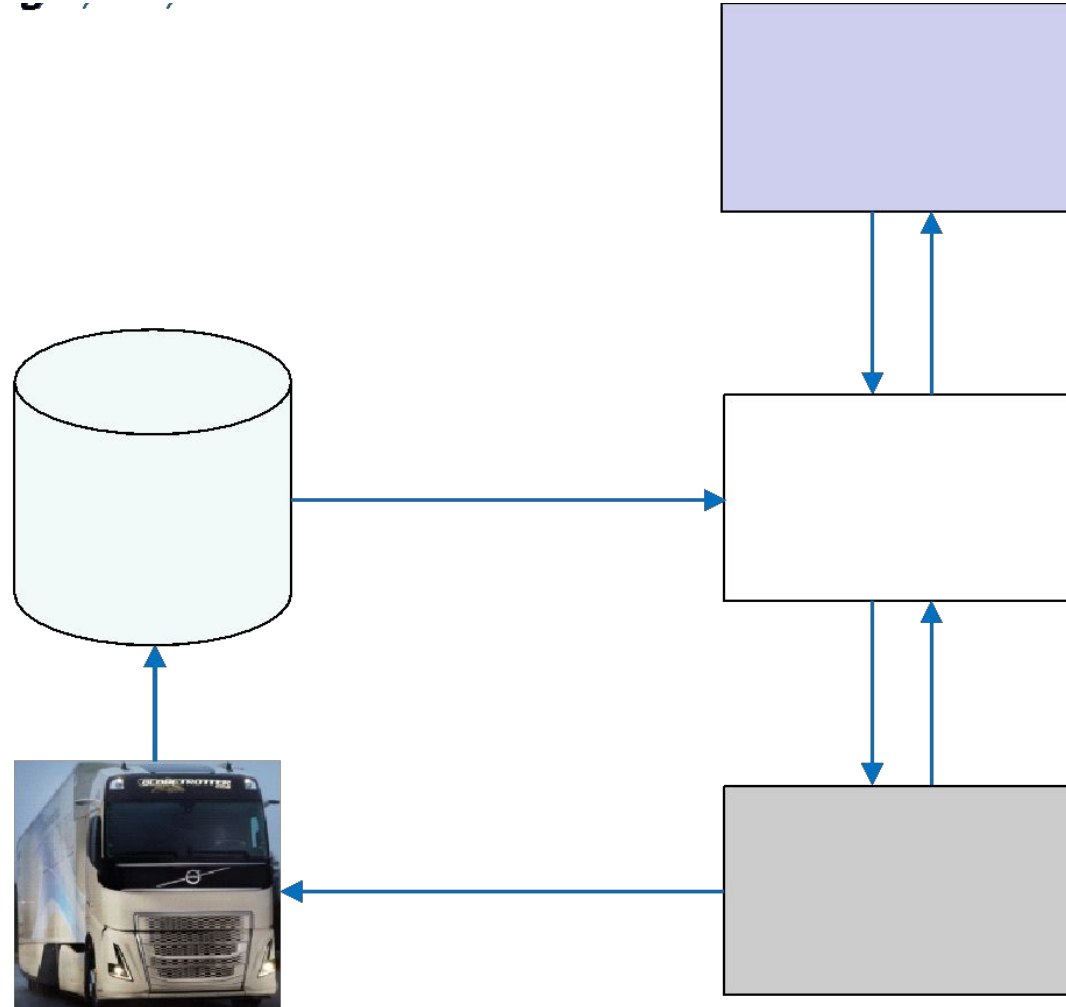
- Scheduling & dispatching** algorithms that accounts for driving range and charging needs, among other operational factors (travel time, cargo weight, service time window, etc.)





Refueling (charging) becomes more complex

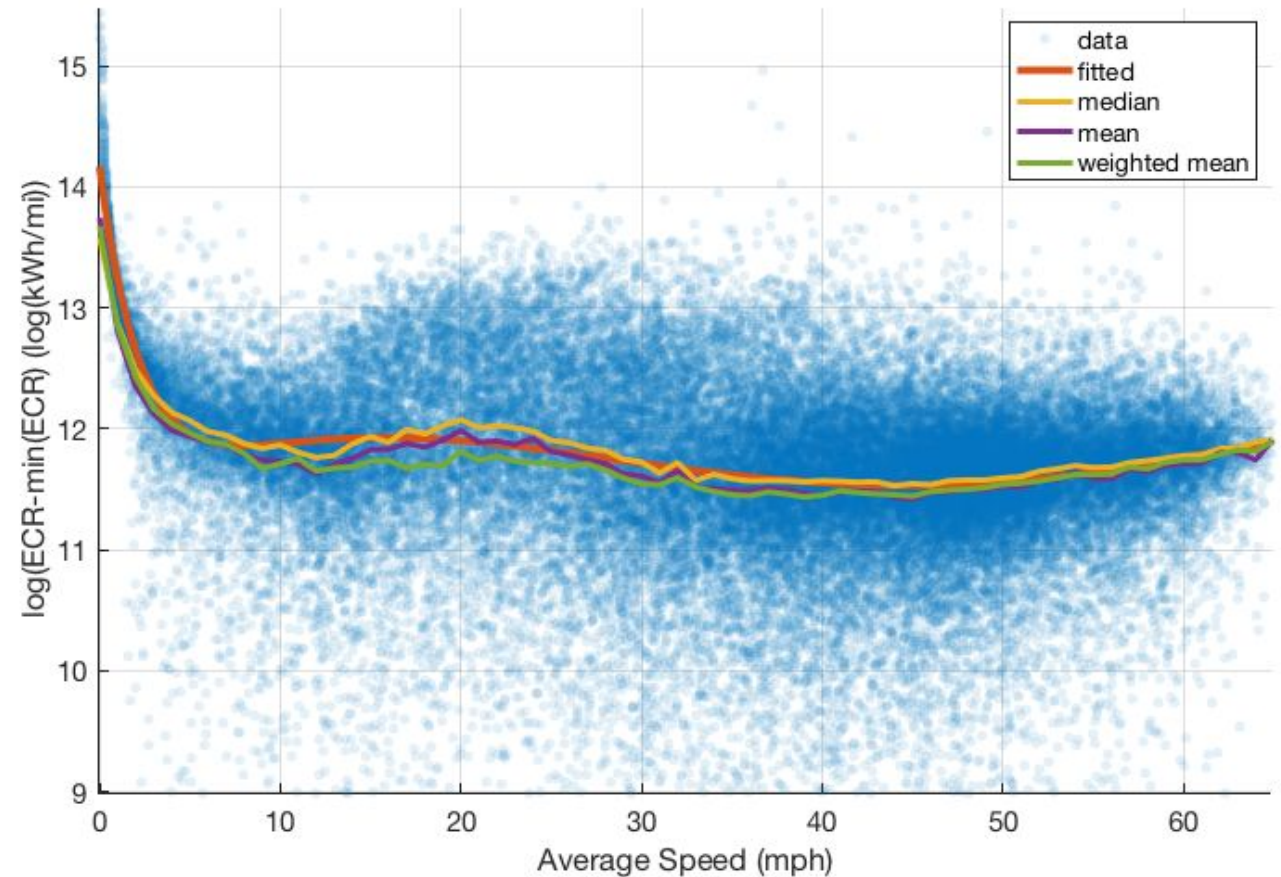
- **BET charging management** that optimizes usage of charging infrastructure (and distributed energy resources, if any) in coordination with truck schedules





Knowing driving range becomes more important

- **State of charge (SOC) prediction** tools that account for real-world impact of many factors
 - Weight carried
 - Road terrain
 - Traffic condition
 - Weather condition
 - Driving behavior
 - Etc.



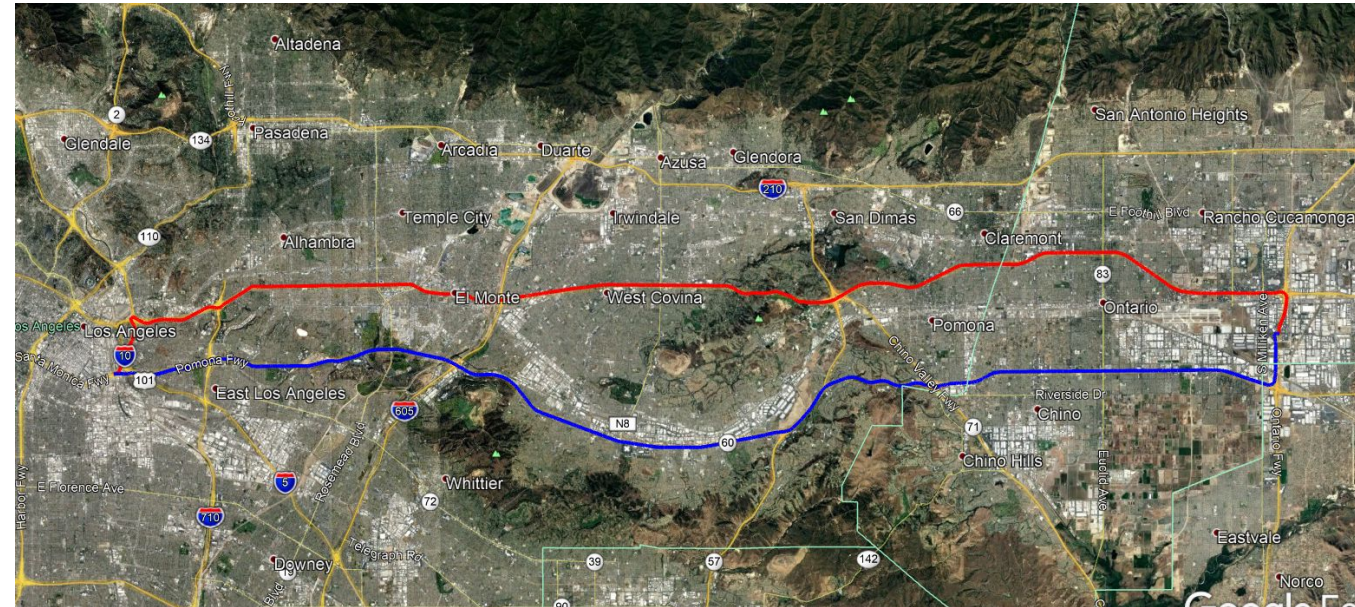


Truck Eco-Routing can save fuel (or electricity)

- **15%** fuel savings on some trips with minimal impact on travel time
 - Translated to extended range for BETs



Two identical trucks used in the field experiment



Two alternative routes for the same trip



More research is needed

- **Supporting technologies** for BET operations
 - Scheduling & dispatching
 - Charging management
- **Charging infrastructure deployment** for BETs
 - Transportation and electrical grid network integration
 - Public-private partnership
- **Public health and other benefits** of truck electrification
 - Ensuring equitable deployment of BETs and charging infrastructure
 - Protecting against unintended consequences



Thank You

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