



Freight Electrification

NASEO Energy Policy Outlook
February 9, 2023

[CALSTART.org](https://calstart.org)



TECHNOLOGY DEVELOPMENT

CALSTART develops and organizes competitive project teams around strategically important technologies to help fund and speed their commercialization.



ASSESSMENT & VALIDATION

CALSTART provides trusted, third-party performance analysis and evaluation of clean vehicles, technologies, and fuels.



MARKET ACCELERATION

CALSTART advises governments and agencies in developing incentive programs supported by fleets and industry to encourage the adoption of advanced technology vehicles and fuels.



PUBLIC POLICY

CALSTART supports industry stakeholders in government to develop and implement public policies that advance the clean transportation technology industry.



MEMBER SUPPORT

CALSTART seeks out and fosters partnership opportunities among our members as well as assistance in obtaining grants and funding.



NETWORKING

CALSTART hosts meetings and conferences so that our members may connect with like-minded professionals and leaders in the industry.

The freight industry is the backbone of our economy.

- **Trucks move >72% of the nation's freight.**
- **The trucking industry employs nearly 8 million people.**
 - This includes ~3.5 million drivers.
- **Nearly 39 million trucks are registered and used for business purposes in the U.S.**
 - These trucks are registered to nearly 2 million carriers.
 - These trucks travel >302 billion miles annually, consuming over 35 billion gallons of diesel and 9 billion gallons of gasoline.
 - ~10% are Class 8 trucks.
- **Commercial trucks paid >\$48 billion in federal and state highway-user taxes in 2020.**

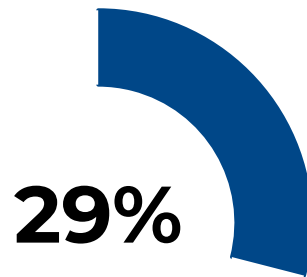
Source: American Trucking Associations (ATA)

Medium- and heavy-duty vehicles (M/HDVs) disproportionately pollute our communities.

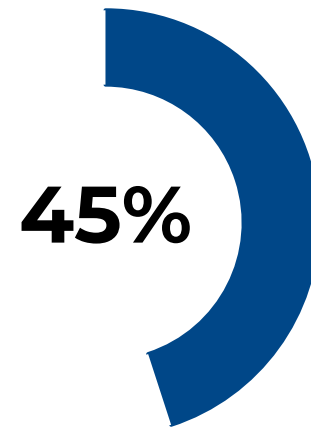
M/HDVs account for <10% of vehicles on the road.



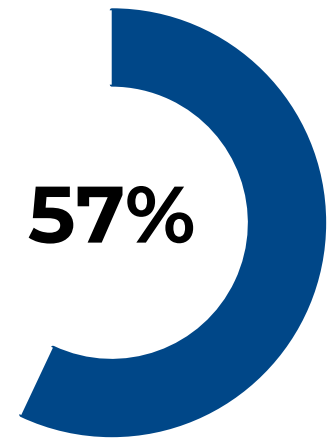
M/HDVs account for nearly one-third of on-road vehicle GHG emissions.



M/HDVs account for 45% of on-road NOx emissions.

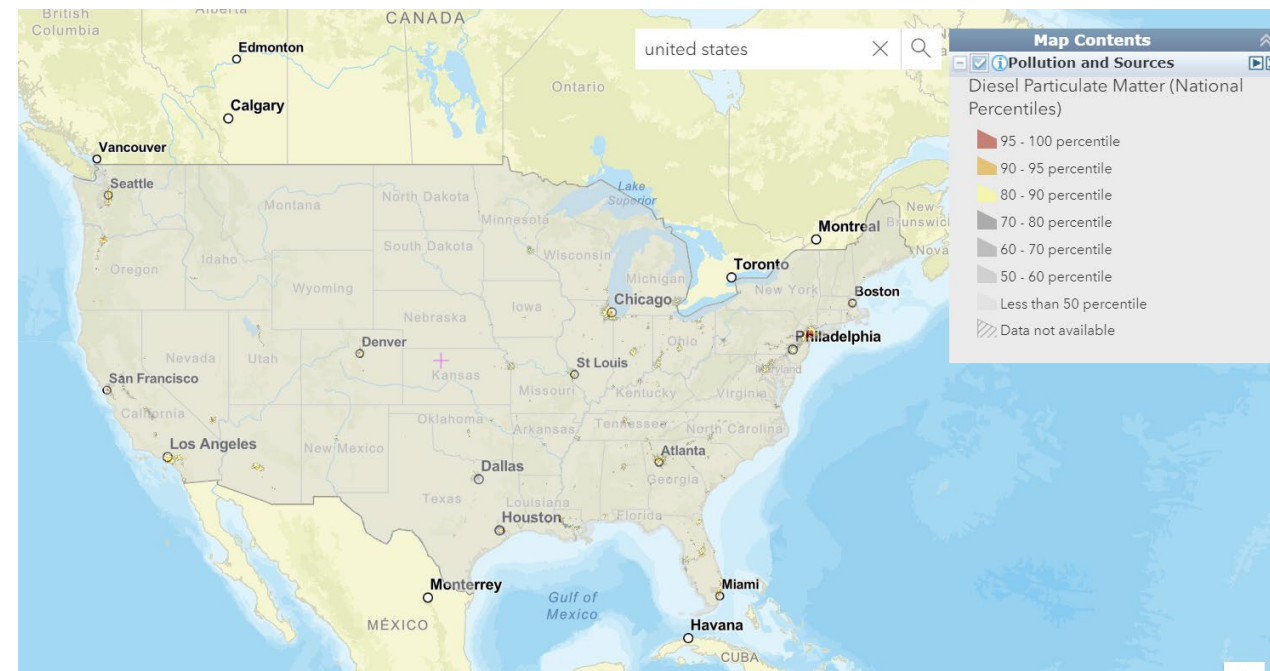
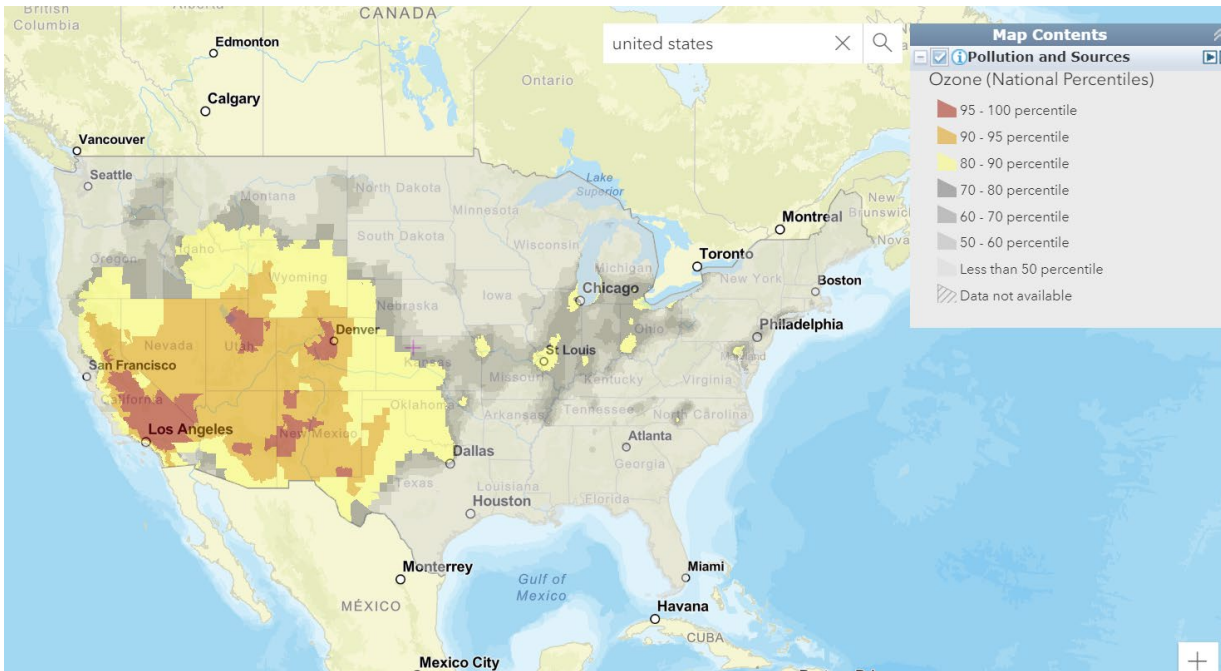


M/HDVs account for 57% of on-road, direct PM2.5 emissions.



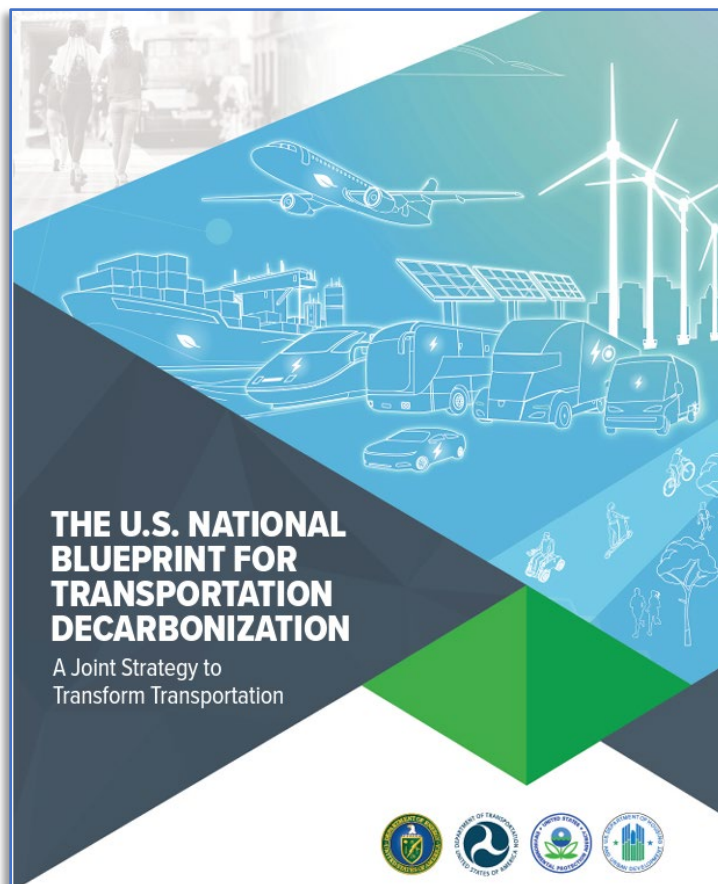
Source: UCS

Pollution from M/HDVs disproportionately impacts disadvantaged communities.



Source: EPA EJScreen

The US has committed to 100% of new M/HDV sales being ZE by 2040, with an interim goal of 30% by 2030.

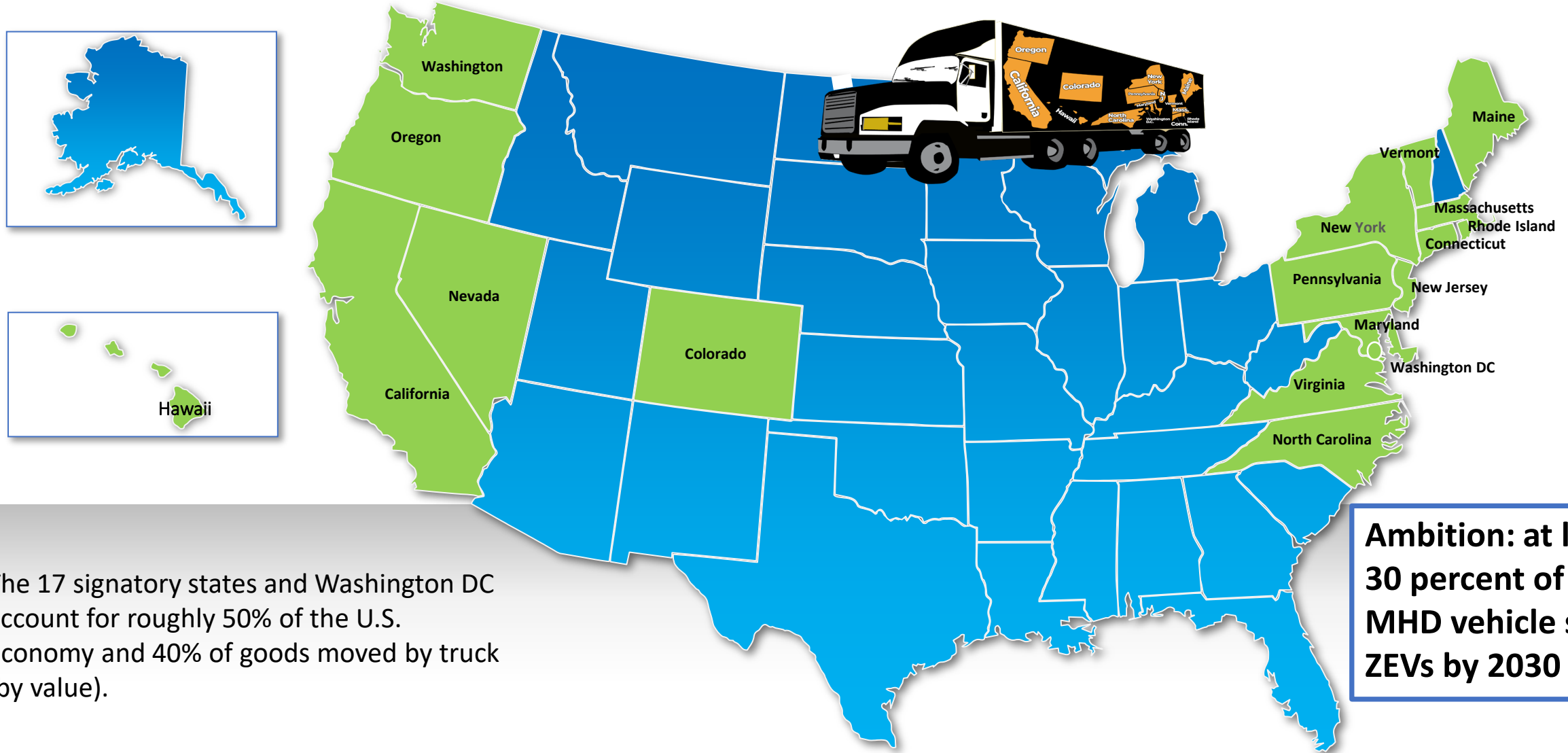


Transportation Mode	Share of Current Transportation Emissions	Federal GHG Emissions Reduction Goals
Light-Duty Vehicles	49%	<ul style="list-style-type: none"> Achieve 50% of new vehicle sales being zero-emission by 2030 supporting a pathway for full adoption, and ensure that new internal combustion engine vehicles are as efficient as possible Deploy 500,000 EV chargers by 2030 ^{REF} Ensure 100% federal fleet procurement be zero-emission by 2027 ^{REF}
Medium and Heavy-Duty Trucks and Buses	21%	<ul style="list-style-type: none"> Aim to have 30% of new vehicle sales be zero-emission by 2030 and 100% by 2040 ^{REF} Ensure 100% federal fleet procurement is zero-emission by 2035 ^{REF}
Off-road	10%	<ul style="list-style-type: none"> Work to establish specific targets Focus resources to develop technology pathways and set efficiency and zero-emissions vehicle and equipment targets
Rail	2%	<ul style="list-style-type: none"> Work to establish specific targets Focus resources to develop technology pathways and set efficiency and zero-emissions vehicle targets Encourage greater use for passenger and freight travel to reduce emissions from road vehicles
Maritime	3%	<ul style="list-style-type: none"> Continue to support the Zero-Emission Shipping Mission (ZESM) goals to ensure that 5% of the global deep-sea fleet are capable of using zero-emission fuels by 2030, at least 200 of these ships primarily use these fuels across the main deep sea shipping route, and 10 large trade ports covering at least three continents can supply zero-emission fuels by 2030 ^{REF} Support the U.S. domestic maritime sector by performing more RD&D into sustainable fuels and technologies and incentivize U.S. commercial vessel operators to move towards lower GHG emissions Work with countries in the International Maritime Organization to adopt a goal of achieving zero emissions from international shipping by 2050 ^{REF}
Aviation	11%	<ul style="list-style-type: none"> Reduce aviation emissions by 20% by 2030 when compared to a business-as-usual scenario Achieve net-zero GHG emissions from the U.S. aviation sector by 2050 Catalyze the production of at least three billion gallons of SAF per year by 2030 and ~35 billion gallons by 2050, enough to supply the entire sector ^{REF}

At COP27 on Nov. 16, 2022, the U.S. joined the Global MOU on Zero-Emission Medium- and Heavy-Duty Vehicles.



17 States Sign MHD ZEV MOU



The 17 signatory states and Washington DC account for roughly 50% of the U.S. economy and 40% of goods moved by truck (by value).

Ambition: at least 30 percent of new MHD vehicle sales ZEVs by 2030

Sources:

U.S Bureau of Economic Analysis <https://apps.bea.gov/itable/iTable.cfm?ReqID=70&step=1#reqid=70&step=1&isuri=1>;

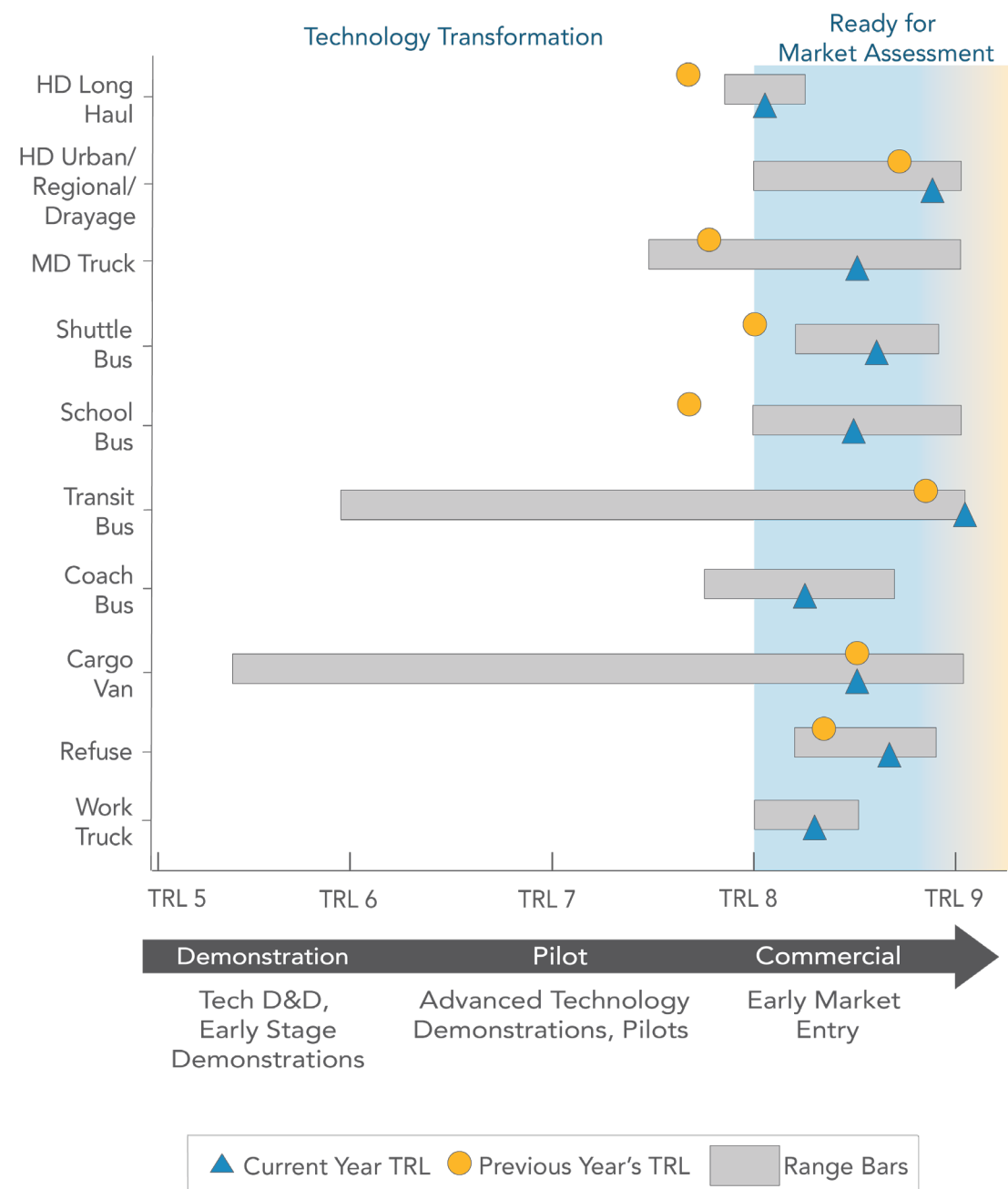
FHWA Freight Analysis Framework <https://faf.ornl.gov/faf4/Extraction1.aspx>

Technology developments and expanded supply chains drive electrification in increasing vehicle segments.



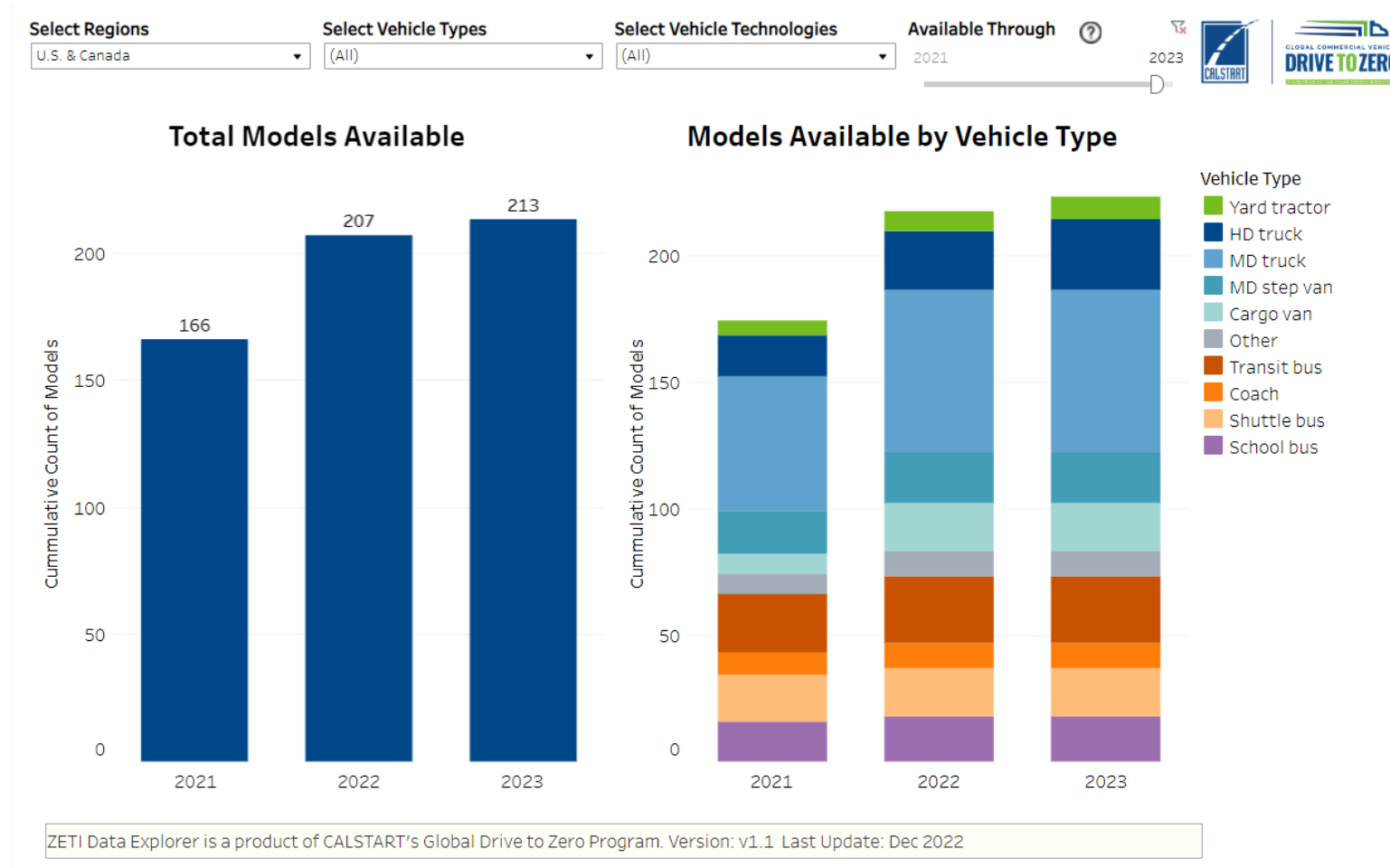
Source: CALSTART

ZE technology is commercially available for all on-road applications.



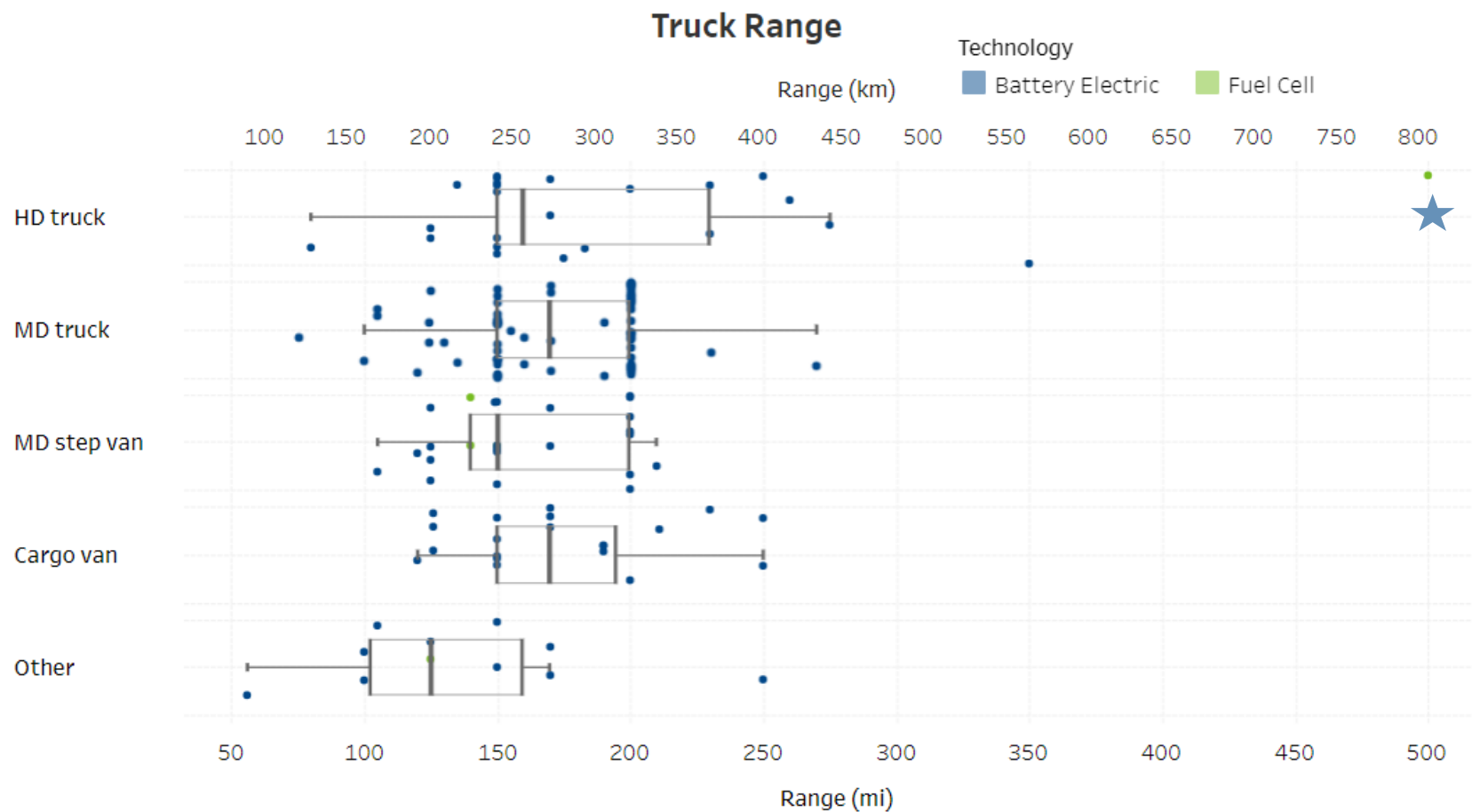
Source: CARB & CALSTART

Over 200 ZE models are available today.



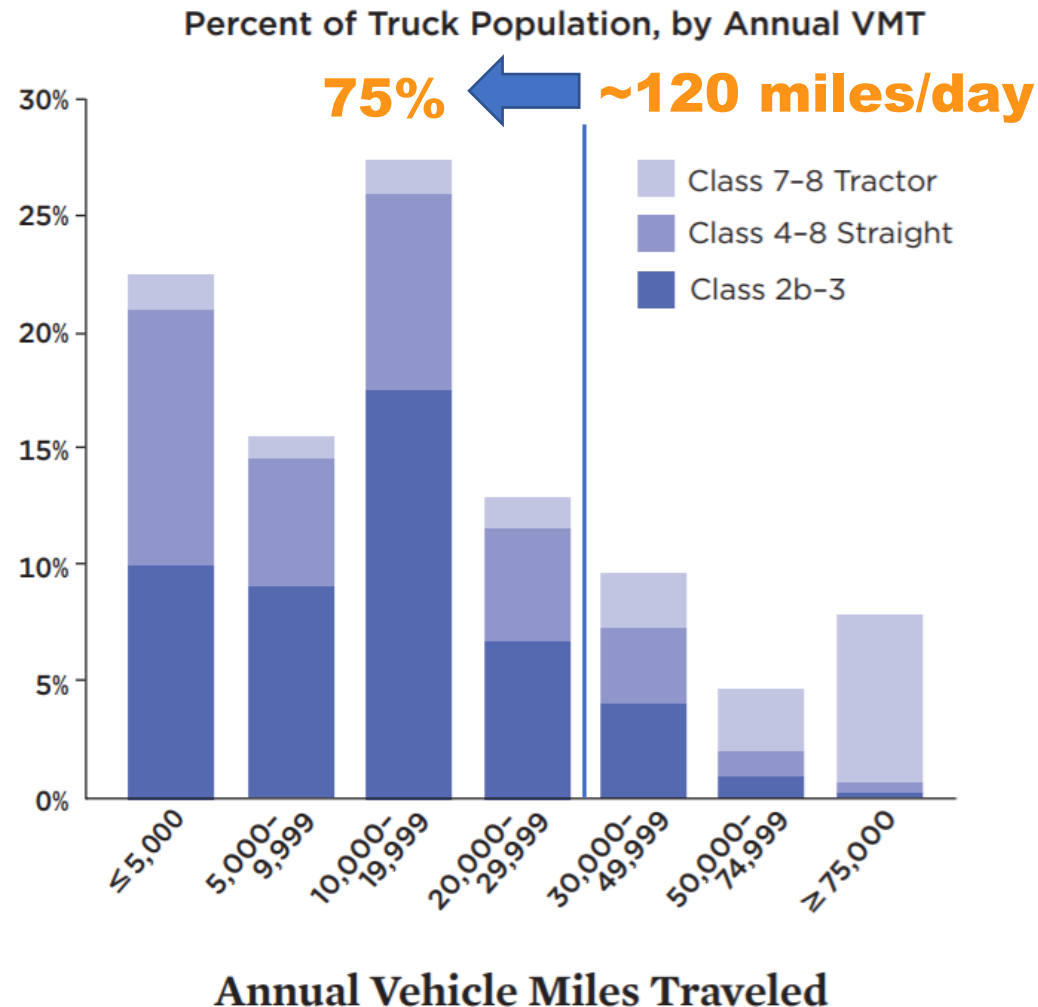
Source: CALSTART Zero-Emission Technology Inventory (ZETI) Data Explorer

The range of available models is increasing.



Source: CALSTART Drive to Zero

ZET technology is suited for many applications.



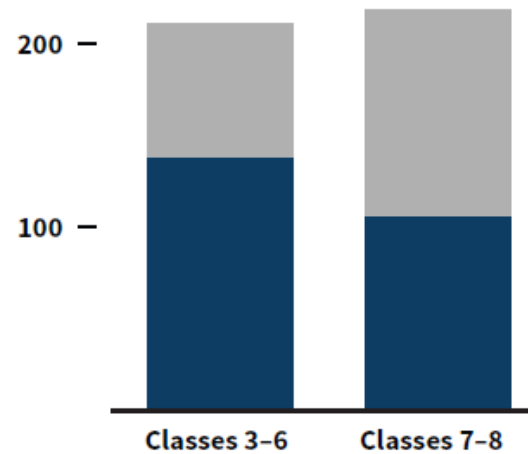
Analysis of real-world duty cycle data shows ~65% of MD and ~49% of HD trucks are currently electrifiable with existing technology.

2019 Medium- and Heavy-Duty Vehicle Estimates

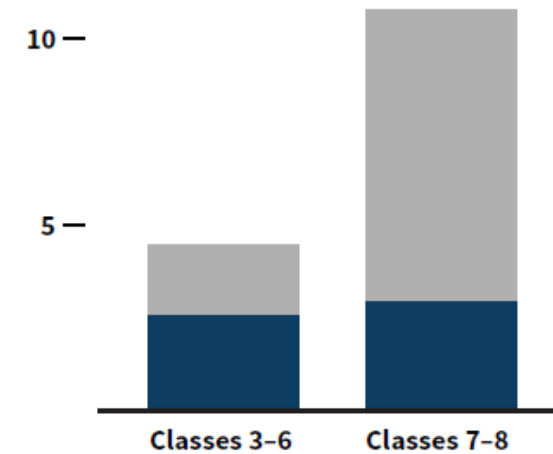
■ Electrifiable ■ Other

California

Vehicle count (thousands)

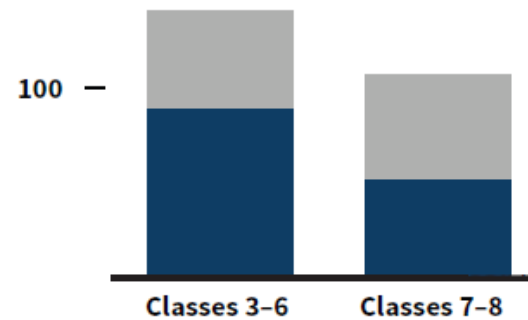


Vehicle miles traveled (VMT) (billions)



New York

Vehicle count (thousands)



Vehicle miles traveled (VMT) (billions)

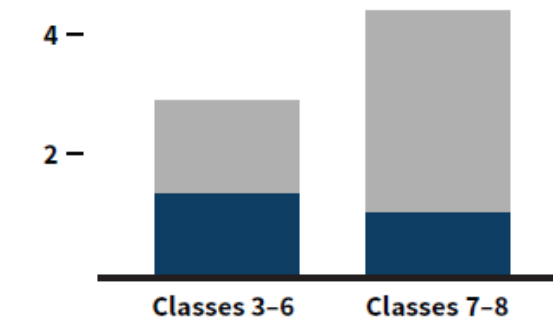
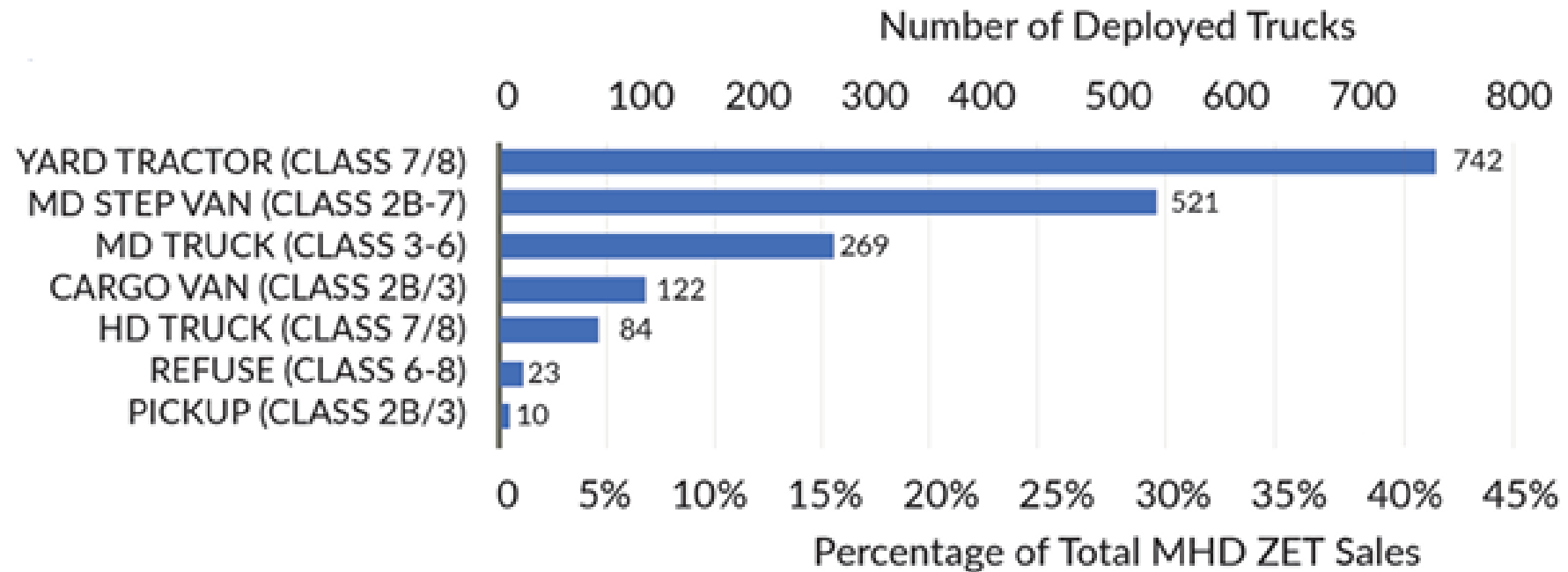


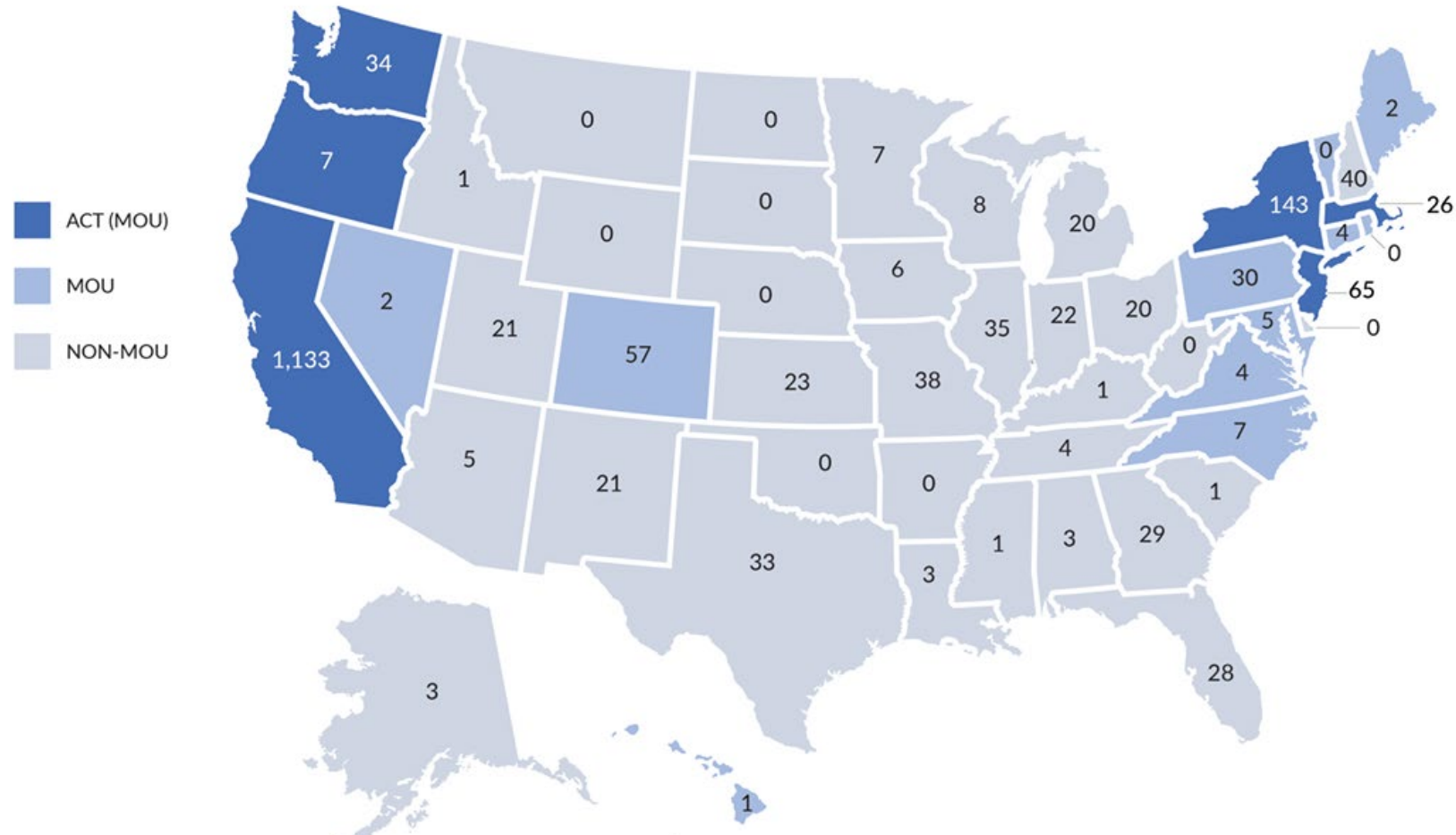
Chart: RMI Source: Geotab

Sales are increasing.



Source: CALSTART Zeroing in on Zero-Emission Trucks

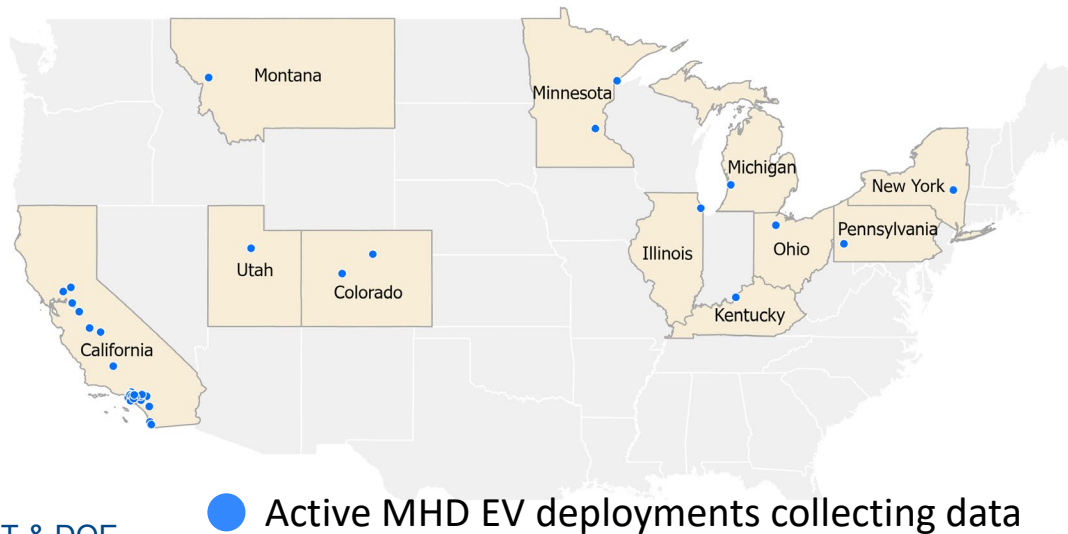
ZET sales are highly correlated to state-level policies and incentives.



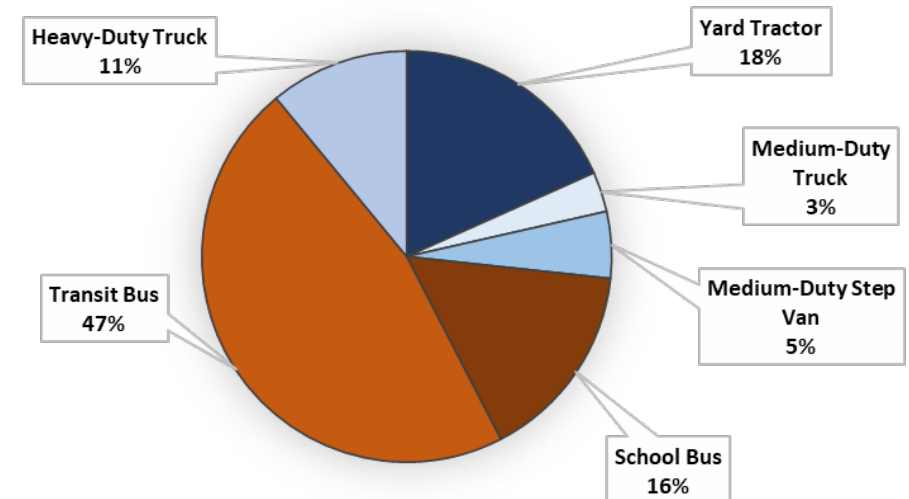
Source: CALSTART Zeroing in on Zero-Emission Trucks

We are learning a lot from these real-world deployments.

- DOE-funded project to collect, validate, analyze, & provide summary results on operational data from ZE M/HDs
 - October 2019 – September 2023
 - Capturing diverse data from **191 vehicles** across **11 states** and **37 distinct fleets** participating in the program



Confirmed Vehicle Makeup



Source: CALSTART & DOE

Preliminary findings show that suitability is growing (but with limitations).

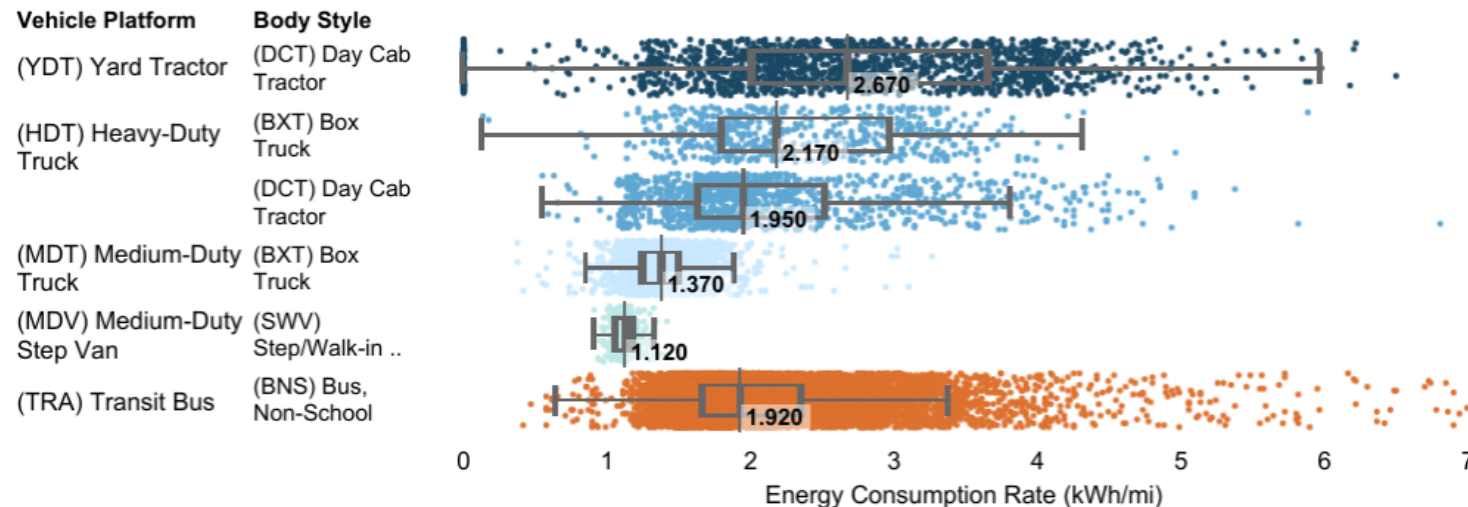
- Based on observable data and fleet interactions, most electric **yard tractors, delivery vans and transit buses** have been found to **perform comparably** to the conventional baseline vehicles used on similar duty cycles.
- However, EV models in the **HD truck** segment proved capable of meeting **duty cycles limited to one single shift and less than 200 miles** per day. Challenges are found when there is dynamic/unpredictable routing, longer routes, longer idling time or trucks not returning to home base each day to charge.

Source: CALSTART



ZE M/HDVVs are more efficient than ICE counterparts (though efficiency impacted by climate).

- MHD EVs were found to be 2-4x more efficient than comparable diesel vehicles.
- Seasonal patterns in vehicle efficiency were observed across different regions, indicating a correlation between ambient temperature and vehicle efficiency.
- Stronger efficiency impacts were observed in colder climates.

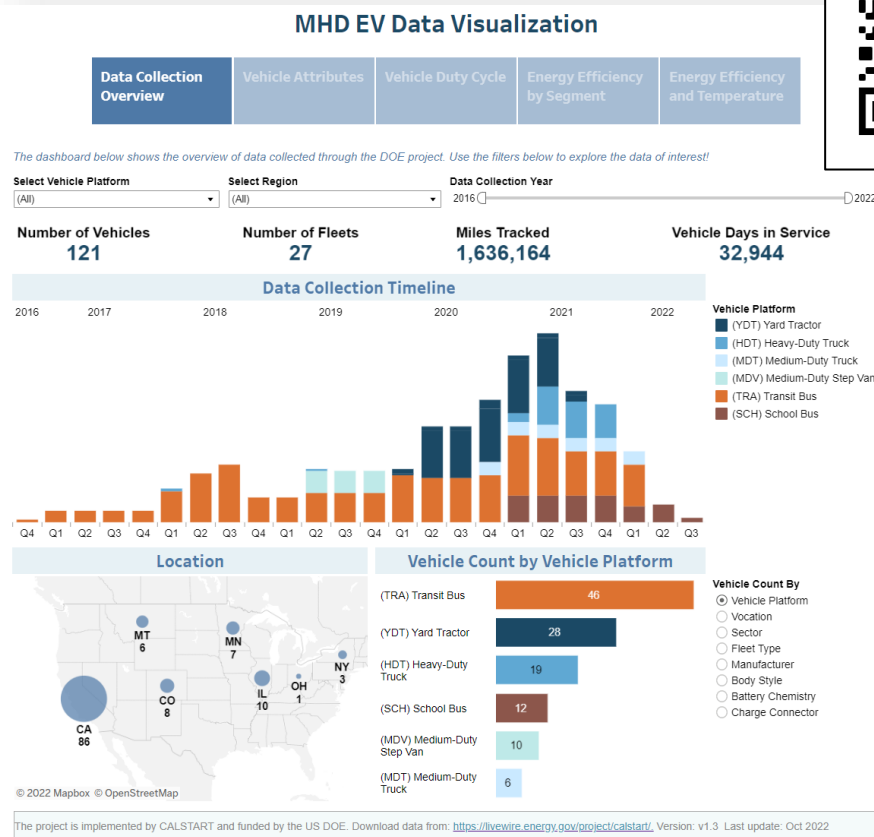


Source: CALSTART

Learn more!

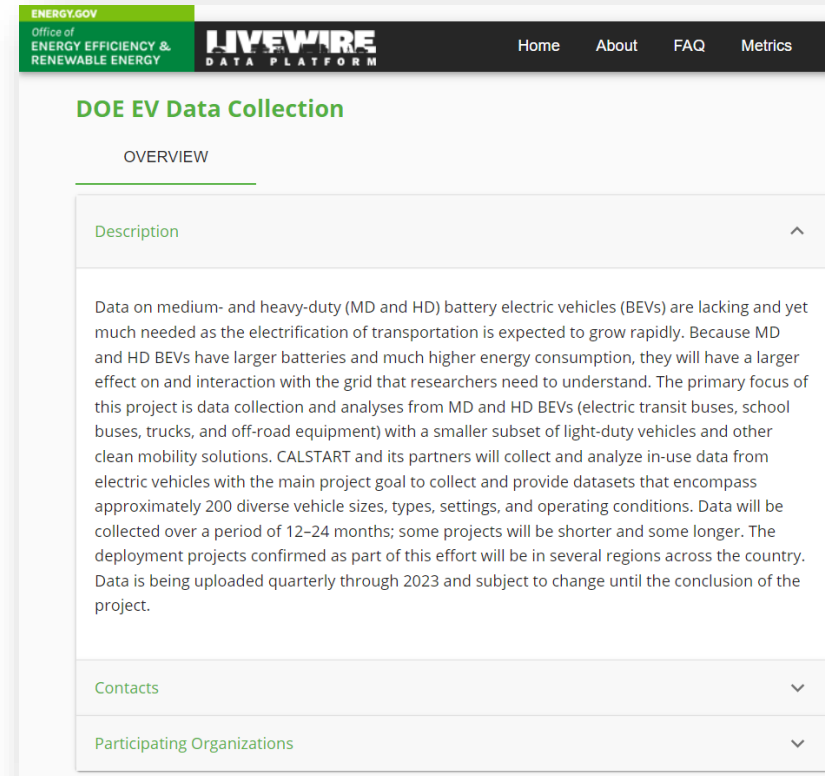
Access the Dashboard in Project Website:

<https://calstart.org/projects/medium-heavy-duty-ev-deployment-data/>



Download Data from LiveWire:

<https://livewire.energy.gov/project/calstart>



We're also learning from demos and pilots.

- **Near-term challenges include costs – both on the vehicle side and related to electricity rates.**
 - Demand charges can comprise half of a fleet's electricity bill
 - Insurance (5.5%), compounded by federal excise tax (12%), CA sales tax (8%), and CA registration fees, sum to an additional \$90-100k added to the Class 8 ZETs upfront cost, preventing them from achieving cost parity with diesel trucks in an average vehicle lifetime.
- **Fleets can expect insurance and upfront costs to decrease as ZET production increases and battery technology improves; incentives will play a key role in supporting production increases.**
- **Battery electric trucks (BETs) have many benefits , but they are not yet a like for like replacement for diesel trucks.**
 - Shorter driving range
 - Longer refueling time and fewer refueling stations
 - Lower cargo weight capacity

2040 Roadmap



1. ESTABLISH BEACHHEADS

Launch all beachhead ZE-MHDV applications

2. SECURE POLICY ALIGNMENT

Secure aligned and ambitious targets and policies

3. LAUNCH LONGHAUL

Establish priority zero-emission long-haul corridors by 2025

4. SATURATE CITIES

Reach 100% sales in cities by 2030

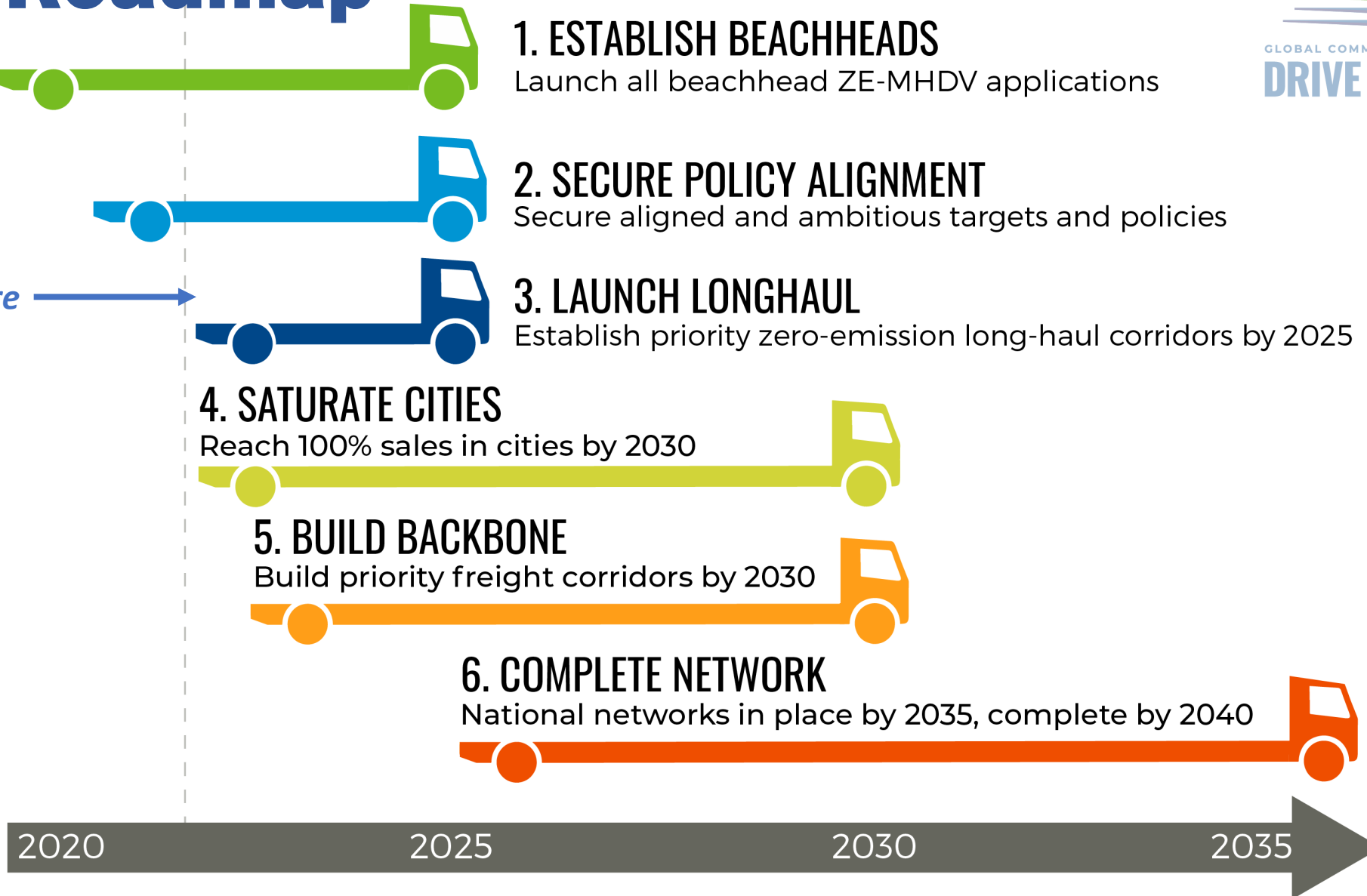
5. BUILD BACKBONE

Build priority freight corridors by 2030

6. COMPLETE NETWORK

National networks in place by 2035, complete by 2040

We are here



Long-haul routes are shrinking in favor of more regional haul.

- Trucking is changing in favor of hub-to-hub, drop-and-hook, relay, and pony express routing.
- The average dry van truckload length of haul has dropped from about 800 miles 20 years ago to about 500 today. (American Transportation Research Institute)
- Data point: in March 2020, the industry ordered 3,900 Class 8 tractors. The vast majority — 3,300 — were day cabs. (ACT Research)

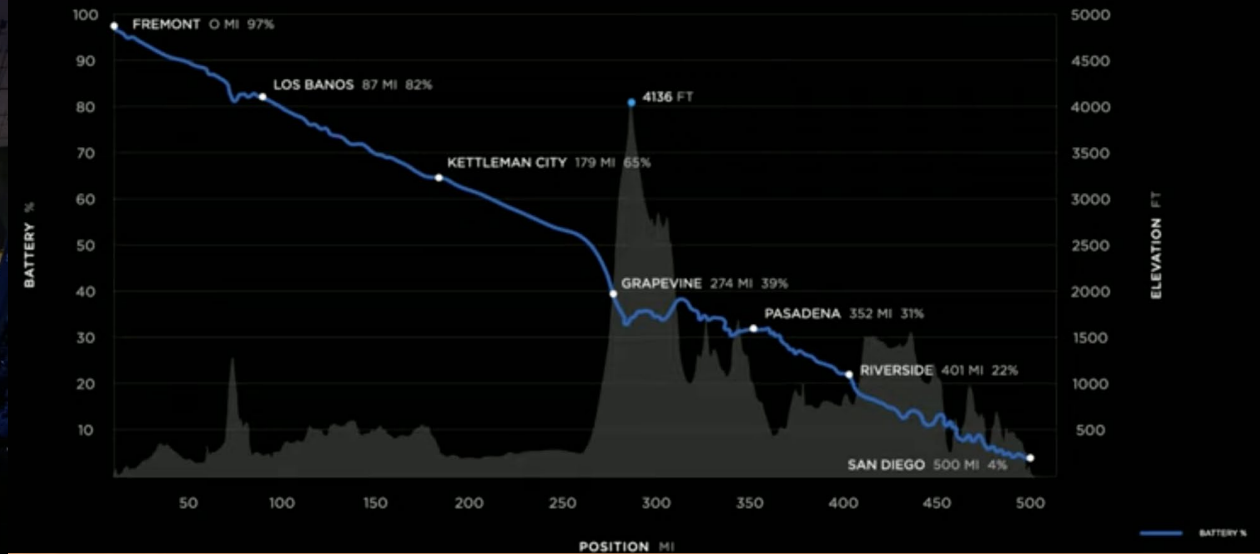
Source: NACFE





Tesla Semi begins deliveries, boasts 500-mile range

NOV. 25 | 500 MI TEST RUN COMPLETE



Nikola Tre FCEV now eligible for HVIP, 500-mile range, 20-min refuel time, order books open



New Investments in Infrastructure

- **Port of Long Beach** installs public HD chargers.
- **WattEV** - network of sites with 47 charge dispenser in Southern California between Bakersfield, the Inland Empire, and the ports of Los Angeles and Long Beach in 2023 capable of charging 94 electric trucks concurrently.
- **TerraWatt** - Announced plans for MHDV charging corridor with stations every 150 miles from Los Angeles, California to El Paso, Texas.
- **Daimler** – announced JV with BlackRock and NextEra to develop MHDV public charging corridors.
- **Electrified Charging Corridor Project** - \$2M CEC investment to Volvo, its CA dealers, and Shell Recharge Solutions to develop a publicly accessible MHDV charging network connecting several of California's largest metro areas.
- **Volvo** - announced partnership with Pilot truck stops for national network of public MHDV stations.
- **Voltera** - will provide turnkey charging solutions for fleets and other customers.
- **Nikola** has announced plans for 60 hydrogen stations by 2026.
- **CPUC** - new \$1B program for transportation electrification with focus on MHDVs & infrastructure in disadvantaged communities.

Begin planning for future highway charging sites now.

- Highway fast-charging sites will need ready access to clean electricity.
- By planning ahead, we can meet these power needs—and bring down costs for charging deployment.
- Identify “no-regrets” upgrades at “no-regrets” sites—so we can build grid infrastructure once, and build it right.



Significant Increase in Federal Funding Support

▪ **Bipartisan Infrastructure Law**

- \$13.2M CMAQ for Zero-Emission MDHD Vehicles
- \$6.420M Carbon Reduction Fund
- \$500M State Energy Program
- \$5B for corridors and infrastructure

▪ **Inflation Reduction Act**

- 45W Qualified Commercial Clean Vehicle Credit
 - \$40,000 or 30% credit for ZEV MDHD vehicles weighing more than 14,000 pounds
- \$1B for Clean Heavy-Duty Vehicle program
- \$2.250M for zero emission equipment and technology at ports
- \$15B for Greenhouse Gas Reduction Fund
- \$60M to reduce diesel emissions in goods movement
- 30C provides \$30K to \$100K in tax incentives for alternative fueling station

Optimizing Federal Funds for ZEVs

- The **Infrastructure Investment and Jobs Act of 2021 (IIJA)** and **Inflation Reduction Act of 2022 (IRA)** will **allocate billions of dollars** to states to reduce emissions from the transportation sector, **presenting a momentous opportunity for states to significantly grow zero-emission commercial vehicle adoption and improve mobility** across the United States through the strategic deployment of funds.
- **CALSTART can help support state governments in making resource allocation decisions** to accelerate zero-emission technology adoption by advising on:
 - FTA's LOW-NO transit program,
 - Commercial vehicle, infrastructure, and clean mobility incentive programs;
 - MHD deployment (pilots and planning);
 - Alternative fuel corridors (commercial ZEV infrastructure planning and build out);
 - and more!

IRA commercial vehicle incentives may support ZET sales shares of 39% to 48% by 2030.

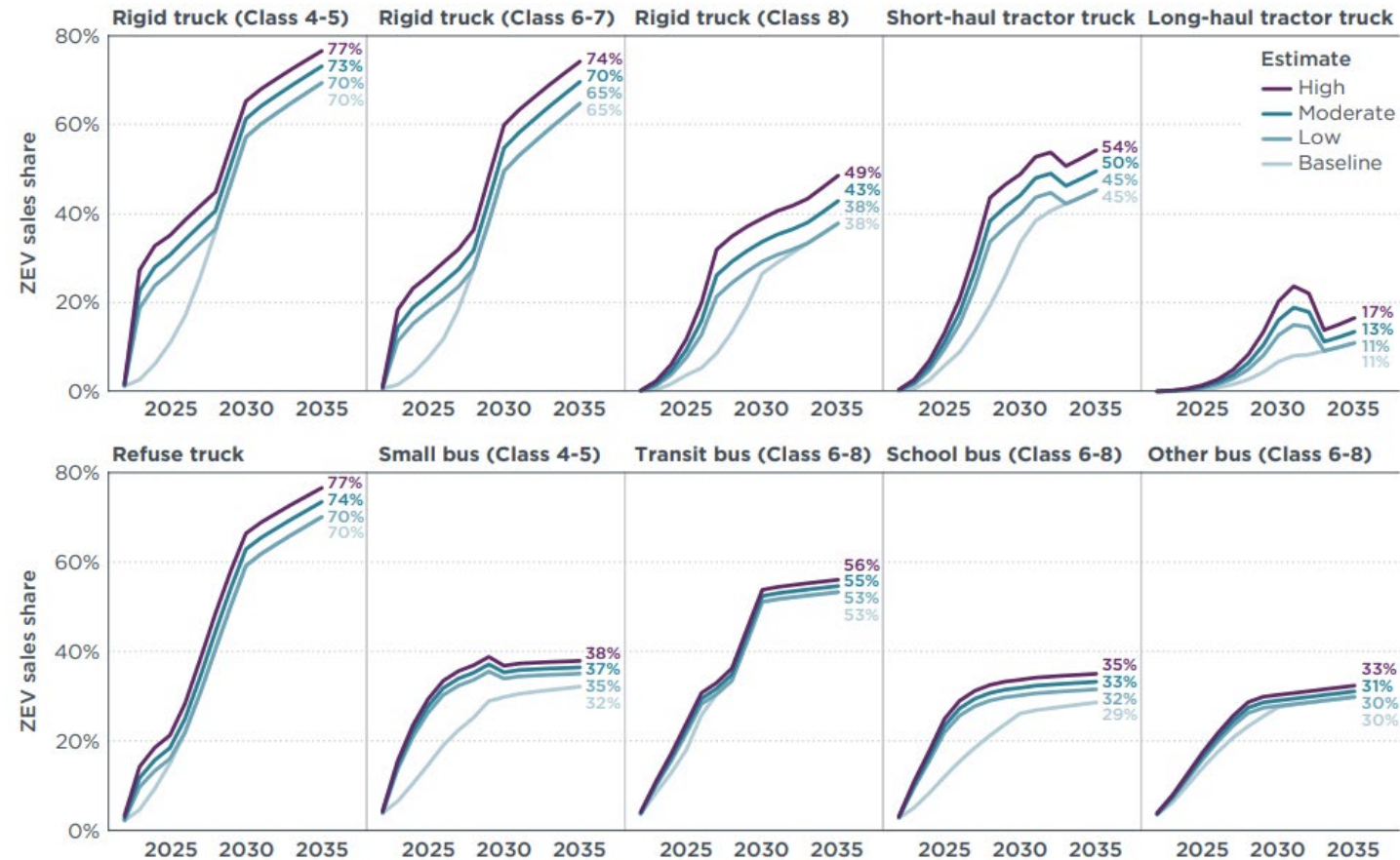


Figure 7. Baseline, IRA Low, IRA Moderate, and IRA High scenarios for U.S. heavy-duty ZEV (BEV + FCEV) sales shares by category, 2022-2035

Source: ICCT

State Policy is Rapidly Developing

- **CALSTART's State Outreach on Federal Funding Opportunities**

- CALSTART led Commercial ZEV and NEVI Webinar Series
- IIJA Investment Strategies in the Northeast paper (2022)
- Currently updating MHDV CALSTART voucher paper specific to new federal funding
- In conversations with various states about MHDV voucher programs

- **Advanced Clean Trucks Rule**

- **7 states** have adopted ACT (California, Massachusetts, New Jersey, New York, Oregon, Washington, Vermont)
- Numerous others actively working on regulation

- **Advanced Clean Cars II**

- **5 states** have adopted ACC II: Washington, Oregon, Vermont, Massachusetts, New York

Commercial ZEV Infrastructure

Top #10 Considerations for NEVI State Deployment Plans & Discretionary Funds

1. Stakeholder Engagement
2. Freight Focus
3. Convenient Fleet Access
4. Higher Power DC Fast Charging
5. Infrastructure and Vehicle Incentives
6. Flexible Fueling
7. Microgrid Deployment
8. Utility Policy Design and Energy Management
9. Contract with Multiple Suppliers
10. Technical Assistance



Commercial ZEV Infrastructure and IIJA Incentives

We are at a pivotal moment in our nation's history, where smart and timely actions are required to combat the threat of climate change. Transitioning vehicles from fossil fuels to zero emission vehicle (ZEV) technology is critical to mitigating the effects of climate change and reducing the impact on public health, especially in communities disproportionately overburdened by transportation emissions.

By incentivizing the deployment of electric charging and fueling infrastructure for zero-emission commercial medium- and heavy-duty vehicles, we can spur technology adoption, create jobs, promote prosperous and healthy communities, and support the transition to a zero-emission transportation future.

Prioritizing Incentives for Commercial ZEV Infrastructure

As the nation moves forward with implementation of the Bipartisan Infrastructure Law's National Electric Vehicle Formula Program and discretionary grant program for Charging and Fueling Infrastructure, it is critical that states include commercial vehicle infrastructure needs into their respective plans and programs. This document serves to provide guidance on key considerations to prioritizing incentives for commercial ZEV infrastructure.



Benefits of Commercial ZEVs and Infrastructure Needs

Fast Charging
Infrastructure that accommodates high power charging as well as lower power charging as needed.

Vehicle Incentives
Incentives for commercial electric vehicles and infrastructure that support commercial vehicle use.

Flexible Fueling
Infrastructure that provides depot-level charging and refueling options (stationary and mobile) to support local utility grid.

Considerations for Commercial ZEV Infrastructure

- 1. Stakeholder Engagement**
Conduct outreach to and engage with public and private stakeholders and community-based organizations to site and prioritize commercial vehicle infrastructure to increase commercial ZEV adoption in disadvantaged, low-income and rural communities.
- 2. Freight Focus**
Prioritize commercial vehicle charging and alternative fueling infrastructure nearby urban centers and freight hubs such as ports, distribution centers, warehouses, and rail yards to reduce emissions impact on communities.
- 3. Convenient Fleet Access**
Accommodate public commercial vehicle charging and fueling needs such as turning radius, truck parking, restrooms, and amenities for fleet operators.



Market Trends

1. states have committed to 2050 and state level. Currently, there are over 100,000 commercial vehicles in the market. The time to act is now to build the nation's zero-emission ecosystem for commercial ZEVs.

Visit CALSTART's [Global Drive to Zero Program website](#) to learn about today's latest [priority](#) for commercial ZEVs that include battery-electric and hydrogen fuel cell vehicles.

8. Utility Policy Design & Energy Management

Work with utilities to develop EV charging policies that support commercial vehicle needs including rate design (reduces cost per kWh) and make-ready and charger incentive programs that decrease the cost of infrastructure development. Encourage alignment of utility upgrades with commercial ZEV deployment by incentivizing innovative infrastructure solutions such as load monitoring software to prevent peak loading, which results in demand fees, and to manage energy requirements for commercial EV charging.



9. Contract with Multiple Suppliers

A competitive marketplace for Electric Vehicle Supply Equipment (EVSE), network operators, and energy management providers will deliver the best results for EV users. Engagement with multiple procurement partners rather than relying on a single company will nurture that marketplace.

10. Technical Assistance

Establish a technical assistance resource hub for commercial ZEV infrastructure development for commercial users, public and private stakeholders. Example: [CALSTART's Energy Infrastructure Readiness Center](#)



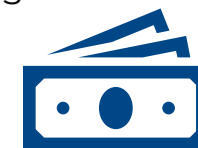
Contact Us

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Ecosystem of state actions to drive the ZE freight market:

- **Adopting policies like sales & purchase requirements (e.g., ACT, ACF) and ZET weight exemptions**
 - Way to go, CA, OR, WA, NJ, NY, MA & VT!
- **Providing vehicle & infrastructure incentives**
 - E.g., HVIP, EnergiIZE, NYTVIP, Colorado Clean Fleet Vehicle Technology (CFVT) Grant Program
 - Vouchers more effective than grants
 - LCFS
- **Investing in public M/HDV chargers**
 - Look to new federal funding
 - Encourage wide, pull-through stalls
 - Demos and pilots to prove out technology with infrastructure @ scale
- **Streamlining permitting requirements for M/HDV charging infrastructure**
- **Working with utilities, PUC, etc.**
 - Electricity costs (TOU rates, demand charges, etc.)
 - Make-ready infrastructure
 - Proactively upgrade grid
- **Educating stakeholders**
- **Investing in workforce development & training**





Thank You

We change transportation for good.

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