Powering zero-emission trucks: U.S. infrastructure needs through 2030

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Heavy-Duty Vehicles Program
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2021 U.S. heavy-duty vehicle market trends

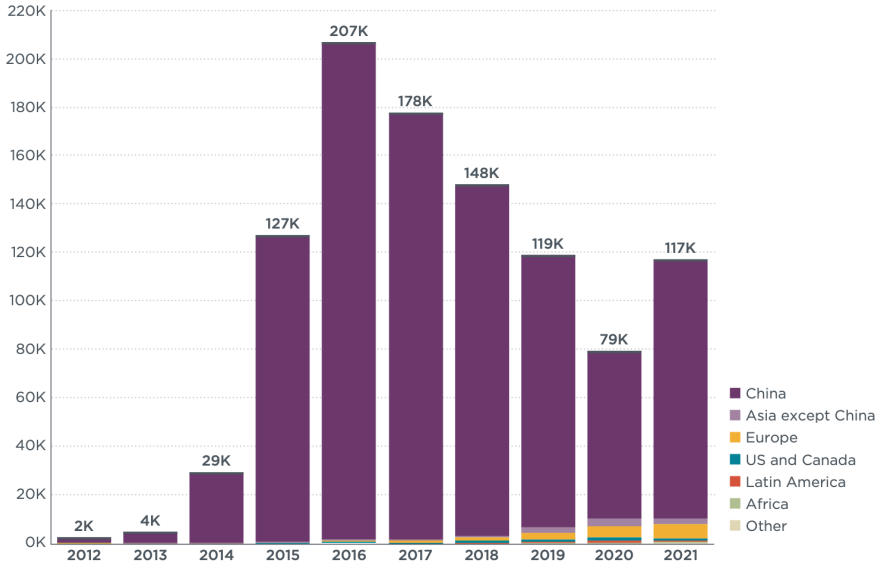
Globally ~117,000 zero-emission HDVs sold in 2021

China accounts for ~92% of global HD ZEV market

600+ zero-emission HDV sales sold in the **United States** in 2021

~80% of **United States** HD ZEV sales in 2021 were buses

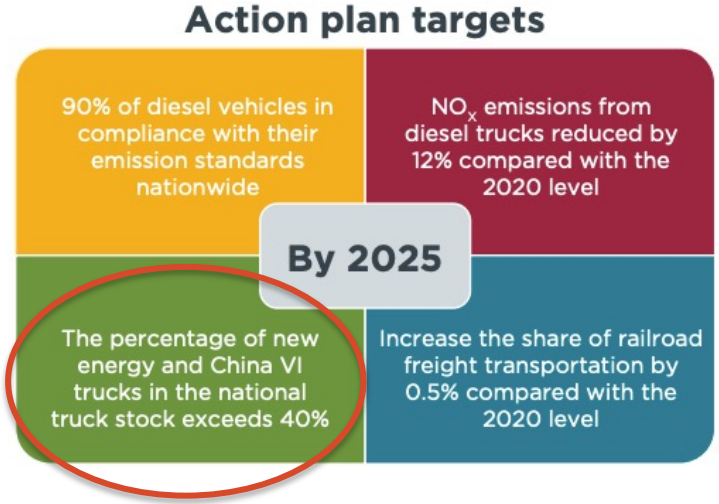
Zero-emission heavy-duty vehicle sales worldwide, 2012-2021



Buysse, C. (2021). *Zero-emission bus and truck market in the United States and Canada: A 2021 update* (p. 8). International Council on Clean Transportation. https://theicct.org/publication/update-ze-truck-bus-market-us-can-sept22/

International HD ZEV goals

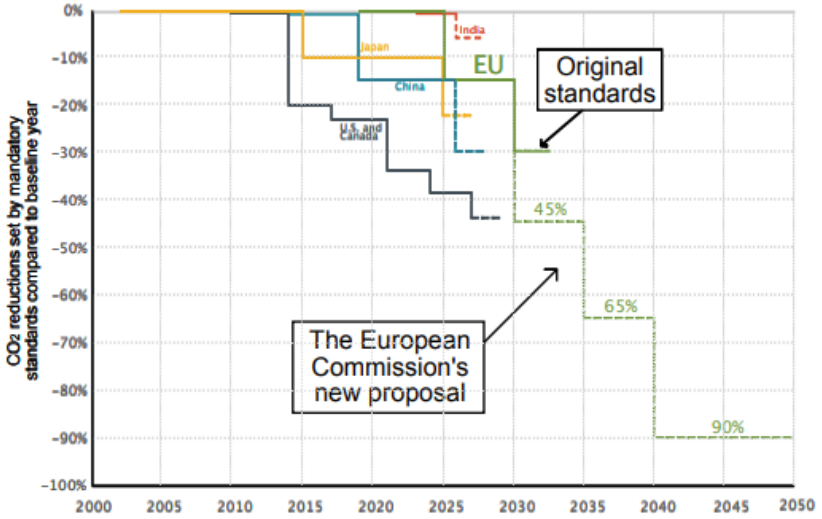
China's Clean Diesel Action Plan Phase II



KEY REGIONS NEV sales share to reach 80% for public buses, urban trucks, and refuse trucks

https://theicct.org/wp-content/uploads/2023/02/Clean-diesel-action-plan-II_final.pdf

EU 2023 heavy-duty CO2 standard proposal

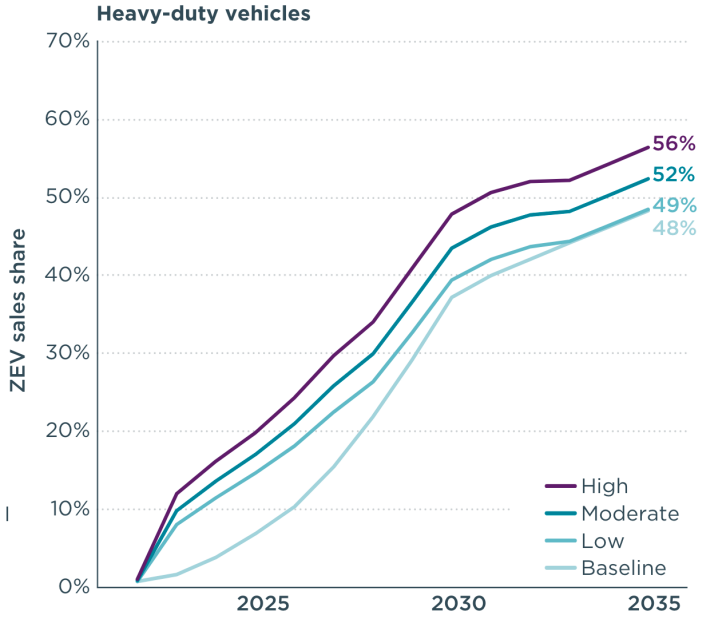


https://theicct.org/wp-content/uploads/2023/02/presentation-slides-eu-co2-standards-from-hdvs.pdf

Inflation Reduction Act incentives will boost heavy-duty zero-emission vehicle sales

ICCT projects HD ZEV sales share to grow to ~44% (39-48) in 2030

Fuel cell market share will not exceed ~2% of truck sales



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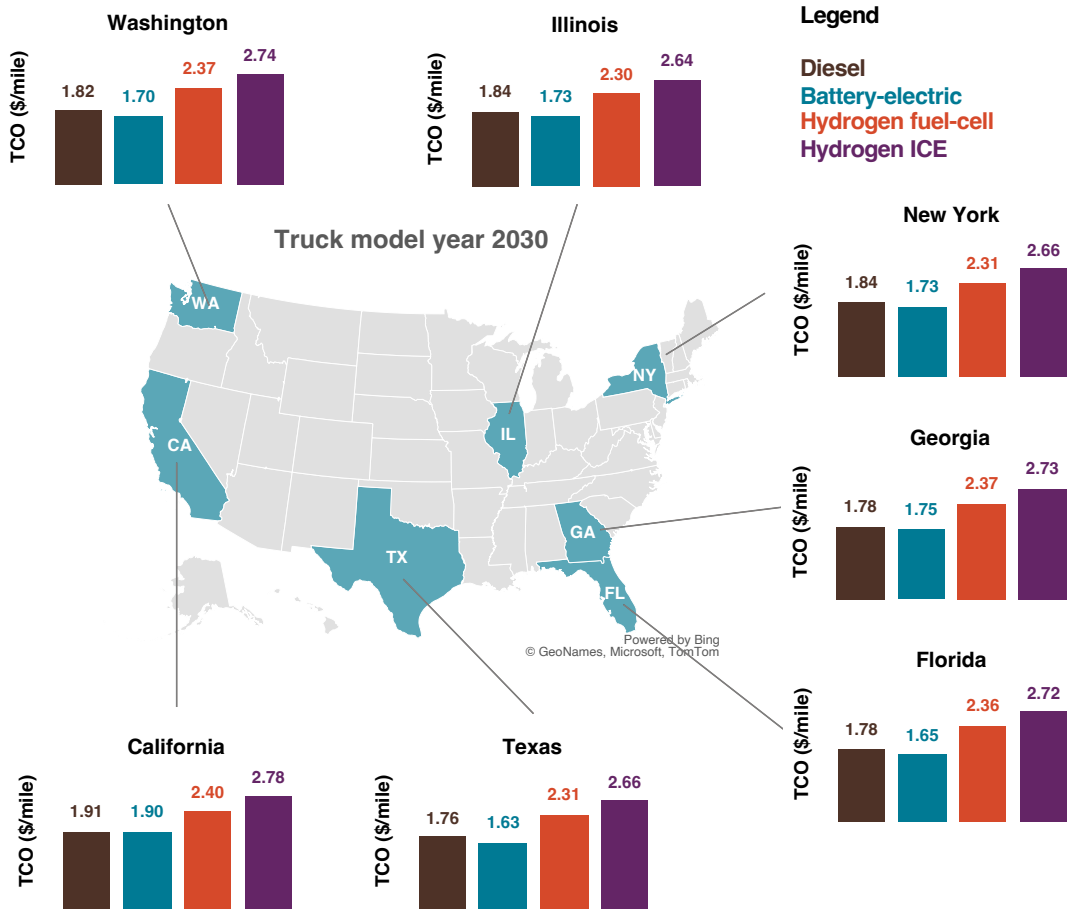
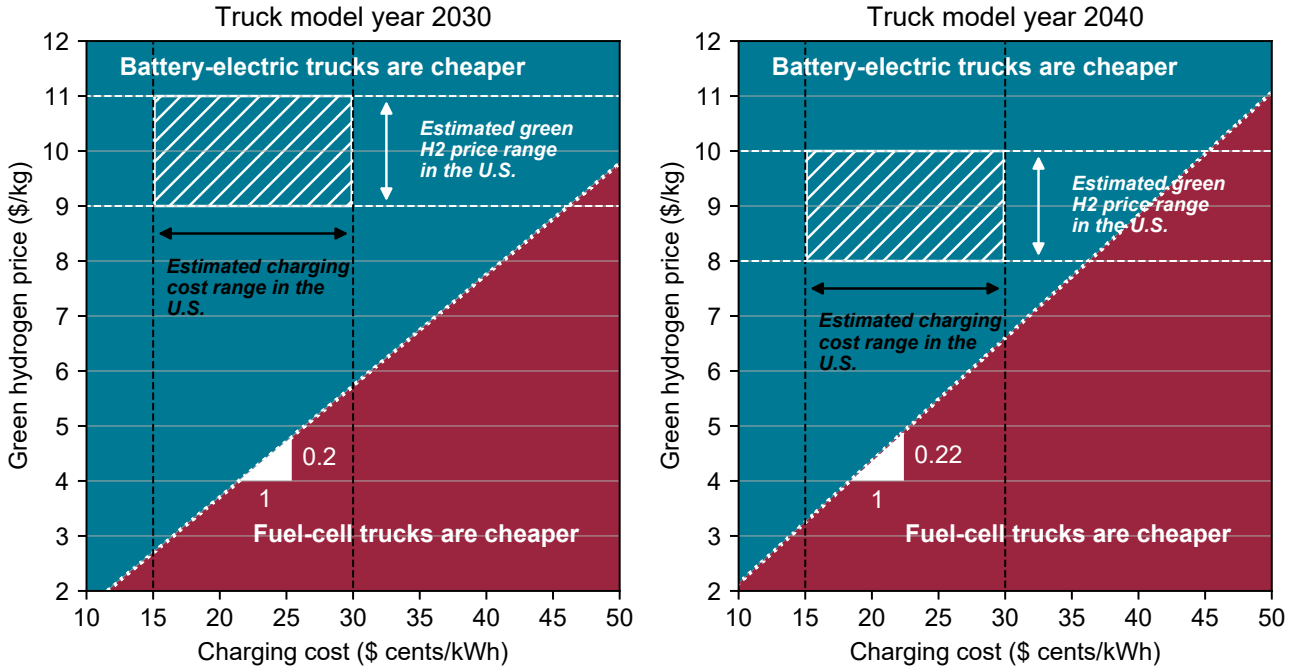
Slowik, P., Searle, S., Basma, H., Miller, J., Zhou, Y., Rodríguez, F., Buysse, C., Minjares, R., Kelly, S., & Pierce, L. (2023). *Analyzing the impact of the Inflation Reduction Act on electric vehicle uptake in the United States*. International Council on Clean Transportation. https://theicct.org/publication/ira-impact-evs-us-jan23/

Battery-electric long-haul trucks are expected to record the lowest TCO by 2030 in most states



Basma, H., Buysse, C., Zhou, Y., & Rodríguez, F. (2023). Total cost of ownership of alternative powertrain technologies for Class 8 long-haul trucks in the United States. *International Council on Clean Transportation*. https://theicct.org/publication/tco-alt-powertrain-long-haul-trucks-us-apr23/

Battery-electric trucks are expected to achieve a lower TCO than fuel-cell trucks



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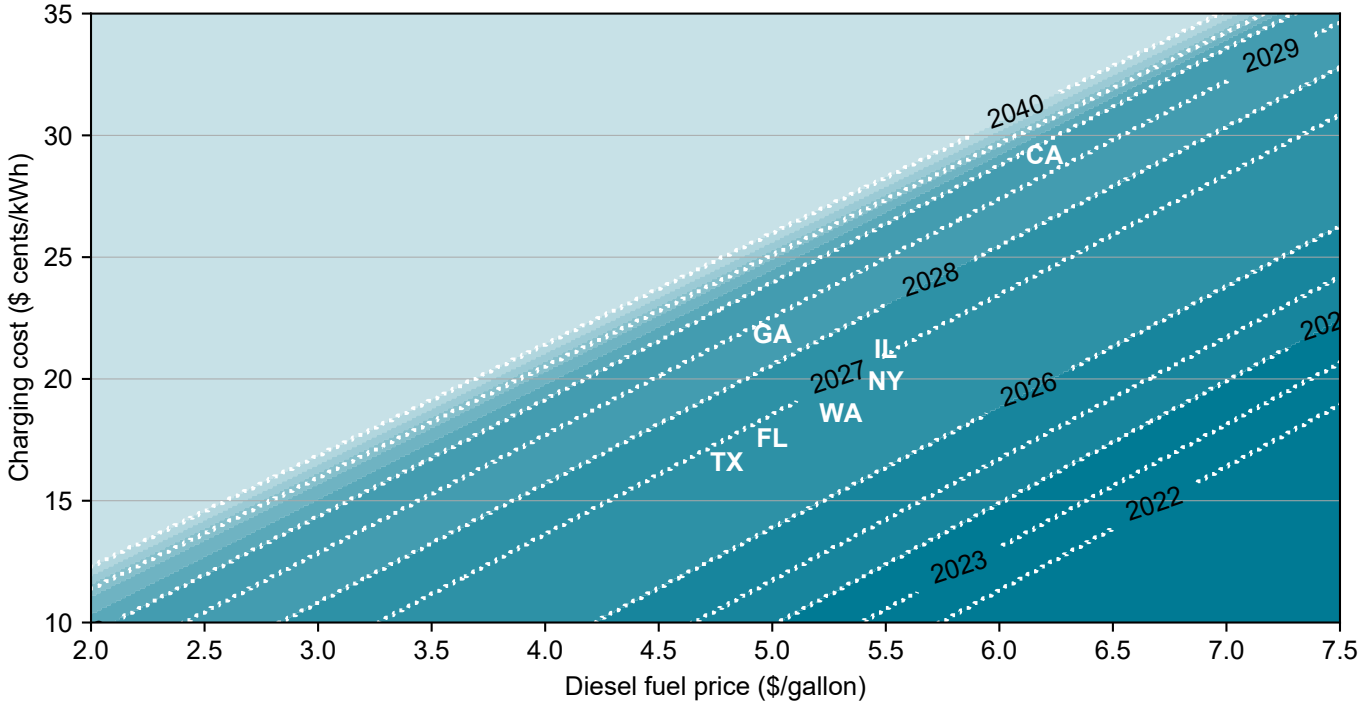
TCO parity map – BET vs Diesel



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A formula for successful zero-emission truck deployment nationwide

Vehicle product availability

Vehicle total cost of ownership

Charging infrastructure readiness

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Three questions to determine national charging infrastructure readiness for heavy-duty vehicles

1. **Where** to locate charging infrastructure?
2. **When** does this charging infrastructure need to be ready?
3. **How much** power to make available at each location?

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Assessment of infrastructure needs based on freight activity

ZET deployment

- Vehicle sales and stock modelling
- Based on projected market growth
- Energy demand by vehicle category
- 2023-2030

ZET activity

- HPMS traffic activity data
- Map daily energy needs onto U.S. road network
- County-level
- National Highway Freight Network

Infrastructure needs

- Assumptions on fleet preferences, charging level, depot vs public
- Size of charging hubs
- Peak charging load
- Nameplate capacity

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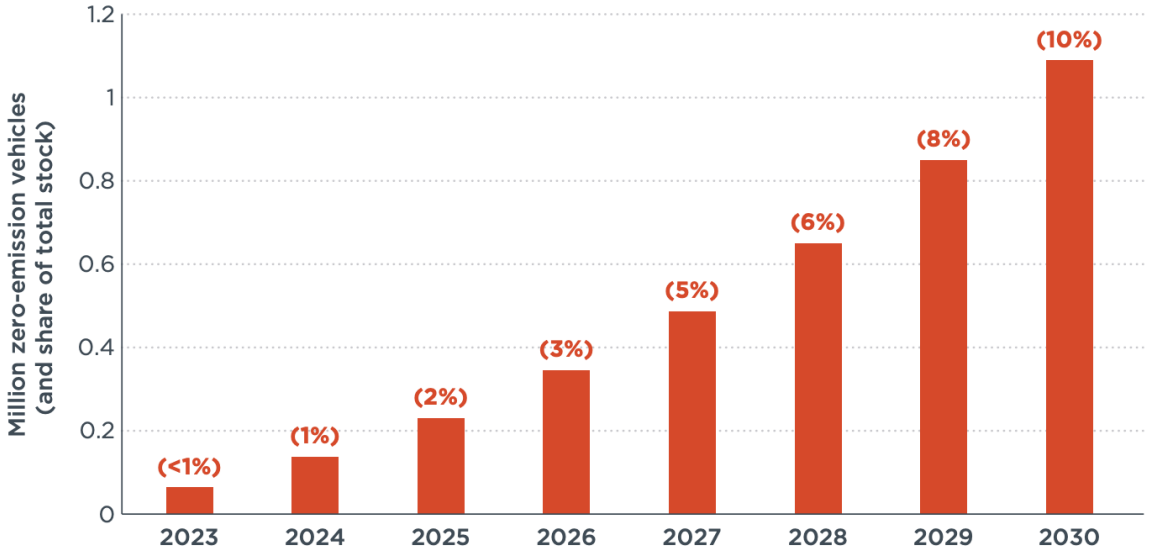
Ragon, P.L., Kelley, S., Egerstrom, N., Brito, J., Sharpe, B., Allcock, C., Minjares, R., and Rodriguez, F. (2023). Near-term infrastructure deployment to support zero-emission medium-and heavy-duty vehicles in the United States. Washington, D.C., International Council on Clean Transportation. *https://theicct.org/publication/infrastructure-deployment-mhdv-may23/*

At least 1.1M zero-emission trucks and buses expected by 2030

Projected stock of Class 4-8 zero-emission MHDVs based on market developments, 2023-2030



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Top 10 states account for 49% of national charging needs in 2030

Energy demand is concentrated in states that have adopted the ACT rule and states with the largest industrial activity

Texas and California will account for a combined 19% of energy needs

Energy needs from electric MHDVs in ACT states

Rank in U.S.	State	Total daily VKT, Class 4–8 MHDVs (km)	Total daily eVKT, Class 4-8 MDHVs (km)	Daily energy consumption from charging (MWh)	Share of national energy consumption
2	California	180,728,114	23,719,908	11,196	8%
10	New York	50,770,266	6,923,440	4,231	3%
22	Washington	60,919,508	5,450,202	2,398	2%
25	Oregon	49,076,476	5,367,451	2,229	2%
26	New Jersey	43,720,773	6,348,471	2,047	1%
31	Colorado	42,265,662	5,098,477	1,849	1%
32	Massachusetts	48,185,397	6,862,962	1,732	1%
48	Vermont	1,909,384	212,349	276	0%
U.S. total		**3,523,436,176**	**399,077,768**	**139,865**	**100%**

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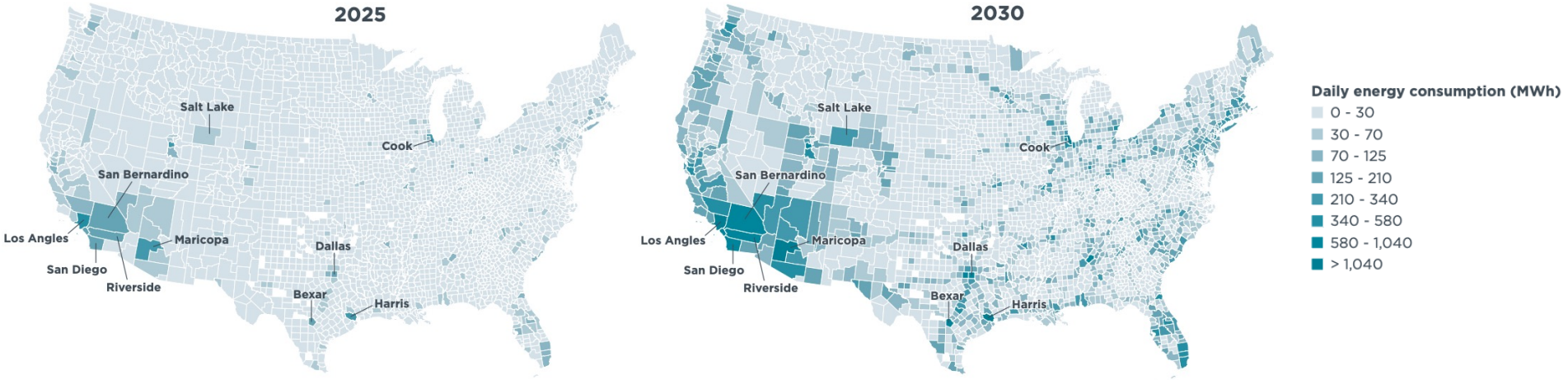
Growth in energy demand will be concentrated in freight zones, such as ports, industrial zones, and freight corridors



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Top 1 percent of counties account for 15% of national charging needs in 2030

Top ten counties by zero-emission truck charging demand in 2030

Rank	County	Daily energy consumption (MWh)	Estimated peak charigng load (MW)	Overnight chargers	Fast chargers	Ultrafast chargers	Nameplate capacity of chargers on local distribution grid (MW)
1	Los Angeles, CA	1,791	132	8,666	80	38	974
2	Maricopa, AZ	1,616	119	7,125	72	41	832
3	Harris, TX	1,613	119	7,036	72	41	826
4	Cook, IL	1,266	93	6,051	57	28	683
5	Dallas, TX	1,019	75	3,963	45	31	490
6	San Bernardino, CA	943	70	4,166	41	23	482
7	San Diego, CA	940	69	4,463	42	21	505
8	Salt Lake, UT	937	69	5,014	42	16	541
9	Riverside, CA	708	52	3,360	31	15	379
10	Bexar, TX	698	51	2,789	31	20	340
US total		**139,893**	**10,317**	**580,054**	**7,869**	**5,639**	**69,157**

Note: Counties are ranked in descending order of energy consumption. This table was updated on May 22, 2023 to accurately reflect modeling assumptions.

Projected 2030 national daily energy consumption is equal to **1%** of total electric retail sales in 2021*

Distribution capacity is far more urgent than generation capacity

*2021 total electric retail sales taken from Energy Information Administration https://www.eia.gov/electricity/sales_revenue_price/pdf/table2.pdf

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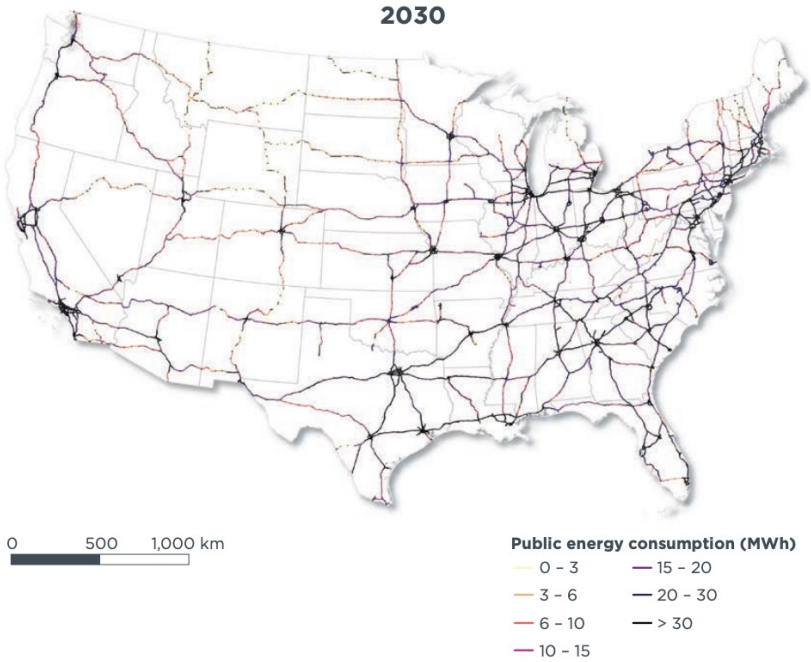
Setting targets for charging station deployment along key NHFN corridors can accommodate up to 85% of long-haul charging needs by 2030



Minimum size of public charging stations every 50 miles along the NHFN to support long-haul trucks

Percentile of annual average daily traffic count on the NHFN	2025 minimum station size	2030 minimum station size
0 – 25%	350 kW/station	1,900 kW/station
25% – 50%	400 kW/station	4,300 kW/station
50% – 75%	700 kW/station	7,200 kW/station
>75%	1,400 kW/station	13,500 kW/station
NHFN national average	**600 kW/station**	**6,200 kW/station**

Note: This table was updated on May 23, 2023 to accurately reflect modeling assumptions.

NHFN = National Highway Freight Network

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Opportunities for smart and timely charging infrastructure deployment

KEY PRINCIPLES

- Maximize use of existing grid capacity today
- Accelerate deployment of grid capacity tomorrow

Actions that do not require regulatory approval

- Short-term load rebalancing
- Use non-firm distribution capacity
- Dynamic line rating
- Smart charging
- Third-party finance, design and construction

Actions that require regulatory consent or administrative approval

- Explicitly include transportation load forecasts into distribution system planning
- Allow third parties to submit applications on behalf of customers

Options that require regulatory approval or state legislation

- Authorize pre-construction of grid infrastructure in ‘no-regret’ freight zones and corridors
- Steer connections to higher voltage transmission lines, especially along highways

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Discussion

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Questions?

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