WHITE PAPER

Zero-Emission Truck Policy Group at 2023 Climate Week NYC

Roundtable on Electric Vehicle Charging Infrastructure and the Grid

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Context and Motivation

There are **~13 million medium- and heavy-duty vehicles (MHDVs) in the United States** across a large variety of vehicle types ranging from heavy-duty pickup trucks and box trucks to full-size buses and Class 8 tractor semi-trailers.

Despite representing only 5% of vehicles on the road, MHDVs emit almost **25% of total U.S. transportation greenhouse gas (GHG) emissions** and are a major source of air pollution, which poses substantial health burdens and disproportionally affects disadvantaged communities.

It is thus **critical to transition to zero-emissions solutions**: battery electric vehicles (EVs) and fuel cell electric vehicles (FCEVs) can be viable solutions for multiple market segments. **EVs are coming fast.** NREL estimates that with continued improvements in vehicle and fuel technologies, zero-emission vehicles (ZEVs) can reach total-cost-of-driving parity with conventional diesel vehicles for all MHDV classes (without incentives) by 2035. ZEV sales could reach more than 40% of all trucks by 2030, reflecting lower vehicle purchase and operating costs.

Electrification will have far-reaching impacts for energy systems and the grid. EVs are expected to be the largest source of electricity load growth over the next decade and can provide much needed demand-side flexibility.

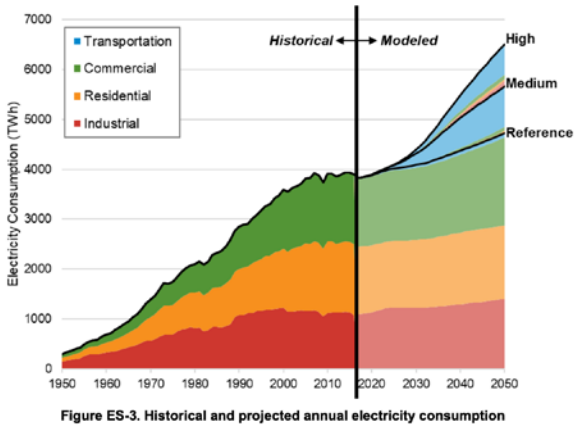

Figure 1. EVs will be the largest source of electricity demand growth in the coming decade. NREL's Electrification Futures Study projects up to 1,424 TWh of EV electricity consumption by 2050, and more recent net-zero studies show even more aggressive growth.

How can we ensure enough charging infrastructure will be available and that EVs will be effectively integrated with the grid?

Sources and further readings:

1. *The U.S. National Blueprint for Transportation Decarbonization* – DOE/DOT/EPA/HUD 2022
2. *Road to Zero: Research and Industry Perspectives on Commercial ZEVs* – iScience 2023
3. *Decarbonizing On-Road MHDVs: ZEVs Cost Analysis* – NREL 2022
4. *Electrification Futures Study* – NREL 2018

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Charging Infrastructure

EV charging can occur at many types of locations, not limited to traditional "fueling stations":

- **Depot charging can cover most needs.** Today, only about 10% of heavy-duty trucks require an operating range of 500 miles or more, whereas about 70% operate within 100 miles. Charging at depots requires reliable onsite charging at "low" power levels (5–150 kW).
- **High-power en-route charging** (up to MW+) is needed for long-haul applications and as a safety net for vehicles that normally charge at depots.
- **Opportunity charging** (e.g., while loading/unloading or on break) could provide additional convenient charging opportunities.

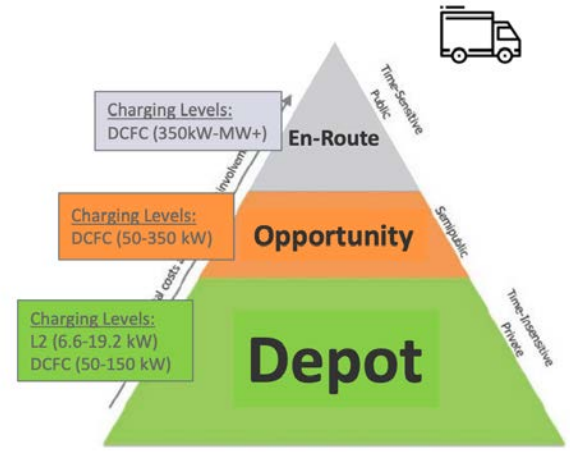

Figure 2. Electric MHDV charging will be heterogeneous, with most vehicles leveraging convenient "slow" depot charging.

It is critical to assess the charging needs for different vehicle types and applications. **Analytical tools can inform the planning of EV charging infrastructure deployments**—from the regional, state, and national levels to site and facility operations.

Sources and further readings:

1. *Perspectives on Charging Electric MHDVs* – NREL 2021
2. *Heavy-Duty Truck Electrification and the Impacts of Depot Charging on Electricity Distribution Systems* – Nature Energy 2021
3. *Charging Needs for Electric Semi-Trailer Trucks* – Renewable and Sustainable Energy Transition 2022
4. *The 2030 National Charging Network* – NREL 2023

Effective Grid Integration

EVs are expected to be the largest load growth opportunity for electric utilities over the next decade or more. Supporting these new loads **will require major investments in generation, transmission, and distribution**. At the same time, EV charging can be scheduled to better align with electricity supply—especially from wind and solar—and EV batteries can provide back-up power for other loads or the grid. EVs are thus not a "burden" on the grid: **smart integration of EVs can strengthen the grid by providing flexibility to reduce electricity costs and increase resiliency**.

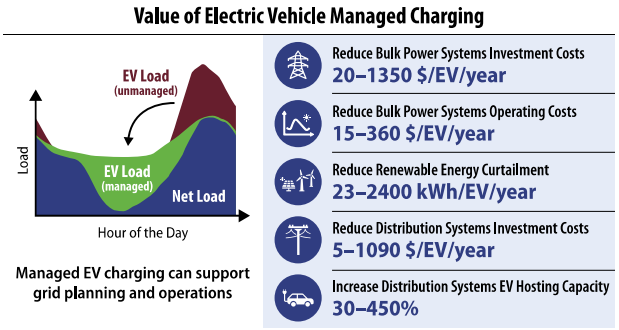

Figure 3. Many studies demonstrate significant value of managed EV charging in improving energy system sustainability, economics, and reliability and stress how EVs can support and complement the expected large-scale deployment of solar and wind.

For example, a recent California Public Utilities Commission study states, "Rather than necessarily adding to rates, we think that **electrification could actually put downwards pressure on rates** as the cost of the additional infrastructure is spread across more units of electricity sold."

Integrated transportation-power-systems modeling and analysis can help guide the effective integration of EVs to realize these potential benefits.

Sources and further readings:

1. *The Rise of EVs* – Progress in Energy 2021
2. *Assessing the Value of EV Managed Charging* – Energy & Env. Science 2022
3. *Electrification Futures Study* – NREL 2021
4. *EV Managed Charging Forward-Looking Estimates of Bulk Power System Value* – NREL 2022

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