Charging forward

Recommendations for reducing charging infrastructure costs for heavy-duty trucks

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Transforming the icons of American highways

Heavy-duty trucks are the workhorses of our economy. They move our food and products and support millions of jobs throughout the country. But because they are powered by diesel fuel, they contribute a disproportionate amount of transportation-related climate and local air pollution and saddle trucking companies with high fuel bills.

Their outsized portion of pollution from diesel makes heavy-duty trucks critical candidates for new technology. Electrifying them would eliminate on-road emissions like carbon dioxide, combustion-related particulate matter and nitrogen oxides. If charged with clean renewable electricity, such a transition could be even more powerful by reducing the greenhouse gas emissions generated by fossil fuel electricity. With improved efficiency, lower energy prices, and less maintenance, electric trucks represent a cost reduction measure for major vehicle owners, once the initial purchase and charging system installation are complete.

Several states have already committed to transition their truck market, an important signal to manufacturers and other companies in the electric vehicle ecosystem.

Heavy-duty trucks, however, present unique challenges for electrification. They carry heavy loads and have longer routes and unique schedules. Until now, there's been little publicly available research using real-world data that examines the technical feasibility of electrifying heavy-duty trucks or the infrastructure investment required for fleets to transition to electric trucks without significant changes to their operations.

The policy recommendations outlined here focus on the cost of charging infrastructure, the greatest challenge of electrifying heavy-duty trucks as identified by groundbreaking research from Gladstein, Neandross & Associates.

First-of-its-kind, real-world data analysis

Commissioned by EDF, Gladstein, Neandross & Associates analyzed a year of real-world, Class 8 trip data from two Class 8 truck fleets to evaluate the trip capabilities of electric trucks, the requirements and costs of charging systems, and the impact of managed charging and on-site distributed energy resources on the ability to electrify this important truck class.

GNA evaluated one year of real-world trip data from two national trucking companies.

- 50 Class 8 NFI trucks operated in California, averaging approximately 40,000 vehicle miles per year.
- 42 Class 8 Schneider trucks, operated in California, averaging approximately 67,000 vehicle miles per year.
- Evaluated distances and locations traveled, driving and dwell times, fuel use and other variables.
- Examined the technical capabilities of current electric models, diesel versus electricity "fuel" costs, infrastructure costs, and the grid and cost-mitigation impact of managed charging and on-site-deployment of distributed energy resources (DERs) over various commercial rate structures in California.
- Modeled 32 scenarios – all possible combinations of the following variables:

  Charging Strategy:
  Unmanaged and Managed

  Charger Power Rating:
  50, 150, 350, and 800 kW

  Vehicle Battery Capacity:
  300, 500, 750, and 1000 kWh
- Analyzed the cost and impact of on-site solar installations that would provide approximately 80% of the location's annual energy needs, as well various energy storage (battery) configurations.
- Analyzed the amount of revenue fleets would receive, after they electrified, through carbon credits generated under a policy like a low carbon fuel standard.

The recommendations included in this report were developed by EDF and informed by a technical analysis of Class 8 fleet data conducted by Gladstein, Neandross & Associates (GNA). The full GNA analysis is available online at (insert link).

Key findings

EDF's recommendations address the key findings of the GNA technical analysis.

- Existing and upcoming electric Class 8 truck models, paired with commercially available charging equipment, can meet the technical requirements of the vast majority of truck-trips analyzed with on-site (depot) charging – though operational challenges remain.
- Charging infrastructure investments required for Class 8 fleets are significant and can vary dramatically.
- Managed (smart) charging and on-site and deployment of distributed energy resources (DERs) like batteries or solar will be critical to making infrastructure costs affordable.
- Additional policies and programs that reduce the infrastructure costs required for fleet electrification will be essential to accelerate the transition of Class 8 trucks.

Recommendations

Electric vehicles offer long-term operational and maintenance savings compared to diesel vehicles. GNA's analysis, for example, found that electrification has the potential to save these companies $550,000 (Schneider) and $750,000 (NFI) in annual fuel costs.

	Diesel	Electricity	Savings
Schneider Annual Fuel Cost	$1,536,656	$981,843	$554,813
NFI Annual Fuel Cost	$1,397,735	$639,424	$748,311

Currently, however, fuel savings are not sufficient to mitigate the upfront infrastructure costs required for electrification. GNA determined the total infrastructure investment needed to electrify NFI's 50 trucks and Schneider's 42 trucks would be $10.4 million (NFI) and $8.9 million (Schneider), including charging hardware and other construction (make-ready) costs.

Based on GNA's research, EDF recommends policies and programs that focus on reducing charging infrastructure costs.

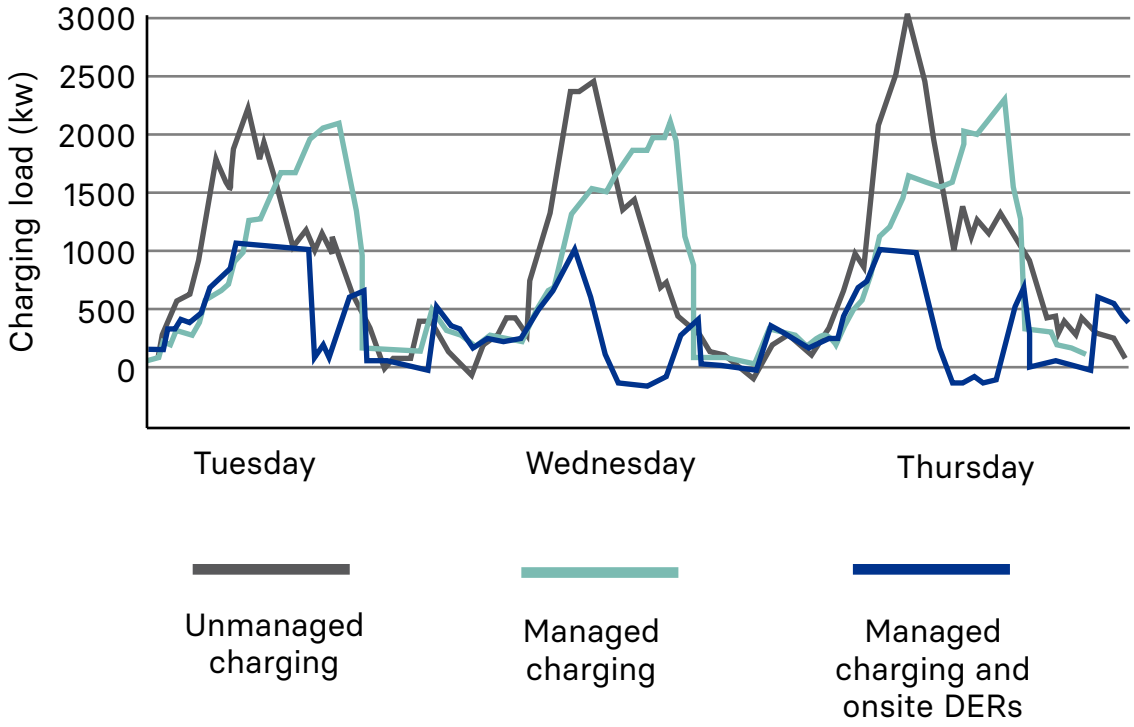
1 States and utilities seeking to accelerate the adoption of electric trucks should pursue policies and programs that encourage and reward the use of managed charging.

Managed charging allows fleets to use real-time data like grid load and electricity cost to determine optimum charging schedules and provides benefits to the fleet owner, the utility, and the environment. With the proper rate design, utilities can encourage off-peak charging or charging when renewable energy resources are plentiful. This would reduce stress on the grid, save fleet owners money, and reduce emissions from fossil-fuel power plants.

Not only will managed charging be necessary to improve the economics of electrifying Class 8 truck fleets, GNA's analysis suggests that optimized managed charging programs could be much more powerful than they are today.

GNA's model was based on current California electric vehicle charging rates and produced savings of $20,000 - $110,000 per year for the Schneider fleet and $100,000 - $1.5 million per year for the NFI fleet. Optimizing rates to further encourage off-peak charging could produce more favorable savings.

Three charging strategies — three load profiles



The figure above illustrates three modeled days of charging behavior using actual NFI fleet data under three scenarios: unmanaged charging, managed charging, and managed charging with on-site solar and fixed battery storage. Managed charging allows fleets to delay charging to periods of lower demand, higher availability of clean electricity from the grid, and lower cost electricity. The addition of on-site solar and batteries to managed charging results in dramatically lower peak loads and reduction in overall demand from the grid.

2 States and utilities seeking to accelerate the adoption of electric trucks should pursue programs that encourage and reward the deployment of clean, on-site distributed energy resources.

Distributed energy resources (DERs) provide energy generation or reduce energy demand within the distributed electricity grid. DERs can reduce energy costs and emissions by reducing the amount of energy needed from fossil fuel power plants. But they can also add stability to the grid if used to reduce the amount of electricity utilities must provide to large users, like truck charging depots. For this analysis, GNA examined two types of clean DERs: on-site solar panels and on-site energy storage, or batteries.

When added to GNA's managed charging scenarios, DERs produced additional annual electric savings of $625,000 (Schneider) and $835,000 (NFI), further reducing the long-term cost of fleet electrification.

The combination of managed charging and DERs reduced annual on-peak load by 611 kW for the Schneider fleet and 4 MW for the NFI fleet. This would not only reduce costs for the truck companies, but the utility, as well. If scaled to all trucks in a utility's territory, these load reductions could drastically decrease the amount of grid upgrades needed to accommodate electric fleets.

3 State and federal agencies should explore policies, programs or market-based tools that reduce the up-front infrastructure costs of electrifying heavy-duty truck fleets.

The combination of reduced operational and fuel costs, managed charging, and on-site DERs can significantly reduce the long-term cost of electrifying truck fleets. Those savings, however, take time to realize and cannot fully mitigate the up-front costs fleet owners would have to absorb to electrify.

There are various state and federal programs and grants that help reduce the up-front cost of replacing vehicles. But GNA's analysis makes clear that transitioning to electric fleets is more complicated and costly than simply replacing vehicles and installing chargers. It can involve significant construction and utility improvements that must be completed before the first charger is installed. Existing state and federal efforts should be re-examined and expanded to more directly consider these up-front infrastructure costs. As the upfront costs for electric trucks continues to decline over the coming years, these programs can be scaled down.

4 State and federal agencies should accelerate R&D to improve battery performance and optimize en route charging infrastructure design.

Electric truck models are already very capable and are constantly improving. GNA found that existing or announced electric models and charging equipment could meet the technical needs of 93% of NFI's trips and 88% of Schneider's trips without any route modification or en route charging. Most of the trips that could not be completed could have been with less than an hour of en route charging or with larger or more efficient batteries.

Despite significant recent advancements in battery technology, better batteries would significantly improve electric truck performance and capabilities. For example, improving battery density (the amount of energy a battery can hold per pound of battery weight), would increase a fleet's range. Improving the speed at which batteries can accept a charge would reduce charging time and make en route charging more feasible. Just as expanding public charging availability and capability will spur the electrification of passenger vehicles, it will also further the electrification of truck fleets.

The future of trucking is zero emissions

GNA's analysis shows that electrifying heavy-duty trucks will require getting charging right, especially for fleet owners.

Despite the annual fuel and maintenance savings electrification offers over diesel, the infrastructure cost of this transition will be significant. Through effective rate design, managed charging and the use of on-site DERs, the infrastructure costs can be reduced. Even as this market matures and costs decline, up-front infrastructure costs will be significant.

Policymakers and regulators who see the economic, environmental, public health and equity benefits of electrifying America's truck industry must help design programs and policies that prioritize investment in vehicle charging infrastructure, reduce up-front infrastructure costs, and encourage fleet companies to make the transition.