CHARGING FORWARD WITH ELECTRIC TRUCKS

This report covers charging considerations for commercial battery electric vehicles (BEVs) currently in production for freight delivery. Charging infrastructure includes not only the chargers themselves, but the interrelated system of vehicles, duty cycles, chargers, and electric utilities. Because most BEVs currently are being deployed in the goods movement sector in the medium-duty urban delivery and heavy-duty drayage sectors, many of the best practices and lessons learned come from these applications. And while the report touches on considerations for long-haul BEVs, much of this information is speculative; although battery electric truck deployment for long-haul usage is rapidly expanding, it is still in its pilot phase.

In March 2019, The North American Council for Freight Efficiency (NACFE), published a report titled *Amping Up: Charging Infrastructure for Electric Trucks*. Since then there has been an acceleration of the movement toward the electrification of commercial vehicles. But the successful incorporation of electric vehicles into a fleet requires that they are able to be easily, reliably, and efficiently fueled.

Electric service is something that truck fleets often notice only when something bad happens, like a power outage or when they receive a surprisingly high utility bill. However, fleets that are considering electric vehicles need a basic working understanding of electricity and the way utilities work in order to estimate charging costs, install chargers easily, and realize the fuel savings that can come with using electricity instead of diesel to power trucks.

ACKNOWLEDGMENTS

NACFE Report Team:

Mike Roeth, NACFE executive director, RMI trucking lead
Robert Graff, Lead author, NACFE/RMI senior technical advisor
Ari Kahn, RMI manager, carbon free transportation
Rick Mihelic, NACFE director of emerging technologies, Mihelic Vehicle Consulting
John Richardson, NACFE electrification consultant
Dave Schaller, NACFE director of industy engagement
Denise Rondini, NACFE communications director, Rondini Communications
Kim Ehrenhaft, NACFE design director

Fueling an Electric Truck

Fueling BEVs economically requires charging in a way that works with the grid economics of minimizing demand (the maximum rate which you are charging) and maximizing off-peak charging (the time of day you are charging). Charging infrastructure is a combination of hardware and rigorous management of electricity demand.

Charging electric trucks is a complex process that requires considering a variety of factors. Fleets need to allow sufficient time and resources for the careful planning required and need the support from many companies in the electric trucking "ecosystem." There are many participants in the collaborations that must interact for the various future electric truck charging infrastructure needs.

Determining charging needs is somewhat of a chicken-and-egg iterative process. It is significantly more complex than planning for an on-site diesel fueling operation. Fleets need to know how much energy they will need to keep their fleet operating, add a margin for uncertainty, and then design a charging system that can reliably deliver that power to their vehicles in the least expensive way.

That energy can be provided in many ways and can be optimized for the fleet's property and operational preferences. A MWh of charge to a battery can be provided in many ways. A 1 Megawatt-hour charge can be delivered via 100 kW over 10 hours, 250 kW over 4 hours, or 1 MW over 1 hour. In general, charging at a lower power is less expensive both for the infrastructure and the electricity.

Charger Types

Fleets can choose from a variety of charger types to match chargers to their vehicle charging needs. Level 2 AC chargers provide 208/240V AC at up to 80 amps to provide up to 19.2 kW of power and is sufficient for many commercial truck fleets, particularly those that use Class 3 through 6 vehicles, return to base, and are parked for a long period each day.

Level 2 electric vehicle supply equipment (EVSE) is technically not charging stations, but rather devices that communicate with and safely deliver AC power to the vehicle's onboard charger. The vehicle's onboard charging system accepts this AC voltage and converts it to DC voltage. The DC power is used to charge the battery pack.

Level 3 DC charging, more commonly referred to as DC Fast Charging (DCFC), is a broad category of charging that delivers DC, rather than AC, electricity to the vehicle, eliminating the need for on-vehicle conversion from AC to DC using EVSE.

The characteristics of your vehicles, and how they are deployed, as well as the availability of power at your site will determine the power levels and types of chargers that are most appropriate for your fleet.

Figure ES1 summarizes the primary characteristics of the main two types of charging infrastructure used for BEVs.

All chargers have an upper limit to the rate at which they can deliver electricity (the maximum charge rate).

METHODOLOGY

This report was written from interviews with subject matter experts at fleets, OEMs, utilities, charger manufacturers, research groups and industry organizations.

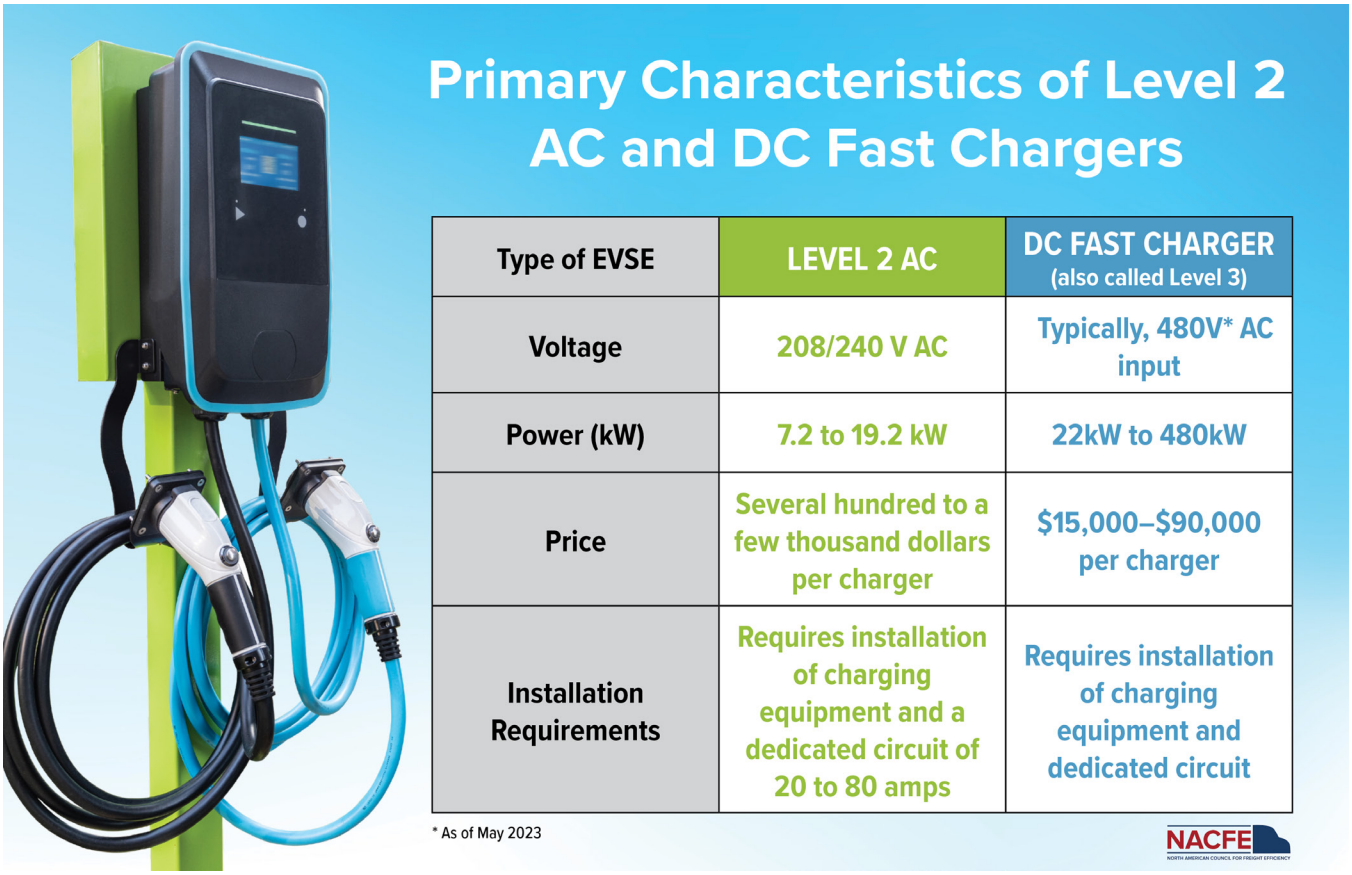
Available public information has been referenced to support findings and conclusions. This report builds on NACFE's previous report, *Amping Up: Charging Infrastructure for Electric Trucks*.

"Charging infrastructure is just one part of a system integrating your vehicle needs, electricity rate structure, and the timing and cost of bringing additional electricity to your site."

— Mike Roeth, Executive Director, NACFE

FIGURE ES1

IT'S IMPORTANT TO UNDERSTAND THE CHARACTERISTICS OF LEVEL 2 AC VS. DC FAST CHARGERS



In addition, each vehicle has an upper limit to the rate it can accept electricity (the maximum charge acceptance rate). There are several standard plugs and sockets in use for charging BEVs. Some can be used only for Level 1 and Level 2 AC charging, some for only DCFC, and some for both AC and DC charging. There are two types of connectors in common use in North America for commercial BEVs, a SAE J1772 or a CCS.

Fleets need to select a set of chargers to provide the electricity they need in a way that minimizes overall total cost of operation, including capital cost for the infrastructure, cost for electricity, any associated equipment, and maintenance and repair costs.

Since *Amping Up*, NACFE's initial 2019 report on charging infrastructure, charging business models have evolved. However, today the most common model is for fleets to purchase their charging stations outright, either through their OEM or through an RFP process.

Charging as a Service (CaaS) is new to the industry but gaining traction in the market. A CaaS provider invests in all the assets needed to assure client vehicles are ready to carry out their duties when needed. A CaaS company will select, procure, permit, install and provide power for all the hardware needed to charge your fleet. As the customer, you will pay a negotiated fee.

Trucking as a Service (TaaS)/Fleet as a Service (FaaS) takes CaaS one step further. Under this model, drivers can reserve a fully charged BEV to be picked up at specified time.

Managing Charging

Managing charging can dramatically reduce the cost of charging BEVs. There are a several types of charging networks and options for charging. There is no one right answer when it comes to selecting a managed charging network or charging option. However, it is clear that managed charging should be used to control electricity costs.

There are three types of charging station networks.

- **Non-networked:** typically used in residential applications, where charging is predictable, and the amount of electricity dispersed is relatively low;
- **Closed:** a local network server that communicates

with all the charging stations at the site; and

- **Open:** which allows charging stations to connect to multiple open networks, including off-site networks managed by an off-site vendor.

Steps to Implement Truck Charging

Creating and deploying an effective plan for fleet electrification must consider many variables. While each project involves some bespoke engineering since each site and project is different, there are some common factors to consider. The Charging Procurement Roadmap from NACFE's original 2019 infrastructure report was one of our most downloaded graphics and has been a key resource for the industry in developing charging plans. We engaged with many stakeholders to update it for this report.

ES2 shows the steps needed to implement a charging infrastructure, which include:

1. **Assign an internal manager:** Select someone to champion the project internally and work with all stakeholders.
2. **Consult with key stakeholders early and often:** This includes utility, landlord, AHJ, OEM, etc.
3. **Assess electrical service:** Work with your utility and contractor to understand current service capacity, additional capacity needs, timelines and costs.
4. **Select electric vehicles:** Choose vehicles based on your fleet's usage, duty cycles, distance traveled, load characteristics, etc.
5. **Select chargers:** Choose chargers based on fleet requirements, utility cost structure, and OEM's recommendations.
6. **Assess financing:** Explore local, state, federal, and utility incentives, grants, and rebates as well as ownership models.
7. **Procure charging components:** This includes hardware, software and service plan.
8. **Design site plan/permit the project:** Consider hiring an engineering team.
9. **Construct charging infrastructure:** Maintaining schedule is paramount, mitigating delays is a team effort.
10. **Commission charging hardware:** Use authorized commissions agents for this step.

FIGURE ES2

FOLLOW THESE STEPS TO CREATE AN EFFECTIVE PLAN FOR FLEET ELECTRIFICATION.

Financial and Other Assistance

With efforts to expand vehicle electrification as a priority at national and state levels, a push for market share by manufacturers, and desire for utilities to serve potential new customers, there are a lot of sources for financial and technical assistance. These can, however, be challenging to find and they change regularly.

Clean Cities Coalitions and your electric utility are excellent sources of information on financial incentives and can often help you access these resources. Assistance is available on the federal level to support the purchase of BEVs and the development of charging infrastructure. Assistance available depends on your particular use case, and includes grants, loans, rebates, tax credits, and technical assistance. States and utilities vary greatly in financial assistance available to support truck electrification.

Conclusions

There are many factors that go into successfully installing an electric vehicle charging infrastructure. The study team offers the following recommendations on how to implement a successful charging infrastructure.

1. **Electric trucks and chargers must work together.** Charging infrastructure is just one part of a system integrating your vehicle needs, electricity rate structure, and the timing and cost of bringing additional electricity to your site. Choose individual components only after designing the entire system, not only for initial implementation, but for potential future needs. Choose equipment with a track record for reliability and make plans for its maintenance. Not all chargers work well with all vehicles. Work closely with your vehicle manufacturer(s) as you select charging equipment. Expect the process to be iterative.
2. **Your utility is a key partner.** Electric trucks use a lot of power, probably more than you currently have available. Your power usage will grow as your fleet's use of BEVs grows. Determine how much power you need in both the short- and long-term to fully implement your plans. Learn how much power you already have on site to charge trucks, and how much more you will need to get beyond the pilot stage. It is essential that you meet in person with your utility as soon as you begin thinking about electric trucks, as they will be your partner in providing the power you need. Increasing power delivery to your facility can take time. Coordinate closely with your utility and modify your implementation schedule to assure you have power when you need it.
3. **Use and design greatly affect charging cost.** Both AC and DC chargers are available in a wide variety of power outputs and technologies appropriate for any vehicle. In general, spreading charging over the longest time and using lower charging power makes both the charging equipment and electricity costs lower and maximizes battery life. Design your charging strategy to make the best use of vehicles' scheduled downtime. Charging management software can pay for itself by ensuring your vehicles are ready to roll when needed at the lowest cost.
4. **The transition requires staff and attention.** The transition to BEVs and associated charging infrastructure requires attention and expertise. You need to have a single point of contact with internal and external authority and to lead the project. If your utility has a BEV team, reach out to them. Talk to other fleets and resources like your local Clean Cities Coalition. You may benefit from hiring an expert consultant at the start of your move to owning BEVS.
5. **Consider other charging business models.** You may wish to explore options other than owning and operating your own charging infrastructure as

"The more information we have from the customers on what their 5-10-15 year electrification plans are, the more equipped that utility is to have those proactive conversations and try to make good EV rates and good legislative initiatives. "

— Jennifer Deaton, Manager Corporate Strategy & Electrification, Oncor

a stopgap or long-term model. These include CaaS and TaaS. CaaS provides a contracted service to provide all your charging, either on your site or at a nearby shared location. TaaS adds the electric trucks to the CaaS offering. In addition, turnkey BEV infrastructure financing, design, installation, operations, and maintenance can be provided by specialized businesses.

6. **Other key considerations.** There are a host of other things to consider when it comes to EV infrastructure as well as additional developments to be aware of.
    - Grants, incentives, and subsidies are at an historic high, offering a window of opportunity for fleet electrification.
    - If you do not own your facility, talk with your landlord early.
    - Microgrids are emerging from the shadows.
    - Reliability and interoperability of chargers must improve.
    - Training a skilled workforce to support and service BEVs and charging hardware is critically important.
    - Processes to improve electricity transmission/distribution infrastructure must be improved.
    - BEV makers must increase miles per kilowatt, reduce vehicle costs and weight, and increase payload and reliability.

Waiting for the perfect intersection of battery electric vehicle, energy and charging infrastructure will keep fleets parked on the sidelines of this transition. The perfect solution may never come: What are you waiting for?

"You want to try to future proof that infrastructure as much as possible while at the same time right sizing it."

— Ramiro Lepe, Medium & Heavy Duty Transportation Electrification Sr. Advisor, Southern California Edison

ABOUT US

ABOUT NACFE

The North American Council for Freight Efficiency (NACFE) works to drive the development and adoption of efficiency enhancing, environmentally beneficial, and cost-effective technologies, services, and operational practices in the movement of goods across North America. NACFE provides independent, unbiased research, including Confidence Reports on available technologies and Guidance Reports on emerging ones, which highlight the benefits and consequences of each, and deliver decision-making tools for fleets, manufacturers, and others. NACFE partners with RMI on a variety of projects including the Run on Less demonstration series, electric trucks, emissions reductions, and low-carbon supply chains. Visit NACFE.org or follow us on Twitter @NACFE_Freight.

ABOUT RMI

RMI is an independent nonprofit founded in 1982 that transforms global energy systems through market-driven solutions to align with a 1.5°C future and secure a clean, prosperous, zero-carbon future for all. We work in the world's most critical geographies and engage businesses, policymakers, communities, and NGOs to identify and scale energy system interventions that will cut greenhouse gas emissions at least 50 percent by 2030. RMI has offices in Basalt and Boulder, Colorado; New York City; Oakland, California; Washington, D.C.; and Beijing. More information on RMI can be found at www.rmi.org or follow them on Twitter @RockyMtnInst.

GET INVOLVED

NACFE could use the assistance of fleets, manufacturers and other trucking industry stakeholders in improving freight efficiency. Become a part of this exciting opportunity.

Learn more at www.nacfe.org or contact Mike Roeth at mike.roeth@nacfe.org