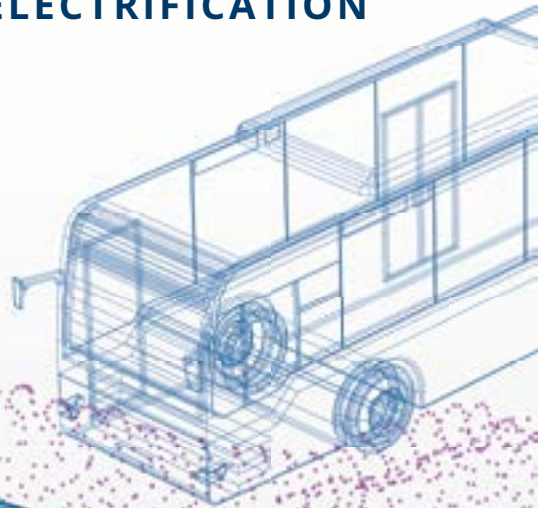
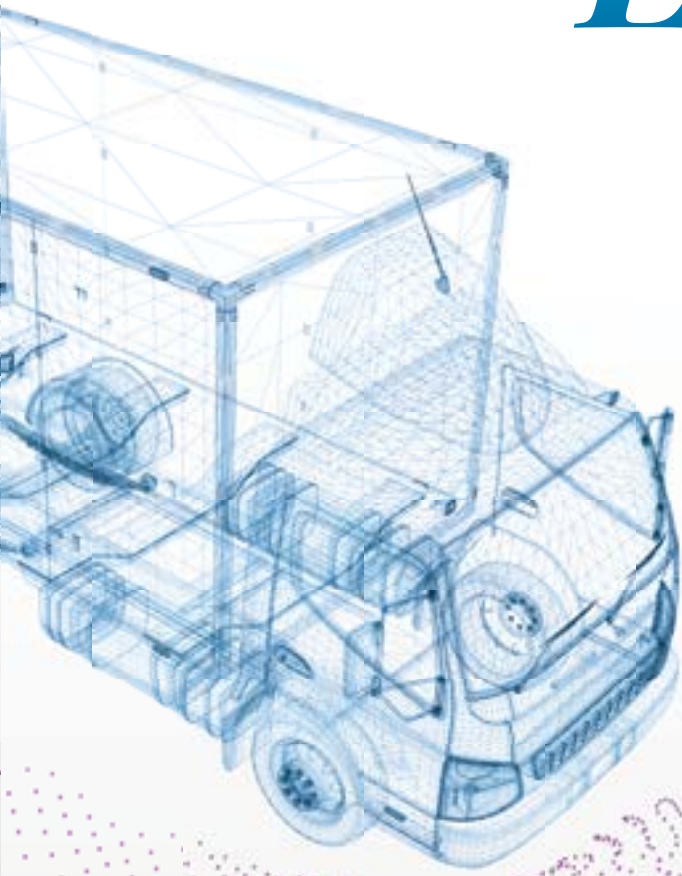


Electric Fleets

**8 STEPS TO MEDIUM
AND HEAVY-DUTY FLEET
ELECTRIFICATION**



Introduction

Transportation in the U.S. is becoming more sustainable, competitive, and innovative. At the core of this innovation is the electric powertrain, which produces no harmful emissions and is cheaper to fuel and maintain. As light-duty electric vehicle (EV) sales continue to soar, fleet and sustainability managers are banking on advances in power electronics, battery prices, and battery performance to mainstream medium and heavy-duty vehicle electrification. These upcoming EVs help managers capture savings, improve driver working conditions, and meet emission standards that are unattainable with diesel trucks and buses.

Fleet and sustainability managers are navigating a new maze of technologies. For the first time, they must consider the power and telecommunications infrastructure as part of their operations. To accelerate schedules and minimize costs of fleet electrification projects, Black & Veatch encourages managers to use our 8 Steps to select ideal technologies, plan for power delivery, and construct optimal high-power charging facilities.



Electric Fleet Progress and Production

Globally, the medium to heavy-duty electric fleet (eFleet) market is off to a promising start. There are 385,000 electric buses (eBuses) in operation,¹ with predictions that 50% of the world's city bus fleet will be electric by 2025.² The market for electric trucks (eTrucks) is expanding alongside heightened automaker and supplier investment. Several companies are piloting all-electric medium and heavy-duty eTrucks, and research and development are intensifying, too. Daimler committed \$3.2 billion to eTruck and eBus technology, and Volkswagen \$1.7 billion.³ While applications are still evolving, automaker investment will advance the technology and electric models available, which will create long-term stability in eBus and eTruck adoption.⁴ As proof of this growing stability, Tesla has 2,000 pre-orders for their semi-truck with little effort to solicit sales.⁵

In the U.S., smart fleet and sustainability managers are planning high-powered charging facilities. The most prepared managers will be in the best position to capitalize on funding opportunities when electric medium and heavy-duty vehicles hit the market. With early action, fleet and sustainability managers will also be able to stay ahead of stringent emission regulations, which are pressing transit agencies, school districts, and delivery companies, like Amazon, UPS and FedEx, to deploy cleaner, quieter fleets. Adding momentum, battery energy density is increasing, while battery prices continue to fall. From 2010-2018, the average cost of a battery pack fell 85% to \$176/kWh. Costs will continue downward, reaching \$94/kWh in 2024 and \$62/kWh in 2030,⁶ which will help lower initial purchase prices of all EV classes.

¹ Bloomberg New Energy Finance. 2018. Electric Buses in Cities. Driving Towards Cleaner Air and Lower CO2.
² Bloomberg New Energy Finance. 2018. E-Buses to Surge Even Faster Than EVs as Conventional Vehicles Fade.
³ Business Insider. 2018. Preview of The Electric Truck Report.
⁴ North American Council on Freight Efficiency. Medium-Duty Electric Trucks: Cost of Ownership.
⁵ CleanTechnica. 2018. Albertsons Pre-Orders 10 Tesla Semi Trucks.
⁶ Bloomberg New Energy Finance. 2019. A Behind the Scenes Take on Lithium-ion Battery Prices.

The Bottom Line for Fleet and Sustainability Managers

Dollar per Gallon Equivalents (DPGe) factor in electricity rate structures, fleet charging strategies, and vehicle class to compare eFleet costs to gasoline and diesel. DPGe for the top 25 Metropolitan areas in the U.S. show that on average, electric fuel is:

26%

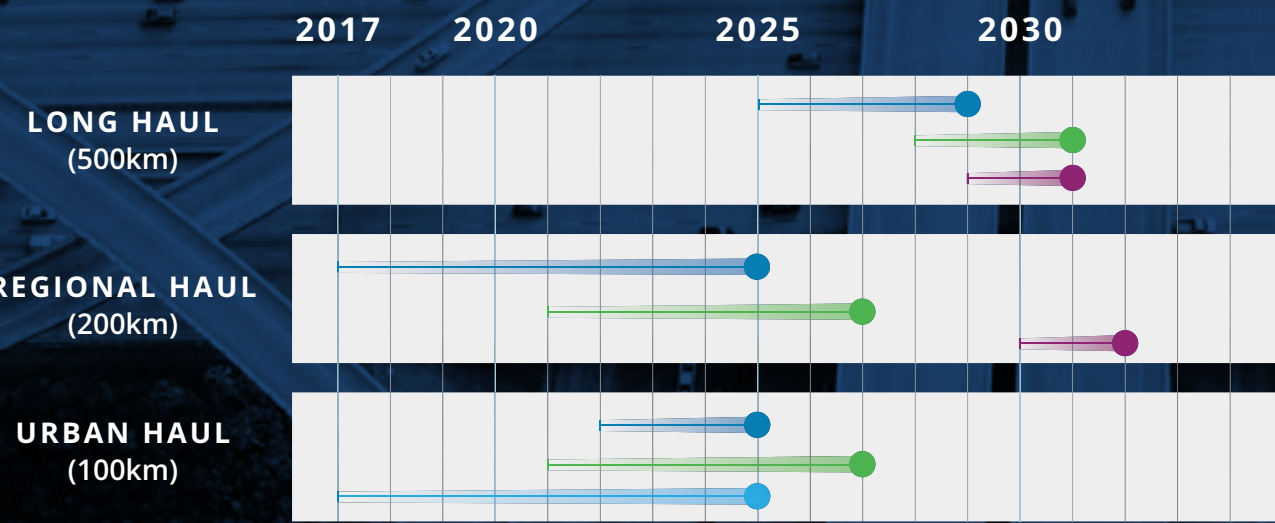
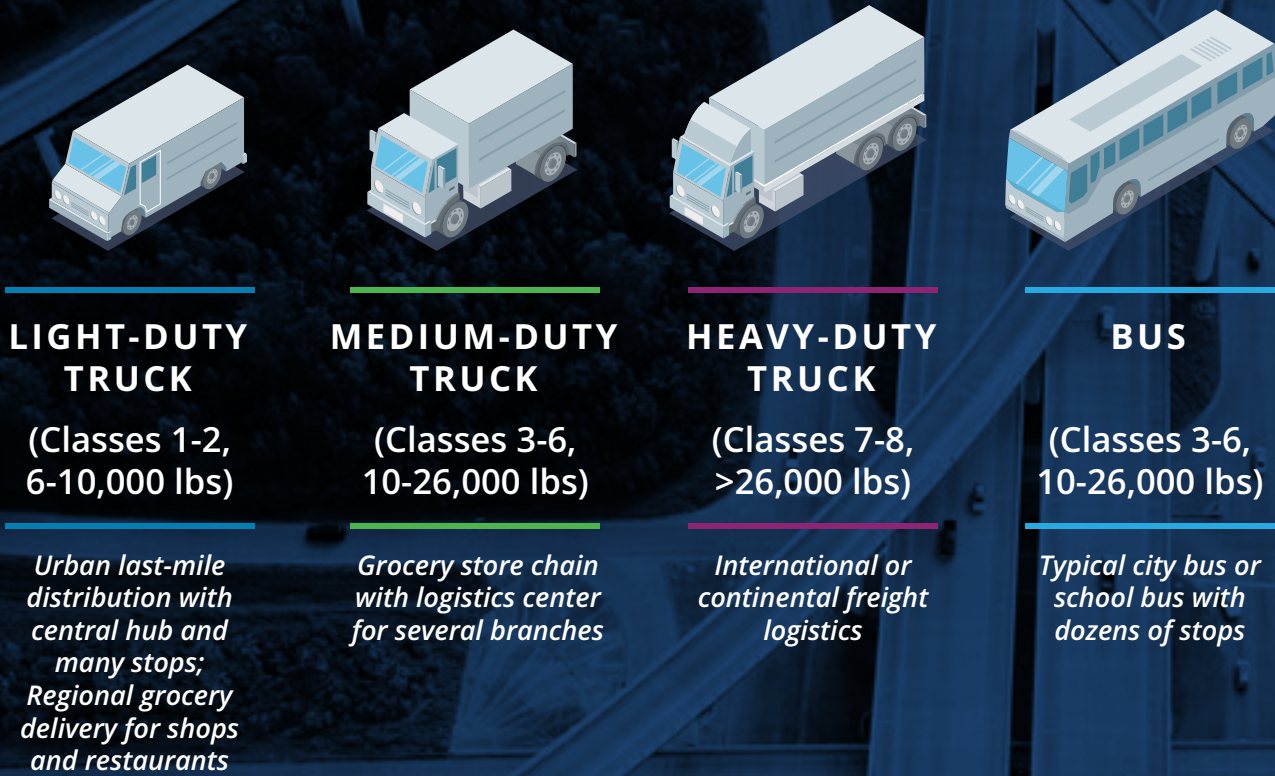
CHEAPER
THAN GASOLINE-FUELED
LIGHT-DUTY FLEETS IN 19 OF
THE 25 METRO AREAS.

40%

CHEAPER
THAN GASOLINE-FUELED
BUS FLEETS ACROSS ALL
25 METRO AREAS

Source: Amply. 2019. [Understanding Electric Vehicle Fueling Costs Compared to Gasoline for Fleets.](#)

Electric Fleets Roll Towards Cost-Parity



Source: McKinsey & Company. McKinsey Center for Future Mobility.

Why Electrify Fleets?

COAST TO COAST, FLEET AND SUSTAINABILITY MANAGERS ARE PONDERING PILOT PROGRAMS AND LAUNCHING SMALL AND LARGE-SCALE eFLEETS. HERE'S WHY THEY ARE CHARGING UP.

MEET TOUGH EMISSION STANDARDS:



It is estimated that the U.S. e-Commerce sector generates 55,000 metric tons of carbon dioxide equivalents per day from shipping and last-mile delivery,⁷ which is equal to over 5.4 million gallons of diesel consumed.⁸ To protect communities, regulators have passed rigorous laws on fuel economy and emissions. eTrucks and eBuses can operate in areas with stringent emission regulations—an impossibility with diesel vehicles.

LOWER OPERATING COSTS:



As battery costs decline, the unsubsidized costs of eFleets will be cheaper than diesel in a few years.⁹ In addition, the fuel economy of transit eBuses is 5x that of diesel buses operated on the same route.¹⁰ These savings lower the total cost of ownership (TCO). The TCO of one electric school bus is \$31,000 cheaper than diesel, and one electric transit bus is \$81,000 cheaper.¹¹ TCO for eTrucks is still evolving, but Tesla and UPS expect their eTrucks to have 20% lower operating costs.^{12, 13}

Vehicle-to-grid (V2G) capabilities leverage the large batteries and predictable downtime of eFleets to enable peak shaving, demand charge management, and revenue streams as two-way power flow and [utility digitization](#) advances. In fact, pilot programs show that one V2G eBus can generate \$6,100 annually.¹⁴ Smart charging and advanced technologies provide additional savings and value. On-board telematics monitor and optimize charging and route management, which saved UPS \$400 million in annual fuel and labor costs.¹⁵

Managers can cut charging costs by using low-cost renewable energy and storage, and reduce labor costs by using [autonomous vehicles](#) for on-route and depot operations. Finally, eFleets have quiet drivetrains, so managers can extend operation/delivery hours into the evening without disturbing neighborhood residents.

IMPROVE WORKING CONDITIONS AND SAFETY:



Electric motors are quiet, fumeless, and do not vibrate, which provides several safety and operational benefits. First, the driving experience of eFleets is improved, which reduces driver fatigue and increases driver retention.

Second, without a loud, rumbling engine, drivers can clearly hear critical radio communication, which increases safety. In addition, on-board telematics collect speed data, which enables managers to monitor and encourage safe driving habits.

⁷ Bloomberg. 2019. Etsy Wants to Make Your Home Delivery Carbon Free.

⁸ Greenhouse Gas Equivalencies Calculator. 2019. 55,000 metric tons of carbon dioxide equivalent to 5,402,750 gallons of diesel consumed.

⁹ Forbes. 2018. Electric Buses Can Save Local U.S. Governments Billions. China's Showing Us How It's Done.

¹⁰ Environmental and Energy Study Institute. 2018. Battery Electric Buses: Benefits Outweigh the Costs.

¹¹ WISPIRG. 2018. Electric Buses. Clean Transportation for Healthier Neighborhoods and Cleaner Air.

¹² UPS. 2018. Inside UPS's Electric Vehicle Strategy.

¹³ The Drive. 2018. DHL Predicts Big Savings from Tesla Semi Electric Trucks.

¹⁴ Clinton Global Initiative. 2018. V2G EV School Bus Working Group. Demonstration Project.

¹⁵ UPS. 2018. Inside UPS's Electric Vehicle Strategy.

Big Oil Joins Utilities in the Race for Charging

Oil Giants and Electric Utilities are pivoting towards charging infrastructure as electric vehicle (EV) adoption soars and disrupts their markets. Both players are leveraging EV charging deployment to bolster their bottom lines, but the U.S. could be the big winner as charging infrastructure increases and sustainable mobility expands.

THE U.S. EV INDUSTRY IS BOOMING

80%

INCREASE IN U.S. EV
SALES FROM 2017
TO 2018

51

NUMBER OF EV MODELS
TO BE RELEASED IN U.S.
BETWEEN 2019 AND 2023

10%

EV CAR SALES IN 2025
AS PERCENTAGE OF
TOTAL CAR SALES

IMPACTS TO BIG OIL, ELECTRIC UTILITIES

5-6
MILLION

BARRELS OF OIL
PER DAY (TOTAL OIL
DEMAND) THAT EVs WILL
DISPLACE BY 2040

2018

THE PEAK SALES
YEAR FOR INTERNAL
COMBUSTION ENGINE
VEHICLES; DELIVERIES
IN DECLINE

56%

SURVEYED U.S. UTILITIES
WHO SAY EVs ARE THE MOST
IMPORTANT APPLICATION
THEY WILL HAVE TO SUPPORT
IN THE NEXT 3-5 YEARS

8%

INCREASE IN LOAD
ON ELECTRIC GRID
FROM EVs IN 2027

How Are Oil Giants And Utilities Shaping EV Charging?

1) CREATING NEW ALLIANCES: Mergers, acquisitions, and partnerships between Big Oil, utilities, OEMs, technology integrators, and pure-play charging companies are redrawing lines of engagement and services.

2) BUILDING CHARGING NETWORKS: U.S. utilities are investing billions in service territory charging networks to capture load growth and manage charging impacts.

3) EXPANDING CAPABILITIES: Shell, Chevron, and BP are investing broadly in charging startups in North America and beyond.

4) REPURPOSING ASSETS: Oil Giants have sprawling networks of service stations that could support EV charging facilities.

Sources:

Bloomberg NEF. Electric Vehicle Outlook 2019.

Automotive News. 2019. Big Oil Taps into Electric Era. (Contains research from Navigant Research, Gartner, and Wood Mackenzie.)

Microsoft. 2019. Oil Companies and Utilities are Buying Up all the Electric Car Charging Startups.

Black & Veatch. 2019. Smart Utilities. Strategic Direction Report.

Shell. 2018. Energy Transition Report.

InsideEVs. 2019. Fewer And Fewer ICE-Powered Cars Will Be Sold In The Coming Years But More EVs Are Expected.

Ready to Charge Up?

Fleet and sustainability managers are navigating a new maze of technologies, infrastructure choices, and supply chains as electricity becomes their new fuel. The transition to eFleets is different for each organization. Some leaders electrify major portions of their fleets, while others begin with a smaller trial project to help with proof-of-concept. Regardless of the undertaking, these 8 Steps guide the process, inform scheduling, and help managers cost-effectively plan optimal high-power charging facilities.





STEP 1

Define Drive Cycles, Duty Cycles, & Operational Considerations

This information helps determine the TOC, optimize battery sizes, and translate route data into cost savings. Managers will decide how many vehicles they will electrify, as well as when and where vehicles will charge based on duty cycles and routes. Options include depot charging, on-route, shared, and destination/endpoint charging — either alone or in combination — to meet capacity and resilience requirements over time. This information also helps a technology integrator, like Black & Veatch, develop an infrastructure plan to meet current and future capacity needs of the fleet.

STEP 2

Review & Select Technology Options

Fleet and sustainability managers will need to consider types of trucks and buses, as well as charging connectors, charging speeds, and networking capabilities. These selections help managers build the ideal system and delineate all-in deployment costs. Technology continues to rapidly advance. Managers will benefit from insight around vendors and their equipment to ensure interoperability so that separate technologies form a cohesive network.

For commercial fleets, Level 2 and DC Fast Charging technologies are most appropriate. Medium-duty vehicles may only need Level 2 technology if they have ample time to charge, but trucks with large batteries and less downtime will require High AC and DC Fast Charging. In addition to hardware, it's important to consider software/network solutions. These solutions enable data analytics functions to optimize charging, cost of energy, and potential revenue streams, and integrate on-site facilities and the distributed energy resources (DERs) grid. A networked system is especially valuable as the size of fleets and battery capacities grow exponentially.

STEP 3

Understand Charging Loads & Power Delivery

It is essential to determine daily power requirements of charging. In transit, multi-megawatt sites are common, which generates big energy demand. As a point of reference, a fleet of 56 buses would require roughly around 11 MWh/day; a fleet of 542 could demand around 109 MWh/day.¹⁶ The requirement to substantially increase energy at the site presents an opportunity to deploy microgrid technology. Microgrids integrate clean, resilient, efficient, and secure on-site power generation and energy storage, which helps offset energy costs and contributes to corporate sustainability goals.

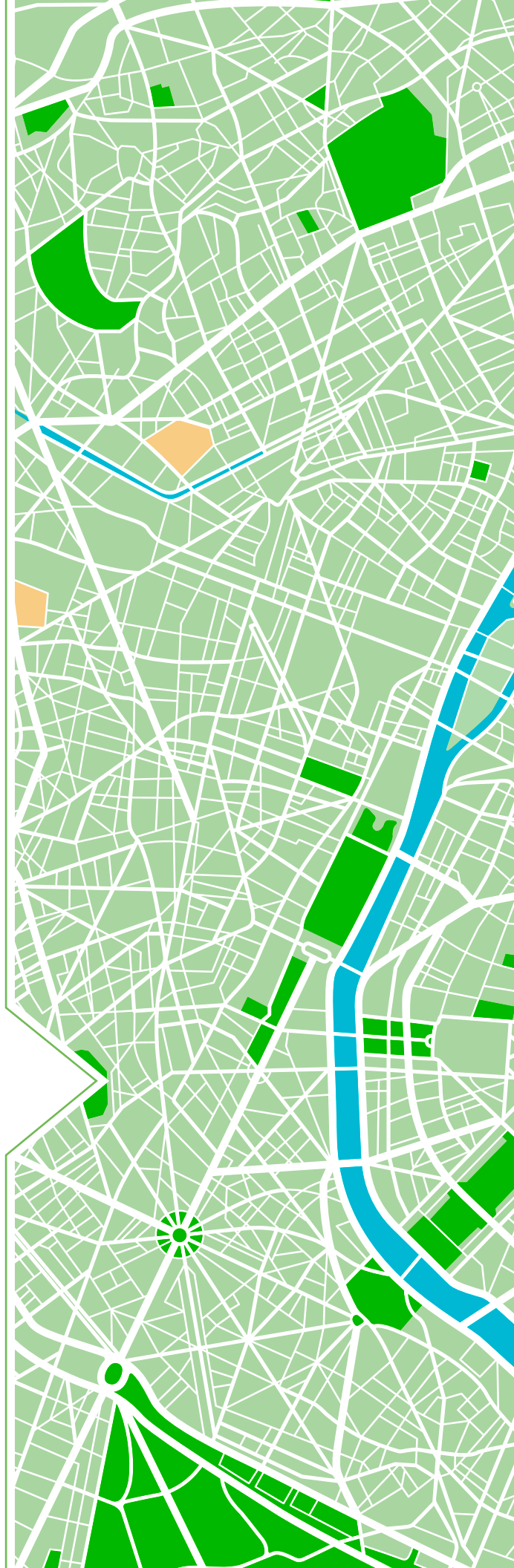
The addition of high-power charging load and DERs will typically require equipment upgrades to grid elements and building facilities. Building retrofits require electrical and utility interface planning, cooling design, and space for equipment. Distribution grid upgrades vary greatly, but Step 7 outlines upgrades that Black & Veatch most commonly sees during charging facility planning.

STEP 4

Site Planning

In most cases, managers will retrofit charging facilities at their existing properties; careful consideration of physical space and power supply is critical. If new sites are needed, then thoughtful and informed site selection will minimize project cost and time to orient charging facility layout and bring adequate power to the site. Regardless of whether sites are existing or new, several factors can dramatically affect schedule and cost, like distance from the site to a substation and whether additional upgrades are needed along the distribution circuit resulting from competing site developments and charging load.

¹⁶ Black & Veatch. 2018. Fleet Requirement Estimates at 100% Electric. Estimates do not include additional energy for articulated buses, weather, terrain and other factors.



STEP 5

Conduct Utility Coordination, Engineering & Design

Fleet and sustainability managers benefit from starting utility engagement as early as possible in the design process. Utility coordination is facilitated by strong existing relationships and knowledge of utility engineering and business practices. Managers that work with a technology integrator with these attributes can often accelerate utility design and service delivery for high-power charging. During this phase, managers and their technology integrators will work with host utilities to develop power delivery roadmaps that leverage utility programs and charging rates. Calculated savings based on future charging loads will be incorporated into the planning process.

To future-proof design, it's important to consider growth over 5-10 years (and longer) to anticipate power capacity for a facility. While charging technology will continue to advance, it is most cost-effective to plan for and install anticipated on-site infrastructure (like conduit and switch gear) and make room for transformers, energy storage, and utility interconnections during initial construction versus down the road, which requires costly re-work construction.¹⁷

¹⁷ The International Council on Clean Transportation. 2018. Lessons Learned on Early Electric Vehicle Fast-Charging Deployments.

STEP 6

Apply for Permit and Approvals

Land use, right-of-way, and permitting requirements become more complex with increased power levels. This is driven by space requirements for charging equipment, as well as the required permits and permissions that the utility will need to cross multiple parcels belonging to multiple land owners as part of power delivery. Frequently, completing permitting and utility applications with new products and technologies can be challenging because specifications and certifications are still being finalized. But, states are working hard to make permitting easier. Many states and utilities have checklists and guides that help managers submit correct and complete compliance documentation, as well as expedited permitting that streamlines the permit, installation, and inspection process.

Beyond permits, required paperwork can include interagency agreements and approvals, state environmental impact filings, and applicable terms and conditions of equipment, including differences of vehicles, infrastructure, lease holder agreements, and deployment services. The bottom line: Start early to finish on time.

STEP 7

Distribution Grid Upgrades

Beyond building upgrades, new charging loads may require upgraded or new utility feeders, substation modernization, and even new substations. Engineering, design, and construction scopes become more substantial with increasingly complex upgrades, which affects deployment cost and schedule.

In general, a power delivery schedule without grid upgrades is about 8 months. A schedule with grid upgrades can run 48 months or longer depending on complexity of the upgrade, with a new substation serviced by new transmission lines being the most complex.

WHILE UPGRADES ARE UNIQUE TO EACH SITE, BLACK & VEATCH OBSERVES SEVERAL TYPICAL POWER DELIVERY SCENARIOS RELATED TO CHARGING FACILITIES:

NO DISTRIBUTION CIRCUIT UPGRADES (UP TO 1 MW):

Often, site loads below 1 MW can be supported with a new service transformer connected to the local distribution grid.

SUPPLY CONDUCTOR UPGRADE, NO GRID UPGRADES (UP TO 1 MW)

The supply conductor may require replacement to serve the increased load. The service transformer may also be replaced with a larger size.

MEDIUM VOLTAGE SERVICE, NO GRID UPGRADE (OVER 2 MW)

The manager may have to take primary service at medium voltage to allow for multiple service transformers (customer owned) behind the meter if the site load exceeds standard service transformer and low voltage switchboard ratings (typically around 3000 A).

GRID UPGRADE DEPLOYMENT: RE-CONDUCTOR OR NEW LINE EQUIPMENT (OVER 1 MW)

The overhead or underground wire may require upsizing to increase the load capacity and improve voltage regulation on the feeder if the charging load overloads the distribution circuit.

GRID UPGRADE DEPLOYMENT: NEW FEEDER (OVER 5 MW)

A new circuit may be installed from the substation to project site if a proposed project exceeds the line capacity and line upgrades cannot address overloads.

SUBSTATION UPGRADE: NEW TRANSFORMER BANK (OVER 10 MW)

An overloaded transformer bank is either replaced by a larger bank in the substation or an additional bank is added.

NEW SUBSTATION (OVER 20 MW)

A new utility or dedicated high voltage substation may be required for very large installations.

STEP 8

Obtain Equipment, Construct, & Commission

Once a manager obtains all permits and approvals, site construction using UL and field-certified equipment can begin. Equipment usually includes chargers, switchgear, transformers, panelboards, cable, and connectors; storage will be necessary to protect equipment during installation. Construction usually involves exterior building work, which may include boring, trenching, paving, and landscaping, as well as internal building work, which may include drywall, painting, and ceiling repair. Traffic control is often required. Site safety plans are managed by the construction companies. Typically, additional commissioning and testing are conducted once full power has been delivered to the site, which needs to be reflected in the project schedule.

¹⁸ Alternative Fuels Data Center. 2019. Search Federal and State Laws and Incentives, Grants, Rebates, and Tax Incentives for EV Technology for Private Business Owner, Alternative Fuel Purchaser, and Other across the U.S.

Funding for Fleet Electrification

It's essential to explore funding sources such as grants and rebates, as well as emerging funding alternatives such as equipment leasing, energy supply contracts, and infrastructure-as-a-service. With increased industry emphasis on electrification, funding options are available.

126

THE NUMBER OF GRANTS,
INCENTIVES, AND REBATES
AVAILABLE TO HELP
ELECTRIFY U.S. FLEETS¹⁸





Conclusion

ELECTRIFICATION OF MEDIUM AND HEAVY-DUTY VEHICLES IS ADVANCING FAST, AND SMART FLEET AND SUSTAINABILITY MANAGERS ARE DEVELOPING THEIR CHARGING INFRASTRUCTURE STRATEGIES NOW TO GET READY. THE TIME IS RIGHT.

Massive industry investment and advances in vehicles, power electronics, battery prices, and battery performance are generating technology confidence and motivating fleet and sustainability managers to begin fleet electrification.

But, an eFleet is a non-starter without well-designed power delivery and charging facilities. As long-term investments, charging facilities are intended to be enduring networks that support fleet owners and their unique transportation mission well into the future. Insightful planning is critical because present-day design decisions impact longevity, scalability for future growth, and bottom line TCO. As a qualified, experienced power and telecommunication service company, Black & Veatch provides valuable analysis and design services for high-power charging facilities, built for today and tomorrow, with better outcomes in design, costs, and timeframes.

Black & Veatch is proud to be a part of the ecosystem that is collaborating to accelerate and advance clean energy and transportation in our [communities](#). Together, we will deliver a sustainable future.

Information ahead of innovation.

Digital technology deployment
is accelerating. Our eBook series
fast-tracks industry transformation.

Click and read below.



BLACK & VEATCH

© Black & Veatch Corporation, 2019. All Rights Reserved.
The Black & Veatch name and logo are registered
trademarks of Black & Veatch Holding Company.
REV 2019-11