10 Steps to Deploy Military Electric Fleets

Optimal Charging Networks for Reliability, Resilience, and Sustainability.

BLACK & VEATCH

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Introduction

Executive Order (EO) 14057 aims to establish the federal government as a sustainability leader. The electrification of Department of Defense (DOD) fleets is a priority under the EO because the DOD consumes more energy than any other federal agency.[1] Black & Veatch developed this eBook, *10 Steps to Deploy Military Electric Fleets*, to help service fleet managers, Zero-Emission Vehicle (ZEV) action officers, and installation energy managers select charging technology and sites, plan for power delivery, and deploy optimal energy and electric vehicle (EV) charging facilities.

What you can't see can make all the difference. Behind EV chargers are elaborate energy systems that, when well-designed, provide the cleanest, lowest cost energy, at the right time, and without fail. Black & Veatch makes the invisible invaluable by helping managers scale fleet charging, reach operational goals, and create an enduring sustainability framework.

Vehicle Electrification as a Climate Action

Transportation makes up 27% of all GHG emissions in the U.S. and 14% globally.[2] EO 14057 requires the DOD to transition to 100% ZEV in their non-tactical vehicle (NTV) fleet. This includes 100% light-duty ZEV by 2027 and 100% medium- and heavy-duty ZEV by 2035. At the same time, the Federal Sustainability Plan asks federal agencies, including the DOD, to procure power from carbon pollution-free sources and build climate resilient infrastructure and operations.[3] Combined, these actions will contribute to national energy security and combat climate change.

Fleet Electrification Actions Escalate

$3 billion

more needed to cover FY2022 fuel costs due to spiking fuel **prices.**[4]

$3.45 billion

spent on installation energy in 2020, including $3.3B to power, heat, and cool buildings; and $0.15B to **fuel its fleet of NTVs**.[6]

181,040

military NTVs in the DOD that **will be electrified**.[8]

77%

of energy used by the federal government are **consumed by the DOD**.[5]

9.2 billion

spent on 78M barrels of fuel to **power DOD ships, aircraft, combat vehicles, and contingency bases** in 2020.[7]

12%

reduction of the U.S. Army's GHG emissions per mile achieved by removing 18,000 NTVs from its fleet and adding 3,000 hybrid vehicles.[9]

Energy independence and electric mobility also support military missions. Distributed energy resources (DER), such as microgrids and solar PV arrays, create installation resilience and energy reliability, which improves mission assurance and the operation of mission critical facilities. Similarly, an electric fleet decreases the installation's reliance on fossil fuel-powered vehicles and generates large amounts of on-board vehicle power and electricity to help the military capitalize on modern sensors, electronics, computing, and command and control systems.[10]

Sustainability Solutions for Resilience and Reliability

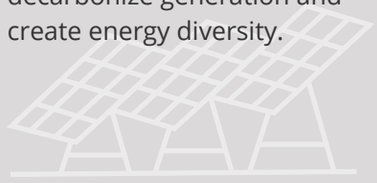
As service fleet managers, ZEV action officers, and installation energy managers plan their transition to clean energy and mobility systems, it's advantageous to adopt a holistic view of mobility--one that includes an array of sustainability solutions. Comprehensive planning avoids repetitive and redundant investments, gains efficiencies of scale, and achieves optimal energy and charging systems. Black & Veatch offers several solutions that reduce emissions, conserve resources, and capture climate intelligence to mitigate infrastructure impacts of climate change.

GHG Inventory:

- Identify emission sources and quantify associated emissions via standardized methods.
- Establish a baseline from which to measure GHG reduction after implementation of projects such as fleet electrification or renewable energy integration.

Microgrid + Renewable Energy + Energy Storage:

- Gain energy self-sufficiency and guard against cyber and environmental threats on energy systems. Maintain mission readiness at installations and in the field by generating, managing, and storing the energy needed to operate during an outage or field operations.
- Renewable energy sources decarbonize generation and create energy diversity.



Climate Resiliency Analytics:

- Quantify and mitigate potential costs of climate change.
- Black & Veatch meteorologists use a proprietary, comprehensive analysis to evaluate how climate change events such as flooding, forest fires, and hurricanes will impact critical human infrastructure.

Lifecycle Accounting:

- Account for sustainability and resilience value, economic and community impact, emission impacts, supply chain materials and product impacts, and costs.
- Compare and design ideal projects and locations that align with overarching goals, achieve triple bottom line benefits, and embody sustainable design and engineering.

The Powerful Influence of Federal Fleets

Although federal fleets account for only 2.3% of all vehicles registered in the U.S.,[11] they accelerate technology innovation and electrification in the private sector because of their economies of scale and immense purchasing power. When federal fleets electrify, the positive effects ripple across several areas:

Technology

Large fleets foster technological evolution. As components such as power electronics mature, their performance increases, vehicle quantities grow, and vehicle technology and infrastructure costs drop.

Electrification Process Improvements

Through repetition, fleet electrification culls costly inefficiencies from the process. For example, installations, permitting agencies, and utilities speed deployments by developing checklists, best practice guides, and toolkits that simplify the process.

Public Health

Clean transportation slashes tailpipe emissions and improves air quality, which would help generate over $1.2 trillion in health benefits across the U.S. between 2020 and 2050. These benefits include 110,000 lives saved, over 2.7 million child asthma attacks avoided, and 13.4 million lost works days.[12]

Electrification Equity

Lifecycle accounting helps identify routes and areas that would benefit most from electric fleets, such as those with higher pollutant exposure or designated environmental justice communities. Federal fleets can prioritize electrification in sensitive zones to decrease pollutants among the most vulnerable communities around their installations.

Climate Change

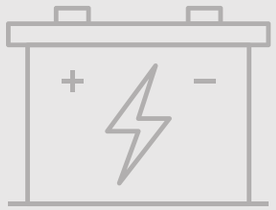
Over $1.7 trillion in global climate benefits could be achieved by reducing over 24 billion metric tons of GHG emissions by 2050.[13]

Four Ways Installations Can Leverage Sustainability to Create Internal Value[14]

1. Infuse sustainability into military culture
2. Address sustainability issues broadly and collaborate with stakeholders
3. Account for sustainability factors when selecting and evaluating suppliers
4. Allow sustainability to influence how they manage energy and transportation networks at the installation.

Market Trends that Speed Fleet Electrification

Several factors increase technology confidence and adoption. Fleet and sustainability managers confidently transition to electric fleets, encouraged by several favorable market trends and the positive outcomes of electrifying cars, vans, and buses. (See the *Electric Vehicle Adoption Charges Ahead!* infographic to understand electrification momentum across vehicle classes.)



Battery Innovation Continues: Iron-flow batteries offer 4-24 hours of energy storage compared to 1-4 hours provided by lithium-ion batteries.[21] Several U.S. industries are using them to decarbonize energy and foster sustainability and resilience.

Batteries

Batteries are essential for energy resilience and clean transportation. As battery costs decline and performance increases, their application to military and federal operations expand. Battery costs declined 86% over the last ten years, which helps lower initial purchase prices of all EV classes. The price of battery packs in 2021 was $132/kilowatt-hour (kWh), and costs are expected to drop to $127/kWh in 2023.[15] To reach needed battery cell production capacity and strengthen supply chains, 13 new EV battery factories will be operational in the U.S. by 2030,[16] and the U.S. Department of Energy is funding nearly $3 billion to develop a national battery supply chain for use in EV and energy storage.[17]

Battery performance increases year after year — in fact, warranty claims based on capacity loss are rare. On average, battery health degrades 2.3% per year, 1.6% under ideal climate and charging conditions.[18] Battery warranties range from 8-10 years, at which time 77%-87% of capacity will likely remain; the battery may run longer than guaranteed.[19] The California Air Resources Board proposed a rule — applicable to the 2026 model year and beyond — that would require EV to maintain 80% of their certified test-cycle range for 15 years or 150,000 miles,[20] which helps neutralize concerns over range and performance.

Investment and Incentives

The 2021 U.S. Infrastructure Bill earmarked $12.5 billion for a national EV charging network and low- or zero-emission buses.[22] Additionally, the Federal Highway Administration allocated $615 million nationwide to the National Electric Vehicle Infrastructure Formula Program to build the Alternative Fuel Corridors national network.

Electrification of Land and Air Mobility

Electric mobility is expanding across the transportation sector. Today, there are 122 models for electric sedans/wagons, pickup trucks, and SUVs, in addition to dozens of models for vans, shuttles, and other medium and heavy-duty vehicles.[23]

Accelerated by the technical innovation and success of EV and fleets, electric aviation is taking off. Towards a decarbonized future, drone deliveries, aerial ridesharing, and regional electric flights are quickly becoming a crucial part of our new zero-emission mobility.

Sustainability Commitments

Electric fleets help federal agencies meet their sustainability commitments. As an energy system, charging facilities open the opportunity to integrate clean, distributed energy into installation facilities, which builds resilience and reliability into operations while slashing GHG emissions.

Electric Vehicle Adoption Charges Ahead

Despite the global chip shortage and supply chain issues, EV adoption across all vehicle classes is strong. If the U.S. reaches the EV adoption targets, EV would grow from around 3 million today to more than 48 million in 2030—about 15% of all vehicles on the road in the U.S. The related electricity demand for EV charging would leap from 11 billion kilowatt-hours (kWh) now to 230 billion kWh in 2030.[24] While EV adoption aligns with federal sustainability goals, critical emphasis must be placed on reliable, clean energy in the "right" places to make this transition successful.

Electric Light-Duty Vehicles[25]

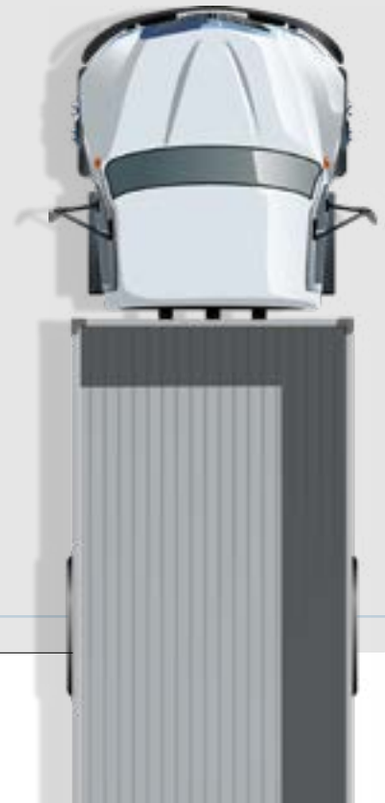
- U.S. **sales doubled** in **2021**
- **700,000** total **EV registrations**
- EV now **4.5% of U.S. car market**

Electric Medium and Heavy-Duty Vehicles[26]

- **1,215 zero-emissions vehicles** Class 2b through Class 8 on road
- **140,000** pending orders
- **By 2035,** electric MHDV will cost the same as or **less than diesel trucks**

Electric Transit Buses[27]

- **Sales grew 112%** from 2018—2021
- **3,533 buses** on the road or on order in **46 states**
- At **cost-parity** with, or less than, **diesel**



Electric Delivery Vans and Step Vans[28]

- **e-Commerce boom** is driving growth
- **Multiple OEM** models
- **FedEx, UPS, Amazon,** and **Walmart** placing orders
- **2,200 on road** in U.S. & Canada by **2025**

Black & Veatch provided electric charging design and engineering expertise to help Daimler Trucks North America and Portland General Electric launch the first-of-its-kind public charging station designed for medium- and heavy-duty electric commercial vehicles. The site, formerly a fast-food restaurant, was re-designed to accommodate large electric vehicles. Electric Island is ready for megawatt-level charging, energy storage, and solar arrays.

10 Steps to Deploy Military Electric Fleets

As electricity becomes their new fuel, service fleet managers, ZEV action officers, and installation energy managers navigate a maze of technologies, infrastructure choices, and supply chains. The transition to electric fleets is different for each federal agency and installation. Some managers electrify major portions of their fleets, while others begin with a smaller trial project to help with proof-of-concept. Regardless of the undertaking, fleets present a substantial opportunity for agencies to reduce their operating costs, build resilient energy systems, and drive the adoption of emissions-free transportation.

Electrification must be systematically tackled to avoid increased costs.[29] Black & Veatch developed these steps to guide the process, inform scheduling, and cost-effectively plan optimal charging facilities.

Step 1:

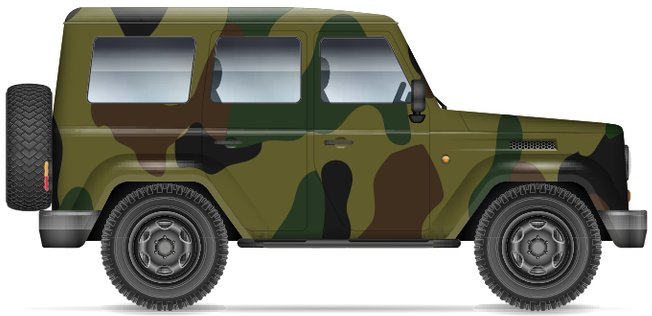
Define Fleet Profile & Use

Define duty/drive cycles, fleet route length and conditions, lifetime cycles, payload, dwell time, and maintenance & operational considerations. Quantify the number of ZEV that each installation identified for vehicle replacements can acquire. This information helps determine the TCO, optimize technologies, and translate route data into cost savings. Options include depot charging, on-route, shared, and destination/endpoint charging, either alone or in combination, to meet capacity and resilience requirements.

Step 2:

Manage Organizational Changes

Electrification requires staff to adopt a new way of working. Apply change management methods to set an organizational strategy to guide the transition to an electric operation. This strategy helps determine and manage operational impacts, keep morale high during the transition, ensure staff skills evolve to support electric fleet operations, and align ZEV transition with federal fleet executive and statutory requirements.



Step 3:

Review & Select Technology Options

Consider types of vehicles, charging technologies, communications networks, and software platforms for ZEV charging coordination and management. These selections help service fleet managers, ZEV action officers, and installation energy managers integrate installation facilities and DER, and optimize these systems around management of fleets, green energy, and charging. A networked system is especially valuable to managers and utilities as the size of fleets and capacities grow exponentially. Supply chain bottlenecks create long lead times for equipment such as switchboards and batteries. Order equipment early.

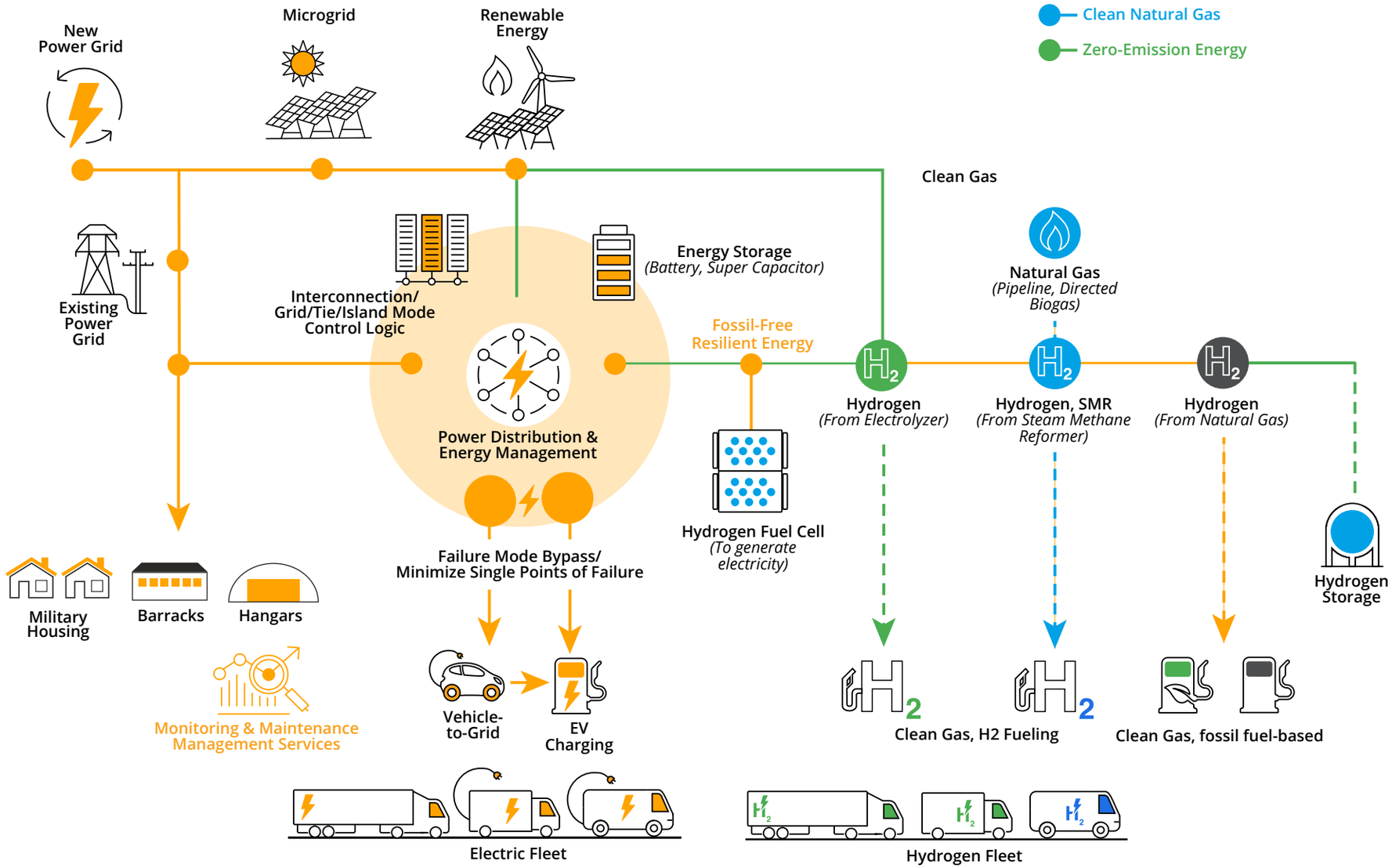
Step 4:

Optimize On-Site Energy

Evaluate options for on-site renewable energy and storage to minimize peak demand charges, balance loads, and lower the cost of clean energy. A flexible, low-cost energy system monetizes energy sources to control fleet expenditures, speeds return-on-investment, and reduces the TCO.

Emissions reduction requires a fundamental shift in fleet operations. This shift is an opportunity to include generation sources and on-site storage to monetize energy sources and control fleet expenditures. As part of EV charging planning, managers can choose a flexible, modular design that supports energy storage and a mix of energy sources such as renewables, electricity, biogas, hydrogen, and liquified natural gas. The system evolves to support new apps and technologies as they mature. (See Black & Veatch's proprietary Multi-Energy Hub concept presented on the next page.)

Multi-Energy Hub Concept



Step 5:

Understand Demand for On-Site Electric Power

EV sites need power. For example, a fleet of 56 buses would require around 11 MWh, and a fleet of 542 could demand around 109 MWh.[30] Equipment upgrades to grid elements and facilities may be required to support on-site charging. Building retrofits require electrical and utility interface planning, cooling design, and space for equipment.

Step 6:

Site Selection & Planning

Careful consideration of zoning, permitting, physical space, communications, and power supply is critical. Thoughtful and informed site selection minimizes project cost and time. Sites need to accommodate a functional facility layout ideally located and built within the community. Several factors can dramatically affect schedule and cost, like distance from the site to a substation and whether upgrades are needed along the distribution circuit due to competing site developments and charging load.

Step 7:

Conduct Utility Coordination, Engineering, & Design

Start local and regional utility engagement early to develop a power delivery roadmap that leverages utility programs and charging rates. The planning process incorporates calculated savings based on future charging or production loads. To future-proof design, consider growth over five to ten years (and longer) to anticipate power capacity for a facility. Charging and energy production and storage technology will continue to advance, but it may be most cost-effective to install existing and anticipated on-site infrastructure at the same time.[31]

Step 8:

Apply for Permit & Approvals

Zoning, land use, permitting, and right-of-way requirements become increasingly complex with larger scale developments and increased power levels. This complexity comes from space requirements and the many real property agreements needed by the utility to cross parcels for power delivery. Required entitlements may include state environmental impact filings and interagency agreements and approvals. Other related paperwork that may be required includes applicable terms and conditions of equipment, vehicles, and infrastructure, leaseholder or property owner agreements, and deployment services.

Real estate is quickly becoming a competitive hot spot in electrification. Guided by sustainability and resilience goals, many managers actively purchase suitable sites and rent out sites until they are ready to develop. Obtaining the right sites now will save money in the long run. Black & Veatch services help simplify this process:

- Pre-Acquisition & Acquisition
- Title Services
- Land Use
- Environmental, Regulatory & Permitting
- Siting & Routing Services
- Right-of-Way Services
- Fielding Services

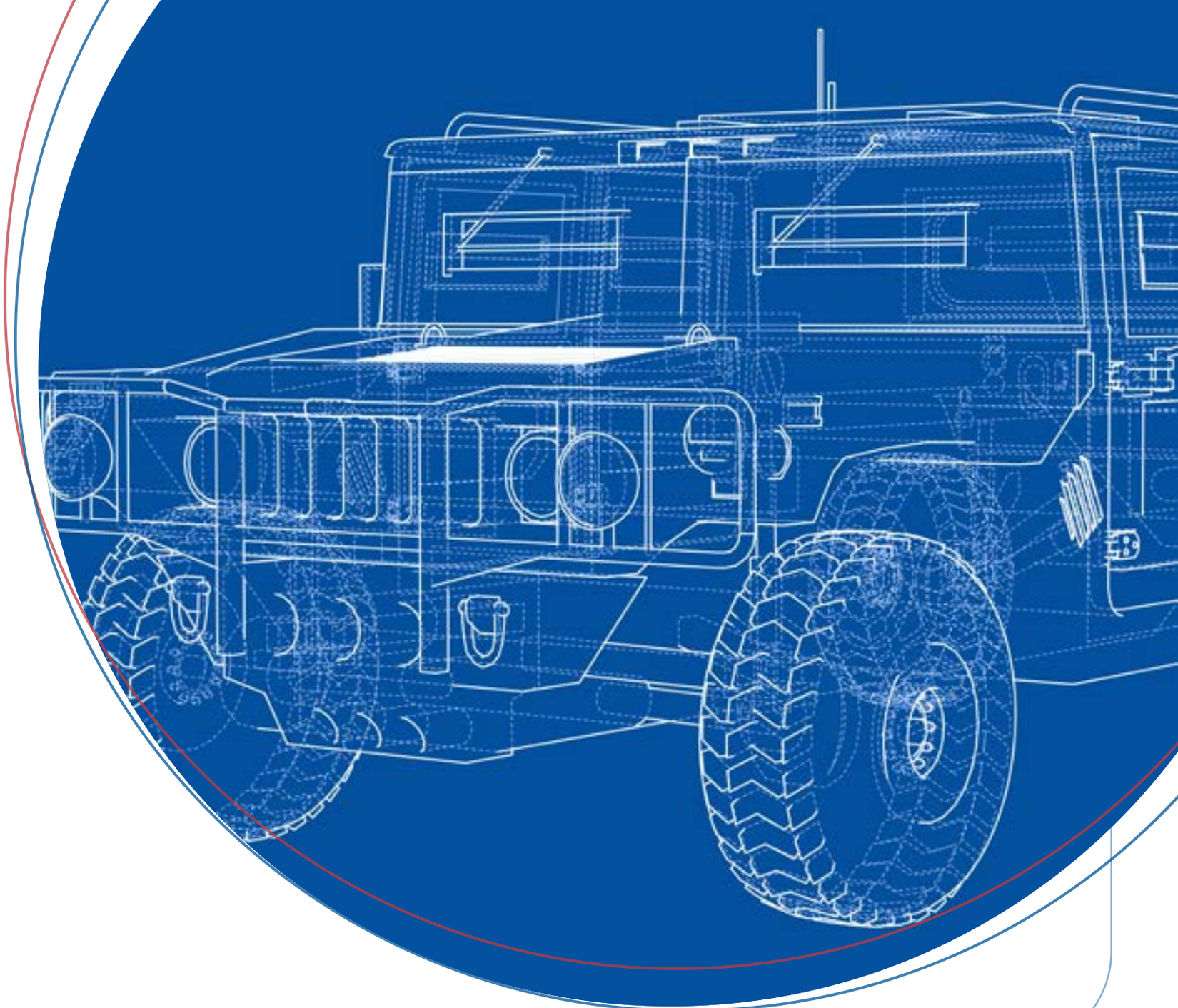
Step 9:

Distribution Grid Upgrades

New charging loads may require upgraded or new utility feeders, substation modernization, and even new substations. Engineering, design, and construction scopes become more intricate with increasingly complex upgrades, affecting deployment cost and schedule. A power delivery schedule without grid upgrades is about eight months. As the *Grid Connection Lead Times* Infographic shows, grid upgrades can run 48 months or longer depending on the complexity.

Grid Connection Lead Times

Charging Site Capacity	Grid Upgrade	Example Timeline
Up to 1 MW	**No distribution circuit upgrades.** Site is supported with a new service transformer connected to the local distribution grid.	2-4 months
1 MW	**No grid upgrades.** The supply conductor may require replacement as service transformer size increases.	6-10 months
	Grid upgrade, re-conductor or new line equipment. If the distribution circuit overloads, then the overhead or underground wire may require upsizing to increase the load capacity and improve voltage regulation on the feeder.	10-14 months
2 MW	**No grid upgrades.** The site may require primary service at medium voltage if the site load exceeds standard service transformer and low voltage switchboard ratings (typically around 3000 A). Medium voltage accommodates multiple service transformers (behind the meter, customer owned).	3-6 months
5 MW	**Grid upgrade, new feeder.** A new circuit from the substation to project site is required if site capacity exceeds the line capacity and line upgrades cannot address overloads.	12-26 months
10 MW	**Substation upgrade, new transformer bank.** An overloaded transformer bank is either replaced by a larger bank in the substation or another bank is added.	24 months or more
20 MW	**New substation.** A new utility substation or dedicated high voltage substation may be required for very large installations.	24-48 months or more



Step 10:

Integrate Equipment, Construct, & Commission

Construction starts when the service fleet manager, ZEV action officer, or installation energy manager receives all permits and approvals including a signed/ sealed drawing package and a utility design package. If new or upgraded electric service is required, the utility will complete their infrastructure construction before energizing the site.

After inspection and commissioning, the installation will need to conduct regular and preventative maintenance of charging equipment to ensure the physical infrastructure and user interface function properly, accurate power supply, and safe operation of the charger. The installation will need to monitor utilization data, drive cycles, and vehicle charging rates to understand fleet profile and use, and adjust operations for optimized charging.

End Notes

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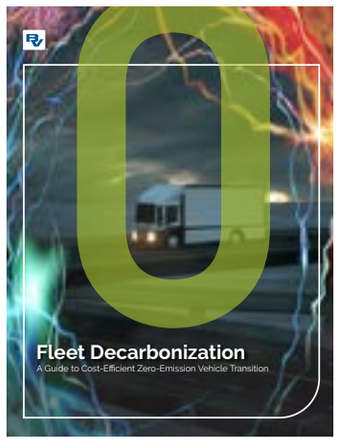
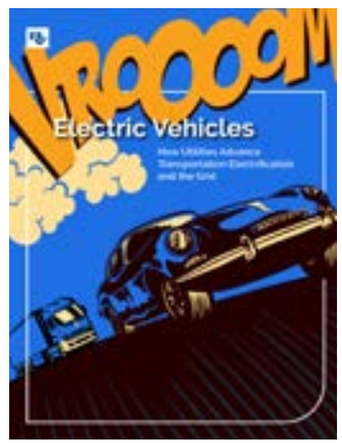
Conclusion

Massive charging infrastructure investment and favorable market conditions are generating technology confidence and motivating federal agencies and military installations to transition to an electric fleet. As long-term investments, charging facilities are enduring networks that support installations and their unique missions. Insightful planning is critical because present-day design decisions impact longevity, scalability for future growth, and bottom line TCO.

As an infrastructure leader in transportation, resilient energy systems, telecommunications, and mission critical facilities, Black & Veatch provides valuable planning, analysis, site acquisition, and design services for optimal charging facilities. We go beyond the project to enable sustainability, resilience, reliability, and more.





At Black & Veatch, we've made it our mission to help federal agencies and installations identify, evaluate, and deploy the most advanced clean transportation technologies available.

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