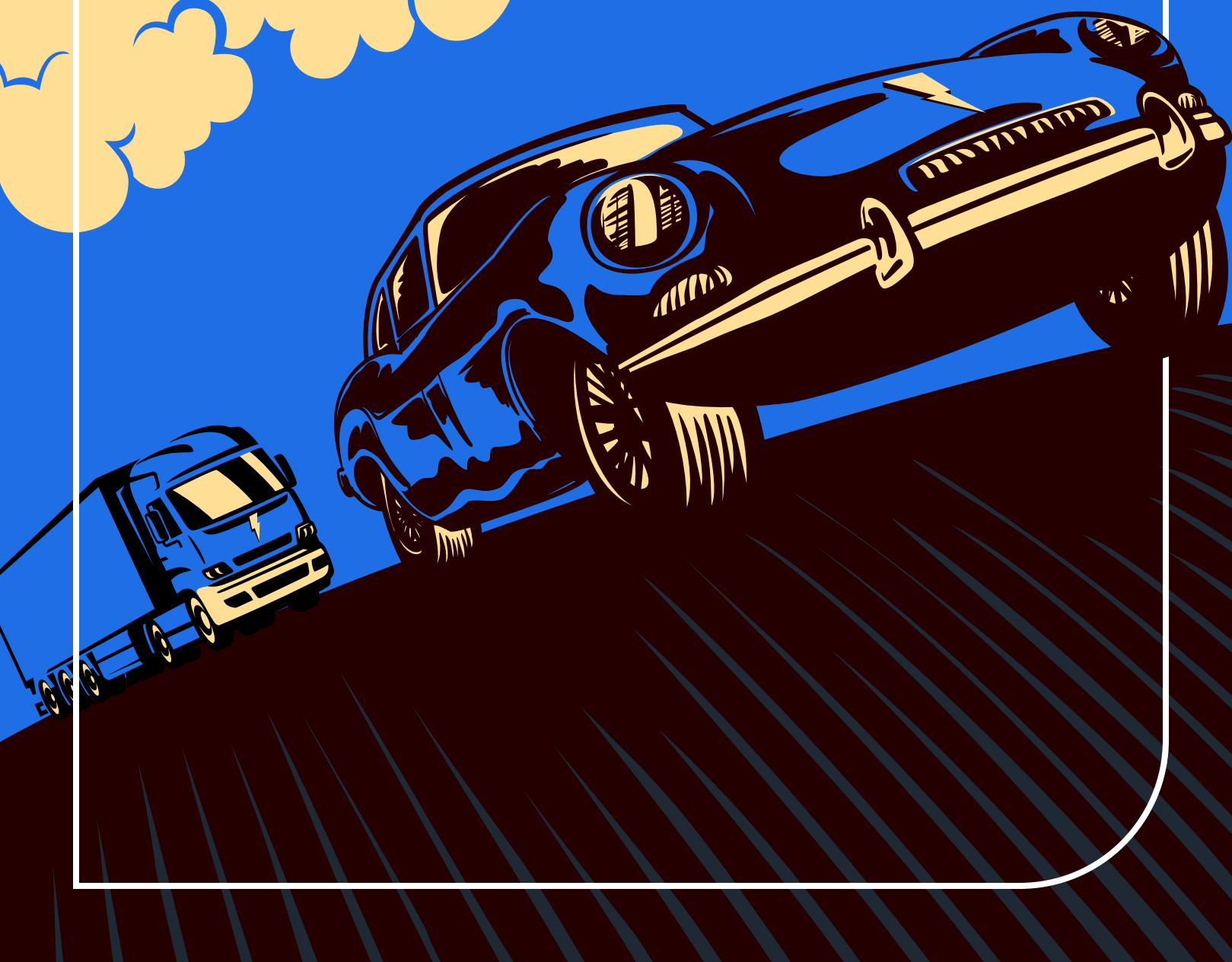




Electric Vehicles

How Utilities Advance
Transportation Electrification
and the Grid







Introduction

Despite wavering federal support, over 30 U.S. states incentivized clean transportation over the last several years to improve local air quality and reduce the emissions that contribute to climate change. Electric vehicle (EV) adoption is a big part of their strategy. As states invest in EV deployments, the spotlight is on electric utilities and how they plan to evolve alongside transportation electrification. The focus is more of criticality than curiosity. Trends show that multi-megawatt charging stations will push annual power demand into the terawatts. This demand will only increase as electrification expands as predicted into autonomous vehicles, as well as into industrial, mining, buildings, agriculture, and other markets.

Electrification of travel and transport is happening, and investors are evaluating clean energy options to meet demand. To stay in the game, utilities are positioning to provide effective response to the power demand by modernizing their grid and their business models, experimenting with technology and rates, and ultimately increasing load and revenue. As electricity becomes intertwined with and influenced by transportation and other industries, long-term, holistic planning is essential, and utilities need to start now. Our electric future is here, and there is no turning back.



Advancing Clean Transportation



Black & Veatch estimates it could take **24 months or more to deliver power** to a large charge port installation, which puts EV investors and electric utilities into a formidable time crunch.

From modest beginnings, the clean transportation movement has grown exponentially with no end in sight. In 2010, U.S. EV sales were at 345. New vehicles sales in 2019 rose to over 236,000.¹ As an indication of escalating momentum, sales rose 80% from 2017-2019.² Hydrogen fuel cell electric vehicle (FCEV) sales are growing, too. The U.S. operates 7,241 FCEV passenger vehicles and 30,000 fuel cell forklifts, and 35 FCEV buses are in active demonstrations. The U.S. targets 5.3 million FCEVs on the road by 2030.³

Thirty U.S. states incentivized clean transportation to improve local air quality and reduce the emissions that contribute to climate change.⁴ These states established rebates and incentives to speed zero-emission vehicle (ZEV) adoption and

infrastructure deployment; but even with incentives, the U.S. may not meet infrastructure demands. This is most concerning for EVs because they are scaling fast. Bloomberg New Energy Finance estimates that 3.6 million EVs (cars and light trucks) will be on U.S. roads by 2025,⁵ and reach 22 million by 2030.⁶

To support large-scale electrification, the U.S. needs to construct 9.6 million charge ports by 2030, composed of a mix of Level 2 and DC Fast chargers.⁷ The scale of deployment and resulting grid impact is sounding alarms among electric utilities. As medium and heavy-duty vehicles and fleets become electrified, utilities will experience the impact of simultaneous charging, corridor-charging hubs, and large charging depots—all with charging requirements of 5 MW, 10 MW or more. In fact, Black & Veatch found that 85% of utility respondents expect multiple charging sites ≥ 5 MW in their territory by 2023, but 25% are not taking steps to prepare for EVs.⁸ This is troubling considering that simultaneous charging of 60,000 100 kWh EV batteries with a 5-minute charge time would equate to an instantaneous demand of 70 gigawatts.⁹

¹ Electric Drive Transportation Association. 2019. Electric Drive Sales Dashboard.

² BloombergNEF. 2019. Electric Vehicle Outlook 2019.

³ Deloitte/Ballard. 2019. Fueling the Future of Mobility. Hydrogen and Fuel Cell Solutions for Transportation.

⁴ Center for Climate and Energy Solutions. 2019. U.S. State Clean Vehicle Policies and Incentives.

⁵ International Council on Clean Transportation. 2019. Quantifying the Electric Vehicle Charging Infrastructure Gap Across U.S. Markets

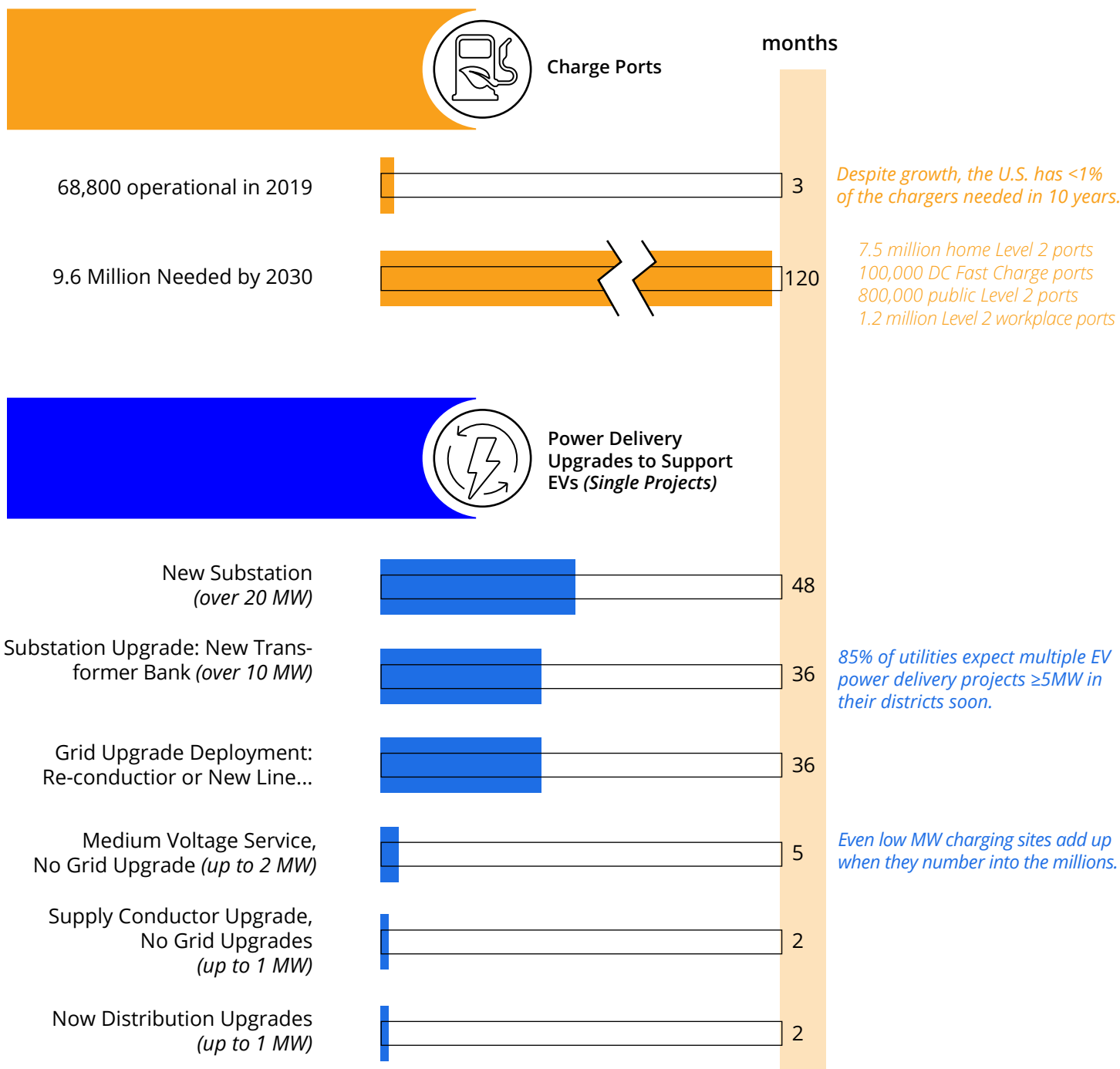
⁶ BloombergNEF. 2019.

⁷ IEI/EEI. 2018. Electric Vehicle Sales Forecast and the Charging Infrastructure Required Through 2030.

⁸ Black & Veatch. 2019. Electric Survey Report Results. Q68: How many EV fleet charger installation projects (5MW or more) do you anticipate will provide load to you in the next 5 years? Q67: How are you preparing for EV Fleet conversion?

⁹ Wood MacKenzie. 2017. The Rise of the Electric Car: How Will it Impact Oil, Power and Metals?

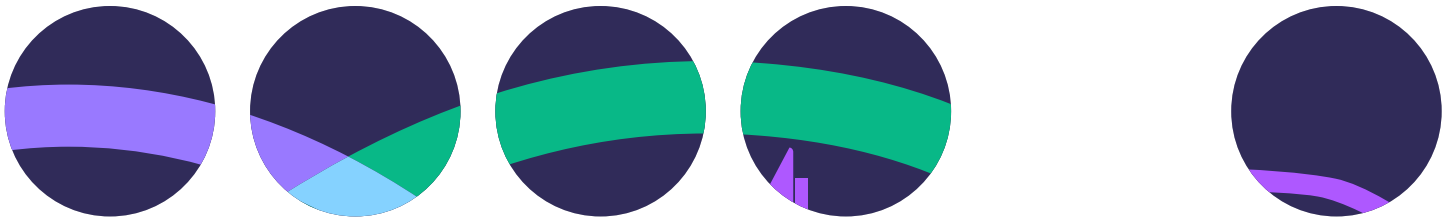
Electric Vehicles (EVs) are scaling fast, but charging infrastructure is lagging. The U.S. needs 9.6 million charge ports by 2030,¹⁰ but delivering power to one 20MW charging site can take 24-48 months¹¹ for utilities to plan and deploy. Utilities need to get out in front of charging demand. Over 38% of surveyed utilities that see electrification as a good opportunity to capture new load, but know they need to upgrade infrastructure to prepare for EVs.¹²



¹⁰ IEI/EEI. 2018. Electric Vehicle Sales Forecast and the Charging Infrastructure Required Through 2030.

¹¹ Black & Veatch. 2019 Electric Fleets. 8 Steps to Medium and Heavy-Duty Fleet Electrification.

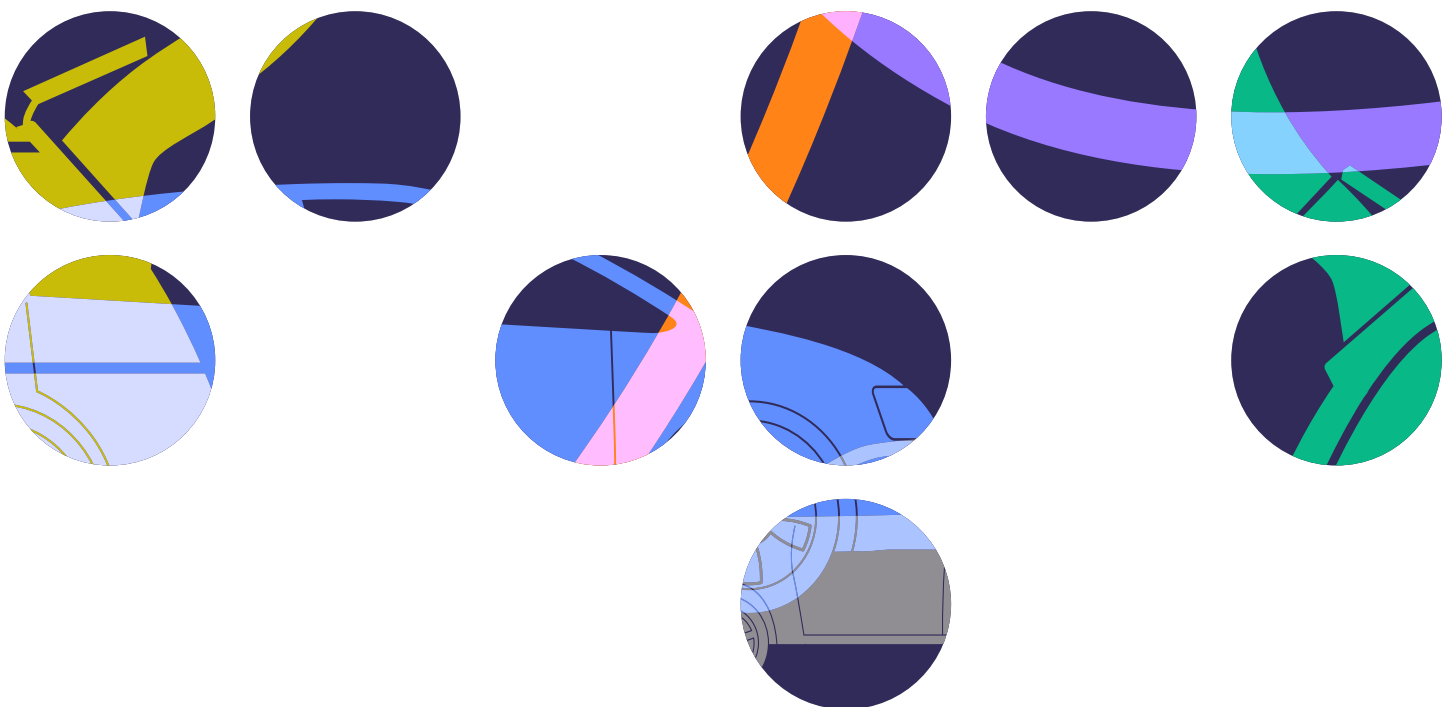
¹² Black & Veatch. 2019 Electric Survey Report. Question 65: Is fleet vehicle conversion to EV an opportunity or a concern to your company?

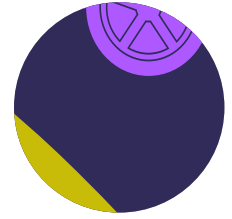
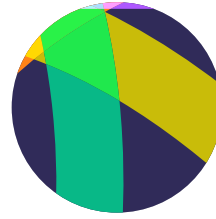
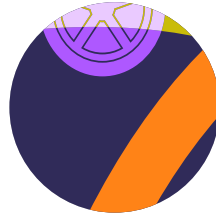
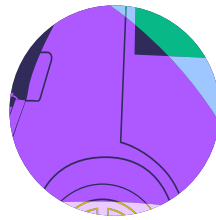
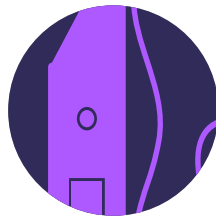
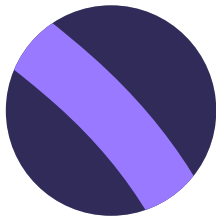
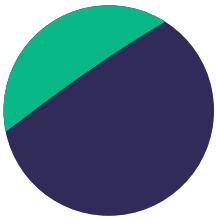


Technology and Grid Resilience

Bloomberg indicates that over \$10 trillion will be invested in renewable wind, solar and battery assets by 2050.¹³ This degree of investment will cause significant ripple effects across the grid due to intermittency and load balancing.¹⁴ Of equal importance, electrification is expanding across markets—into autonomous, transit, drones, aircraft, and marine vehicles, buildings, agriculture, and beyond—as value propositions and ROI ring true.

Many tech-trailblazers are using these seven technologies to create work-arounds to the traditional grid, but these technologies can help utilities thrive in an electrified world, too. These technologies stabilize the grid, align electricity supply and demand, and provide pathways to new services. These technologies increase customer participation in grid programs, encourage EV adoption, electrification, and load growth, and increase revenue to defray the high costs of grid modernization and infrastructure upgrades.

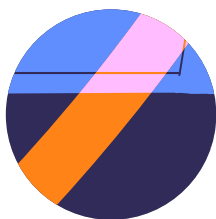
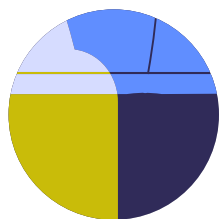




1. Charging Infrastructure

Electric utilities are well positioned to enter this market because they provide the grid connections, can shape EV energy management, and understand large-scale, distributed infrastructure. Regulations are changing to support utility investment in EV charging infrastructure that the U.S. desperately needs. EV charging is an opportunity for utilities to capture new load, speed EV adoption, and slash emissions. To jumpstart charging, many utilities are developing make-ready electrical infrastructure that accommodate a variety of chargers.

1,000 and 870: Numbers of charging sites Southern California Edison (SCE) has built for light-duty vehicles and will build for medium and heavy-duty vehicles via their innovative and cost-friendly Charge Ready programs.



60MWh: Amount of storage that Black & Veatch helped Advanced Microgrid Solutions (AMS) to design, engineer, permit, and construct via **20 first-of-a-kind** Hybrid Electric Buildings® in California.

2. Battery Storage

Recent pilot studies gave utilities operational experience and favorable results that prompted many utilities to increase energy storage capacity. EV hot spots and spikey loads from high-power charging stations are expected to increase peak load at the local level by 2030, quickly overloading feeder-circuit transformers if unmanaged.¹⁵ With falling battery prices, battery storage is an attractive way to smooth load profiles. In one study, on-site storage at an EV charging station levelled spikey load profiles—from 100 kW to 27 kW, and slashed demand charges by 73%.¹⁶

3. Mobile Battery Storage

Many EV batteries on the market have capacities of 40-65 kWh, with Tesla batteries topping 100 kWh. With the addition of a power control system, an EV battery operates like stationary storage to provide vehicle-to-

¹³ Bloomberg New Energy Finance. 2019. New Energy Outlook 2019 Executive Summary.

¹⁴ Navigant 2018. Energy Cloud 4.0. Capturing Business Value Through Disruptive Energy Platforms.

¹⁵ McKinsey & Company. 2018. The Potential Impact of Electric Vehicles on Global Energy Systems.

¹⁶ McKinsey & Company. 2018. How Battery Storage Can Help Charge the Electric Vehicle Market.

home (V2H) power during outages. Mobility-as-a-service (MaaS) will allow rideshare companies, eFleet managers, and other mobility providers to amass EV energy stored in their batteries and use them as virtual power plants (VPPs). To extract value and stabilize the grid, utilities and fleet owners are collaborating to create EV-grid services such as vehicle-to-grid (V2G) and managed charging.

4. Vehicle-to-Grid and Managed Charging

Utilities will use V2G and managed charging to turn EV charging stations into a grid-regulating tool that balances performance like voltage, frequency, and ramp rate reduction. Right now, third party companies own the majority of charging stations, but utilities are becoming increasingly involved. They are well positioned to create profitable grid services in addition to charging services. As they expand their charging services, utilities will need software to remotely monitor and control EV charging across their districts to support managed charging and demand response. Software helps manage charging loads and schedules to reduce charging costs and optimize fleet and grid operations.¹⁷

5. Microgrids

In addition to providing backup power during outages, microgrids simplify EV charging power delivery by supplying clean onsite energy for fleets, airports, and seaports. In addition, microgrids are a viable work-around to insufficient power to support EV charging in dense, urban areas.

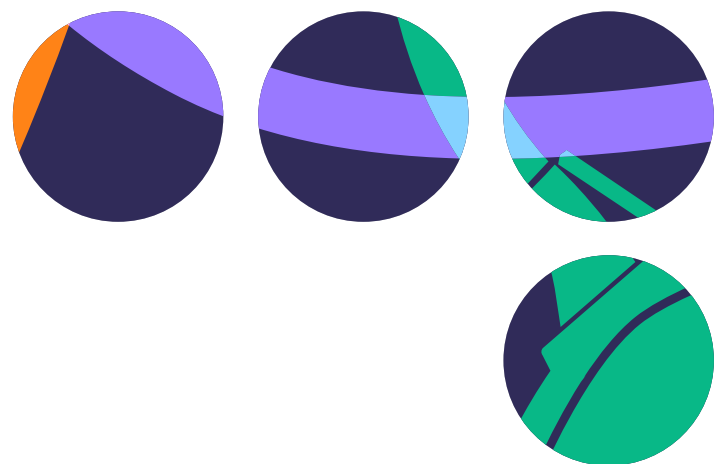
6. Solar Photovoltaic (PV)

The cost to install solar dropped more than 70% over the last decade, and prices have reached historical lows across all markets. The non-residential and utility-scale markets are primed for growth, with 37,000 MW of utility-scale solar projects in operation and another 112,000 MW in development. Notably, more than 80% of 2018 solar projects were procured voluntarily versus as a requirement of renewable portfolio standard (RPS), demonstrating the profit-power of solar.¹⁸ Utilities that use solar PV and battery storage, with or without microgrids, will expand their energy portfolio and capture new sources of energy.

Solar-plus-storage is growing across markets. Black & Veatch and Sharp Electronics engineered **six solar PV and energy storage sites** for the Santa Rita Union School District in California. The systems include 1 MW of solar PV integrated with 1.1 MWh behind-the-meter energy storage.

7. Data Analytics

Data has been dubbed “the commodity of the 21st Century” and for good reason: data provides system transparency and optimization that balances dynamic local networks. For utilities, this translates to speed, visibility, and control deeper into the [distribution system](#) where it’s most needed. With more distributed assets, 53% of surveyed utilities think upgrades to their [communications network](#) are essential.¹⁹



¹⁷ Solar Energy Industries Association. 2019. Solar Industry Research Data. Growth in Solar is Led by Falling Prices.

¹⁸ Black & Veatch. 2020. Smart Utility Report survey question. n=627

¹⁹ Black & Veatch. 2020. Smart Utility Report survey question. 'How do distributed assets factor into discussions about reliable and resilient communications?' n=627

Ways Electric Utilities Can Pivot and Profit

In 2018, Navigant cautioned that electric utilities had five years to reposition in the energy market or risk losing significant market share to new entrants.²⁰ This is already happening. Power marketers, such as Engie and EDF, are generating clean electric power and selling electricity to consumers who traditionally bought from their utility. As of 2019, 14 states had implemented full retail competition for customers Investor Owned Utilities (IOUs) and 11 more are considering electric sale restructuring.²¹ Power marketer retail sales have risen dramatically. They now hold 21% of the retail electricity sales in the U.S., while retail sales of IOUs have declined.²²

²⁰ Navigant. 2018. Energy Cloud 4.0. Capturing Business Value through Disruptive Energy Platforms

²¹ Concentric Energy Advisors. 2019. Retail Competition in Electricity. What Have We Learned in 20 Years?

²² U.S. Energy Information Administration. 2018. Power Marketers are Increasing their Share of U.S. Retail Electricity Sales.

1. Market Distributed Energy Resources (DERs). DERs can become a grid-side resource to manage grid load and impacts and offer new value-based services like DER installation, sale of stored DER generation, or DER maintenance packages.²³

23.8%

surveyed utilities regularly consider ROI from non-wired alternatives, like behind-the-meter DER investment or incentives, in lieu of infrastructure upgrades.²⁴

2. Build Charging Infrastructure. Utilities can capture new load, play a substantial role in advancing clean transportation, and shape energy management while offering charging-as-a-service.

\$31.6

million: state funding given to New York's six regulated utilities in 2019 to build over 1,075 charging stations with cost-recovery.²⁵

3. Promote Building Electrification. Utilities can collaborate with homebuilders to build all-electric homes with renewable components and work with homeowners to swap oil-based heating systems for electric. Utilities can provide consulting for efficiency reviews and electrification retrofits and develop demand flexibility programs and time-varying rates for customers.²⁶

365

GWh: increased load demand that the Sacramento Municipal Utilities District expects from building electrification in their district by 2030.²⁷

²³ T&D World. 2019. Moving Beyond Simple DER Management.

²⁴ Black & Veatch. 2020. Smart Utility Survey Question, 'On a scale from 0-5, to what degree are non-wires alternatives being considered at your utility?' n=627

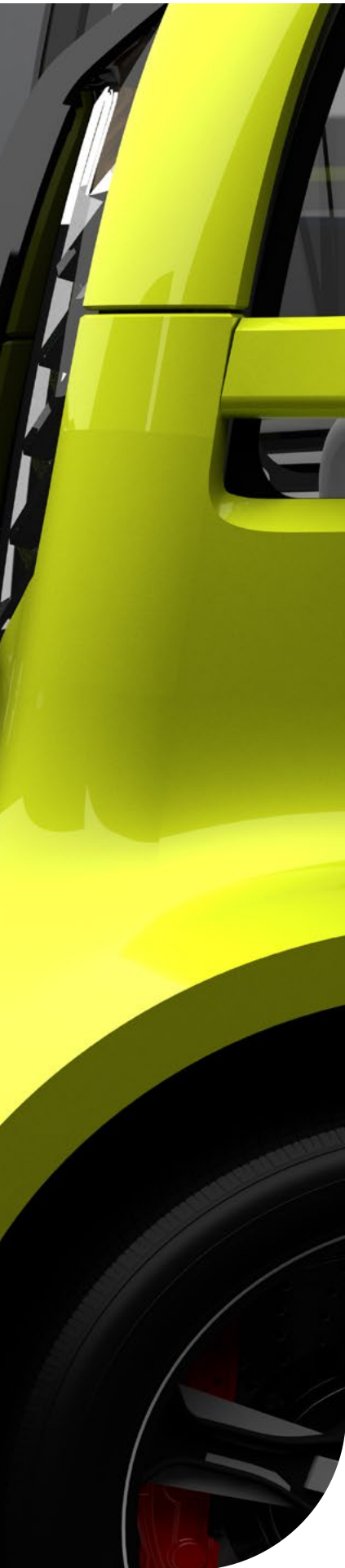
²⁵ New York State. 2019. Governor Cuomo Announces \$31.6 Million in Funding Available to Dramatically Expand Electric Vehicle Usage.

²⁶ Rocky Mountain Institute. 2018. The Economics of Electrifying Buildings.

²⁷ Sacramento Municipal Utilities District. 2018. Resource Planning Report.



Pillars of Support for EVs



Each stakeholder—regulators, automakers/medium to heavy duty OEMs, EV service providers, technology integrators, and utilities—is important to encourage EV market growth and to manage the energy impacts of widespread charging. But utilities are the linchpin. EVs and charging networks are advancing, but the EV market will stagnate without timely planning and infrastructure to deliver adequate power to charging sites.

Federal and State Regulators

Despite wavering federal support for electrification, the bi-partisan America's Transportation Infrastructure Act of 2019 proposes \$4.5 billion to support clean transportation projects. The funding would support projects that reduce highway-related carbon emissions and advance alternative fuel infrastructure, like EV charging stations, along designated highway corridors. At the state level, the California Public Utilities Commission (PUC) approved a \$750+ million budget to fund proposals by the state's investor-owned utilities to expand EV infrastructure and rebate programs. Many other states are pressing to approve utility EV infrastructure programs to add more charging stations and explore rate scenarios. Regulators support electrification when they:

- Recognize that energy and transportation are merging.
- Develop/extend rebates and incentives on EVs and charging infrastructure.
- Support electric utilities as they develop rates and programs for EV charging.

Automakers and Medium to Heavy-duty OEMs

Detroit's Big Three Automakers—GM, Ford, and Fiat Chrysler—will spend billions in the next 10 years to establish electrification programs, build battery plants, and develop new EV models.²⁸ They are also creating strategic relationships with suppliers and other industry leaders to accelerate electrification. To boost sales, automakers can advance EVs by investing in EV charging networks, providing materials, and creating incentives for EV buyers. Domestic and international OEMs support electrification when they:

- Continue to offer compelling models and market them effectively across the U.S.
- Participate in state and federal policy and regulation-setting to support electrification.

²⁸ CNBC. 2019. Detroit's Big Three Automakers are Looking to a Battery-Powered Future, but Each Forging its Own Path.

EV Service Providers

EV service providers are deploying infrastructure and collaborating with each other to expand consumer access to charging stations across the U.S. Recently, ChargePoint and Electrify America created a “roaming partnership” where consumers can charge on either network with no additional fees. Several EV service providers are also integrating their networks which promotes interoperability and increases charging station use and value. EV service providers and utilities are also creating interconnection best-practices to clarify installation requirements and speed deployment. EV service providers support electrification when they:

- Create clear channels of communication with utilities about charging station planning.
- Understand utility interconnection requirements and provide critical information for site planning.



Technology Integrators

Technology integrators like Black & Veatch unify planning and deployment of new technologies across stakeholders and systems. Integrators help utilities develop new business models and understand grid, vehicle, and charging technology, as well as policy and rate design. Integrators are plugged into the transportation electrification market to advise program, project, and planning approaches. Nearly 46% of surveyed utilities consider integrated transmission, distribution and resource planning highly important,²⁹ especially as the electric industry becomes intertwined with and influenced by transportation and other industries. From this perspective, technology integrators are critical for whole-system design reflective of current trends and technologies to ensure present-day decisions positively impact longevity, scalability for future growth, and ROI. Technology integrators support electrification when they:

- Help utilities understand energy implications of charging deployments.
- Develop rates to encourage beneficial consumer behavior.
- Help utilities site, engineer, upgrade and interconnect high-power utility service.
- Develop and deploy energy solutions in areas where enough power does not exist.

Electric Utilities

Electric utilities are at the center of the new energy ecosystem and the gatekeeper to expanded electrification across all markets. Many U.S. utilities are embracing the trends, and planning for new load growth from efficient electrification, which could rise 24-52% by 2050.³⁰ Transportation electrification is of keen interest because EVs across applications continue to scale and will demand 93 terawatt-hours (TWh) of annual energy consumption in the U.S. by 2030.³¹

²⁹ Black & Veatch.2020. Smart Utility Survey Question, ‘How is your organization viewing the importance of integrating its planning functions (e.g., transmission, distribution, resource planning)?’ n= 627

³⁰ Electric Power Research Institute. 2018. U.S. National Electrification Assessment.

³¹ Smart Electric Power Alliance (SEPA). 2019. Preparing for an Electric Vehicle Future: How Utilities Can Succeed.

While we all benefit from electrification, utilities have the most to gain if they can work through their top challenges in transportation electrification such as uncertainty of future EV load growth, customer management of EV charging costs, and implementing appropriate software tools.³² Utility pilot-programs—once scarce, now plentiful—are running across the country, testing everything from charging stations to managed charging. These evaluations reveal the curiosity and commitment of the electric industry to evaluate new business models and services that could simultaneously support U.S. carbon goals while reviving an outmoded electric system. Utilities support electrification and will benefit from increased customer engagement, new loads, and new services when they:³³

- Include EVs and charging infrastructure into load forecasting and generation resource planning.
- Engage customers, like fleets, to obtain EV plans and forecasts.
- Understand how highly-local grid impacts from EVs and charging affect distribution.
- Continue to modernize the grid for better visibility, automation and control of DER integration.
- Develop apps and tools to guide charging hub placement to minimize grid impacts.
- Look for opportunities to add load management, including managed charging and rate design.

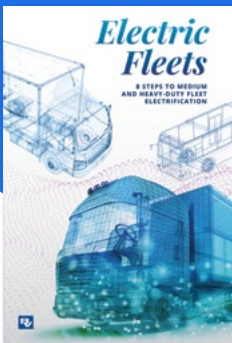


^{32,33} Smart Electric Power Alliance (SEPA). 2019. Preparing for an Electric Vehicle Future: How Utilities Can Succeed.

Conclusion

EV and energy investors know the value of electrification and are scaling technologies that advance alternative energy generation and management, as well as electrification of transportation and other clean technology sectors. As innovators devise work-arounds to the traditional grid system, the pressure mounts for utilities and regulators to lead and enable the new energy ecosystem and unlock the predicted value.

The U.S. needs 9.6 million charge ports by 2030 to support EV market growth. Black & Veatch estimates it could take up to 24-48 months to deliver power to a large charge port installation, which creates a formidable time crunch. To help utilities meet demand, all stakeholders have important roles. Technology integrators, such as Black & Veatch, have a holistic vision of the EV market, the grid, and technologies, which makes them ideal partners to study, select, and integrate technologies, business models, and rates. Black & Veatch is a market leader in clean energy planning and transportation infrastructure, with expertise in communication networks, grid modernization, and emerging technologies. The electric future is here, and utilities that haven't started planning or implementing programs and upgrades will need to work double time to catch up.



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