Who’s Driving Electric Vehicle Charging?

Utilities, automakers, regulators and charging companies are preparing the landscape for mass adoption of electric vehicles. Utilities are pivotal to adoption success—and they could have much to gain.
Mass electric vehicle (EV) adoption benefits communities through improved air quality, lower vehicle operating costs, and reduced noise and environmental impact, so it’s no wonder EV demand is increasing. In response, automakers and charging companies are providing affordable vehicle models and distributed charging networks. However, the energy demand associated with expansive and high-powered vehicle charging raises questions about power delivery, energy management and grid stability.

As electric vehicles (EVs) gain traction, new approaches to financing and technology solutions are vital. Utilities must drive energy infrastructure upgrades, balance distributed energy resources (DER), and remodel the customer-utility relationship. By working together, utilities and other stakeholders will unlock significant new market revenue potential and help shape a new world of energy and sustainability.
ELECTRIFYING TRENDS
Once considered niche technology, EVs are breaking into the mainstream market. Light-duty EV sales in the U.S. rose 37% in 2016. Volkswagen AG estimates that 25% of sales will be electrified by 2025, while General Motors plans to introduce at least 20 fully electric, zero-emission models by 2023. Adoption upsurge reasons include improved battery technology, more EV models with a longer battery range, and lower cost even before incentives. Consumers have more confidence in EVs and are signing on the dotted line for new models.

City fleet operators also have eyes on electric. Cities are obligated to reduce pollution, which is why many cities are electrifying transit and light duty fleets, and are piloting everything from garbage trucks to police cars. Cost is always a consideration. Electric medium-duty vehicles and heavy-duty vehicles generally have a higher upfront purchase price than conventional models, but some EVs, like transit buses, are now cost-competitive to conventional vehicles based on total cost of operation. Adding to the momentum of going electric, Black & Veatch observes that fleet maintenance costs dip 10-80%, depending on vehicle type and duty cycle.

EVs TAKE THE LEAD
By 2038, EV sales will outpace internal combustion engine sales

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The Electric Vehicle Market is Moving Fast
The past decade drove the electric vehicle from obscurity to trending. Within two decades, EVs will dominate the mainstream vehicle market.

2016
EV sales jumped 37% in the United States and 41% globally.

2021
EV battery manufacturing capacity is expected to triple, and battery costs will continue to drop.

2025
The cost to produce EVs will be the same as internal-combustion vehicles.

2035
An estimated 30 million fully and partially autonomous vehicles (AVs) will be on the road globally.

2040
54% of U.S. vehicles sold, and 40% of all vehicles sold globally, will be electric. In the U.S., EV electricity consumption will grow by 33 terawatt-hours (TWh) annually by 2025, reaching 551 TWh by 2040.

BREAKTHROUGH TECHNOLOGY
Alongside EV adoption, battery density is also increasing, allowing for larger capacity battery packs which are a requirement for faster charging rates. New high-powered charging infrastructure will deliver up to 350 kilowatts (kW)—seven times today’s most common charging capacity (50kW). Charging hubs are multiplying to support fast-growing adoption, and the energy implications are alarming. Consider this: the U.S. population drove 251 million cars in 2014, and electrifying them will require 1,377 TWh per year—this is equal to 37% of total U.S. electricity consumption in 2015.

ELECTRIC GRID
Energy management becomes complex as EV adoption climbs and more charging hubs—some of them high-power—go live. There is plenty of energy to support EVs, but the question is whether utilities can distribute power where EV owners need to drive and fleets need to operate while managing the variable power demands of charging across cities and timeframes. This question has many utilities, charging companies, and technology integrators like Black & Veatch thinking out loud, and for good reason. As the EV count rises, unmanaged EV growth could:

- Overload electric transformers in areas of high residential adoption
- Alter an electric utility’s overall load profile, affecting the timing of generation dispatch
- Drive anticipated changes in retail electric sales
- Stretch electric utility resources for grid planning, upgrades and operations

To get ahead in EV energy management, Black & Veatch and the Smart Electric Power Alliance (SEPA) observe that it is critical to anticipate the number of EV adopters, the location and timing of adoption, and planned charging hub locations. This information helps utilities prepare the grid and maintain reliable supply of electricity. Even more compelling, managed EV adoption and charging can:

- Help utilities serve more load and increase revenue
- Help balance grid demand and supply
- Integrate variable renewable resources like wind and solar
- Provide valuable grid services that leverage charging flexibility
- Support the growth of EV charging services market

A SEPA and Black & Veatch case study found that consumers could outspend utilities in the adoption of solar, storage, EV and other distributed energy resources (DER), making it essential for utilities to track and integrate these DER into their planning processes to benefit their customers and the grid.
EV ESCALATION AND ENERGY MANAGEMENT

Customer-owned DER technologies are on the rise. DER includes distributed generation (DG), energy-efficient products like LED lightbulbs, demand response (DR), energy storage and managed charging. It is expected that EVs will be the most common and widespread DER on the grid. Black & Veatch’s 2017 Strategic Directions: Smart City/Smart Utility Report found that many electric utility leaders are concerned about the lack of control over customer-owned DER and maintaining grid stability. However, utilities also see opportunities for new utility business models and for DER to provide locational value on the grid².

To create value, utilities have to consider widespread EV charging, the added demand of high-power charging, and DER grid impacts simultaneously. Utilities that manage DER as a portfolio will be able to take advantage of synergies and manage complex supply and demand dynamics. As Vehicle-Grid Integration (VGI) occurs, utilities can supplement traditional power generation with energy storage, managed charging, and coordinated control of distributed grid assets to meet EV charging needs; this can also help optimize use of conventional generation. Four main energy management strategies can help the transportation and energy industries manage energy effectively, and perhaps profitably, as EV charging escalates.

²Black & Veatch, 2017 Black & Veatch Strategic Directions: Smart City / Smart Utility Report, p. 39, 2017
1. Solar Generation and Distributed Generation

Policy support, efficiency gains and rapid cost declines have driven solar photovoltaics (PV) growth. The total installed cost has declined 80% since 2009\(^3\). In some cases, solar PV can support powering EV charging hubs and offset charging demand and storage applications. Solar PV is ideal for EV workplace or midday charging, and solar energy can be used onsite instead of exported to the grid or curtailed. Offsite renewables like community/shared solar and renewable energy credits can also cost-effectively supply high-power EV charging load\(^4\). Other types of DG like microturbines, fuel cells, and combined heat and power systems also integrate well with EV charging systems and provide resilience.

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“Businesses that do not electrify will be at a competitive disadvantage.”

—PAUL STITH, DIRECTOR OF STRATEGY AND INNOVATION, BLACK & VEATCH, TRANSFORMATIVE TECHNOLOGIES
2. Demand Response (DR) and Energy Efficiency

Energy efficiency includes energy-saving products like LED lightbulbs that reduce customer electric bills and permanently decrease overall utility load. DR changes customer loads at specific times based on signals from the utility. For example, smart thermostats use Wi-Fi to receive utility requests to lower the air conditioner when the electricity demands spike on hot days. This automation saves money and reduces the need for expensive “peaking” generation units.

Increasingly, utilities are geographically targeting energy efficiency and DR programs to reduce load on specific distribution circuits before they become overloaded. Efficiency and DR can be managed in conjunction with EV charging to minimize non-EV load overall and adjust other flexible loads as EV demand rises and falls.

Commercial microgrids and home energy networks balance the grid while serving local resilience needs. They create synergy between electricity supply and demand behind-the-meter at the local distribution level and at the regional transmission level.
3. Energy Storage
The electric grid must continually balance supply and demand. Energy storage, which can act as both a generation source and a load source, adds flexibility to the grid and helps customers manage their energy use.

As utilities aggregate and effectively control fleets of, distributed energy storage, then behind-the-meter storage can provide many services to the grid like back-up power for customers; transmission and distribution deferral for utilities; or voltage support for independent system operators (ISO) and regional transmission organizations (RTO).

Energy storage also allows customers to reduce their peak demand on the grid, shift their energy consumption to times of lower cost, and maximize self-consumption of on-site DG like solar PV. EV charging hubs combined with energy storage reduce the cost of charging and allows on-site DG to be stored for future use by EV chargers as needed. Energy storage allows the integration of renewable energy production and makes the magnitude and timing of EV demand more manageable.

“Synergy between electric vehicles, solar power generation, and energy storage boosts grid resilience and improves the economics of vehicle charging.”

—MARYLINE DAVIAUD LEWETT, DIRECTOR OF BUSINESS DEVELOPMENT, BLACK & VEATCH TRANSFORMATIVE TECHNOLOGIES
4. Managed EV Charging
With increased adoption, EV charging will contribute significant load for electric utilities across the country. Concentrated EV charging at the wrong time can lead to:

- Distribution-level grid impacts, like transformer overloads
- Transmission-level impacts on the utility load profile
- Localized outages
- Increased capital and operational spending at utilities

Managed charging gives utilities control over energy distribution across charging stations. Communication signals sent by the utility allow the charging station or vehicle to reduce the rate of charging or can delay charging altogether if a high-load event is occurring on the grid. Utilities can use this control to turn charging stations into a flexible load source to gain capacity, emergency load reduction, reserves or regulation, or to absorb excess energy from renewable energy resources like solar and wind.

Pacific Gas & Electric and BMW completed a study in California demonstrating that a fleet of 100 EVs effectively respond to DR signals from the utility, meaning that EV charging can be a valuable form of DR. When designed well, managed EV charging allows utilities and grid operators to capture grid benefits by harnessing the latent capabilities of EVs, which are often parked over 95% of the time.

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5Smart Electric Power Alliance, Utilities and Electric Vehicles: The Case for Managed Charging, 2017
Utilities Make the Case for Electric Vehicle Integration

Because of major impact to the grid, utilities are central to EV adoption.

Communities and citizens are seeing the benefits of going electric. Thirty US cities asked auto, bus and truck manufacturers to provide 114,000 EVs for their city fleets.

Utilities could see a 3,000 KWh per vehicle, per year, charging potential from EVs.

69% of utilities are planning, researching or considering EV managed charging programs.

Austin Energy predicts $8-23 million gross revenue from EVs by 2030 and a $400 million total EV market revenue potential.

By 2030, if utilities have not upgraded their infrastructure, then distribution transformers will overload in areas of high EV adoption.

Utilities that don’t upgrade residential feeders may not be able to support high EV adoption and could miss out on EV revenue.

A Sacramento Municipal Utilities District (SMUD) worst case energy demand scenario found that many of the utility’s service transformers may require replacement due to overloads associated with EV growth and unmanaged charging.

Utilities that don’t upgrade residential feeders may not be able to support high EV adoption and could miss out on EV revenue.

71% of utilities say budget constraints stall progress toward smarter, more integrated systems. Ecosystem partnerships can open funds for infrastructure updates to accommodate EV charging.

*Rough estimates by Black & Veatch using 201KWh per day.

Electrek, https://electrek.co/2017/03/15/electric-vehicle-order-114000-vehicles-40-companies-competing
INDUSTRY COLLABORATION IS CRITICAL
Each stakeholder—utilities, automakers, regulators and technology integrators—is important to encourage continued EV market growth and manage the energy impacts of widespread charging. It’s time to get creative and form new alliances, points of interaction, and business models that promote the social and environmental benefits of EVs. For example, the Department of Transportation is establishing a national network of alternative fueling and charging infrastructure along national corridors, in collaboration with the Department of Energy, multiple states, automakers, utilities, and alternative fuel providers. Similarly, Black & Veatch is working with Volta to accelerate the approach to EV infrastructure and quickly scale EV charging infrastructure nationwide to build consumer confidence.
Policymakers and Regulators
Federal, state and local policymakers can either facilitate EV adoption and new revenue for the utilities or create barriers that stunt EV market growth. Markets with policymaker support will help the industry establish operation, policy and technology platforms that expand EV adoption and prepare the U.S. grid for widespread charging. The top three actions that policymakers and regulators can take to support the EV market and the grid are:

1. Encourage investment strategies that leverage public and private funding for infrastructure.

2. Drive consumer behavior and adoption by developing rebates and incentives on EVs and charging infrastructure.

3. Support electric utilities as they develop rates and programs for EV charging that keep pace with technologies and evolving system load profiles.

California’s Low-Carbon Fuel Standard Utility Rebate Program funds rebates and incentives for current and future EV owners through their participating electric utility. Owners can receive EV purchase rebates, a credit on their electric bill, or an incentive to buy or lease a home-charging station.
Through EV ecosystem collaboration, automakers are developing creative public incentives that keep the market moving and produce an environment where everyone wins. Automakers, utilities, charging companies and state governments are working together to offer cash incentives, complimentary public charging, free municipal parking, and even carpool lane access with the purchase of a new EV.

**Automakers**

The industry will benefit from automakers who continue to develop compelling vehicles that meet and exceed consumer and commercial fleet expectations. Automakers can also work with stakeholders to mitigate adoption challenges. The top three actions automakers can take are:

1. Share anticipated charging requirements with utilities to enable facility upgrades and promote early engagement.

2. Inform the industry about vehicle programs and applications as technologies progress that benefit from electrification.

3. Share data to inform EV planning and charging operations and express the grid value of an electrified fleet.
Utilities
The growth of EVs carries both risks and opportunities for electric utilities. Utilities will need to adopt best practices and technologies for grid planning and operations, as well as explore new business models, rates and programs. The top three actions utilities can take are:

1. Incorporate EVs into load forecasting, generation resource planning, transmission/distribution planning, market designs, and real-time distribution operations.

2. Create technical and market mechanisms to make managed EV charging a versatile grid asset.

3. Prepare for EV growth by investing in distribution grid hardware, communications networks, operational technologies/software, and staff hiring/retraining.

The Sacramento Municipal Utilities District (SMUD) ran an extreme energy demand scenario that included 240,000 EV on the road by 2030. SMUD found that in the worst case, many service transformers may require replacement due to overloads associated with EV growth and unmanaged charging. Quantification and option evaluation gave SMUD a useful analysis to help them respond to changing conditions and prepare to avoid future challenges.
Technology Integrators
Technology Integrators like Black & Veatch and EV service providers recognize the objectives and challenges of all stakeholders. Integrators unify planning and deployment of new technologies across stakeholders and systems to balance competing interests, establish stakeholder rules of participation, and align charging hubs with energy and transportation systems. The top three actions technology integrators can take are:

1. Analyze operational EV charging stations to help utilities understand energy implications and develop rates to encourage beneficial consumer behavior.

2. Help utilities site, engineer, upgrade and interconnect high-power utility service, including medium voltage supply.

3. Develop and deploy energy solutions in areas where sufficient power does not exist, and help integrate DER into the grid.

To guide EV planning in the greater Kansas City metropolitan area, Black & Veatch evaluated EV adoption’s impact on electricity distribution. In the Electrify the Heartland report, Black & Veatch found that residential feeders were the most limiting factor to high EV penetration. Without the necessary planning and investments, utilities will not be prepared for transformer and conductor overloads or voltage violations.
CONCLUSION

All stakeholders have a role to propel and support widespread EV adoption and charging. Utilities are at the center of this new energy ecosystem. U.S. EV adoption rates continue to outperform forecasts, which spotlight the importance of timely utility planning to meet growing and variable energy demands. Utilities that lead—instead of follow—this transformative EV-energy market will unlock enormous market opportunities. Through early, insightful planning, utilities can create significant new revenue streams that benefit their bottom line, lower overall delivered customer energy costs, and energize the entire EV ecosystem. Equally important, leading utilities are shaping the future of energy and are helping to fulfill the promise of clean transportation and sustainable communities.