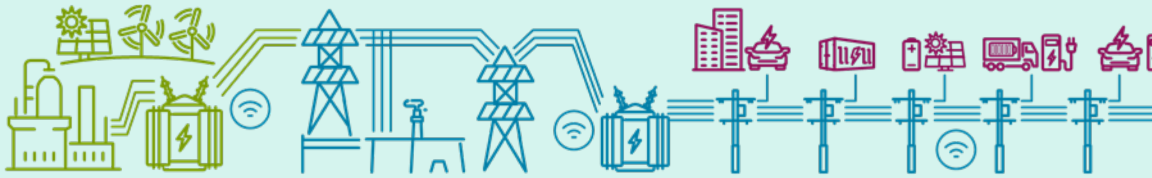
Decarbonized | Reliable | Resilient | Cost-effective



EVGrid Assist Webinar Highlights

U.S. DEPARTMENT OF ENERGY
EVGrid Assist
ACCELERATING THE TRANSITION

EV Basics

Electric vehicles are not just the future of transportation. They are the present.
The impact of EVs is already being felt and that impact only stands to grow as increased customer demand and an influx of federal funding aimed at decarbonizing both the electricity and the transportation sectors drive the demand for more vehicles and rapid deployment of charging infrastructure.

More than 100 plug-in EV models are already on the market, and in the first half of 2022, EVs accounted for more than 6% of U.S. vehicle sales, up from around 4% in 2021. Several vehicle manufacturers have announced their intention to stop producing internal combustion vehicles in the coming years, and some states have passed legislation that will ban the sale of such vehicles. In the decade to come, millions of new personal and commercial vehicles will hit the road, demanding hundreds of terawatts of power, and meeting that demand will require innovation, cooperation, and coordination between stakeholders who have had little reason to interact in the past.

Utilities alone are not responsible for meeting the fueling requirements of this new, electrified generation of vehicles. The electrification of transportation requires an entire ecosystem and the merging of two of the economy's largest sectors. The interdependence of the power and transportation sectors is forging new relationships and requiring new thinking to transform how customers get where they need to go and how goods are moved across the country.

Components of an Electric Vehicle

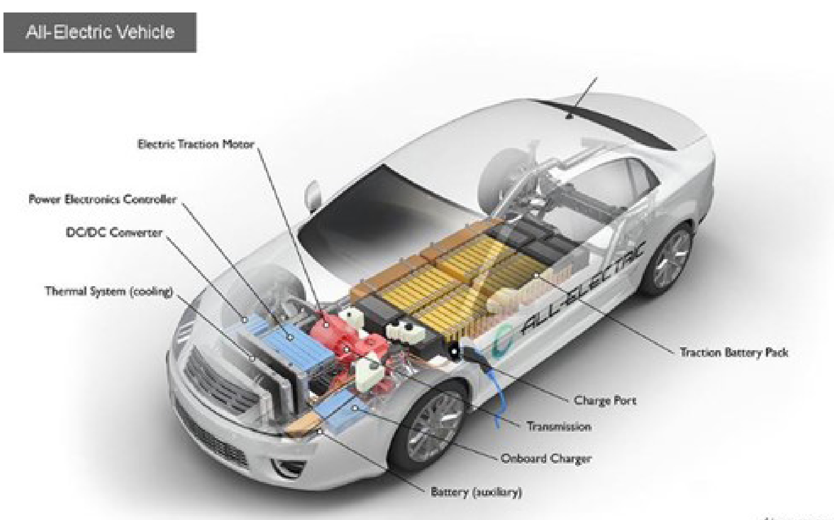


Figure 1. Key Components of an Electric Vehicle

Traction batteries are the largest and most expensive part of an electric vehicle, though their prices are coming down – and their performance is going up – every year. But the battery doesn't work alone. Under the hood, EVs rely on a traction motor to propel the vehicle, a DC/DC converter to supply the correct levels of power to various components, a thermal cooling system to keep power electronics from overheating, and an onboard charger with communications capability that is critical to the future of EV integration with the grid.

A light-duty car consumes about 0.35 kWh to drive a mile, while a medium-duty delivery truck consumes around four times as much power (1.4 kWh/mile). A heavy-duty big rig requires nearly double that again at 2.5 kWh/mile.

The Right Charger for the Right Job

Several options are available for charging depending on the consumer's needs, and knowing those needs – vehicle class, utilization, dwell times – are critical to selecting the right charging infrastructure and anticipating the demand on the grid.

- **Alternating current (AC) L1 & L2 (3-19 kW):** Ideal for light-duty vehicles with long dwell times, light operations, and duty cycles
- **Direct current fast charging (DCFC) (50-100 kW):** Light- and medium-duty vehicles with short to moderate dwell times and lower energy requirements. Some heavy-duty vehicles with larger packs and long dwell times
- **Extreme fast charging (XFC) (150-400 kW):** Light- and medium-duty vehicles with very short dwell times and high energy needs
- **Megawatt charging (MCS) (1-3.75 MW):** Heavy-duty vehicles with short dwell time and high energy demand

Going electric will mean drastic shifts for some businesses. For example, truck stops have operated with very low power demand for decades, needing just a few hundred kilowatts of electricity to keep the lights on and run the gas pumps. But with a bank of megawatt chargers and a few dozen DCFC, truck stops will now be drawing power at the equivalent of a cluster of high-rise complexes and a block of smaller office buildings all in one location, as much as 125MW of load. Such massive impact to the grid can't just be added, it must be integrated.

Vehicle Class	Charging Type	Power Range	Illustration	Power Equivilance to Common Applications
Light duty	Level 1 120 VAC	1.4 kW		Hairdryer
Light duty	Level 2 240 VAC	3 – 19 kW		Dryer, Water heater
Light and medium duty	DCFC & XFC	50 - 400 kW		Small Office Bldg.
Heavy duty	High Power Charging	200kW – 3.75 MW		High Rise/ Retail mega-center

Figure 2. EV Charging Systems, Ratings, and Power Equivalence

Considerations for Different Charging Types

Another consideration for charging stations is the fact that there's no universal plug that works for all vehicles. Different charging connectors are available depending on the make of the car or the charger power level.

Diagram	Connector Type	Maximum Output Power	Application Notes
	SAE J1772	19.2 kW AC	Used for Level 1 and Level 2 charging in North America. Commonly found on home, workplace, and public chargers.
	CCS	450 kW DC	Used for DC fast charging most vehicle models in North America. Generally installed at public chargers.
	CHAdeMO	400 kW DC	Used for DC fast charging select vehicles models in North America. Generally installed at public chargers.
	Tesla	22 kW AC 250 kW DC	Non-standardized proprietary connector used for both AC and DC fast charging for Tesla models only.
	J3068	166 kW AC 450 kW DC	Standard for both AC and DC charging utilizing the IEC 61851 'type 2' connector for North America three-phase charging
	SAE J2954	22 kW light-duty 200 kW heavy duty	Wireless power transfer. Standard for MD/HD vehicles is under development.
	SAE J3105	>1 MW	Automated connection device to charge MD/HD vehicles. Variants include pantograph up or down and pin-and-socket.
	Chaoji	900 kW DC	Conductive charging for sub-MW charging of LD/MD/HD vehicles in Asia. Standard is under development.
	CharIN MCS	3.75 MW DC	Conductive MW-level charging for MD/HD vehicles. Standard is under development.

Figure 3. Electric Vehicle Charging Connectors

Residential chargers are predominately AC L1 or L2 chargers, which is ideal for controlled or intelligently managed charging. Grid operators can count on loads being relatively predictable, and they can delay or change power levels to shift load (or the amount of electricity required) according to the conditions of the grid at the time.

Public charging poses a different challenge. Someone charging on the go wants to plug in and move along as soon as possible, resulting in higher loads to accommodate DCFC or XFC charging. Similarly, medium- and heavy-duty will require greater loads, but they may be able to be managed in some cases. At depots, trucks that have long, overnight dwell times can use DCFC or even L2 to be ready for work the following day.

Travel centers, on the other hand, will require megawatt charging to quickly get large trucks back on the road. Even truckers who plug in to charge for several hours while they sleep will require at least DCFC for their heavy-duty rigs to be ready to get back on the road. Such demands will require innovative ideas to minimize the impact on the grid through distributed energy resources (DERs), such as on-site storage and generation from wind and solar.

Smart Charge Management (SCM) allows grid operators to avoid spikes and smooth the demand curve of EV charging through communication between EVs and the grid. Today, SCM is basically just turning on, turning off, or controlling the EV charge rate based on real-time grid conditions. But in some cases, vehicles and the grid can exchange information regarding vehicle status, charging energy required and available – or more simply, when, how much, and even where to charge. However, not all vehicles have this ability to communicate, and some use proprietary communication software. SCM will require standardization to fully realize its benefits.

Anticipating Future Energy Needs

Meeting the coming demand of millions of EVs may seem daunting, but this sort of expansion is not unprecedented. The most ambitious scenarios anticipate the need for 30 TW of new generation capacity by 2030. The United States regularly exceeded that level of growth every five-year period from 1955 to 2009, with technological advancements of the time sometimes demanding as much as 95 TWh of new generation.

In the past decade, the need for new generation has fallen off, but that is largely due to increased efficiency of new technologies and buildings, the use of DERs, and advancements in grid management. Generating the power needed to electrify transportation is not an insurmountable challenge.

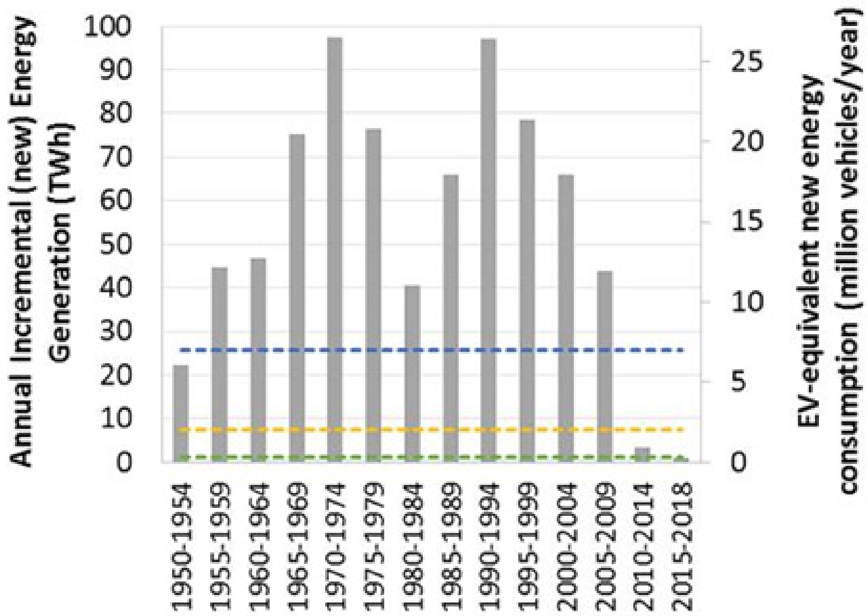


Figure 4. Historical data showing U.S. annual incremental (new) energy generation over time, averaged in 5-year increments

However, generation is not the only challenge. The power must also be delivered to the vehicle. Many transmission and distribution systems in America have not been upgraded in decades, and others that have didn't need to adapt to much higher demand than they faced when they were first established. Further assessment of the grid is needed for EVs at scale. Both a dense urban area and a distant rural one can face similar challenges managing charging loads on legacy infrastructure – transmission constraints, thermal overloading, reaching grid assets' rated capacity – if several EVs are suddenly added. Therefore, a planning for increasing EVs needs to be a team effort, bringing together metropolitan planners, utility planners, charging network operator, utility customers, fleet operators, vehicle dealers, and more.

Thinking About the Future

Elements to futureproof a charging station can include adding ports, upgrading to higher power, installing wireless charging, and integrating on-site storage and renewables. Technological advances will demand upgrades, so it is important to try to anticipate them. Often, the most expensive part of such upgrades isn't the new equipment, but rather tearing up concrete and digging trenches. Running conduit large enough to feed more wires in the future is an example of a simple measure that can be taken now to save money in the future.

Establishing codes and standards for EV charging infrastructure will also be important for planning for the future. Currently, multiple standards development organizations cover different components of the EV ecosystem – the vehicle, the charger, and grid equipment. Standards harmonization, along with other considerations like cybersecurity and data sharing – both crucial to SCM – or station architecture, raise questions and require discussion.

The electrification of transportation poses many challenges, but these can be faced and overcome with information, coordination, and innovation.