Electric Vehicles: Outlook and Implications for Electric Cooperatives

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Overview

Battery technology continues to revolutionize the utility and automobile industries. For electric cooperatives, the growth of electric vehicles (EVs)—whether plug-in hybrids (PHEV) that rely on the combination of an internal combustion engine and rechargeable batteries for propulsion or all-electric (battery-only) models (BEVs)—will impact utility operations both in terms of electricity sales and accommodating an emerging demand for electric charging stations.

EV batteries (16 kWh and larger) are generally fully charged after 8 to 12 hours when connected to a regular 120-V outlet (Level 1 charging, up to 16 A) or more quickly (four hours) using a Level 2 (240 V, usually around 30 A) charging station. Fast-charging stations using AC current (Level 3, 240 V, drawing up to 96 kW) and high-speed DC chargers (at 480 V DC and up to 90 kW) can replenish fully depleted EV battery packs to 80 percent strength in approximately 30 minutes. Fast-charging stations are being deployed at public locations (e.g., airports, shopping centers and highway truck stops) around the country now to address the growing demand for EVs.

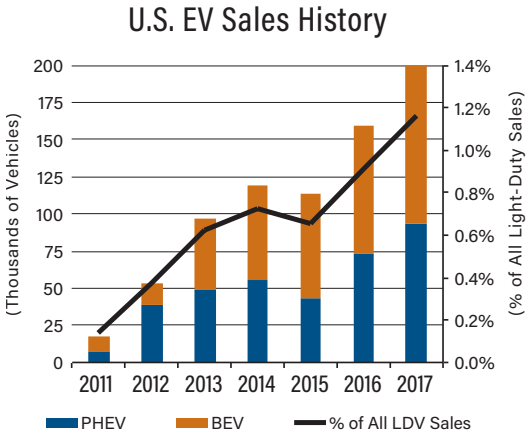
At present, the U.S. EV market is driven partly by early adopters and partly by financial and tax subsidies that offset higher initial costs. EVs are presently constrained by the limited number of affordable models and their restricted driving range. Long term, as lower priced and more diverse models are introduced and driving ranges improve, the number of EVs should rise considerably.

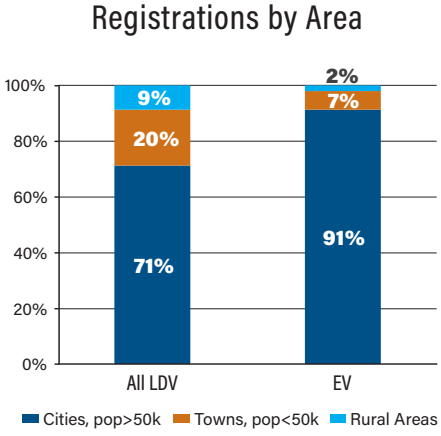
A Windshield Glance at the EV Market

In 2017, 1.2 million EVs (amounting to only 1.3 percent of the total auto market) were sold worldwide. Within the United States, 200,000 EVs were purchased—reflecting just 1 percent of all light-duty vehicles (LDVs) sold. Higher costs for EVs, a limited number of models, fledgling charging infrastructure and constrained range between charges (most can travel less than 120 miles) have all contributed to slow adoption rates so far. Not surprisingly, U.S. EV ownership remains heavily concentrated in urban areas *(see chart on page 2)*.

The U.S. EV market receives an assist from state policy mandates and incentives. At least 10 states—California, Connecticut, Maine, Maryland, Massachusetts, New Jersey, New York, Oregon, Rhode Island and Vermont—have established zero-emissions vehicle targets, which on average set 15.4 percent of new car purchases being EVs by 2025. Other states are considering adopting similar policies.

In addition, a federal EV tax credit (ranging from $2,500 to $7,500 to the first 200,000 EVs manufactured and sold by each automaker) along with state tax breaks up to $3,000 have helped boost EV sales. EV owners have also tapped into various subsidies/grants available from utilities and other state agencies for installing home charging stations. On top of this, lower sales taxes and auto registration fees, access to high-occupancy lanes on highways, designated parking spaces and mandated time-of-use rates to reward off-peak charging have all helped spur EV traffic.





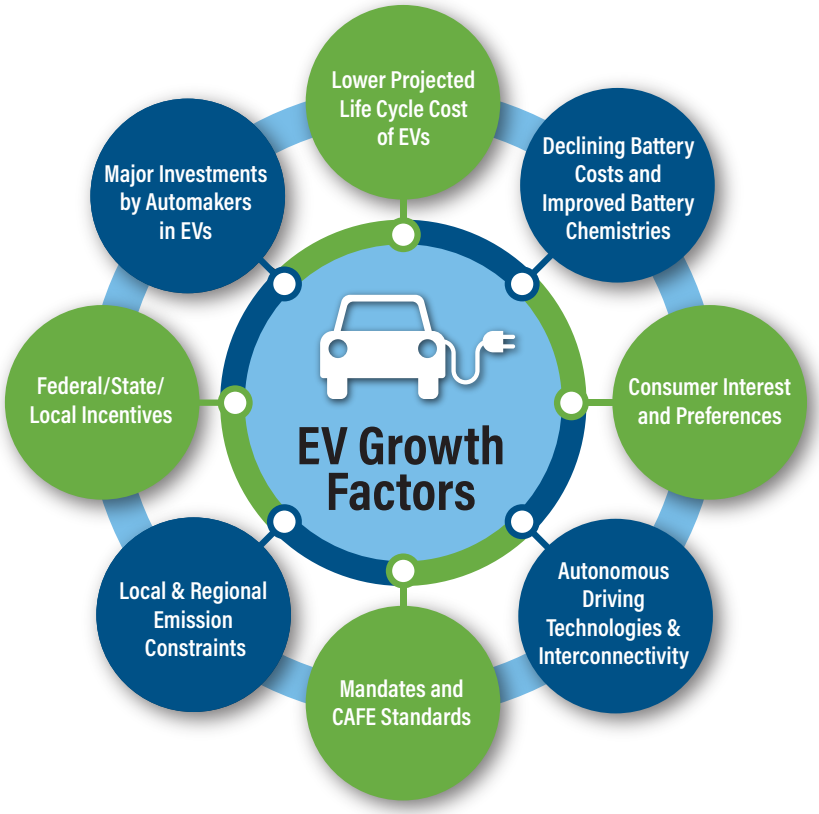
Sources: U.S. Department of Energy Alternative Fuels Data Center; insideevs.com; U.S. Bureau of Economic Analysis; U.S. Department of Energy Vehicle Technologies Office.

EV Market Projections

Adoption of EVs worldwide should climb rapidly in coming decades, following the 40 percent-plus annual growth rate experienced since 2010. In the United States, EVs recorded 20 percent compound annual growth from 2013 to 2017.

Significant EV expansion depends on a number of key factors, all of which are expected to materialize in the next seven to 10 years. Key among them are anticipated price parity of EVs with internal combustion engine cars (ICEs), wider deployment of charging infrastructure, broader range of EV models offered, decline in prices fueled by falling battery costs and improvement in EV driving range on a full charge *(see graphic for additional factors driving the growth of EVs).*

U.S. and Worldwide Drivers of EV Growth



A recent report from the Edison Electric Institute and the Edison Foundation Institute for Electric Innovation predicts a major boom in domestic EV sales over the next several years. The two groups forecast that more than 7 million EVs will hit the road by 2025, resulting in 3 percent of the 258 million LDVs that are expected to be on U.S. roads at that time.

Potential Impact of EVs on Cooperative Electricity Sales

Vehicle electrification represents a new load-growth opportunity for electric cooperatives. In recent years, conservation measures, appliance efficiency standards and energy efficiency upgrades have all contributed to dampen electric sales growth. According to data from the U.S. Energy Information Administration, retail electricity sales over the 10-year period between 2008 and 2017 declined by 1.4 percent. In this environment, higher kilowatt-hour sales from EVs are a welcome development for electric cooperatives.

A typical household in an electric cooperative's service territory that charges an EV at home will see a 20 percent to 33 percent increase in annual electricity consumption. This carries particular importance because the residential sector accounts for around 60-plus percent of typical cooperative sales and revenue. If 10 percent of residential consumers in a typical electric cooperative were to purchase an EV, that would account for 2 percent of annual electricity sales.

CFC has estimated how EVs will affect aggregate cooperative electricity sales based on conservative assumptions and the expectation that rural residents will adopt EVs at a much slower rate than folks living in cities, exurbs and suburbs (see chart below).

In the base case, the total number of EVs on U.S. roads should reach 15 million by 2030 (5 percent of total) and rural communities will maintain a 4 percent share, double the existing total. Electric sales growth in cooperative service territories nationwide from EVs will run approximately 0.5 percent (relative to 2016) by 2030.

Cooperative Demand from EVs

Year	Number of Rural Area EVs	Potential Increase in Co-op Electricity Sales
2030	480,000	0.4%
2050	1.2 million	10.4%

Source: CFC

Sometime between 2040 and 2050, approximately 150 million EVs are projected to be operating on U.S. roads. If rural areas experience a proportional EV ownership share—around 8 percent to 10 percent—then electric cooperative sales of electricity to serve EVs could increase 10 percent to 13 percent relative to 2016.

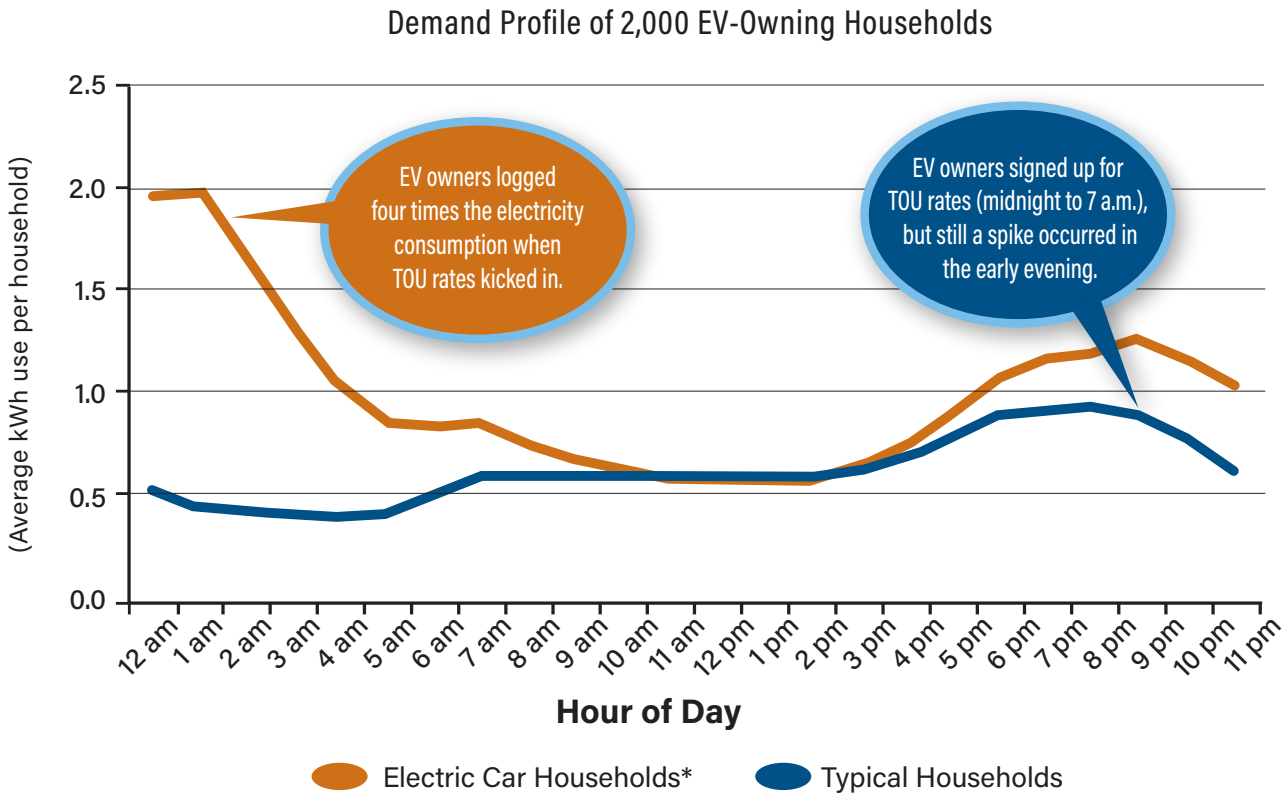
It should be noted that these estimates constitute the aggregate effect on the electric cooperative sector as a whole. Individual systems could experience substantially higher or lower impacts. Cooperatives will be well served by assessing their individual situations and preparing for developments.

Electric Cooperative Operational Considerations Stemming from EVs

Kilowatt-hour sales growth prospects arising from EVs present electric cooperatives with a number of grid design and operational challenges. EVs will require cooperatives to manage charging loads effectively while investing in additional distribution infrastructure, charging infrastructure and smart-grid capabilities to meter and control EV charging loads.

EVs require a relatively large amount of capacity during charging periods—studies have shown that most EV owners charge their vehicles at home and during nighttime hours. Unmanaged charging exposes cooperatives to damaging load spikes that can stress distribution systems and adversely spike wholesale power costs, especially if several chargers are accessed simultaneously by consumers. The typical EV can require a power draw of up to 20 kW for a Level 2 charging event, equivalent to the peak power requirement of three or four mid-sized homes. Transformer and circuit overloads, both on the primary and secondary sides of the meter, are also possible if charging loads are not properly handled.

A variety of strategies to address these issues include requiring all charging station installations to be pre-notified/cleared, developing or enhancing load-control capabilities to cover charging stations, establishing pricing mechanisms such as time-of-use (TOU) rates to encourage off-peak charging, and considering future EV charging loads in distribution planning (including strategically located energy-storage units and load-handling equipment).



**Electric car households defined as customers enrolled in a nighttime charging plan.*

A demand profile of 2,000 EV-owning households (see chart) illustrates a massive spike in electricity consumption from EV owners beginning at midnight, around four times the typical household level. This corresponds to the beginning of TOU rates offering discounted electricity between midnight and 7 a.m., which all EV owners in this analysis were signed up for.

One solution entails adopting managed charging, which is similar to traditional demand-response programs in that signals are sent to a receiver on the charging station to remotely control when batteries can be "refueled." Depending on the needs of the grid, electric cooperatives can increase or reduce charging rates or curtail the process entirely.

Electric cooperatives can deploy also battery energy storage systems to meet localized, anticipated demand spikes to protect distribution networks as well as to address charging load as it materializes.

Charging Opportunities

Range anxiety—the fear of exhausting batteries, which limits driving distance, both real and perceived—remains a major barrier to wider EV adoption. Range can be expanded by increasing EV battery size (which raises vehicle costs) or by a buildout of Level 2 and Level 3 charging infrastructure.

While current research indicates that around 85 percent of EV charging occurs at home, a substantial buildout of non-residential charging facilities will be critical to realizing broader EV adoption, particularly in rural areas where driving distances tend to be longer. Charging facilities at workplaces, along highways and at public spaces will promote EV ownership.

Cooperatives can capitalize on the need for charging networks to create new revenue streams as well as partnering with public and private entities or engaging with third parties to develop charging infrastructure and avoid investment risks. Business opportunities to participate in charging infrastructure development include owning and managing charging stations or leasing them to provide electric service for third party-run charging stations.

Chart to right illustrates the range of potential actions and initiatives electric cooperatives could consider for implementation as EV adoption progresses in their service areas.

EV Adoption Maturity Timeline

	KEY ACTIONS
Be Informed	▪ Monitor developments and assess trends. ▪ Predict areas of likely EV adoption; anticipate charging demands. ▪ Incorporate EVs into business planning and load forecasting. ▪ Implement systems to be up-to-date on the EV activity in service area. ▪ Assess distribution system to handle potential EV loads.
Engage Members	▪ Educate members on EVs, organize demos. ▪ Educate members on charging equipment, options. ▪ Offer and explain EV rate plans (TOU rates). ▪ Offer incentives for charging installations. ▪ Finance or lease EV charging equipment. ▪ Develop and roll out managed charging and load-control programs.
Charging Infrastructure	▪ Evaluate business opportunities and develop business strategy—own, operate and maintain versus partnerships. ▪ Consider EV fleet and "pilot" charging stations at strategic and visible locations. ▪ Partner with third parties to develop charging infrastructure. ▪ Deploy public charging in service area, on highways, etc. ▪ Standardize charging equipment for deployment.

Wrap-Up

Despite being a small part of the current U.S. auto market, industry experts are predicting that EVs will become a major force within 10 to 20 years due to a convergence of environmental concerns, declining costs for batteries, major capital commitment in EV and related production facilities by large auto manufacturers and expanding consumer interest. As EVs become price competitive with internal-combustion engines and range-anxiety issues are addressed, electric cooperatives will see new demand for electricity both in higher load and revenue growth.

Cooperatives must stay proactive as this load builds through measured infrastructure upgrades, consumer education and cost-effective incentives.

CFC believes that ongoing evolution of battery technologies and the EV industry merits close monitoring to gauge the impact on electric cooperatives. Topics currently being monitored by CFC staff include rate design for EV charging stations, trends in battery cost and performance, state of the battery supply chain and lessons learned from electric cooperative implementation of EV-related initiatives. CFC plans to present results of these analyses in forthcoming periodic publications.