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Garage of the Future: Supporting America's New Re-Fueling Station

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Inside…

Key Points:

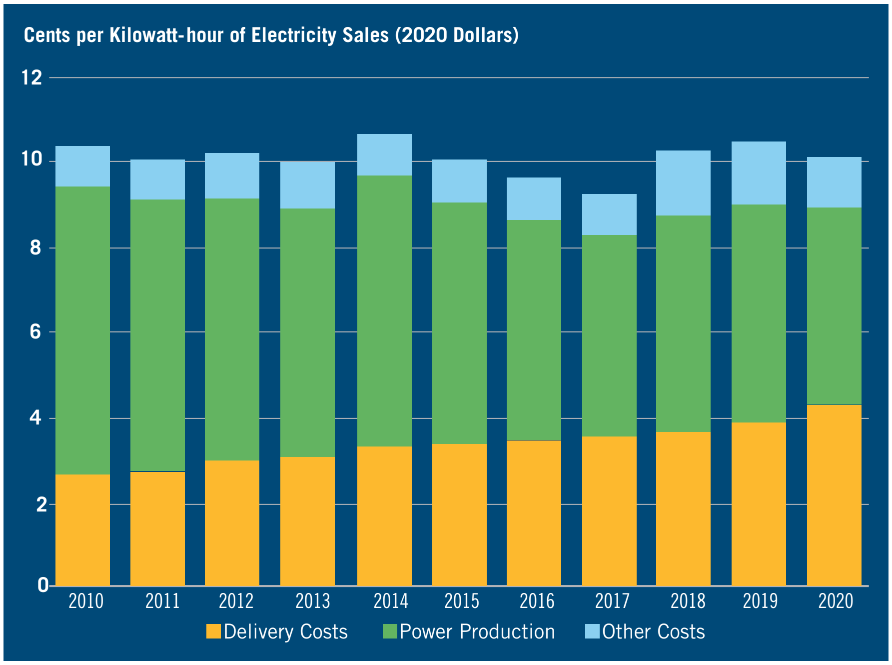
- While U.S. electricity generation can adequately support the transition to electric vehicles (EVs), it is far from clear whether the distribution system is equally prepared to deliver 30% more electricity. Widespread uncontrolled charging, whether from residential or commercial members, could inevitably overwhelm local systems.
- As transportation turns electric, co-ops' load flexibility will enable them to vary EV charging load up or down, balance load, and maintain system stability. The challenge, of course, is for electric cooperatives to figure out when member drivers will charge their EVs and how to influence that point of charge.
- Most EV charging takes place in home garages, and will continue to. However, thoughtful planning on the placement of public chargers could be an economic boost to local business, keeping an even greater share of consumer spending in the community.
- The additional revenue that electric cooperatives earn from community charging will eventually offset the increased investment needed for new and upgraded distribution assets. However, this investment is needed now, which puts electric cooperatives under pressure to manage growth as more members ultimately adopt EVs.

Introduction

The shift toward electric transportation will take more than just a dealership sale. Our research and discussions with electric cooperatives last year[1] revealed a need for cooperation amongst co-ops and, more broadly, collaboration along the entire supply chain. Further, the need is growing for targeted investment in new and upgraded distribution assets to handle high-charging demand for members in certain locations and time periods.

Drivers' embrace of EVs means that electric cooperatives, car dealerships, convenience stores, homebuilders, electricians and other community stakeholders need to take note and prepare. In this report, we examine the framework for electric co-op preparation. In a follow-up report, we will review the core co-op program elements that support member adoption.

EXHIBIT 1: Major U.S. Utilities Annual Spending
By Spending Category (2010-2020)



Source: U.S. Energy Information Administration

Distribution: Reinforcing the 'Point of Charge' is Really the Point

U.S. retail electricity sales have stagnated over the past two decades. After a century of growth, it slowed in the late 1990s as energy efficiency grew, U.S. manufacturing fell, and customer-owned generation increased. Electricity sales growth then abruptly stopped in the early 2000s. Now, electrification is poised to accelerate growth over the next two decades or more[2] as the marketplace embraces a future based on electric vehicles.

As member adoption picks up, co-ops need to determine just how much power supply will be required to charge a growing fleet of EVs and most importantly, where – and when – that charge will occur. Studies measuring the impact of mass EV deployment on the bulk U.S. electric power system demonstrate that recent trends in investment ensure that the country's generation portfolio will be adequate to support the country's transition.[3] It is far from clear whether the U.S. distribution system or the points of charge are equally prepared to deliver 30% more electricity.[4]

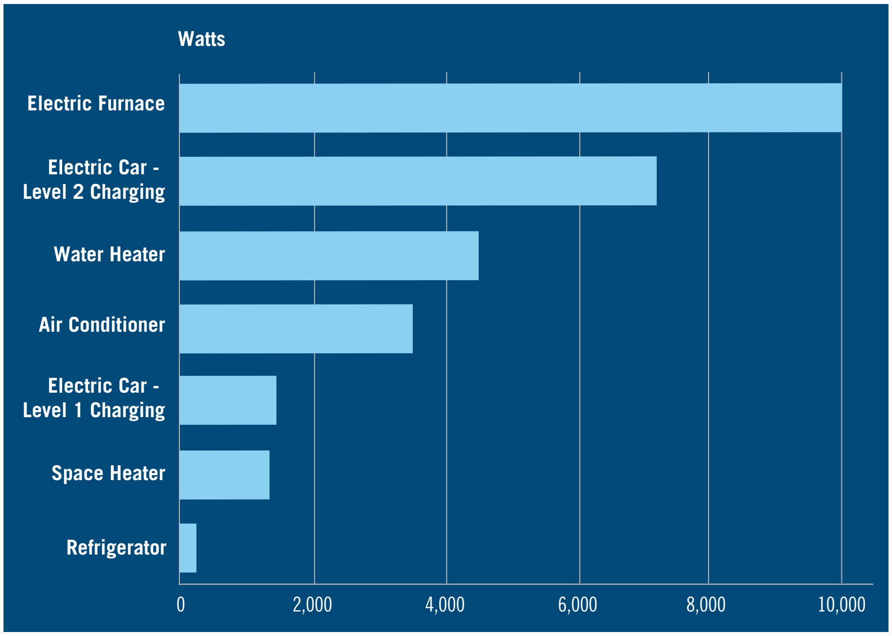
Generally speaking, local resources will increasingly be relied upon to meet electrification-driven growth. The challenge is that the long-term trend of flat electricity sales and the preference to invest in generation, possibly at the expense of delivery, has created a game of musical chairs. Aging, higher-cost generating assets have largely been swapped out to deliver the same amount of electricity, along the same paths to the same type of consumers.

And, while spending between generation and delivery is now considerably more balanced compared to a decade earlier, still greater attention will have to be paid to the 'last mile' in order to meet future requirements.[5] According to EIA, in 2010 major utilities spent 2.6 cents/kWh on electricity delivery (in 2020 dollars). By comparison, spending on delivery was 65% higher in 2020 at 4.3 cents/kWh. Conversely, utility spending on power production decreased from 6.8 cents/kWh in 2010 to 4.6 cents/kWh in 2020[6] *(Exhibit 1).*

Regulation, planning, and investment might prove far less than straight forward than the previous decade of mostly adding utility-scale generation. "Pain points" encountered ahead at the distribution level will depend on the existing system design, driver makeup, and the location and type of charging required.

There is also an obvious chicken and egg problem on making necessary grid investment too far ahead of member adoption. Costs – and therefore pressure on rates – will likely magnify as EV adoption ramps up. As we considered a generalized framework for co-op EV planning, our industry catchphrase comes to mind – if you know one co-op, then you know one co-op. Yet, we now have a sufficient number of EVs on the road and a concentration of charging in certain regions that can offer important insights for distribution planning.

EXHIBIT 2: Power Draw for a Typical Appliance



Source: Department of Energy

Note: L1 (Level 1 charging) is typically 1.4kW / 12Amp / 120V. L2 (Level 2 charging) is typically 7.2kW / 30 Amp / 240V at (240v).

Importance of Knowing the Where and When of Charging

The greatest opportunities for electricity demand growth from EV adoption is at-home car charging.[7] According to the U.S. Department of Energy, over 80% of EV charging today happens at home, where EV owners have set up their own chargers. Other than heating and cooling equipment, EV charging will draw the most power in a home *(Exhibit 2),* likely resulting in a 13% to 40% bump in household load with EV adoption.[8]

The balance of charging away from home will then be met in a commercial space, likely alongside other charging vehicles. More limited studies available on commercial consumers, such as workplace charging and retail outlets, show the potential of achieving even greater load densities given the aggregation of charging. A National Renewable Energy Laboratory (NREL) study released last year found that "an electric vehicle station has the potential to dwarf a big box building's power demand if behind the same meter, increasing monthly peak power demand at the site by over 250%."[9]

Either way, widespread uncontrolled charging of this magnitude, whether from residential or commercial members, could inevitably overwhelm local systems. The challenge, of course, is for electric cooperatives to figure out when member drivers will charge their EVs and how to influence that point of charge. Acknowledging the possibility that charging behavior will evolve as EV adoption grows and charging opportunities expand, we still believe that recent studies can shed light on the potential magnitude and shape of load growth that electric co-ops will encounter.

Sandia National Laboratories published a report last year simulating two EV charging scenarios – an at home-dominant and a work-dominant scenario – with the following findings:[10]

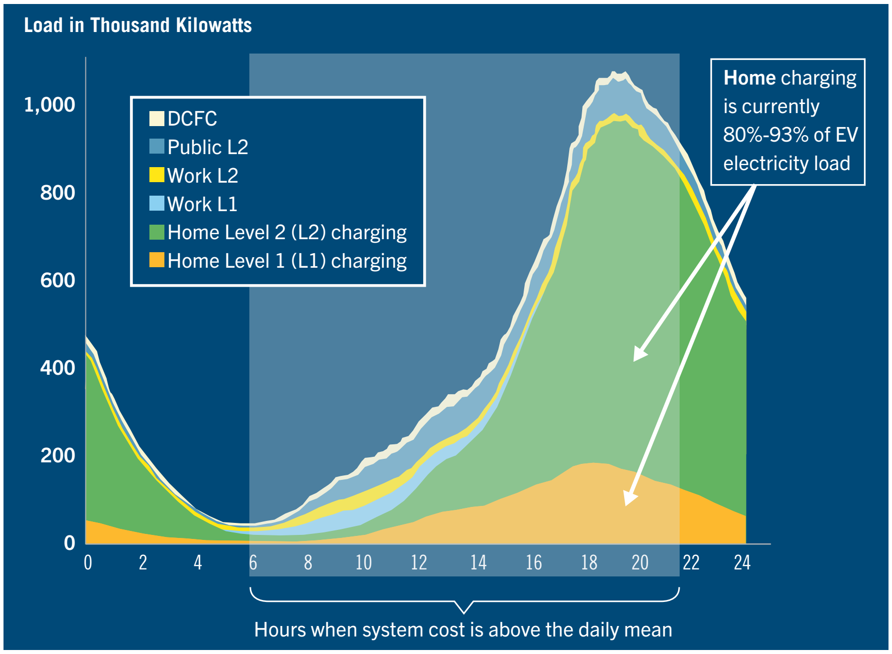
- The home-dominant case added very little load during the middle of the day, but increased the load by a notable amount in the evening when the residential, commercial, and mixed use feeders were already at peak load without EVs. This peak load, which often occurred around hour 20 (8 p.m.), increased by 11.7% and 9.8% on average.
- Under the work-dominant charging scenario, each of the feeders experienced an increase in EV loads both during the middle of the day and during the evening peak. The commercial feeder had a larger increase in peak load, as the large amount of work charging created a new midday peak – peak load increased by 16.9% and shifted to around 10 a.m.

Similar studies undertaken by NREL for Colorado reinforce Sandia Lab's guidance of a residential or home-dominant load shape, with an evening peak and significant day-time elevation, caused by add-on commercial charge loads[11] *(Exhibit 3).*

Taken together, this work provides a more complete picture of the possible "where and when" of community-based charging and what member behaviors might systematically increase or decrease a co-op's cost of service. The good news is that the research indicates that there will be a good deal of load flexibility – in being able to vary charging load up or down in the evening, to balance load and maintain system stability. But this all depends on member buy-in and engagement.

Pricing signals such as time-of-use rates could influence charging behavior and shift loads during periods with low system cost. Offering an EV-specific electric rate to engage members – both residential and commercial – could encourage such load shifting.[12] For at home charging, the key will be to spread out the charging overnight. And, while there is possibly less flexibility with at-work charging and still diminishing options for retail outlets, pilot projects that involve sending intra-day price signals to commercial establishments might expand the field of load flexibility options.

EXHIBIT 3: EV Load by Hour



Source: National Renewable Energy Lab (NREL), March 22, 2019, page 10. Electric Vehicle Charging Implications for Utility Ratemaking in Colorado: Background Research for Colorado Public Utilities Commission.

Note: DCFC (Direct-Current Fast Charging) ranges are 36kW / 75Amp / 480V (3-phase AC input) to 350 kW. Typically 50kW.

Reimagining Route 66: Coops Collaborate on EV Charging to Reinvigorate Rural America

Before thousands of gas stations dotted the public highways, U.S. motorists purchased gasoline from hardware and general stores, and even pharmacies.[13] These locally-owned businesses had existing relationships with oil refineries[14] and a loyal following of community drivers, uniquely positioning them to play a role in America's early refueling era.

With drivers now transitioning away from gas-fueled cars and toward EVs, another "buy local" movement appears to be in the cards. While most charging will take place in home garages, thoughtful planning on the placement of public chargers could provide a boost to local business, keeping an even greater share of consumer spending in the community.

Studies have shown knock-on retail opportunities when drivers spend extended time at the "charge pump." Compared to the two to three minutes it takes to refuel at a gas station, EV re-charging takes at least 15 to 30 minutes, expanding retail opportunities for host outlets.[15,16] It could even be argued that there is a critical synergistic relationship between shops and chargers that might be key for achieving sustainable and more supportable growth of EVs. The combination of additional dwell-time spending and charging fees may create the sort of real returns that could enable charging infrastructure to keep pace with EV adoption.[17]

Sources Used

[1] "EV Scenario Analysis Workshop Series", CoBank Beacon Strategic Planning and Facilitations Group, 2021.

[2] Increased demand for electricity will likely overshadow all other energy resources this decade and next, "World Energy Outlook 2020, Outlook for electricity – A new path is lit?", International Energy Agency (IEA), October 2020.

[3] One study, in particular, pointed out that in the latter half of the 20th century there were periods of demand growth equivalent to as many as 25 million new light duty EVs showing up on the road (or about 150% of all new U.S. vehicle sales). "Summary Report on EVs at Scale and the U.S. Electric Power System", U.S. DRIVE Grid Integration Technical Team and Integrated Systems Analysis Technical Team, November 2019.

[4] "Electrification Futures Study: Scenarios of Power System Evolution and Infrastructure Development for the United States", NREL, January 2021.

[5] "The Costs of Revving Up the Grid for Electric Vehicles", Boston Consulting Group, December 2019.

[6] "Major U.S. utilities spending more on electricity delivery, less on power production", EIA, November 2021.

[7] Space heating and cooling accounts for more than half of energy use in homes. Most electric vehicles charging at home on a 240-volt level 2 charger will draw about 7,200 watts or less. For comparison, a typical electric furnace draws about 10,000 watts and a water heater uses 4,500 watts. "Electric Vehicle Charging at Home Typically Draws Less Than Half the Power of an Electric Furnace", DOE, September 2017.

[8] "Will Electric Vehicles Take Charge in Co-op Nation?", NRECA, February 2018.

[9] "Impact of electric vehicle charging on the power demand of retail buildings", NREL, August 2021.

[10] "Uncontrolled Electric Vehicle Charging Impacts on Distribution Electric Power Systems with Primarily Residential, Commercial or Industrial Loads", Sandia National Laboratories, March 2021.

[11] "Electric Vehicle Charging Implications for Utility Ratemaking in Colorado", NREL, March 2019.

[12] A price differential of at least 2:1 peak to off-peak prices appears to be effective at shifting majority of load. Ibid 10.

[13] We recently explored the important relationship between retail outlets and electric cooperatives with CoBank's Power Plays podcast series, featuring Nate Boettcher, CEO of Pierce Pepin Cooperative Services, "Reimagining Route 66: Coops Collaborate on EV Charging to Reinvigorate Rural America."

[14] Establishing a critical supply-chain relationship through the sale of kerosene used for lighting.

[15] "Retrofitting Convenience Stores for Electric Vehicle Charging", Petroleum Equipment Institute (PEI), NACS and the Fuels Institute, October 2021.

[16] EV Charging Stations for Retail Businesses. EVgo 2021.

[17] "Retail co-location may prove key to sustainable funding for EV charging, panel finds", Utility Dive, May 2020.

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