Smart Charging: The Future of Residential Electric Vehicle Charging

*Analysis and recommendations for developing the next generation of EV charging*

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ABSTRACT:

This paper analyzes the impacts of projected increases in residential EV charger power levels and the potential for shifting EV charge cycles to optimal times. Higher power EV charging is imminent and has the potential to create higher EV charging loads at suboptimal times for electric grids, increasing the cost and GHG emission impacts of EV charging.

We created a simulation model using 92 homes and over 45 thousand charge cycles from our residential electricity consumption database in 2018-2019. Our analysis projects future EV charging load by simulating the actual charge cycles we observed in our database with higher power EV chargers. We then projected the EV charge load if charge cycles were shifted to different times of day using mechanisms such as demand response programs or time of use rates and evaluated the cost impacts.

Increasing the power level of the chargers in our sample increased the cost and variance of EV charging load. The largest impacts, however, came from shifting EV charge cycles to different times of day. Moving 35% of residential EV charging kWh leads to a 43% wholesale electric cost differential between the highest and lowest scenario outcomes. This difference grew to 60% in the ERCOT summer peak load season.

Utility pricing signals and smart charging technology offer promising solutions for unlocking the value of optimized EV charging at scale. We recommend time-variant rate options that incentivize fleet-wide optimized EV charging and deploying smart charging technologies, such as owner-operated programmable charging functions and direct charge control functions in conjunction with time-variant pricing signals. Our analysis shows that utilities, auto manufacturers, regulators, public interest organizations, and EV owners will need to work together to establish a new paradigm for residential EV charging that enables accelerated decarbonization of the transportation and electric sectors.