Electric Vehicles Are Driving Rates Down

June 2023 | Melissa Whited, Tyler Fitch, Jason Frost, Eric Borden, Courtney Lane, Ben Havumaki
Sarah Shenstone- Harris, and Elijah Sinclair

National Update

Electric vehicles (EVs) offer a key opportunity to reduce harmful emissions and save consumers money at the same time. EVs are responsible for far fewer greenhouse gases and local air pollutants than conventional vehicles[1] and become cleaner as more renewable electricity is added to the grid. In addition, EVs are generally much cheaper to operate than conventional vehicles.

EVs are growing as a share of the light-duty vehicle market. As of the March 2023, more than 3.3 million EVs have been sold in the United States alone.[2] Federal, state, and industry action to incentivize and increase the adoption of EVs promise to accelerate this transition.[3] The new electricity load and flexible demand represented by these vehicles has major implications for our future energy system and could increase total electricity use by 25 percent.[4] By charging during hours of the day when there is least demand on the grid, however, the EV transition could reduce energy costs for everyone.

Evaluating the impact of EVs on the road today can help us understand their effect on the grid and how they might shape the power system in the future. Accordingly, this analysis examines costs and revenues associated with EVs between 2011 and 2020 across the United States. **We observe that over the last decade, EV drivers across the United States have contributed approximately $1.7 billion more than associated costs, driving rates down for all customers.**

How Are EVs Affecting Electricity Rates?

Recent growth in EV adoption has raised the question of how EVs affect the electricity rates paid by all households, including those that do not own EVs.

This is an important equity question that should be analyzed when determining the role that electric utilities should play in supporting the transition to EVs. Answering this question requires comparing electric utility revenues from EV charging with utility costs associated with serving EV load. If the utility revenues from EVs exceed the utility system costs, then EV adoption can reduce electricity rates for all customers. Conversely, if the costs are greater than the revenues, non-EV owners could end up paying more for their electricity.

To address this question using real-world data, Synapse evaluated the utility system revenues and costs associated with EVs in investor-owned utility service territories across the United States. This analysis tracks revenues and costs associated with 1.7 million battery electric and plug-in hybrid EVs sold between 2011 and 2020.[5]

Specifically, we analyzed the electricity rates that EV owners pay compared to the marginal cost of providing that electricity (generation, transmission, and distribution costs) plus the expenditures associated with utility EV programs.

We gathered data from across the country to inform this analysis. While managed charging and time-of-use tariffs are becoming the norm across the country, we assume for the purposes of this analysis that most EVs are charging according to a non-managed shape, based on a 2017 US Department of Energy (DOE) study of EVs.[6] We use hourly marginal costs based on the California Public Utilities Commission's Avoided Cost Calculator.[7] We also use a database of EV program expenditures,[8] assuming that these investments will be paid off over 10 years.

Tracking EV Adoption Across the 50 States

In 2011, which was the first year of our analysis, just 16,000 EVs were on the road nation-wide. By 2020, EVs numbered at 1.7 million[9] – a 100-fold increase from 2011. Figure 1 shows cumulative EV adoption rates by region in the United States.

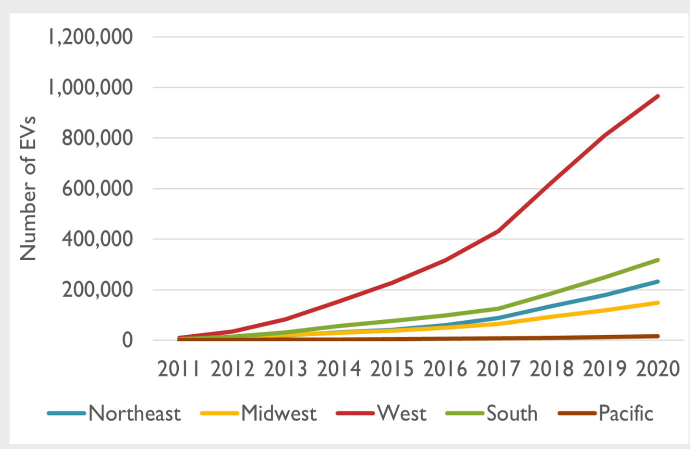

Figure 1. Cumulative EV Adoption in the United States, 2011-2020, by Region[10]

The Western region, anchored by California which counted almost 800,000 EVs alone in 2020, far outpaces the other regions of the United States. Nevertheless, EV adoption rates are accelerating nationwide, with BloombergNEF predicting that EV sales will represent more than half of all car sales by 2030.[11]

When Do EVs Typically Charge from the Grid?

EVs will pull their energy from the electricity grid, but when charging actually occurs defines the cost and carbon content of its power and the impacts on the grid overall. If vehicles charge when demand is already high and electricity is the most expensive, EVs could exacerbate grid impacts and costs. If they can take advantage of low overnight demand or plentiful solar power in the afternoon, however, they can improve the economic and environmental performance of the power system overall. For this analysis, we assume EVs charge according to a pattern developed by the US DOE in their 2017 *National Plug-In Electric Vehicle Infrastructure Analysis.*[12] This curve assumes that the majority of EVs are charged at home, most of which occurs in the early evening at the end of the workday. Figure 2, below, shows the DOE load curve used for EVs in this study (for all states except California and Arizona).[13] This curve corresponds with real-world data, representing charging patterns of EVs not taking service on time-of-use rates (which represents the vast majority of EVs on the road).

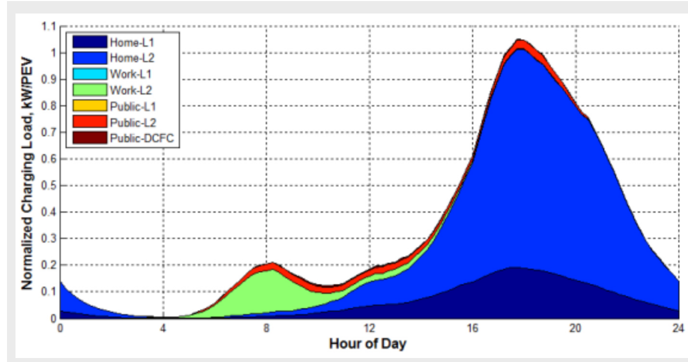

Figure 2. Typical EV Charging Curve, 2017 US DOE National Plug-In Electric Vehicle Infrastructure Analysis.

State Case Study: California and Time-of-Use Charging

Time-of-use tariffs affect the costs that consumers pay depending on when they use electricity, and they can incentivize consumers to use electricity when it is least expensive for everyone. We can already see the impact this has on EV charging based on data reported by California's largest investor-owned utilities. Figure 3, below, shows the projected daily charging curve for EVs on time-of-use tariffs in 2017 in Southern California Edison territory versus the DOE estimated national charging curve. The area shaded in red represents typical hours for "peak" usage across the country, when demand on the electricity is highest and energy is most expensive.

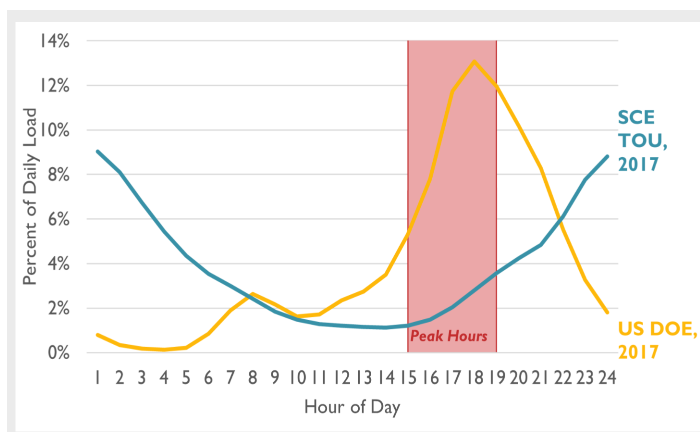

Figure 3. Typical Charging Curve versus System Peak Hours, US DOE 2017 versus Southern California Edison EV Charging on Time-of-Use Tariffs.

The price signals provided by the time-of-use tariff, combined with EV technology that allows for managed charging, shifts typical EV charging from times of peak use to overnight, when demand is typically low. These shifts reduce costs to EV owners and operators for charging their vehicles, while also more efficiently using electricity infrastructure and reducing costs for everyone.

How does EV charging impact overall electricity rates?

By comparing the revenues generated by EV charging to the utility's marginal cost to serve these EVs, we can construct a picture of whether EVs are creating more revenues than costs (driving costs for everyone down) or creating more costs than revenues (driving costs for everyone up).

The results of our analysis indicate that, across all regions in the United States, EVs have increased utility revenues more than they have increased utility costs, leading to downward pressure on electric rates for EV-owners and non-EV owners alike. Between 2011 and 2020, we estimate that EV drivers across the 50 states have contributed $1.7 billion more than associated costs (in 2020 dollars). Figure 4 shows the extent to which revenues from EVs outweigh the costs imposed for the period 2011-2020.[14]

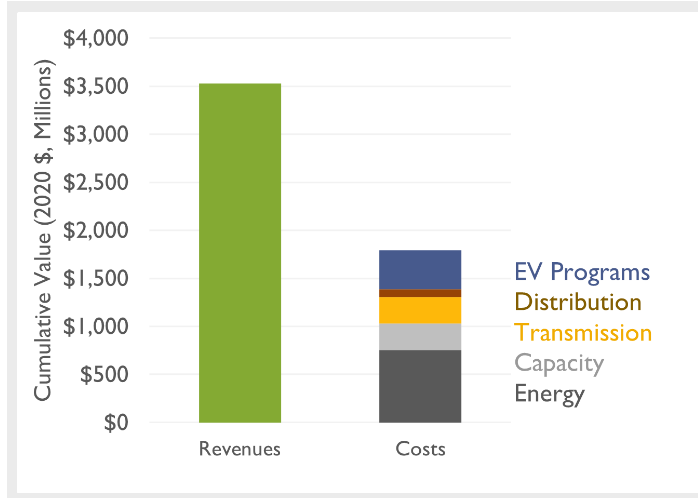

Figure 4. Total Revenues versus Total Costs of EV Charging across the United States, 2011-2020.

Figure 5 shows revenues versus costs by US region. The western region—anchored by California, which has the most EVs by far of any state—drives two-thirds of revenues and costs. Revenues outpace costs in every region.

A key reason why revenues from EVs outweigh the costs is that EV customers — particularly those on TOU rates — tend to charge during off-peak hours. By charging during off-peak hours, EVs impose minimal costs on the grid and help to utilize resources more efficiently. In fact, a report published in 2019 by Lawrence Berkeley National Laboratory, PG&E, and the Natural Resources Defense

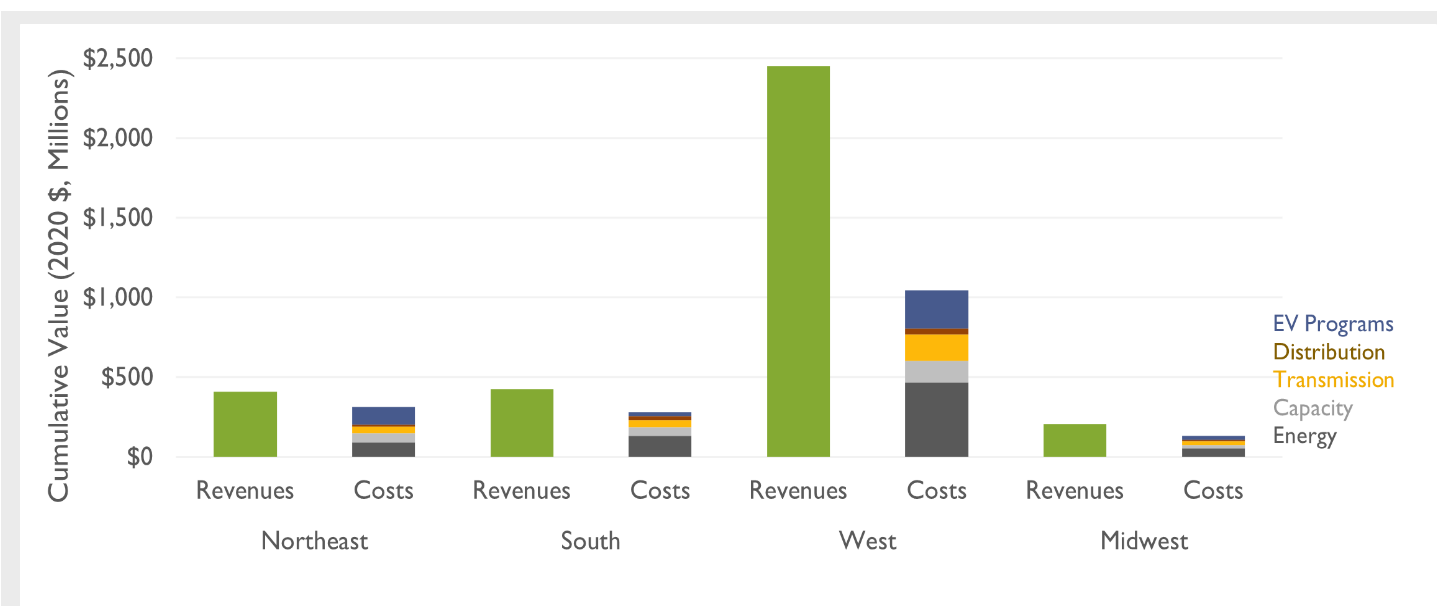

Figure 5. Total Revenues versus Total Costs of EV Charging across the United States by Region, 2011-2020.[15]

Council shows that shifting EV charging to off-peak times could allow the grid to accommodate all homes having EVs without upgrading most parts of the distribution system.[16]

Even in the service territories with the most EVs, the observed costs have been minor. For instance, in California where EV adoption has been markedly higher than other states, EV-related distribution upgrade costs appear minor compared to total distribution costs. Despite the fact EVs are often more concentrated in many neighborhoods and distribution circuits, California utilities collectively spent less than 0.03% of their total distribution-related expenses[17] on distribution system upgrades associated with residential EV adoption.[18]

EV Revenues Support EV-Enabling Investments

As EV adoption accelerates across states and use cases, state are investing in public charging infrastructure to support expanding EV fleets. These investments both support the fleet that exists today and enables its continued expansion.

EV investment varies wildly by state, with some states spending $1,000 per EV on the road today while others have not committed to any public spending. Our analysis shows however, that on a regional and national basis, revenues created by EV charging support both the costs to serve energy and public EV investments to date.

Revenues from EVs Can Help Fund EV Charging Infrastructure

EVs can provide substantial emissions reductions while also helping to reduce electricity rates for all customers by using the system more efficiently. Utilities can play an important role in ensuring that EVs benefit both EV drivers and non-EV drivers alike by encouraging EV customers to enroll in time-of-use rates and charge during off-peak periods. In addition, utility investments that facilitate the deployment of charging infrastructure can accelerate the EV market, growing the potential benefits from widespread EV adoption.

If done carefully, utility-funded investments can deliver benefits to all ratepayer in excess of their costs. Our analysis indicates that EV adoption in the US has already resulted in more electricity revenues than costs, and future growth in the EV market will lead to further increases in utility revenues. With TOU rates and targeted investments in charging infrastructure, EV adoption can reduce costs for both EV-drivers and other electric customers while reducing harmful emissions.

Endnotes

[1] Rocky Mountain Institute (2022). More EVs, Fewer Emissions. Available at: https://rmi.org/insight/more-evs-fewer-emissions.

[2] Alliance for Automotive Innovation (2023). Accessed May 18, 2023. Advanced Technology Vehicle Sales Dashboard. Data compiled using information provided by S&P Global Mobility and Hedges & Co. Last updated 3/3/2023. Available at https://www.autosinnovate.org/resources/electric-vehicle-sales-dashboard.

[3] See California's requirement that all vehicles sold by 2035 will be plug-in electric vehicles and General Motors' announcement that they will only sell zero-emissions vehicles by 2035.

[4] National Renewable Energy Laboratory (2022). Electrification Futures Study: Scenarios of Electric Technology Adoption and Power Consumption for the United States. Available at: https://www.nrel.gov/docs/fy18osti/71500.pdf.

[5] Atlas EV Hub. State EV Registration Data. Accessed September 2022. Available at: https://www.atlasevhub.com/materials/state-ev-registration-data/.

[6] United States Department of Energy (2017). National Plug-In Electric Vehicle Infrastructure Analysis, Available at: https://www.nrel.gov/docs/fy17osti/69031.pdf.

[7] Avoided Cost Calculator for Distributed Energy Resources (DER) (2022). Available at https://www.ethree.com/public_proceedings/energy-efficiency-calculator/.

[8] Atlas EV Hub. Electric Utility Filings. Accessed September 2022. Available at: https://www.atlasevhub.com/materials/electric-utility-filings/.

[9] Atlas EV Hub. State EV Registration Data. Accessed September 2022. Available at: https://www.atlasevhub.com/materials/state-ev-registration-data/.

[10] Regions based on US Census Regions. States in each region are as follows: Northeast: ME, NH, VT, MA, RI, CT, NY, PA, NJ; Midwest: OH, MI, IN, WI, IL, MN, IA, MO, ND, SD, NE, KS; South: MD, DE, DC, WV, VA, NC, SC, GA, FL, KY, TN, MS, AL, AR, LA, OK, TX; West: WA, OR, CA, NV, ID, MT, WY, CO, NM; Pacific: AK, HI

[11] Boudway, Ira (2022). More Than Half of US Car Sales Will Be Electric by 2030. Bloomberg. Available at: https://www.bloomberg.com/news/articles/2022-09-20/more-than-half-of-us-car-sales-will-be-electric-by-2030.

[12] United States Department of Energy (2017). National Plug-In Electric Vehicle Infrastructure Analysis, Available at: https://www.nrel.gov/docs/fy17osti/69031.pdf.

[13] EV load curves for California and Arizona are from Southern California Edison 2017 hourly usage data. To determine the EV-specific load profile, we subtracted non-EV residential loads from the EV and home combined residential loads. We assumed EVs were on non-TOU rates in California and TOU rates in Arizona (the majority of residential customers take service under TOU rates in Arizona). Data from 2017 Joint IOU Load Research Report, Public Utilities Commission of the State of California, Rulemaking 13-11-007. Available at: https://www.sdge.com/sites/default/files/regulatory/Joint%20IOU%20EV%20Load%20Research%20Report.pdf.

[14] This assumes that program costs are depreciated over 10 years.

[15] The "Pacific" region, representing 1 percent of total national revenues, was omitted from this graph for legibility.

[16] Institute for Electrical and Electronics Engineers. Coignard et al (2019). Will Electric Vehicles Drive Distribution Grid Upgrades?: The Case of California" Available at https://ieeexplore.ieee.org/document/8732007.

[17] Total distribution costs exclude depreciation, return on rate base, taxes and franchise fees. Pineda, A., and Ngo, A (2022). 2021 California Electric and Gas Utility Cost Report: AB 67 Annual Report to the Governor and Legislature. California Public Utilities Commission. Available at*:* https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/reports/reports-on-utility-costs/2021-ab-67-report.pdf.

[18] EV-related distribution system upgrade costs include electric distribution system and service line upgrade costs incurred by Pacific Gas and Electric Company (PG&E), Southern California Edison (SCE), and San Diego Gas & Electric (SDG&E),and exclude EV program costs. Joint IOU Electric Vehicle Load Research and Charging Infrastructure Cost Report: 10th Report. March 31, 2022. *Available at*: https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/transportation-electrification/10th-joint-iou-ev-load-report-mar-2022.pdfdivisions/energy-division/documents/transportation-electrification/10th-joint-iou-ev-load-report-mar-2022.pdf.