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Electric Vehicles Are Driving Electric Rates Down

June 2020 Update

Jason Frost, Melissa Whited, and Avi Allison

Plug-in electric vehicles (EVs) offer a key opportunity to reduce harmful emissions and save customers money at the same time. EVs are responsible for far fewer greenhouse gases and local air pollutants than conventional vehicles and become cleaner as more renewable electricity is added to the grid. In addition, EVs are generally much less expensive to operate than conventional vehicles.

EVs are growing as a share of the light duty vehicle market. At the end of 2019, more than 1.4 million EVs had been sold in the US alone.[1] Another sign of the accelerating transition to cleaner electric transportation is the number of electric models that auto manufacturers are planning to introduce in the next few years. For example, GM announced in March 2020 that the company will launch 20 EV models globally by 2023 and aim to sell 1 million EVs per year by 2025.[2] With more available options that suit a wider range of customer needs, sales of EVs are likely to continue increasing in the coming years. With large quantities of cars plugging into the grid, there is a potential for significant electric utility system impacts. EVs hold significant potential to reduce electric rates for all customers because they can bring in more revenue than associated costs, largely due to the fact that EVs can be charged during hours of the day when the electric grid is underutilized.

This analysis examines costs and revenues associated with EVs between 2012 and 2019 in the two utility service territories in the US with the most EVs of any---Pacific Gas & Electric (PG&E) and Southern California Edison (SCE). **We observe that over those eight years, EV drivers in PG&E's and SCE's service territories have contributed $806 million more in revenues than associated costs, driving rates down for all customers.**

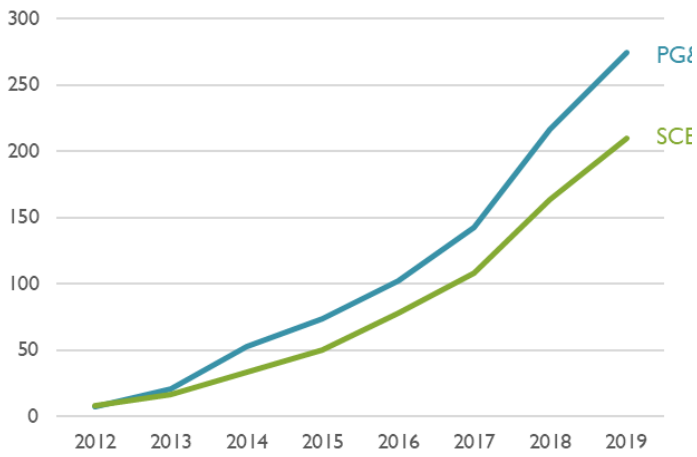
How Are EVs Affecting Electricity Rates?

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 the service territories of Pacific Gas & Electric (PG&E) and Southern California Edison (SCE), the two utilities that have the most EVs of any utility in the US, with more than 484,000 EVs in their territories as of the end of 2019.[3]

Specifically, we analyzed the electricity rates that EV owners pay compared to the marginal cost of electricity plus the expenditures associated with utility EV infrastructure programs.

Figure 1. Cumulative EV Adoption in California Utility Service Territories



Our analysis relied on EV load profiles from the California Joint IOU Load Research Reports, as well as marginal costs from the CPUC's Avoided Cost Calculator.[4] We also used the load profiles for residential customers that are available on PG&E's and SCE's websites as an estimation of residential load profiles without EVs.

Revenues from EVs

Charging an EV can substantially increase household electricity consumption. On average, we estimate that EVs in California increase consumption by approximately 250 kilowatt hours (kWh) per month.

California is currently transitioning to default time-of-use (TOU) rates and away from the existing default tiered electric rates. Under the old tiered rate structure, the price of electricity increases as customers move into higher-usage tiers. The extra electricity required to charge EVs is likely to push people into higher tiers. As a result, EV drivers paying these rates tend to pay high rates for charging their electric vehicles.

Unlike tiered rates, TOU rates have different prices during on-peak hours and off-peak hours and are meant to align prices more closely with the actual cost to provide electricity during those hours. By charging EVs primarily during off-peak hours, customers can simultaneously lower their electric bill and reduce costs on the grid. However, the TOU rates onto which most customers will be defaulted in California are not designed for more flexible loads, such as EVs. Optional TOU rates designed for EVs with higher on-peak to off-peak price ratios generally offer EV drivers greater savings while providing a greater incentive to charge during off-peak hours.

Accounting for the Costs Imposed by EVs

The costs imposed by EVs are the most important factor in determining the impact of EVs on electric rates. Fortunately, the Load Research Reports show that EVs are requiring few distribution system upgrades and, when on TOU rates, are charging at low-cost times for the grid.

Substantial EV Charging Can Be Integrated Without Substantial Cost

The 2019 Load Research Report shows that the integration of EVs in California has required very few utility system upgrades. Between 2012 and 2018, just one out of every 670 EVs resulted in a distribution system or service line upgrade (this data was not reported in 2019).[5] Between 2012 and 2019, PG&E's and SCE's EV-related utility system upgrade costs averaged $16 per vehicle in 2019 dollars. This suggests that California has yet to hit a point where distribution system EV integration costs become meaningful.

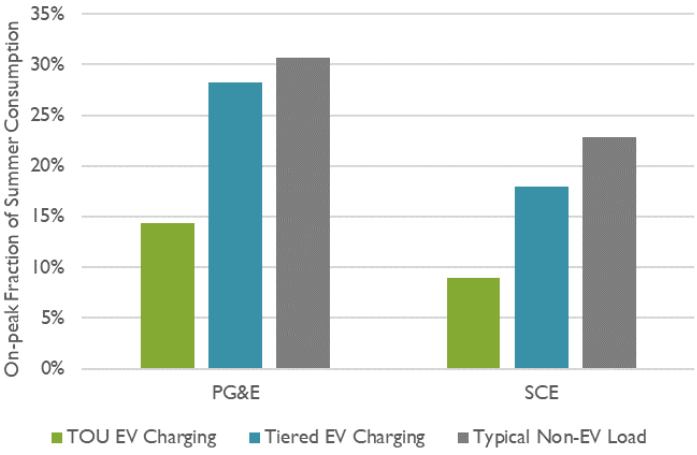
EV Customers on TOU Rates Charge in Low-Cost Ways

TOU rate structures generally include a high-priced "on-peak" period centered around weekday afternoons, a low-priced off-peak period that mainly covers night and early-morning hours, and an in-between "mid-peak" period. It turns out that these rates are effective at encouraging customers to shift their electricity usage to lower-cost hours. EV charging load profiles were calculated based on 2018 data from the 7th Load Research Report, as the April 2020 Charging Infrastructure Cost Report does not include updated load profile data for 2019.

EV Customers on TOU Rates Charge Off Peak

In California, EV customers on TOU rates consistently consume a far lower percentage of their electricity during on-peak hours compared to standard residential customers, in response to price signals that encourage use of the grid at lower cost times. Figure 2 shows how EV drivers on TOU rates tend to reduce their charging at peak hours relative to those on standard tiered rates. On average, EV customers on PG&E's TOU rates charged only 14 percent during on-peak hours in the summer months. Only 9 percent of EV charging occurred during on-peak hours for customer on SCE's TOU rate.

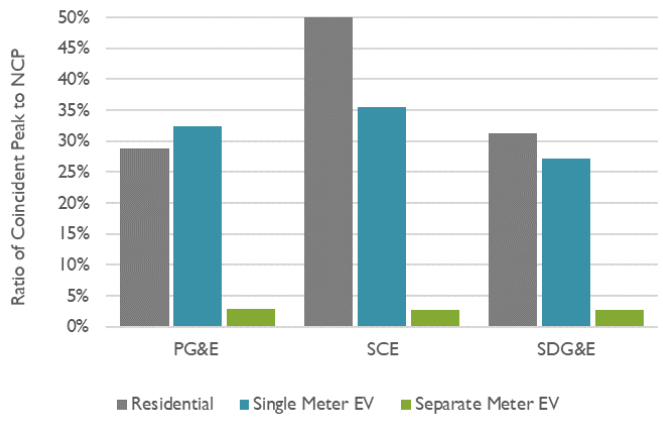
Figure 2. EV Customers on TOU Rates Consume Little During System Peak Hours



TOU on-peak and off-peak periods are a rough approximation of when the electric system is stressed. But system costs are disproportionately driven by only a few highest-peak hours of the year. What happens during those few hours when the electric system hits its peak demand? It turns out that customers on EV rates

avoid charging their vehicles during those hours, too. By comparing the annual average peak demand of EV customers (also known as a non-coincident peak, or NCP) to that group's average demand during the system peak (also known as coincident peak demand), we can estimate how much EV customers contribute to system coincident peak demand. On average, separately metered EVs consume less than 5 percent of their peak levels during system peaks, which is much lower than standard residential customers (see Figure 3).

Figure 3. EV Customers on TOU Rates Consume Little During System Peak Hours



Rather than increasing demand on the system, EV customers on TOU rates often hit their monthly maximum demand when the system is least taxed – typically between 11 p.m. and 2 a.m.

EV Customers on TOU Rates Peak in Beneficial Patterns

Although EV customers charge during off-peak hours, concerns have been raised that these customers will create new peaks on the distribution system by charging at the same time (when the off-peak period begins).

While there is substantial variability across the three utilities, EV customers tend to have diversified peaks, similar to the residential class as a whole. This is measured by comparing the class peak demand to the sum of the individual customers' peak demands. If all individual customers peaked at the same time, then the class peak demand would be the same as the sum of the individual customers' peak demands. If individual customers peak outside of the class peak hour, then the class peak demand will be lower than the sum of the individuals' peak demands.

However, the data indicate that the diversity of demand varies considerably by utility. This phenomenon is the result of how the TOU rates and off-peak periods are designed. Specifically, the number of hours in the off-peak period is likely the primary factor driving the difference in EV customer peak diversity across the California utilities. SCE's 10-hour off-peak period provides the greatest diversity of demand, while SDG&E's 6-hour off-peak period encourages customers to charge at more or less the same time. Thus, expanding the number of hours covered by an off-peak period would likely result in increased peak diversity among customers on TOU rates.

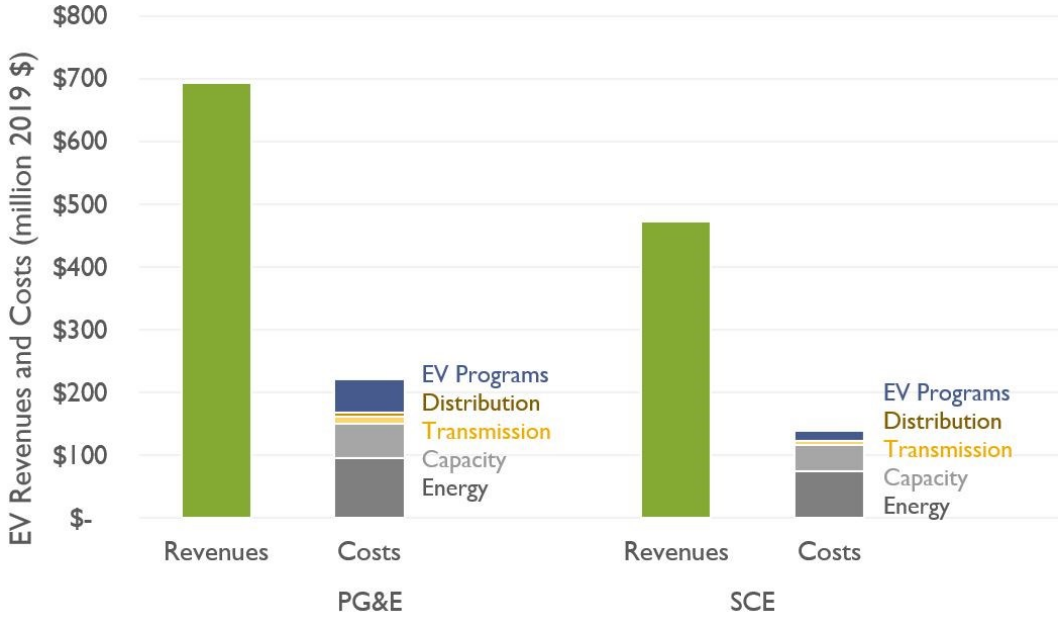
Impacts on Rates

By comparing the revenues from EVs to the costs imposed by EVs, we can determine the impacts that EVs are having on electricity rates. Since California is currently in the process of transitioning to default TOU rates, we conducted this analysis for one case in which most EV customers are assumed to be on traditional tiered rates (as has been the case in recent years) and one in which most customers are on TOU rates. The rate structure that a customer is on impacts both 1) the utility revenues associated with EVs and EV charging behavior and 2) the associated electric supply and distribution costs. Importantly, we find that EVs generate more utility revenue than costs and put downward pressure on rates when customers are on either type of rate.

In the first case, in which approximately 80 percent of customers remain on tiered rates, our analysis indicates that in the two utility service territories with the most EVs in the US, 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 2012 and 2019, EV drivers in PG&E and SCE territory have contributed $806 million more than associated costs (in 2019 dollars.) Figure 4 shows the extent to which revenues from EVs outweigh the costs imposed for the period 2012-2019.[6]

This finding holds across both utilities and is not simply a result of the fact that the majority of EV drivers are paying higher tier prices on default tiered rates. To see how the fraction of EV drivers on TOU rates impacts the net benefits, we recalculated the costs and benefits under the assumption that 75 percent of EV drivers paid TOU rates throughout the study period. (In reality, closer to 20 percent of EV drivers have been on optional TOU rates designed for EVs, but that could change with the implementation of default TOU rates in California, which

Figure 4. PG&E and SCE Revenues and Costs of EV Charging, 2012-2019



will provide an opportunity to educate customers about the optional rates designed for EVs.) In the case with more EV customers on rates designed for EVs, revenues still exceeded costs between 2012 and 2019 by a total of $621 million.

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, recent research conducted by Lawrence Berkeley National Laboratory, PG&E, and the Natural Resources Defense 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.[7]

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 TOU rates. 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 ratepayers in excess of their costs. Our analysis indicates that increased EV adoption in the two utility service territories with the most EVs 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]Transportation Research Center at Argonne National Laboratory. Available at: anl.gov/es/light-duty-electric-drive-vehicles-monthly-sales-updates.

[2]Boudette, Neal E. March 4, 2020. "G.M. Lays Out Ambitions for Electric-Vehicle Lineup to Rival Tesla." *New York Times.* Available at: https://www.nytimes.com/2020/03/04/business/gm-electric-vehicles.html.

[3]8th Joint IOU Electric Vehicle Charging Infrastructure Cost Report. April 1, 2020.

[4] 2018 Avoided Cost Calculator. Available at https:// www.cpuc.ca.gov/general.aspx?id=5267.

[5] 7th Joint IOU Electric Vehicle Load Research Report. April 2, 2019. Available at: https://efiling.energy.ca.gov/GetDocument.aspx?tn=228787-14&DocumentContentId=60075.

[6] We have included the full costs of the EV programs and distribution upgrades incurred to date in this graph, rather than depreciating the costs over time. This is a conservative assumption, as most of these costs will likely be depreciated over the useful lives of the equipment. If we were to show the depreciated costs, the EV Program and Distribution costs incurred between 2012 and 2018 would be reduced by 84 percent for both utilities.

[7] Coignard et al., Will Electric Vehicles Drive Distribution Grid Upgrades?: The Case of California. June 5, 2019. Available at https://ieeexplore.ieee.org/document/8732007.