Electric Vehicles Are Driving Electric Rates Down

June 2019 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 globally, with more than 1.2 million EVs in the United States 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. According to a June 2018 study by the consulting firm AlixPartners, 207 new EV models will be available globally by 2022.[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.

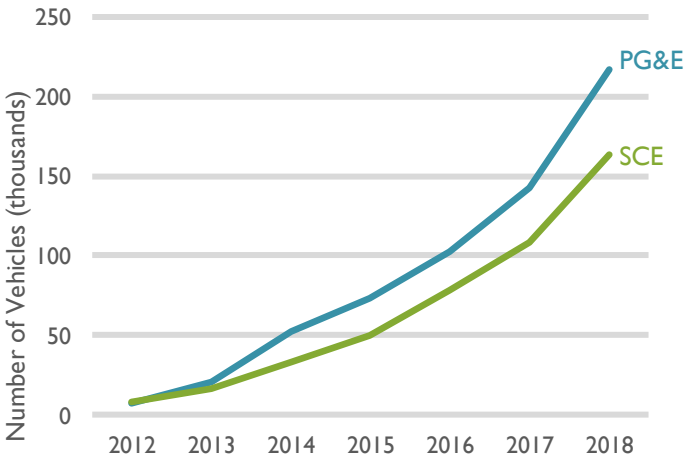
How Are EVs Affecting Electricity Rates?

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 an EV. This is an important equity question that should be analyzed when determining the role that electric utilities should play in supporting transportation electrification. Answering this question requires comparing electric utility revenues from EV charging with the costs of 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 United States, with more than 380,000 EVs in their territories at the end of 2018.[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 California Public Utility Commission'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

Adding 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.

Currently, most California EV drivers pay tiered electric rates, in which 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, these customers tend to pay high rates for charging their electric vehicles.

However, roughly one quarter of EV drivers in California are on time-of-use (TOU) rates. These rates have different prices during on-peak hours and off-peak hours, and they 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.

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

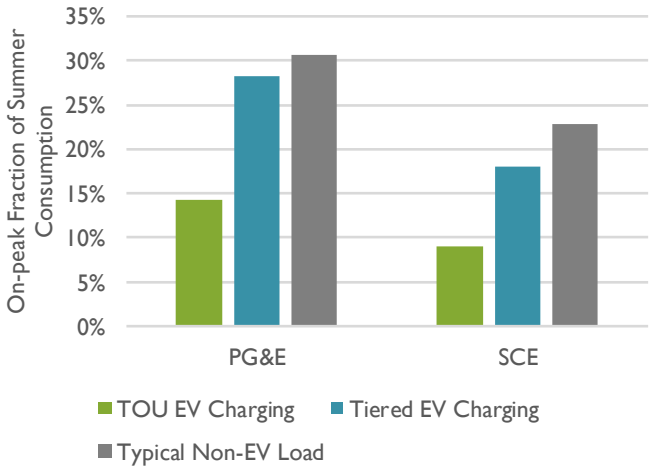
The latest load research report shows that very few EVs in California have required system upgrades. Over the past seven years, just one out of every 670 EVs has resulted in a distribution system or service line upgrade.[5] When averaged across all EVs in the utilities' service territories, the costs associated with all upgrades has amounted to less than $17 per vehicle. 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.

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. 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.

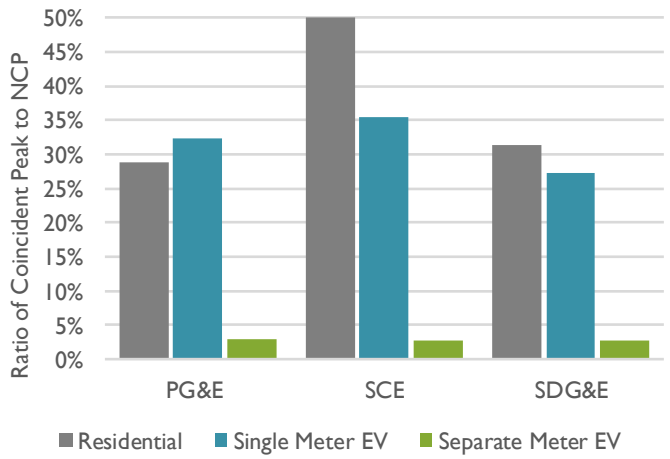
Figure 2. EV Customers on TOU Rates Consume Little During System Peak Hours



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 five 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 typically 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.

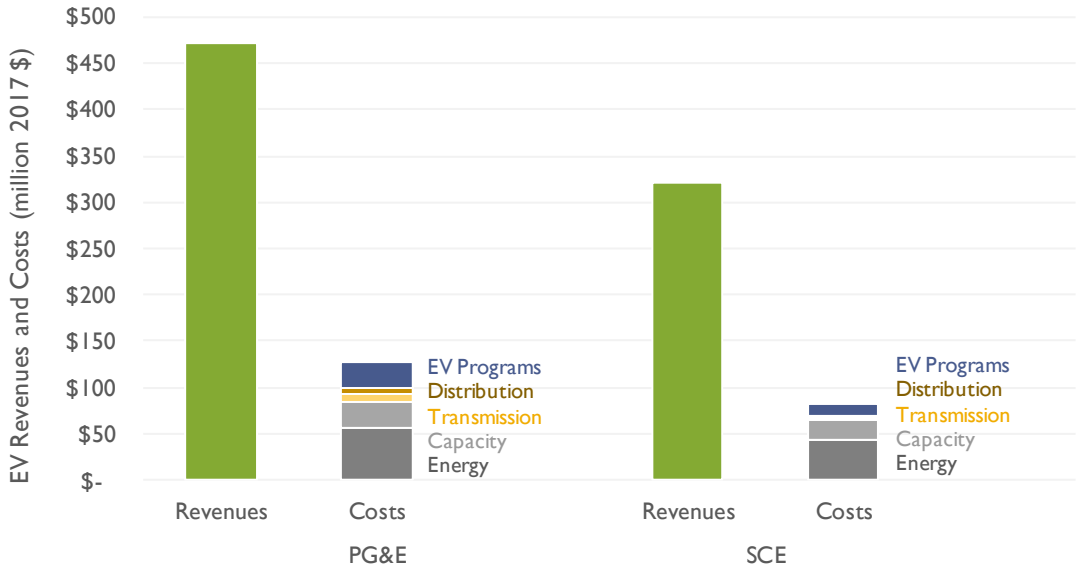
Impacts on Rates

By comparing the revenues from EVs to the costs imposed by EVs, we can determine the impacts that EVs are having on electricity rates. Our analysis indicates that, from 2012 through 2018, in the two utility service territories with the most EVs 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. Over the seven-year period, EV drivers in PG&E and SCE territory have contributed $584 million more than associated costs (in 2017 dollars.) Figure 4 shows the extent to which revenues from EVs outweigh the costs imposed for the period 2012-2018.[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 25 percent of EV drivers are on TOU rates.) In the case with more TOU customers, revenues still exceeded costs between 2012 and 2018 by a total of $450 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

Figure 4. PG&E and SCE Revenues and Costs of EV Charging, 2012-2018



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 help to accelerate the EV market, enhancing 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 increased EV adoption in the two utility service territories with the most EVs in the United States 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] Alliance of Automobile Manufacturers. Advanced Technology Vehicle Sales Dashboard. Available at https://autoalliance.org/energy-environment/advanced-technology-vehicle-sales-dashboard/

[2] AlixPartners. 2018. "A 'pile-up of epic proportions' awaits auto industry as investments necessary to an electric and autonomous future balloon just as market slows, according to AlixPartners study." Available at https://www.alixpartners.com/media-center/press-releases/pile-up-awaits-auto-industry-investments-electric-autonomous-future-balloon/

[3] 7th Joint IOU Electric Vehicle Load Research Report. April 2, 2019.

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

[5] Analysis of data provided in the 7th Joint IOU Load Research Report.

[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.