What Happens If EV Purchasers Don't Like TOU Rates?

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With the emergence of the growing electric vehicle (EV) market, the potential risk with EV charging to service transformers, and to a lesser extent, substation capacity, has captured significant attention. One solution to mitigate charging risk is to implement time based rate (TOU) structures, but our research suggests that less than half of customers may not adhere to this tariff structure.

This study utilized an innovative and customer centric approach to EV market research methodologies by creating an "inferred savings" method embedded within a discrete choice framework. Our goal was to more accurately predict customers' willingness to shift energy use from peak to off peak hours, aiming to provide a quantitative prediction of the price threshold (i.e., peak vs. off peak price spread) sufficient to motivate a shift. Our findings reveal that TOU alone is not enough to mitigate all the risks of EVs. Therefore alternative solutions that can supplement TOUs are also explored.

TOU alone is not enough

In order to understand what customers think about TOU, a unique customized online interview was developed. Customers were presented multiple trade-off questions or discrete choices that shed light on the sensitivity of charging cost and the importance of when to charge. Regression based analysis derived the value score that measures customer preference toward charging windows and prices. Consistently all customers prefer the flexibility to charge anytime during the day. Market simulations were performed to derive charging costs under low/medium/high risk-reward scenarios. During peak hours, under cost based revenue neutral rates, customers are expected to pay $4 - $8 to fully fuel their vehicles. Unfortunately, this price level is not high enough to motivate all customers to charge off peak. The probability of charging at a given cost in a give time window was also calculated, revealing that about 50% of customers will continue charging on peak no matter the magnitude of this cost.

Alternative Solutions

The paper then explores alternative solutions that can be used separately, or in conjunction with TOUs, to further mitigate on peak charging risk. First, where the utility has control over some fraction (approx 30%) of the homes on a circuit, dynamic dispatching is the best option. Dynamic dispatching is not energy efficiency, and not demand response. Rather, its value is greater than the sum of both. By optimally scheduling and dispatching end uses including AC, water heat and electric vehicles, and choreographing end uses mathematically (e.g., using IDROP optimization software), bumpy loads can be significantly levelized, not only flattening the load on the entire circuit (by only dispatching to 30% of homes), but mathematically guaranteeing the least cost dispatching solution.

Where utilities don't have control over end uses, or have no prior information of EV adoption, spatial load forecasting (e.g., LoadSEER, Foresite) can be used to provide significantly more accurate planning horizon forecasts for distribution planners. This approach takes into consideration of solar, wind, natural load growth, demand side management and other GIS based layers at the acre level to gauge the risk of EV additions on distribution assets. By putting load forecasting at a more granular level into the hands of distribution planners, a more robust and accurate planning function can be used to mitigate risk on circuits.

Finally, where the foregoing spatial forecasts reveal early "hot spots" of risk within certain regions or neighborhoods, a set of detailed service transformer load management analytics can be conducted to evaluate service transformer at risk on particular sections of circuits. Here, we can use household level load forecasting, coupled with actual weather and EV addition scenarios, to gauge the expected loss of life to service transformers, given the addition of one, two or more EVs on each service transformer. In this manner, advanced planning is able to highlight which distribution assets are at risk first, from EV adoption. And where, in many cases, customers are not likely to notify the utility of the purchase of an EV, this type of advance planning is necessary to mitigate this risk.

Conclusion

The paper concludes that TOU rate alone is not enough to mitigate potential risks from EV. Since approximately 50% of customers will not be motivated to use TOU, regardless of how appealing the TOU rate design is, alternatives such as dynamic dispatching, spatial load forecasting and enhanced TLM should be considered.