Driving Transportation Electrification Forward in New York

Considerations for Effective Transportation Electrification Rate Design

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Executive Summary

Electrifying the transportation sector will be necessary to achieve large-scale greenhouse gas reductions. Converting internal combustion engine (ICE) vehicles to electric vehicles (EVs) could also provide substantial net benefits to society through substantially reducing transportation fuel costs while simultaneously reducing electricity rates through better utilization of existing infrastructure. These benefits are far from certain, however. Achieving these benefits hinges on two key factors:

1) Charging EVs in a manner that minimizes costs to the grid, and

2) Widespread adoption of EVs.

Electric utilities are in a unique position to influence both of these factors through electric rate design.

Managing peak demand is a key challenge for electric utilities. As the penetration of EVs increases, charging EVs during times of peak demand could exacerbate grid constraints, require the construction of new power plants or transmission and distribution infrastructure, and increase costs for customers.[1] In addition, certain electric rate structures can pose financial barriers to potential EV customers and owners of public EV charging stations. These barriers could reduce demand for EVs and slow the transition to the cleaner transportation system necessary to meet state goals.

To avoid these pitfalls, electric utilities should provide EV customers with clear electricity price signals to encourage charging off-peak. Further, well-designed electricity pricing can help encourage the adoption of EVs and support the financial viability of public EV charging stations. This report examines best practices in EV rate design and provides comments on New York utilities' EV rate design proposals submitted in Docket 18-E-0206.

Rate Design Options

Standard, time-invariant electricity rates do little to encourage EV adoption or optimal charging times. In fact, these rates may even directly discourage efficient charging practices, since customers are apt to charge when it is most convenient to them, rather than when it is most beneficial to the grid. In contrast, time-varying rates convey price signals that better reflect the cost of producing and delivering energy during different hours. Time-varying rates include time-of-use (TOU) rates, critical peak pricing, peak time rebates, and dynamic hourly pricing. In addition, some utility rates include a demand charge, which is typically based on a customer's maximum consumption during a month.

Each of the above rates has advantages and drawbacks. However, TOU rates are the most popular form of time-varying rate, both for EV customers and non-EV customers. TOU rates are popular for several reasons:

[1] Current penetrations of EVs are unlikely to have a material impact on the grid, but as adoption increases, more attention to load management is warranted.

- **Effectiveness:** TOU rates have proven to be highly effective in shifting EV load. Both whole-house and EV-only TOU rates have been implemented at all three of California's large investor-owned utilities (IOU) and have been extremely successful in motivating customers to avoid charging on-peak. At Pacific Gas & Electric, 93 percent of charging on the EV-only rate occurs during off-peak hours, while at Southern California Edison, 88 percent of charging is off-peak.[2]

- **Simplicity:** TOU rates provide an easy-to-understand price signal that reflects general trends in utility costs, without requiring customers to monitor hourly energy prices. TOU rates are particularly well suited to "set it and forget it" technologies, such as the timers on many EV chargers.

- **Efficiency:** TOU rates can be designed by layering different types of utility costs (generation, transmission, and distribution) to reflect the temporal variability of all three.

Section 3.2 below provides more detail regarding the methods that can be used for designing TOU rates in a manner consistent with the time-varying nature of generation, transmission, and distribution costs.

Demand charges, which are typically based on a customer's maximum usage during a month, are generally not well suited to providing price signals that will support EV adoption. In fact, demand charges can work to discourage critical EV charging infrastructure deployment while the EV market is still in early development. A demand charge that applies during any hour of the day effectively becomes a fixed charge that cannot be avoided by scheduling EV charging for off-peak periods. For public charging stations, demand charges can undermine the financial viability of the station. While the maximum electricity demand at these stations is very high, energy use tends to be low due to the limited number of EVs on the road today. This means that demand charges tend to dominate the electricity bills for these stations, and these costs are very difficult to recover from the low number of EV customers.

To address this problem, some utilities have temporarily reduced or eliminated demand charges for public charging infrastructure, opting instead to price electricity using TOU rates. Cross-subsidization due to such rates is unlikely as long as electricity is priced at or above the utility's marginal cost of service,[3] since EV stations are supporting incremental load growth, rather than representing existing load on the system.[4]

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[2] Synapse Analysis of Joint Utilities Load Research Report, December 2017.

[3] Any required distribution upgrades directly related to the charging station should also be recovered from the charging station owner in order to avoid shifting these costs on to other customers.

[4] Existing tariffs are designed to recover embedded costs from existing load, which enables incremental load to be priced at marginal cost, at least during the early years of EV adoption.

Metering Technologies for EV-Only Rates

Customers may prefer an EV-only TOU rate to a whole-house rate because it is much easier for customers to monitor and control the timing of EV charging than the use of other appliances in the home. However, EV-only rates require a separate revenue-grade meter or the use of submetering technology to record electricity use that is specifically attributable to EV charging.

Although a second meter makes it easy to apply TOU rates only to EV charging, the additional meter and installation charges involved can be formidable. The installation can cost thousands of dollars up front for customers, eliminating virtually all of the fuel cost savings associated with the EV-only rate. Some utilities also assess a second customer charge for the second meter. These high costs have contributed to very low customer enrollment in EV-only TOU rates that require a second meter.

Several different submetering technologies are available. These include:

- Stand-alone submeters such as the WattBox™ from eMotorWerks, with a cost of approximately $250. In some pilot programs, connectivity and data transfer issues have been a problem. In addition, installation typically requires an electrician and will incur an additional cost.

- Submeters integrated with the EV supply equipment (EVSE). At-home EVSE are generally Level 2 charging with costs typically between $500 to $900. The installation of these EVSE requires an electrician at additional cost. EVSE-integrated submeters have been used by some municipal utilities, is being piloted at a large scale in California, and will soon be piloted in Minnesota.

- Mobile (in-car) submeters such as the FleetCarma C2 device. This device is "plug-and-play," allowing the EV owner to simply plug it into a port under the dash of the vehicle. The device then collects vehicle charging and driving data and sends the data securely to FleetCarma servers over the cellular network. However, the annual costs to the utility associated with the use of this device at present appear quite high.
- On-board metering (integrated into the vehicle itself) may be an option for off-peak charging rebate programs and could potentially be extended to other rate structures in the future. A key barrier to extending on-board metering to other rate structures is the requirement for revenue grade metering and the implications for billing responsibility.

Each metering option has certain advantages and drawbacks. While a second utility meter is a straightforward option, the costs of installation can be prohibitively high, and customer charges associated with a second meter can deter customers. Submetering is promising, particularly if installation costs can be reduced further and data transfer issues can be fully resolved.

Maximizing Customer Enrollment

To achieve the benefits promised by time-varying rates, customer enrollment levels must be maximized. Simply designing a rate well is not sufficient to ensuring its success. Due to customer inertia, low levels of customer enrollment are common when customers are required to actively opt-in to the rate. Currently enrollment levels in most New York utilities' existing TOU rates are below 0.5 percent.

Electric utilities can achieve high levels of customer enrollment through defaulting customers onto a rate (through an opt-out design). Where defaulting customers onto a time-varying rate is not feasible, utilities must actively encourage enrollment through a combination of education, outreach, and incentives. In addition, it is important to ensure that utility incentives, auto dealership incentives, and customer incentives are all aligned. Activities to maximize EV customer enrollment in EV rates may include:

- **Website Tools:** Rate comparison calculators, such as Southern California Edison's Electric Vehicle Rate Assistant Tool, provide an easy way for customers to compare their potential cost savings over several different rate options.

- **Dealership Education and Incentives:** Auto sales representatives often have little to no understanding of the rates available to EV drivers, or the potential savings these could provide to customers. In California, a collaboration of organizations developed and conducts a dealership training curriculum, and a $250 dealership incentive is provided for each EV purchase in which the customer also signs up for an EV rate.[5]

- **Direct Outreach to EV Customers:** It can be difficult for a utility to identify which of its customers have purchased an EV. To identify customers, utilities may be able to work with state agencies to access Department of Motor Vehicle registration records and directly contact EV drivers. Some utilities also offer gift cards or other rewards to customers. For example, Salt River Project in Arizona provides EV customers with a $50 gift card simply for signing up for the utility's EV mailing list. Establishing these points of contact can be an important first step to educating and enrolling customers in an EV rate.

- **Price Guarantees:** Price guarantees may be offered for the first six months or year after a customer signs up for a new rate. These guarantees ensure that the customer will not pay more on the time-varying rate than they would on a standard rate, thereby reducing the customer's risk of signing up for a rate structure that is new to them.

Assessment of New York Utility EV Rate Proposals

The New York electric IOUs recently submitted proposals for residential EV tariffs to comply with New York Public Service Law Section 66-o(2). The overall structure of these proposed rates is sound, but there are several key areas where the proposals could be strengthened. In particular, many of the

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[5] The monetary incentive was recently approved for SDG&E. *See:* California Public Utilities Commission. Decision on the Transportation Electrification Priority Review Projects. Decision 18-01-024. January 11, 2018, page 39.

proposals fail to deliver the fuel cost savings needed to encourage customers to enroll in the rate and to motivate EV purchase decisions.

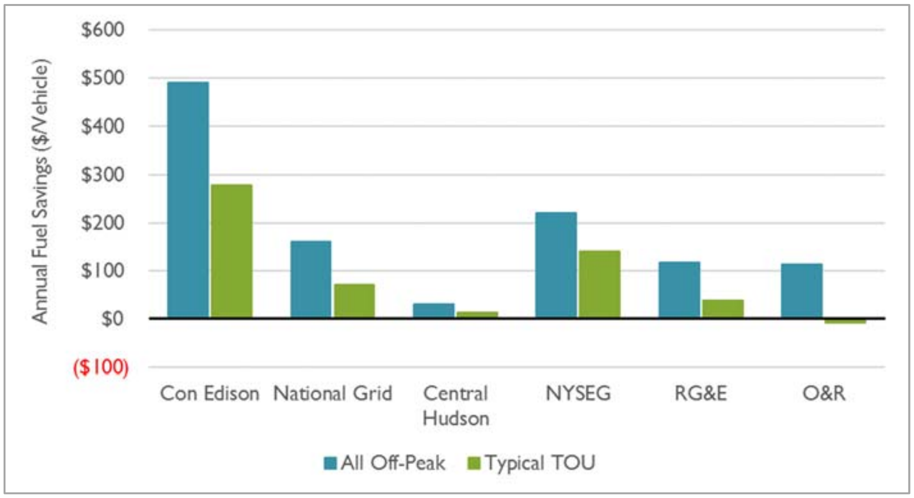
- **Metering:** None of the New York IOUs have proposed a submetering option using an EVSE for their EV rates, nor have they explained why submetering was not proposed. Instead, the IOUs that offer an EV-only rate would require a second traditional utility meter, with the exception of Consolidated Edison Company of New York's (Con Edison) ongoing SmartCharge NY program. The high cost of installing a second meter could dampen enrollment levels in EV-only TOU rates.

- **Rate Structure and Price Guarantee:** Each of the proposed residential EV tariffs use a TOU rate structure and include a one-year price guarantee that ensures that customers will not pay more on a whole-house TOU rate than they would have if they had remained on their original rate. These are very positive design decisions that will help to attract customers to the rate.

- **Fuel Cost Savings under Whole-House TOU Rate:** To achieve New York's policy goals, the ability for EV drivers to achieve fuel savings on the rate should be a central component of the rate design. Fuel cost savings are important for encouraging customers to adopt the rate and to motivate EV adoption. Synapse evaluated two metrics for assessing a customer's fuel cost savings: (1) savings on the TOU rate relative to the standard rate, and (2) savings from fueling the EV on the TOU rate relative to the cost of fueling an ICE vehicle. In both cases, we assumed a battery electric vehicle (BEV) with a range of 100 miles, similar to a Nissan Leaf or a BMW i3.

  Our analysis indicates that the fuel cost savings of the proposed TOU rates relative to standard rates vary substantially across utilities, as shown in the figure below. The figure shows fuel cost savings under two different scenarios: one in which 100 percent of the customer's EV charging occurs off-peak; and the other assuming more typical customer behavior in which most, but not all, charging occurs off-peak.

Figure ES-1. Whole-house TOU rate annual fuel cost savings relative to standard rate

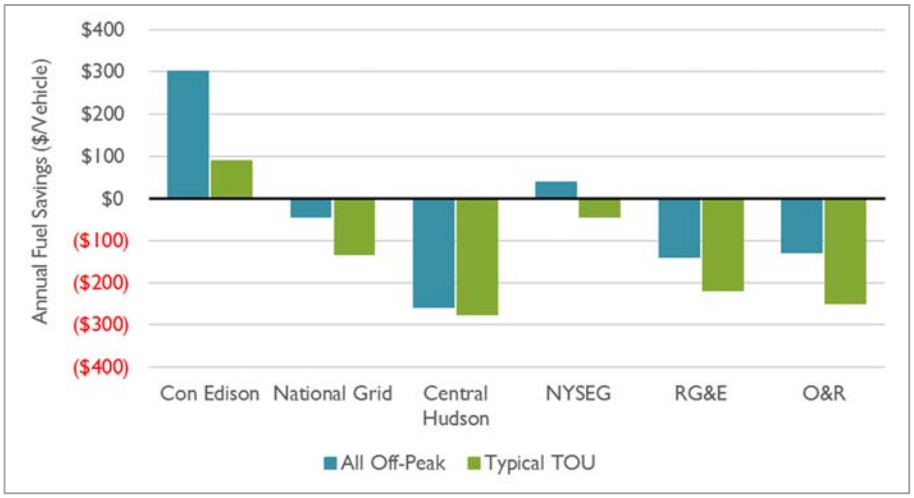


Source: Synapse Energy Economics analysis.

The whole-house rates proposed by Con Edison and New York State Electric and Gas (NYSEG) offer the greatest potential savings, with Con Edison customers experiencing annual fuel cost savings of approximately $500. In contrast, Central Hudson's rate (which has a low price differential between on-peak and off-peak), average annual savings amount to less than $50 even if all charging takes place during off-peak hours.

- **Fuel Cost Savings under EV-Only TOU Rate:** Con Edison, Orange and Rockland Utilities (O&R), NYSEG, and Rochester Gas and Electric (RG&E) include the option for customers to charge EVs under a separately metered TOU rate, rather than under the whole-house TOU rate. However, separately metered customers would likely have to pay an extra customer charge. The figure below shows that customers receive lower fuel cost savings from switching to the utilities' EV-only TOU rate, as the additional customer charge offsets the savings associated with a lower off-peak energy charge. In fact, we estimate that typical separately metered EV customers would incur *increased* fuel costs at every utility other than Con Edison. Customers of O&R could incur additional EV fuel costs of $250 by switching to the separate-meter TOU rate.

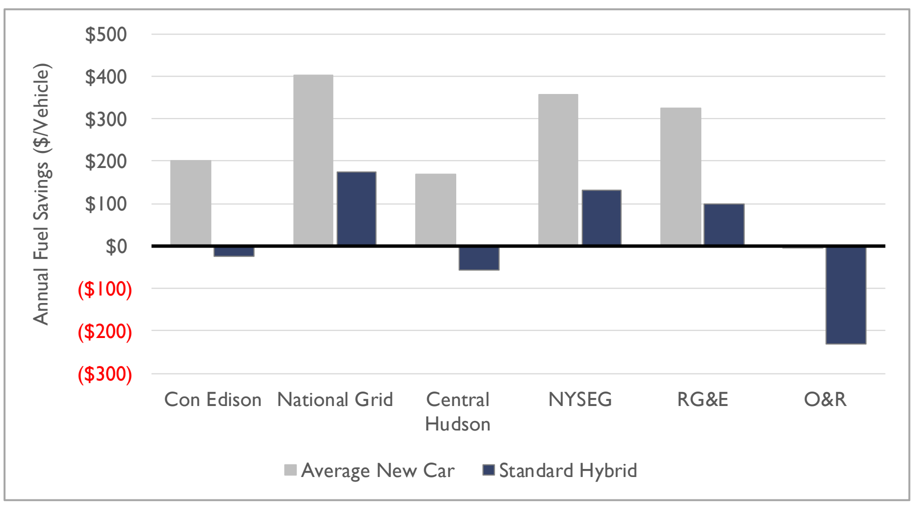
Figure ES-2. EV-only TOU rate annual fuel cost savings relative to standard rate



Source: Synapse Energy Economics analysis.

- **Fuel Cost Savings Relative to Gasoline-Powered Vehicles:** The fuel cost savings provided by EVs on the proposed TOU rates relative to ICEs also vary greatly depending on the utility and the ICE in question. The figure below presents our calculated fuel cost savings for each utility for a typical 100-mile BEV on a whole-house TOU rate relative to two alternative types of ICEs: a typical new car with an efficiency of 38 mpg, and a standard hybrid with an efficiency of 55 mpg.

Figure ES-3. Annual fuel cost savings on whole-house TOU rate relative to alternative ICE types



Source: Synapse Energy Economics analysis.

In nearly all utility service territories, the whole-house TOU rate would generate positive fuel cost savings relative to a typical new gasoline-powered vehicle. However, when compared to a standard hybrid vehicle, such as a Toyota Prius, EV fuel savings largely disappear. This comparison is important, because customers considering purchasing an

EV are likely to compare these vehicles to high-efficiency ICE options, such as standard hybrids. At three of the six IOUs, an EV customer would likely have higher fuel costs relative to a hybrid vehicle—more than $200 higher in O&R's territory.

One of the primary reasons that O&R's EV-only rate option offers the lowest fuel cost savings relative to both a standard residential rate and an ICE is that it has a relatively high customer charge of $12.00 per month. This charge is nearly three times greater than any other utility. This additional customer charge could potentially be avoided if the utility employed submetering rather than a second meter. However, it is not clear that a second customer charge is even fully justified for a second meter, given that many customer-related costs (such as the cost of the final line transformer and service drop) would not change upon the installation of a second meter on the customer's premises.

- **Ratio Between Peak and Off-Peak Rates.** Higher ratios between on-peak and off-peak price help to encourage EV customers to charge during off-peak hours and better enable customers to achieve fuel cost savings. Con Edison and O&R's proposed on-peak to off-peak price ratios are greater than 14:1 in the summer months and greater than 5:1 in the winter months. In contrast, Central Hudson's rate has a ratio of only 1.2:1 throughout the year.

  The IOUs also offer standard offer supply service TOU rates for customers who do not purchase electricity supply from a retail supplier. Con Edison's TOU standard offer service rates vary dramatically between peak summer hours and other times of the year, whereas the TOU standard offer service of NYSEG and RG&E do not exhibit marked differences between peak and off-peak hours. The reason for this differential could lie in zonal wholesale market prices, but it is worth reviewing the price differentials to ensure that the standard offer service prices contribute to an efficient overall TOU price.

- **Customer Enrollment in TOU Rates.** To date, enrollment in the New York IOUs' TOU rates has been very low, with most enrollment levels below 0.5 percent of residential customers. Although not required by the law, it is clear that to encourage EV customers to enroll in the utilities' new TOU rates, the IOUs must do more than simply establish the rate. The utilities must actively encourage enrollment through a combination of education, outreach, and incentives for both customers and auto dealerships. In addition, utility incentives should also be aligned with enrolling customers in EV rates. This could take the form of Earnings Adjustment Mechanisms that establish targets not only for customer adoption of EVs, but also for enrollment in an EV rate.

In conclusion, the New York utilities have a unique opportunity to influence EV adoption and steer EV charging practices to benefit the grid and society. The utilities' recent proposals represent a step in the right direction but require additional work to unlock their full potential. Specifically, we offer six recommendations:

1) Utilities with low price differentials between on-peak and off-peak rates increase the price ratio to motivate off-peak charging and enable greater fuel savings;

2) Ensure that a customer who charges mostly off-peak achieves fuel savings relative to a customer who remains on a standard rate and charges only on-peak;

3) Reduce or eliminate the customer charge for second meters;

4) Explore submetering as a means to lower the cost for EV-only rates;

5) Evaluate whether the proposed rate will provide sufficient fuel savings to encourage customers to adopt EVs over high-efficiency ICE vehicles; and

6) Endeavor to maximize customer enrollment through education, outreach, and incentives.

Finally, we recommend that these actions on residential rate design be complemented by an analysis of commercial and industrial rates to determine whether modifications are warranted to support EV charging stations, fleet electrification, and workplace charging.

1. INTRODUCTION

New York State will need to electrify its transportation sector to achieve large-scale greenhouse gas reductions.[6] This electrification could also substantially reduce transportation fuel costs, while simultaneously putting downward pressure on electricity rates through better utilization of existing infrastructure. In short, converting internal combustion engine (ICE) vehicles to electric vehicles (EVs) could provide substantial net benefits to society.[7] However, the extent to which those potential benefits are achieved hinges upon appropriate utility rate design.

Utility rate design is a key motivator for influencing whether customers charge EVs in a manner compatible with grid conditions, as well as the extent to which customers save money when refueling. Rapid adoption of EVs will be needed to meet energy policy goals, and studies reveal that saving money relative to an ICE is one of the most important motivators of EV purchase decisions.[8] Thus, the viability of an essential pathway to mitigate climate change and reduce America's exposure to the volatility of the global oil market depends upon appropriate rate design and on the decisions made by state utility regulators.

In New York, transportation accounts for roughly 34 percent of greenhouse gas emissions, whereas the state's electric power sector comprises less than 20 percent of emissions.[9] Addressing transportation emissions will be critical for achieving Governor Andrew Cuomo's target of reducing economy-wide

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[6] *See:* Daniel Steinberg et al., "Electrification & Decarbonization: Exploring U.S. Energy Use and Greenhouse Gas Emissions in Scenarios with Widespread Electrification and Power Sector Decarbonization" (NREL, July 2017), https://www.nrel.gov/docs/fy17osti/68214.pdf; J.H. Williams et al., "Pathways to Deep Decarbonization in the United States" (The U.S. report of the Deep Decarbonization Pathways Project of the Sustainable Development Solutions Network and the Institute for Sustainable Development and International Relations, 2014); International Energy Agency, "Transport, Energy, and CO2: Moving Toward Sustainability" (Paris: IEA/OECD, 2009), https://www.iea.org/publications/freepublications/publication/transport2009.pdf; National Research Council, "Transitions to Alternative Vehicles and Fuels" (Washington, DC, 2013), https://www.nap.edu/catalog/18264/transitions-to-alternative-vehicles-and-fuels.

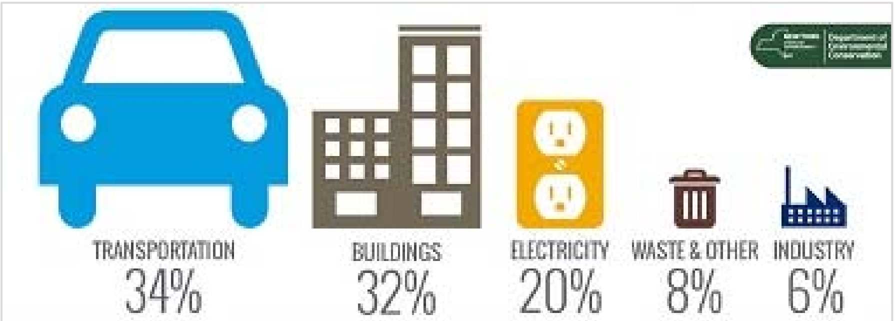
[7] We use the term "electric vehicles" to refer to both plug-in hybrid electric vehicles and battery electric vehicles.

[8] For example, a survey of nearly 20,000 EV owners in California found that fuel cost savings are the number one motivator for an EV purchase. In addition, NREL's annual surveys for the years 2015–2017 show that fuel cost savings consistently ranks as either the first or second most important reason for considering EVs. *See:* Center for Sustainable Energy (2016). California Air Resources Board Clean Vehicle Rebate Project, EV Consumer Survey Dataset: http://cleanvehiclerebate.org/eng/survey-dashboard/ev. *and* Mark Singer, "The Barriers to Acceptance of Plug-in Electric Vehicles: 2017 Update" (NREL, November 2017), https://www.nrel.gov/docs/fy18osti/70371.pdf.

[9] New York Department of Environmental Conservation, Mitigation of Climate Change: https://www.dec.ny.gov/energy/99223.html

greenhouse gas emissions by 40 percent by 2030 and 80 percent by 2050,[10] and for complying with Zero Emission Vehicle (ZEV) regulations that will require approximately 800,000 EVs in New York by 2025.[11]

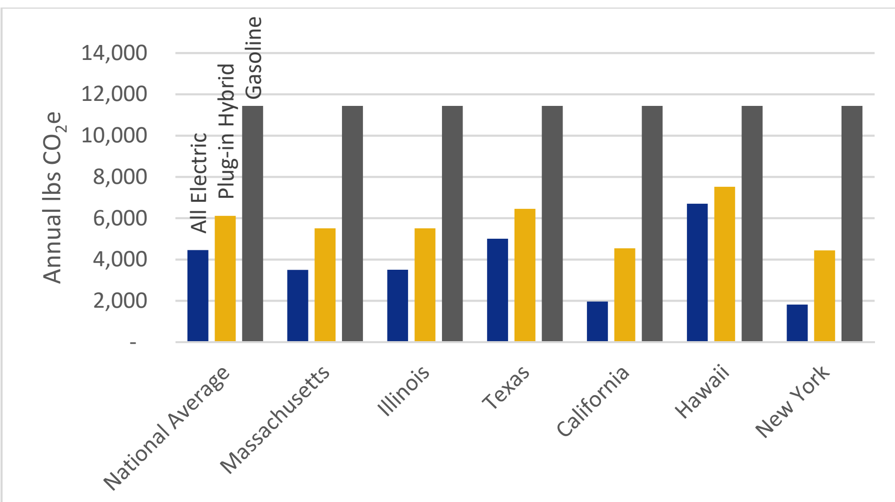
Figure 1. Greenhouse gas emissions by sector in New York



Source: New York Department of Environmental Conservation.

EVs provide a tremendous opportunity to enable New York to meet its greenhouse gas reduction targets and save money at the same time. On average, battery electric vehicles in the United States produce approximately one-third of the greenhouse gas emissions as ICEs. In New York, EVs are even cleaner—battery electric vehicles produce only 16 percent of the emissions of ICE vehicles (see Figure 2).[12]

Figure 2. Emissions from EVs and gasoline powered vehicles



Source: U.S. Department of Energy Alternative Fuels Data Center.

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[10] New York's State Energy Plan established emission reduction targets of 40 percent below 1990 levels by 2030 and 80 percent below 1990 levels by 2050. https://energyplan.ny.gov/.

[11] New York State is one of nine states that have adopted California's ZEV standards. These are incorporated by reference in 6 NYCRR Part 218, specifically Subpart 218-4.1 ZEV Percentages. These standards require automakers to produce a certain percentage of zero emission vehicles to improve air quality and combat climate change.

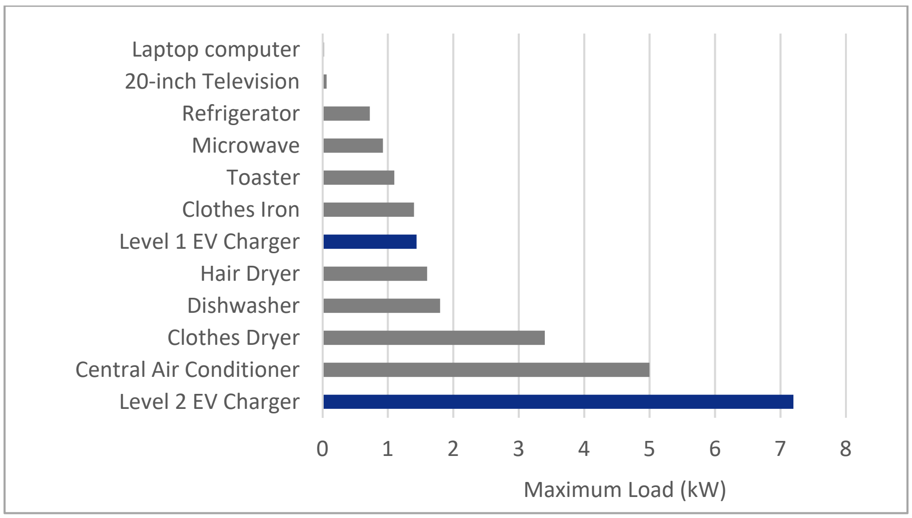
[12] U.S. Department of Energy Alternative Fuels Data Center. 2015. "Emissions from Hybrid and Plug-In Electric Vehicles." Available at: www.afdc.energy.gov/vehicles/electric_emissions.php.

By utilizing existing electricity infrastructure more efficiently, EVs can help lower electricity costs. For example, EVs can help to absorb excess energy from renewables when that energy is plentiful but demand is low, such as during the overnight hours. And by increasing the volume of electricity sold, EVs allow the fixed costs of the grid to be spread over more kilowatt-hours, thereby reducing electricity rates for all customers—regardless of whether the customer drives an EV. As technology evolves, EVs may increasingly provide services back to the grid and operate as “virtual power plants,” helping to integrate renewable resources and enhance reliability.[13]

Achieving these benefits depends on (1) charging EVs in a manner that minimizes costs to the grid, and (2) widespread adoption of EVs. This is where electric utility rate design plays a critical role.

EVs are large consumers of electricity. Further, their instantaneous power draw can be significantly higher than any other typical household appliance, as shown in the figure below. In fact, an EV can easily double a household’s peak demand when charged with a Level 2 charger.[14]

Figure 3. EV charging load relative to household appliances



Managing peak demand is a key challenge for electric utilities. As the penetration of EVs increases, charging EVs during times of peak demand could exacerbate grid constraints, require the construction of new power plants or transmission and distribution infrastructure, and increase costs for customers.[15]

Maximizing the benefits of transportation electrification also requires that barriers to EV adoption be removed. Certain electric rate structures can pose financial barriers to potential EV customers and

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[13] In the simplest case, EVs can operate as load reducers by temporarily deferring charging when the grid is stressed. But since EVs are essentially mobile batteries, their batteries can be tapped to provide more sophisticated services as well, such as frequency response and other ancillary services historically provided only by large power plants.

[14] A Level 1 charger uses a standard 120-volt outlet and provides approximately 4.5 miles per hour of charging. A Level 2 charger uses a 240-volt outlet and provides approximately 20 miles per hour of charging. DC fast chargers are another, much more expensive option, and they deliver power at 200–600 V_{DC} to provide approximately 240 miles per hour of charging.

[15] Current penetrations of EVs are unlikely to have a material impact on the grid. But as adoption increases, more attention to load management is warranted.

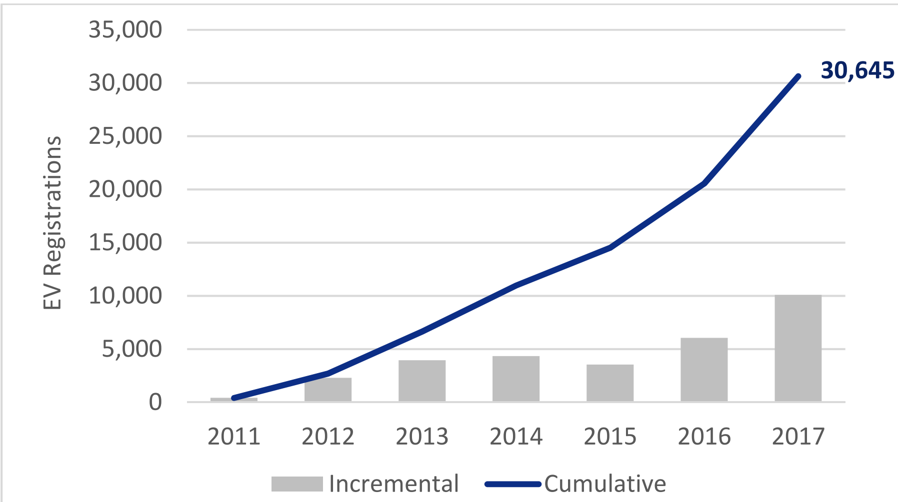
owners of public EV charging stations, thereby reducing demand for EVs and slowing the transition to the cleaner transportation system necessary to meet state goals.

To avoid these pitfalls, electric utilities should provide EV customers with clear electricity price signals to encourage charging off-peak. Further, electricity prices can be used to help encourage the adoption of EVs and support the financial viability of EV charging stations. This report examines best practices in electric vehicle rate design and comments on New York utilities' EV rate design proposals submitted in Docket 18-E-0206.

2. The Case for Effective Rate Design

Electric vehicle adoption in New York is rising rapidly: new EV registrations doubled from 2016 to 2017, as shown in Figure 4. Currently, New York is second only to California in the number of EVs in the United States.

Figure 4. EV growth in New York



Source: Auto Alliance.

At current levels of penetration, EVs could potentially add 215 megawatts (MW) of demand to New York's system if they all charged at the same time using a Level 2 charger. This is nearly equivalent to the total demand reduction expected from current energy efficiency programs.[16] Fortunately, this need not be the case. Because the electricity used to charge an EV's battery is often not immediately used to propel the vehicle, there is generally some flexibility regarding the timing of EV charging. Most drivers do not care when their EVs get charged, as long as the vehicles are ready to drive when needed. This inherent flexibility sets EVs apart from most major residential electricity end-uses (e.g., air conditioning) and opens up the possibility of encouraging efficient charging without inconveniencing consumers.

Given the rapid pace of EV adoption and the potentially large positive or negative impacts that EVs could have on the grid, it is critical that New York set in place a framework that will enable it to integrate EVs into the grid in a low-cost manner and avoid negative grid impacts. Electric utilities can play a prominent role in this regard, as they can provide price signals to customers to encourage EV owners to charge in a manner that is consistent with grid conditions.

[16] NYISO Power Trends, 2017.

Effective EV price signals can:

1) Encourage customer adoption of EVs by maximizing fuel cost savings relative to gasoline or diesel;

2) Lower electricity rates for all utility customers through more efficient grid utilization;

3) Avoid unnecessary grid upgrades by encouraging customers to shift charging to off-peak hours; and

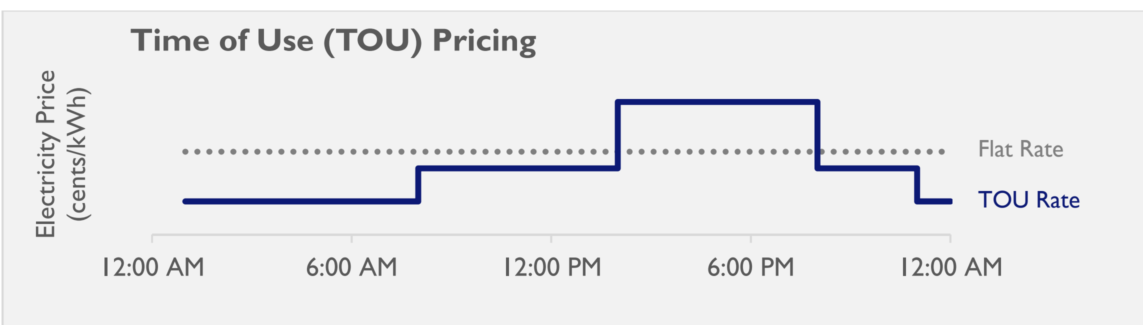
4) Reduce emissions by better aligning charging with renewable energy production.

The following sections discuss effective rate design options.

2.1. Rate Design Options

Standard, time-invariant electricity rates do little to encourage EV adoption or optimal charging times. In fact, these rates may even directly discourage efficient charging practices. Customers are apt to charge when it is most convenient to them, rather than when it is most beneficial to the grid. In contrast, time-varying rates convey price signals that better reflect the cost of producing and delivering energy during different hours. The most common forms of time-varying energy rates are described below, along with a stylized depiction of how each rate could be implemented.

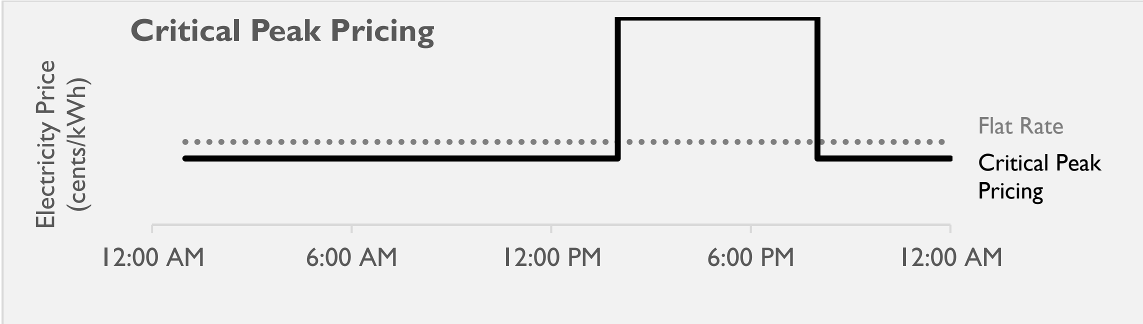
- *Time-of-Use (TOU) Rates:* TOU rates consist of two or more pricing tiers, based on pre-set time periods. Electricity is priced higher during hours when the peak is more likely to occur, and lower during hours that are generally off-peak. An advantage of this type of rate structure is that it has low financial risks to customers, because the pricing is known ahead of time and customers choose whether to curtail their electricity use during on-peak times.



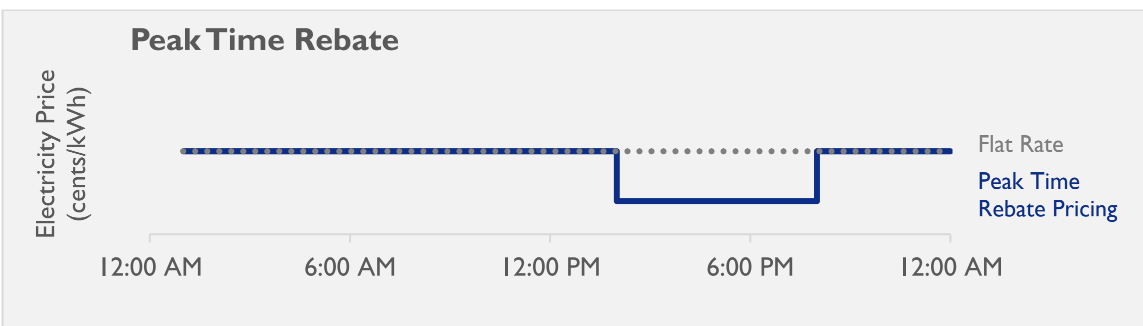
- *Critical Peak Pricing (CPP):* This rate structure is often used in conjunction with TOU rates but can be used with an otherwise flat rate structure as well. Critical peak pricing implements a very high price tier that is only triggered for very specific events, such as system reliability or peak electricity market prices.[17] The timing of the events is

[17] Hledik, R. et al., 2016.

generally not known until a day in advance, and the events typically last for only 2–6 hours.



- *Peak Time Rebates (PTR)*: A peak time rebate program is similar to critical peak pricing, except that customers earn a financial reward for reducing energy relative to a baseline, instead of being subject to a higher rate. As with critical peak pricing, the number of event days is usually capped for a calendar year and is linked to conditions such as system reliability concerns or very high supply prices.[18] While PTR programs tend to be widely accepted by customers, they have two drawbacks relative to critical peak pricing:
    - Baseline usage can be difficult to determine with accuracy. For example, a customer may earn a reward simply because the customer was out of town on the day of the event rather than because the customer actively reduced their electricity consumption in response to the event.
    - Peak time rebates tend to result in lower reductions than critical peak pricing. Customers generally respond more strongly when they are faced with paying more for consumption during peak hours than when they are offered a reward for lowering consumption.

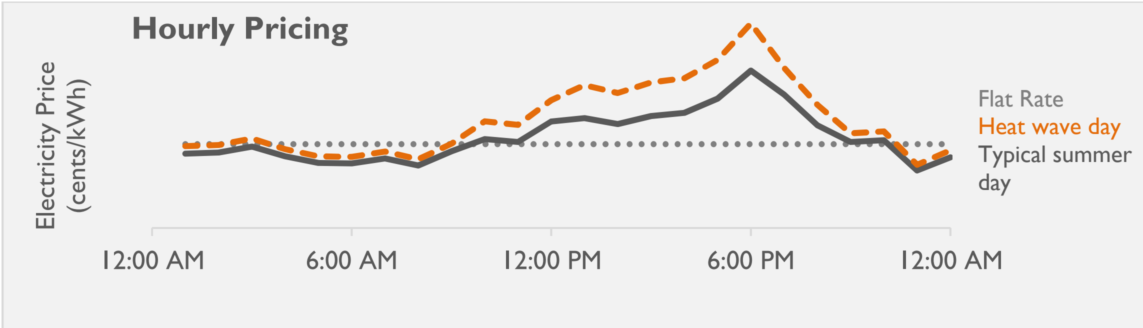


- *Real-Time Pricing and Hourly Pricing:* These rates charge customers for electricity based on the wholesale market price rather than a pre-set rate schedule.[19] Rates fluctuate hourly or in 15-minute increments, reflecting changes in the wholesale price of

[18] United States of America. Federal Energy Regulatory Commission. *Assessment of Demand Response and Advanced Metering.* Washington D.C.: United States, 2010.

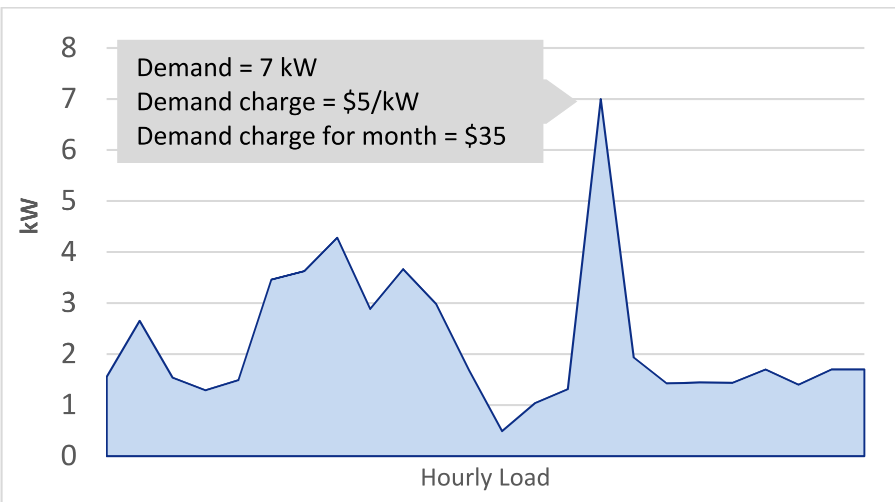
[19] *Id*.

electricity. Customers are typically notified of prices on a day-ahead or hour-ahead basis.



In addition to time-varying energy rates, some utility rates include a demand charge, particularly for large commercial and industrial customers. Instead of assessing a charge based on when and how much energy is consumed (measured in kWh), demand charges are applied to a customer's maximum consumption (measured in kW) during a month.[20] Demand charges can be designed to be time-limited (that, is they only apply during certain peak hours of the day), or they can apply during any hour. Figure 5 illustrates how a demand charge functions.

Figure 5. Hypothetical demand charge example



2.2. Considerations for Rate Design Selection

Overarching Considerations

Each of the above rates has advantages and drawbacks. However, TOU rates are the most popular form of time-varying rate, both for EV customers and non-EV customers. These rates have been offered by

[20] In some cases, demand charges are applied to some measure of a customer's maximum consumption over the course of a year.

utilities for decades and are gaining popularity now that advanced meters are reducing the costs associated with implementation. Results from a survey conducted by the Smart Energy Power Alliance (SEPA) indicate that at least 45 utilities across the country have TOU rates targeted to EVs.[21]

TOU rates are popular for several reasons:

- **Effectiveness:** TOU rates have been shown to be highly effective in shifting EV load.
- **Simplicity:** TOU rates provide an easy-to-understand price signal that reflects general trends in utility costs, without requiring customers to monitor hourly energy prices. TOU rates are particularly well suited to "set it and forget it" technologies, such as the timers on many EV chargers.
- **Efficiency:** TOU rates can be designed by layering different types of utility costs (generation, transmission, and distribution) to reflect the temporal variability of all three.

In contrast, critical peak pricing and peak time rebates only target a few peak hours per year. While such an approach may work well for avoiding additional generation capacity costs, it does not avoid daily higher-cost energy hours. In addition, such rates typically do not reflect the wider range of local distribution peak hours. Another consideration is that the specific hours for critical event days are generally called only a day in advance, making critical peak pricing and peak time rebates less compatible with "set it and forget it" technologies.

Hourly dynamic pricing is an efficient alternative to TOU pricing but is more complex and shifts more risk to customers. Where dynamic pricing is offered, enrollment tends to be low.[22] Further, dynamic pricing may be too variable for public charging stations. In California, the Public Utilities Commission rejected San Diego Gas & Electric's proposed dynamic rate for public charging infrastructure. The Commission wrote, "Dynamic rates are complicated, highly variable, and do not provide enough predictability for drivers that may not be participating in a specific utility program."[23] Instead, the Commission directed the utility to design a TOU rate that provides more predictability for drivers.

Demand charges are even less well-suited to providing price signals that will support EV adoption. In fact, demand charges can work to discourage critical EV charging infrastructure deployment while the EV market is still in early development. Demand charges that apply during any hour of the day effectively become a fixed charge that cannot be avoided by scheduling EV charging for off-peak periods. In the case of workplace and public DC fast charging (DCFC) stations, demand charges can pose

[21] Erika Myers, Medha Surampudy, and Anshul Saxena, "Utilities and Electric Vehicles: Evolving to Unlock Grid Value" (Smart Electric Power Alliance, March 2018), 24.

[22] For example, only about 17,500 customers out of 3 million have enrolled in Commonwealth Edison's dynamic pricing program. Dick Munson, "Data Reveals Real-Time Electricity Pricing Would Help Nearly All ComEd Customers Save Money," *EDF Energy Exchange* (blog), November 14, 2017, http://blogs.edf.org/energyexchange/2017/11/14/data-reveals-real-time-electricity-pricing-would-help-nearly-all-comed-customers-save-money/.

[23] California Public Utilities Commission, Decision on the Transportation Electrification Priority Review Projects, Decision 18-01-024, Application 17-01-020 et al, January 11, 2018, page 42.

a significant financial disincentive because of the potential to raise customers' bills. Further, demand charges for public charging stations are difficult for the site host to pass on to EV drivers, since the charges billed to the site host are not proportional to utilization by drivers. We discuss this in greater detail in the following section.

Considerations for Public Charging Rates

Rate designs that support, rather than hinder, the development of public charging stations are important for encouraging EV adoption. DCFC stations generally provide power between 50 kW and 350 kW, which enables long-distance electric travel and helps to provide prospective EV drivers with range confidence. Public charging stations are also important for providing charging options for customers in multifamily dwellings or single-family households with on-street parking.[24] In addition, DCFC stations support the electrification of medium- and heavy-duty fleets, such as transit buses, that have intensive duty cycles.

However, most public charging stations are billed on a commercial rate, which typically includes a demand charge. While the electrical demand (kW) at these stations is very high, energy use (kWh) tends to be low due to the limited number of EVs on the road today. This means that the demand charges tend to dominate the electricity bills for these stations. This phenomenon is particularly true for DCFC stations: empirical analysis by Rocky Mountain Institute demonstrated that demand charges can drive over 90 percent of the costs of operating these stations during summer months in California, making it extremely challenging to recoup costs while EV penetration and station utilization are still low.[25]

To illustrate, consider a DCFC station with two 50-kW ports that occasionally has two vehicles charging at once, for a total of 100 kW of demand. Under a high demand charge of $20/kW, the customer would pay a monthly demand charge of $2,000. Under a more moderate demand charge of $6/kW, the monthly demand charge would be $600.[26] While such demand charges may be tenable for future levels of EV penetration, currently many charging stations experience low utilization rates, with some only being used once every few days.

Under the high demand charge case, a charging station with a low utilization rate of one charge every two days (15 charges per month) would have an operating cost of $142 per charging session, equivalent to a cost of $2.84/kWh. At four times the utilization rate (60 charges per month), the cost would fall to only $39 per session (equivalent to a cost of $0.77/kWh).

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[24] Approximately 25 percent of U.S. households live in multifamily dwellings, and approximately 39 percent of single-family households have no access to charging at home. National Research Council of the National Academies, *Overcoming Barriers to Deployment of Plug-In Electric Vehicles* (Washington, DC: National Academies Press, 2015), 85, https://download.nap.edu/cart/download.cgi?record_id=21725.

[25] Garrett Fitzgerald and Chris Nelder, "EVgo Fleet and Tariff Analysis" (Rocky Mountain Institute, April 2017), https://www.rmi.org/wp-content/uploads/2017/04/eLab_EVgo_Fleet_and_Tariff_Analysis_2017.pdf.

[26] Demand charges generally range from $3/kW to $25/kW. In the Northeast, distribution demand charges average approximately $11/kW.

A more moderate demand charge of $6/kW would still result in a cost per session of $49, assuming only 15 charges per month, or $15 per session assuming 60 charges per month. These results are shown in Table 1 below. Such costs would be difficult, if not impossible to recoup from customers under such low utilization.

Table 1. Impact of a demand charge on a charging station with 100 kw demand

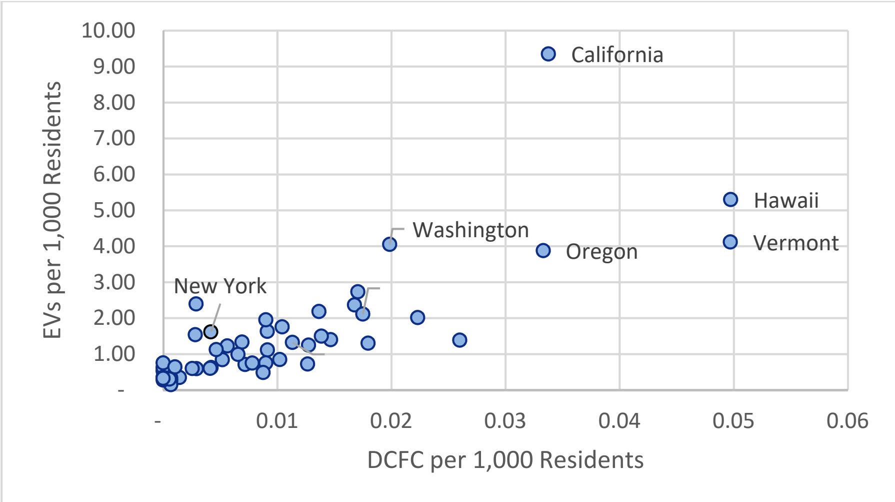
		High Case	Mid Case
Demand Charge ($/kW)		$20	$6
Customer Charge (4/Month)		$70	$70
Energy Charge ($/kWh)		$0.08	$0.08
Energy per Session (kWh)		50	50
15 charging sessions/month	Annual DCFC Bill	$25,560	$8,760
	Cost/session	$142	$49
	Cost/kWh	$2.84	$0.97
60 charging sessions/month	Annual DCFC Bill	$27,720	$10,920
	Cost/session	$39	$15
	Cost/kWh	$0.77	$0.30

To date, DCFC station deployment and EV adoption in New York have been relatively limited. According to data provided by the Alternative Fuels Data Center at the Department of Energy, there are currently 203 DCFC plugs in New York, but only 83 are non-Tesla DCFC plugs.[27] In comparison, there are currently more than 1,300 non-Tesla DCFC plugs in California.[28] The figure below shows the relationship between DCFC and adoption of EVs, controlling for population.

[27] U.S. Department of Energy, Alternative Fuels Data Center, https://www.afdc.energy.gov/data_download, accessed May 2018. Charging stations may contain more than one plug or "port." Often, stations will have two ports. When Tesla charging stations are included, there are 203 in New York compared with 1,775 in California. However, Tesla employs proprietary DCFC charging stations that only Tesla vehicles can access. Therefore, we have focused on charging stations accessible to a wide variety of vehicles.

[28] *Id.*

Figure 6. DC fast chargers (non-Tesla) and EV adoption



Source: Synapse Energy Economics analysis of data from U.S. Department of Energy Alternative Fuels Data Center.

To meet New York's ZEV goal of approximately 800,000 EVs by 2025, many more DCFC will be needed. According to analysis tools developed by the National Renewable Energy Laboratory, New York will require roughly 4,087 DCFC plugs by 2025 to meet its ZEV target.[29]

Where rate design hinders public charging infrastructure, EV adoption is likely to be slow. This begets a chicken-and-egg problem: low levels of EV adoption will result in low charging station utilization and unfavorable business cases for charging station operators, while too few charging stations can slow EV adoption. To address this problem, some utilities have temporarily reduced or eliminated demand charges for customers on EV rates, opting instead to price electricity using TOU rates.

Some have raised concerns that reducing costs for EV charging stations, at least temporarily, could result in cross-subsidization. However, cost shifting will not occur as long as electricity is priced at or above the utility's marginal cost of service.[30] This is because the EV stations are supporting incremental load growth, rather than representing existing load on the system. Existing tariffs are designed to recover embedded costs from existing load, which enables incremental load to be priced at marginal cost, at least during the early years of EV adoption.

[29] To achieve a penetration of 800,000 EVs by 2025, the U.S. Department of Energy's Electric Vehicle Infrastructure Projection Tool (EVI-Pro) Lite estimates that 4,087 DCFC plugs will be required to meet charging demand in New York, using the assumption that 80 percent of customers have access to charging at home. The tool is available at https://www.afdc.energy.gov/evi-pro-lite. EVI-Pro Lite is a simplified version of EVI-Pro, which was developed through a collaboration between the National Renewable Energy Laboratory and the California Energy Commission, with support from the U.S. Department of Energy. EVI-Pro uses personal vehicle travel patterns, electric vehicle attributes, and charging station characteristics to estimate the charging infrastructure required to support various levels of EV adoption.

[30] Any required distribution upgrades directly related to the charging station should also be recovered from the charging station owner in order to avoid shifting these costs on to other customers.

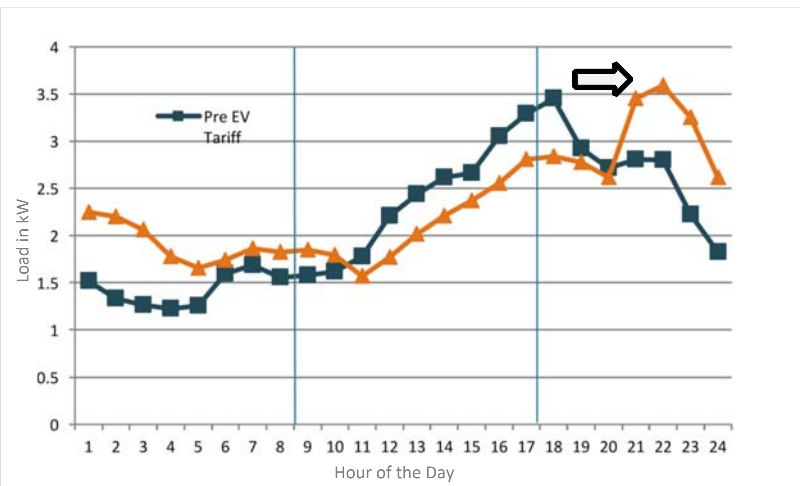
3. Implementation of EV Rates: Lessons from the Field

3.1. Effectiveness of Time-Varying Rates

As noted above, TOU rates have been widely implemented, and in some cases specifically tailored to EV customers. These rates have proven extremely effective in motivating customers to charge off-peak, since customers can save money doing so and off-peak hours generally align with the hours that customers have parked their car at home.

Most TOU rates are applied to all of a customer's load, rather than just the EV load itself. For residential customers, this is referred to as a "whole-house" TOU rate. To test the response of EV customers to such a rate, Baltimore Gas & Electric (BGE) monitored EV customer load before and after enrolling customers in the whole-house TOU tariff. As the graph below shows, without the tariff, customer load peaked at approximately 6 pm, likely when customers returned home from work and plugged in their vehicles. Once customers received the TOU price signal, average load dropped and the peak shifted to the night-time hours.

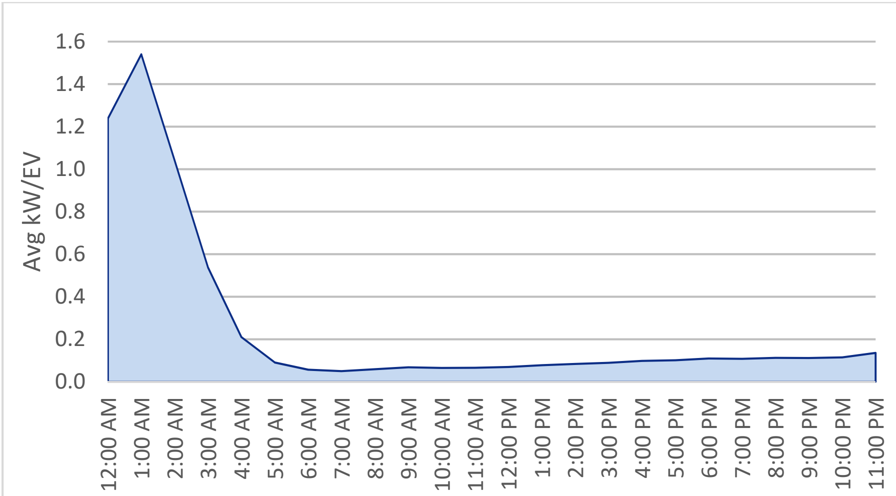
Figure 7. Results of BGE EV tariff pilot



Note: Average weekday customer load before (blue squares) and after (orange triangles) BGE's pilot.
Source: BGE Electric Vehicle Off Peak Charging Pilot, presentation by John Murach, 2017.

The shift in peak load is even more evident for customers on separately metered EV-only rates. For example, under San Diego Gas & Electric's (SGD&E) EV-only rate, the vast majority of load occurs during the middle of the night, as shown in the graph below.

Figure 8. Average load profile for SDG&E customer on EV-only rate



Source: SDG&E Data Response to NRDC DR02-Q6, A.17-01-021.

Both whole-house and EV-only TOU rates have been implemented at all three of California's large IOUs and have been extremely successful in motivating customers to avoid charging on-peak. At Pacific Gas & Electric, 93 percent of charging on the EV-only rate occurs during off-peak hours, while at Southern California Edison, 88 percent of charging is off-peak.[31]

3.2. Design of TOU Rates

Price Ratios

To ensure an effective TOU rate design, the ratio between peak and off-peak prices must be sufficient to motivate customers to shift their load. A study of early-adoption EV customers in SDG&E's service territory found that a peak to off-peak price ratio of 6:1 results in about 10 percent more off-peak charging than a ratio of 2:1.[32]

Reflecting Generation, Transmission, and Distribution Costs

Despite the fact that approximately half of the EVs in the United States are located in California, very few costly grid upgrades due to EVs have occurred to date. According to reports filed by the utilities, grid upgrades due to EVs have totaled less than 0.01 percent of distribution capital costs.[33] This is likely due, at least in part, to the time-varying rates offered by all three of California's IOUs.

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[31] Synapse Analysis of Joint Utilities Load Research Report, Dec 2017.

[32] Nexant. 2014. "Final Evaluation of SDG&E Plug-in Electric Vehicle TOU Pricing and Technology Study." Available at www.sdge.com/sites/default/files/documents/1681437983/SDGE%20EV%20%20Pricing%20&%20Tech%20Study.pdf.

[33] *Id.*

To be efficient, time-varying rates must reflect grid costs. One way in which this is done is by assigning marginal generation, transmission, and distribution costs to each hour of the year. For capacity, this can be done using loss of load expectations for each hour of the year, while for energy, the costs are based on the variable operating costs of different power plants.

The tables below show "heat maps" that reflect hourly marginal costs (in terms of dollars per kWh) for a California utility. The months are shown on the vertical axis, while the hours of the day are shown along the horizontal axis. When the heat maps are combined (Figure 12), the areas of high and low costs can be used to set TOU windows and price differentials.

Figure 9. Marginal energy costs

Columns: Hour Ending (PPT) Rows: Months	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
January	0.049	0.048	0.047	0.047	0.048	0.050	0.058	0.062	0.049	0.046	0.045	0.044	0.041	0.042	0.043	0.046	0.057	0.081	0.077	0.071	0.063	0.060	0.055	0.051
February	0.048	0.047	0.047	0.047	0.048	0.050	0.059	0.053	0.047	0.044	0.043	0.043	0.042	0.042	0.043	0.044	0.049	0.067	0.076	0.073	0.065	0.060	0.054	0.050
March	0.047	0.046	0.046	0.046	0.046	0.047	0.052	0.049	0.045	0.040	0.037	0.032	0.027	0.030	0.038	0.040	0.042	0.050	0.062	0.079	0.069	0.061	0.056	0.049
April	0.046	0.044	0.044	0.044	0.045	0.047	0.051	0.044	0.040	0.035	0.032	0.030	0.028	0.029	0.036	0.038	0.040	0.044	0.050	0.069	0.071	0.058	0.052	0.047
May	0.046	0.045	0.044	0.044	0.045	0.047	0.047	0.043	0.039	0.037	0.037	0.037	0.036	0.037	0.038	0.040	0.041	0.045	0.047	0.063	0.071	0.062	0.054	0.048
June	0.047	0.045	0.045	0.045	0.046	0.047	0.046	0.042	0.039	0.038	0.038	0.039	0.038	0.039	0.040	0.042	0.044	0.050	0.048	0.065	0.074	0.070	0.057	0.049
July	0.049	0.046	0.045	0.045	0.045	0.047	0.046	0.043	0.040	0.041	0.042	0.044	0.046	0.049	0.053	0.056	0.060	0.073	0.059	0.096	0.079	0.070	0.060	0.053
August	0.049	0.047	0.046	0.046	0.046	0.048	0.050	0.045	0.043	0.042	0.042	0.043	0.044	0.046	0.049	0.053	0.060	0.074	0.065	0.092	0.080	0.067	0.059	0.053
September	0.049	0.047	0.046	0.046	0.046	0.049	0.055	0.049	0.044	0.042	0.042	0.042	0.043	0.045	0.048	0.050	0.057	0.073	0.090	0.106	0.074	0.062	0.057	0.051
October	0.048	0.047	0.046	0.046	0.046	0.048	0.054	0.054	0.045	0.042	0.041	0.041	0.042	0.043	0.045	0.046	0.048	0.062	0.073	0.079	0.067	0.060	0.056	0.050
November	0.049	0.047	0.047	0.047	0.047	0.049	0.055	0.050	0.046	0.044	0.044	0.043	0.043	0.044	0.045	0.048	0.061	0.089	0.076	0.068	0.063	0.059	0.054	0.050
December	0.050	0.048	0.048	0.048	0.048	0.050	0.057	0.057	0.049	0.047	0.046	0.046	0.045	0.045	0.046	0.048	0.060	0.084	0.077	0.073	0.066	0.062	0.059	0.052

Figure 10. Marginal generation capacity costs

Columns: Hour Ending (PPT) Rows: Months	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
January	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
February	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
March	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
April	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
May	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.000	-	-	-
June	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.000	0.002	0.004	0.007	0.010	0.165	0.164	0.009	-	-
July	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.000	0.011	0.031	0.002	-	-
August	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.000	0.003	0.008	0.007	0.054	0.621	0.214	0.004	-	-
September	-	-	-	-	-	-	-	-	-	-	-	-	-	0.000	0.003	0.023	0.107	0.249	2.665	1.789	0.441	0.019	0.000	-
October	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.000	0.000	0.000	0.004	0.011	0.002	0.000	0.000	0.000	-
November	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
December	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Figure 11. Marginal distribution capacity costs

Columns: Hour Ending (PPT) Rows: Months	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
January	0.002	0.001	0.001	0.001	0.001	0.003	0.007	0.006	0.006	0.005	0.003	0.002	0.003	0.003	0.004	0.006	0.006	0.024	0.018	0.015	0.010	0.007	0.008	0.005
February	0.002	0.001	0.001	0.001	0.001	0.002	0.006	0.007	0.006	0.005	0.004	0.004	0.004	0.005	0.004	0.005	0.006	0.014	0.015	0.013	0.008	0.007	0.007	0.005
March	0.002	0.000	0.001	0.001	0.000	0.002	0.005	0.005	0.004	0.002	0.003	0.002	0.002	0.002	0.003	0.004	0.006	0.008	0.010	0.010	0.010	0.008	0.006	0.004
April	0.002	0.001	0.001	0.001	0.001	0.001	0.004	0.003	0.002	0.002	0.002	0.002	0.002	0.002	0.003	0.003	0.006	0.011	0.008	0.010	0.009	0.009	0.007	0.005
May	0.004	0.001	0.001	0.001	0.001	0.001	0.003	0.003	0.003	0.002	0.002	0.003	0.003	0.003	0.004	0.006	0.009	0.020	0.013	0.015	0.016	0.012	0.008	0.006
June	0.005	0.002	0.001	0.001	0.002	0.001	0.002	0.003	0.003	0.005	0.004	0.006	0.004	0.008	0.010	0.016	0.020	0.028	0.020	0.021	0.022	0.021	0.017	0.010
July	0.009	0.005	0.003	0.002	0.003	0.004	0.007	0.007	0.009	0.009	0.012	0.013	0.012	0.019	0.025	0.029	0.043	0.088	0.060	0.043	0.036	0.032	0.024	0.015
August	0.011	0.005	0.003	0.003	0.003	0.006	0.009	0.008	0.009	0.011	0.013	0.014	0.016	0.024	0.031	0.049	0.071	0.095	0.065	0.047	0.040	0.032	0.025	0.017
September	0.007	0.003	0.002	0.002	0.002	0.004	0.010	0.008	0.008	0.009	0.010	0.011	0.015	0.019	0.026	0.040	0.059	0.101	0.044	0.046	0.036	0.025	0.021	0.015
October	0.003	0.001	0.000	0.001	0.001	0.003	0.005	0.005	0.005	0.004	0.004	0.004	0.003	0.006	0.008	0.015	0.022	0.039	0.024	0.030	0.017	0.011	0.008	0.006
November	0.002	0.001	0.001	0.001	0.001	0.002	0.005	0.005	0.004	0.004	0.004	0.004	0.004	0.004	0.006	0.006	0.009	0.045	0.024	0.014	0.009	0.007	0.007	0.005
December	0.003	0.001	0.001	0.001	0.001	0.003	0.006	0.006	0.006	0.005	0.004	0.004	0.003	0.004	0.005	0.006	0.007	0.041	0.025	0.019	0.013	0.009	0.008	0.006

Figure 12. Total marginal costs

Columns: Hour Ending (PPT) Rows: Months	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
January	0.051	0.049	0.048	0.048	0.049	0.053	0.069	0.078	0.055	0.050	0.048	0.046	0.044	0.045	0.047	0.057	0.099	0.169	0.115	0.086	0.074	0.067	0.063	0.056
February	0.050	0.048	0.047	0.048	0.049	0.052	0.064	0.060	0.053	0.049	0.047	0.047	0.046	0.047	0.047	0.051	0.084	0.162	0.133	0.086	0.072	0.067	0.061	0.055
March	0.049	0.046	0.046	0.046	0.046	0.049	0.057	0.054	0.049	0.042	0.039	0.034	0.029	0.033	0.041	0.044	0.065	0.131	0.155	0.103	0.078	0.070	0.062	0.053
April	0.048	0.045	0.045	0.045	0.046	0.048	0.055	0.047	0.042	0.036	0.033	0.032	0.030	0.031	0.039	0.041	0.046	0.102	0.170	0.087	0.080	0.067	0.059	0.052
May	0.050	0.046	0.045	0.045	0.046	0.049	0.050	0.046	0.042	0.039	0.039	0.039	0.039	0.040	0.043	0.045	0.050	0.106	0.156	0.088	0.087	0.073	0.062	0.054
June	0.052	0.047	0.046	0.046	0.047	0.049	0.048	0.046	0.043	0.044	0.044	0.045	0.043	0.047	0.051	0.059	0.066	0.112	0.157	0.215	0.194	0.097	0.074	0.059
July	0.058	0.051	0.048	0.047	0.048	0.050	0.053	0.050	0.049	0.050	0.054	0.057	0.058	0.068	0.077	0.086	0.102	0.203	0.218	0.145	0.134	0.103	0.084	0.068
August	0.060	0.052	0.049	0.049	0.049	0.054	0.058	0.053	0.052	0.053	0.055	0.057	0.059	0.070	0.080	0.104	0.146	0.235	0.249	0.511	0.248	0.101	0.084	0.070
September	0.056	0.050	0.048	0.048	0.048	0.052	0.065	0.057	0.052	0.051	0.052	0.054	0.058	0.064	0.076	0.104	0.185	0.381	1.844	1.225	0.374	0.099	0.079	0.066
October	0.051	0.048	0.047	0.047	0.047	0.051	0.060	0.062	0.050	0.045	0.045	0.045	0.046	0.049	0.052	0.061	0.089	0.180	0.173	0.111	0.084	0.071	0.064	0.056
November	0.050	0.048	0.048	0.048	0.048	0.051	0.060	0.055	0.050	0.048	0.048	0.047	0.047	0.048	0.051	0.079	0.157	0.200	0.099	0.082	0.072	0.065	0.061	0.056
December	0.053	0.049	0.048	0.049	0.049	0.054	0.063	0.063	0.055	0.051	0.050	0.050	0.049	0.049	0.051	0.054	0.122	0.255	0.107	0.092	0.080	0.072	0.067	0.058

When designing TOU rates, it can be instructive to examine distribution costs on a class level as well. In some cases, commercial areas peak during the middle of the days, while circuits serving residential customers peak in the evening. Such findings may suggest establishing different on-peak and off-peak periods for different customer classes.

Another consideration is how wide to set each on-peak and off-peak window. Narrow peak periods and wide off-peak periods provide customers with the most flexibility to shift energy consumption to off-peak hours, but care must be taken to avoid creating a new peak by shifting load to immediately before or after the peak period window.[34] Narrow off-peak windows concentrate energy consumption, which can be problematic when this occurs with large EV loads clustered in small areas. Because EV adoption tends to occur in certain neighborhoods and regions more than others, areas with high penetrations of EVs could see local spikes in demand when all EVs begin charging simultaneously. To avoid this, longer off-peak periods can be beneficial.

3.3. Alternatives to Demand Charges

As noted above, demand charges can be a barrier to both DCFC as well as workplace charging. For this reason, some utilities have proposed to reduce the demand charge for these customers, or to temporarily suspend the demand charge (instead shifting the cost recovery to the energy charge). For example, in California, Southern California Edison proposed to exclude a demand charge from its EV rate designs. Instead, it is recovering costs through TOU rates for a period of five years. The demand charge would then be gradually phased back in over the next five years. Similarly, in New York, the Consolidated Edison Company of New York's (Con Edison) proposed to provide a temporary discount to public fast charging stations (with an aggregate capacity of at least 100 kW) through its Business Incentive Rate program. This program reduces customers' delivery charges by nearly 40 percent for a period of up to seven years.[35] The New York Public Service Commission approved this discount, noting the importance of publicly available EV charging stations in supporting adoption of EVs. The Commission also stated that the discount would "help mitigate the high cost of EV charging station operation in an immature market with low charging station utilization."[36]

[34] To mitigate the sharp rise in demand at the beginning of the off-peak period, some utilities are exploring managed charging. Managed charging would allow a utility (or third party) to remotely reduce the rate of vehicle charging in a manner similar to traditional demand response programs. However, the cost of the communications infrastructure necessary to relay such signals may be cost prohibitive. *See:* Erika Myers, "Utilities and Electric Vehicles: The Case for Managed Charging" (Smart Electric Power Alliance, April 2017), 5, https://sepapower.org/resource/ev-managed-charging/. In some cases, utilities assign customers a specific time to start charging to avoid a sudden surge in demand. Conversation with Pasi Miettinen, President and CEO of Sagewell, Inc.

[35] To be eligible, customers must not impose substantial additional distribution facility costs on the system, unless those costs are borne by the customer.

[36] New York Public Service Commission, Order Approving Tariff Amendments, Case 17-E-0814, April 24, 2018, page 6.

3.4. Metering Technologies for EV-Only Rates

Customers may be hesitant to enroll in a whole-house TOU rate plan because it can be a challenge to shift certain energy-intensive behaviors from expensive on-peak periods to cheaper off-peak periods. It is much easier for customers to monitor and control EV charging than appliances in other parts of the home. For this reason, customers may prefer an EV-only TOU rate to a whole-house rate.

While customers on a whole-house TOU rate plan would only need a single meter to monitor electricity use, EV-only rates require a separate revenue-grade meter or the use of submetering technology to record electricity use that is specifically attributable to EV charging. Each metering option has certain advantages and drawbacks. While a second utility meter is a straightforward option, the costs of installation can be prohibitively high, and customer charges associated with a second meter can deter customers. Submetering is promising, particularly if installation costs can be reduced further and data transfer issues can be resolved. We discuss these and other metering options below.

Second Meter for EV Charging

Standard utility practice for EV-only rate plans is to combine TOU rates with the installation of a second meter designated specifically to monitor EV charging. Some utilities provide the EV billing meter free of charge while others require that customers pay for it through an up-front fee or additional monthly charge. Although a second meter makes it easy to apply TOU rates only to EV charging, the additional meter and installation charges present a significant barrier to widespread adoption of EV-only rates.

Regardless of who pays for the second meter, customers are generally responsible for the installation costs, which include the meter socket(s) with a lever bypass and conduit and wiring performed by an electrician. The installation can cost thousands of dollars up front for customers, eliminating virtually any of the fuel cost savings associated with the EV-only rate. The Minnesota Public Utilities Commission notes that residential customers typically spend between $1,725 and $3,525 on electrical wiring and metering costs to enroll in Xcel Energy's current EV tariff.[37]

As a result of the high costs associated with separately metered programs, enrollment has been low to date in many jurisdictions.[38] For example, as of April 2017, Xcel Energy (Minnesota) had only enrolled 95 customers on its second-meter EV rate over the course of nearly two years.[39] In recognition of these

[37] Minnesota Public Utilities Commission, Order Approving Pilot Program, Granting Variance, and Requiring Annual Reports. Docket No. E-002/M-17-817, May 9, 2018, page 2.

[38] Utilities offering second-meter EV rates include Southern California Edison, PG&E, SDG&E, Detroit Edison, Consumers Energy, Xcel MN, and Dominion Energy.

[39] Minnesota Public Utilities Commission Staff, Briefing Papers, In the Matter of Xcel Energy – Electric – Petition for Approval of a Residential EV Service Pilot Program, E002/M-17-817, April 12, 2018, page 14.

barriers to enrollment, Xcel has initiated a submetering pilot to attempt to reduce costs and provide additional options to customers.[40]

In a similar case, Dominion Power had to extend its pilot EV pricing plan due to low enrollment. Dominion's pilot consists of two EV pricing plan options: an EV-only TOU rate and a whole-house TOU rate. The EV-only rate requires a separate meter, while the whole-house TOU rate requires an upgraded meter that is capable of recording interval usage. Dominion provides the meters to customers at no charge, but customers are responsible for the installation costs. [41] Customers on the EV-only rate also face an additional monthly customer charge.

Dominion's pilot was originally approved by the Virginia State Corporation Commission in 2011 with an enrollment limit of 1,500 participants. As of October 2013, the pilot program had 230 enrolled participants, but Dominion noted that EV adoption levels in its service territory had grown by more than 700 percent over the course of the original program.[42] The Commission approved the extension to allow more time for the pilot to reach full enrollment and to enable Dominion to more fully analyze the results. In 2016, five years after commencement, the pilot closed enrollment at only 600 customers – less than half of the cap.

Both of these examples illustrate the magnitude of the cost barrier associated with using a second meter to provide EV rates. Because the cost of installing the second meter can be such a deterrent, utilities and regulators have started to seek other options, such as submetering. Submetering offers much promise, but currently faces cost challenges of its own. Another option is to utilize the metering equipment in the EV itself (on-board metering), but this has not been explored to the same extent as other forms of submetering.

Submetering Technologies

Submetering is similar to having an additional meter, except that the submeter is located between the primary meter and the EV. This allows the EV load to be billed on a time-varying rate, while the rest of the household usage is billed on a standard rate. Submeters are not yet widely used for EV-only tariffs, but California has conducted extensive testing on the technology, and several utilities are piloting

[40] Xcel Energy, In the Matter of Xcel Energy – Electric – Petition for Approval of a Residential EV Service Pilot Program, E002/M-17-817, November 17, 2017.

[41] Under the EV-only rate, a dedicated hard-wired circuit is required, and an electrician may recommend changes to the existing electrical set up, which would incur additional costs. Under the whole-house TOU rate, service upgrades may be required due to the additional energy consumed at a home, which would incur additional costs from an electrician.

[42] Rivera-Linares, Corina. 2013. Dominion Virginia Power seeks to extend electric vehicle pilot program by two years. TransmissionHub. Available at: https://www.transmissionhub.com/articles/2013/11/dominion-virginia-power-seeks-to-extend-electric-vehicle-pilot-program-by-two-years.html

submetering for EV tariffs.[43] The current technology options and costs associated with submeters include:

1) Stand-alone submeters like the WattBox™ from eMotorWerks, with a cost of approximately $250;[44]

2) Submeters integrated with the EV supply equipment ("EVSE," colloquially "charging station"). At-home EVSE are generally Level 2 charging stations such as the JuiceBox™ from eMotorWerks with a cost of approximately $899,[45] or the ChargePoint Home from ChargePoint with a cost of approximately $674; [46] and

3) Mobile (in-car) submeters such as the FleetCarma C2 device.

Installation of both stand-alone and EVSE-integrated submeters typically requires an electrician and will incur an additional cost. In contrast, FleetCarma's C2 device is "plug-and-play," allowing the EV owner to simply plug it into the on-board diagnostics port found under the dash of the vehicle. All three submeter types collect EV charging data and use WiFi or a cellular network to record and transmit usage data to third-party vendors or directly to the utility.

California has actively sought to promote the development of submetering technologies as a lower cost option to traditional metering options. To that end, a two-phase multi-year pilot was initiated in California to test submetering functionality. The two-phase pilot ran from 2014 to 2018 and provided opportunities to identify submetering challenges and work to overcome those barriers. In addition to California's pilot, EVSE-embedded submetering has been implemented for EV off-peak charging rewards at Belmont Light in Massachusetts and will be soon be tested in Minnesota. Mobile (in-car) submeters are currently in use for Con Edison's Smart Charge Rewards program and have also been used for pilot in Toronto and Arizona.[47]

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[43] California is in Phase II of its submetering pilot, while Xcel Minnesota recently obtained approval to proceed with its submetering pilot. Submetering has also been tested by some municipal utilities, such as Belmont Light in Massachusetts.

[44] Cook, J. et al. 2016. California Statewide PEV Submetering Pilot – Phase 1 Report. Nexant. Prepared for the California Public Utilities Commission. Page 31.

[45] Pricing as of May 2018 on eMotorWerks website store: https://emotorwerks.com/store/residential/juicebox-pro-75-smart-75-amp-evse-with-24-foot-cable?gclid=CjwKCAjw_47YBRBxEiwAYuKdw3px-uQc2d5KVUzQHr-KOnLCI3sNmkUyDNm6e6VifNu-PrYt15dCmhoCtM8QAvD_BwE

[46] Pricing as of May 2018 on ChargePoint website store: https://store.chargepoint.com/chargepoint-home

[47] Toronto's program is called ChargeTO, and the results of its pilot are available from FleetCarma here: https://www.fleetcarma.com/resources/chargeto/. The Salt River Project's pilot results are available here: https://www.srpnet.com/newsroom/releases/011018.aspx.

Stand-Alone and Embedded EVSE Submetering

Technical Challenges and Progress

Several submetering pilot programs have noted issues with data transmission associated with WiFi, which can result in problems with customer bills. Almost all of the participants in Phase 1 of California's Plug-In Electric Vehicle Submetering Pilot, which ran between 2014 and 2016, used stand-alone submeters with WiFi for data transmission. A common problem was spotty data coverage, submeters going offline, and software issues with data server. Analysis of a sample of submeters in use suggested that 10–20 percent experienced some sort of data accuracy problem over the course of the Phase 1 Pilot.[48]

Belmont Light in Massachusetts reported a similar experience, stating that it was unable to provide accurate rebates to customers for off-peak EV charging due to WiFi connectivity and data access issues with stand-alone submeters.[49] However, participants with EVSE embedded submeters did not report the same data issues.[50] Belmont Light was also able to verify customer charging via smart meter data, whereas the California utilities reviewed program data from third-party Submeter Data Management Agents, who measured EV electricity use and delivered data to the utilities on a daily basis for billing purposes.

The California Phase 1 submetering pilot was a relatively small-scale pilot with only 241 participating customers. Phase 2, which began in January 2017 and concluded in April 2018, was designed to address some of the issues encountered in Phase 1 and test even more stringent levels of metering accuracy. For example, the accuracy threshold for submeters was lowered from 5 percent to 1 percent for Phase 2, as recommended in the Phase 1 evaluation report.[51] This threshold eliminates most of the stand-alone submetering technologies and requires the use of a submeter integrated with the EVSE.

In addition to the submetering pilot, SDG&E plans to deploy 3,500 EVSE with embedded submeters for its *Power Your Drive* vehicle-to-grid integration pilot and up to 60,000 EVSE with embedded submeters for its residential charging program.[52] Currently vendors are undergoing multi-month testing to ensure that the EVSE can provide dynamic, hourly rates (on a day-ahead basis) to the driver, allow the customer to set charging needs, and collect and transmit the hourly usage data to the utility.[53] These advanced

[48] Cook, J. et al. 2016. California Statewide PEV Submetering Pilot – Phase 1 Report. Nexant. Prepared for the California Public Utilities Commission. Page 12.

[49] Conversation with Rebecca Keane, Energy Resources Analyst at Belmont Light. April 26, 2018.

[50] Conversation with Rebecca Keane, Energy Resources Analyst at Belmont Light. April 26, 2018.

[51] Jonathan Cook et al., "California Statewide PEV Submetering Pilot – Phase 1 Report.," Prepared for the California Public Utilities Commission (Nexant, April 1, 2016), 13.

[52] California Public Utilities Commission, Decision on Transportation Electrification Standard Review Projects, Decision 18-05-040, May 31, 2018.

[53] SDG&E. Electric Vehicle-Grid Integration Pilot Program ("Power Your Drive") Third Semi-Annual Report of San Diego Gas & Electric Company, Rulemaking 13-11-007, September 19, 2017.

technical requirements have required that EVSE vendors develop custom software solutions, and they will certainly help to further the state of the technology.

EVSE-Embedded Submetering Costs

Although submetering is intended to lower costs to customers, there are often substantial costs associated with installation for submeters embedded in Level 2 EVSE. These costs can be a deterrent to drivers. In California, Nexant found that installation costs must be kept low and charging savings must be approximately $15/month, on average, to be attractive to EV owners. Increasing the installation costs of a submeter by $150 reduced the likelihood of program enrollment by one-third, while an increase of $300 reduced the likelihood of enrollment by one-half.[54]

Cost issues were less important for Belmont Light, where many of its customers that participated in the pilot program already had Level 2 chargers that could be integrated with smart meters to provide EV charging data to the utility. These customers received a rebate from the utility of $5/month in exchange for a promise to shift charging to off-peak hours. (Note that Belmont Light does not currently have TOU rates.) Customers were allowed up to three charges per month during on-peak times to retain this incentive.[55]

Mobile Submeters

Mobile (in-car) submeters offer another option for utilities to gather information on the charging and driving patterns of EV owners. Con Edison currently offers an off-peak charging incentive program to EV customers using the FleetCarma C2 device, which is installed by plugging it into the vehicle's on-board diagnostics port. The device then collects vehicle charging and driving data by decoding signals from the vehicle's internal computer system and sends the data securely to FleetCarma servers over the cellular network.

Rather than apply a TOU rate structure, the SmartCharge NY program rewards participants with e-gift cards for off-peak charging behavior anywhere in the Con Edison service territory (EV owners do not have to be Con Edison customers).[56] Con Edison launched the program in April 2017 with 100 EVs with the C2 device. The program was expanded to full scale in July 2017, and then in September 2017 the *Bring Your Own Charger Fleet Program* component was launched. As of January 2018, there were 875 EVs enrolled in the program (431 private EVs and 444 New York City electric fleet vehicles), representing

[54] Cook et al., "California Statewide PEV Submetering Pilot – Phase 1 Report.," 10.

[55] Going forward, Belmont Light has combined its customers into one group and increased its incentive to $8/month for off-peak charging. Conversation with Rebecca Keane, Energy Resources Analyst at Belmont Light. April 26, 2018.

[56] Sherry Login, "SmartCharge New York," January 22, 2018, 4, http://www.state.nj.us/bpu/pdf/publicnotice/stakeholder/20180205/NJ%20EV%20Stakeholders%20Meeting_January%2022%202018%20Con%20Ed.pdf.

15 percent of the EVs in Con Edison's service territory. By charging off-peak, Con Edison estimates the program has achieved a 0.63 MW peak load reduction.[57]

Through the use of a mobile submeter and rewards program, SmartCharge NY avoids the need for electricians or utility crews to install equipment, does not require a separate EV tariff, does not require complex billing processes, and avoids additional customer charges from the utility. The rewards offered for off-peak charging may also be updated as needed with no filing requirements, and EV owners do not have to be utility account holders.[58] Importantly, Con Edison has found that SmartCharge NY has higher enrollments than its TOU programs, with 875 vehicles enrolled in nine months. In contrast, the TOU Rate with one-year price guarantee had 55 customers enrolled over the course of four years, and the EV-only TOU rate program has only four customers enrolled.[59]

A key drawback of this technology and program type is its cost. Based on program data provided by Con Edison, the annual non-incentive costs of the program total approximately $250 per year per EV customer enrolled.[60] In other jurisdictions with lower enrollments, the non-incentive costs have been estimated to be many times higher.[61] Other challenges to greater program enrollment include: customer awareness, privacy concerns (FleetCarma attempts to manage this issue by anonymizing the data provided to utilities), difficulties installing the C2 device in Tesla vehicles, and the limitation to light-duty vehicles.[62] Next steps for the SmartCharge NY program include a four-month pilot program evaluating the viability of cloud-based technology as an alternative to the C2 device.[63]

On-Board Metering

On-board metering (or "on-vehicle metering") could offer a low-cost alternative submetering approach but requires more testing and support to mature. By using the vehicle's built-in metering and telemetry capabilities, on-board metering could avoid the need for a separate, external device and communications infrastructure altogether. In comments filed in California, GM stated "On-vehicle metering is a consideration that could provide the most cost-effective, communications capable,

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57 Login, 16.

58 Login, 18.

59 Information on TOU rates can be found at: https://www.coned.com/en/save-money/energy-saving-programs/time-of-use.

60 Login, 3.

61 For example, NV Energy's estimated administrative cost for the program totaled approximately $1,400 per customer. This high cost is likely related to the small scale of NV Energy's proposed program, which would only provide incentives to 300 EV customers. *See:* Direct Testimony of Will Toor on behalf of Nevadans for Clean Affordable Reliable Energy, Docket 18-02002, May 8, 2018, page 11.

62 *Id*. Slide 19.

63 *Id*. Slide 20.

regulatory compliant and utility/customer friendly solution for measuring and recording BEV and PHEV electricity consumption."[64]

Although the potential for on-board metering has been noted both in the United States and abroad, it has yet to gain widespread attention or adoption, except for in specific applications such as aggregated demand response. A key barrier to the use of on-board metering for implementing time-varying rate structures is the requirement for revenue grade metering and the implications for billing responsibility. Specifically, metering requirements generally follow American National Standards Institute (ANSI) standards for metering accuracy of +/- 0.2% or +/- 0.5% and require rigorous testing and certification processes. Further, resolution of billing disputes where submeters are involved can be complicated.[65]

To overcome these barriers, the need for stringent metering standards for submetering may need to be revisited and clear rules for dispute settlement established. California's submetering protocol proceedings and pilots are currently exploring some of these issues. However, they primarily focus on embedded EVSE submetering, rather than on-board vehicle metering.[66]

While on-board metering has not been developed to the point where it is used for traditional rate structures, it is being used or piloted for applications where metering requirements are less onerous. These applications include providing demand response where the performance of multiple EVs are aggregated together and rebate programs that provide customers with rewards (such as gift cards) for off-peak charging outside of the traditional utility billing process.[67]

3.5. Maximizing Customer Enrollment in EV Rates

Low levels of customer enrollment in EV rates can prevent achievement of the substantial benefits associate with TOU rates. Enrollment levels can be low due to several reasons, including:

- Rates that are too complex to be easily understood by customers,
- Customer inertia (the "hassle factor"),
- Lack of awareness of the rate, and
- Uncertainty regarding whether customers will save money on the new rate.

As discussed in Chapter 0, TOU rates are the most widespread time-varying rate in use today, in part because of their simplicity and customer acceptance. Sometimes TOU rates are combined with critical peak pricing to provide even more targeted price signals, which has also been successful. Although there

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[64] GM. Comments in response to Rulemaking (R.) 09-08-009 "The Utility Role in Supporting Plug-In Electric Vehicle Charging" Staff Issues Paper, August 30, 2010.

[65] Communication with George Bellino, June 7, 2018.

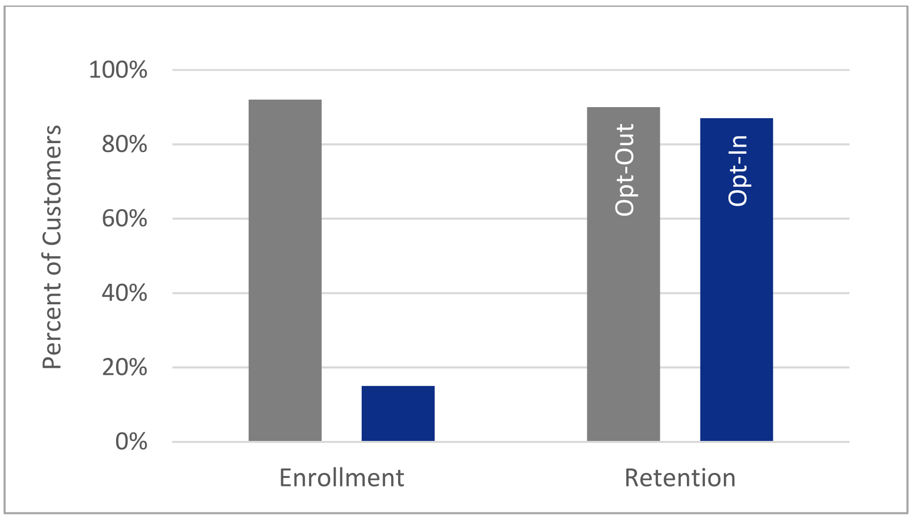
[66] California's submetering pilot program documents are available at http://www.cpuc.ca.gov/general.aspx?id=5938.

[67] The authors understand that Con Edison is currently exploring on-board metering for its off-peak rebate programs.

is theoretical appeal in more dynamic rates (such as those that vary by hour or by location), such rate designs are generally too complex for residential customers and likely to lead to low enrollment.[68]

Due to customer inertia, low levels of customer enrollment are common when customers are required to actively opt-in to the rate, but high levels of customer enrollment can be achieved through defaulting customers onto a rate (through an opt-out design). This has been found to be true for both EV customers and non-EV customers. For example, an analysis of 10 time-varying rate pilots found that, under an opt-in rate structure, less than 20 percent of customers enrolled. In contrast, the two utilities that employed a default (opt-out) design attained enrollments of more than 90 percent of customers. After a year, the default design retained a slightly larger proportion of customers than even the opt-in structure.[69]

Figure 13. TOU enrollment and retention levels



Until customers become more familiar with time-varying rates, opt-in programs will likely be the norm. Where opt-in rates are used, utilities must do more than simply establish the rate—they must actively encourage enrollment through a combination of education, outreach, and incentives. In addition, it is important to ensure that utility incentives, auto dealership incentives, and customer incentives are all aligned.

Activities to maximize EV customer enrollment in EV rates may include:

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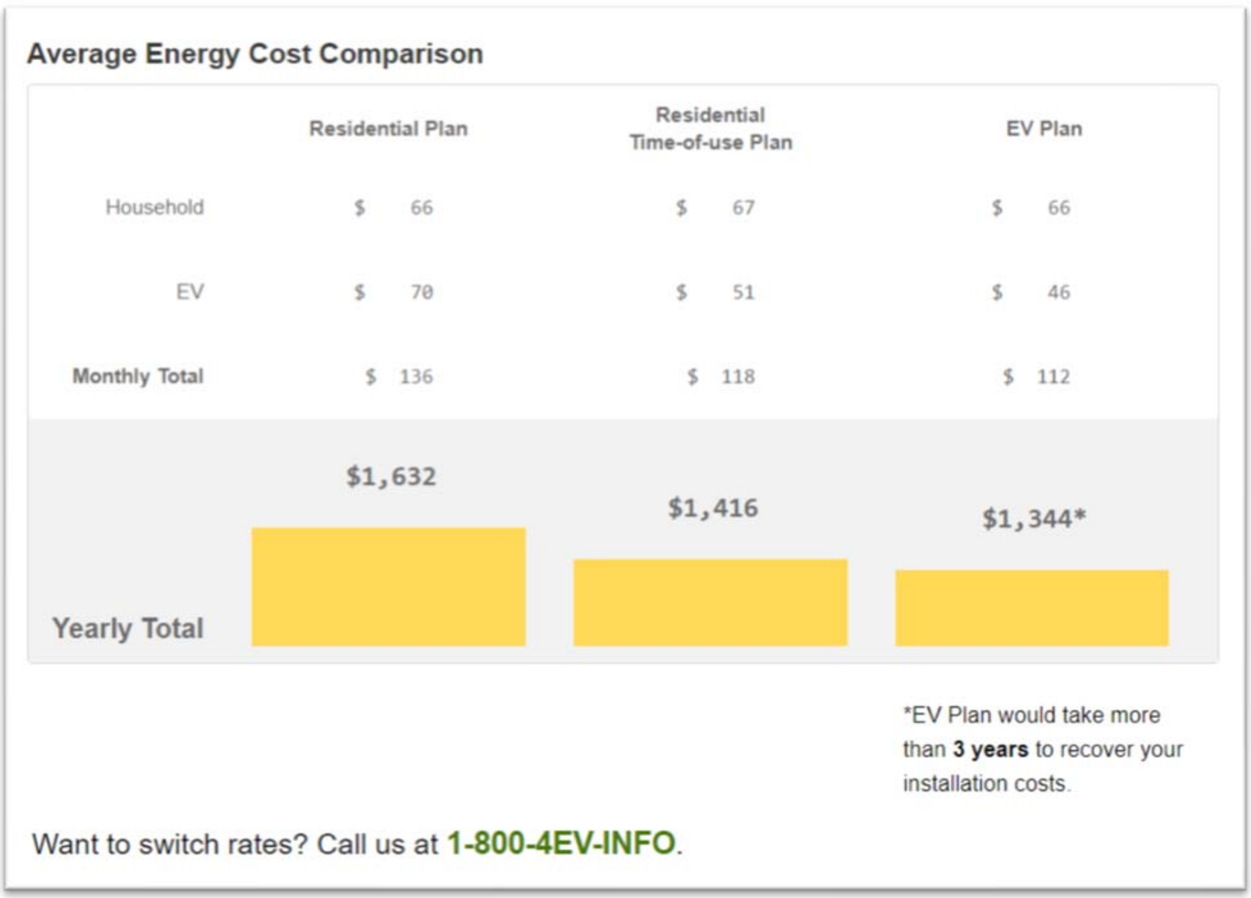
[68] For example, in 2017 SDG&E proposed a residential EV rate that would include both an hourly dynamic rate and critical peak pricing, the timing of which would vary by circuit across the utility's territory. Regulators rejected the rate design, stating "While some early adopting customers may be savvy enough to monitor and respond to daily price signals, SDG&E has provided no evidence suggesting the average residential customer will respond to a different charging period every day based on day-ahead pricing signals." *See: Proposed Decision of ALJs Goldberg and Cooke, Decision on the Transportation Electrification Standard Review Projects, Application 17-01-020 et al., March 30, 2018, page 47.*

[69] Customer Acceptance, Retention, and Response to Time-Based Rates from the Consumer Behavior Studies; Smart Grid Investment Grant Program; November 2016.

- **Website Tools:** Determining whether an EV rate will save a customer money is a complex quantitative exercise. Rate comparison calculators, such as Southern California Edison's Electric Vehicle Rate Assistant Tool, provide an easy way for customers to compare their cost savings over several different rate options. The image below shows a screenshot of sample results from the Rate Assistant Tool—a simple web-based tool that guides customers through the rate comparison process.[70] We note that the rate assistant tool also provides a dedicated EV customer service phone number that customers can call to enroll.

Figure 14. Example web-based rate comparison calculator



- **Dealership Education and Incentives.** Lack of familiarity with EVs can lead auto sales representatives to shy away from selling EVs, or even to actively discourage purchase of EVs. [71] Furthermore, auto sales representatives often have little to no understanding of the rates available to EV drivers. For example, Consumer Reports found that "When asked how much it would cost to charge an EV, only about 19 percent of salespeople

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[70] https://www.sce.com/wps/portal/home/residential/electric-cars/charging-and-installation/EV-Rate-Assistant

[71] John Voelcker, "Many Car Dealers Don't Want To Sell Electric Cars: Here's Why," *Green Car Reports*, February 14, 2014, https://www.greencarreports.com/news/1090281_many-car-dealers-dont-want-to-sell-electric-cars-heres-why.

gave reasonably accurate answers."[72] In California, a dealership training curriculum was developed and is conducted by a collaboration of organizations, and a $250 dealership incentive is provided for each EV purchase in which the customer also signs up for an EV rate.[73]

- **Direct Outreach to EV Customers.** It can be difficult for a utility to identify which of its customers have purchased an EV. To identify customers, it may be possible for utilities to work with state agencies to access Department of Motor Vehicle registration records and directly contact EV drivers. Some utilities also offer gift cards or other rewards to customers. For example, Salt River Project in Arizona provides EV customers with a $50 gift card simply for signing up for the utility's EV mailing list. Establishing these points of contact can be an important first step to educating and enrolling customers in an EV rate.

- **Price Guarantees:** Many utilities offer a price guarantee for the first six months to a year that a customer enrolls in a time-varying rate. These guarantees ensure that the customer will not pay more on the time-varying rate than they would on a standard rate, thereby reducing the customer's risk of signing up for a rate structure that is new to them.

[72] Charles Morris, "Are Auto Dealers the EV's Worst Enemy?," *Charged Electric Vehicles*, September 9, 2014, https://chargedevs.com/features/are-auto-dealers-the-evs-worst-enemy/.

[73] The monetary incentive was recently approved for SDG&E. *See:* California Public Utilities Commission. Decision on the Transportation Electrification Priority Review Projects. Decision 18-01-024. January 11, 2018, page 39.

4. ASSESSMENT OF NEW YORK UTILITY EV RATE PROPOSALS

Recent utility attention to EV rate design in New York State has arisen partly in response to a state law requiring that each New York electric IOU file an application to establish a residential tariff for the purpose of charging EVs no later than April 1, 2018.[74] This same law allows for periodic updates to residential EV rates, and it requires that IOUs regularly report on the number of customers taking service under the residential EV tariff and the total amount of electricity delivered under the tariff.[75]

In March 2018, all six New York electric IOUs submitted filings in compliance with requirements to develop residential EV tariffs. Three of the utilities—Con Edison, Niagara Mohawk Corporation d/b/a National Grid (National Grid), and Orange and Rockland Utilities, Inc. (O&R)—stated that their compliance was based on previously proposed or implemented EV TOU rates.[76] The other three—Central Hudson Gas & Electric Corporation (Central Hudson), New York State Electric and Gas Corporation (NYSEG), and Rochester Gas and Electric Corporation (RG&E)—proposed new residential EV tariffs for consideration by the New York Public Service Commission.[77]

Below, we assess the tariffs that the New York IOUs propose to use to comply with the requirement that they develop and maintain residential EV rates. We evaluate both design considerations and the likely impact of these tariffs on customer fuel costs.

4.1. Positive Aspects of Residential EV Rate Proposals

Each of the proposed residential EV rates shares certain important and positive characteristics. Chief among these are the inclusion of a TOU rate structure and a price guarantee mechanism.

Overarching Rate Design Structure

Each of the proposed residential EV tariffs incorporates a reasonable rate design structure. Specifically, each proposed rate uses a TOU structure and does not include a demand charge. As discussed previously, TOU rate designs combine efficient price signals with simplicity to provide an accessible price signal for residential customers. TOU energy rates provide a clear incentive for EV customers to charge their vehicles during low-cost, off-peak hours without requiring that these customers pay constant attention to their hour-to-hour energy usage. Customer charges should generally be kept to low levels

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[74] New York Public Service Law Section 66-o(2)

[75] New York Public Service Law Section 66-o(6)

[76] Con Edison Compliance Filing Regarding Compliance with Public Service Law § 66-o. March 30, 2018; National Grid Compliance Filing Regarding Public Service Law Section 66-o(2) – Residential Tariff for Electric Vehicles. March 30, 2018; O&R Compliance Filing Regarding PSL§ 66-o. March 30, 2018. To date, adoption of these existing TOU rates has been minimal. For example, Con Edison recently indicate that fewer than 2,000 customers, or less than 0.1 percent of residential customers, have adopted its residential TOU rate. See Con Edison AMI Metrics Report Appendix 18. April 30, 2018. Filed in New York Public Service Commission Docket 16-00253.

[77] Central Hudson Letter to Public Service Commission Regarding Compliance Filing to Effectuate Amendments to Public Service Law § 66. March 29, 2018.; NYSEG & RG&E Compliance Filing Regarding Plug-In Electric Vehicle Tariff. March 30, 2018.

but are a reasonable mechanism for recovering costs that are clearly tied to the number of customers on a utility system, such as costs for installing and reading meters.

It is worth noting that the state law requiring the establishment of residential EV rates does not include any requirements or guidance regarding the design of those rates. It is therefore commendable that the New York IOUs developed TOU rate structures.

Price Guarantee

Each of the New York IOU proposals includes a whole-house TOU rate with a one-year price guarantee. Under this mechanism, customers switching onto the whole-house TOU rate have the option of comparing their first-year charges to the charges they would have incurred if they had remained on their original rate. If they pay more under the TOU rate, the customers will be eligible to receive the difference between what they actually paid and what they would have paid under the standard rate. This feature provides the type of assurance that is helpful for convincing wary customers to switch onto a TOU rate. This insurance against a bad outcome is particularly important in the context of new rate options that a customer must be enticed to adopt (rather than being defaulted onto), as is the case in New York.

4.2. Fuel Cost Savings Under EV Rates

Even with a one-year price guarantee, EV owners are only likely to switch to and remain on TOU rates if those rates provide noticeable savings relative to their standard rates. Without such savings, there is little incentive for customers to transition to a new rate, or to remain on that rate.

Fuel cost savings are also one of the primary motivators of EV purchase decisions.[78] Providing greater fuel cost savings from charging an EV on a TOU rate relative to filling up a gas-powered vehicle incentivizes customers to purchase an EV and contribute to the achievement of New York's EV adoption policy goals.

To determine whether the proposed rates would provide meaningful fuel cost savings, we estimated per-vehicle annual fuel cost savings of charging an EV under the IOUs' proposed TOU rates relative to both charging an EV on a standard rate and operating an ICE vehicle.

Our analysis sought to account for all the various fuel cost components faced by EV owners, including incremental customer charges, TOU delivery charges, standard offer service supply charges, and various miscellaneous volumetric charges.[79] We assumed ICE fuel costs based on average monthly regional gas

[78] Singer, "The Barriers to Acceptance of Plug-in Electric Vehicles: 2017 Update."

[79] These include Merchant Function charges, Clean Energy Standard charges, System Benefit Charges, and Revenue Decoupling adjustments.

prices from 2017.[80] Monthly assumptions for average vehicle miles traveled were derived from research conducted by the AAA Foundation for Traffic Safety.[81]

Our analysis focused on average savings for an owner of a typical full battery electric vehicle (BEV) with a range of 100 miles, similar to a Nissan Leaf or a BMW i3. Based on the U.S. Energy Information Administration's (EIA) Annual Energy Outlook (AEO) 2018, we assume that 100-mile BEVs achieve an average fuel efficiency of 93 miles per gallon of gasoline equivalent, or 2.8 miles per kWh.[82]

We evaluated savings under two charging profiles for customers on EV TOU rates: one in which all charging takes place during off-peak hours, and one consistent with the typical charging patterns of California EV customers facing TOU rates, in which most – but not all – charging occurs during off-peak hours. The latter profile is more likely to be representative of actual customer charging behavior. Consideration of this more realistic charging behavior is important for ensuring that customers will have a reasonable opportunity to achieve fuel savings, even when they must occasionally charge during on-peak hours. This aspect of EV rate design was recognized by the California Public Utilities Commission, who wrote:

> Although our goal is to maximize off-peak charging, we appreciate that, at times, Electric Vehicle owners will need to charge their vehicles during peak periods or may simply find it convenient to do so. To ensure broad consumer acceptance of Electric Vehicles, it is crucial to accommodate the Electric Vehicle owners' charging needs and preferences…[83]

We discuss the results of our analysis in the following sections.

Results: TOU Savings Relative to Charging on Standard Rate

Whole-House TOU Rate

Our analysis indicates fuel cost savings provided by the IOUs' whole-house residential EV rates relative to standard residential rates vary substantially across utilities. Figure 15 presents fuel cost savings by utility and charging pattern.

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[80] New York State Energy Research and Development Authority. Monthly Average Motor Gasoline Prices. https://www.nyserda.ny.gov/Researchers-and-Policymakers/Energy-Prices/Motor-Gasoline/Monthly-Average-Motor-Gasoline-Prices. According to this date, statewide gasoline prices averaged $2.49 per gallon in 2017.

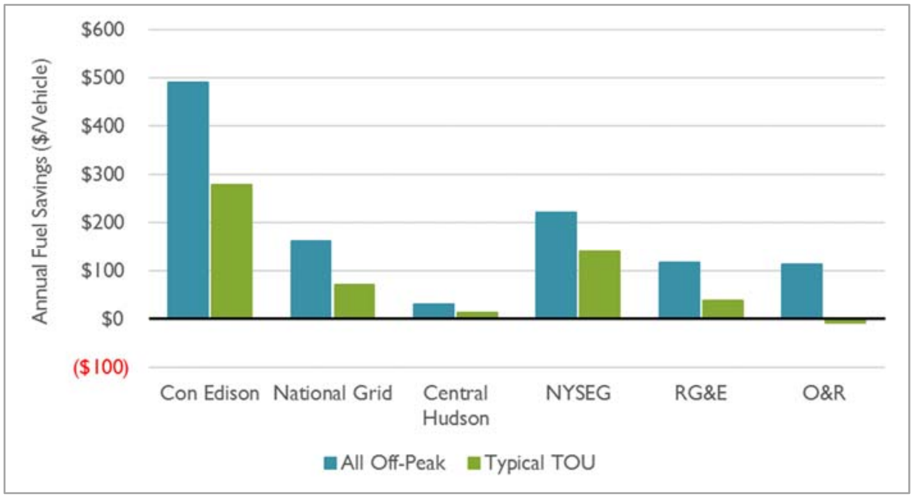
[81] AAA Foundation for Traffic Safety, American Driving Survey 2015-2016. https://aaafoundation.org/wp-content/uploads/2018/02/18-0019_AAAFTS-ADS-Research-Brief.pdf; AAA Foundation for Traffic Safety, American Driving Survey 2013-2014. https://newsroom.aaa.com/wp-content/uploads/2015/04/REPORT_American_Driving_Survey_Methodology_and_year_1_results_May_2013_to_May_2014.pdf. Based on this data, the average vehicle travels 11,381 miles per year.

[82] U.S. EIA. AEO 2018 Table 41. https://www.eia.gov/outlooks/aeo/supplement/excel/suptab_41.xlsx .We note that this assumption is likely conservative, as many new EVs have fuel economies of 3.3 miles per kWh.

[83] California Public Utilities Commission, D.11-07-029 Establishing Policies to Overcome Barriers to Electric Vehicle Deployment and Complying with Public Utilities Code Section 740.2, July 14, 2011, 15.

Assuming that all charging occurs off-peak, customers of all utilities would benefit from fuel cost savings, but the magnitude of these savings varies greatly across utilities. The rates proposed by Con Edison and NYSEG offer the greatest potential savings, with Con Edison customers experiencing annual fuel cost savings of approximately $500. Customers of RG&E, National Grid, and O&R experience savings of about $100 per year. In Central Hudson's territory, where there is a relatively small difference between on-peak and off-peak TOU rates, average annual savings amount to less than $50 even if all charging takes place during off-peak hours.

Figure 15. Whole-house TOU rate annual fuel cost savings relative to standard rate



Source: Synapse Energy Economics analysis.

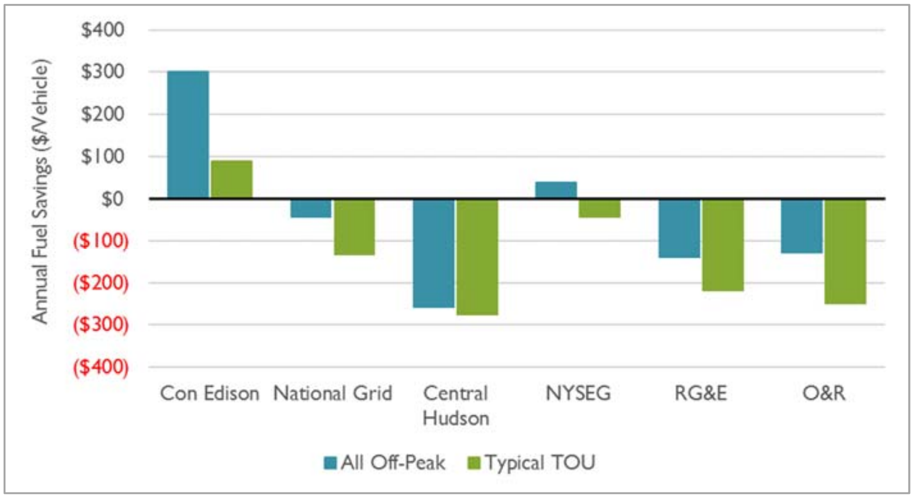
Under the scenario in which most, but not all, charging occurs during the off-peak period, the fuel cost savings are reduced substantially. A typical 100-mile BEV customer would be expected to save an average of approximately $250 per year at Con Edison. In contrast, we would expect that a typical O&R customer would experience a small *increase* in fuel costs from switching onto the proposed residential EV rate. Meanwhile, an average EV customer of Central Hudson or RG&E would experience fuel cost savings of less than $50 per year from switching rates. The benefits of such low savings in the Central Hudson and RG&E territories may not outweigh the inconvenience and risk associated with whole-house TOU rates.

EV-Only TOU Rate

Several of the New York IOU residential EV tariff proposals—including those of Con Edison, O&R, NYSEG, and RG&E—include the option for customers to charge EVs under a separately metered TOU rate, rather than under the whole-house TOU rate. However, separately metered customers would likely have to pay a full extra customer charge on top of their standard service customer charge. In exchange, these customers would not have to worry about managing their regular household appliance load in accordance with TOU periods.

Figure 16 shows that customers receive fewer fuel cost savings from switching to a separately metered TOU rate, as their higher total customer charge offsets the savings associated with a lower off-peak energy charge.[84] In fact, we estimate that typical separately metered EV customers would incur increased fuel costs in the service territories of every utility other than Con Edison. Customers of O&R could incur additional EV fuel costs of $250 by switching to the separate-meter TOU rate.

Figure 16. EV-only TOU rate annual fuel cost savings relative to standard rate



Source: Synapse Energy Economics analysis.

Results: EV Fuel Cost Savings Relative to ICEs

We find that the fuel cost savings provided by EVs on the proposed TOU rates relative to ICEs also vary greatly depending on the utility and the ICE in question. Figure 17 presents our calculated fuel cost savings for each utility for a typical 100-mile BEV on a whole-house TOU rate relative to two alternative types of ICEs: a typical new car with an efficiency of 38 mpg, and a standard hybrid with an efficiency of 55 mpg.[85]

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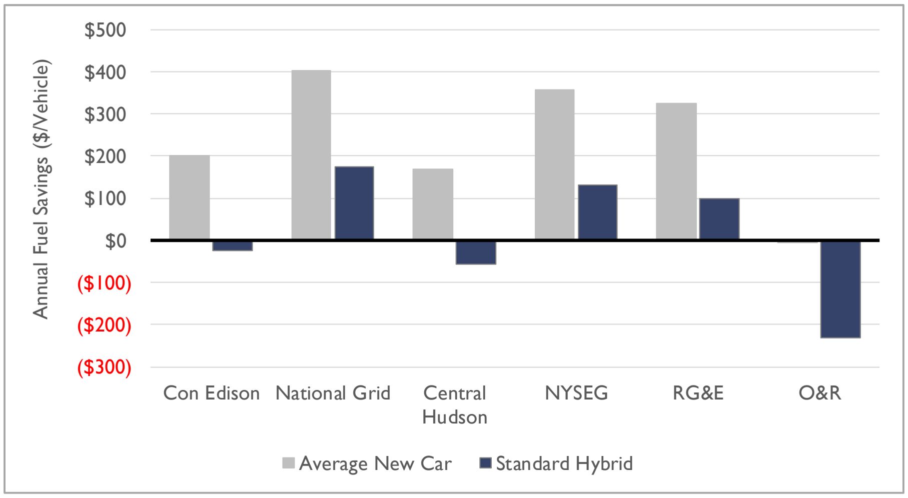
[84] Although National Grid and Central Hudson did not specifically propose to allow EV customers to separately meter their EV loads, for the purposes of a comparative analysis we assumed that this would be allowed. The changes in fuel cost savings from Figure 15 to Figure 16 for National Grid and Central Hudson are due to the additional customer charge that we assume these customers would be required to pay in order for the EV to be metered separately.

[85] U.S. EIA. AEO 2018 Table 41. https://www.eia.gov/outlooks/aeo/supplement/excel/suptab_41.xlsx . Standard hybrids do not draw electricity from an external source, and therefore must rely at least in part on gasoline during their standard operation. A Toyota Prius is one of the more common examples of a standard hybrid vehicle.

Figure 17. Annual fuel cost savings of 100-mile BEV on whole-house TOU rate relative to alternative ICE types



Source: Synapse Energy Economics analysis.

In nearly all utility service territories, an EV operating under the utility-proposed whole-house TOU rate would generate positive fuel cost savings relative to a typical new gasoline-powered vehicle. The savings provided by a new EV relative to a typical new ICE range up to more than $400 per year for a National Grid customer, although they are essentially zero for O&R customers.

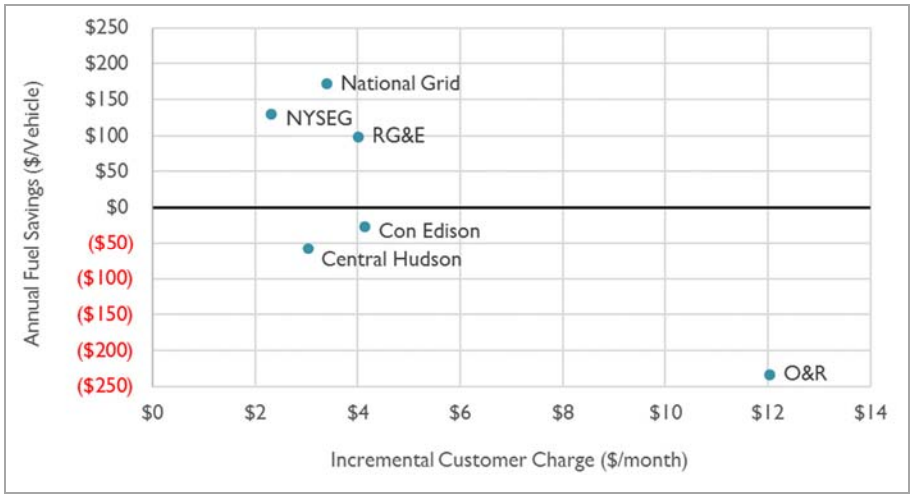
When compared to a standard hybrid vehicle, such as a Toyota Prius, EV fuel savings largely disappear. At three of the six IOUs, an EV customer would likely have higher fuel costs relative to a hybrid vehicle. This comparison is important, because customers considering purchasing an EV are likely to compare these vehicles to high-efficient ICE options, such as standard hybrids.

Once again, our analysis indicates that the EV TOU rates proposed by O&R and Central Hudson are the least favorable to EV customers. We estimate that a typical EV customer would incur increased annual fuel costs of more than $200 relative to a standard hybrid in O&R's territory, and more than $50 in Central Hudson's territory. In contrast, EV TOU customers of National Grid and NYSEG would experience annual fuel cost savings of more than $130, even compared to a standard hybrid. We note that for cost-conscious vehicle purchasers, an EV's fuel cost savings would need to be sufficiently large to out-weigh the current higher up-front costs of an EV.

Role of Customer Charges

One of the main determinants of the variation in our fuel cost savings estimates across utilities appears to be the level of incremental customer charge incorporated in each whole-house TOU rate. All six utilities charge customers at least an additional two dollars per month in fixed customer charges when they switch from a standard rate to a whole-house TOU rate. For five of those utilities, the incremental customer charge is less than $4.50 per month. But for O&R, it is $12.00 per month, nearly three times greater than any other utility. This goes a long way toward explaining why our results indicate that O&R's EV TOU rate option offers the lowest fuel cost savings relative to both a standard residential rate and an ICE. Figure 18 provides evidence of a negative, if imperfect, relationship between the incremental customer charge and fuel cost savings of an EV on a utility's TOU rate relative to a standard hybrid vehicle.

Figure 18. Average annual fuel cost savings of 100-mile BEV relative to standard hybrid compared to customer charge increase



Source: Synapse Energy Economics analysis.

It is unclear to what extent higher customer charges faced by whole-house TOU customers are justified. Customer charges typically recover a variety of costs associated with serving a customer, such as billing and customer service costs, as well as the cost of the meter, final line transformer, and service drop. Some of these costs may be higher for a whole-house TOU customer than for a customer on standard rate, particularly if a more sophisticated meter is required for measuring hourly usage. However, most costs (such as the cost of the final line transformer and service drop) will not be higher. It is very unlikely that the large incremental customer charge incurred by O&R customers is justifiable on cost causation grounds, much less on grounds of encouraging adoption of TOU rates or purchase of EVs.

4.3. Additional Important EV Rate Design Characteristics

Besides overall rate design structure and impacts on fuel costs, there are several other design characteristics that can impact the effectiveness and efficiency of EV rates. We again find major differences among the New York IOU proposals across several of these characteristics. Below, we focus on the proposals' peak-to-off-peak price ratios, relationship to standard offer service rates, and alignment of TOU periods with system costs.

Ratio Between Peak and Off-Peak Rates

The ratio between peak and off-peak prices is a key determinant of the effectiveness of TOU rates at encouraging EV customers to charge during off-peak hours. A study of early-adoption EV customers in

SDG&E service territory found that a peak to off-peak price ratio of 6:1 results in about 10 percent more off-peak charging than a ratio of 2:1.[86]

Table 2 lists the ratios between peak and off-peak TOU delivery charges under the whole-house TOU rates proposed for residential EV customers by each of the IOUs. Con Edison and O&R each offer rates with ratios greater than 14:1 in the summer months, and greater than 5:1 in the winter months. In contrast, Central Hudson's rate has a ratio of only 1.2:1 throughout the year. Such a low ratio has two likely repercussions. First, it makes it less likely that customers who adopt the TOU rate will charge their EVs exclusively during off-peak periods. Second, it lessens the opportunity for EV customers to control and reduce their fuel expenses. This effect helps explain why our analysis finds that Central Hudson's proposal would result in such low (and sometimes negative) fuel cost savings for EV customers.

Table 2. Ratios between peak and off-peak TOU delivery charge

Utility	Summer	Winter
Con Edison	14.2	5.2
National Grid	6.5	6.5
Central Hudson	1.2	1.2
NYSEG	2.7	2.7
RG&E	2.7	2.7
O&R	15.5	5.6

Relationship to Standard Offer Service Rates

Another important distinction among the EV TOU rate offerings of the New York utilities is the extent to which those rates are linked with TOU energy supply rates. Since New York is a competitive retail access state, the IOUs do not provide energy supply services to all residential customers. However, they do provide standard offer service rates to customers who do not select a competitive supplier. These utilities therefore have the ability to offer TOU standard offer service rates to complement the delivery TOU rates that they are presenting as their residential EV tariffs.

It appears that all six IOUs already offer TOU standard offer service rates to complement their TOU delivery rate offerings. However, there is variation in the degree to which these standard offer service offerings contribute to strong differentials between the total energy charges faced by TOU customers during on-peak and off-peak periods. Con Edison offers rates that vary dramatically between peak

[86] Nexant. 2014. "Final Evaluation of SDG&E Plug-in Electric Vehicle TOU Pricing and Technology Study." Available at www.sdge.com/sites/default/files/documents/1681437983/SDGE%20EV%20%20Pricing%20&%20Tech%20Study.pdf.

summer hours and other times of the year, whereas the TOU standard offer service offerings of NYSEG and RG&E do not exhibit marked differences between peak and off-peak hours.

Given that customers ultimately perceive and pay a total per-kWh energy charge that incorporates both delivery and supply charges, it is important that both delivery and standard offer service TOU offerings contribute to an efficient price signal regarding the least-cost times to charge EVs. The difference in price ratios across the utilities for standard offer service prices may be due to variations in zonal wholesale market prices. However, it is worth reviewing the price differentials to ensure that the standard offer service prices are as efficient as possible.

TOU Periods

Another point of inconsistency across the New York IOUs is in their selection of on-peak and off-peak hours. All of the utilities apply their highest peak TOU rates to summer (June through September) weekdays between 2 p.m. and 7 p.m. Beyond that point of consistency, differences arise.

One notable inconsistency is in the seasonality of peak periods. O&R and Con Edison offer peak periods that are limited to just the summer months. These utilities apply a “semi-peak” rate in between the on-peak and off-peak rates to winter afternoon and evening hours. All other utilities apply the same price to all hours throughout the year.

The summer focus of O&R and Con Edison is likely rooted in the fact that New York has a summer-peaking electricity system. In each of the past three years, each of the top 100 annual peak system hours occurred between June and September.[87] However, the timing of peak periods should account for marginal energy costs as well as marginal system capacity costs. Though New York’s peak load events occur during the summer, its highest energy prices often occur during winter evenings. Figure 19 presents a heat map showing that the highest system energy prices in 2017 came during the months of December and January between 4 p.m. and 9 p.m.[88] Accounting for this pattern, it likely makes sense to apply peak periods to winter evenings, as most New York IOUs do.

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[87] NYISO Market & Operational Data, Custom Reports: Real-Time Actual Load. http://www.nyiso.com/public/markets_operations/market_data/custom_report/index.jsp?report=rt_actual_load

[88] NYISO Market & Operational Data, Custom Reports: Day-Ahead Market LBMP – Zonal. http://www.nyiso.com/public/markets_operations/market_data/custom_report/index.jsp

Figure 19. 2017 average NYISO locational marginal prices

	Month											
Hour	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	$29	$24	$24	$18	$18	$18	$22	$20	$17	$17	$19	$32
2	$27	$22	$23	$17	$16	$16	$20	$18	$15	$15	$17	$30
3	$26	$21	$22	$16	$15	$15	$18	$16	$13	$14	$16	$28
4	$25	$21	$22	$16	$14	$14	$17	$15	$12	$13	$16	$28
5	$26	$21	$22	$16	$14	$13	$16	$15	$12	$13	$16	$29
6	$28	$23	$24	$17	$16	$14	$16	$16	$14	$15	$19	$33
7	$33	$27	$31	$23	$21	$17	$18	$17	$17	$22	$26	$42
8	$36	$29	$35	$26	$24	$20	$21	$19	$18	$24	$30	$45
9	$38	$29	$35	$30	$26	$22	$24	$22	$20	$23	$31	$46
10	$39	$30	$34	$31	$28	$25	$26	$24	$22	$25	$31	$47
11	$38	$29	$33	$30	$29	$26	$28	$26	$23	$25	$30	$47
12	$37	$29	$32	$30	$28	$28	$31	$28	$25	$26	$29	$44
13	$35	$27	$30	$28	$27	$30	$33	$29	$26	$25	$27	$41
14	$34	$26	$28	$27	$27	$31	$36	$31	$28	$25	$27	$39
15	$33	$26	$27	$26	$27	$32	$38	$33	$30	$26	$26	$39
16	$33	$26	$26	$25	$27	$34	$40	$35	$32	$26	$27	$40
17	$39	$28	$28	$26	$28	$35	$43	$36	$34	$28	$32	$51
18	$50	$36	$31	$28	$31	$36	$43	$36	$33	$30	$39	$66
19	$48	$39	$36	$30	$29	$32	$37	$31	$30	$34	$38	$62
20	$43	$35	$40	$34	$30	$30	$34	$29	$31	$34	$35	$56
21	$39	$31	$37	$36	$33	$29	$32	$28	$28	$28	$31	$50
22	$36	$28	$32	$28	$27	$27	$29	$26	$23	$24	$27	$44
23	$32	$26	$27	$22	$22	$22	$25	$22	$19	$20	$23	$38
24	$29	$24	$24	$19	$20	$19	$23	$20	$18	$18	$19	$34

The choice of peak hours within a season is another area of difference across the IOUs. Central Hudson's peak period is the narrowest of the utilities, running from 2 p.m. to 7 p.m. O&R's peak period is limited to summer hours between noon and 7 p.m. The peak periods of the other four IOUs are much longer, lasting from at least 8 a.m. through 11 p.m. Based on load and price data from the past three years, the longer peak periods appear to better capture higher-cost hours without stretching into the lowest-cost overnight hours.[89] Figure 19 indicates that Central Hudson's shorter peak period would miss both the winter morning peak and the end of the winter evening peak, which represent some of the highest-cost hours of the year. In addition, over the past three years the top 100 annual NYISO peak hours have included summer hours between 10 a.m. and 2 p.m., and between 7 p.m. and 9 p.m.

4.4. Metering

None of the New York IOUs have proposed a submetering option using an EVSE for their EV rates, nor have they explained why EVSE submetering was not proposed. Instead, all of the IOUs would require

[89] Of course, peak periods should not be so long as to produce brief off-peak periods that may limit fuel cost savings opportunities and lead to distribution peak clustering concerns. However, as long as the off-peak period remains at least eight hours in length, these concerns are likely to be minor.

traditional utility meters for customers who wish to enroll in an EV-only rate, with the exception of Con Edison's ongoing SmartCharge NY program (which uses the FleetCarma C2 device). The failure of the New York utilities to consider submetering options could dampen enrollment levels in the proposed EV TOU rates.

4.5. Reporting Metrics

Regardless of the rate designs ultimately implemented for EV customers, it will be important to use the lessons learned to improve rate design moving forward. To enable data-driven assessment of the effectiveness of each utility's rates, we propose that the utilities report additional data to the Commission and stakeholders. Ideally, such reporting would occur frequently enough to make mid-course corrections, if necessary. We recommend that the utilities file publicly available quarterly reports containing the following metrics and data (in spreadsheet format):

- Number of customers on whole-home versus EV-only rate
- Number of customers who opted to leave the TOU rate
- Aggregated customer load profiles, including the percentage of EV charging that occurred on-peak versus off-peak
- Monthly average energy (kWh) and peak demand (kW) associated with EVs
- Costs to integrate EVs into the grid, including the location of any distribution upgrades and the type of upgrade required
- TOU rate education and outreach activities undertaken by utilities, including relevant budgets
- Lessons learned and modifications made; for example, if low enrollments prompted a utility to seek an alternate marketing approach, this should be discussed.

4.6. Enrollment in TOU Rates

While the design of TOU rates is critical to ensuring their success, even the best-designed rates will suffer from low enrollment levels if customers are not well informed regarding the rate options and potential fuel savings, or if enrollment is time-consuming and difficult. Each of the New York IOUs currently has a residential TOU rate in place.[90] Enrollment in these rates has been exceedingly low: Only one IOU has seen more than 1 percent of its residential customers choosing the TOU rate, as shown in Table 3, below.

[90] Note, however, that there is no on-peak to off-peak distribution rate differential for NYSEG and RG&E.

Table 3. Residential enrollment in TOU rates currently in effect

Utility	Residential TOU Customers	Total Residential Customers	% TOU
National Grid	5,624	1,475,271	0.4%
Con Edison	1,720	2,896,029	0.1%
Central Hudson	1,000	266,061	0.4%
RG&E	1,273	334,750	0.4%
NYSEG	4,016	766,954	0.5%
O&R	3,399	198,331	1.7%

Sources: Con Edison AMI Metrics Report Appendix 18. April 30, 2018. Filed in NY PSC Docket 16-00253; Niagara Mohawk Rate Case Testimony of Electric Rate Design Panel. April 28, 2017. Book 20, Exhibit 1 (p. 77). NY PSC Case No. 17-E-0238; Central Hudson Cost of Service Exhibits. July 28, 2017. (p. 6). NY PSC Case No. 17-E-0459; RG&E Revenue Allocation, Rate Design, Economic Development, and Tariff Panel Testimony. May 20, 2015. (p. 73). NY PSC Case No. 15-E-0285; NYSEG Revenue Allocation, Rate Design, Economic Development, and Tariff Panel Testimony. May 20, 2015. (p. 61). NY PSC Case No. 15-E-0283; O&R Electric Rate Filing Exhibits. January 26, 2018. Volume 2 (p. 522). NY PSC Case No. 18-E-0067.

To encourage EV customers to enroll in a TOU rate, the IOUs must do more than simply establish the rate. They must actively encourage enrollment through a combination of education, outreach, and incentives. In addition, utility incentives, auto dealership incentives, and customer incentives should all be aligned. As described in Section 3.5, these activities may include setting up a web-based rate comparison tool and monetary incentives for enrollment in an EV rate (paid either to EV drivers or dealerships who help the customers enroll). In New York, utility incentives could be established through Earnings Adjustment Mechanisms that establish targets not only for customer adoption of EVs, but also for enrollment in an EV rate.

5. CONCLUSIONS AND RECOMMENDATIONS

Utilities have a unique opportunity to influence EV adoption and steer EV charging practices to benefit the grid and society. To attain these benefits, EV rates must be designed carefully and thoughtfully. Our evaluation of the New York utilities' recent proposals can be used to illustrate many of the rate design principles discussed throughout this report.

The New York utilities have taken an important step in the right direction by offering a whole-house TOU rate that would enable EV drivers to save money on fuel costs, while encouraging beneficial charging behavior. Several of the utilities have also opted to offer an EV-only rate, which provides a great option for customers who are hesitant to adopt a whole-house TOU rate. Further, all of the utilities offer a price guarantee, which reduces the risk to customers of signing up for a new rate.

However, most of the utilities' rate proposals require additional work to unlock their full potential. In many cases, the potential fuel cost savings are minimal, or even negative, relative to the standard rate. Further, the fuel cost savings relative to the cost of operating an efficient ICE (e.g., a hybrid) are generally also low or negative.

To achieve greenhouse gas emission reductions of 40 percent by 2030 and 80 percent by 2050, and to comply with Zero Emission Vehicle (ZEV) regulations that will require approximately 800,000 EVs in New York by 2025, the utilities' EV rate designs must be improved. We offer six recommendations that could commence today:

1) Utilities with low price differentials between on-peak and off-peak rates increase the price ratio to motivate off-peak charging and enable greater fuel savings;
2) Ensure that a customer who charges mostly off-peak achieves fuel savings relative to a customer who remains on a standard rate and charges only on-peak;
3) Reduce or eliminate the customer charge for second meters;
4) Explore submetering as a means to lower the cost for EV-only rates;
5) Evaluate whether the proposed rate will provide sufficient fuel savings to encourage customers to adopt EVs over high-efficiency ICE vehicles; and
6) Endeavor to maximize customer enrollment through education, outreach, and incentives.

Finally, we recommend that these actions on residential rate design be complemented by an analysis of commercial and industrial rates to determine whether modifications are warranted to support EV charging stations, fleet electrification, and workplace charging.