March 1, 2019

Mrs. Judith Whitney, Clerk
Vermont Public Utility Commission
112 State Street
Montpelier, VT 05602

Filed electronically on e-PUC

Re: **Case No. 18-2660-INV** Investigation into promoting the ownership and use of electric vehicles in the State of Vermont

Dear Mrs. Whitney,

Thank you for the opportunity to offer our perspective and information in the Commission's ongoing investigation into electric vehicle ("EV") policies in the state of Vermont. Please accept these comments filed on behalf of the Sierra Club in the above-referenced docket, responding to the call for information in the Commission's February 4, 2019 Order in advance of the March 15, 2019 workshop. These comments offer information responsive to two of the Commission's questions, based on Sierra Club's experience with EV and regulatory issues before state public utility commissions across the country. Specifically, these comments address the following issues:

> "(3) incorporation of growing EV charging load into the electric grid and issues associated with serving that new load; and
> (4) the potential benefits of managed EV charging to the electric grid, including using EV batteries for purposes such as peak shaving and regulation, and the likelihood of realizing such benefits based on EV usage in Vermont and existing and expected technological capabilities."

I. GRID RELIABILITY AND RESILIENCE

The flexibility of EV charging means that EVs have significant potential to benefit the grid. We refer to this potential as vehicle-grid integration ("VGI"), which can help achieve three complementary goals: (1) improving integration of renewable generation, (2) reducing total cost of vehicle ownership, and (3) facilitating cost-effective grid management.

A. Flexible EV Load Can Deliver Grid Benefits

Like energy efficiency, transportation electrification can reduce energy costs for all customers, regardless of whether they drive or ride in EVs. EVs, with the exception of public transit and fleet vehicles, typically sit idle for the overwhelming majority of the day; this flexibility allows for a large share of EV charging to occur at off-peak times when the grid is underutilized and when marginal costs to serve additional load are low. By increasing utility revenues and system load factor without

commensurate increases in utility costs, off-peak incremental EV load can help shield all utility customers from electricity rate increases and put downward pressure on electricity rates by spreading fixed system costs over a greater number of kilowatt-hours (kWh) sold.

EVs, if properly incentivized, can provide the grid with flexible, manageable load.[1] Most passenger vehicles are driven for only a fraction of a given day, and are otherwise sitting idle; for EVs, this means they can be plugged in and, with the right policies or programs in place, potentially deliver grid services that support grid reliability, flexibility and resilience. If charging is managed to occur during off-peak periods, EV load can "fill valleys" in load without increasing overall capacity requirements. With appropriate policies in place, EV load can be shifted to facilitate the integration of variable generation from renewable sources.[2] By increasing usage of standing assets, smoothing and shifting loads, and improving reliability, EV charging can lower the marginal cost of electricity for all customers.

As the Regulatory Assistance Project notes in a recent report, in 2016 Texas curtailed more than 800 gigawatt-hours of wind energy (equating to approximately 1.6 percent of its total wind generation that year), and the Midcontinent Independent System Operator curtailed more than 2000 GWhs for wind (more than 4 percent of its wind energy potential for the year), and California curtailed more than 300,000 MWhs of wind and solar combined.[3] Shifting EV demand to meet renewable production can limit curtailment.

B. Vehicle-Grid Integration: Clarifying Terms and Identifying Integration Pathways

"Vehicle-grid integration" encompasses the variety of potential pathways for EVs to provide grid services.[4] Although the potential for EV batteries to transmit electricity back into the grid, (often referred to as "vehicle-to-grid," or "V2G"), represents one type of vehicle-grid integration, the necessary technology for that type of bi-directional power flow is still emerging.[5] The more widely proven vehicle-grid integration pathways (sometimes referred to as "V1G") are (1) the use of time-variant electricity rates and (2) managed charging. Using these tools to "flex" EV load can relieve pressure on the grid during peak-demand times. Each is described below.

Time-variant rates: When properly designed, time-of-use rates create effective and efficient price signals for energy consumers. The Department of Energy's EV Project, which has tracked the charging behavior of thousands of EVs since 2011, has shown that in areas with time of use rates – and effective utility education and outreach – the majority of EV charging occurs during off-peak hours. This was not the case in areas without time of use rates, where EV demand generally peaked in the early evening, exacerbating early-

[1] *See, e.g.*, Regulatory Assistance Project*, In the Drivers Seat: How Utilities and Consumers Can Benefit From the Shift to Electric Vehicles* at 4-7 (April 2015); CAISO, *California Vehicle-Grid Integration (VGI) Roadmap: Enabling Vehicle-Based Grid Services* (2014).

[2] *Id.*

[3] Regulatory Assistance Project, *Beneficial Electrification*, at 32 (2018).

[4] California Independent System Operator, *California Vehicle-Grid Integration (VGI) Roadmap*, at 3 (2014).

[5] *See* Max Baumhefner, et al., Natural Resources Defense Council, *Driving Out Pollution: How Utilities Can Accelerate the Market for Electric Vehicles*, at 5 (June 2016) ("*In the future*, EV batteries could even put electricity back onto the grid when it is most needed."), and 13 ("Questions remain as to the willingness of automakers to allow their vehicles' batteries to be used for [vehicle-to-grid]. Likewise, the scalability of [vehicle-to-grid] *remains to be seen*."). *See also* Citizens Utility Board, *The ABCs of EVs,* at 21 (2017) ("[*Vehicle-to-grid] transactions are not imminent* . . . however the systems to make it work are being developed.").

evening system-wide peak demand.[6] Time-variant rates thus provide one well-tested means to shift EV charging times to a specific time of day.[7] By charging higher prices in times of peak demand and lower prices in off-peak times, time-of-use rates can influence EV charging behavior.

The effectiveness of time-variant rates, of course, depends on the pattern and magnitude of the price variations. In general, time-of-use rates are effective at shifting EV load where they provide EV owners with easy-to-understand price signals without requiring customers to monitor real-time rates. A recent Citizen Utility Board report concludes that market-based rate schedules, which approximate the difference between average wholesale prices at different times of day, are not as effective at changing consumer behavior as rate designs that entail larger and more uniform price variation.[8] That report suggests instead using time-of-use rates with pre-determined ratios of peak to off-peak pricing. Consumers could easily understand and respond to price signals that set rates for off-peak, shoulder peak, and peak hours at ratios of, say, 1-2-4 or 1-3-6.[9] One study of early-adopter EV owners in California indicates that a peak to off-peak price ratio of 6:1 resulted in approximately 10 percent more off-peak charging than a ratio of 2:1.[10]

To both ensure EV customers are adequately motivated to charge during off-peak hours and to maximize fuel cost savings relative to gasoline, the Sierra Club suggests rates with at least a 2:1 on-peak to off-peak price ratio, and no more than three time-of-use periods (e.g., on-peak, off-peak, super-off-peak) that remain constant throughout the year, even if the prices during those time-of-use periods vary to reflect differences in seasonal costs. Shifting time-periods or introducing new time-periods seasonally will confound consumer understanding and undermine the associated response. Off-peak periods should be of sufficient length to accommodate the regular charging needs of EV drivers, even at lower power levels, while on-peak periods should be concentrated into as few hours as possible, in order to ease the burden on customers, produce a better response, and actually track underlying increased costs, which are themselves concentrated into relatively few hours of the day and year.

Managed charging: Managed charging refers to EV charging that is managed or adjusted based on grid conditions via communication with a utility or grid operator.[11]

The "smarts" that exist in EVs and charging stations can enable real-time adjustments to charging power rates (thereby decreasing or increasing demand). Managed charging typically requires an EV driver to cede some level of control over their charging to a third party. That third party could be a utility or a third-party aggregator. Charging rates can be remotely ramped up or down based on a variety of factors such as real-rime output from wind or solar installations, time-of-use pricing, and overall grid demand, among others. By flattening peaks and filling in valleys of load shape, smart

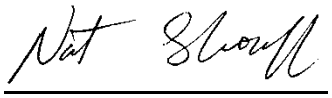
[6] *See* Schey, et al., *A First Look at the Impact of Electric Vehicle Charging on the Electric Grid, The EV Project at EVS26* (May 2012).
[7] At least 45 utilities across the country already implement time-of-use rates to help encourage EV charging during off-peak hours.
[8] Illinois Citizens Utility Board, *ABCs of EVs, A Guide for Policy Makers and Consumer Advocates*, at 20 (April 19, 2017).
[9] *Id.*
[10] Synapse, *Driving Transportation Electrification Forward in Pennsylvania: Considerations for Effective Transportation Electrification Ratemaking* at 16 (2018).
[11] Smart charging can be facilitated through EV charging stations, the EV itself, or other technologies. *Compare* "managed charging" with time-variant electricity pricing, which, while effective, is a more blunt instrument for load control in most cases and is a passive form of load management.

charging enables increased adoption of EVs without new grid infrastructure and promotes grid reliability by allowing a central operator to curtail EV charging during peak demand. The Commission should examine potential program offerings that utilities or third parties could offer to pilot managed charging, and to examine potential challenges, including communications between cars, charging stations, third parties and utilities.

Thank you for the opportunity to provide input on the Commission's ongoing efforts to accelerate EV adoption and promote transportation electrification in Vermont.

If you have any questions about the material in the comments, please do not hesitate to contact me at 415.200.9778 or nathaniel.shoaff@sierraclub.org.

Respectfully submitted,



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