COMMONWEALTH OF VIRGINIA

STATE CORPORATION COMMISSION

APPLICATION OF Virginia Electric and Power Company For approval of plan for electric distribution grid transformation projects	Case No. PUR-2019-00154

Direct Testimony of Erin Camp, PhD

On Behalf of Sierra Club

December 13, 2019

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1. INTRODUCTION AND QUALIFICATIONS

Q Please state your name, title, and employer.

A My name is Erin Camp. I am a Senior Associate at Synapse Energy Economics, located at 485 Massachusetts Avenue, Cambridge, MA 02139.

Q Please describe Synapse Energy Economics.

A Synapse Energy Economics (Synapse) is a research and consulting firm specializing in electricity and gas industry regulation, planning, and analysis. Our work covers a range of issues, including economic and technical assessments of demand-side and supply-side energy resources; energy efficiency policies and programs; integrated resource planning; electricity market modeling and assessment; renewable resource technologies and policies; and climate change strategies. Synapse works for a wide range of clients, including attorneys general, offices of consumer advocates, public utility commissions, environmental advocates, the U.S. Environmental Protection Agency, U.S. Department of Energy, U.S. Department of Justice, the Federal Trade Commission, and the National Association of Regulatory Utility Commissioners. Synapse has over 30 professional staff with extensive experience in the electricity industry.

Q Please summarize your educational and professional experience.

A I received my Doctorate from Cornell University in a cross-disciplinary energy systems program. I have more than seven years of experience in energy research and analysis with over three years of experience in energy and economic consulting. At Synapse, I have worked on issues related to transportation electrification, distributed energy resources, and policies to address climate change. I recently developed an electrification model for the Province of Newfoundland, Canada that was used in expert testimony to support rate mitigation. I have coauthored over five reports on a variety of topics relating to energy

economics, including one pertaining to impacts of vehicle electrification on consumers and the electric grid.[1] My resume is attached as Exhibit EC-1.

Q On whose behalf are you testifying in this case?

A I am testifying on behalf of the Sierra Club.

Q Have you testified in front of the Virginia State Corporation Commission previously?

A No.

Q What is the purpose of your testimony?

A The purpose of my testimony is to address the design of the Company's electric vehicle (EV) Smart Charging Infrastructure Pilot Program ("Pilot Program"), focusing on the light-duty EV stock growth projection for the Company's service territory. The EV stock growth projection, which is used to calculate the number of EV charging stations eligible for rebates in the Pilot Program, underestimates the likely adoption of light-duty EVs in the Company's service territory. By 2030, the number of registered EVs in the Company's service territory is likely to be double what Navigant has predicted. My testimony explains that encouraging EV adoption with a well-designed utility program can put downward pressure on rates and benefit all consumers in the Company's service territory. A well-designed program will also ensure that the benefits of transportation electrification are equitably distributed to all customers, including low- and moderate-income customers, by improving access to clean, electric transportation options in the form of electric transit (i.e., buses) and charging stations to support EV charging at multi-family buildings.

Because sufficient charging stations are a necessary precursor for supporting EV adoption, it is imperative to inform this Pilot Program with an accurate EV sales growth forecast. My testimony provides several alternative EV sales growth forecasts and makes a recommendation for which is the most accurate in the Company's service territory. Finally,

[1] Knight, P., E. Camp, D. Bhandari, J. Hall, M. Whited, B. Havumaki, A. Allison, N. Peluso, T. Woolf. 2019. "Making Electric Vehicles Work for Utility Customers: A Policy Handbook for Consumer Advocates." Synapse Energy Economics. https://www.synapse-energy.com/sites/default/files/Making-Electric-Vehicles-Work-for-Utility-Customers.pdf.

my testimony uses that recommended projection to calculate the necessary charging stations to support the future adoption of EVs. Overall, my recommendations support the implementation of a Pilot Program that is effective, equitable, and maximizes benefits to all customers, whether those customers own an EV or not.

2. SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

Q Please summarize your primary conclusions and recommendations.

A I support the overall thrust of the Company's Pilot Program, but I recommend the program be modified to provide greater and more equitable benefits to customers. Generally speaking, the Company's Pilot Program will help to increase EV adoption, which is likely to reduce electricity rates by using the electric system more efficiently. However, the Company's program unnecessarily delays implementation of time-varying electricity rates and does not provide sufficient charging infrastructure where it is needed most. I have three recommendations to ensure the Company's Pilot Program is effective, equitable, and maximizes benefits to all ratepayers. My recommendations are as follows:

i) The Company should recalculate the number of Public Level 2 and DC Fast Charging (DCFC) rebates it is offering through the Pilot Program, consistent with the sales trajectory projected by Bloomberg New Energy Finance and with more accurate input assumptions provided in this testimony.

ii) The Company should substantially increase the number of multi-family rebates it is offering in order to better support access to home charging and EV adoption for all customers, including low- and moderate-income customers.

iii) The Company should implement an energy-only time-varying rate within its Pilot Program. Doing so will reduce costs on the grid for all customers, reduce operating costs for EV owners (thereby encouraging greater adoption of EVs), and help inform future rate designs and alternatives to the managed charging program. It is important to ensure that EV drivers "see" meaningful TOU prices (*i.e.*, drivers should face

transparent $/kWh prices that vary by time period, allowing drivers to respond to the price signal by charging during off-peak hours).

iv) For the four DCFC stations the Company plans to own and operate, charging should be at least as cheap as gasoline.

3. OVERVIEW OF THE COMPANY'S EV INFRASTRUCTURE PILOT PROGRAM

Q What is the stated purpose of the Company's EV Smart Charging Infrastructure Pilot Program?

A According to the Company, the purpose of the Pilot Program is to support EV adoption in the Company's service territory while minimizing impacts of EV charging on the distribution grid.[2]

Q What are the key barriers to EV adoption that the Company can influence?

A The primary barriers to EV adoption are the cost of the EV (both upfront and operational) and access to charging stations (at home, work, and along travel corridors). The Company is able to influence the operational cost of EVs via electricity prices at charging stations owned and operated by the Company. The Company is also able to increase access to charging stations in a variety of locations through EV supportive programs such as the Pilot Program. In this testimony I discuss the ways in which the Company can improve its Pilot Program to further reduce these barriers.

Q How does the Company propose to achieve these goals through the Pilot Program?

A The Company intends to collect information that will provide it with the data and tools necessary for understanding and managing future EV charging load.[3] The two primary components of the Pilot Program are (i) rebates for make-ready infrastructure and upgrades, if necessary, at future EV charging sites, and (ii) rebates for smart charging

[2] Direct Testimony of Nathan J. Frost on Behalf of Virginia Electric and Power Company, Case No. PUR-2019-00154, September 30, 2019, at 35.

[3] *Ibid.*

equipment that enables managed charging. In addition to providing rebates for charging stations, the Company intends to own and operate four DCFC stations to support the electrification of the rideshare market during the Pilot Program.

Finally, the Company will implement modest communications and education components within the Pilot Program. These components will solicit customer enrollment, educate customers about managed charging, and request customer feedback via surveys.

Q How many chargers does the Company expect to support through its program?

A Based on an EV adoption projection developed by Navigant, Inc. ("Navigant"), the Company is requesting rebates for up to 25 chargers in the multi-family segment, up to 400 chargers in the workplace segment, up to 30 chargers in the DCFC segment, and up to 60 chargers for the transit segment (electric buses).[4]

Q Given that the Company intends to minimize impacts of EV charging on the distribution grid, is the Company proposing to implement a time-varying rate structure for these customers?

A No, not at this time. Instead, the Company plans to file for an experimental, time-varying rate in late 2021, following the Pilot Program.

4. CRITERIA FOR AN EFFECTIVE AND EQUITABLE PILOT PROGRAM

Q Do you support the Company's pilot program?

A Yes, I support the overall thrust of the Company's Pilot Program, but I recommend that the Program be modified to provide greater benefits to customers. Generally speaking, the Company's Pilot Program will help to increase EV adoption, which is likely to reduce electricity rates by using the electric system more efficiently. However, the Company's program unnecessarily delays implementation of time-varying rates and does not provide

[4] *Id.* at 40.

sufficient charging infrastructure where it is needed most. I elaborate on these points below.

Q How would supporting EV adoption in the Company's service territory provide economic benefits to customers?

A At a basic level, electricity rates are determined by dividing the total amount of electricity sold by the total costs associated with delivering the electricity. If total electricity sales increase while costs remain relatively stable, rates will decline.[5,6,7] Supporting EV adoption in the Company's service territory with a well-designed program would increase total electricity sales (due to increased EV charging) with minimal additional cost. This would put downward pressure on rates for all customers—including EV owners and non-EV owners—in the Company's service territory.

Q What aspects of an EV-supportive utility program would ensure the rate benefits to electricity customers described above?

A The following aspects of an EV-supportive utility program would help to ensure rate benefits to all customers, including those that do not drive an EV:

i) Programs or incentives to ensure charging occurs primarily during low-cost hours (such as through managed charging or a well-designed time-of-use (TOU) rate that is seen and understood by EV drivers—the individuals that must respond to a time-variant price signal);

[5] Frost, J., M. Whited, A. Allison. June 2019. "Electric Vehicles are Driving Electric Rates Down." Synapse Energy Economics. Available at: https://www.synapse-energy.com/sites/default/files/EV-Impacts-June-2019-18-122.pdf.
[6] Knight, P., E. Camp, D. Bhandari, J. Hall, M. Whited, B. Havumaki, A. Allison, N. Peluso, T. Woolf. 2019. "Making Electric Vehicles Work for Utility Customers: A Policy Handbook for Consumer Advocates." Synapse Energy Economics. https://www.synapse-energy.com/sites/default/files/Making-Electric-Vehicles-Work-for-Utility-Customers.pdf.
[7] M.J. Bradley & Associates. June 2018. "Electric Vehicle Cost-Benefit Analysis: Plug-In Vehicle Cost-Benefit Analysis: Kentucky." Available at: https://mjbradley.com/sites/default/files/KY%20PEV%20CB%20Analysis%20FINAL.pdf.

ii) Sufficient charging stations in diverse, well-balanced, long dwell-time locations (e.g., multi-unit or multi-family dwellings, workplaces, highways, and transit routes) to encourage adoption of EVs and promote customer equity; and

Q How can programs or incentives help to encourage EV charging during low-cost hours?

A Managed charging allows a utility or third-party to control charging patterns to align with the availability of electricity on the grid. A well-designed TOU rate encourages customers to consume electricity during times when there is available energy on the grid, instead of when electricity is in high demand. One analysis found that EVs on separately-metered TOU rates in California consume less than five percent of their total kilowatt-hours (kWh) during system peak hours.[8] Moreover, a national study funded by the Department of Energy found that, in locations with TOU rate options, EV demand spikes at the beginning of off-peak periods.[9] Such programs and incentives help to ensure that electricity is primarily being consumed at off-peak times of the day, which helps to minimize the marginal costs associated with EV charging.

Q Why is it important to design a program to promote ease of access and a diversity of charging locations?

A Promoting EV adoption across a wide variety of customer segments will promote equity, better encourage EV adoption, and help to ensure that EV infrastructure will be well-utilized.

Specifically, an EV charging station network with sufficient chargers for the number of EVs in the service territory would mitigate range anxiety, thereby encouraging EV adoption and electricity consumption. Additionally, public charging stations should be installed in a well-balanced ratio, focusing on both multi-family and workplace chargers,

[8] Frost, J., M. Whited, A. Allison. June 2019. "Electric Vehicles are Driving Electric Rates Down." Synapse Energy Economics. Available at: https://www.synapse-energy.com/sites/default/files/EV-Impacts-June-2019-18-122.pdf.
[9] Schey, S., D. Scoffield, J. Smart. May 2012. "A First Look at the Impact of Electric Vehicle Charging on the Electric Grid in The EV Project." EVS26. Available at: https://www.energy.gov/sites/prod/files/2014/02/f8/evs26_charging_demand_manuscript.pdf.

followed by a smaller number of DCFC stations that have the necessary make-ready infrastructure for future upgrades to higher-powered stations. Renters and residents of multi-family dwellings often lack dedicated, off-street parking spots. In cases where residents of multi-family dwellings do have dedicated parking spots, the parking spots are often far from access to electricity or the vehicle owners do not have the ability to modify parking areas to install charging stations. Lack of access to charging infrastructure presents a key barrier to EV adoption for these households, who tend to be lower income. Therefore, installing public charging stations in the multi-family segment specifically supports EV adoption for low- and moderate-income communities.

Q Does the Company's proposed Pilot Program meet the criteria described above?

A No. The Pilot Program only partially meets the first criterion described above by providing a foundation for the development of a managed charging program in the future.[10] The Company is proposing to provide rebates to offset the incremental cost of smart chargers, which allow a utility or third-party to manage charging. Because smart chargers are more expensive than traditional ones, this rebate will encourage adoption of smart chargers and increase the number of customers that can participate in managed charging.

Q In which ways does the Company's proposed Pilot Program not meet the criteria described above?

A The Pilot Program does not meet the remaining criteria in the following ways:

i) The Company's program does not promote sufficient charging stations in those market segments where EV charging is most needed to support regular, long-dwell time charging needs;

ii) The Company does not intend to implement any programs or incentives to encourage off-peak charging for commercial and industrial customers until late 2021—two years

[10] Direct Testimony of Nathan J. Frost on Behalf of Virginia Electric and Power Company, Case No. PUR-2019-00154, September 30, 2019, at Page 45.

from now. As explained above, time-of-use rates are a proven method for integrating EV charging load. There is no need to delay implementation of a time-variant rate and no reason for such a rate to be offered on a "pilot" basis when implemented.

In the following sections, I provide recommendations for modifying the Company's Pilot Program to meet the criteria for an effective and equitable EV program that maximizes benefits to ratepayers. I support the approval of the Company's Pilot Program with the modifications recommended in this testimony.

5. THE COMPANY'S EV FORECAST SIGNIFICANTLY UNDERESTIMATES THE NUMBER OF CHARGING STATIONS REQUIRED TO SUPPORT EV GROWTH

Q Why do you claim that the Company's program is insufficient and not adequately diverse?

A Based on my analysis, the number of EV chargers eligible for rebates in the Pilot Program is insufficient to support the expected adoption of EVs in the Company's service territory. The EV growth projection used by the Company drastically underestimates the likely number of EVs in the Company's service territory in the coming decade. Without access to a comprehensive network of EV charging stations that meet potential drivers' needs, the adoption of EVs will be stifled.

Q How did the Company develop its EV growth projection for the EV Smart Charging Infrastructure Pilot Program?

A The Company hired Navigant to forecast EV adoption in the Company's service territory through 2030. As illustrated in Exhibit EC-2, Navigant used a proprietary model (VAST Model) to calculate the number of EVs on the road in the Company's service territory by 2030. The model estimates that there will be approximately 169,000 EVs in the Company's service territory in 2030.

Q Do you have any concerns regarding Navigant's EV growth projection?

A Yes. Compared to other nationally recognized projections, Navigant's EV growth trajectory significantly understates the likely growth of EV adoption in the Company's territory.

Q How did you determine that the Company's projections understate EV growth?

A I compared Navigant's projection to five nationally recognized EV sales projections for the United States. These include the Transportation and Climate Initiative[11] Reference Case, Bloomberg New Energy Finance's (BNEF) 2019 projection[12], the U.S. Energy Information Administration's (EIA) 2019 projection[13], Energy Innovation's projection[14], and Boston Consulting Group's (BCG) 2017 projection.[15] Figure 1 shows these five projections of EV sales from 2020 to 2030. Note that Virginia's historical EV sales percentage in 2018 was 1.66 percent.[16]

[11] Transportation & Climate Initiative. Reference Case Results Webinar. August 8, 2019. https://www.transportationandclimate.org/sites/default/files/20190808%20-%20TCI%20Webinar%20-%20Reference%20Case%20Results.pdf.

[12] Bloomberg New Energy Finance. 2019. Electric Vehicle Outlook 2019. https://about.bnef.com/electric-vehicle-outlook/.

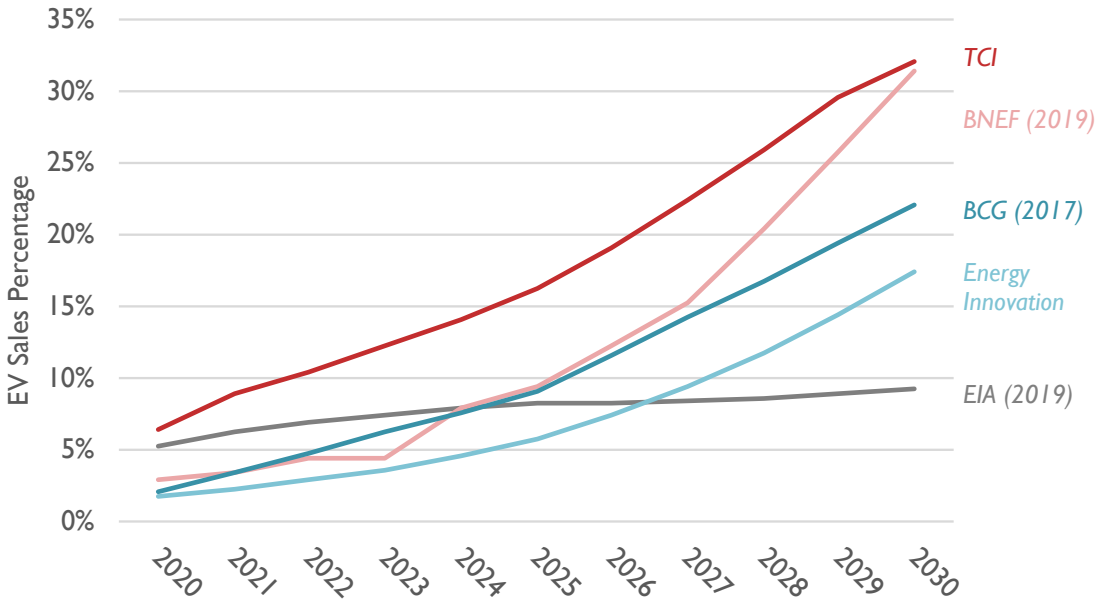
[13] U.S. Energy Information Administration. 2019. Annual Energy Outlook 2019. https://www.eia.gov/outlooks/aeo/data/browser/#/?id=48-AEO2019&cases=ref2019&sourcekey=0.

[14] Energy Innovation. Last accessed December 4, 2019. *Energy Policy Simulator*. Version 2.0.0. https://us.energypolicy.solutions/scenarios/home.

[15] Boston Consulting Group. 2017. https://www.slideshare.net/TheBostonConsultingGroup/the-electric-car-tipping-point-81666290.

[16] AutoAlliance.org. Last accessed December 4, 2019. https://autoalliance.org/in-your-state/VA.

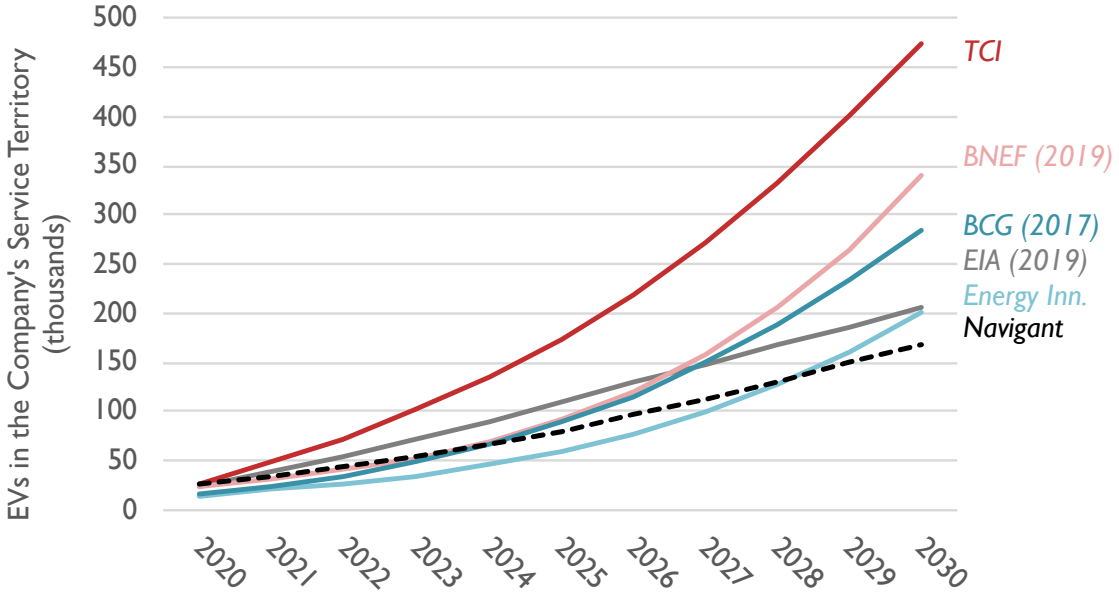
Figure 1. Comparison of national EV sales projections for the United States



Navigant's EV projection is not included in Figure 1 because Navigant only provided an EV stock projection without an accompanying EV sales percentage projection. To compare Navigant's EV stock projection (in total number of vehicles) for the Company's service territory to the five national EV sales projections (in percentages), I translated the national EV sales projections into EV stock values for each year. To do this, I multiplied the EV sales percentage for each year (2020–2030) by the projected number of light-duty vehicle sales in the state. The projected number of light-duty vehicle sales was derived by applying the EIA's projection of year-over-year light-duty vehicle sales growth to the number of light-duty vehicle sales in Virginia in 2018. I calculated the total number of registered EVs on the road in Virginia in each year by summing all EVs sold in prior years and subtracting out the number of vehicles expected to be retired. To conservatively estimate the fraction of EVs that will be remain on the road after a given number of years, I applied the Vehicle Survivability function for cars developed by the U.S. Environmental

Protection Agency (EPA).[17] This methodology provides a conservative estimate of the number of EVs on the road because cars tend to last for fewer years than light trucks based on the EPA data. As a result, using the distribution for cars tends to underestimate the number of EVs remaining on the road in the future. Finally, after calculating the EV stock in Virginia, I multiplied the result by the fraction of Virginia's residential electricity customers that is served by the Company to estimate the number of EVs owned by the Company's customers. Figure 2 compares the projections of EV stock in the Company's service territory.

Figure 2. Comparison of projected EV stock in the Company's service territory



[17] U.S. Environmental Protection Agency. July 2016. "Draft Technical Assessment Report: Midterm Evaluation of Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards for Model Years 2022-2025." EPA-420-D-16-900.

Q What were the results of your analysis?

A Navigant's forecast is lower than all of the other projections I examined, despite the conservative assumptions made in calculating EV stock based on the EV sales projections.

Q What projection of EV growth should the Company use instead?

A Instead of using Navigant's forecast, I recommend using the projection based on BNEF's EV sales forecast for several reasons. First, of the five national projections examined, BNEF's estimate of 2019 EV sales aligns most closely to Virginia's historical EV sales. BNEF estimates that EV sales by the end of 2019 will be 2 percent of light-duty vehicle sales, whereas Virginia's EV sales percentage in 2018 was 1.66 percent. Second, BNEF's forecast for 2018 EV sales proved true: BNEF forecasted EV sales would rise to roughly 2 percent from 1.2 percent in 2017, and actual sales in 2018 were approximately 1.95 percent nationally.[18] Third, this projection falls in the middle of the other projections and serves as a reasonable consensus estimate. BNEF annually surveys the EV industry and produces an estimate of the most recent cost of lithium ion batteries for EVs, which is used to inform BNEF's EV sales projection. BNEF also releases an Electric Vehicle Outlook annually, so the BNEF sales projection is based on the most recently available data.

Further, there are drawbacks to using the TCI, BCG, EIA, and Energy Innovation projections. The EIA forecast, which was developed using EIA's NEMS model, relies on outdated battery cost projections. Battery costs are a key component of EV prices; until about 2017, the battery comprised over half of the total price of an EV.[19] For the 2018 EIA forecast, which produced a similar rate of EV adoption as the 2019 forecast, battery prices were assumed to remain above $200/kWh in 2015 dollars through 2025. In their

[18] Bloomberg New Energy Finance. July 2017. "Electric Vehicle Outlook 2017: Executive Summary." Page 3. Available at: https://data.bloomberglp.com/bnef/sites/14/2017/07/BNEF_EVO_2017_ExecutiveSummary.pdf.

[19] Bullard, N. April 2019. "Electric Car Price Tag Shrinks Along With Battery Cost." Bloomberg New Energy Finance. Available at: https://www.bloomberg.com/opinion/articles/2019-04-12/electric-vehicle-battery-shrinks-and-so-does-the-total-cost.

most recent survey, BNEF found that the cost of batteries in 2019 had already fallen to $156/kWh in 2019 dollars, significantly lower than EIA's 2018 projection of what batteries will cost in 2025.[20]

The TCI forecast is another reputable forecast of EV adoption. It was also developed using EIA's NEMS model. However, through a stakeholder process overseen by the TCI states, some of the input assumptions (most notably lithium ion battery prices) were adjusted to create a more reasonable Reference Case scenario. On the other hand, TCI forecasts substantially more EV adoption than the other forecasts rather than aligning with any of the other forecasts. It also includes high levels of EV sales in the near term, which would represent a substantial increase in adoption relative to recent historical data.

The BCG forecast is the oldest forecast presented, as it dates to 2017. Because battery costs have been falling substantially in recent years, the BCG forecast includes outdated lithium ion battery cost forecasts that overestimate the cost of batteries in the future. For example, BCG forecasted that batteries would cost $128/kWh in 2020, whereas BNEF's survey of battery prices recorded a cost of $127/kWh in 2018. This means that the BCG battery cost forecast is already too expensive, therefore their EV sales forecast is likely too low.

The Energy Innovation forecast is from the Energy Policy Simulator, an online tool that can be used to examine the effects of energy sector policies. The simulator focuses almost exclusively on vehicle cost, assuming that the lowest cost vehicles available will be purchased. This is an overly simplistic view of EV adoption in the light-duty vehicle market, which is likely to be influenced by many other factors (e.g., customer desire to drive a zero-emission vehicle, performance advantages of an all-electric vehicle, etc.). The Energy Innovation battery cost forecast is also higher than BNEF's, reaching $96/kWh compared to $62/kWh in 2030 measured in 2018 dollars.

[20] Bloomberg New Energy Finance. December 3, 2019. "Battery Pack Prices Fall As Market Ramps Up With Market Average At $156/kWh In 2019." Available at: https://about.bnef.com/blog/battery-pack-prices-fall-as-market-ramps-up-with-market-average-at-156-kwh-in-2019/.

In summary, I recommend use of the BNEF projection for the purposes of estimating future EV sales in the Company's service territory.

Q Using the BNEF projection, how many EVs are expected to be registered in the Company's service territory in 2030?

A By adopting the EV sales projection developed by BNEF, I calculate that there will be approximately 340,000 registered EVs in the Company's service territory in 2030. This is double Navigant's estimate of 169,000 registered EVs. By 2021, the final year of the Pilot Program, there will be nearly 31,000 registered EVs in the Company's service territory. For comparison, there were roughly 11,110 EVs in the Company's service territory at the end of 2018.[21]

6. THE COMPANY SHOULD EXPAND ITS PROGRAM TO PROVIDE SUFFICIENT CHARGING INFRASTRUCTURE IN CRITICAL MARKET SEGMENTS

Q How did the Company calculate the types and quantities of EVSE necessary to meet the electric vehicle charging needs in 2030?

A The Company used the Department of Energy's EVI-Pro Lite online tool to calculate the necessary number of chargers for Navigant's estimated 169,000 EVs in 2030. The Company used the following default assumptions provided in the tool:[22]

i) The Company assumed that 100 percent of drivers have access to home charging, and

ii) The Company assumed that 50 percent of future EVs will be battery electric vehicles (BEV) and 50 percent will be plug-in hybrid electric vehicles (PHEV).

[21] Direct Testimony of Nathan J. Frost on Behalf of Virginia Electric and Power Company, Case No. PUR-2019-00154, September 30, 2019, Page 32.

[22] Direct Testimony of Nathan J. Frost on Behalf of Virginia Electric and Power Company, Case No. PUR-2019-00154, September 30, 2019, at Schedule 10, Page 1.

Q How would you recommend calculating the number of EV chargers of each type required for the Pilot Program?

A I recommend recalculating the number of charging stations required for the Pilot Program using the following approach in EVI-Pro Lite:

i) Update the number of registered EVs in the Company's service territory in 2021 to 30,329.

ii) Update the fraction of BEVs and PHEVs based on the current ratio in the Company's service territory. According to the Company, there were 8,741 BEVs and 7,764 PHEVs in the Company's service territory in 2018.[23] Therefore, the percentage of BEVs should be increased to 53 percent and the percentage of PHEVs should be decreased to 47 percent. Because the ratio of BEVs to PHEVs is expected to increase in future years, we consider this a conservative assumption, since BEVs require more electricity (and therefore chargers) than PHEVs.

iii) Decrease the percentage of drivers with access to home charging to 56 percent, based on a 2013 national study by researchers at Carnegie Mellon University.[24] Their research suggests that approximately 56 percent of vehicles in the United States have an off-street parking space, which is a necessary prerequisite for home charging.

Q Using the updated EV growth projection, how many chargers of each type would be required for the EV Pilot Program?

A According to EVI-Pro Lite, by 2021 the Company's service territory will need 948 workplace L2 chargers, 614 public L2 chargers, and 94 DC fast chargers during the Pilot Program years (2020–2021). See Exhibit EC-3 for more details. Because my analysis was conservative, this means that the Company's Pilot Program should provide at least an additional 550 rebates for workplace L2 chargers and 65 additional rebates for DC fast

[23] Case No. PUR-2019-00154. 2019-11-21 Sierra Club Set 1 Responses, Question No. 7. Available in Exhibit EC-4.

[24] Traut, E., T.C Cherng, C. Hendrickson, J. Michalek. "US residential charging potential for electric vehicles." *Transportation Research Part D*, Vol. 25, pages 139-145. https://www.cmu.edu/me/ddl/publications/2013-TRD-Traut-etal-Residential-EV-Charging.pdf.

chargers. See Table 1 for more details. The Company did not propose any rebates for public L2 chargers; we recommend the Company consider encouraging adoption of chargers in this market segment in future programs after the Pilot to further support EV adoption.

Table 1. Comparison of necessary workplace and DC fast chargers for the Pilot Program.

	The Company's Proposal	Recommendations from this Testimony
Workplace L2 Chargers	400	948
DC Fast Chargers	30	94

Q How does this compare to the Company's proposal?

A The Company proposes rebates for "up to 400" workplace chargers in its Pilot Program but only "up to 25" multi-family dwelling charging stations. This is a 16-fold advantage for workplace chargers. Given that the vast majority of EV charging happens at home,[25] the quantity of charging stations at multi-family dwellings that are eligible for rebates through this Pilot Program should be increased. Doing so will increase access to home charging for low- and moderate-income customers, who tend to live in multi-family dwellings. As such, I recommend that the Company provide a greater number of charging stations for multi-family dwellings, following a detailed survey of multi-family dwellings and their demand for EV chargers.

Q How will the increase in the quantity of rebates for charging stations impact the cost of the Company's proposal?

A The quantity of required chargers for the Company's service territory is greater than the Company's original proposal. Specifically, I recommend doubling the number of rebates available for workplace L2 chargers and DC fast chargers. Therefore, based on my

[25] Direct Testimony of Nathan J. Frost on Behalf of Virginia Electric and Power Company, Case No. PUR-2019-00154, September 30, 2019, at 43.

recommendation, the total cost of the rebates offered in the Pilot Program will be higher than in the Company's proposal. However, this modest upfront investment will support the expected adoption of EVs and thereby increase electricity sales during the Pilot Program and in years beyond. As mentioned and cited previously in my testimony, investment in charging stations will have the eventual result of lowering utility costs and electricity prices for all customers, so long as there is a well-designed TOU rate in place.

Q What does your analysis have to say about the years following the Pilot Program?

A While the number of registered light-duty EVs in the Company's service territory is expected to be roughly 31,000 in 2021, by 2030 that number will have increased nearly eleven times, to about 340,000. This means that the quantity of necessary chargers will increase substantially in the coming decade, and as such I recommend the Company prepare for a more ambitious charging infrastructure program in the future. Furthermore, the ratio of BEVs to PHEVs is expected to increase in the coming years, as more affordable all-electric vehicles enter the market. This ratio is a key variable in the EVI-Pro Lite tool and will influence the resulting number of charging stations needed in the future.

Lastly, I recommend the Company consider implementing future infrastructure programs that support the electrification of adoption of medium- and heavy-duty vehicles (MDVs and HDVs)—including fleets and additional transit vehicles. Electrifying medium- and heavy-duty trucks warrants attention. As electric MDVs and HDVs become more affordable, they will also require sufficient infrastructure support, in addition to the infrastructure needs quantified in this testimony for electric LDVs. Such a program will ensure that the benefits of electric vehicle adoption are distributed equitably to low-income customers. Disadvantaged communities located along freeways or near ports often shoulder a disproportionate amount of air pollution burden. Providing charging infrastructure to facilitate the electrification of school buses, transit buses, heavy trucks, or other large vehicles can substantially reduce criteria pollutants in these areas.

7. THE COMPANY SHOULD IMPLEMENT A TIME-VARYING RATE WITHIN ITS PILOT PROGRAM

Q Why should the Company implement a program to encourage off-peak charging prior to designing its managed charging program?

A As discussed above, programs and incentives to encourage charging during off-peak hours help to minimize the marginal costs associated with EV charging, thereby lowering costs on the grid of integrating EVs. Such programs can also reduce the operational costs of EVs that are able to charge during off-peak hours, reducing the financial barrier to adopting EVs. Although the Company intends to implement a managed charging program in 2021, there is no reason to delay implementing a time-varying rate program in the interim for customers participating in the pilot.

Under the Company's proposal, managed charging would not be implemented for two years, meaning that customers who adopt EVs in the interim would have little incentive to charge in a manner that minimizes costs on the grid.[26] This delay represents a wasted opportunity to educate customers regarding optimal charging times and to encourage customers to adopt charging habits that align with grid needs.

In addition, the Company's proposal represents a missed opportunity to test customer adoption and effectiveness of the Company's specific time-varying rates. Customers who participate in the program will install smart chargers, which will enable EV load to be metered separately and allow for the implementation of time-varying rates. Further, participation in the program will be associated with direct customer-utility communication. This is a perfect opportunity to educate customers about optimal charging patterns and encourage adoption of time-varying rates, which is likely to improve customer enrollment rates while reducing the costs of customer outreach and marketing.

[26] Although the testimony of Gregory Morgan notes that the Company intends to implement an experimental time-varying rate in 2019, this rate would only be available to residential customers with AMI and would not apply to the pilot program.

Another reason to implement voluntary time-varying rates during the Pilot Program is that not all customers may be able to take advantage of managed charging. Some charging station operators may not be able to allow their customers' charging to be throttled by the utility, as doing so may result in customer backlash. These customers may be more likely to enroll in a time-varying rate program than a managed charging program. Therefore, such customers should not be considered when designing the managed charging program based on charging behaviors in the Pilot.

Finally, implementation of a time-varying rate will reduce operational costs for customers who can charge primarily off-peak, such as transit buses, municipal fleets, and residential customers who drive during the day. Reducing operational costs addresses the financial barrier to adopting EVs, thereby supporting growth of the EV market in the Company's service territory—a primary goal of the Pilot Program.

Q With a time-varying rate option, how should the Company ensure that TOU prices are passed on to EV drivers at public, workplace and multi-unit dwelling stations deployed pursuant to the Pilot Program?

A The terms of the Pilot Program should provide that the default arrangement for pricing at stations deployed pursuant under the program is that site hosts pass on TOU rates to EV drivers. Site hosts should have the option to pass on an alternative rate to customers, but a TOU rate should be the default pricing. In the context of a program funded by utility customers, it is important to ensure that EV drivers pay for charging on time-variant $/kWh rates that both maximize fuel cost savings and encourage off-peak charging that supports the electric grid. This is particularly important for those market segments where drivers are captive consumers, like multi-unit dwellings and workplaces.

The importance of ensuring EV drivers see meaningful TOU prices is demonstrated by real-world data. Consider programs implemented by two California utilities—San Diego Gas & Electric (SDG&E) and Southern California Edison—to support deployment of EV charging at multi-family dwellings, workplaces, and public "destination" locations. In

SDG&E's "Power Your Drive" program, the utility's time-variant rate was the default pricing passed on to customers; however, site hosts were given the choice to take service on that time-variant rate or implement alternative pricing to drivers. The vast majority of site hosts embraced the default, and, as a result, 90 percent of kWh delivered in the program occur during off-peak and super-off-peak hours.[27] This approach preserves flexibility for site hosts while maintaining focus on grid benefits.

Conversely, in Southern California Edison's "Charge Ready" program, the default was for site hosts to set their own pricing (while taking service on TOU rates). As a result, the fees were extremely variable—often more expensive than gasoline—and did not reflect grid conditions or TOU periods.[28] The result is predictable: drivers plugged in when convenient, often during peak hours, because they had no reason to do otherwise. Accordingly, the program did not contribute to the improved utilization of the grid—one of the justifications for the investment of utility customer dollars and goals set by the Company. Southern California Edison has sought to fix this issue in the second phase of its "Charge Ready" program.

Setting time-of-use pricing as the default for EV charging stations deployed pursuant to utility programs has been a feature consistently included in such programs in other jurisdictions.[29] The Company should do the same in this case by adopting a provision that

[27] San Diego Gas & Electric, "Electric Vehicle-Grid Integration Pilot Program ("Power Your Drive") Fourth SemiAnnual Report of San Diego Gas & Electric Company (U902-E)," March 20, 2018 (available at https://www.sdge.com/sites/default/files/documents/FINAL_Power_Your_Drive_Semi_Annual_Rpt.pdf, last visited Dec. 12, 2019).

[28] Southern California Edison, "Charge Ready and Market Education Programs; Pilot Report," April 2, 2018 (available at https://www1.sce.com/wps/wcm/connect/7d14b200-60d0-4407-b0ec-b45a8184e4e6/5227_SCE_ChargeReadyReportSummary_r4.pdf?MOD=AJPERES&attachment=false&id=1520974086455, last visited Dec. 12, 2019).

[29] Order Approving Pilots with Modifications, Authorizing Deferred Accounting, and Setting Reporting Requirements, Docket No. E-002/M-18-643, Minnesota Public Utilities Commission (approving $24M Xcel Energy EV charging program where participation is conditioned on "agreement by site hosts to have a default time-differentiated rate structure that reflects the on-peak and off-peak time periods of Xcel's pilot tariff and an energy rate differential ratio of at least 2:1. Site hosts may opt out of the default arrangement at their discretion to set pricing that reflects other considerations or needs, provided that such prices are

will ensure that the default arrangement is that EV drivers see TOU prices that both encourage off-peak charging that supports the grid and that maximize fuel cost savings for those who charge in a manner that is consistent with grid conditions.

At a minimum, the Company must require site hosts that receive a rebate for a level 2 charging station or a DC Fast Charging station to report prices charged to EV drivers. Reporting this information is critical for the Commission and stakeholders to understand whether the Company's program is meeting its goals of accelerating EV adoption and maximizing the electricity system benefits of transportation electrification.

Q Does the Company already offer a time-varying rate that customers with EV charging equipment could take advantage of?

A Yes, but the rate schedule offered was not designed specifically for EV customers (residential or otherwise) and is therefore suboptimal for EV customers. Specifically, rate schedule GS-2T (Intermediate General Service Time of Usage) can be selected by customers who have demands generally ranging from 30 kW to 500 kW. This rate schedule assesses a higher on-peak energy charge on summer weekdays from 10 a.m. to 10 p.m., and on non-summer weekdays from 7 a.m. to 10 p.m. However, this rate schedule also features a distribution demand charge, a generation demand charge, and a transmission demand charge.

Q Why is it problematic that the Intermediate General Service Time of Usage rate features several demand charges?

A Demand charges can undermine the economics of EVs, particularly for customers who have relatively low energy usage but high demand. This is particularly true for public DC

reported to the utility for purposes of Xcel's annual reporting."); Order Approving Settlement Agreement, Case No. U-20134, Michigan Public Service Commission (approving $10M Consumers Energy EV charging program with "default charging option…for site hosts to pass through the Company TOU rate to customers [EV drivers]."); Order, Case No. U-20162, Michigan Public Service Commission (approving $13M DTE Energy EV charging program and requiring "that DTE Electric shall work with potential site hosts to educate them on available rates, discuss benefits, and assist in determining reasonable and market-based pricing options, while also providing the site hosts flexibility and authority to set rates based on their individualized needs.").

fast charging stations and fleets that are beginning to transition to heavy duty EVs (such as transit buses). These charging stations operate at high power levels (generally 50 kW to 350 kW) but have relatively low energy use due to the limited number of EVs on the road today. This means that demand charges tend to dominate the electricity bills for these customers, resulting in a very high effective cost per kilowatt-hour, resulting in net losses for public charging stations or vehicle fleets.

Q How has the problem of demand charges been addressed by other jurisdictions?

A To address this problem, some utilities have temporarily reduced or eliminated demand charges for public charging infrastructure, opting instead to price electricity using TOU energy rates only.[30] For this reason, I recommend that the Company implement an energy-only TOU rate for EV customers.

Q Should the Company design multiple TOU rates for different EV customer types?

A Yes. There may be a cost difference for L2 charging stations and DCFC stations due to charging at different power levels and the unique infrastructure needed to serve them. Therefore, the Company should offer multiple options designed to reflect different levels of cost causation by different types of customers. The Company should let customers choose which TOU rate option they would like to pass onto EV drivers, which will depend on the customer's individual level of risk tolerance and ability to shift load.

Q Please summarize your recommendations regarding incentives for off-peak charging.

A I recommend that the Company offer customers participating in the pilot program the ability to take service on a time-varying energy only rate (such as a TOU rate) for three reasons:

[30] This has been done by Pacific Power in Oregon, National Grid in Rhode Island, Con Edison in New York, Southern California Edison, Baltimore Gas and Electric, Connecticut Light and Power, Hawaiian Electric Company, and several others. For more information on each utility's specific case, see Whited et al. September 2018. "Driving Transportation Electrification Forward in Pennsylvania." Synapse Energy Economics. Pages 16-17. Available at: https://www.synapse-energy.com/sites/default/files/PA-EV-Rates-Report-18-021.pdf.

1. Offering a time-varying rate would encourage customers who can shift charging to off-peak times to charge when the grid is less stressed, thereby reducing costs on the grid for all customers.

2. Offering a time-varying rate would reduce the cost of adopting EVs by customers who can charge primarily off-peak, thereby encouraging greater adoption of EVs. For example, a TOU rate would likely significantly reduce the operational costs of operating transit buses and government fleet vehicles that can charge overnight.

3. Offering a time-varying rate would enable the Company to examine the charging behaviors of EV drivers to its specific TOU rate option, which would help inform future rate designs and alternatives to the managed charging program.

8. ELECTRICITY SOLD AT CHARGERS OWNED BY THE COMPANY SHOULD BE AT LEAST AS CHEAP AS GASOLINE

Q Did the Company specify a rate for the electricity to be sold at the four charging stations it proposes to own?

A No, the Company did not specify a rate for the four DCFC stations it proposes to own and operate.

Q What do you recommend with regard to the price of electricity sold at the Company's charging stations?

A I recommend that an upper limit be set for the price of electricity sold at the Company's charging stations, with the purpose of supporting fuel cost savings for EV drivers. Specifically, electricity sold at the Company's charging stations should be at least as cheap as gasoline. According to a survey of nearly 20,000 EV drivers, fuel cost savings relative to gasoline are the single biggest motivator of EV purchase decisions.[31]

[31] California Clean Vehicle Rebate Project, EV Consumer Survey Dashboard (available at

The utility-owned charging stations are primarily intended to collect data in support of electrification of the rideshare market segment; therefore, setting a price ceiling equivalent to the price of gasoline will protect the expected adoption of EVs in at least the rideshare market in the Company's service territory. If the charging stations the Company wishes to deploy do not provide the fuel cost savings that motivate EV purchase decisions, the Pilot Program's ability to support and analyze the EV rideshare market will be compromised.

9. RECOMMENDATIONS

Q What do you recommend for the design of the Company's Pilot Program?

A Overall, I support the goals of the Company's Pilot Program. However, I have several recommendations to ensure the program is effective, equitable, and maximizes benefits to ratepayers. My recommendations are as follows:

i) The Company should recalculate the number of Public Level 2 and DCFC rebates it is offering through the Pilot Program, consistent with the sales trajectory projected by Bloomberg New Energy Finance and with the more accurate input assumptions provided in this testimony.

ii) The Company should substantially increase the number of multi-family rebates it is offering, which will provide more equitable program benefits to those without easy access to home charging and to low-income customers.

iii) The Company should implement an energy-only time-varying rate within its Pilot Program. Doing so will reduce costs on the grid for all customers, reduce operating costs for EV owners (thereby encouraging greater adoption of EVs), and help inform future rate designs and alternatives to the managed charging program.

iv) For the four DCFC stations the Company plans to own and operate, charging should be at least as cheap as gasoline.

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https://cleanvehiclerebate.org/eng/survey-dashboard/ev , visited Sept 6, 2018).

Q **Does this conclude your testimony?**

A It does.