STATE OF VERMONT
PUBLIC UTILITY COMMISSION

Case No. 19-3586-TF

Tariff filing of Green Mountain Power	)
Corporation for approval to implement two	)
new electric vehicle charging rates to be	)
effective on bills rendered on or after	)
November 4, 2019	)

PREFILED DIRECT TESTIMONY OF
Richard Anderson

January 16, 2020

Summary: Summary: Mr. Anderson will show how lower Electric Vehicle (EV) charging rates are needed to accelerate EV adoption in Vermont as part of Vermont's Comprehensive Energy Plan. This includes demonstrating the need of low EV charging rates to offset cold weather effects, EV maintenance cost risks, high Level3 charging rates, and incorrect advertising of the relative fuel costs of EVs relative to other options. He further illustrates how that can be achieved with an EV charging rate at or below $0.08/kWh and illustrates availability of similar rates. He will illustrate errors in Green Mountain Power's analysis of EV electricity sales estimate and Green Mountain Power's analysis used for the proposed EV charging rates.

Exhibits:	AND-1	GMP/EVgo Utilization
	AND-2	Comparison of cost per mile of EVs and ICE vehicles
	AND-3	EV Charging Data Used to Establish Proposed Rates
	AND-4	Energy Use from Green Mountain Power Bill
	AND-5	2017 Vermont Top Vehicle Registrations
	AND-6	ChargePoint EV charging profile
	AND-7	Hourly electric consumption during a day

Exhibits:	AND-8	Calculation Error of Coincident kW
	AND-9	Itron Residential EV Sales
	AND-10	EV Revenue Analysis by Green Mountain Power
	AND-13	Plug-In Hybrid Vehicle Battery Sizes
	AND-14	Corrected GMP EV Sales in Dollars at Current and Proposed Rates
	AND-15	Green Mountain Power Daily Load
	AND-16	Vermont EV Registrations

Pre-filed Direct or Testimony
Of
Richard Anderson

Q. Please identify yourself.

A. My name is Richard Anderson. Green Mountain Power Corporation provides the power to our home in Jericho, Vermont.

Q. Please summarize your background and professional experience.

A. I graduated from Massachusetts Institute of Technology in 1987 with a Bachelor of Science in Electrical Engineering and a Master of Science in Electrical Engineering and Computer Science.

Over a 31 year period I worked for NCR, IBM, and Global Foundries as an engineer, team leader, and manager. I helped to develop and launch new products for both in the US and international markets. My international experience includes Belgium, Sweden, United Kingdom, France, Israel, Japan, China, Canada, Germany and Italy. I helped develop business models for several of IBM's $1B+ semiconductor technology nodes as well as managing multi-million dollar development budgets. I also hold a number of US patents

Q. Is there other relevant experience?

A. Yes, some of my volunteer experiences illustrate my commitment to the public good as well as relevant skills.

I am a volunteer through AARP Tax-Aid preparing Federal and Vermont income tax returns for seniors and lower income clients.

I volunteer as Stroke and Turn Swim official for Vermont's summer swim program.

I am the volunteer head coach for the Mount Mansfield Boys Volleyball team.

I am high school math tutor.

Through Strive For College, I provide guidance to students applying to college.

This experience outside the workplace provides additional relevant experience and a perspective to improve the lives of others.

Q. What is the purpose of your testimony?

A. The purpose of my testimony is to provide electric vehicle (EV) information and engineering analysis to be considered for establishing residential charging rates to will improve EV adoption in Vermont.

The impact of human energy use on the environment in Vermont and beyond requires changes in behavior and policies to mitigate global warming. As an example, I have taken steps to reduce my personal energy use to reduce impact on the environment. I became an early owner of an EV to be an example to others of another way to help improve Vermont's energy and economic profile. My goal is to convince others to replace their internal combustion engine (ICE) vehicles with electric vehicles.

Q. What EV do you own?

A. I acquired a 2018 Tesla Model 3 All-Wheel Drive (AWD) in September 2018.

Q. Why did you choose a Tesla Model 3 over other EVs?

A. Tesla as network of Level 3 SuperChargers across the US and Canada enabling Tesla EVs to be used for long trips. The Tesla Model 3 is the lowest cost Tesla model available at the time it was aquired.

The Tesla Model 3 is also the most energy efficient electric vehicle per the U.S. Department of Energy website: https://www.fueleconomy.gov/.

Q. Where there additional reasons for choosing a Tesla Model 3?

A. Yes, safety was another important consideration because I transport children. The Tesla Model 3 is one of the safest cars based on data from the Insurance Institute for Highway Safety (https://www.iihs.org/ratings) and National Highway Traffic Safety Administration (https://www.nhtsa.gov/ratings) . The AWD feature improves the ability of car to move through some of the challenging Vermont winter road conditions.

Q. Where do you charge your Tesla Model 3?

A. The Model 3 is mostly charged at our home using a ChargePoint brand Electric Vehicle Supply Equipment (EVSE).

Q. How much does it cost to charge the Tesla Model 3 at home?

A. When I received the ChargePoint EVSE, I also signed up for the EV Unlimited Plan which provides unlimited charging for $29.99 per month.

Q. Where there any additional costs associated with the EV Unlimited Plan ?

A. Yes, I was surprised that the Energy Efficiency Charge of $0.01371/kWh for the EV charging was included on the bill. This was not disclosed in the agreement nor the advertising for the program. The Energy Efficiency Charge imposed on EV charging appears contrary to Vermont's Comprehensive Energy Plan. https://outside.vermont.gov/sov/webservices/Shared%20Documents/2016CEP_Final.pdf

Q. Do you receive ownership questions regarding your Tesla Model 3?

A. Yes, I received questions from friends and strangers as well as from participants from several events I have attended to promote EVs.

Q. How does EV ownership differ from ICE vehicles?

A. There are a number of areas where an EV owner faces challenges when compared to owning an ICE vehicle. These include the ability to take long trips, and planning for long trips, high energy costs for long trips, cold weather impacts which dramatically reduce range and dramatically increase electricity use, incorrect information comparing EVs to ICE vehicles, and the risk of high EV maintenance costs.

Electric Vehicle Challenges during Longer Trips

Q. How does taking a long trip in an EV compared to a similar trip in an ICE vehicle?

A. Both an EV and ICE vehicles have a limited range based on the amount of energy stored on-board. Very little planning is needed to refuel and ICE vehicle because of large infrastructure of gas stations in the United States. EV drivers do not have the option to just look for the next gas station in their path. EV drivers must map out available chargers near their path and ensure that they will have sufficient range between each opportunity to charge.

Q. How does the time to charge an EV compared to an ICE vehicle during a trip?

A. An ICE vehicle can be refueled in 5-10 minutes. With a Level 3 charger, 20-60 minutes is typically needed to continue a trip. The EV charging rate decreases as the battery charge level increases. Often more time is required for charging from 80% to 100% than it takes to charge from 20% to 80%. Thus charging time can be optimized if the EV has sufficient range when charged to around 60-80% to make it to the next Level 3 charger.

Q. Are there any effects on the EV battery when used for long trips?

A. Yes. There are two important negative effects during long trips which can reduce the lifetime and/or capacity of the EV battery. The first is rapid charging reduces the battery lifetime. EV owners can mitigate this effect by charging to an appropriate level at slower charging rates using a Level 2 or Level 1 charger before departing as well as at the end of the trip each day.

The second effect is a reduction EV battery life time is when the battery remains charge to a level between 80%-100%.

Q. Are Level 3 chargers readily available to support long trips?

A. Owners of Tesla EVs benefit from a network of Tesla SuperChargers available in the United States, Canada and other countries. Tesla's Level 3 SuperChargers typically can provide up to 120kW and Tesla has shared plans for SuperChargers with double that charging rate.

Q. Are there other public Level 3 chargers available in Vermont?

A. Based on https://www.plugshare.com/ data and Green Mountain Power EV map (https://greenmountainpower.com/map/ev-charging-stations/), there are 14 50kW EVgo Level 3 chargers across the state.

Q. Is Level 3 charging rate (kW) for EVs constant?

A. No, the energy delivered to an EV varies based on the temperature, charge level of the battery, and the charging station configuration. When the battery charge is low, the rate of charging can be very high such >80kW for Tesla EVs. As the battery charge level increases the charging rate tapers off. The charging rate is also reduced at both low temperatures and high temperatures.

Q. How does the cost of using GMP /EVgo Level 3 chargers compared to Tesla's SuperChargers?

A. Tesla SuperChargers typically cost less than half than the GMP/EVgo Level 3 chargers. GMP/EVgo 50kW Level 3 chargers cost $0.35/minute or $0.31/minute with a monthly subscription of $7.99 (https://www.evgo.com/charging-plans/). Telsa Superchargers in Vermont cost $0.26/minute when charging above 60kW and $0.13/minute when charging below 60kW (https://www.tesla.com/support/supercharging).

Q. How does the cost of Green Mountain Power/EVgo Level 3 chargers compare to Level 3 charging in nearby Quebue?

A. First, it is important to note the exchange rate from United States Dollars (USD) to Canadian Dollars (CAD) which has ranged between $0.75-$0.77 USD to $1.00 CAD over the past year.

Circuit Electrique has a Level 3 charging network in Quebque. These Level 3 50kW chargers cost $11.78 CAD/hour or $0.196 CAD /minute (https://lecircuitelectrique.com/bornes-et-tarifs). Using the higher value of $0.77USD to $1.00 CAD the cost in USD is $0.08USD / hour = $11.78 CAD/hour X $0.77USD/CAD. This results in a cost of $0.15 USD /minute. The cost of GMP/EVgo 50kW Level 3 chargers cost $0.35/minute or $0.31/minute with a monthly subscription of $7.99. The GMP/EVgo Level 3 50kW chargers cost more than twice as much (2.33X) more than the Circuit Electrique Level 3 50kW Level 3 chargers.

Q. Can Level 2 chargers be used for trips?

A. No, not effectively because the charge rate is so slow. Level 2 chargers charge at EVs at a rate of about 20 miles / hour, which is why they are good for overnight home charging. Level 2 chargers are not effective for trips because it would take 5 hours of charging to go the next 100 miles. Level 2 chargers are good options at home and destinations where the EV can be charged for multiple hours such as at hotels and work locations.

Q. What is the impact to EV owners taking longer trips in Vermont?

A. EV owners using GMP/EVgo Level 3 chargers will pay more than double then if they were travelling in nearby Quebec. Tesla owners can use Tesla Superchargers which are also more than one-half the cost of GMP/EVgo owners. Drivers of ICE vehicles do not face a similar double the cost of fuel when taking trips.

Q. How are GMP/EVgo Level 3 chargers related to this case?

A. The intent of GMP investment in Level 3 chargers is demonstrate support of Vermont's Comprehensive Energy Plan.
https://outside.vermont.gov/sov/webservices/Shared%20Documents/2016CEP_Final.pdf
This is reflected in Scott Anderson's testimony on behalf of Green Mountain Power Corporation dated December 9th, 2019. Page 3, lines 3-5 of the testimony states, "GMP also owns and operates over 50 Level 2 and Level 3 public charging stations throughout Vermont, leading the initial buildout of charging infrastructure to boost EV adoption."
The cost of charging with the GMP/EVgo Level 3 chargers is very high when compared to similar Level 3 chargers. This high cost deters Vermonters from adopting an EV.

Q. What is the utilization of the Green Mountain Power / EVgo Level 3 chargers?

A. As reported by Robert Dostis, VP Stakeholder Relations, Green Mountain Power on March 1, 2019. The utilization of the Green Mountain Power public charging stations is extremely low. This includes the Level 2 and DC fast Level 3 EVgo chargers. Page 8 of his presentation is shown in Exhibit AND-1 : GMP/EVgo Utilization

Q. How can potential future investment in Level 3 DC fast chargers be used more effectively?

A. The investment or a portion of the investment can be redirected as incentives to provide controlled Level 2 chargers to EV owners who are not covered by another program. The additional investment in residential Level 2 chargers can shift EV charging to electricity can be provided at a lower cost and to help to avoid periods of peak demand which impacts all ratepayers.

Cold Weather Effects on Electric Vehicles

Q. Does cold weather affect an electric vehicle?

A. Yes, cold weather dramatically affects the range and efficiency. Anecdotal reports are that the range can be cut in half and double to triple the amount of electricity is needed to recharge the battery. AAA conducted environmental testing on five EVs with results reported in "AAA ELECTRIC VEHICLE RANGE TESTING" dated February 2019 https://www.aaa.com/AAA/common/AAR/files/AAA-Electric-Vehicle-Range-Testing-Report.pdf

A primary focus of the study was to understand the reduction of range at 20 degrees Fahrenheit relative to 75 degrees. The average range loss was 41% with the worst being 50% for a BWM i3s. This information lead Consumer Reports to recommend customers purchase an EV with at least twice the range needed for their commute. (This report can be accessed with an online subscription to Consumer Reports).

The study also measured the impact on energy cost which increased 85% when averaged across the five test vehicles.

Q. Are there any factors controlled in the study which would vary in real world driving?

A. The AAA study was well designed and provides useful information and conclusions which EV owners can use in their purchase decisions and EV driving.

One important factor is that only one low temperature of 20 degrees was used; however, temperatures can go far lower in Vermont where the battery and EV performance is even worse. Another factor is that a typical commuter or driver running errands will park the car which allows the car and battery temperature to drop back to the ambient temperature.

Yet another factor is that the AAA study didn't include the effect of air flow around the car due to wind or highway speeds reducing the vehicle's temperature. This is more commonly known as wind chill

Q. Are EV users' anecdotal reports of wrong?

A. No, it is easy to extend the effects of lower temperatures and extended time periods between trips during the day further increasing EV energy use.

Q. Is there data which shows the impact of driving in cold weather as well as the impact of cold weather charging which support the anecdotal reports?

A. Yes, the data was collected from a Tesla Model 3 for driving on Dec. 21, 2019. The car reported that over the distance of 52.1 miles driving that day, 23kWh were used and the efficiency was 447 wh/mile. The ChargePoint EVSE reported that to charge the car to the same level took 31.587 kWh. While the Tesla Model 3 is rated at 260wh/mile, the consumption was 72% higher. While the car reported that 23kWh was consumed by driving that day, 31.587kWh were needed to recharge the car which is 37% higher. The Model 3 efficiency that day was 606 wh/mile, which is 2.3 times more than the rated 260wh/mile. This is consistent with the anecdotal reports of 2X-3X more energy consumption on cold days.

Q. What was the temperature on the day the Tesla data was collected?

A. It was a cold day, with a low of 2 degrees Fahrenheit and a high of 26 degrees

Fahrenheit measured at the Burlington International Airport weather station.

Q. What important methodology to determine efficiency was used in the AAA study, which most EV drivers don't measure correctly?

A. The AAA study methodology measured the energy delivered to the car and the actual mileage covered for analysis. This is the same as recording the number of gallons pumped into a car during a fill-up and recording the mileage. The AAA methodology ensured that other factors such as charger efficiency (~85%) are accounted for in the analysis.

Q. What measurements might a car owner record for efficiency?

A. Car owners may use the efficiency recorded by the car which is useful for optimizing driving style but may not include charger inefficiency, energy to warm the battery, etc. Car owners may also use reports from their charger such as a ChargePoint which uses a fixed value for the mileage based on the number of kWh delivered. The ChargePoint miles reported can be very different from the actual number of miles driven. This was illustrated using the data from December 21, 2019 where the car reported 23kWh were consumed, while the ChargePoint EVSE reported 31.587 kWh to recharge the car which is 37% higher.

Q. Does cold weather affect EV operation?

A. Colder weather reduces a Tesla's regenerative braking and at lower temperatures it may be completely disabled. The Tesla Model 3 can start to reduce regenerative braking between 30-35 degrees Fahrenheit. The reduction or elimination of regenerative braking reduces the EV's efficiency. The driver must be aware when regenerative braking is compromised and change their driving behavior to compensate.

Electric Vehicle and Internal Combustion Engine Vehicle Comparison

Q. Did the Tesla Model 3 replace another vehicle?

A. Yes, the Tesla Model 3 replaced a 2010 Hyundai Elantra.

Q. What was the fuel economy of the 2010 Hyundai Elantra?

A. The 2010 Hyundai Elantra has a combined EPA efficiency rating 29MPG.

Q. How does the fuel economy of the 2010 Hyundai Elantra compare to the Tesla Model 3?

A. Based solely on EPA efficiency estimates, the cost per mile is illustrated in Exhibit AND-2. The Elantra cost $0.0931/mile for gas while the Model 3 cost $0.0475/mile. This excludes factors cold weather affects that were previously discussed.

Q. Does Green Mountain Power Advertise a fuel savings of an EV compared to an ICE vehicle?

A. Yes, Green Mountain Power has repeatedly stated that the equivalent fuel cost of an EV is $1.00/gallon or less. This statement has been part of this rate filing. It has also been broadly advertised on GMP's web site. An example from the web site is: *For GMP customers, the cost to charge up is like paying less than $1.00 a gallon for gasoline!* https://greenmountainpower.com/2019/11/13/driving-an-ev-cuts-carbon-and-can-save-you-money-just-ask-harold/

Q. Is the Green Mountain Power's (GMP) comparison of the equivalent fuel cost estimate of less than $1.00 / gallon correct?

A. No. The GMP analysis is based on an incorrect assumption of the ICE vehicles used in the comparison. GMP uses 22.5MPG as the point of comparison, which GMP has stated is the average of the entire Vermont vehicle fleet. This includes a number of vehicles such as trucks and vans for which there is no comparable EV for sale in Vermont. As illustrated by Exhibit AND-5, the highest number of registrations in Vermont are for Ford trucks, Chevrolet trucks, Toyota trucks, and GMC trucks. This information can be found in the VTrans report "The 2017 Vermont Transportation Energy Profile" dated September 2017, which provides insight into the privately owned vehicle fleet.

The top four all electric vehicle registrations in Vermont are the Nissan Leaf, Chevrolet Bolt, Tesla Model 3, and Tesla Model S as reported by Drive Electric Vermont based on data from the Vermont DMV. https://www.driveelectricvt.com/Media/Default/docs/maps/vt_ev_registration_trends.pdf. All of these vehicles are cars.

Q. Is there a better approach for determining representative vehicles for a fuel economy comparison?

A. Yes. A better approach which captures the environmental benefit is compare the EV to the ICE vehicle it replaces.

Q. Does the data exist to determine which vehicles that EVs have replaced?

A. Yes, the Vermont DMV and Vermont Department of Transportation have the records of both ICE and EV purchases and sales for each owner

Q. Do you have a recommendation for arriving at a better EV to ICE vehicle comparison?

A. Yes, the Vermont DMV and Vermont Department of Transportation should be parties to this case to provide the replacement vehicle data. The information is also important for measuring progress towards meeting Vermont's energy plan.

Q. Why is important to correctly represent the relative fuel economy of an EV?

A. Incorrect information from trusted sources such as a publicly regulated utility company will lead to lower adoption rate of EVs and increase the risk that Vermont will not meet its energy emission goals.

Q. What is the equivalent cost per gallon of a Chevrolet Bolt when compared to a Toyota Prius?

A. The Bolt and Prius are very similar which makes the comparison very relevant. Based solely on EFA efficiency estimates used in Exhibit AND-2, a Chevrolet Bolt gets 52MPG with an assumed cost of $2.70 / gallon of gas. Based on GMP Rate 1, it costs 52 miles X $0.0511/mile = $2.66 to cover the same distance with a Chevrolet Bolt. This is not a compelling financial reason to purchase a $36,620 2019 Bolt over a $23,770 Prius. It is also important to remember that using a Bolt for a long trip in Vermont using the GMP/EvGo Level 3 charger results in more than double the cost per mile in the example above.

Q. What is the equivalent cost per gallon of a Tesla Model 3 and Nissan Leaf when compared to a Hyundai Elantra?

A. Based solely on EFA efficiency estimates used in Exhibit AND-2, the Hyundai Elantra gets 29MPG with an assumed cost of $2.70 / gallon of gas. Based on GMP Rate 1, it costs 29 miles X $0.0475/mile = $1.38 to cover the same distance with a Model 3 and 29 miles X $0.0566/mile = $1.64

Q. Why are these effective cost per gallon numbers of $2.66, $1.38, and $1.64 so different from GMP's advertised $1?

A. The assumption of using 22.5MPG which represents the entire Vermont vehicle fleet doesn't reflect the vehicles which EVs are replacing.

Q. Are there less obvious energy costs associated with an EV?

A. Yes, an EV battery loses about 1% of the total charge capacity each day. This is one of the reasons that it is recommended to leave an EV plugged in so that the battery charge level can be maintained. A Tesla Model 3 with a 75kWh battery loses 0.75kWh/day when sitting idle. During the course of a year a total of 365 days X 0.75kWh/day = 273.75 kWh/year. This phantom loss costs 273.75kWh/year * $0.16893/kWh = $46.24 /year. This is more than a fill-up of 15 gallons of gas at $2.70 / gallon, which is $40.50.

The recommendation is to leave the EV plugged in when parked, so that the battery can be recharged due to these idle losses.

Q. What about plug-in hybrid vehicles?

A. The battery size of plug-in hybrids are small. In the 18 plug-in hybrids from Drive Electric's fact sheet (https://www.driveelectricvt.com/Media/Default/docs/fact-sheet-drive-electric-vermont.pdf)

only four have a battery larger than 12kWh as shown Exhibit AND-13. These first 16 plug-in hybrids can easily be fully charged overnight using a standard outlet.

(120Volts AC X 10Amps X 10 hours = 12kWh), which is Level 1 charging. Level 1 charging with a dedicated 15A circuit would deliver 18kWh in the same time period, which covers all but the BMW i3 REx from that list. It is also important to remember that fully charging a battery reduces its life expectancy.

A Level 2 charger is not needed to charge a plug-in hybrid and the up-front cost of a Level 2 charger and installation may not be justified.

Even if not fully charged or if the owner forgets to connect the charger in the evening, plug-in hybrids can always use the gas engine.

The participation of plug-in hybrids in the Green Mountain Power Level 2 charger programs also shows that owners of plug-in hybrids are not installing Level 2 chargers. From the spreadsheet from the GMP discovery response, "Attachment GMP.Anderson1.Q3.a" shows that 423 all electric vehicles participated and 239 plug-in hybrids participated. Exhibit AND-16, shows that as of July 2019 there were 1,265 all electric vehicles registered in Vermont and 2,032 plug-in hybrids. It would be expected that the ratio of fully electric vehicles to plug-in hybrids to be very similar between GMP Level 2 charger programs and the total EVs in the state. The ratios are very different as the GMP level 2 charger programs had 423/239 = 1.77 compared to the total Vermont registrations of 1265/2032 = 0.623. This illustrates that plug-in hybrid owners are not installing Level2 chargers at home.

Electric Vehicle Maintenance

Q. What are the maintenance costs for an EV?

A. EVs are so new that the long term maintenance costs are not well understood. For my Tesla Model 3 the recommended maintenance includes periodic replacement of the brake fluid and battery/motor coolant. Like ICE vehicles, it is expected that the wear of tires and brakes will eventually require replacement.

Q. Are there other maintenance items which are not mentioned in the maintenance schedule?

A. The batteries, motors, and electronics in EVs are new technologies where the long term failure rates and mechanisms are not known. Each EV owner assumes a higher maintenance risk with an EV relative to an ICE vehicle.

Q. Are there any examples of this risk?

A. Yes. Early degradation of batteries in Nissan Leaf EVs has been a problem in warm climates. The most recent has been with 30kWh Nissan Leaf EVs as reported in "Accelerated reported battery capacity loss in 30 kWh variants of the Nissan Leaf" by FlipTheFleet on March 15, 2018.

Q. What does this mean for EV owners?

A. While the EV maintenance schedule is short, the EV history isn't long enough to understand the risk of needing to replace a major/expensive EV component much sooner than expected.

Green Mountain Power EV Charging Analysis

Q. What EV charging data was used in the Green Mountain Power analysis to arrive at the proposed EV charging rates?

A. Scott Anderson representing Green Mountain Power provided an Excel spreadsheet with the analysis done for the rate proposals. The basis for the analysis was data from the "Load Shapes" tab of the analysis and is shown in Exhibit AND-3.

Q. What does this data represent?

A. The data appears to be an average across a population of chargers showing energy delivered by a typical EV charger for each hour of the day.

Q. What additional information isn't known about the data collected?

A. The time frame of the data collection is not known. The data could be from any period of time from just one day to a period of over a year or more.

Q. How could the time period of the data collection affect the results?

A. As illustrated earlier, cold weather increases EV power consumption so colder months of the year would cause more power to be consumed.

Q. What does the EV charging data show?

A. The data shows that many EV owners are plugging in when they arrive home around 6PM and their EV immediately starts charging. Many of the EVs complete charging around 12AM.

Q. Is the methodology used to collect the data valid?

A. The assumption for GMP's analysis was the data from uncontrolled charging.

While the charging may not have been controlled by GMP, EV owners can control the time charging occurs using the EVSE and/or the EV. The methodology for data collection is likely flawed because GMP didn't exclude data based on charging controlled by EV owners.

Some number of the EV owners are using the ability to control charging with either the charger or EV to delay charging. These owners are aware that in most parts of the United States the cost electrical production is lower late at night and early morning.

Q. Do you have an example of an EV owner delaying charging to the late night and early morning periods?

A. Yes, my Tesla is programmed to start charging at 12AM. During cold weather, charging may be further delayed so that the battery is warm at departure time. The impact of the delayed charging time is shown in Exhibit AND-4. The exhibit is a snapshot of a GMP bill which shows the percentage of energy consumption during six 4-hour time periods during the day. The highest energy consumption (55%) occurs between 12AM-4AM due to the EV charging.

Q. How do the owners who control EV charging affect the results?

A. The methodology is based on the assumption of uncontrolled charging. The EV owners who are controlling charging times skew the results because they are unlikely to be charging during the time of day when peak events occur. The GMP analysis to establish EV rates misses the benefit of owners who are controlling charging period to not include the times of day when peak events typically occur.

Q. Does Green Mountain Power have information to determine which EV charging information to exclude from the data?

A. Yes, Green Mountain Power has two sources of information to identify delayed EV charging. EVSE such as the ChargePoint (one of GMP's approved EVSEs), provide a time profile of EV charging as shown in Exhibit AND-6. This charging profile shows that the EV is charging between 1AM-4AM. A second method is the residential Smart Meter data which captures energy use versus time and is the mechanism GMP uses to create the graph shown in Exhibit AND-4 which appears on each monthly residential customer bill. GMP also provides residential customers a graph showing hourly electrical use as illustrated in Exhibit AND-7. In this example the EV is charging from approximately 3AM to 7AM so that the battery is warm for departure.

If desired, a customer can also download electrical consumption in 15 minute intervals.

Green Mountain Power EV Rate Analysis

Q. Are there errors in the calculation of the benefit of shifting EV charging away from peak times?

A. Yes, there is at least one error in the calculation. This error prevents identifying additional sources of error in the analysis.

The error is in the calculation of the line "Coincident kW (kW)" in Exhibit GMP-SRA-4. GMP provided the spreadsheet in Excel format for Exhibit GMP-SRA-4 and is already evidence in this case.

For both the FCM and RNS columns the Coincident kW the result of multiplying the EV Charge Connected Load (kW) by the Peak Coincidence Factor. The Peak Coincidence Factor is calculated by dividing a value from another tab by the EV Charge Connected Load. First dividing and then multiplying by the same value results in no change to the Coincident kW. Exhibit AND-8 illustrates this by using a value of 105.000kW for the EV Charge Connected Load which is compared to the 5.250kW in the GMP analysis. This shows that the value of the Coincident kW is independent of the EV charging rate as the result is the same for any value of the EV Charge Connected Load. The EV Charge Connected Load is important in the GMP analysis because it is used to establish the benefit of shifting the EV charging from peak times and thus should be directly proportional.

Thus the remainder of the analysis based on the Coincident kW is unlikely to be correct. This also limits the possibility of verifying the analysis prior and after this point.

Green Mountain Power EV Electricity Sales

Q. Is there an estimate of future Green Mountain Power residential EV electricity sales?

A. Yes, Green Mountain Power submitted a prepared by ITRON titled "Green Mountain Power, 2020 Budget Forecast Report" as part of a prior case. Table 1 as shown in Exhibit AND-9 shows the predicted sales from different customer classes from 2019 through 2029. The second column in the table shows the residential power (MWh) for residential customers along with the percentage change from the prior year.

The EV portion of residential sales (MWh) is shown in Table 3 of the same report. The EV sales are shown in column 6, titled EV for each year starting in 2019 through 2029.

Q. Does Green Mountain Power's revenue projection accurately reflect sales from all residential EV charging at the proposed EV rates?

A. No, because the all EV owners will participate in one of the two rates. Not all EV owners will participate. EV owners who are not able to participate in one of GMP's programs which provides a new charger or otherwise do not have a compatible charger will not be able to take advantage of the proposed EV charging rates.

Plug-in hybrid vehicles are even less likely to participate in an EV charging rate because Level 1 charging is sufficient for all but the BMW i3 Rex.

Q. Are there errors in Green Mountain Power analysis of EV electricity sales?

A. The first error in the GMP analysis is that 2019 sales are added to Itron's estimate of sales in future years. . For each of the years 2020, 2021, and 2022, 5,814,124 kWh of

EV sales were incorrectly added.

Q. Q: How can it be determined that each year in the ITRON report represents total sales rather than incremental amount from the prior year?

A. "Table 1: Customer Billed Sales Forecast (MWh)" in Exhibit AND-9 includes the percentage change from the prior year in each customer class column. If the amount in the next row was incremental then the sales would be approximately double from the prior year. The text in the ITRON report is clear that each row in Table 1 is total sales for that year rather than an incremental amount.

The residential column from Table 1 matches the last column labeled Forecast in Table 3 "Residential Sales Forecast Desegregation" with both showing the estimate of total residential sales in each year.

Each row in Table 3 shows base sales without energy efficiency impacts in column 2. Columns 3 - 6 show the impact of energy efficiency impacts, solar production, Tier 3 programs, and EVs. These impacts are summed up in column 7 - TtlAdj. TtlAdj is added to the base sales to arrive at the forecast in the last row. Each row in Table 3 reflects the sales (MWh) in that year.

Thus the EV sales in column 6 is not an incremental value from the prior year.

Q. What was the second error in the Green Mountain Power analysis?

A. Two different methodologies for estimating EV sales were mixed. For 2019 GMP's analysis based on Drive Electric Vermont data arrived at 5,814,124 kWh of sales while for 2019 ITRON's analysis based on VEIC data was 684,000kWh which is a factor of 8.5X. It is important to also observe that GMP's analysis for 2019 of 5,814,124 kWh also exceeds ITON's 2020 estimate of 3,922,000 kWh.

Q. What are the correct EV sales for future years?

A. A corrected table is shown in Exhibit AND-14 which uses the annual (kWh) from the Itron report.

Q. Why is correcting the error in the sales analysis important?

A. The Green Mountain Power sales analysis over predicts EV penetration. This can lead to a conclusion that lower EV rates are not needed to accelerate EV adoption in Vermont.

Electric Vehicle Charging Rates and Electric Vehicle Adoption

Q. Are EV charging rates important for EV adoption?

A. Similar to ICE vehicles where fuel cost is an important operational cost, charging rates are the most important operational costs for EVs.

As shown earlier the 2X-3X lower EV efficiency in the winter should be offset by a similar factor in EV charging rates.

The risk of adopting a new technology can be partially mitigated by very attractive rates.

The high cost energy delivered Level 3 chargers in Vermont to enable longer trips can be partially offset by EV owners being able to charge at a much lower rate at home.

Offering consumers the opportunity to purchase energy at less than ½ the price they pay for other residential loads is a powerful incentive to adopt an EV.

Q. Has a Vermont Utility offered residential customers an EV charging rate which is less than ½ of the residential rate?

A. Yes, the Burlington Electric Department (BED) offers EV charging at $0.08/kWh.

Q. How is it possible to offer a low rate?

A. Low rates can be offered during times of day when electrical demand is low. An example is shown in Exhibit AND-15 which illustrates low demand from 11PM to 7AM.

Q. Does Green Mountain Power (GMP) offer any rate similar to BED's EV charging rate?

A. Yes, GMP offers rate 13 which has an off-peak rate of $0.08374/kWh between 11PM and 7AM, which is an ideal time to charge an EV.

Q. What are the least expensive times during the day for Green Mountain's Power electricity production?

A. The time of day when the lowest incremental cost of power production is strongly related to the time of day when demand is lowest. Exhibit AND-15 the lowest demand is from approximately 11PM until 7AM the next day. During this low demand period there is idle generation and transmission capacity such that the incremental cost to provide the next 1kW is very low because the fixed costs do not increase to produce incremental power.

Q. Are there times of day when EV charging should be discouraged?

A. Yes, based on Exhibit AND-15, times of high demand between 4PM and 9PM should be avoided. Customers should still be given the option to charge during these times because cold weather effects reducing EV range, so that they can go to evening events such as a child's performance.

Q. Does the Green Mountain Power (GMP) proposed rates subsidize other rate payers?

A. GMP stated that EVs charging outside of the periods of peak demand will save money for all rate payers. The first source is in the subtitle of Exhibit XXX - "LOAD SHAPING 101: GENERATE SAVINGS FOR ALL CUSTOMERS". It is also stated in GMP's discovery response to Anderson:GMP.1.2. "When incremental sales produce incremental revenue greater than incremental cost, those sales have a rate-reducing effect, all else equal." Thus, the additional revenue paid by EV rate payers lowers the cost for all ratepayers resulting in EV rate payers subsidizing other ratepayers.

The subsidy for other rate payers can be mitigated by offering a much lower EV rate.

Q. How important is for EV drivers to charge at optimal times for the grid?

A. Green Mountain Power (GMP) and other utilities should lower the financial barrier for using EVES Level 2 chargers to encourage charging during low demand times to better balance utilization of the electrical generation and distribution. Without incentives, the EVs will be charged during peak events increasing the costs for all ratepayers.

Even with an offer of a ‘free’ Level 2 charger, the owners of Plug-in hybrid vehicles may not want to incur the cost of installation. The EV charging rate should be set lower to create an incentive for plug-in hybrid owners to install a Level 2 charger which can be controlled.

Q. What strategies are EV owners adopting who have not been to take advantage of Green Mountain Power’s EV incentives?

A. Some EV owners are installing solar panels to offset the cost of EV charging. The lowest cost periods for EV charging are at night when there is no solar production. The result is an odd shifting of power production and consumption.

Q. Does this conclude your pre-filed direct testimony?

A. Yes.