STATE OF VERMONT
PUBLIC UTILITY COMMISSION

Tariff filing of Green Mountain Power requesting a 5.45% increase in its base rates effective with bills rendered January 1, 2019, to be fully offset by bill credits through Sept. 30, 2019	))))	Case No. 18-0974-TF

PREFILED REBUTTAL TESTIMONY OF

JOSHUA CASTONGUAY

ON BEHALF OF GREEN MOUNTAIN POWER

September 12, 2018

Summary of Testimony

Mr. Castonguay responds to Department of Public Service DPS witnesses McNamara, Dawson, and Winn concerning GMP's innovative products and services, including the Tesla Powerwall program. He explains the significant benefits created by these programs for customers and highlights why these projects are cost-effective for all customers and critical to the transformation of the grid. He also explains how GMP evaluates demand resource alternative in its development of innovative pilot programs. Finally, he responds to the Commission's Information Requests regarding GMP's innovative services.

Exhibit List

GMP-JC-3 (Rev.)	Revised Innovative Pilots – Costs & Revenues
GMP-JC-4	ePark Project Folder
GMP-JC-5	ePark Aerial Photo

Q1. Please state your name and position.

A1. My name is Joshua Castonguay and I am Vice President, Chief Innovation Executive and Power Supply at Green Mountain Power ("GMP").

Q2. Have you previously submitted testimony in this proceeding?

A2. Yes, I previously provided prefiled direct testimony in this proceeding dated April 13, 2018.

Q3. What is the purpose of your testimony today?

A3. I respond to issues raised by Department of Public Service ("DPS" or "Department") witnesses regarding the Tesla Powerwall, Heat Pump Water Heater ("HPWH") and Heat Pump innovation projects. Specifically, in Section I, I address concerns regarding the Tesla Powerwall Program, and also explain the small adjustments GMP has adopted to account for the installation of Powerwalls over the 2019 rate period that result in a small additional rate decrease. In Section II, I respond to the Department's other concerns and proposed adjustments, including explaining how we have considered demand resources alternatives in our evaluation of innovative pilot programs. In Section III, I address additional Information Requests from the Commission regarding GMP's innovative services.

SECTION I – TESLA POWERWALL PROGRAM & OTHER BATTERY STORAGE PROJECTS

Q4. Mr. McNamara outlines the Department's general support for GMP's innovative programs and services but expresses the opinion that the Tesla Powerwall program should be delayed and not included in rates in the '19 rate period. How do you respond?

A4. As emphasized in my initial testimony, GMP views the development and deployment of these innovative products and services as critical to the transformation of the grid and to keeping costs down for all our customers. As we have explained before, we are facing a reality of declining retail sales coupled with increasing regional transmission, capacity, and net-metering cost pressures. If we do nothing, the result will be significant rate increases for customers over the next several years but particularly in five to ten years as the regional grid spends billions on infrastructure with no new sales currently forecasted to support it. That is why our innovative programs, which bring in new revenues and values to reduce otherwise increasing costs for customers, such as the Tesla Powerwall program, are so critical. We have worked closely with DPS on the initial development of these programs, and we look forward to continuing that relationship. We also share the Department's goal of ensuring these programs provide maximum benefits not just to those customers who elect to install innovative products, but more broadly for all our customers, regardless of whether they choose to participate in the program.

While we appreciate the Department's general support for these programs, we are very concerned that the Department seeks to delay including the Tesla Powerwall program in rate base. As discussed further below, while still in the pilot period, the Tesla

Powerwall program has proved enormously popular with our customers and incredibly valuable in terms of driving down the costs of peak events this summer. As a result of the partnership between GMP and the host customers installing these units, the Program is generating substantial benefits for all of our customers (including non-participating customers), which we believe should be passed through to customers as soon as practicable, by including the pilot in the '19 rate period. If the most recent August 29, 2018 ISO-NE peak event holds as the summer peak, GMP's battery resources saved over $750,000, with the customer-hosted Powerwalls alone generating over $367,000 of the total savings for customers. This benefit is only increasing as more Powerwalls are installed each month. These are meaningful, presently-quantifiable benefits in the face of steadily increasing regional transmission costs. DPS's position is that both the costs and benefits associated with this program should be excluded from the case, and that recovery should be delayed until more information is available on the benefits of the program. We do not believe we should delay further in providing these benefits to customers. In our view, now is the time to accelerate these types of innovative programs, not discourage their implementation through delay and "below the line" treatment. As discussed further below, we are nearly fully committed on the 2000 Powerwalls in the Energy Transformation Pilot due to strong customer demand for this offering, including offering a free Powerwall to 100 low-income customers thanks to a grant that GMP was successful in procuring. GMP is presently evaluating options for moving this program to a fully-tariffed offering in advance of the end of the 18-month pilot period because we see these programs as critical for many reasons, chief among them to drive down costs for customers.

Q5. Mr. McNamara raised a question about whether the anticipated 2000 Powerwalls in GMP's case will be installed by the end of the rate period. Can you please briefly provide an update on the status of the Powerwall program?

A5. Yes. As noted above the program is extremely popular and we continue to see strong demand for the Powerwalls. We installed 106 Powerwalls in the month of August alone, bringing us to a total of 694 units installed and currently operating, with an additional 930 units under contract. This brings the total number of Powerwall units either installed or currently being scheduled for installation to 1624 units. In addition, we have 582 customers that are at various stages of the sign-up process but have not yet executed a contract. Because many customers ended up procuring two Powerwall units instead of a single unit, we will end up hitting our target for deploying remaining available units and not be able to provide batteries to everyone remaining in the queue. As described in testimony, discovery, and in person to the DPS, we are on track to complete installation of the full 2,000 units by summer 2019.

With this level of customer demand the only limiting factor is just how quickly the units sought by customers can be installed. Tesla is making significant progress in accelerating the number of installations per month to keep up with demand, and the fact that many customers are requesting two units is helping to accelerate the number of units installed (as installing two is essentially the same amount of work as installing one unit). We have looked closely at the pace of installation, and while we are confident the total 2000 units will be installed in the rate period, we have made a minor adjustment to the installation schedule to line up with current expectations, and to help reduce the overall cost of the program in the rate period. In our previous Cost of Service model, we used

April 2019 as the end month for installations. In our revised Cost of Service accompanying this testimony, we have pushed that final installation date out to the beginning of September 2019. This aligns conservatively with the pace of installation we currently anticipate, and as described in Mr. Ryan's testimony, the adjustment results in a slight overall rate reduction during the rate period.

Q6. Mr. McNamara and Mr. Dawson express some concern about the ability of the Powerwall program to provide expected benefits. Can you start by explaining how Powerwalls benefit all customers?

A6. As I described in my direct testimony, the Powerwall program is benefitting customers in a variety of ways, some of which are direct financial benefits, and some of which are more qualitative in nature.

First, and most important, the program is designed to provide benefits to all of our customers (including non-participating customers) in multiple ways. These financial benefits for customers are derived from a combination of GMP utilizing the batteries for power supply cost reductions as well as collecting a payment from the participating customer. These power supply cost reductions are derived mainly from the dispatching of batteries during peak power usage times which ultimately lower our Regional Network Service ("RNS") and Forward Capacity Market ("FCM") costs. In addition to the FCM and RNS cost reductions, we are able to harvest some value through energy arbitrage—or discharging the batteries when prices are high, such as during peak times, and recharging them when the energy prices are lower. Lastly, the batteries provide GMP with a tool to manage voltage and reactive power or "VARS" on the distribution system. We have not

yet attempted to monetize this value for customers, however, having this capability in a distributed fashion across the entire system provides GMP with tremendous flexibility on managing and maintaining a stable and reliable grid in the face of changing and flexible loads, intermittent distributed generation, and strategic electrification.

Mr. Dawson's testimony confirms that the program is beneficial to all customers. He acknowledges in his testimony on page 38 that the program is "marginally beneficial" even when customer payments are excluded, and that its benefits "noticeably outweigh the costs" when the associated customer payments are included in the analysis. He also acknowledged in discovery that he was not taking the position that customer payments should be excluded when evaluating the programs impacts on other customers.

In addition to benefits provided to all of our customers, the Powerwall program also provides benefit to the participating or 'host' customer. The main benefit to the host customer is improved reliability using a clean energy system. In cases where the host is forgoing the use of a fossil fuel generator there's the added benefit of lower carbon emissions. Unlike a backup generator, the battery system has no exhaust emissions, no noise, requires no refueling, requires no regular maintenance, and is in general much more responsive in an outage event than a traditional generator. This host benefit is important because it is the aspect of the program that encourages so many people to participate, thereby allowing GMP to generate the broader net benefits for all of our other customers. This win-win between host-customer and all of our other non-participating customers is exactly the type of partnership that is so critical for transforming the energy delivery system and providing a lower cost, more reliable, and cleaner energy system.

Q7. Can you explain further how GMP operates the Powerwalls to generate these benefits for all customers?

A7. Yes. GMP utilizes Tesla's software control platform, called GridLogic, to continuously monitor and dispatch the fleet of Powerwall batteries across the entire system. A team of people at GMP constantly watch and predict when peak loads will occur, using a set of analytical tools to help us narrow in which hours the peak loads will occur. From there, we are able to schedule the battery resources through a grid control software platform in anticipation of the peak event. As we approach the peak periods, we also have real-time control to make adjustments as we see fit in order to maximize the peak benefit. We also notify host customers automatically via e-mail in advance of each peak event. As you will see below, we have successfully hit every potential ISO New England peak that has occurred so far this summer with incrementally more Powerwalls each time as summer has gone on thanks to the continued deployment of units. These Powerwalls are just one tool in a larger library of resources that GMP is tapping into when these peak loads occur, and we will discuss the other resources further below in response to questions about Demand Response programs. I also discuss the Virtual Peaker operational control system we use to manage a suite of other connected resources in more detail in Question 22, which responds to one of the Commission's Information Requests about this software platform.

Q8. Can you explain further how FCM and RNS benefits are calculated and realized using battery storage?

A8. Yes. I'll start with FCM. ISO New England conducts an auction each year to procure enough Capacity (which can be a mix of generation resources as well as demand side resources, like Demand Response and Efficiency) to meet the needs of the forecasted peak 3 years from the auction year, as well as additional capacity to assure they have an appropriate buffer to assure reliability during the year, which is known as the capacity reserve margin. In addition, these auctions set the annual capacity price that those resources will receive. Each year, ISO New England uses the hour with the highest demand to set an annual coincident peak that is used to determine each market participant's share of the annual capacity obligation for the year that will begin in June of the following calendar year. This peak currently occurs in the summer and now tends to be later in the afternoon.

Whatever GMP's load is during the coincident peak hour forms the basis for our capacity supply obligation, which is then adjusted by ISO-NE's effective reserve margin to determine GMP's annual obligation. The total financial obligation for GMP is based on this volume as adjusted for self-supplied capacity and the Hydro Quebec Interconnection Capability Credit, multiplied by the monthly Net Regional Clearing Price, which is based on the results of the Forward Capacity Auction held three years in advance of the capacity year as mentioned above. For example, in 2017, ISO procured 36,000 MWs to meet capacity needs including the reserve margin but had an actual peak of only 23,508 MWs, meaning that there was an effective reserve margin of over 50%. This ultimately translates to a higher cost for GMP customers since our demand during

that hour will be adjusted by an additional 50%. In this case, every 1MW of demand during the coincident peak hour would actually cost our customers the equivalent of 1.5MW, or conversely, every 1MW saved by utilizing battery storage, actually reduces our obligation by 1.5MW. This is the basis for our FCM savings that is generated by dispatching the battery during the single ISO New England peak hour.

Thus far in 2018 we targeted the ISO peak 6 different times, and each time hit the peak window perfectly with the Powerwall system. We ultimately pay for capacity based on the single highest peak hour during the year, but to assure we always hit it we constantly monitor forecast loads for New England and dispatch our load management tools whenever we project a potential ISO New England peak. As explained above, this peak reduction is extremely valuable as the annual coincident peak sets our cost of capacity for an entire year.

The storage program also provides benefits by reducing Regional Network Service ("RNS") charges, which are the payments that each utility makes to compensate owners of the bulk regional transmission network, known as Pool Transmission Facilities, or PTF. These RNS charges, unlike the FCM charges, are calculated based on each month's peak Network Load. Each month, Vermont looks back to determine its highest single load hour which determines how much each VT utility will pay for Regional Network Service. The RNS rate, which is multiplied by our RNS load each month, is set by ISO-NE each year and charged to all of the distribution utilities in New England based on their monthly coincident peaks (i.e. the peak hour for all of Vermont regardless of whether it is any specific utility's peak). Similar to the FCM, we are able to use the batteries to lower these monthly peaks and thereby lower the amount GMP

customers must pay for RNS. It is important to note that any under-collections for RNS (relative to the formula volume) that may be caused by a utility shaving its peak in a given month may end up being collected in the following year as an adjustment (i.e. a true up) to the next year's RNS rate. But to the extent that a rate is adjusted upward in any given year, the Vermont distribution utilities would receive their load share, which for Vermont totals about 4% of the true up, versus the 100% of the RNS costs originally saved by peak shaving. As more transmission continues to be constructed throughout New England, GMP anticipates that this RNS rate will continue to rise, so the benefits of cutting peak load should only increase.

Q9. Are the Powerwalls that have already been installed currently providing benefits to GMP customers? If so, what specific benefits have been realized?

A9. Yes, as discussed above, GMP leverages the Powerwalls to provide value back to our customers as soon as they go into service by lowering the peaks used for calculating FCM and RNS charges. In fact, in the first summer of operation the units were successfully deployed for all potential summer FCM peaks. As shown in Table 1 below GMP has successfully hit 7 potential predicted ISO peak hours this summer, including the year-to-date ISO FCM peak that occurred on August 29th. This is subject to potential changes that may occur in the 90-day resettlement process, but we believe that it is unlikely to change at this point.

Table 1 – 2018 ISO Peak Performance

2018 ISO Peak Performance with Battery Storage & DR				
Date	Total MW Dispatched	Total FCM Value	Powerwall Only MWs	Powerwall Only FCM Value
2-Jul-18	5.30	$650,000	2.30	$283,000
3-Jul-18	5.30	$650,000	2.30	$283,000
5-Jul-18	5.30	$650,000	2.30	$283,000
6-Aug-18	5.50	$676,000	2.50	$ 307,000
7-Aug-18	5.50	$676,000	2.50	$ 307,000
28-Aug-18	6.14	$755,000	3.00	$ 367,000
29-Aug-18	6.14	$755,000*	3.00	$ 367,000*
*Current 2018 ISO Peak[1]				

As shown above, during the August 29th event the Powerwalls alone were able to reduce our peak load by 3 MWs. This is much higher than the earlier FCM potential peaks in the summer of 2018 due to the fact that Powerwalls continue to be deployed and added to the software platform. Our financial model reduced the anticipated peak reduction effectiveness value for various issues such as communications, battery degradation, and other factors (further described in Question 13, below); however, so far in 2018, we have been close to achieving 100% peak reduction value from the units already deployed during potential FCM peak hours, versus the 72% assumed in the financial model. If August 29th remains as the New England peak day as we expect, the Powerwalls will

[1] Note that the total estimated GMP savings for FCM are only those shown for August 29th (the values for the other dates are the savings that would have been realized had the peak occurred on any of those dates).

provide almost $370,000 in peak cost savings in the next capacity year that start in June of 2019.

In addition to the FCM peak, the batteries have been used to lower GMP's RNS peaks. Specifically, we have reduced RNS costs by approximately $45,000 since January of 2018. In contrast to the FCM benefit, these RNS savings benefit customers in the month the load reduction occurs. As the rollout of Powerwalls continues we anticipate seeing this value from RNS peak shaving growing quite rapidly.

Q10. Is the capital investment associated with achieving these benefits currently included in rate base?

A10. No. While the program is being used now to produce benefits to customers, the cost associated with this program are not including in rate base during the 2018 rate year. The program started in 2017, but in a typical customer-focused, conservative approach, GMP did not seek rate recovery in the first year to assure that the units were deployed as expected and were providing the anticipated value. As of the end of August 2018, GMP has invested approximately $5.14 million in the deployment of Powerwalls. The past year has demonstrated conclusively that the innovative Powerwall program is very well received by our customers, and more importantly, shows that the units can and do provide benefits to all of our customers, including those not directly participating in the program. As a result, based on the data available from the current program, GMP is moving to put these units into rate base in 2019.

Q11. How do you respond to Mr. McNamara's position that more time is needed to assess the benefits before including the program's capital expenditures in rate base?

A11. I disagree. The program is already demonstrating substantial success in providing the expected benefits for our customers. GMP has made and will continue to make a significant capital investment in pursuing innovative programs and achieving net power cost benefits for customers. As such we believe it is now appropriate to include these investments in rate base as they are already generating substantial customer benefits. In addition, removing the program's benefits associated with transmission savings, capacity savings, and Powerwall revenues to correspond with DPS's recommendation to delay recovery will lead to increased rate pressure on our customers as this summer's peak benefits would not be passed through to our customers as per our current plan.

Q12. Mr. Dawson also raises some questions regarding the methodology GMP used to model the benefits for the Powerwall program. How do you respond to those comments?

A12. I disagree with Mr. Dawson's view of our modeling approach for this program. On pages 39-40 of his testimony he expresses concerns over the assumptions and forecast we utilized in our analysis of program benefits, echoing many of the same points he makes regarding our JV Solar-storage modeling elsewhere in his testimony, although he acknowledges that some of these concerns are less relevant to our Powerwall program. Mr. Smith responds in detail to Mr. Dawson's modeling critiques in his rebuttal testimony and explains why the assumptions GMP used are reasonable and the analysis we conducted was appropriate and consistent with the approach we take for evaluating

other power purchases. Mr. Dawson does point out that our assumption of capacity prices varied between the model we ran for the JV Solar Storage Project and the Powerwall program. As Mr. Smith notes in his testimony, this difference is due to these two separate analyses being originally conducted at different times.

Q13. What is your response to Mr. Dawson's concerns regarding battery degradation and warranty response?

A13. I disagree with Mr. Dawson's opinion that we have not accounted for potential battery degradation in our modeling. Contrary to his claim, GMP did incorporate reasonable assumptions regarding potential battery degradation and our analysis of the Powerwall program's ability to provide peak benefits takes this information into consideration and is therefore appropriately conservative.

When talking about battery degradation, it is important to note that the degradation is a measure of the loss of amount of total available energy that can be stored in a battery system over time. The absolute power rating of the battery does not follow this degradation—it remains at the nameplate of the inverter. In other words, even as the amount of available energy degrades over time, the amount of instantaneous power that the battery can provide does not. So, for example, a Powerwall battery has a 5kW power rating with 13.5kWhs of total energy stored at the beginning of its life. At the end of 10 years it is guaranteed to have at least 70% of the original energy or a total energy storage of approximately 9.5kWHs, but the available power rating remains at 5kW. It is worth emphasizing that this is the guaranteed amount of available energy and is based on an assumption of cycling the battery almost every single day for 10 years. The GMP

program does not require the battery to cycle anywhere close to daily so it is highly likely there will be more energy available at the end of 10 years.

We do, however, still assume that degradation will occur in our modeling. On day one of the battery's life, we expect to be able to discharge 5kW for 2.7 hours and at the end of 10 years, we are guaranteed to have 5kW available for slightly less than 2 hours. When it comes to dispatching against the peak, we anticipate dispatching our storage systems anywhere from 2.5–4 hours in order to enable us to hit the peaks. The longer duration will typically be needed more in the shoulder months as the peaks tend to flatten out. Our financial model takes this into account by de-rating the actual FCM and RNS peak "effectiveness" down to 72% and 62% respectively on day one, effectively building in the degradation upfront. This means that even in the early years, we are modeling that we will be 72% effective at hitting the FCM peak—or achieving about 3.6kW of the total 5kW available for peak reduction available for each battery. This is a conservative approach, as it is much more likely that we will have a higher peak capacity reduction, particularly in the early years of the program. For example, so far for the summer of 2018, we were able to get the full 5kW of FCM peak reduction (or 100% effectiveness) out of each battery that was online during the potential peak times, despite the fact that the model assumes only 72% "effectiveness". To put this differently, with 10MWs of available battery power, we model a peak reduction benefit of only 7.2MW each year after taking into account all of the factors mentioned above, including degradation of the batteries. As indicated by recent experience, we expect to achieve much higher peak reduction benefits than assumed in the model, particularly during the early years of the

program, and therefore expect to achieve an even higher financial benefit for customers than presently modeled.

Energy degradation also comes directly into play in our estimates of value achieved through energy arbitrage, because in that scenario the value stream is tied to the total energy consumption or discharge from the battery system participating in a market. Our model includes a small financial value associated with the potential energy arbitrage use case for the batteries. As described through detailed discovery responses to the DPS, our financial modeling for energy value includes the full degradation factor of the battery system which is approximately 3% per year. Because this value stream is directly tied to the available energy in the battery, not the power capability, energy degradation is directly incorporated into the modeling.

Q14. Mr. McNamara expresses concern about the overall size of the Powerwall pilot. How do you respond to that concern?

A14. With respect to the size of the pilot program, we believe that 2,000 units is an appropriate size for a pilot program of this type. This is particularly true given the overall importance of exploring and then rapidly scaling up the type of innovative, transformative programs that our customers demand, that will help create key new revenue streams and benefits for our customers. Overall, the total deployed units will represent approximately 1500 customers due to many customers installing 2 units. This is less than 1% of GMP total customer base (about 0.5%). In order to adequately assure that a program or service can be expanded without impact to grid safety, reliability and stability, it is important to move beyond just a handful of systems and get a true representation of a distributed virtual

power plant system. Two thousand units, while still very small overall, is a quantity that will provide us with a good view of what scale can create and allows us to expand to other offerings such as our "Bring Your Own Device" program, which allows customers to purchase their own battery from a third-party vendor and participate in our peak reduction program. As shown in Table 1 above, every additional Powerwall provides more benefit to customers. Although we have not yet modeled the benefits of aggregation in recently designed ISO markets, such as the Price Responsive Demand or Frequency Regulation market, we will be exploring these opportunities as well. Should we determine that expanding into those additional markets makes sense for all customers, a pilot of this size provides a greater aggregation potential.

The size of the pilot also provides us with an important operational view across a mix of factors including things such as different grid locations and solar saturations in the area, different customer reliability needs, and different customer demographics. For example, some pilot customers will have net-metered solar connected to the system and some will not. Some will live in areas where outages may occur more often, and therefore their individual use of the battery system will be different than other customers who rely on the battery less frequently. Some customers will choose to install two Powerwalls and some only one. The size of the pilot allows us to evaluate and understand these various use cases. As with any pilot, our focus is delivering on three main goals: a solution that the host customer will benefit from, a solution that provides all non-participating customers with a financial benefit, and lastly, a new resource that can be used to manage a distributed grid. This energy storage pilot provides us with the data necessary to confirm the capabilities of these systems and more importantly, confirm that

an aggregated resource like this can be operated without creating new stability or reliability issues on the distribution system.

Q15. Do you agree with Mr. McNamara's proposed adjustment for the Powerwall Program?

A15. No. As mentioned previously, GMP has not included the program in rates during the first year of deployment, bearing the cost of the program while providing the peak reduction benefits on to customers. This delay was intended to allow us to be certain that the batteries would perform as designed. Our experience demonstrates substantial customer interest in the program, and we have a highly successfully track record now predicting peak events and executing the discharge of batteries to reduce peak loads, thereby delivering anticipated benefits for customers. The peak-shaving capacity of the Powerwall program has become an important part of our expanding portfolio of peak demand resources. The benefits of the program are not hypothetical—they are proven and we want to continue flowing these benefits through to customers while including the costs in rate base.

Although we disagree with the Department's proposal to remove the entire program from the rate period, we are proposing an adjustment that will modestly reduce the overall rate impact of the Powerwall program during the rate period. As noted above, we have adjusted the anticipated installation schedule for the project. By extending the installation period we are pushing out the time at which a number of the units will be closed to plant, and the resulting impact on associated expenses and revenue on balance

produces a decrease in the cost of service for customers. This adjustment aligns with our currently anticipated installation schedule.

SECTION II – RESPONSE TO OTHER DPS PROPOSED ADJUSTMENTS

Q16. The Department also recommends an adjustment to remove the Heat Pump Hot Water Program from the Cost of Service. Do you agree with this adjustment?

A16. No. GMP has spent time over the past year testing equipment to control heat pump water heaters ("HPHW"). As of this summer, GMP has two control options for heat pump water heaters—the stand-alone Rheem water heater, which includes its own control feature, as well as the Aquanta control unit, which can be used to retrofit or add on controls to other HPHWs. GMP plans to offer the Heat Pump Water Heater as a tariffed service, and through the tariff process will provide all of the details regarding control of these systems. GMP has successfully tested the control functionality for the systems mentioned above and is using our Virtual Peaker distributed energy resource platform to control the test units. Our program moving forward will be proposed with these controls.

Q17. Mr. Dawson states on page 45 of his testimony that GMP has not thoroughly considered demand response alternatives. In your opinion, has GMP appropriately considered these resources in its evaluation of innovative program offerings? Please explain.

A17. Yes, GMP has followed a strategy of looking at all potential Demand Resources and constructing a portfolio that delivers the highest likelihood of success through a blended model of controllable resources, rate structures, behavioral responses, and other

methodologies to deliver power cost savings while meeting customer demand. The DPS recently commissioned GDS Associates and Cadmus to develop a comprehensive "Demand Response Catalog". Based on a draft of this report, GMP is actively involved in a majority of the listed products and programs and has provided feedback to the DPS for Demand Response offerings that were not included in the draft that GMP is currently offering customers (e.g. controllable EV Charging). The catalog of Demand Response resources is helpful, but the customer adoption potential it portends is not based on real world experience and in GMP's view is overly optimistic. GMP's pilot programs provide actual data for evaluating these expectations.

GMP is very active in the behind-the-meter demand resource space with both commercial and residential customers. We have deployed various programs that include rate design critical peak pricing such as:

Residential

- Rate 3 – Water Heater Control Rate provides a lower electric rate for electricity for water heaters in exchange for controlling the devices during peak times.
- Rate 9 – Residential Critical Peak Pricing includes a slightly lower kWh rate (as compared to standard Residential Service Rate 1) during all hours of the day except during critical high peak demand times when the rate is increased.
- Rate 11 – Residential Time of Use provides a traditional time of use rate for residential customers with differentiated on- and off-peak prices for energy.

- Rate 13 – Electric Storage Space Heating is priced specifically for customers using electric thermal storage heating systems and features an extremely strong peak period price signal ($0.86014/kWh) to incent customers to charge this equipment during non-peak periods.
- Rate 14 – Residential Time of Use and Critical Peak Pricing provides both a traditional time of use rate structure at slightly reduced rates (as compared to standard TOU Residential Service Rate 11) in addition to a critical peak pricing element.

Commercial & Industrial

- Rate 63/65 – Traditional C&I time of use rates with both on- and off-peak energy chargers as well as on- and off-peak demand charges.
- Curtailable Load Rider – Customer can participate in curtailing load during peak demand times in exchange for lower total cost of supply.
- Critical Peak Rider – Similar to curtailable load rider; allows GMP to call critical peaks with 1-hour notice and provides savings to customers (via lower rates compared to standard Rate 63/65) if they participate and shed load during events.
- Pilot Load Response Rider – Shares savings with customer based on the actual value saved when a peak event is called.

In addition to the rate options listed above for customers, GMP also has a number of pilots and programs being tested which include:

- Residential EV Charger Program – Customers get a networked Level 2 EV charger that integrates with GMP and allows GMP to control the charger during peak energy times.
- eWater Water Heater control – This program is similar to Rate 3 above but it uses a much more dynamic control system that GMP is testing with both resistive and heat pump water heater systems.
- Sensibo Heat Pump control – GMP is actively controlling heat pumps utilizing a 3rd party resource known as Sensibo. The customer gets a free Sensibo device in exchange for allowing GMP's Virtual Peaker platform to increase or decrease the temperature setpoints during the peak times with minimal impact to the customer.
- Ice Energy Storage – GMP is in the early stages of testing ice energy storage systems at various scales to determine their potential value for our customers and whether they make sense as a larger offering. We are currently partnering with a third party and C&I customer to develop a pilot that will allow testing of a commercial scale ice energy storage system.
- Electric Thermal Storage – GMP partnered with a college to deploy and test a fleet of electric thermal storage systems.
- Additional batteries – GMP has deployed and tested various battery systems aside from the Powerwall for demand management.

- Smart Thermostat Control – Through our Virtual Peaker platform GMP is able to access and manage connected thermostats on home heating or central air systems.

GMP is actively working on a suite of demand resource offerings focused on creating value for both the participant and for all our customers that will make the process simple, and in some cases invisible to the customer. We strongly feel that an approach centered on simplicity, rather than requiring customers to alter their energy consumption behaviors, will lead to wider customer adoption. This is evident when we look at GMP's curtailable programs. Historically, the greatest response levels to our Curtailable Load Rider have occurred during winter months when there is significant heating load and snow making activity that businesses are able to curtail. Summer however, is a different story. Unlike many southern states, Vermont does not have significant summer curtailment opportunities since most homes do not have central air conditioning. By having a portfolio of programs GMP is able to achieve benefits for our customers throughout the year, with programs such as Powerwalls and eWater controls providing a benefit during the summer months when there are limited Curtailable Load Rider benefits.

GMP's approach to exploring Demand Resource alternatives is to focus on programs and offerings that deliver a net benefit to all customers and not programs that result in net cost to all nonparticipating customers. With this in mind, we view every program that delivers a benefit to customers as something worth pursuing as part of this suite of offerings. Each option has a unique cost structure but by creating a portfolio of different programs we are able to provide customers with a choice of options that will

work for them as there is no such thing as a one size fits all approach to energy transformation resources. It is also important to note that GMP has designed many of its programs (e.g. Powerwalls and Heat Pumps) to include a contribution from participating customers to help cover fixed costs and ensure that nonparticipating customers are not subsidizing them, but in fact benefiting from them through lower overall rates.

Mr. Dawson acknowledged in discovery that his review of our current demand response options only included our discovery responses and not the pilot filings themselves, which provide full detail on the projected economics of each program. Reviewing the pilot offerings allows for a fuller understanding of each program's costs and benefits as well as the potential for adoption. The Pilot programs are an innovative way to test demand response options that will help GMP advance its energy transformation goals of reducing cost and carbon while enhancing reliability and resiliency—goals that are aligned with State energy policy.

The table below shows alternative demand-response and load management programs that GMP is currently pursuing as well as modeled associated Net Benefit or (Cost) on a kW/month basis.[2]

[2] It is important to note that the underlying analysis for each program may have slightly differing assumptions reflecting existing market conditions and outlooks at the time GMP prepared the analysis in support of a decision to pursue each program. While the table values have been updated to reflect consistent assumptions for products such as energy and capacity (and the latest capacity auction results), they still reflect differences in original assumptions such as line losses and reserve margins, making the relative benefits shown between the programs indicative, not precise.

Alternative Program	Net Benefit/(Cost)
Curtailable Load Rider	$6.96/kW-month
Sensibo Heat Pump Controls	$6.34/kW-month
Pilot Demand Response Rider	$5.68/kW-month
Milton Solar-Battery Project	$5.19/kW-month
Critical Peak Rider	$4.40/kW-month
Aquanta Water Heater Controls	$3.76/kW-month
EV Car Chargers	$3.59/kW-month
Tesla/Sonnen Residential Batteries	$1.67/kW-month
Water Heater Program[3]	$(16.68)/kW-month

Some of the programs (e.g. Sensibo and Aquanta) are in the early stage of being rolled out and may experience different Net Benefits/(Costs) over time. Some programs, such as the residential batteries, may provide additional distribution grid benefits beyond the specific reduction of transmission costs that comes from reduction of peak loads—such as reactive power, conversation voltage reduction, and distribution islanding. GMP continues to work on developing a methodology to ascribe a monetary benefit for any of these additional grid benefits, above and beyond these clear transmission benefits, but has not justified or model the projects based on these other potential benefits.

[3] Water Heater Rate 3 includes an implied incentive for use of electricity for water heating versus oil, propane, or natural gas; the benefits of this incentive (e.g., additional electric sales volumes) are not included in the net benefit figure above. For illustrative purposes an incentive valued at 2.0 cents/kWh would result in a Net Benefit of $0.82/kW-month.

SECTION III –RESPONSES TO COMMISSION INFORMATION REQUESTS

Q18. With respect to the PUC Information Request #2 related to the ePark project at Emerald Lake State Park: did GMP consider undergrounding or rerouting the distribution line that currently serves the State Park?

A18. The off-grid battery storage option proposed was not just innovative but was the most cost-effective way to provide reliable service. As indicated in the supporting capital folder (provided electronically as ***Exhibit GMP-JC-4***), GMP did consider alternatives to the off-grid option, including evaluating the option of rebuilding the line. GMP estimated the cost of this alternative at a minimum of $120,000, not including on-going maintenance costs, such as tree-trimming, that would be accrued over time. Although not discussed in the capital folder, GMP determined that undergrounding or re-routing the distribution line at this location was not a reasonable or practicable alternative due to physical constraints as explained below, and therefore did not expend time or resources estimating specific costs for these approaches.

Exhibit GMP-JC-5 shows an aerial image of the State Park and the incoming distribution line feeding it, which is scheduled to be removed. This campground facility sits in a heavily wooded area alongside steep mountains. There is a good deal of ledge in the area along with the wetland locations surrounding Emerald Lake itself. As is evident on ***Exhibit GMP-JC-5***, there currently is no distribution feed along Route 7 in this location, and the other distribution lines are quite distant, so a feed from a different direction would require considerable construction and tree clearing through state forest land and the campground. This would include traversing significant embankments along

the Route 7 corridor, then crossing a railroad right-of-way, heavily forested areas, and a significant wetland complex. In short, undergrounding would be very challenging given the ledge and other features in the area; re-routing would have created habitat and environmental disturbance through a new corridor. For those reasons, those alternatives were not considered practicable in this location and therefore were not further analyzed.

Q19. Regarding PUC Information Request #6, the Commission asked several questions regarding GMP's battery storage program. Can you start by explaining GMP's current fleet of battery storage facilities?

A19. Yes. GMP's current fleet of battery resources includes the Powerwall program described previously in this testimony, the Stafford Hill solar/storage facility, and most recently the Panton energy storage project which was commissioned earlier this year. Additionally, GMP has 14 Sonnen battery systems located in an affordable housing complex and one Sunverge battery system that are dispatched in a similar fashion to the Powerwall program.

Q20. In further response to PUC Information Request #6, can you provide an estimate of the annual savings that GMP expects to obtain from its current fleet of battery storage facilities and confirm that GMP's forecast of power expenses reflect these anticipated savings?

A20. Each of the battery storage projects listed above is delivering value to customers through reduction of the FCM and RNS peaks mentioned previously, and in some cases through added benefits such as energy arbitrage and frequency regulation. This current fleet of

battery units (Stafford Hill, Panton Battery, and the installed Tesla Powerwall units) are projected to create a total savings of approximately $940,000 during the 2019 rate period, including approximately $670,000 in reduced RNS charges, and $270,000 in reduced RNS charges. These numbers represent reduced power supply costs for customers recognized within the rate period, not those future benefits that will be realized after this period based on battery performance that occurs within the rate period it. For example, the savings achieved from the operation of battery resources during the rate period (summer 2019) ISO FCM peak will benefit customers the following year, in the June 2020 to May 2021 period. On the other hand, projected ISO peak savings achieved this summer (2018) will benefit customers in the last four months of the rate period (June–September 2019). Only those savings that actually reduce costs during the rate period (January through September 2019) are directly reflected in the forecast of power expenses included the rate case filing. These savings represent the types of savings GMP discussed in its recent press release describing the peak reduction benefits obtained through our battery storage program. Beyond the current fleet, GMP expects the three JV Solar/Storage projects will begin to deliver Power Supply expense reductions within the rate period (June–September 2019), but these savings are not included in the above ("current fleet") calculations. These estimates also do not include benefits associated with the three Ice Energy storage systems located in Rutland. These systems work like a battery in that they make ice during the off-peak hours such as overnight, and then use that ice during the peak hours to cool they space they are serving, instead of running the energy intensive electric compressors to cool the space.

Q21. In Information Request #6, the PUC also asked about the ability of battery storage systems to address winter peaks. Do battery storage projects have the ability to address winter peaks and does GMP reflect those savings in its power costs?

A21. Yes, battery storage will help to reduce winter peaks in Vermont. The RNS peaks, described previously in this testimony, occur each month throughout the year, and Vermont's highest peaks generally occur in the winter. During the winter months these peaks generally occur during nighttime hours, and battery storage, in addition to load management devices like heat pumps and water heaters, provide an excellent resource for reducing winter RNS peaks. GMP realized $11,500 in RNS savings associated with the use of battery storage to shave winter transmission peaks in its net power costs, specifically in its "purchased transmission" costs.

Q22. Regarding PUC Information Request #7, can you please explain in more detail the type of controls and equipment the behind-the-meter platform is intended to manage and how that management will be used to both control use by the customer and, where appropriate, to send electricity from the customer into the system.

A22. Yes. The behind-the-meter platform we use is called Virtual Peaker, which provides the tools to manage various behind-the-meter devices for the purposes of reducing overall system load during times of peak demand. As noted in Question 7, above, we also use Tesla's platform GridLogic to manage our fleet of Powerwalls. Using predominately software integrations with device manufacturers, the platform provides control capability of several categories of device types. These include:

1. Level 2 Residential Car Chargers

GMP is able to use the behind-the-meter platform to manage the amount of amperage flowing from the electrical grid through the charger into the connected electric vehicle. This amperage can be throttled from 100% down to 0%. The current use case for Level 2 car chargers is to reduce the amount of power being called for by electric vehicles during times of peak demand. For the handful of events called per month, GMP is adjusting the power rate to 0%, effectively disallowing a vehicle from charging for a period of time. Customers are notified of an event in advance via an automatic email sent out by the platform that also provides the opportunity for customers to opt out of any GMP peak event. However, it's important to note that as we anticipated, very few choose to opt out during an event. We currently have 168 chargers in the program, and during a typical event we have seen an opt out rate of less than 2%. Once the peak event window has passed, the management of the devices ends and power flows through the chargers as normal. The behind-the-meter platform also pulls in several data points from each charger, providing individual as well as aggregate information to GMP. The power and energy consumption of the chargers is reportable and displayed in charts in the platform's user interface. It also tracks whether or not customers opt out of any events, and if so, how much energy is being consumed during a peak event. This data is being used for the purpose of billing customers who are participating in GMP's EV Unlimited charging plan, which provides a flat monthly fee for customers to charge their EV.

2. Residential Battery Systems/Arbitrage

The behind-the-meter platform provides the ability to manage multiple residential battery types in aggregate. GMP utilizes batteries for two main purposes. The first is to reduce overall load during times of peak demand. The platform sends charge and discharge signals to the batteries when GMP schedules a peak event. When discharging, the batteries will first satisfy any house needs, and if there is excess energy, it flows back to the grid, effectively becoming a power plant, or in this case a virtual power plant. When the event is over, the house gets energy from the grid and the batteries are recharged to be prepared to provide backup power in the case of a grid outage. The behind-the-meter platform also pulls in several data points from the battery systems in place and displays this information to GMP both on the individual and aggregate levels. GMP is able to see the total energy available, the power at any given point in time, the total house consumption, and solar production. In addition to peak reduction, the behind-the-meter platform is also utilizing the battery systems to perform energy arbitrage. Using ISO-NE day-ahead and real time pricing, the platform uses algorithms to manage the batteries' charging and discharging patterns according to the real time energy prices. The platform uses the batteries to charge when energy prices are low, and discharge when energy prices are high, which enables GMP to realize cost savings based on true market values. The two control methods described above work together to provide multiple value streams, from one device type, that reduce costs for GMP customers.

3. Mini Split Heat Pumps/Sensibo

The behind-the-meter platform has integrated with a third-party add-on for mini-split heat pumps called the Sensibo. The Sensibo provides customers with the ability to manage their heat pumps remotely from a smart phone. Similarly, this integration also provides GMP the ability to manage the fleet of heat pumps for the purpose of peak reduction. GMP utilizes these devices by changing the set points of the heat pumps by a few degrees for a period of a few hours. If heat pumps are in AC mode, the platform knows to increase the temperature by the desired change, and if the heat pumps are in Heat mode, it also knows to decrease the setpoint by the desired change. Prior to an event, a notification is automatically sent to customers that informs them of the timing and changes being made. Customers always have the ability to opt out of GMP events simply by changing a setting on their Sensibo app, or with the heat pump remote. The behind-the-meter platform pulls in data to display to GMP on an individual unit basis. Data points include the current set point of a heat pump, the mode of a heat pump, and the ambient temperature at the home. These data sets are able to be exported in tabular form and are charted for graphical display.

4. Electric Resistance Water Heaters

The behind-the-meter platform has integrated with an electric resistance water heater retrofit control called the Aquanta. This integration allows GMP to utilize the platform to curtail water heaters in a dynamic way during peak hours. GMP can schedule water heaters to effectively turn off for a period of time to reduce the amount of consumption on the grid during peak events. There is intelligence built

into both the Aquanta and the platform to ensure customer comfort. If a customer draws enough hot water during an event and reaches a "low hot water threshold" set within the system, the platform will opt the specific device out of the GMP event and allow the water heater to begin heating water to satisfy customer needs. Once a peak event comes to an end, the water heaters all return to their original setpoint and begin heating water again if necessary. The behind-the-meter platform pulls in several data points for both tabular and graphical display. GMP is able to see current water temperature, current set point, and current mode for each individual tank. GMP can also see the total energy and power for both the individual tanks as well as the aggregate fleet of water heaters.

5. Heat Pump Water Heater

The behind-the-meter platform also provides direct control of heat pump water heaters of a specific manufacturer. The control scheme and data points are all the same as described for Electric Resistance Water Heaters, except we have one additional control option which is with the specific manufacturer Rheem. We have developed an integration directly with their control system as described in Question 16, above.

While GMP is not currently utilizing management of thermostats, the behind-the-meter platform does provide for that opportunity should GMP find the right use case in the future. In addition to the control and management capabilities outlined above, the platform also provides reporting for event performance, including the number of customers who have opted out, devices that have participated, and energy consumption

where available. Finally, because communication with devices is dependent on customer internet, and therefore can present challenges for continuous communication, the behind-the-meter platform provides GMP with the ability to send notices to customers that have had offline devices for various lengths of time to remind them that the connection needs to be remedied.

Q23. Regarding PUC Information Request #8, can you explain the meaning of "A&G Absorbed that would flow into O&M" on Exhibit GMP-JC-3?

A23. Yes. Administrative and General ("A&G") spending supports efforts in the field. This includes for example, GMP staff time to handle billing and financials, customer care representatives time, and Information Technology time spent to support the field operations. Each year an A&G adder is determined by dividing A&G costs by the total spending—expense and capital—associated with field operations. This A&G adder is then applied to each new capital project throughout the year. All A&G costs that are not covered by capital projects are Operations and Maintenance ("O&M") expenses.

Exhibit GMP-JC-3 (Rev.), which is provided in both PDF and an electronic Excel format via thumb drive with the hard copy filing, shows $441,576 as the amount of "A&G Absorbed that would flow into O&M." This description refers to the amount of A&G costs that, if not covered by this program, would flow into O&M. This calculation may be found by tracing cell E36 in the "Summary" tab to cell N37 in the "Plant in Service" tab. Cell N36 shows that $6,002,987 of Energy Innovation Center initiatives are to be placed into service during the rate period. This figure includes the A&G adder of 7.94%, which means that the original capital cost was $5,561,411. The difference

between $6,002,987 and $5,561,411 is $441,576. The $441,576 represents A&G costs absorbed and paid for by Energy Innovation Center program participating customers that would otherwise flow to expense. Since synergy savings are currently split equally between GMP and customers, customers receive 50% of the $441,576 benefit that results from these Energy Innovation Center programs absorbing A&G costs which is also shown in ***Exhibit GMP-JC-3 (Rev.)***. To summarize, these are costs that would be borne by all GMP customers were it not for the innovative programs that are priced in such a way that includes A&G as part of the costs paid for solely by the participating customer.

Q24. Referring to PUC Information Request #9, please refer to Exhibit GMP-JC-3, and specifically the net additional revenue of $365,120. Please explain whether this figure was calculated using the revenue forecasts developed by ITRON, and if not, how the figure was calculated?

A24. The figure was not based on the ITRON forecast, which models deployment throughout our customer territory, but rather represents the average number of heat pumps and heat pump water heaters that GMP expects to deploy as part of its own efforts through its Energy Innovation Center programs during the rate period. We did not use the ITRON forecast for purposes of this exhibit because that amount would include units not placed into service through GMP programs and the intent was to show the value of GMP's programs. ITRON's forecast is based upon GMP's imputed portion of all heat pumps expected to be installed in Vermont in VEIC's forecast, and the EIA water heater intensity projection to capture the growth of this technology. As a result of ITRON's methodology, its estimate includes both GMP's specific programs, as well as the number

of heat pumps and heat pump water heaters that are installed throughout GMP's service territory not directly associated with GMP's programs. Using the ITRON forecast would have required backing out these non-GMP program units, which would have been a more complicated methodology to develop this analysis.

For purposes of this analysis, the increase in electricity usage in ***Exhibit GMP-JC-3*** reflects values for heat pumps (2.32 MWh) from a Cadmus study commissioned by the DPS (ITRON used this same electricity usage value in its analysis). The GMP program heat pump water heater usage (1.32 MWh) was based on a number provided by Energy Futures Group, an outside consultant. The margin per unit of $70/MWh represents the expected retail price minus the expected power supply cost. While the value of $70 has been used as a historical rule of thumb to simply quantify the impact of heat pumps and heat pump water heaters, recent analysis in response to a discovery question proved that this value is still valid.

It should be noted that the original calculation in ***Exhibit GMP-JC-3*** showed a full-year basis impact of the additional retail sales, while the rate period is only 9 months. The original file has been revised to show the benefits incorporated into the 9-month cost of service, and a new ***Exhibit GMP-JC-3 (Rev.)*** is attached. For simplicity, the additional MWh of retail sales per unit per year have thus been multiplied by 9/12 or 0.75. Additionally, the heat pump water heater sales now include the units associated with the Vermont State Employee Credit Union program. The $365,120 of net additional annual revenue in the original exhibit is now $278,110 in the revised exhibit to correct for the 9-month rate period. It is important to note that the Cost of Service is in no way affected by these changes, as this exhibit was meant to identify separately the costs and

revenues associated with the Energy Innovation Center programs. It does not feed directly into the calculation for the rate request. Specifically, as mentioned above, ITRON's revenue forecast utilized in the Cost of Service was calculated independently of the additional retail sales associated with GMP's Energy Innovation Center programs, shown in ***Exhibit GMP-JC-3 (Rev.)***.

Q25. Does that conclude your testimony today?

A25. Yes, it does.