STATE OF VERMONT
PUBLIC UTILITY COMMISSION

Case No. 23-3501-PET

Petition of Green Mountain Power for approval of its zero outages initiative as a strategic opportunity pursuant to 30 V.S.A. § 218d and GMP's multi-year regulation plan

PREFILED DIRECT TESTIMONY OF

BILL JORDAN

ON BEHALF OF THE

VERMONT DEPARTMENT OF PUBLIC SERVICE

March 15, 2024

Summary: My testimony provides an analysis of Green Mountain Power Corporation's ("GMP") Zero Outages Initiative ("ZOI") from an engineering perspective. I discuss GMP's service quality and reliability metrics within the context of GMP's ZOI, including a consideration of whether the ZOI is needed to meet these metrics, and how the efficacy of the ZOI on service reliability should be evaluated if the ZOI is approved. My recommendation, if approved, is for GMP to be held to higher service quality and reliability standards, with careful consideration of how customer reliance solely on energy storage during an outage may differ from electric utility service.

Mr. Jordan Sponsors the Following Exhibits:

Exhibit DPS-BJ-1	VT Utility Reliability Performance Measures
Exhibit DPS-BJ-2	GMP Reliability Values 2013-2023
Exhibit DPS-BJ-3	GMP Outage Causes 2020-2023
Exhibit DPS-BJ-4	Average SAIFI – CAIDI by Circuit
Exhibit DPS-BJ-5	Illustrative Example of Customer Outages Per Year
Exhibit DPS-BJ-6	Q.DPS.GMP.1-61
Exhibit DPS-BJ-7	Q.DPS.GMP.1-60
Exhibit DPS-BJ-8	Outage Scenarios Involving Storage
Exhibit DPS-BJ-9	Options for GMP's Reliability Metrics Over Time

Q1. Please state your name, title, and business address.

A1. My name is Bill Jordan. I am the Director of Engineering at the Vermont Department of Public Service ("Department" or "DPS"). My business address is 112 State Street, Montpelier, Vermont 05620.

Q2. Please describe your educational background and experience.

A2. I have worked for the Department since February 2007, and have held the positions of Electrical Engineer, Assistant Chief Engineer, and Director of Engineering. In my current role, I oversee the Department's Division of Engineering, which includes Electrical, Gas Pipeline, and Nuclear Engineers. Prior to working for the Department, I worked for the Vermont Public Service Board (now the Public Utility Commission) as a Utilities Engineer. I hold both bachelor's and master's degrees in electrical engineering.

Q3. Have you previously testified before the Vermont Public Utility Commission ("Commission")?

A3. Yes. Over the past 16 years, I have provided testimony in numerous cases, most recently in Case No. 23-2861-PET.

Q4. What is the purpose of your testimony in this proceeding?

A4. My testimony describes reliability metrics as related to GMP's proposed ZOI.

Q5. What are the reliability standards to which GMP is currently held?

A5. Title 30 of the Vermont Statutes Annotated requires utilities "to furnish reasonably adequate service, accommodation, and facilities to the public."[1] However, the statute does not define "adequate service." The powers given to the Department by Title 30 include: "supervision and evaluation under chapters 5 and 77 of this title of the quality of service of public utility companies."[2] Each utility has a Service Quality and Reliability Plan ("SQRP") approved by the Commission under the authority of 30 V.S.A. §§ 209(a)(1), 209(a)(3), and 219.[3] Alternative regulation under 30 V.S.A. § 218d also requires a Commission finding that the alternative regulation will "deliver safe and reliable service" and "promote improved quality of service, reliability, and service choices."[4] GMP's current SQRP contains a variety of performance standards relating to service quality, including the two reliability metrics System Average Interruption Frequency Index ("SAIFI") and Customer Average Interruption Duration Index ("CAIDI").[5] SAIFI is a measure of the average number of times a customer has experienced an outage, and CAIDI is a measure of the average length of time, in hours, that was required to restore service to customers who experienced an outage. These terms are also defined in Commission Rule 4.900 (Electricity

[1] 30 V.S.A. § 219.
[2] 30 V.S.A. § 2(a)(3).
[3] *Investigation into Proposed Revisions to Green Mountain Power Corporation's Service Quality and Reliability Performance, Monitoring and Reporting Plan*, Docket No. 8231, Order of July 23, 2014 at 3.
[4] *See* Final Order Case Nos. 21-3707-PET and 22-0175-TF, of June 23, 2022 (current GMP MYRP).
[5] GREEN MOUNTAIN POWER CORPORATION SERVICE QUALITY & RELIABILITY PERFORMANCE, MONITORING & REPORTING PLAN, Revised August 8, 2014 at 12, *available at* https://puc.vermont.gov/sites/psbnew/files/doc_library/gmp-service-quality-plan.pdf (as approved in Docket No. 8231, Final Commission Order of July 23, 2014); See Exhibit DPS-CMF-1.

Outage Reporting).[6] Rule 4.900 also defines "outage" as "a zero-voltage event, exceeding five minutes, to one or more customers." One of the challenges, from a regulatory perspective in reviewing GMP's proposed ZOI is that there is no definition (in statute or rule) of adequate service to which we can compare the ZOI. While GMP does have reliability performance measures in its Commission-approved SQRP, these are system-wide averages, which allow individual customers to experience a wide variability of reliability, as will be explained later in my testimony.

Q6. Please explain how Rule 4.900 relates to GMP's SQRP.

A6. Rule 4.900 requires electric utilities to report on an annual basis (due by January 30th for the preceding calendar year), the system-wide, calendar year values for SAIFI and CAIDI, a breakdown of customer hours out by outage cause, and an overall assessment of reliability addressing locations and causes of outages. The Rule also allows, at the utility's option, the inclusion of supplemental indices that net the effect of outage anomalies. Rule 4.900 contains the formulas for calculating SAIFI and CAIDI and definitions of terms. The Rule 4.900 report includes all outages and is an informational filing (with no standards or penalties).

By comparison, GMP's SQRP contains a total of 16 performance standards related to service quality, including the two reliability standards SAIFI and CAIDI as defined in Rule 4.900. The utilities file quarterly SQRP reports, but only report on SAIFI and CAIDI on an annual basis in the fourth quarter

[6] Commission Rule 4.900, effective 11/01/2000, https://puc.vermont.gov/document/commission-rule-4900-electricty-outage-reporting

report due by January 30 each year. Each of the SQRP performance standards has a "performance measure" associated with it, and if the utility fails to meet the performance measure, the SQRP contains a formula for calculating a financial penalty. GMP's performance measure for SAIFI is 2.4, and GMP's performance measure for CAIDI is 2.7. This means that the yearly system-wide average of the number of outages experienced by GMP customers should not be more than 2.4, and that the yearly system-wide average outage duration should not be more than 2.7 hours. If GMP fails to satisfy either of these performance measures, it may be subject to a penalty. However, GMP's (and the other utilities') SQRP allows it to exclude "major storms" that meet all three of the following criteria: (1) extensive mechanical damage to the utility infrastructure has occurred; (2) more than 10% of the customers in a service territory are out of service due to the storm or the storm's effects; and, (3) at least 1% of the customers in the service territory are out of service for at least 24 hours. Presumably, when the GMP SQRP was developed, it was deemed reasonable to allow the utilities to exclude (then rarer) severe storms beyond the utilities' control from the calculations of SAIFI and CAIDI because a financial penalty is associated with failing to meet the performance measures. Therefore, when GMP submits its SQRP report in January of each year, the values of SAIFI and CAIDI are net of major storms.

In summary, the major distinctions between the Rule 4.900 and SQRP reports are that Rule 4.900 includes *all* outages and is informational only (no standards or penalties), while GMP's SQRP is net of major storms but does include standards and penalties. The Rule 4.900 report is what the utility's

customers actually experienced, while the SQRP is for what the utility is held financially accountable.

Q7. How were GMP's SQRP performance measures for SAIFI and CAIDI developed?

A7. It is my understanding that all the electric utilities' SQRP performance measures for SAIFI and CAIDI were individually negotiated between the Department and each utility in the 1990's. Each utility has unique performance measures for SAIFI and CAIDI based on the individual characteristics of its service territory.[7] GMP's current performance measures for SAIFI and CAIDI were developed in 2012 when legacy GMP acquired and merged with the former Central Vermont Public Service Corporation ("CVPS") to form the current incarnation of GMP. The legacy GMP's performance measures were 2.1 for SAIFI and 2.2 for CAIDI. The former CVPS's performance measures were 2.5 for SAIFI and 3.5 for CAIDI. I was involved with the blending of the legacy GMP and former CVPS performance measures into the current GMP performance measures of 2.4 for SAIFI and 2.7 for CAIDI.

[7] See **Exhibit DPS-BJ-1**.

Q8. Has GMP been meeting its SQRP performance measures for SAIFI and CAIDI?

A8. Yes. For the 11 calendar years (2013-2023) after the merger of legacy GMP and the former CVPS, the current version of GMP has met its SQRP performance measures each year *with major storms excluded* (which is the standard for SQRP). However, if we compare the Rule 4.900 values for SAIFI and CAIDI with the SQRP performance measures (i.e. with and without "major storms"), in most years, the values with all outages included do exceed the SQRP performance measures for SAIFI, CAIDI, or both.[8]

Q9. If GMP is officially meeting its reliability metrics, then why do you think the ZOI is being proposed?

A9. As mentioned above, the SQRP performance measures exclude major storms, which results in a dissonance between the actual customer experience (reflected in the Rule 4.900 report) and the reliability performance measures (set by the SQRP). During some of the recent major storms, the Department's division of Consumer Affairs and Public Information ("CAPI") received complaints from GMP (and other utility) customers regarding the frequency and duration of outages. As I mentioned during the Commission workshop in Case No. 23-0834-INV, Vermont is approximately 70-80% forested, trees are getting taller each year, severe storms appear to be increasing in frequency, and people are becoming

[8] See **Exhibit DPS-BJ-2**.

more dependent upon electricity, especially for telecommunication needs.[9] Therefore, it seems that both the likelihood and consequences of electrical outages are increasing. A number of outages during these storms are caused by tall, otherwise healthy trees that fall on an overhead electric line from outside of the utility right-of-way ("ROW"), which means that routine vegetation maintenance within the ROW will not solve this problem. In addition, as part of routine vegetation maintenance, utilities identify any trees outside the ROW that could pose a hazard to the line, and then must negotiate with the landowner to remove the tree.[10] **Exhibit DPS-BJ-3** includes outage data from GMP's Rule 4.900 reports over the 2020 through 2023 time period, and it shows that trees caused over 50% of the outages and over 70% of the duration of the outages. Because a number of outages are not caused by vegetation, and a number of outages are caused by vegetation outside the ROW, the solution to this problem must go beyond vegetation management, which is what GMP is proposing in the ZOI.

Another point to mention here is that the SAIFI and CAIDI values reported are system-wide averages (i.e., an average of GMP's approximately 270,000 customers). Some customers may, in fact, experience zero outages during a given calendar year, while others will experience a far greater number and duration of outages than the reported values for SAIFI and CAIDI. In discovery, Attachment Q.GMP.DPS.1-3a, GMP provided circuit-level data for

[9] Investigation into the performance of the Vermont electric utilities during the winter of 2022-2023 on the delivery of electricity in Vermont.
[10] See the following link for a discussion of "danger trees" and "hazard trees."
https://www.tdworld.com/vegetation-management/article/20960772/vegetation-management-terms.

SAIFI and CAIDI averaged over the time from 2013 through 2023 for each of its 286 circuits.[11] I have used these data to create a histogram for SAIFI and a histogram for CAIDI, which show that the peak values cluster around the performance measures for SAIFI and CAIDI and then there is a tail to the right with a diminishing number of customers experiencing an increasingly large number of outages or outage duration.[12] While the circuit-level data are more granular than the system-wide data, they are still an average of an average (data averaged over the customers on the circuit, which is then averaged over 10 or 11 years), and the customers on each circuit would experience different outages, depending on where they are located on the circuit (generally, more outages farther from the substation). This averaging does not reveal the extreme values for individual customers in any given year.

An even more illuminating analysis would be to view the data on an individual customer basis. For example, if GMP were able to provide a histogram for a single calendar year with the vertical axis representing the number of customers and the horizontal axis representing the number of outages experienced, we would likely see results similar to the circuit-level data with the peak somewhere in the vicinity of the SAIFI value for the year (as SAIFI is the average number of outages experienced by a customer), but with a potentially much longer tail to the right as these data are not averaged and we would see the

[11] See **Exhibit DPS-BJ-4**.
[12] Id.

extreme values for individual customers.[13] We would likely see a similar result if we plotted outage duration on an individual customer basis.

The bottom line is that while GMP is meeting its official reliability metrics, they are net of major storms, and because they are system-wide averages, there are still a number of customers on the tail end of the curve experiencing a large number of outages that could be argued, on an individual-customer basis, to not be receiving "adequate service." In my mind, it is especially for these customers that a proposal such as the ZOI would serve.

Q10. What is your assessment of GMP's proposed ZOI as the solution to this problem?

A10. The ZOI, with its three-pronged approach of storm-hardening overhead lines, placing more lines underground, and energy storage will certainly help to reduce the frequency and duration of outages, especially for those customers "on the tail end of the curve" as discussed above. However, based on what GMP has submitted to date, I am not convinced it will be possible to get to *zero* outages by 2030.

In Zones 1, 2, and 3, as defined in GMP's ZOI Petition and its supporting documents, GMP is primarily proposing to storm harden the three-phase lines with spacer cable and tree wire and to place the single-phase lines underground. If we assume that this could eliminate outages on the main (primary) lines due to trees, weather, and accidents, GMP still has an average of approximately 3,600

[13] See **Exhibit DPS-BJ-5** for an illustrative example of what this might look like.

outage events per year to these lines (affecting, on average, approximately 170,000 customers) due to other causes, such as power supplier issues, company initiated shutoffs, equipment failure, etc.[14] In addition, the ZOI does not include the secondary service drops to the customers. In discovery, GMP provided data on the percentage of outage events on these service drops.[15] Multiplying these percentages by the number of outage events from **Exhibit DPS-BJ-3** results in approximately 4,000 outages on service drops per year. GMP witness Mr. Josh Castonguay addressed this in his testimony, at page 8, by stating:

> A comprehensive approach is needed for customers to experience zero outages, as with grid hardening alone there still could be impacts not only from very significant, unpredictable weather events but also from potential regional grid events, whether a physical or cyber interruption to service. Customer and community storage can ensure customers do not experience outages and remain connected in these events.

GMP witness Mr. Michael Burke, after explaining the first two ZOI components of "undergrounding lines" and "spacer cable and tree wire for overhead lines," at pages 4 and 5 of his testimony, provides the third component as: "Energy Storage for All. We then achieve the zero outages aspect of this Initiative by providing energy storage resiliency in all homes and communities through a combination of battery storage, microgrids and new technologies such as incorporating electric vehicles in the home and on the grid." In Zone 4, GMP is not planning to storm harden the lines, due to the low customer density per

[14] See "Averages" section of **Exhibit DPS-BJ-3**.
[15] See **Exhibit DPS-BJ-6**.

mile, and is relying solely on storage to eliminate outages for these customers. In Zones 1 through 3, GMP would use storage to supplement the storm hardening of the lines. Therefore, while GMP is still expecting there to be outages to its *system*, although reduced due to storm hardening in Zones 1 through 3, GMP is expecting storage to keep the *customers* from experiencing these outages. This means that a critical element of the ZOI is that GMP is expecting to be able to restore all outages on its system before the storage devices in the homes and businesses are depleted. While this may be possible for residential applications, it may prove to be much more challenging with respect to commercial and industrial applications that draw much larger loads, as discussed by Department witness Mr. Kevin Mara in his prefiled direct testimony. Another question to consider is whether a fault to an underground cable should be restored before storage devices are depleted. While underground cable typically experiences fewer outages, it does take longer to repair than overhead lines. In discovery, GMP stated that it has a technique to provide a temporary repair to restore service more quickly until the permanent repair can be made.[16]

There is also the question of whether it is fair to consider reliance on storage as not an outage. Is operating under storage equivalent to utility service? For example, GMP's round one discovery answer to Q.DPS.GMP.1-38 states that GMP educates customers about battery usage and recommends that customers do not use high energy appliances, such as electric clothes dryers or ovens, while

[16] See **Exhibit DPS-BJ-7**.

relying on energy storage during an outage. **Exhibit DPS-BJ-8** shows several possible scenarios while operating under storage. Time proceeds from left to right in columns B through E. Column B is prior to an outage on the utility system, columns C and D (if applicable) are during the outage, and column E is the utility service coming back online. Row 3 is the status of the storage device, which is in standby or charging prior to the outage, discharging during the outage (column C), possibly depleted if the outage lasts longer than the storage capacity (column D), and recharging once the utility service is restored (column E). Scenario 1 is that the storage rides through the entire outage and the customer does not change behavior (for example, either because the customer is unaware of the outage of utility service or otherwise chooses to behave normally). In Scenario 1, operating under the storage device is equivalent to utility service, and I have assigned this an "outage score" of "0" in column F, meaning that this should not be considered an outage to this customer at all. In Scenario 2, the storage device rides through the outage, but the customer does change behavior by conserving electricity due to worrying that the storage device might not make it through the outage otherwise. In column C, I label this a "partial outage" and assigned it an outage score of 0.25. In Scenario 3, the customer does not change behavior while operating under storage, but the storage does not make it through the entire outage, resulting in the customer being completely out for the later part of the outage. I assigned Scenario 3 an outage score of 0.5 because the customer behaved as if there were no outage for the first portion of the outage and then was completely out for the later portion of the outage. In Scenario 4, the customer

changes behavior by conserving while operating under the storage and the storage does not make it through the entire outage. Scenario 4 was assigned an outage score of 0.75 because the customer behaved differently during the first part of the outage (0.25) and then was completely out during the later part of the outage (0.5). Scenario 5 (no storage) is included for completeness to indicate how outages are currently treated (a score of "1" is a full outage). A complicating factor here is that we will likely never know if the customer changes behavior and conserves during an outage, and it is for this reason that I am hesitant to consider it a "zero outage" even if the storage device rides through the entire outage – because the customer *may* behave as if normal utility service is *not* present. Another factor relating to storage is that in all four zones there will be loads large enough that GMP's standard PowerWall offering will not be sufficient. Mr. Mara discusses this issue in more detail in his prefiled direct testimony.

Q11. Based on the testimony and discovery responses from GMP, what is your understanding of GMP's approach towards its reliability metrics should the ZOI be approved?

A11. The testimony of Mr. Josh Castonguay (at pages 5, 6, 7) uses language such as "to achieve zero outages by 2030," "to deliver zero outage service to customers by 2030" and "to deliver zero outages service for all." The testimony of Mr. Michael Burke (at page 6) states that GMP will: "build the statewide roadmap and systems to ramp up this work throughout all of our service territory so that customers will not experience any outages by 2030." When asked in discovery if, based upon a specific example provided by GMP, the goal of the ZOI is to achieve a SAIFI of

2.0, GMP responded "No. The goal of the ZOI is for customers not to experience outages."[17] The above testimony and discovery response seem to imply setting the performance measures for SAIFI and CAIDI to zero after 2030. When asked in discovery if GMP is proposing to amend its SQRP metrics to align with the spirit of the ZOI, GMP responded "Separate from the Zero Outages Initiative, GMP has started updating SQRP metrics and will be working with the Department through this process. We are anticipating changes to portions of the SQRP that have a direct correlation to the work happening through ZOI."[18] The Department and GMP have not yet started working on updating GMP's SAIFI and CAIDI standards to align with the ZOI.

Q12. Given the above testimony, to what reliability standards do you believe GMP should be held if the ZOI were to be approved?

A12. The statements made in GMP's testimony and discovery responses, taken literally, would lead to setting SAIFI and CAIDI to zero starting in 2030 or 2031. However, for the reasons mentioned above, I think this would be unrealistic. Instead, I first recommend that GMP's SQRP tariff be revised to no longer allow GMP to exclude major storms. I also recommend that the Commission require GMP and the Department to work together to arrive at new SQRP metrics for SAIFI and CAIDI and file the revised SQRP tariff for Commission approval as a condition of the ZOI if approved. I envision there being two phases to the reliability metrics: 1) a transition period between now and 2030, and 2) 2031 and

[17] See **Exhibit DPS-AM-1**.
[18] See **Id**.

beyond. **Exhibit DPS-BJ-9** shows four options for the transition period during construction between now and 2030 (note: in this example, the values for SAIFI and CAIDI were set to zero in 2031, but they could also be set to a small non-zero value in 2031). Scenario 1 is a linear step down of the performance measures for SAIFI and CAIDI. Scenario 2 is to keep the performance measures as they are through 2030 and then drop abruptly down to the final value in 2031. Scenario 3 is a non-linear reduction with less reduction early in the process and an accelerating reduction later in the process. Scenario 4 is for most of the reduction to happen early in the process and a diminishing reduction later in the process. Starting in 2031 GMP would be operating under the final performance measures for reliability metrics.

As discussed previously, SAIFI and CAIDI are system-wide averages, and some customers "on the tail end of the curve" experience a far greater number of outages or outage duration than the reported values for SAIFI and CAIDI. I also envision, both during the transition period between now and 2030 and especially beyond 2030, if SAIFI and CAIDI are set to non-zero values, that "guardrails" should be put in place to limit the maximum number of outages, and the maximum outage duration, a customer can experience (i.e., eliminate the tail end of the curve by shifting all of those customers to the left).

One of the more difficult aspects of this negotiation might be how to handle storage during outages for the reasons discussed above. The questions will be whether to discount storage by some amount and, if so, by how much.

Q13. Do you have any recommendations for topics GMP should address in its rebuttal testimony?

A13. Yes. I recommend that GMP address the following topics in its rebuttal testimony, which will be extremely helpful in arriving at realistic reliability performance measures should the ZOI be approved:

a) The definition of an outage – is GMP using the definition in Rule 4.900 of "a zero-voltage event, exceeding five minutes, to one or more customers" or is GMP including outages of any duration, including those less than five minutes?

b) Actual customer experience – GMP should provide a histogram for each of calendar years 2020, 2021, 2022, and 2023 indicating number of individual customers on the vertical axis and bins with number of outages experienced on the horizontal axis (similar to the example provided in **Exhibit DPS-BJ-5**). GMP should also provide a histogram for each of calendar years 2020, 2021, 2022, and 2023 indicating number of individual customers on the vertical axis and bins with total outage duration experienced on the horizontal axis. [Note: these four calendar years were chosen because they are the most recent, and 2020 and 2021 are lighter years in terms of outages and 2022 and 2023 had heavier outages].

c) Storage for large loads – GMP should discuss how storage would eliminate outages for large loads such as commercial and industrial customers.

d) Finally, GMP should discuss its thinking on whether storage should be treated as eliminating an outage or whether it should be discounted (as I discussed in Q&A 10 and **Exhibit DPS-BJ-8**).

Q14. Does this conclude your testimony?

A14. Yes, it does.