STATE OF VERMONT
PUBLIC UTILITY COMMISSION

Case No. _________

Petition of Green Mountain Power for a Certificate of Public Good pursuant to 30 V.S.A. § 248 authorizing the rebuild of the Lowell Substation and the upgrade of 18.1 miles of the B20 line from Johnson to Lowell, and Joint Petition of GMP, the Village of Morrisville Water and Light Department, and the Village of Johnson Water and Light Department for a CPG pursuant to 30 V.S.A. § 248 to authorize the upgrade of 1.5 miles of the B22 line, in the Towns of Lowell, Eden, Johnson, and Morristown, Vermont	

DIRECT TESTIMONY OF WITNESS
DOUGLAS C. SMITH
ON BEHALF OF THE GREEN MOUNTAIN POWER

November 4, 2019

Mr. Smith discusses how this Project, in addition to being a key asset condition and reliability project, is part of a least-cost package of solution steps that will cost-effectively reduce current congestion of the Sheffield-Highgate Export Interface ("SHEI"), resulting in a significant economic benefit to Vermont electric customers. Mr. Smith provides a detailed description of the current SHEI transmission constraint, describes the robust process that GMP and others have engaged in to explore potential ways to mitigate the SHEI constraint, explains why this Project is expected to reduce congestion, and provides an assessment of the net economic benefits that will flow to customers as a result of increasing the benefits that Vermont electric customers receive from renewable generation in northern Vermont.

DIRECT TESTIMONY OF DOUGLAS C. SMITH

1. Q. Please state your name, business address and occupation.

A. My name is Douglas C. Smith. I am Chief Power Supply Executive for Green Mountain Power ("GMP").

2. Q. Please summarize your relevant educational background and experience.

A. I have worked for over 25 years in the electric industry, focusing on topics that include electric system and portfolio planning, wholesale and retail power transactions, and market price forecasting. I hold a Bachelor of Science degree in Mechanical Engineering from Brown University.

I began my career as an analyst at the Vermont Department of Public Service (the "Department") and was subsequently promoted to the position of Electrical Planning Engineer. From 1991 to 2007, I worked at La Capra Associates ("La Capra"), a Boston-based consulting firm that specializes in planning and regulatory issues in the electric industry. I ultimately became La Capra's Technical Director. While at La Capra, I advised several Vermont utilities regarding their power transactions, risk management strategies, and Integrated Resource Plans. On behalf of state agencies and large electricity customers, while at La Capra I reviewed the procurement strategies of numerous large utilities in the eastern, central and western U.S. I also led the firm's forecasting of New England wholesale electricity market prices, and assisted in the siting applications of several proposed electric generating plants.

I joined GMP in 2007. I currently play a primary role in the development of GMP's power supply strategy. My team conducts the bidding of GMP's load and generation sources into the ISO New England, Inc. ("ISO-NE") energy and a capacity market, sells Renewable Energy Certificates ("RECs") produced by GMP's resources, and leads the evaluation of potential power supply sources and transactions. During 2018 and 2019 I have played a lead role in a working group of Vermont utilities that has (with VELCO's assistance) considered potential steps that could be taken to reduce current levels of congestion at the Sheffield-Highgate Export Interface ("SHEI"), and I have been directly involved in GMP's evaluation of those potential solution steps.

3. Q. Have you provided testimony to the Vermont Public Utility Commission (the "Commission") previously?

A. Yes. I have testified before the Commission on numerous occasions, on topics that include resource planning, proposed power contracts and generation projects, electric utility revenue requirements, potential non-transmission alternatives to proposed transmission projects, and the development of standard offer rates and PURPA avoided cost rates. Most recently I testified in Case No. 18-0974-TF (GMP Rate Case) and Case No. 17-1247-NMP (Petition of Derby Solar) relating to transmission constraints, and in Case No. 18-1633-PET relating to GMP's multi-year regulation plan.

4. Q. Please describe the purpose of your testimony and summarize your primary findings.

A. My testimony explains how this Project, in addition to being a key asset condition and reliability project as described in the Direct Testimony of Kim Jones, is part of a least-cost package of solution steps that is expected to cost-effectively mitigate a substantial portion of the adverse impacts that result from the existing SHEI transmission constraints. My testimony has six parts.

In Section I, I provide a description of the SHEI, the related transmission constraints that are being experienced in this area of Vermont, and the resulting adverse financial impacts being experienced by GMP and other Vermont Distribution Utilities ("VDUs").

In Section II, I summarize the robust process GMP has engaged in – along with other VDUs, and assisted by VELCO – to explore potential ways to mitigate the SHEI constraint, and explain how an initial package of anticipated solution steps which includes the Project as well as deployment of automatic voltage regulation ("AVR") capability at the Sheldon Springs hydro plant and potentially at the Sheffield Wind plant, is expected to cost-effectively mitigate a substantial portion of the adverse impacts that result from the existing SHEI constraint.

In Section III, I discuss the extent to which the Project is expected to increase SHEI export limitations, including an analysis of the associated reductions in SHEI-driven congestion and generation curtailments that are expected as a result of this Project and other solution steps.

In Section IV, I provide an assessment of the benefits of an increased SHEI export limit, including an analysis of the estimated reductions in lost generation that would be obtained by implementing the proposed Project and other anticipated solution steps.

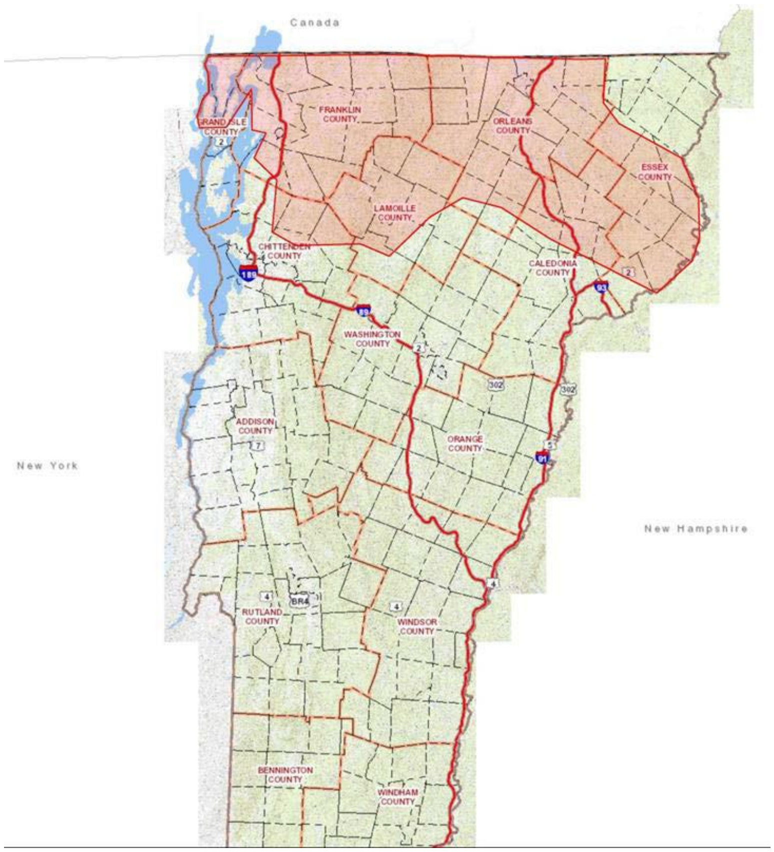
In Section V, I provide an analysis of the benefits to Vermont electricity customers that are expected to flow from this Project, and describe how we evaluated these benefits in comparison to Project costs. I explain why the Project is - based on conservative estimates - expected to provide almost $12 million in net benefits through reductions in curtailment of renewable generation in the SHEI area, increased market values for energy generated in the SHEI, and reduced energy losses. On a lifetime basis, the projected benefits and avoided costs associated with the Project exceed the projected cost to customers by more than half.

Finally, in Section VI, I provide an analysis of the Project's compliance with several key provisions of Section 248, including my assessment that the Project: (a) is expected to have an economic benefit to the State and its residents under 30 V.S.A. § 248(b)(4); (b) is needed to meet the need for present and future demand and is consistent with least-cost principles as contemplated by 30 V.S.A. § 248(b)(2); (c) is consistent with the Vermont Electric Plan as required by 30 V.S.A. § 248(b)(7); (d) is consistent with GMP's IRP as contemplated by 30 V.S.A. § 248(b)(6); and (e) complies with 30 V.S.A. § 248(b)(10) because it will result in a significant economic benefit to Vermont electric utility customers.

Part I: Adverse Impact of Current SHEI Congestion.

5. Q. Please describe the SHEI.

A. The SHEI refers to an export constrained portion of the electric transmission system that encompasses an area in northern Vermont extending from approximately the Vermont/New Hampshire border in northeastern Vermont to Alburgh in northwestern Vermont. Its approximate boundaries are highlighted in the map below.



The primary energy resources in the SHEI are imports from Hydro-Québec across the Highgate converter station, Kingdom Community Wind ("KCW"), Sheffield Wind, Sheldon Springs Hydro, Coventry Landfill, Newport Hydro (when the Newport load is served from Vermont) and numerous relatively small hydro, solar and farm methane generators. The collective volume of energy generated in this area typically exceeds local demand substantially, so power typically flows out of the SHEI area in substantial volumes. There are only a few paths for electricity to flow out of the SHEI area. In the event of some potential contingency events on the grid (*e.g.*, a fault on a particular transmission line), the required post-contingency flow out of the SHEI area if all available generation were producing would lead to unacceptable operating results that threaten system reliability unless some of the existing generation is curtailed. ISO-New England created the SHEI and applies operating procedures to ensure that exports from the area do not reach levels that would jeopardize reliable operation of the bulk electric system (under current conditions or in the event that certain contingencies were to occur).

6. Q. Can you please summarize how the SHEI export limit is managed?

A. The SHEI is managed by ISO-NE in accordance with its Do Not Exceed ("DNE") dispatch framework, under which the output of generating plants that participate[1] directly in the ISO-NE energy market (including renewable plants like KCW) is dispatched based on offer price, along with other factors.[2] On an ongoing basis ISO-NE sends each participating generator a signal (*i.e.*, a DNE limit, in MW) that expresses the generator's maximum allowed output at a point in time; the DNE limits are updated regularly (up to twelve times an hour) as needed to reflect changes in system conditions. The DNE limits for generators within the SHEI area are adjusted by ISO-NE on an automated basis in response to changing system conditions, to ensure that total flow over the interface will remain within the applicable limit. When the SHEI is constrained (*i.e.*, when the potential flow of energy out of the SHEI area exceeds the SHEI interface limit established by ISO-NE to ensure reliable system operation), at least one generator will receive a DNE limit that is less than its potential maximum output at the time.[3]

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[1] Plants that operate as "load reducers" are not monitored or dispatched by ISO-NE, and therefore are not required to reduce output when SHEI is constrained.

[2] While the precise formulae utilized by ISO-NE to manage the SHEI constraint are not published by ISO-NE, GMP's understanding is that the DNE limits that are assigned to generators within the area reflect the relative energy offer prices of those resources, along with other factors such as the relative effect of various generators on SHEI interface flows.

[3] For example, if at a given point in time KCW is capable (based on current wind conditions and turbine availability) of producing 60 MW, and if ISO determines that limiting KCW output to 50 MW would prevent the SHEI export limit from being exceeded, KCW might receive a DNE limit of 50 MW (representing 10 MW of lost/curtailed output).

7. Q. Can you please provide a visual example of how the SHEI interface can limit the output of existing generation in northern Vermont?

A. Yes, Figure 1 below illustrates how congestion of the SHEI can limit the output of existing generation. For purposes of this illustration, limitations of KCW's output during portions of one sample day are provided.

<u>Figure 1: KCW Operation on April 3, 2019</u>

In this example, Figure 1 contains operating data (in 5-minute intervals) for the KCW plant over the 24 hours of April 3, 2019. Specifically:

- The green line shows what KCW's output could have been in the absence of transmission constraints based on KCW's Economic Maximum ("EcoMax"), which is a very short-term estimate of the plant's potential output based on current wind conditions and the number of turbines that are available to generate. As shown on the graph, during this day the potential output was relatively high in the early morning hours, declined to only a few MW near mid-day, then increased rapidly in the early afternoon and remained near the plant's maximum potential output for the remainder of the day.

- The purple line represents KCW's DNE limit as established by ISO-NE. During most of this day the DNE limit ranged between about 25 MW and 45 MW, illustrating the type of limitations that KCW or other local generation can face as a result of transmission constraints.
- The blue line shows KCW's actual output, which closely followed the lesser of the EcoMax or the DNE limit.

For a portion of this day, SHEI congestion was apparent when KCW's DNE limit (*i.e.*, its maximum allowed output) was lower than the plant's potential output. This occurred during two extended periods: once for a few hours in the early morning hours and again from early afternoon to midnight. During these periods the difference between the green line (what KCW output could be without constraints) and the blue line (KCW's actual output) represents potential wind generation that was lost because the SHEI interface was constrained.

I should emphasize that the daily example above is provided primarily as context, to illustrate some of the key concepts and terminology associated with SHEI congestion; this particular day is not intended to be a representative daily profile. The depth, duration, and "shape" of SHEI congestion events can vary greatly from day to day and season to season depending on grid conditions and weather conditions, and can differ greatly from the sample day shown here.

8. Q. How often has the SHEI been congested, and how much generation reductions have been required by ISO-NE?

A. SHEI becomes congested (export-constrained) when the available output from energy resources exceed the load in the area, and the transmission lines leading out of the area cannot transport all of the excess energy out of the area without jeopardizing reliable operation of the grid. SHEI congestion is most likely to occur during times when local generation (particularly wind and hydro, along with deliveries over the Highgate Converter) is high, or when the SHEI export limit is temporarily reduced due to outages or planned maintenance work on the transmission system. Congestion is also more likely to occur when loads in the area are relatively low. SHEI congestion can occur in both the Real-Time and Day-Ahead energy markets. From the implementation of ISO-NE's DNE dispatch framework in late May 2016 through calendar year 2018, SHEI has been congested about 11% of the time in the Real-Time market, and about 8% of the time in the Day-Ahead market. SHEI has been congested most frequently during non-summer months and months during which SHEI limits were reduced due to outages of elements on the transmission system.

GMP's review of historical data under the DNE framework indicates that when SHEI was constrained, KCW was usually the marginal source in the area whose output was limited to manage the constraint.[4] Potential KCW generation lost to SHEI-driven curtailments has ranged from less than 1 MWh to as much as 60 MWh for brief periods, with most events ranging in depth from a few MWh to 40 MWh. Significant fractions of the congestion and lost generation have occurred during "all lines in" or "ALI" conditions, although the deepest generation

[4] This outcome is consistent with the fact that some other generators in the area operate as load reducers, or sell their output under PPAs based on payments for delivered energy so they may be incented to maximize energy output even when SHEI is constrained and local LMPs are low or negative.

reductions have tended to occur during transmission outage events. GMP estimates that on a monthly basis, potential KCW generation lost to SHEI-driven curtailments has ranged from under 100 MWh in some summer months to several thousand MWh in some months, with a maximum monthly volume of over 6,000 MWh.

9. Q. When the SHEI is congested, how are GMP and its customers adversely affected?

A. There are two adverse effects: curtailment, and suppressed market value of energy that is actually produced relative to the charges being assessed at the same point in time for serving load in Vermont. First, during times when the SHEI is constrained, some amount of potential generation in the area must back down, which I will refer to as curtailment or lost generation (recall the illustration above). As I noted above, in actual practice the KCW plant has typically been the plant that reduces output based on dispatch instructions from ISO-NE. When this occurs, GMP loses the market value of the KCW energy that could have been produced, along with renewable energy certificates and federal Production Tax Credits associated with the plant's output. Second, when the SHEI is constrained, energy market prices (*i.e.*, locational marginal prices or LMPs) within the SHEI area are reduced relative to prices in the rest of Vermont and New England. This LMP reduction, in the form of a negative congestion price component – reduces the net energy revenues that GMP receives for the output from all of its resources located in the SHEI area that participate in the ISO-NE market,[5] increasing GMP's net power supply costs.

When one or both of these outcomes occur, GMP's net power costs and total cost of

[5] Negative congestion pricing can and does occur in the Day-Ahead and the Real-Time markets.

service are increased, putting upward pressure on the retail electric rates that our customers pay. Since the DNE regime was implemented by ISO-NE in 2016, GMP has experienced several million dollars of increased net costs due to congestion of the SHEI interface. I will discuss this topic further in the context of evaluating potential steps (including the proposed Project) that could be taken to mitigate SHEI congestion.

10. Q. Does GMP receive a significant portion of its energy supplies from sources that generate or deliver their output in the SHEI area?

A. Yes, GMP receives substantial volumes of energy from power purchase agreements that deliver in this area. The largest of these are a long-term HQUS power purchase agreement (GMP's share is over 170 MW, and provides roughly 20 percent of GMP's annual energy supply), and a long-term purchase of output from the Sheldon Springs hydroelectric plant (approximately 27 MW maximum output). GMP also is the owner of the 63 MW Kingdom Community Wind plant; 8 MW of the plant's output is sold to VEC on a long-term basis.

11. Q. Are other VDUs also adversely affected when SHEI is constrained?

A. Yes, the largest of Vermont's other VDUs (Vermont Electric Cooperative ("VEC"), Burlington Electric Department ("BED"), Washington Electric Cooperative ("WEC") each report that they have experienced significant net cost increases as a result of SHEI congestion. This makes sense because these VDUs also receive significant energy supplies from resources participating in the ISO-NE wholesale energy markets in the SHEI area, and experience the same type of erosion in LMP revenues that I mentioned above (although these DUs may not have experienced comparable resource curtailments to those of KCW). Most notably, other VDUs obtain more than 40 MW of output from Vermont's long-term HQUS PPA (225 MW), along with several other sources:

- Sheffield Wind (40 MW, most of which is presently sold to VDUs other than GMP);
- Coventry Landfill (about 8 MW, fully owned by WEC);
- Highgate Falls hydro (about 12 MW, fully owned by Swanton Village Electric);
- Other smaller sources.

Because other VDUs receive LMP revenues from the operation of these significant generation sources in the SHEI, they have collectively experienced net power cost increases when the SHEI is congested and LMPs in the area are reduced. Thus, the other VDUs collectively will benefit when solution steps are implemented to increase the SHEI limit or otherwise enable more generation to be accommodated within that limit.

12. Q. Does congestion of the SHEI provide any offsetting benefits to Vermont customers?

A. Although SHEI congestion overall harms the clear majority of Vermont customers, it does provide some limited benefits. The resulting lower LMPs within the SHEI area also lower the corresponding LMP for the Vermont Load Zone in proportion to the (small) fraction of Vermont load that is located in the SHEI area. Accordingly, to the extent that GMP or other Vermont utilities are purchasing energy in the affected (Day-Ahead or Real-Time) market at the time, suppressed LMPs can translate into some savings. Because the output of generation sources that deliver energy in the SHEI area (and experience reduced revenues) consistently dwarfs the amount of load in the area, however, the extent to which SHEI congestion lowers the Vermont Load Zone LMP is typically quite small. The benefit to GMP from reduced charges for load has been small relative to the costs of lost generation and congestion that I described above.

13. Q. Are all VDUs affected by SHEI congestion to the same extent?

A. No. The financial effect on each utility depends on the specific ISO-NE settled energy sources within the SHEI area that the utility obtains output from (via ownership or PPAs), the extent to which those sources tend to operate when the SHEI is congested, and the size of those resources compared to the utility's load requirement. As noted above, GMP and Vermont's other larger distribution utilities all receive significant fractions of their energy supplies from sources (including the HQUS long-term PPA, which the vast majority of Vermont utilities participate in and is the largest single source in the area) that deliver in the SHEI, and it is clear that SHEI congestion increases net power costs for these utilities and for Vermont utilities as a whole. Because not every Vermont utility receives energy from the HQUS PPA or other ISO-NE market settled sources in the SHEI area, I expect that one or more of Vermont's smaller utilities may not be adversely affected (or may even benefit modestly) when SHEI is congested. I have not attempted to estimate the extent to which the proposed Project would benefit individual VDUs; GMP plans to assess the relative benefits of relieving SHEI congestion in collaboration with the other VDUs.

Part II: How the Project Mitigates Adverse Economic Impacts.

14. Q. Why is this Project expected to mitigate the adverse economic impacts associated with the SHEI constraint?

A. In short, the Project is expected to mitigate the SHEI constraint because it will increase the capacity of one of the few electrical paths out of the SHEI area. This tends to improve the performance of the grid in northern Vermont under contingency conditions (*e.g.*, when a key transmission line experiences a fault) upon which the SHEI export limits are developed and therefore to increase the amount of power that can be reliably exported from the area.

The assessment of how effective various potential solution steps (including the Project) would be at relieving SHEI congestion and the associated value that this would provide includes three major components.

- First, we needed to understand the extent to which a range of potential steps would be expected to increase the SHEI limits. The Northern Vermont Export Study[6] ("NVES"), which was developed by VELCO and its consultant, EIG, is the key resource for this step because it used detailed electrical modeling of the Vermont electric grid to estimate the extent to which each of a wide range of potential steps (including the Project) would affect the SHEI limits. We also explored potential steps that were not addressed in the NVES.
- Next, we estimated the amount of SHEI congestion that could be relieved, along with the amount of generation that could be recovered, by deploying potential solution steps (individually, and in combination). We did this by comparing the amount of SHEI limit increase that can be expected from particular solution steps (based on the NVES results) to the actual SHEI congestion (in 5-minute intervals) that has been observed since the implementation of the DNE framework in mid-2016.
- Finally, we used the results of these two steps to estimate the financial value of additional

[6] The NVES report is available here: https://www.vermontspc.com/library/document/download/5995/VELCO_SHEI_Study_FinalReport.pdf

renewable generation output from existing plants in the SHEI and on reduced congestion charges to Vermont electric utilities and their customers.

I will explain each of these steps further in my testimony below, along with an additional form of benefit (reduced energy losses) that the Project is expected to provide.

15. Q. Have GMP and others considered a wide range of potential options to reduce SHEI congestion?

A. Yes. After the financial consequences of SHEI congestion increased significantly with the deployment of ISO-NE's DNE dispatch framework in 2016, GMP and VEC took some operational steps to limit the magnitude of SHEI congestion.[7] Since 2018 GMP has collaborated with a working group of Vermont utilities, with VELCO assisting on a regular basis, to explore a wide range of options that could potentially be deployed to increase the SHEI limits and thereby reduce the existing congestion issues. These include numerous options that are discussed and analyzed in the NVES, ranging from reactive devices to battery storage to new transmission lines. We also considered the potential for building or shifting of electric load in the SHEI area to increase the amount of generation that can be accommodated in the SHEI area.

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[7] Starting in early 2017, VEC shifted the supply for a portion of its territory ("block load") to be delivered more often from the VELCO system. This change, which was made with the goal of lowering VEC power costs, also had the effect of lowering the magnitude of SHEI congestion costs at times. During this period GMP also tuned its strategy for offering KCW energy into the ISO-NE energy market, with the goal of limiting SHEI congestion costs.

16. Q. Could you please summarize the large scale options that could be deployed to increase the SHEI limits?

A. Yes, the largest options would expand the size of bulk transmission paths out of the SHEI area (*e.g.*, by upgrading existing bulk transmission lines), or by developing additional bulk transmission paths out of the area (*e.g.*, by constructing new bulk lines or segments). These options would greatly increase the SHEI limits (*i.e.*, by many tens of MW), to a degree that would significantly exceed the current depth of SHEI-driven congestion. These options would also require very substantial capital costs (estimated at many tens of millions of dollars, and over $100 million for some projects) and do not appear to feature compelling scale economies (*e.g.*, very large increases in SHEI export capacity when compared to other more modestly priced alternatives). As a result, such capital investments are not as cost-effective based on savings to Vermont electricity customers as the more targeted strategies discussed below.

We also observed that options featuring new or greatly expanded bulk transmission paths would likely require several years for permitting and construction (meaning that it would probably be several years before they could provide SHEI congestion relief). For these reasons we concluded that it would be appropriate to determine whether a set of less costly solution steps that could be deployed more quickly and cost-effectively could address current levels of SHEI congestion while leaving the door open for additional potential future options.

17. Q. Did this exploration yield a viable and cost-effective set of solution steps?

A. Yes. We have identified a set of three anticipated steps, which together are estimated to increase the SHEI limits sufficiently to address most congestion associated with current levels of load and generation in the area in a cost-effective way. These steps are

Automatic Voltage Regulation ("AVR") at Sheldon Springs; the Lowell to Morrisville upgrade project; and AVR at Sheffield. Below is a summary of these projects:

- **Sheldon Springs AVR**: Implementation of AVR[8] at the Sheldon Springs hydro plant, which is owned by Missisquoi LLC, a subsidiary of Enel Green Power of North America ("Enel"), and sells its output to GMP under a long-term power purchase agreement. This project offered the potential to significantly increase post-contingency voltage performance of the northern Vermont grid[9] at a limited capital cost, and could be installed relatively quickly. GMP therefore collaborated with Enel to implement AVR at Sheldon Springs at a total cost of approximately $1 million. Demonstration testing of the AVR project's voltage regulation capability at partial output[10] has been completed. ISO-NE has not yet increased the SHEI voltage limit to reflect the Sheldon Springs AVR capability; this step awaits an update of ISO-NE's electrical modeling of the northern Vermont grid, which is currently underway.
- **The proposed Lowell-Morrisville Project**. Mr. Fiske explains the scope of the proposed Project in detail. From the perspective of the SHEI limit, this Project includes the changes (most notably larger conductor, and a larger transformer at the GMP Lowell substation) that were studied in the NVES as the "B20" and "B22" upgrade options, which expand one of the electrical paths out of the SHEI area. As a result, the Project is

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[8] AVR is an electronic device for automatically maintaining generator terminal voltage at a set value under varying load and operating temperature. Other system voltages benefit from maintaining a set terminal voltage.

[9] For example, Table 4 of the NVES indicates that if the Sheldon Springs AVR were deployed alone, it could increase the SHEI voltage limit under "all lines in" conditions by up to about 27 MW depending on the plant's output. Other NVES cases indicate that Sheldon Springs AVR will increase the SHEI voltage limit when combined with other potential solution steps. This AVR project is not projected to significantly increase the SHEI thermal limit.

[10] The generator for Unit 1 at Sheldon Springs is presently derated, so demonstration of the AVR's full potential will not be possible until that generator is rewound.

projected to significantly increase the SHEI voltage limit and its thermal limit under ALI conditions, and to also increase the limit during outage conditions (*i.e.*, when some transmission system elements are out of service). As explained by witness Jones, the proposed Project represents an expansion of a significant project that GMP would have to implement in the near future to address aging of the assets that make up the B20 path. In the context of evaluating this Project as a potential SHEI solution step, the relevant cost is therefore the additional cost associated with upgrading the B20 and B22 path and increasing the SHEI limits, compared to an alternative and necessary smaller project that would only address asset condition concerns.

- **Sheffield AVR**: Implementation of AVR at the Sheffield Wind plant, which is owned by Terraform Power. This project, which consists primarily of software and control upgrades, is another option to significantly increase post-contingency voltage performance of the northern Vermont grid at an estimated capital cost of less than $1 million. The VDUs are therefore presently exploring the feasibility, timeline and cost of deploying AVR at Sheffield with Terraform. This is not yet a committed project, but based on its apparent technical and economic feasibility I include it in my discussion below of anticipated steps to mitigate SHEI congestion as this capability would provide useful improvements in the SHEI voltage limits.

18. Q. Will the proposed Project also make it possible to further increase the SHEI limits by other means?

A. Yes. VELCO has recently implemented increases to the thermal ratings of its K-42 line, a primary transmission path out of the SHEI area that runs south from Highgate. NVES analysis shows that this low-cost step will not – on its own – increase the SHEI thermal limit because the B20 line remains the limiting element that can be overloaded under some key contingency conditions. The Project will increase the size of the B20 path, and the NVES indicates that once the Project is implemented the increase in K42 line ratings will enable a significant increase in the SHEI thermal limit.

Part III: Extent of Expected Increase to SHEI Export Limitations.

19. Q. How did GMP estimate the extent to which potential solution steps will increase the SHEI limit?

A. ISO-NE sets the SHEI export limits to ensure that the transmission system will be able to perform acceptably if key contingency events (*e.g.*, a transmission line fault) occur. The effectiveness of each potential solution step therefore depends directly on the extent to which that step would improve the performance of the northern Vermont grid (with respect to voltage and thermal criteria)[11] immediately after certain contingency events occur. Specialized electric system analysis is typically required to determine this type of post-contingency performance. The NVES was therefore the key tool for this portion of our assessment because it tested the performance of multiple potential solutions (both individually and in a number of combinations) under contingency conditions that are likely to define the SHEI limits. The NVES cannot guarantee the specific level of SHEI limit increases that ISO-NE will assign based on its system analysis conducted when particular solution steps are being implemented, but the study is based on appropriate electric system analysis and is informed by the professional judgment of VELCO and its consultant, EIG, who have extensive experience with transmission system analysis and

[11] GMP's understanding is that the SHEI export limit is presently driven by post-contingency voltage performance, but that the thermal limit could potentially become binding in the future (*e.g.*, if solutions steps addressing only voltage performance were deployed).

interface limits in the ISO-NE market. VELCO indicates that the NVES results should reasonably approximate the SHEI limit benefits that will ultimately be obtained from various potential steps. See **Exhibit GMP-DCS-1** (correspondence from VELCO which includes confirmation that the Project and other potential solution steps are expected to have the effect of increasing the SHEI export limits by magnitudes consistent with those indicated in the NVES).

20. Q. What SHEI limit increases does the NVES indicate can be achieved by deploying the leading solution steps that you discussed above?

A. The NVES contains summaries of the estimated effects of a range of potential solution steps (individually, and for some steps in combination) on the SHEI interface limits. These summary tables present the results for the SHEI voltage limit and thermal limit separately, and under several particular system conditions (*e.g.*, ALI and when certain transmission lines or devices are out of service). The table below summarizes how the leading solution steps discussed above are estimated to increase the SHEI interface's voltage limit and thermal limit under ALI conditions. The table also identifies the NVES tables and cases that most directly support these figures.

Estimated SHEI Limit Increases
(MW, during "All Lines In" Conditions)

Resources	Total SHEI Voltage Limit Increase	Total SHEI Thermal Limit Increase	Key NVES Case #
Sheldon Springs AVR	27	0	20
Sheldon AVR + Lowell-Morrisville Project	71	60	6, 38, 39
Sheldon AVR + Lowell-Morrisville + Sheffield AVR	88	60	28, 38

Source: Northern Vermont Export Study Table 4 (for Voltage) and Table 5 (for Thermal)

The table shows that under ALI conditions the Sheldon Springs AVR is projected to significantly increase the SHEI's voltage limit (which is presently the binding limit), but not the thermal limit. Adding the proposed Project substantially increases both the voltage limit and the thermal limit, while adding the Sheldon Springs AVR would further increase the voltage limit. The magnitude of SHEI limit increases shown here (on the order of 60 to 90 MW in total, translating to a reduction of roughly half that amount in curtailed wind generation) suggests that this set of solution steps would greatly reduce or eliminate current levels of SHEI congestion under most ALI conditions.

21. Q. Do the SHEI limit increases (MW) shown above translate on a one-to-one basis to increases in allowed generation within the SHEI area?

A. No, not necessarily. The amount of curtailed generation in the SHEI that can be "recovered" by increasing the SHEI limits depends in part on the location of the generation that is being reduced at a particular time, and the particular system conditions. As I mentioned earlier, when the SHEI is constrained in real-time KCW has typically been the marginal generation source in the SHEI area that is instructed to limit its output. It is GMP's understanding that when this is the case, increases in the SHEI limit will tend to increase the amount of possible KCW output on about a 50% basis (*e.g.*, during a time when KCW output is being limited in order to limit flow over the SHEI interface, a 10 MW increase in the SHEI limit would allow KCW to increase output by about 5 MW).

22. Q. Are these solution steps also expected to enable increases in the SHEI limits under transmission outage conditions?

A. Yes. As I mentioned earlier, the SHEI limits are sometimes lowered when one or more elements of the transmission system are out of service (for either planned maintenance or unplanned outages); this increases the likelihood that SHEI will be congested and the potential volume of lost generation. Of particular importance are outages to system elements that are located outside the SHEI area but close enough that they affect the post-contingency voltage or thermal performance of the transmission system in northern Vermont.

There are many potential outages and combinations of outages that could theoretically reduce the SHEI limits at times. It was not practical for VELCO to study all potential outage conditions in the NVES, but VELCO indicates that the K-19 outage condition (one of the conditions studied in detail) should provide a good indication of how potential solution steps will affect the SHEI limits during a significant range of outage conditions that can lower the SHEI limits. The table below summarizes how the leading solution steps discussed above are estimated to increase the SHEI interface's voltage limit and thermal limit under K-19 outage conditions.

Estimated SHEI Limit Increases (MW, during K-19 Outage)		
Resources	**Total SHEI Voltage Limit Increase**	**Key NVES Case #**
Sheldon AVR	0	20
Sheldon AVR + Lowell-Morrisville Project	44	38, 6, 4
Sheldon AVR + Lowell-Morrisville + Sheffield AVR	49	38
Source: Northern Vermont Export Study Table 8		

Because VELCO expects that in the K-19 outage condition the SHEI voltage limit will be the binding limit by a significant margin, the NVES only tested how potential solution steps would increase the voltage limit. The table above shows that under outage conditions the proposed Project is estimated to substantially increase the SHEI limit, while the AVR projects at Sheldon Springs and Sheffield would provide only modest increases. The magnitude of SHEI limit increases shown here (on the order of 50 MW in total, translating to a reduction of roughly half that amount in curtailed wind generation in SHEI) indicate that this set of solution steps would substantially reduce SHEI congestion during transmission outage conditions, but would probably not eliminate the congestion under all conditions (*e.g.*, when local generation is particularly high and/or load is light).

23. Q. How will the SHEI export limit increases identified above translate to reductions in SHEI congestion, and associated curtailment of renewable generation?

A. Increases in the SHEI export limit will (all else equal) tend to reduce the frequency of SHEI congestion, and to reduce the depth of curtailment of renewable generation in the area that is required to prevent exports from exceeding the limits set by ISO-NE. As a result, higher volumes of generation can be realized in the SHEI area when the export limit is increased. The associated increases in renewable generation in the area can range from zero (at times when SHEI exports do not presently exceed the current export limit) to tens of MW (at times when potential exports significantly exceed the limit). To estimate the reductions in SHEI congestion and generation curtailment to expect in the future as a result of SHEI limit increases, GMP examined actual congestion over an extended historical period.

Specifically, we compared the SHEI limit increases identified above to the volumes of

SHEI-driven generation reductions that were actually required during the period June 2016 through December 2018 (31 months). This period captures a wide range of conditions including electric generation and demand in the SHEI area; ISO-NE energy market prices and outages on the transmission system. Whenever the SHEI was historically congested in Real-Time, we compared KCW's actual DNE limit to its potential output to determine the volume of generation that was "lost" because the SHEI was constrained.[12] We conducted this comparison on a 5-minute basis because potential wind output and therefore the depth of required generation reductions can vary so quickly that an hourly comparison does not always capture the depth of reductions that occurred during part of the hour.

24. Q. Before evaluating potential reductions in SHEI-driven congestion and generation curtailments, did you adjust the historical data in any way?

A. Yes. We observed that for almost two months in Spring 2017, the SHEI limits were significantly lower than normal while VELCO's Essex Statcom facility underwent a planned outage for refurbishment. As a result, the depth and breadth of SHEI congestion during this period was unusually high. VELCO indicates that the facility will only rarely require this type of extended outage. To avoid overstating the benefits that the proposed Project and other steps intended to increase the SHEI limits will provide in future years (most of which will likely not feature a major Essex Statcom outage), we adjusted[13] the historical data to remove the estimated effects of the major Essex Statcom outage. I should note that the historical period did not necessarily include all types of major transmission outages that could occur in the future, so

[12] Recall the chart of 5-minute operating data in Figure 1 above, where in the afternoon and evening the amount of "lost" KCW generation would be estimated as the difference between the green line and the purple line.
[13] The specific adjustment was to reduce the volume of SHEI-driven generation curtailment during the Essex Statcom outage period by about 20 MW, and to reduce the observed hours of SHEI congestion accordingly.

our approach could turn out to be conservative.

IV. Assessment of the Benefits of An Increased SHEI Export Limit.

25. Q. Please summarize the estimated increases in local generation that would be obtained by implementing the proposed Project and other anticipated solution steps.

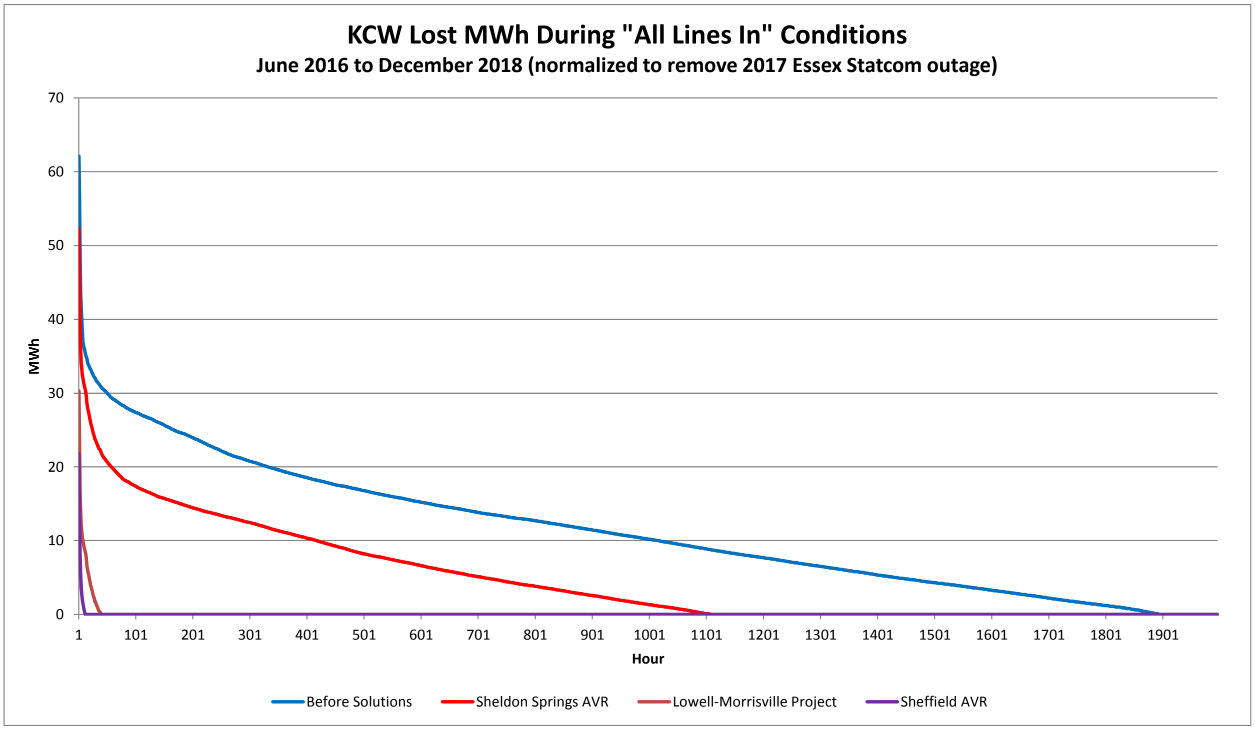
A. The two figures below illustrate the increases in local generation (*i.e.*, reductions in SHEI-driven generation curtailments) that each of several solution steps – Sheldon Springs AVR, the proposed Lowell to Morrisville Project, and Sheffield AVR – would provide, if deployed in sequence, during the historical period. Specifically, Figure 2 presents the results in duration curve form, for ALI conditions when the SHEI export limit was at typical levels:[14]

- The blue line represents estimated lost generation during the period (*i.e.*, without any steps taken to increase the SHEI export limit), sorted in descending order. During this period there were roughly 1,900 hours of time[15] during which the SHEI limit reflected ALI conditions and there was at least some amount of lost generation, with the volume of lost generation typically 25 MW or less.
- The red, darker red, and purple lines show estimated lost generation after deployment of the Sheldon Springs AVR project, the proposed Project and the Sheffield AVR project, respectively. Please note that on this chart and subsequent ones, the effects of each step are depicted cumulatively. That is, the "Lowell-Morrisville Project" line reflects the combined benefit of the Project and Sheldon Springs AVR, and the "Sheffield AVR" line reflects the combined benefit of all three projects.

[14] The posted SHEI export limit during this period was often in the range of 355 MW to 365 MW; we defined ALI conditions as times when the SHEI export was equal to or greater than 348 MW.

[15] As discussed above, it was necessary to develop the raw data and estimated lost generation volumes in 5-minute intervals. The results are presented here in hourly format, with an hour representing a group of 12 5-minute intervals.

Figure 2: Estimated Lost Generation (During All Lines In Conditions)

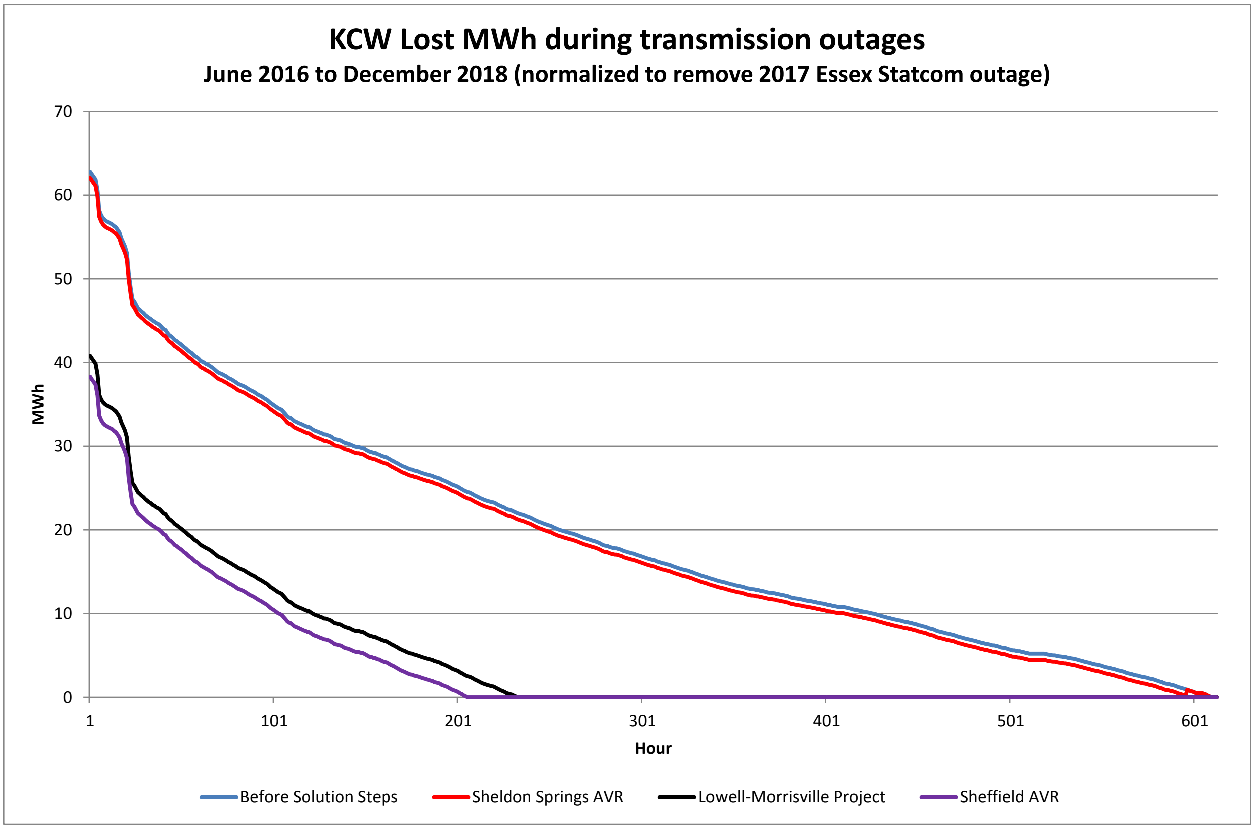


During ALI conditions Sheldon Springs AVR is projected to significantly reduce the frequency and depth of lost generation, with the Project projected to reduce the lost generation much further (to less than 100 hours per year and typical depths of 10 MW or less). Sheffield AVR is projected to eliminate most of the small amount of remaining congestion. Significantly, Sheldon Springs AVR also provides a margin of protection that will reduce congestion when one or both of the other projects is unavailable, or increases the SHEI limit by less than indicated in the NVES analysis.

Figure 3 below presents the same type of lost generation information for the same 31-month period for the subset of time when the SHEI export limit was significantly reduced, indicating that one or more elements on the transmission system were out of service. As I discussed earlier these outage conditions tend to be much less frequent than ALI conditions, but

SHEI congestion is more frequent during outage conditions and the resulting lost generation tends to be deeper.

<u>Figure 3: Estimated Lost Generation (During Outage Conditions)</u>



As illustrated in Figure 3, the Lowell-Morrisville Project is projected to be particularly useful during transmission outage conditions,[16] greatly reducing both the frequency of congestion and the depth of lost generation. The B22 component of the Project is particularly helpful under this condition, providing the majority of the estimated Project benefits shown here. The AVR projects are projected to provide much less benefit during outage conditions than during ALI conditions.

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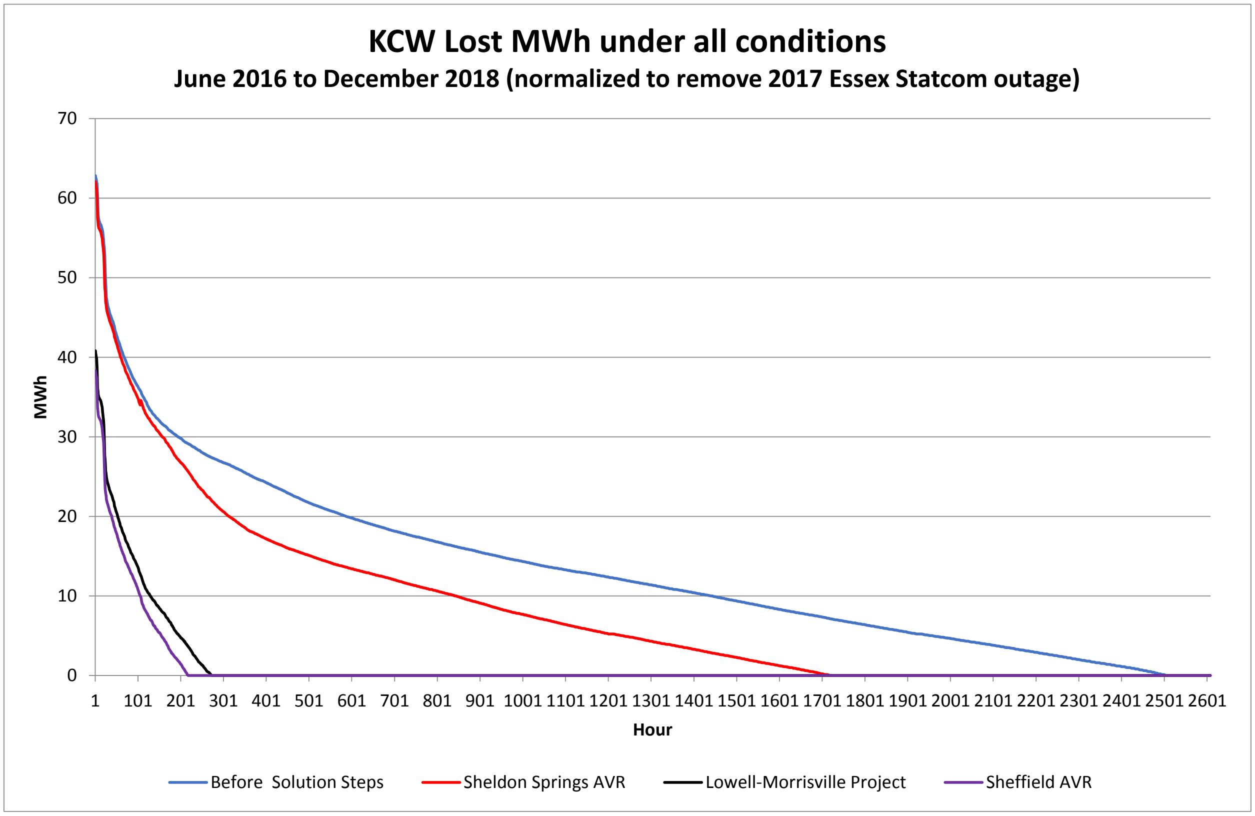
[16] As noted above, we used the K-19 outage condition in the NVES as an indicator for how the solution steps would perform during various types of outages on the transmission system (including the K-19 line itself) outside of the SHEI area that can reduce the SHEI export limit.

Finally, Figure 4 combines the data in Figures 2 and 3 to show how the anticipated solution steps would reduce lost generation over the course of the full analysis period, including "all lines in" and outage conditions.

<u>Figure 4: Estimated Lost Generation (All Hours)</u>



Consistent with Figures 2 and 3, the combination of Sheldon Springs AVR, the proposed Lowell-Morrisville project and Sheffield AVR is projected to eliminate most lost generation observed during the study period. Together, the anticipated solutions are projected to eliminate the vast majority of the hours of congestion and associated lost MWh of generation, with a limited amount remaining over about 200 hours during the historical period (which would translate to an average of less than 100 hours or less per year).

V. Assessment of the Benefits to Vermont Electricity Customers.

26. Q. You have shown above how the proposed Project (along with two other anticipated steps) would increase the SHEI export limits, and the associated reductions in curtailment of generation in the SHEI area. How did you go about estimating how the Project proposed in this case will benefit Vermont electricity customers?

A. Our approach was to estimate and compare the annual costs and benefits that customers will experience as a result of the Project, through the revenue requirements of GMP and other Vermont electric utilities. Specifically, we estimated the financial value of three benefit streams that the Project is expected to provide: increased renewable generation from existing resources in northern Vermont (through reduction of SHEI-driven curtailments), reduced SHEI-driven congestion costs, and reduced energy losses over the B20 subtransmission path. We compared these benefits to the annual utility revenue requirements associated with the Project, less the revenue requirements associated with a significant asset condition project that will (as explained by Ms. Jones) be needed soon if the Project is not implemented.

The analysis shows that the estimated financial benefits of the Project exceed the incremental costs associated with the Project by almost $12 million in present worth. In fact, under our base case analysis the estimated benefits exceed the total cost of the Project – even before considering the critical fact that in absence of the Project, GMP would need to implement a substantial asset condition project that would cost many millions of dollars. I will now explain the major components of this analysis.

27. Q. Please summarize how GMP estimated the value of additional renewable generation that will be enabled by the Project.

A. The stacking analysis that I described above (the results of which are summarized in Figures 2 through 4) identify the approximate volume of increased or "recovered" energy that could have been generated during the historical period if the Project had been deployed to increase the SHEI limits. We assumed that these levels of recovered generation (about 7,100 MWh/year) would occur through the life of the KCW plant,[17] consistent with a future in which electricity demand growth (net of net metered generation) is minimal, and no significant generation is added in the SHEI area unless that generation takes additional steps to increase the SHEI export limit to prevent adverse impacts on existing resources. In contrast, if significant generation additions are actually made in the SHEI area without corresponding steps to increase the export limit, then the frequency and depth of SHEI congestion can be expected to increase compared to the historical period. In that scenario the benefits of the Project to Vermont customers would likely turn out greater than shown in our analysis.

We then estimated the financial value of recovered generation based on the estimated market value of the KCW plant's energy and regional Class 1 RPS RECs (for which KCW is eligible), using the base case market price outlooks presented in GMP's 2018 IRP. We also assigned a value for Federal Production Tax Credits[18] associated with additional generation through 2022. The present value of recovered energy is estimated at about $6.4 million.

[17] Our analysis assumes that KCW will operate in its current configuration through 2047 (a lifetime of 35 years), and that the plant's eligibility for regional Class 1 RPS markets will be limited to the first 25 years.

[18] Wind plants like KCW are only eligible for the federal PTC on output generated during their first ten years of commercial operation; for KCW this will end in December 2022.

28. Q. Please summarize how GMP estimated the value of reduced SHEI-driven congestion that will be enabled by the Project.

A. Recall that SHEI congestion tends to harm our customers by reducing the LMP revenues that GMP generation sources in the SHEI receive (through a negative congestion component). Increasing the SHEI export limit will tend to reduce SHEI congestion, increasing the LMP revenues for energy sources in the SHEI area and reducing net power costs for GMP and most of the other VDUs, which in turn benefits our customers. We therefore began by identifying the extent to which SHEI-driven congestion reduced the LMP revenues that GMP received for each of its major sources that deliver energy in the SHEI area (KCW, Sheldon Springs hydro, and GMP's share of the HQUS PPA)[19] during each month of the historical period, and scaled up the congestion for KCW and HQUS to reflect the total output that VDUs receive from these long-term sources.

We then applied the results of the stacking analysis that I described above (also on a monthly basis) to approximate the fraction of congestion costs that would be relieved as the proposed Project and other steps were implemented. Notable assumptions here are that as the SHEI export limit is increased, monthly congestion costs will be relieved in approximate proportion to the volume of curtailed generation that is recovered as each solution step is applied, and congestion in the Day-Ahead energy market will be relieved at approximately the same rate as in the Real-Time energy market. We reduced these estimated congestion benefits to recognize that (as I discussed earlier) lower LMPs in the SHEI area also tends to modestly lower the cost to purchase GMP's load obligations at the Vermont Load Zone. The present value of reduced

[19] The historical SHEI-driven congestion figures for the HQUS PPA were reduced by 40 percent to reflect that when SHEI-driven congestion lowers LMPs at the Highgate location, a portion of that reduction ultimately flows to the VDU buyers as part of the annual PPA pricing formula.

SHEI congestion is estimated at about $12.7 million.

29. Q. Do these benefits include the value of reduced congestion for all sources that deliver energy in the SHEI area?

A. No. As noted above, the estimated benefits above are limited to relief of congestion for the major long-term sources that GMP purchases from or owns. There will also be some amount of additional benefits associated with relieving SHEI-driven congestion that affects other sources in the SHEI area that operate for the benefit of other VDUs and their customers. GMP recognizes, however, that the estimation of benefits for these other sources can be complex (*e.g.*, depending on such factors as the operating lifetimes of these sources and the pricing structure of VDU PPAs); we have not yet worked with the other VDUs to develop common assumptions upon which such benefits could be estimated. My estimate is therefore conservative. To the extent that congestion benefits actually accrue to additional VDU sources in the SHEI area, the Project's statewide benefits will tend to be greater than I have shown.

30. Q. Is the Project expected to benefit Vermont electric customers by reducing energy losses on the Vermont grid?

A. Yes. As explained by Ms. Jones and Mr. Fiske, the Project will entail upgrading the conductor on the B20 path to a significantly lower impedance than the current path, resulting in a lower level of energy losses for any given amount of power flow over the path. The loss savings can vary significantly across the year depending on line loading; GMP has estimated that the larger conductor will result in a loss reduction of roughly 1 MW at peak load conditions, and roughly 1,400 MWh over the course of a year.

In general, lower losses on the subtransmission system tend to lower the amount of power that must be purchased from the wholesale power market, and to also lower charges that are based on those power requirements. Specifically, loss reductions can be expected to lower GMP's energy requirements in the ISO-NE energy market, along with Regional Network Service charges (based on the size of the monthly peak load on the VELCO transmission system) and Forward Capacity Market obligations ("FCM" which is based on load at the time of ISO-NE's annual peak). Based on current projections of future energy and capacity market prices and RNS rates, we estimate that the financial value of the loss reductions above would amount to between $100,000 and $200,000 per year in the near term, and a present worth of over $4 million over the life of the Project. The actual savings (which could turn out to be larger or smaller than today's estimate) will translate to lower net power costs for GMP and potentially other Vermont utilities, and therefore lower bills for Vermont electric customers.

31. Q. You have just presented several streams of financial benefits that the Project is expected to provide to Vermont electric customers. What are the estimated costs?

A. Ms. Jones presents the Project's estimated capital costs of about $15.4 million. The primary costs that customers will experience as a result of the Project's implementation are those associated with this capital investment: depreciation, return on rate base, income taxes, property taxes, and Vermont gross revenue tax. GMP does not expect that the Project will entail meaningful additional O&M expenses, compared to the alternative asset condition project which would feature the same transmission corridor but a somewhat smaller conductor. We do, however, assume that the Project will significantly increase the level of required local property taxes over the sixty-year Project life, compared to current levels. Together, our estimates of these Project-related utility revenue requirements amount to about $1.8 million per year in the Project's first year of operation, declining gradually over time as the associated net plant in service (along with associated return on rate base and income taxes) declines due to depreciation. Over the Project's assumed economic life of 60 years, the estimated revenue requirements amount to a present worth total of about $22.2 million.

32. Q. What are the estimated costs of the asset condition project that would be needed if the proposed Project were not implemented?

A. GMP is pursuing the proposed upgrade Project, and pursuing it now, because the Project is expected to provide substantial value to Vermont customers by increasing the SHEI limits and reducing costs and lost generation value associated with SHEI congestion. Ms. Jones explains that if GMP did not move forward with the proposed Project, the aging B20 path would require a significant asset condition project within a limited number of years. Thus, the estimated cost of that asset condition project (somewhat smaller in scope, and a few years later) represents an avoided cost that electric customers will face if the Project is not implemented. GMP estimated the annual revenue requirements associated with this asset condition project using the approach summarized above for the proposed Project. We assume that the asset condition project would be completed in 2027 (about 6 years later than the proposed Project), at an estimated capital cost of about $9.9 million (in 2027 dollars). The estimated revenue requirements for the asset condition over its life amount to a total present worth of about $10.4 million (in 2021 dollars).

33. Q. Based on the benefit and cost streams you have summarized above, is the Project a cost-effective investment to reduce SHEI congestion?

A. Yes, by a substantial margin. The following table compares the projected costs associated with the Project to the projected benefits and avoided costs that it will provide to electric customers, on a lifetime present worth basis:

Item	Estimated NPV ($2021) Over Project Life
Cost of Lowell-Morrisville Project	$ 22,211,963
Less: Avoided Asset Condition Project	$ (10,415,365)
Net Incremental Cost of Upgrade	$ 11,796,598
Value of Additional Generation	$ (6,373,580)
Value of Decreased Congestion Costs	$ (12,725,662)
Value of Reduced B20 Losses	$ (4,441,093)
Value of Estimated Benefits	$ (23,540,336)
Net (Benefit)	$ (11,743,738)

As shown above, and in present worth terms, the projected revenue requirements associated with the proposed Project are about $22 million, roughly twice as much as those associated with the asset condition project (which features a smaller scope, and is assumed to occur several years later) that would otherwise be required. The estimated benefit streams of recovered generation and congestion in the SHEI area, along with reduced transmission losses, amount to a total of over $23 million. These estimated benefits exceed the total estimated costs associated with the Project, even before considering the substantial value of avoiding a significant asset condition project. When the avoidance of that asset condition project is considered, the value streams provided by the Project exceed its costs by almost $12 million. Alternatively, if the proposed Project is viewed as an incremental commitment of about $12 million (above the asset condition project that GMP will otherwise need to implement), the estimated net benefit of almost $12 million represents an excellent lifetime benefit/cost ratio of about 2 to 1.

Moreover, as I noted above these financial benefits are conservative in that they do not account for potential congestion benefits for energy sources in the SHEI area that GMP does not own or purchase energy from. As noted above, the VDUs have agreed to engage in a discussion separate from this CPG proceeding regarding the benefits to individual VDUs and a potential methodology that may be used to allocate the cost of SHEI solutions steps. The financial benefits discussed above are not intended to establish specific assumptions or methods that may be relevant to a cost allocation agreement among VDUs.

34. Q. Have you estimated how the Project's benefits and costs will flow to individual VDUs?

A. No. The benefits and costs are estimated and compared here in aggregate, from the perspective of Vermont electric customers as a whole. We have not yet estimated how relief of SHEI congestion will affect individual VDUs other than GMP, primarily because this is a complex exercise that is not needed to conclude that the Project is cost-effective or to demonstrate compliance with the required statutory criteria. But as I discussed earlier, GMP is clearly the largest holder of generation (through PPAs and owned capacity) that is adversely affected by SHEI congestion, so we expect that the clear majority of the benefits (along with its costs) will flow to GMP customers.

Ultimately, the VDUs broadly support implementation of the solution steps I have discussed, including this Project. VDUs that will benefit from the implementation of this Project and other solutions steps have participated in the robust consideration of alternatives and have begun discussions about how to allocate the cost of SHEI solution steps, including this Project, among those VDUs that benefit from these solutions. These VDUs have agreed to engage in the complex task of developing an analysis of the anticipated benefits to individual VDUs as well as the related effort to seek a cost allocation methodology under which VDUs will ultimately contribute to the cost of these solution steps, with GMP expected to bear the largest share of costs by a significant margin.

35. Q. Has GMP considered how the projected benefit/cost results for the Lowell-Morrisville Project might vary if some of the key factors in your analysis turned out differently than the base case assumptions discussed above?

A. Yes. GMP identified several uncertainties that seem the most likely to affect the Project's benefits over time, and defined a pair of alternative cases for each factor that we believe capture a large fraction of the potential range of possible future outcomes for that factor. These uncertainties are:

- **Future regional energy market prices**. This sensitivity tests how higher/lower regional Locational Marginal Prices during times when SHEI is congested would affect the value of recovered renewable generation in the SHEI area. The current energy market price outlook is reflective of GMP's energy outlook presented in its 2018 IRP, which is generally driven by natural gas prices.
- **Future regional REC market prices**. This sensitivity tests how higher/lower market value for RECs would affect the value of recovered renewable generation in the SHEI area (KCW RECs are presently eligible for Class 1 RPS compliance in multiple states). We assume that after 25 years of operation the plant's output will only be eligible for Vermont Tier I RECs unless the plant is repowered, in which case it will continue to

qualify for Class I RPS RECs.

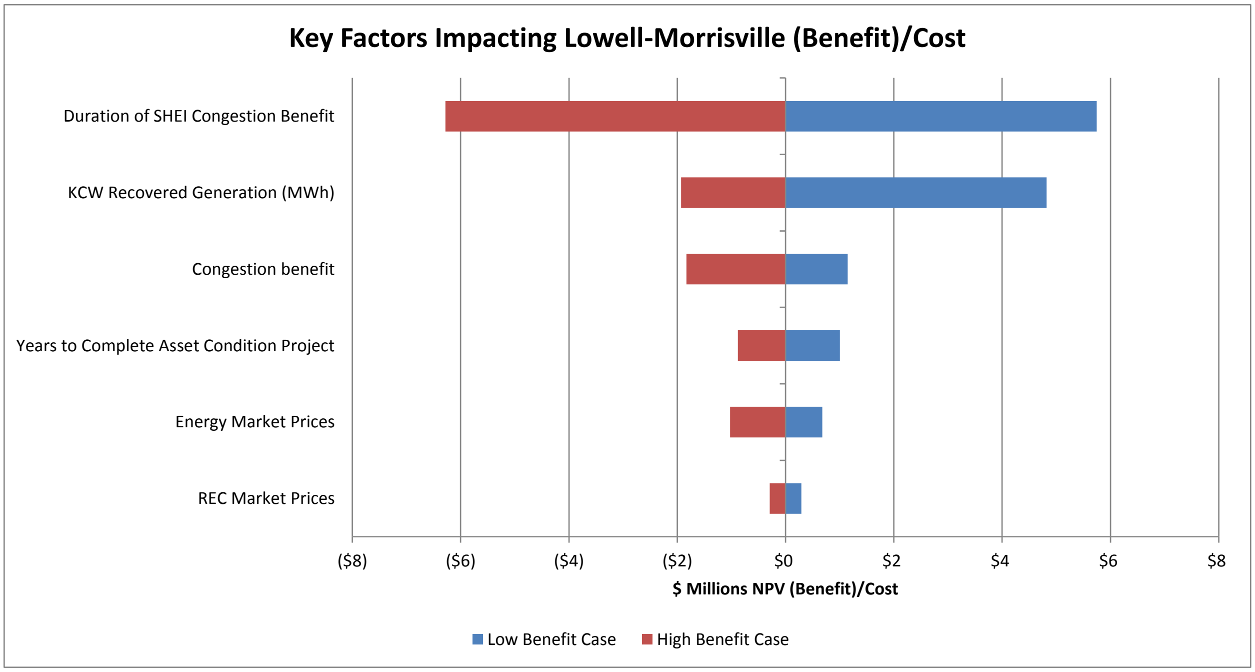
- **Duration of congestion benefits**. Congestion benefits from the Project should persist so long as VDUs continue to receive large scale deliveries of energy in the SHEI area. In this sensitivity we test alternative outcomes for how far into the future KCW operates; all else equal SHEI congestion would decline significantly if/when KCW retires. For simplicity, our analysis makes the conservative assumption that all SHEI congestion (and therefore the congestion benefits of the proposed Project) would cease at that point.
- **Volume of recovered SHEI generation and congestion relief**. This sensitivity tests how the Project's estimated benefits would vary if the actual SHEI limit benefits obtained from the proposed Project and AVR projects turn out more or less than estimated in the NVES.
- **The trend of congestion benefits over time**. This sensitivity tests how SHEI-driven congestion benefits could be influenced by trends in regional LMPs, as well as trends in loading of the Highgate Converter over time (all else equal, higher deliveries over Highgate tend to be associated with higher SHEI congestion).
- **Timing of the (alternative) asset condition project**. This sensitivity tests how the Project's net benefits would change if the alternative capital project (based only on asset condition considerations, not SHEI relief) were implemented earlier or later than our base case assumption of 2027.

The following table summarizes the base case assumptions, along with alternative outcomes that would tend to increase or decrease net benefits for the proposed Project.

Variable	Base Case Assumption	Low Benefits Case	High Benefits Case
Future Energy Market Prices	2018 IRP Base Case Energy	2018 IRP Low Case Energy	2018 IRP High Case Energy
Future REC Market Prices	2018 IRP Base Case RECs	2018 IRP Base Case RECs minus 25%	2018 IRP Base Case RECs plus 25%
Duration of SHEI Congestion Benefit	26 years	16 years	41 years
Volume of Recovered Generation and Congestion Relief	Based on VELCO's Northern Vermont Export Study (NVES)	NVES minus 25%	NVES plus 10%
Trend of Future Congestion Benefits	2018 IRP Base Case Energy, less a one-time drop of 10% in 2025	2018 IRP Low Case Energy less 0.5% per year for ten years and a one-time drop of 10% in 2025	2018 IRP High Case Energy, less a one-time drop of 10% in 2025
Implementation Year for Alternative (Asset Condition) Project	2027	2030	2025

Figure 5 below presents the results, in the form of a “tornado” diagram that illustrates the results – specifically, the extent to which the prescribed change in input assumption for each variable (relative to GMP’s base case assumption) would affect the estimated net benefits of the proposed Project. The red bars on the left side of the chart indicate outcomes that would increase the Project’s net benefits compared to our base case analysis, while the blue bars on the right side indicate outcomes that would be less favorable.

Figure 5: Sensitivity Analysis Results



The sensitivity analysis indicates that our benefit/cost analysis of the proposed Project is relatively robust. The results are relatively balanced, with the magnitude of potential favorable outcomes similar to the unfavorable ones. Alternative outcomes for four of the factors have the potential to change the results by up to $2 million of present worth (a fairly limited fraction of the Project's cost and its projected net benefits), and only two of the factors feature adverse outcomes that would reduce the Project's benefits by more than $5 million. A combination of the adverse outcomes for all of the largest factors together (an unlikely outcome) would be required to eliminate the Project's estimated lifetime benefits under base case assumptions. In the context of a base case estimate of about $12 million of lifetime benefits, this is a robust profile indicating that the Project is likely to remain cost-effective over a substantial range of potential future outcomes.

36. Q. You have shown that the Project's estimated benefits to customers substantially exceed the costs on a long-term basis; how do they compare in the near term?

A. For the first few years of operation, the Project's annual costs are projected to be modestly higher than the annual benefits. This is primarily because the projected utility revenue requirements associated with the capital investment are highest in the early years, declining over time as the asset depreciates. Once the avoidance of a B20 asset condition project is included (our base case analysis assumes that this Project would be completed in 2027), the benefits and avoided costs associated with the Project are expected to exceed the costs by more than $1 million per year. In the long-term, as annual revenue requirements associated with the Project gradually decline and the value of power and congestion savings is projected to gradually increase, the resulting margin of savings increases further.

VI. Analysis of Compliance with 30 V.S.A. § 248 Criteria.

37. Q. Does the analysis above show that the Project will result in an economic benefit to the State and its residents (30 V.S.A. § 248(b)(4))?

A. Yes, clearly. By expanding the scope of an asset condition project that would have been needed anyway in the absence of any SHEI concerns, the Project is expected to increase the SHEI export limits that are presently capping output of existing renewable energy sources in northern Vermont during some conditions, and triggering congestion costs that reduce the financial value of output from sources in the area to Vermont utilities and their customers. The Project is estimated to be strongly cost-effective, with the benefits to Vermont customers from increasing the SHEI limits (along with a reduction in line losses) projected to exceed the costs to implement the Project by a large margin.

I should note that the estimated margin of about $12 million of net benefits for the Project is from the perspective of electricity customers. From this perspective, additional property tax and state income tax payments associated with the Project (estimated at about $3 million in lifetime present worth) are treated in the analysis above as a cost that electric customers would pay as a result of the Project. On the other hand, these tax expenses also represent direct payments to local and state governments, so they provide additional economic benefits for Vermont and its residents as a whole. Additionally, as discussed by witness Jones, the Project will result in other positive economic benefits associated with increased jobs and other activity associated with the construction.

38. Q. Will the Project support deployment of additional renewable generation and the associated economic benefits of such projects in the SHEI area?

A. The primary purpose of the Project is to cost-effectively reduce the frequency and depth of SHEI congestion that is being experienced today (based on the current balance of load and generation in the SHEI area), for the benefit of Vermont electric customers. A secondary effect of relieving current congestion levels is that the extent to which future renewable generation would congest the SHEI will likely be reduced, relative to adding that generation to the current electric system without the Project. Additionally, the Project provides the unique benefit of enabling the increased thermal ratings of VELCO's K-42 line (or a future upgrade of that line) to support a higher SHEI thermal export limit.

This is important because the increase in the SHEI thermal limit unleashes a variety of potential solution steps focused on addressing the SHEI voltage limit that would not likely be effective if the SHEI thermal limit becomes binding. In this way, the Project reinforces the overall transmission system in northern Vermont in a way that makes it a more robust platform that could better accommodate smart generation development with creative mitigation proposals. The Project is therefore supportive of the potential for future deployment of additional renewable generation in the SHEI area. GMP's analysis above does not assign any financial benefit to this feature, although it could (if new generation in the area operates for the benefit of Vermont customers) provide value to Vermont by increasing the feasibility of meeting the RES requirements and limiting the incremental cost of meeting those requirements.

It is critical to recognize, however, that while the Project will increase the SHEI export limits, future deployment of additional generation in the SHEI area would have the offsetting effect of increasing the amount of required flows out of the area. This means that if new generation is added in the area without additional mitigation steps to increase the SHEI limits, such projects will partly or entirely erode the incremental benefits that this Project will create by alleviating transmission constraints. Even after the Project is completed, the deployment of additional generation in the area is likely to trigger some amount of SHEI congestion which would adversely affect (via curtailment and/or reductions in LMP revenues) existing renewable generation and the Vermont electric customers on whose behalf this generation operates. As a result, even though the Project generally makes consideration of additional renewable generation in the SHEI area more feasible, such proposed new generation will still need to be evaluated based on the likely adverse impacts that it would have on SHEI congestion. It is expected that for such new generation to benefit Vermont customers, analysis will be needed and mitigation steps will likely be required to fully mitigate the impact of such projects (*e.g.*, by deploying or sponsoring additional steps to increase the SHEI export limits).

39. Q. Please explain alternatives considered by GMP, the VSPC, VELCO and other VDUs, and explain why the proposed Project is required to meet the need for present and future demand for service which could not otherwise be provided in a more cost-effective manner through energy conservation programs and measures, energy-efficiency and load management measures or distributed generation, including but not limited to those developed pursuant to the provisions of 30 V.S.A. §§ 209(d), 218c, and 218(b) (30 V.S.A. § 248(b)(2)).

A. As described above, GMP and other VDUs, with the assistance of VELCO, have engaged in a robust evaluation of the range of options available to help mitigate the current SHEI constraint. The alternatives considered by GMP and others include potential transmission projects, efficiency, load management, and distributed generation options. The set of solutions steps described above, including the Project, represent—by a substantial margin—the most cost-effective option for significantly reducing SHEI congestion and securing value for Vermont customers through associated increases in renewable energy production, tax credits, RECs, and LMPs values. Below, I discuss some of the more meaningful alternatives considered.

40. Q. Could increased electricity use in the SHEI area mitigate SHEI congestion?

A. In theory, yes. The SHEI becomes constrained when the amount of potential generation in the SHEI area exceeds load in the area to an extent that would require more transmission of energy over the SHEI than can be reliably exported. In general, more electricity demand in the area would tend to offset local generation, reducing the required volume of energy exported from the SHEI area. Directionally, this has the potential to reduce the frequency and/or the depth of SHEI congestion, although the cost-effectiveness of load building depends in part on the utility cost to serve the additional load.

41. Q. Is increasing electricity use in the SHEI area a reasonable alternative to the proposed Project or the other near-term steps that you discussed above?

A. No. The opportunities available for building electric load in northern Vermont appear to be limited, on a much smaller scale than the Project and the other solution steps that I discussed earlier. Load building would also likely take significant time to develop on a meaningful scale, and it is important to keep in mind that not all additional electricity load would help to mitigate SHEI congestion. In order for increased electricity load to reduce SHEI congestion, that consumption must occur during times when SHEI is actually congested – that is, during those hours that tend to be associated with high levels of local generation (wind and hydroelectric) or light load in the area, or outages of equipment on the Vermont transmission or subtransmission systems. I should also note that additional load would need to be cost-effective, considering the extent to which it may increase utility costs during periods of high load and/or wholesale market prices.

42. Q. Could you please elaborate on the potential scale and timing of load building efforts in northern Vermont?

A. Yes. First, for a sense of scale, the magnitude of current electricity demand within in the SHEI area – including all classes of customers – typically ranges from 20 to 65 MW, and averages between 30 and 40 MW. This means that additional electric load in this area on the order of 20 to 30 MW (comparable in scale to the anticipated solution steps discussed above) would require increasing total electricity consumption in the area by more than half.

VEC reports that the area has actually featured flat or declining net loads. Accordingly, in the absence of one or more large load building opportunities, it is not feasible to rely upon load building as a SHEI solution step akin to the solution steps discussed above. Considering that VEC and other VDUs have been engaged in cost effective load building opportunities for years (irrespective of SHEI considerations), increasing load on the scale that would be needed to compete as a viable alternative with this Project in the timeframe needed to obtain the substantial benefits this Project offers Vermont customers is simply not a reasonable alternative.

As part of the robust planning process for this Project, VEC explained its active exploration of opportunities to cost-effectively increase load in its territory, including in the SHEI area, which comprises roughly half of VEC's service territory. The following are highlights that VEC has provided with respect to load building opportunities:

- As part of VEC's energy transformation under Tier III of Vermont's RES, VEC offers financial support to help members adopt efficient electric alternatives for products and services that reduce fossil fuel consumption. Incentives are presently offered for products including cold climate heat pumps; heat pump water heaters; electric vehicles ("EVs"); public EV charging stations; and others.
- Under its Clean Air Program, VEC supports the cost of line extensions and/or service upgrades for VEC members that result in a significant reduction in fossil fuel consumption. This program has supported several upgrades that created about 1,500 MWh/year of new electric load or an average of about two hundred kW on an hourly basis.
- VEC personnel meet regularly to keep apprised of load growth opportunities in the SHEI area and to brainstorm new ideas – such as the pursuit of a "power to gas" pilot project in

partnership with Vermont Gas.

- VEC has had discussions with developers regarding potential substantial, discrete load additions in the area – for example, associated with the location of a data center.
- VEC is exploring further collaboration with Efficiency Vermont (EVT) to procure efficient and controllable electrification.

In summary, VEC is pursuing cost-effective load growth through multiple paths. VEC's experience indicates that there are credible load building opportunities, but that the opportunities are often limited in scale and often require significant time and/or cost to develop. VEC's expectation is that its current and future initiatives with respect to growing load in the SHEI area have a combined potential to increase load by 5 to 10 MW[20] by the mid-2020s, with a significant degree of uncertainty around some of the larger options. VEC therefore views growth of load in the SHEI area as complementary to the Project and other planned solution steps, but not a realistic option to displace one or more of them in addressing current congestion levels. GMP shares this view.

43. Q. Is deploying battery storage a potential tool to reduce congestion in the SHEI area?

A. Yes, battery storage is one of the alternatives that was addressed in the NVES and reviewed by GMP and the other VDUs as part of the screening process for potential SHEI solutions. The reactive power capabilities of grid scale battery storage systems have the potential to increase the SHEI voltage limit by improving post-contingency grid performance in

[20] The 5 to 10 MW range refers to peak load; the associated average load addition over the course of a year would likely be significantly less.

northern Vermont. A storage system also can be used to recover potential curtailed generation in the SHEI area by charging (*i.e.*, drawing electricity from the grid) during times when SHEI is congested. Battery storage systems (unlike many transmission solutions) also have the potential (depending on their configurations and specifications) to generate other value streams by participating in the Frequency Regulation Market ("FRM"), the Forward Capacity Market, or as a load reducer for monthly transmission peaks.

It is important to recognize that cost-effective deployment of storage also faces a number of important limitations or constraints, including:

- A storage system's effectiveness at managing system voltage (and thereby increasing the SHEI voltage limit) can depend significantly on where it is located and interconnected on the grid. VELCO indicates that storage systems can be effective at managing bulk system voltage if interconnected to the bulk system, but this requires much greater interconnection costs than for smaller distributed storage systems. Decentralized battery storage installations that are viewed as load reducers and are not connected to the grid as ISO-NE recognized assets will be much less effective at helping to manage bulk system voltage. VELCO therefore indicates that the potential value of such distributed systems will likely be limited to benefits associated with charging during constrained hours, with very limited potential for reactive power benefits.
- A storage system only provides relief for the SHEI thermal limit when it is charging (*i.e.*, acting as a load), and the relief it can provide is limited by the amount of energy that the system can store. Short-duration storage resources (*i.e.*, those that can store up to four hours of maximum discharge) that GMP and other VDUs are deploying to achieve value streams like peak management would not be well-suited to address the much longer

lasting congestion events that sometimes occur in the SHEI area. Custom grid-scale storage systems can be designed to include additional hours of storage capacity, but this can significantly increase the capital cost.

- The ability of a storage system to produce the additional "stacked" value streams cited above may be limited significantly by the operating requirements associated with using the system to manage SHEI congestion.[21]

44. Q. Did GMP and other VDUs explore the cost-effectiveness of potential battery storage systems to mitigate SHEI congestion?

A. Yes. With the capabilities and tradeoffs above in mind, a subgroup of the VDU working group (assisted by VELCO with respect to estimation of capital costs) considered four potential configurations. Two of the configurations (a 16 MW/64 MWh system and a 16 MW/16 MWh system) were assumed to interconnect to the bulk transmission system near Highgate (an area where voltage support would be particularly helpful). Two of the configurations (four 4 MW/16 MWh batteries and four 4 MW/4 MWh batteries) were assumed to interconnect to the distribution system. Each scenario had unique capital cost considerations and anticipated operational benefits. Overall, the estimated capital costs ranged from $32 million to $74 million for systems capable of operating for an initial twenty years of service.[22]

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[21] For example, a storage system cannot discharge for the purpose of peak reduction or energy arbitrage while simultaneously absorbing energy to mitigate SHEI congestion. Similarly, a battery system's state of maximum readiness for mitigating SHEI congestion would be a near zero state of charge (*i.e.*, the system is nearly empty), while the state of maximum readiness for peak shaving or energy arbitrage during high LMP events would be a full state of charge.

[22] It is expected that the battery storage systems would need to be repowered or replaced every 20 to 25 years (incurring additional capital costs), if SHEI congestion is still present at that point.

45. Q. How do these solutions compare to the Project in terms of cost-effectiveness?

A. The estimated capital costs for the storage options are much higher than those for the Project; those costs would be partially offset by estimated SHEI mitigation benefits (*i.e.*, reduced curtailment and congestion costs) and other potential power supply benefits dictated by their location and configuration. For example, the distribution-interconnected systems were analyzed as load reducers that are capable of providing peak shaving during monthly transmission peaks and would also reduce loads used for determining annual FCM obligations. This helped to increase the cost-competitiveness of these configurations relative to larger battery systems interconnected at the Highgate substation, but led to significantly lower volumes of recovered "lost" energy because they would primarily provide benefits by charging during times when SHEI is constrained and would have minimal reactive power benefits on the bulk system. For the configurations interconnected to the bulk system, most of the recovered KCW generation would be associated with the system's reactive capabilities increasing the SHEI voltage limit, although during periods where the batteries were charging there would also be some thermal benefit. As I noted earlier, this thermal benefit would be somewhat limited due to the limited energy storage capacity of the batteries (*e.g.*, between one and four hours of maximum output) and the fact that the batteries would need to generally be in relatively high state of charge (and therefore not fully available to absorb energy during a SHEI congestion event) on days when peaks are anticipated or while participating in ISO markets. Additionally, certain conditions, such as extreme cold weather, may work to limit the ability of the battery storage system to consume energy rapidly as the normal charge cycle can be doubled when temperatures are below zero degrees. There will not be a change in the amount of energy stored, just the time that it takes to fully charge the battery storage device.

Taking into account the costs and value streams above, our screening analysis indicated that a simple breakeven period for these projects on a cash flow basis would be quite long when compared to the benefits of the Project. Moreover, our evaluation showed that the costs associated with repowering of the battery system could extend the payoff period even longer; or breakeven might not be achieved depending on future battery storage system costs or the relative value of future benefits.

46. Q. Is battery storage likely to be an effective alternative to the proposed Project?

A. No. Deployment of battery storage on a scale to deliver SHEI congestion relief comparable to the Project would be quite capital-intensive, and it does not appear that battery storage would be as cost-effective as the Project even under relatively favorable assumptions with respect to battery market revenues and avoided costs. As I discussed above, the Project also provides other significant benefits that battery storage would not: sustained line loss reductions, and the ability to leverage thermal line rating increases for VELCO's K-42 line (and perhaps an upgrade of that path in the future) to achieve higher SHEI export limits. Together, these considerations indicate clearly that the Project is the preferred option compared to battery storage at this time.

At the same time, the Project does not foreclose use of battery storage to limit SHEI congestion in the future, and it probably will enhance the feasibility of this use case. First, the proposed Project could open the door for battery solutions because one of the challenges with deploying battery storage that I mentioned earlier - the difficulty of addressing long, deep SHEI congestion events - should be reduced by the proposed Project (along with one or more low-cost

AVR projects). Second, it is reasonable to expect that battery system prices will continue to decline significantly over time, making battery storage a more cost-competitive option that could be deployed in the future to strategically offset SHEI congestion that is not fully addressed by this Project (or to support the deployment of future renewable generation in the area).

47. Q. Have you assessed the extent to which the Project would be a cost-effective step to mitigate SHEI congestion if it included a more limited investment in the B20 without deployment of the B22 upgrade component?

A. Yes. As described in more detail above, our assessment of the proposed Project included estimation of the incremental benefits of solution steps, including the specific value of the B22 upgrade. Our analysis indicates that the B22 upgrade is a limited but important part of the Project because it is projected (when added to the other Project components) to increase the SHEI limits, most notably during outage conditions. This enhances the robustness of the Project to mitigate SHEI congestion under a range of potential operating conditions. While the B22 upgrade is important to maximize the Project's cost-effectiveness and robustness, the other components of the Project provide a large portion of the anticipated total benefits with respect to addressing SHEI congestion (including leveraging the thermal line rating increases that VELCO has recently implemented). In summary, the B22 upgrade is a cost-effective component of the overall Project, although it would be appropriate to pursue the other components of the Project without the B22 component.

48. Q. Is the Project consistent with the principles expressed in the Company's IRP (30 V.S.A. § 248(b)(6))?

A. Yes. One of the central principles articulated in GMP's 2018 IRP is GMP's focus on planning and outcomes that increase the Company's capacity to generate and rely on renewable energy sources. Although the proposed Project is a transmission asset condition project, as discussed above, it is also a strategic renewable energy project designed to increase the output and usefulness of renewable generation resources in the SHEI. The IRP specifically identifies the "SHEI Initiative," explains the challenges associated with the SHEI that I have explained above, and discusses an initiative to explore potential steps to address those challenges:

> GMP and other Vermont utilities have formed a working group to address the current problem in this region which adversely affects the generator stakeholders in the SHEI. Collectively, with the assistance of VELCO, we are currently evaluating several options to increase the SHEI limits, many of which were identified and studied in VELCO's Northern Vermont Export Study. The group is evaluating and researching a wide array of options, including traditional transmission projects, battery storage, and demand-side options. The group is focused on cost effectively mitigating current SHEI congestion and providing relief for all affected customers as quickly as possible.

The proposed Project is the result of the work and potential solutions we identified in our IRP. Additionally, GMP's 2018 IRP identifies several objectives that guide our infrastructure investments, including "efficiency," stating that transmission and distribution projects are based, in part on the goal of pursuing projects "for the cost-effective reduction of system losses," including "capacitor placements, line reconductoring, load balancing, circuit reconfiguration, and voltage conversions." As discussed by witness Jones, this project meets this objective as well.

49. Q. Is the proposed Project in compliance with the relevant requirements of the 2016 Vermont Electric Plan (30 V.S.A. § 248(b)(7))?

A. Yes. The Department's 2016 Comprehensive Energy Plan ("CEP") sets ambitious targets for renewable energy and the proposed Project promotes the renewable energy goals of the CEP in several ways. First as explained by Ms. Jones, the Project will address an aging portion of GMP's subtransmission system. The Project will also reduce energy losses on the subtransmission system, which contributes to the financial benefits I discussed earlier and reduces the amount of power that must be generated to meet our customers' electricity needs. By cost-effectively mitigating congestion of the SHEI, the Project will maximize the output of existing renewable sources that deliver energy in the SHEI area, and will maximize the financial value of that generation to Vermont electric customers. Thus, the proposed Project complies with the CEP because it promotes additional output and value from renewable energy sources. In addition to setting ambitious renewable energy targets, the CEP provides that Vermont should, "[p]lan carefully to meet all three tiers of the RES in a least-cost manner," and "strive to lower both energy bills and electric rates." As set forth above, the Project promotes this goal by securing almost $12 million in projected net benefits to Vermont customers by improving the performance of existing renewable generators and therefore comports with the CEP's efforts to achieve renewable goals in a least-cost manner and lower energy bills and electric rates.

In addition, by increasing the SHEI limits the Project (in combination with the other steps I discussed above) will tend to reduce the adverse financial impact of future renewable generation that may be proposed within the SHEI area, and could reduce the scale of solution steps that would be required to accommodate such additional generation. Accordingly, the Project represents a step toward enabling the development of additional renewable energy as contemplated by the CEP, even if it does not eliminate the challenges associated with new generators in this area.

50. Q. Can the Project be served economically by existing or planned transmission facilities without undue adverse effects on Vermont utilities or customers (30 V.S.A. § 248(b)(10))?

A. Yes. The Project will not require expansion of the transmission system in order to be effective. Rather, as discussed in detail above (and in the testimony of GMP witness Jones) the Project is a set of upgrades which will address aging on a significant section of the Vermont subtransmission system, while also reducing the effects of transmission congestion which are presently adversely affecting Vermont utilities and their customers. Not only does the Project have no undue adverse impact on Vermont utilities and customers, it is specifically designed to secure the substantial benefits for customers discussed above.

51. Q. Does this conclude your testimony?

A. Yes, it does.