Attachment 1

Education and Professional Background

Elizabeth R. Nixon

My name is Elizabeth R. Nixon. I am employed as a Utility Analyst with the New Hampshire Public Utilities Commission (PUC). My business address is 21 S. Fruit St., Suite 10, Concord, NH 03301.

I earned a B.S. in Mathematics from the University of Vermont in 1985. I worked for ICF, a consulting firm, where we estimated, modeled, and analyzed the energy, environmental and economic impacts of various emission reduction strategies at electric utilities. At ICF and AER*X, Inc., I assisted companies in implementing market-based emissions trading programs. I provided comments on various air quality programs affecting the electric utilities and other industries in the Northeast and other states. I also worked for the Center for Clean Air Policy where we coordinated a dialogue of states and electric utilities to discuss energy efficiency and other emission control strategies to reduce acid rain and greenhouse gases at electric utilities.

At the New Hampshire Department of Environmental Services, I wrote the air quality permits for Eversource's electric generating facilities as well as other electric generating facilities and manufacturing facilities in NH. I testified before the NH Air Resources Council regarding the determination of the baseline mercury emissions for Eversource's coal-fired electric generating facilities.

I joined the PUC's Sustainable Energy Division in August 2012 where I managed renewable energy incentive programs, determined compliance with the renewable portfolio standard (RPS) program, and conducted analysis of and provided testimony and presentations on

the RPS program and rebate programs. In August 2016, I joined the PUC's Electric Division, where I review the New Hampshire Utilities' benefit-cost analyses and associated assumptions for the energy efficiency programs. I completed electric utility rate training at New Mexico State University's Center for Public Utilities.

Summary of Liberty Utilities and Staff's Benefit-Cost Analyses
of Liberty Utilities Proposed Battery Storage Pilot Program
Utility Cost Test

	Liberty Utilities' Utility Cost Test Benefit-Cost Analysis (NPV) ($ millions)	Staff's Utility Cost Test Benefit-Cost Analysis (NPV) ($ millions)
Benefits		
RNS Costs	$3.8	$2.6
LNS Costs	$0.8	$0.5
Distribution Upgrade Deferral	$0.5	$0.2
Avoided Capacity Costs	NI	$1.3
Customer Contribution	$0.8	NI
Total NPV Benefits	$5.8	$4.6
Costs		
Batteries - Revenue Requirement	($7.2)	($6.8)
Meters - Revenue Requirement	($0.2)	($0.2)
Monthly Meter Reading	($0.2)	($0.2)
Cogsdale Billing Programming Cost	($0.08)	($0.08)
Meter Programming Cost	($0.07)	($0.07)
Total NPV Costs	($7.8)	($7.4)
Total NPV Net Benefits (Costs)	($2.0)	($2.8)
Benefit/Cost Ratio	0.74	0.62

Notes:

NPV of Liberty's Benefit Cost Analysis was conducted using a 10 year period instead of 15 year period for comparison purposes.

Totals may not add due to rounding.

NI = Not Included

Liberty Utilities (Granite State Electric) Corp. d/b/a Liberty Utilities

DE 17-189
Petition to Approve Battery Storage Pilot Program

Staff Data Requests - Set 1

Date Request Received: 2/16/18 Date of Response: 3/9/18
Request No. Staff 1-19 Respondent: Heather Tebbetts

REQUEST:

Refer to the pre-filed Supplemental Testimony of Heather M. Tebbetts, page 4, lines 10-12, stating that "[t]he Tesla batteries provide 5KW and 13.5 kWh of power, about two and a half hours of backup power, which is more than the SAIDI for the rolling 5-year average," and please confirm whether or not this estimate of the back-up power capacity of the Tesla Powerwall 2 battery system is consistent with that promoted in the Green Mountain Power battery program. If not, then please explain the basis for the difference and whether and how that difference may affect customer interest in Liberty's proposed pilot program.

RESPONSE:

Please see Attachment B, page 8, Bates 044, in the supplemental filing for information regarding the capacity and energy of the battery provided by Tesla. The only information from Green Mountain Power that has been publicly provided through a filing to the Vermont Public Utilities Commission is in Attachment Staff 1-19.

Please note the following clarification for the Supplemental Testimony of Heather M. Tebbetts, page 4, lines 10-12. The Tesla batteries provide a maximum of up to 5kW continuous discharge power and 13.5kWh of usable energy. At this rate, the Tesla batteries would provide about two and one-half hours (150 minutes) of backup power. This is above the five-year average outage duration for a Liberty Utilities customer.

The average Liberty Utilities residential customer draws approximately 0.96kW per hour. At this rate, it is expected that the batteries will provide whole home backup for approximately 12 hours. This amount could vary more or less depending on the actual usage by the customer. This amount is comparable to that stated by Green Mountain Power in a filing with the Vermont Public Utilities Commission.

Josh Castonguay, Vice President
Chief Innovation Executive

163 Acorn Lane, Colchster, Vermont 05446
(802)655-8764

July 31, 2017

Electronic and Hand Delivery

Mrs. Judith Whitney, Clerk
Public Utility Commission
112 State Street #4
Montpelier, VT 05620

Re: Tesla Powerwall Grid Transformation Innovative Pilot

Dear Mrs. Whitney:

This letter is to provide notice of Green Mountain Power's Tesla Powerwall Grid Transformation Innovative Pilot (the "Pilot"). Green Mountain Power plans to start offering customers the opportunity to participate in the Pilot after August 15, 2017.

Executive Summary

The Pilot is a first-of-its-kind program that utilizes the Tesla Powerwall 2.0, paired with Tesla's GridLogic software platform, to target a reduction of up to 10 megawatts of peak load, which is the equivalent of taking an average of 7,500 homes off the grid during the peak time. The system will allow customers to store their own energy and power their homes during outages, and when paired with solar, the system can last even longer during a power outage.

What makes this Pilot unique is, under the GridLogic Software platform, GMP will be able to aggregate the 2,000 Powerwalls available in this pilot and use them as a grid resource to directly lower costs for all customers by reducing peak energy demand. We will use the aggregated Powerwalls to:

- Store energy when it is abundant and dispatch it at peak times when it is most expensive, resulting in significant transmission (regional network service) and capacity (capacity supply obligation) savings and other ancillary market revenues that will be split between participating and non-participating customers, like any classic demand response resource;

- Deliver dynamic capacity (energy reserves that can be dispatched when they are needed most) to provide additional grid stability for all GMP customers, especially in areas with significant installation of distributed generation;

- Potentially avoid or reduce the scope of future transmission and distribution-related upgrades and mitigate impacts of high-penetration intermittent resources; and

- Gain operational experience building, operating, and maintaining a control platform that enables aggregated dispatch of thousands of distributed energy resources, preparing us for third-party involvement in energy platforms.

Customers can participate in the Pilot for $15 a month for 10 years or a $1,500 one-time fee. In doing so, they will receive backup power to their home for at least the next 10 years, eliminating the need for traditional, fossil-fuel-fired backup generators. In addition, participating customers will, if applicable receive a Nest smart thermostat, providing further energy savings.

Finally, the Pilot, and GMP's grid transformation activities, are part of our proactive approach to respond to the cost pressures impacting the entire New England region (i.e., declining sales, increasing regional transmission and capacity costs, and increasing net metering cost pressures). Our strategy is to directly confront these external pressures. We are working to reduce our share of transmission and capacity costs via radical peak management that includes, among other things, shared access to devices like the Powerwalls. By dispatching them during peak times in a way that is imperceptible to customers we help lower costs for all customers.

In this way devices like the Powerwalls become both grid and customer assets. They can be used to decrease regional transmission and capacity costs, to generate other revenues from participation in ISO's ancillary services market, to bring in new revenue for non-participating customers, and to increase reliability, both at grid level as well as the home and business level.

Technology Overview

There are two primary components to this Pilot. The first is Tesla's GridLogic platform, and the second is the Tesla Powerwall itself.

GridLogic Energy Management Platform

GridLogic enables the control and aggregation of thousands of Distributed Energy Resourecs (DERs) to provide grid benefits and reduce costs for all GMP customers. The platform offers real-time monitoring, aggregated management, and provides GMP with a user interface to functionally operate individual units or fleets of DERs. Additionally, Tesla will offer services through GridLogic to generate new revenue streams through participation in ISO-NE's:

- ✓ Energy Market;
- ✓ Operating Reserve Market; and
- ✓ Frequency Regulation Market.

As the amount of deployed distributed generation increases, GMP must be proactive in ensuring reliable and stable energy delivery for customers. To do this, GMP will also leverage the GridLogic platform in conjunction with the integrated Powerwall smart inverter to better manage distribution system voltages and power quality. As the grid continues to transition to one that is highly distributed and includes intermittent energy sources, we must continually develop new solutions to maintain and improve on distribution system stability and reliability. To achieve this, we will rely more and more on distributed energy resources that can provide very fast response to fluctuations on the distribution system which require a control platform that can

choreograph all the resources and provide the optimal value depending on the location. As the amount of energy resources continues to grow, the challenge becomes one of scaling up and automating the management of these energy resources to assure the highest, and most efficient, use at any given time. This Pilot, with the support of the team at Tesla, will include the development of algorithms to automatically operate the energy resources to the maximum benefit for customers to drive down costs.

The Powerwall

To effectively utilize GridLogic and test its functionality at scale, GMP will offer the Powerwall 2 to residential customers. The Powerwall 2 is a 13.5 kWh lithium-ion battery that improves upon the previous Powerwall, which had approximately 6.4kWHs of energy storage. The Powerwall 2 is designed for use as a backup power system, and can be coupled with solar, while at the same time, providing a distributed energy resource that can be used by Green Mountain Power as a demand response tool. The Powerwall 2 offers more than double the capacity of the first generation Powerwall. This increase in capacity translates to the ability to provide whole home backup for up to 12 hours and greater value during peak demand events. Customers can choose to install more than one Powerwall 2 and achieve even greater duration for outage events.

Another major improvement in the design of the Powerwall 2 is the addition of an integrated inverter. Rather than a separate external - inverter, the new design of the Powerwall contains an inverter integrated into the battery enclosure. This innovation will make the installation simpler and, if needed, technical support will be easier with Tesla as the point of contact, thus improving the customer expereince.

As always, GMP is focused and committed to safety. The Powerwall 2 makes use of an automatic disconnect that will prevent any backfeeding onto the grid during a power outage.

2, More Details On The Pilot

Under the Pilot, GMP will offer the Powerwall 2 to all customers for a price of $15 per month over a term of 10 years or a one-time payment of $1,500, both of which are exclusive of sales tax. This price will include the Powerwall 2 installed as well as a Nest Thermostat (when applicable) installed. There may be instances where installations are more complex, resulting in costs that are not included in the $15 price. In these cases, the customer will be responsible for the extra costs. The monthly price will remain the same for all customers.

The Powerwall 2 enables whole or partial home backup power as well as solar PV integration. It will provide multiple hours of backup, and allow items like well pumps and heat pumps to be included. Each Powerwall will come with Tesla's standard 10-year battery system warranty. Additionally, customers electing to have a Powerwall installed will have access to the Tesla smart phone app that enables users to monitor the Powerwall, and if applicable, monitor and manage other Tesla products.

Customers participating in the Pilot will share access to the Powerwall with GMP. In addition to the uses described above, GridLogic will enable the use of the Powerwalls in ISO-NE markets. This will provide greater value for all GMP customers, including those that do not participate in a program like this. Shared access for these purposes are also implicit with participation in the Pilot.

Recognizing that shared access of the Powerwall for the purpose of improving the efficiency of the electricity grid may increase customers' electricity bills due to efficiency losses from charging and subsequently discharging the batteries, GMP will credit participating customers an amount equivalent to the estimated amount of those losses. This amount approximates the value of the energy lost due to the cycling of the battery and will depend on how often the batteries are being charged and discharged. Additionally, during a discharge event for a peak demand reduction, if energy flows back onto the distribution system, the customer's account will net out the energy flowing back to the grid against the energy flowing into the home to assure the customer remains whole for energy cycling.

Measurement & Verification

Measurement and verification is a key component of this Pilot to test the assumptions made regarding benefits to the grid and savings to customers – both those participating in the Pilot and those not participating. To that end, Tesla will provide measurement and verification of GridLogic's effectiveness dispatching the DERs. GridLogic will report the available capacity for grid services, monitor which resources are sent dispatch signals, and most importantly, provide the total capacity and energy of the DERs for each event that is called.

Ensuring that the resources are actually realizing the expected value for GMP customers, Tesla has agreed to a performance guarantee that effectively states if the GridLogic system fails to meet expectations in reducing peak costs, GMP customers will be made financially whole.

Timing and Scope

Beginning in August, GMP and Tesla will begin customer signups, with installations expected to begin in September. The partnership between GMP and Tesla targets 2,000 Powerwall installations over the course of the next 12 months.

The Pilot Advances State Energy Goals

The Grid Transformation offering will help advance state energy goals. First, the Powerwall provides a clean alternative backup power solution for customers that would otherwise rely on a fossil-fuel generator. The Technical Advisory Group ('TAG') has characterized a Powerwall Tier III value at 1.4 MWHs and a NEST smart thermostat at 8.7MWHs each. Second, the Powerwall represents an innovative, dispatchable resource that can be used during peak periods to help reduce GMP's power supply costs, which lowers costs for customers. Third, the Powerwall can aid in the significant development of distributed energy resources called for under Act 56, the Vermont Renewable Energy Standard ("RES") enacted in

2015. Specifically, dispatch control of the Powerwall can be used to help smooth grid impacts caused by a high penetration of solar energy, potentially avoiding more expensive, traditional grid upgrades.

Summary of Projected Costs and Revenues

GMP's O&M costs will be limited due to the partnership of Tesla's workforce in this Pilot. Tesla will be responsible for enrolling customers for participation in the Pilot and all aspects of design, site review and installation, including paying for all marketing materials. Tesla will also be responsible for scheduling and completing installation of the Powerwall and the Nest Thermostat (when applicable). GMP will conduct wrap-around quality assurance with customers throughout the installation process. This pilot provides significant value to 'non-participating' customers through revenues and power supply cost reductions. This pilot will provide over $2.3M of net present value benefits to non-participating customers. In addition to the benefits modeled, GMP will be utilizing these resources in ancillary markets such as Frequency Regulation. Any benefits realized in these markets will flow directly to non-participating customers. We have not yet financially modeled these benefits, as we are continuing to work through the technical requirements of behind the meter battery aggregation with ISO-New England and therefore, any revenues received will only increase the NPV to non-participating customers.

See Appendix A for the detailed Financial Summary.

Efficiency Vermont Non-Conflict and Collaboration Certification

By this filing, GMP certifies that the Grid Transformation Pilot does not conflict with work being performed by Efficiency Vermont. GMP has discussed the scope and objectives of this pilot with Efficiency Vermont and Efficiency Vermont is supportive of the Pilot.

1. **Status Updates**

GMP proposes to provide status updates to the Commission regarding the Grid Transformation Pilot's progress on a nine-month basis until the Pilot expires in 18 months. In the event GMP decides to terminate the Pilot prior to the passage of 18 months, it will provide prompt notice to the Commission and the Department. GMP will be tracking a number of metrics to confirm the overall effectiveness of the program, including:

- Once a Powerwall is installed, GMP will call the customer to ensure that their experience with installation was positive, and capture any customer feedback that can be utilized to improve the program.
- In the event of a customer outage, confirming that the Powerwall performed as required in back-up mode.
- Tesla will provide the data necessary to show that the use of the Powerwalls has been successful in reducing GMP peak demands.
- GMP and Tesla will hold weekly conference calls to evaluate and improve processes when where necessary.

- GMP's ability to dispatch 2,000 Powerwall units in an automated fashion with minimal manual intervention.

If you should have any questions, please contact me at (802) 324-8359.

Sincerely,

Josh Castonguay,
VP Chief Innovation Executive
cc: James Porter; Public Service Department
Barry Murphy; Public Service Department
Karen Glitman; Efficiency Vermont

GREEN MOUNTAIN POWER
Generating Possibilities Together
Josh Castonguay, Vice President
Chief Innovation Executive

163 Acorn Lane, Colchster, Vermont 05446
(802)655-8764

Year	1	2	3	4	5	6	7	8
Benefits (Revenue)								
RNS	$ 849,728	$ 890,392	$ 933,281	$ 969,557	$ 987,752	$ 1,003,486	$ 1,019,928	$ 1,036,609
FCM	$ -	$ 710,414	$ 583,450	$ 587,339	$ 599,086	$ 627,125	$ 692,257	$ 768,554
ISO NE Day Ahead Energy	$ -	$ 243,159	$ 229,866	$ 224,079	$ 218,247	$ 212,310	$ 207,098	$ 201,839
ISO NE Operating Reserve	$ -	$ 160,959	$ 160,429	$ 160,272	$ 160,066	$ 159,975	$ 159,882	$ 159,845
ISO NE Frequency Reg	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Customer Payments	$ 381,600	$ 381,600	$ 381,600	$ 381,600	$ 381,600	$ 381,600	$ 381,600	$ 381,600
Total Benefits	$ 1,231,328	$ 2,386,524	$ 2,288,626	$ 2,322,846	$ 2,346,751	$ 2,384,496	$ 2,460,766	$ 2,548,447
Costs								
Program Costs (Make-whole, Software)	($34,100)	($94,816)	($90,895)	($89,772)	($88,639)	($87,505)	($86,511)	($85,518)
Revenue Requirement	($3,795,113)	($2,848,230)	($2,618,308)	($2,427,054)	($2,263,513)	($2,111,572)	($1,959,631)	($1,821,868)
Total Costs	($3,829,213)	($2,943,046)	($2,709,203)	($2,516,827)	($2,352,152)	($2,199,077)	($2,046,142)	($1,907,386)
Net Benefit to Non-Particpating Customers	**($2,597,886)**	**($556,522)**	**($420,577)**	**($193,981)**	**($5,401)**	**$185,420**	**$414,624**	**$641,061**

Year	9	10	11	12	13	14	15	Total
Benefits (Revenue)								
RNS	$ 1,051,758	$ 1,066,797	$ 1,041,773	$ 950,732	$ 794,860	$ 559,568	$ 249,551	$ 8,872,062
FCM	$ 848,593	$ 931,670	$ 989,397	$ 957,122	$ 818,995	$ 600,281	$ 298,233	$ 6,203,510
ISO NE Day Ahead Energy	$ 196,153	$ 190,385	$ 178,389	$ 156,078	$ 124,785	$ 84,013	$ 37,863	$ 1,667,271
ISO NE Operating Reserve	$ 159,755	$ 159,705	$ 153,618	$ 138,042	$ 113,659	$ 78,780	$ 34,728	$ 1,278,045
ISO NE Frequency Reg	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Customer Payments	$ 381,600	$ 381,600	$ -	$ -	$ -	$ -	$ -	$ 2,805,827
Total Benefits	$ 2,637,858	$ 2,730,157	$ 2,363,177	$ 2,201,973	$ 1,852,299	$ 1,322,642	$ 620,376	$ 20,826,715
Costs								
Program Costs (Make-whole, Software)	($84,513)	($83,506)	($70,142)	($31,774)	($30,890)	($30,005)	($29,070)	($691,520)
Revenue Requirement	($1,712,784)	($1,618,201)	$0	$0	$0	$0	$0	($17,764,627)
Total Costs	($1,797,297)	($1,701,707)	($70,142)	($31,774)	($30,890)	($30,005)	($29,070)	($18,456,147)
Net Benefit to Non-Particpating Customers	**$840,561**	**$1,028,450**	**$2,293,035**	**$2,170,199**	**$1,821,409**	**$1,292,637**	**$591,306**	**$2,370,568**

Staff's Benefit/Cost Analysis - Utility Cost Test
Liberty Utilities (Granite State Electric) d/b/a Liberty Utilities Proposed Battery Pilot Project
75% success rate (2019-2022), 50% success rate (2023-2028)
Cellular Based Metering

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	
1	Year	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	
2	Batteries Installed	1,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3	#Batteries with Upfront Contribution	100															
4	#Batteries with Monthly Contribution	900	900	900	900	900	900	900	900	900	900						
	Benefits																**Total**
5	Regional Network System (RNS) rate ($/kW-year)	$128.00	$133.00	$137.00	$137.00	$138.37	$138.37	$138.37	$138.37	$138.37	$138.37						
6	Local Network System (LNS) rate($/kW-year)	$26.04	$27.03	$27.81	$28.09	$28.09	$28.09	$28.09	$28.09	$28.09	$28.09						
7	Avoided Capacity Cost rate ($/kW-year)	$100.00	$73.90	$59.90	$57.60	$58.80	$61.20	$65.70	$71.20	$76.90	$82.50						
8	Regional Network System (RNS) Charges	$458,400	$476,306	$490,631	$490,631	$345,925	$345,925	$345,925	$345,925	$345,925	$345,925						**$3,991,519**
9	Local Network System (LNS) Charges	$93,256	$96,801	$99,595	$100,597	$70,225	$70,225	$70,225	$70,225	$70,225	$70,225						**$811,599**
10	Distribution Circuit Upgrades (Rev Req)	$0	$96,101	$92,889	$89,797												**$278,787**
11	Avoided Capacity Costs	$307,500	$227,243	$184,193	$177,120	$147,000	$153,000	$164,250	$178,000	$192,250	$206,250						**$1,936,805**
12	Total Benefits	$859,156	$896,451	$867,308	$858,146	$563,150	$569,150	$580,400	$594,150	$608,400	$622,400	$0	$0	$0	$0	$0	**$7,018,710**
	Costs																
13	Revenue Requirement - Batteries	($1,508,497)	($1,369,028)	($1,246,774)	($1,136,819)	($1,035,619)	($934,445)	($833,245)	($743,040)	($663,804)	($584,568)	$0	$0	$0	$0	$0	**($10,055,839)**
14	Revenue Requirement - Cell Based Meters	($43,873)	($42,023)	($40,220)	($38,461)	($36,743)	($35,062)	($33,415)	($31,801)	($30,191)	($28,582)						**($360,372)**
15	Monthly Cellular Reading Cost	($36,000)	($36,000)	($36,000)	($36,000)	($36,000)	($36,000)	($36,000)	($36,000)	($36,000)	($36,000)						**($360,000)**
16	Cogsdale Programming Costs	($92,290)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	**($92,290)**
17	Meter MV-90 Programming Costs	($80,000)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	**($80,000)**
18	Total Costs	($1,760,660)	($1,447,051)	($1,322,995)	($1,211,280)	($1,108,362)	($1,005,506)	($902,660)	($810,840)	($729,995)	($649,150)	$0	$0	$0	$0	$0	($10,948,501)
19	Net Benefit to All Customers	($901,505)	($550,600)	($455,687)	($353,135)	($545,212)	($436,356)	($322,260)	($216,690)	($121,595)	($26,750)	$0	$0	$0	$0	$0	**($3,929,791)**

Net Present Value Calculation

20	Required Rate of Return	9.40%
21	Net Present Value of Option	($2,823,624)
22	Net Present Value of Benefits	$4,610,781
23	Net Present Value of Costs	($7,434,405)

NPV

Benefits		
	RNS	$2,604,793
	LNS	$529,751
	Dist Upgrade Deferral	$213,930
	Avoided Capacity Costs	$1,262,306
		$4,610,781
Costs		
	Rev Req - Batteris	($6,814,802)
	Rev Requ - Meters	($235,090)
	Monthly Meter Reading Cos	($227,026)
	Cogsdale Program Costs	($84,360)
	Meter Program Costs	($73,126)
		($7,434,405)
Net Benefit (Cost)		($2,823,624)

1 Year of installation
2 Total units in pilot
3 Number of Units paying upfront
4 (2) - (3)
5 Based on Liberty Utilities projection
6 Based on Liberty Utilities projection
7 AESC 2018 Wholesale Capacity Values Cleared (FCA price), column j on p 273
8 (5)x amount of kW reduced
9 (6)x amount of kW reduced
10 Deferral of distribution upgrade revenue requirement
11 (9)xamount of kW reduced at ISO NE concident peak
12 (8)+(9)+(10)+(11)
13 Battery revenue requirement
14 Meter revenue requirement
15 Liberty's estimated costs for reading meters
16 Liberty's estimated programming costs associated with billing TOU rates
17 Liberty's estimated programming costs associated with reading cellular meters
18 (13)+(14)+(15)+(16)+(17)
19 (12)-(18)
20 Required rate of return or discount factor used for NPV
21 Net Present Value calculation of net benefits using discount rate in Line (20) and net benefits (or costs) in line (19)
22 Net Present Value calculation of benefits using discount rate in Line (20) and benefits in line (12)
23 Net Present Value calculation of costs using discount rate in Line (20) and costs in line (18)

Summary of Assumptions for the Benefit-Cost Analyses Conducted by Liberty Utilities and Staff on Liberty Utilities Proposed Battery Storage Pilot Program

<table>
<tr><th>Assumption</th><th>Liberty Utilities</th><th>Staff</th></tr>
<tr><td>Benefits</td><td></td><td></td></tr>
<tr><td>RNS rate</td><td>
<table>
<tr><th></th><th>RNS rate (kW-year)</th></tr>
<tr><td>2019</td><td>128.00</td></tr>
<tr><td>2020</td><td>133.00</td></tr>
<tr><td>2021</td><td>137.00</td></tr>
<tr><td>2022</td><td>137.00</td></tr>
<tr><td>2023-2033</td><td>138.37</td></tr>
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<tr><td>2023-2033</td><td>138.37</td></tr>
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<tr><td>LNS rate</td><td>
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<tr><th></th><th>LNS rate (kW-year)</th></tr>
<tr><td>2019</td><td>$26.04</td></tr>
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</table>
</td></tr>
<tr><td>kW reduced to meet RNS and LNS</td><td>5000 kW in first year then 3% degradation each year</td><td>Non-NWA batteries
5 kW for 700 batteries; 75% success rate for 2019-2022: 2625 kW
5 kW for 700 batteries; 50% success rate for 2023-2028: 1750 kW

NWA batteries
1.5 kW for 300 batteries; 100% success rate for 2019-2022 for June, July, Aug: 450 kW
5 kW for 300 batteries; 75% success rate for 2019-2022 for all other months: 1125 kW

5 kW for 300 batteries; 50% success rate for2023 -2028: 750 kW

(See Mr. Kurt Demmer’s testimony.)</td></tr>
<tr><td>kW reduced to meet avoided capacity cost</td><td>Not Included</td><td>For 2019-2022: 3075 kW
For 2023-2028: 2500 kW</td></tr>
<tr><td>Distribution Upgrade Deferral</td><td>Assumed to defer for 15 years starting in 2020</td><td>Assumed to only defer for 3 years starting in 2020 through 2022 because batteries will not be able to meet the violations for the requisite timeframe after degradation. (See Mr. Kurt Demmer’s testimony.)</td></tr>
</table>

Assumption	Liberty Utilities	Staff
Avoided Capacity Costs	Not Included	See AESC 2018[1] p. 273, column j, Wholesale Capacity Values Clear (FCA Price).
Customer Contribution	$208,000 in first year with $100,000 from 100 customers paying $1000 upfront plus $108,000 from 900 customers paying $10/month for 10 years.	Accounted for in battery revenue requirements calculation
Costs		
Battery Revenue Requirement	Initial capital of $7,192,000	Initial capital of $7,200,000 ($7,300,000 – $100,000 upfront payment of 1000 from 100 customers). Reduced rate base by the accumulated capital contribution of $108,000 each year from the $10 monthly payment from 900 customers (For the TRC, assumed initial capital cost of $7,300,000 and did not use revenue requirement.)
Meter Revenue Requirement	Initial capital of $255,600 = 600 meters x $426/meter	Initial capital of $255,600 = 600 meters x $426/meter (For the TRC, assumed initial capital cost of $255,600 and did not use revenue requirement.)
Customer Battery Cost	Not Included	Not included in the UCT, but included in TRC with $100,000 in first year for payment upfront of $1000 by 100 customers and $108,000 for $10 monthly payment each year by 900 customers
Monthly cellular reading cost	$36,000 per year	$36,000 per year
Cogsdale billing system programming cost	$92,200 in first year	$92,200 in first year
Meter programming cost	$80,000 in first year	$80,000 in first year
General		
Years of Analysis	15 years[2]	10 years
Discount Rate	9.40%	9.40%

[1] http://www.puc.nh.gov/Electric/Monitoring%20and%20Evaluation%20Reports/AESC%202018.pdf
[2] For comparison purposes, Staff evaluated Liberty's benefit-cost analysis over a 10-year period.

Summary of Staff's Benefit-Cost Analyses using Total Resource Cost Test
of Liberty Utilities Proposed Battery Storage Pilot Program

	Staff's Total Resource Cost Test Benefit-Cost Analysis (NPV) 2.4% discount rate ($ millions)	Staff's Total Resource Cost Test Benefit-Cost Analysis (NPV) 9.4% discount rate ($ millions)
Benefits		
RNS Costs	$3.5	$2.6
LNS Costs	$0.7	$0.5
Distribution Upgrade Deferral	$0.3	$0.2
Avoided Capacity Costs	$1.7	$1.3
Customer Savings	NQ	NQ
Total NPV Benefits	$6.2	$4.6
Costs		
Batteries Capital Cost	($7.3)	($7.3)
Meters Capital Cost	($0.3)	($0.3)
NPV of Monthly Meter Reading	($0.3)	($0.3)
Cogsdale Billing Programming Cost	($0.09)	($0.09)
Meter Programming Cost	($0.08)	($0.08)
Total NPV Costs	($8.0)	($8.0)
Total NPV Net Benefits (Costs)	($1.8)	($3.3)
Benefit/Cost Ratio	0.78	0.58

Notes:

Totals may not add due to rounding.

NQ = Not Quantified