



**STATE OF NEW HAMPSHIRE  
BEFORE THE  
PUBLIC UTILITIES COMMISSION**

Docket No. DE 19-064

Liberty Utilities (Granite State Electric) Corp. d/b/a Liberty Utilities  
Distribution Service Rate Case

**DIRECT TESTIMONY**

**OF**

**MELISSA F. BARTOS**

April 30, 2019

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1 **I. INTRODUCTION**

2 **Q. Please state your name, address, employer, position, and professional qualifications.**

3 A. My name is Melissa F. Bartos. I am an Assistant Vice President with Concentric Energy  
 4 Advisors, 293 Boston Post Road West, Suite 500, Marlborough, Massachusetts. My  
 5 professional qualifications and experience have been provided in Attachment MFB-11.

6 **II. SCOPE OF TESTIMONY**

7 **Q. What is your responsibility in this proceeding?**

8 A. In this proceeding I am responsible for preparing the Marginal Cost Study for Liberty  
 9 Utilities (Granite State Electric) Corp. d/b/a Liberty Utilities (“Granite State” or “the  
 10 Company”).

11 **Q. Please summarize your testimony concerning the Marginal Cost Study.**

12 A. I have prepared a Marginal Cost Study (“MCS”), which is contained in Attachments  
 13 MFB-1 through MFB-10. The marginal costs that I have calculated are derived from data  
 14 and special studies obtained from the Company.

15 As also shown on Attachment MFB-10, the estimated annual marginal distribution costs  
 16 by rate class are summarized in Table 1 below.

17 **Table 1: Total Marginal Costs by Rate Class (\$000)**

	D	D-10	G-1	G-2	G-3	M	T	V	Total
Customer	\$ 13,596	\$ 209	\$ 145	\$ 674	\$ 3,215	\$ -	\$ 397	\$ 8	\$ 18,246
Capacity	\$ 8,385	\$ 114	\$ 8,180	\$ 4,663	\$ 2,954	\$ -	\$ 281	\$ 10	\$ 24,588
Lighting	-	-	-	-	-	\$ 609	-	-	\$ 609
<b>Total</b>	<b>\$ 21,981</b>	<b>\$ 323</b>	<b>\$ 8,326</b>	<b>\$ 5,338</b>	<b>\$ 6,169</b>	<b>\$ 609</b>	<b>\$ 679</b>	<b>\$18</b>	<b>\$ 43,443</b>
	50.60%	0.74%	19.16%	12.29%	14.20%	1.40%	1.56%	0.04%	100.00%

1 **III. MARGINAL COST STUDY**

2 **A. Economic Theory and Marginal Costs**

3 **Q. Please provide an economist's view of marginal cost.**

4 A. "Marginal Cost" is an economic concept; it is a measure of the additional cost that a firm  
5 incurs to provide an additional unit of a good or a service. A well-established principle  
6 of economic theory is that the price of a good that is sold in a perfectly competitive  
7 market will be set at the marginal cost to produce that good. It is a further well-  
8 established principle of economic theory that the best allocation of resources will occur,  
9 and the best consumption decisions will be made, in an economy in which the prices of  
10 goods are set at marginal costs.

11 It has been the Commission's rate-design policy and precedent since the mid-1980s to  
12 apply the concepts of marginal cost pricing in a rate case (a) to determine the share of  
13 total rate case revenue requirement for which each rate class is responsible, and (b) to set  
14 base distribution rates to promote appropriate price signals and, therefore, proper energy  
15 consumption decisions. The basis for the Company's current allocation of revenue  
16 requirement to classes, rate design, and current rate classifications was approved by the  
17 Commission in Order No. 26,005 (April 12, 2017) in the Company's 2016 rate case  
18 filing, Docket No. DE 16-383.

1 **Q. Although the allocation methodology was approved in that proceeding, did the**  
2 **Commission Staff (“Staff”) express any concerns with the methodology?**

3 A. Yes. In that proceeding, Staff questioned the extent to which the Company’s marginal  
4 cost study relied on three year historical average costs rather than the results of regression  
5 analyses.

6 **Q. Did the Company commit in the Settlement Agreement in DE 16-383 to meet with**  
7 **Staff and the Office of the Consumer Advocate (“OCA”) to discuss the marginal**  
8 **cost study methodology before Liberty’s next rate case?**

9 A. Yes.

10 **Q. Are you aware if such a meeting took place and, if so, did you participate in the**  
11 **meeting?**

12 A. Yes. A teleconference was held on January 30, 2019, in which I participated along with  
13 representatives of the Company, Staff, and the OCA. During that meeting, Staff’s  
14 concerns related to the marginal cost study filed in DE 16-383 were reviewed.

15 **Q. Have you addressed those concerns in this current marginal cost study?**

16 A. Yes. While the marginal cost study filed in DE 16-383 used three year historical average  
17 costs for 11 out of 14 cost categories because the results of the regression analyses were  
18 not considered to be reasonable, in this marginal cost study regression analyses were used  
19 for all 14 cost categories, as described in more detail below.

1                   **B. Marginal Cost Study Methodology**

2                   **1. Overview**

3   **Q. Please describe the components of the Company’s marginal costs that you**  
4   **estimated.**

5   A. I prepared calculations and analyses to estimate the marginal Distribution Function-  
6   related costs that the Company would incur to serve (a) additional demand when the  
7   Company is experiencing peak conditions, and (b) additional customers. In general  
8   terms, to estimate the costs that the Company would incur to serve additional peak  
9   demand, I calculated (1) the additional capacity-related distribution plant costs, and (2)  
10   the additional Operations and Maintenance (“O&M”) costs that would be caused by an  
11   increment to peak demand. I also calculated (3) the additional general plant-related costs  
12   associated with the additions to capacity-related distribution plant, (4) the additional  
13   Administrative and General (“A&G”) expenses associated with the additional O&M  
14   expenses, and (5) the additional materials and supplies (“M&S”) and prepayment costs  
15   associated with the additional plant. Lastly, I calculated additional factors to account for  
16   the effects of bad debt and working capital on the calculated marginal costs.

17   **Q. Please describe the data used to develop your estimates of the Company’s marginal**  
18   **costs.**

19   A. The Company provided Concentric with (a) distribution plant and general plant balances  
20   and (b) distribution, customer, customer accounting, A&G, and Materials and Supplies  
21   and Prepayments Expenses, for the period 1997 to the present. In addition, the Company

1 provided Concentric with historical system peak, normalized peak, and customer count  
2 data for the years 2000 to the present.<sup>1</sup>

3 **Q. Please describe each new data series that you created using data that the Company**  
4 **provided.**

5 A. I created the following types of new data series:

- 6 1. I adjusted the Company's data using an appropriate price index. I used a Handy-  
7 Whitman index to restate plant additions in 2018 constant dollars, and I used the  
8 Implicit Price Deflator for Gross Domestic Product, published by Bureau of  
9 Economic Analysis, to restate expenses in constant 2018 dollars.
- 10 2. The Company provided two separate analyses that were used to (1) identify the  
11 amount of the capacity-related distribution plant additions related to growth, and  
12 (2) classify the growth-related plant additions as being related to either the  
13 primary distribution system, secondary distribution system, or line transformers.
- 14 3. The Company provided an analysis of expense accounts that was used to  
15 functionalize distribution Operations expenses and Maintenance expenses as  
16 either capacity-related or customer-related, and also to classify the capacity-  
17 related expenses as being related to either the primary distribution system,  
18 secondary distribution system, or line transformers.

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<sup>1</sup> The historical data for a few of the data series was obtained from SNL Financial, which compiles historical FERC Form 1 data.

1 **Q. Please describe the primary types of analysis that you used to calculate the**  
2 **components of marginal cost.**

3 A. For many of the marginal cost components, I used a statistical process for estimating the  
4 relationship between a specific “Cost Variable” (i.e., measure of costs)<sup>2</sup> and a specific  
5 “Cost Driver” variable.<sup>3</sup> The general form of the regression equations that I estimated is  
6 as follows<sup>4</sup>:

7 
$$\text{Cost Variable} = a + b \times \text{Cost Driver variable}$$

8 Regression analyses are often used to estimate components of marginal costs because the  
9 regression coefficient, the term “b” in the equation above, sometimes referred to as the  
10 slope of the equation, is the estimated marginal cost of the Cost Variable that is  
11 associated with a small change in the Cost Driver variable.<sup>5</sup>

12 **Q. Please describe the general approach used in performing the marginal cost study**  
13 **regression analyses.**

14 A. I reviewed the regression equations that I developed to ensure that the estimates were  
15 reasonable and that they did not violate important statistical requirements.

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<sup>2</sup> Some of the Cost Variables that I used include capacity-related distribution plant, customer-related O&M expense, and A&G Expense.

<sup>3</sup> Some of the “Cost Driver” variables that I used include normalized peak demand and number of customers.

<sup>4</sup> This is a simplified version of the regression equations that were estimated. Each of the regression equations that are provided in Attachments MFB-MCS-1, 4, 5, and 6 may include more than one cost driver and/or dummy variables.

<sup>5</sup> The term “a” is the intercept of the equation. It is the level of the Cost Variable that is constant, regardless of the level of the Cost Driver variable.

1 Specifically, I tested each equation to ensure that there is no statistically significant level  
2 of autocorrelation in the regression equation. Autocorrelation is a violation of the  
3 requirements of regression analysis,<sup>6</sup> which, if not corrected, would inappropriately affect  
4 the regression statistics. The statistical software that I used, SPSS, can identify and  
5 correct for autocorrelation.

6 I also tested each equation to look for “structural shifts,” which are changes in the  
7 relationship between the Cost Variable and Cost Driver variable starting in a specific year  
8 and continuing for a number of years. I specifically looked for structural shifts that might  
9 have been related to the 2012 acquisition of Granite State by Liberty. If I determined that  
10 there was a structural shift, I tested additional regression equations that allowed the slope  
11 and intercept terms to be different for the time periods before and after the time of the  
12 structural shift. If a regression equation with terms addressing the structural shift was  
13 superior to other regression equations, I used the slope coefficient of the structural shift  
14 regression equation as the marginal cost estimate.

15 **Q. What criteria did you use to accept or reject a regression equation?**

16 A. To assess whether a regression equation provided a reliable estimate of the marginal cost  
17 component, I reviewed the regression equation statistics. Specifically, I reviewed:

- 18 • The reasonableness of the regression equation results. I considered that an  
19 equation was reasonable if the slope coefficient had the “right sign”<sup>7</sup> and was the

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<sup>6</sup> Autocorrelation is a violation of the assumption that the regression equation error terms are uncorrelated. In the presence of autocorrelation, the regression does not produce Best Linear Unbiased Estimates.

<sup>7</sup> The slope coefficient is the “right” sign if the coefficient is positive. A negative slope would mean, for example, that as peak demand increased, capacity related distribution plant additions would decrease.

1 “right size.”<sup>8</sup>

- 2 • The explanatory power of the regression equation as a whole, as measured by the
- 3 R-squared statistic.
- 4 • The explanatory power of the slope coefficient, as well as other variables included
- 5 in the model, as measured by the t statistic.

6 **C. Marginal Cost Study Results**

7 **1. Overview**

8 **Q. Please describe how you have organized the marginal cost study.**

9 A. The schedules that make up the Marginal Cost Study are provided in the List of  
 10 Attachments. Table 2 provides a summary of the Marginal Cost Study schedules.

11 **Table 2: Summary of Marginal Cost Study Schedules**

<b>Attachment</b>	<b>Pages</b>	<b>Topics</b>
MFB-1	1–3	Calculation of marginal Capacity-related Plant Additions
MFB-2	1	Calculation of marginal Customer-related Plant Additions
MFB-3	1–5	Calculation of marginal cost of Outdoor Lighting
MFB-4	1–6	Calculation of marginal Distribution Capacity-related Expenses
MFB-5	1–5	Calculation of marginal Customer-related Expenses
MFB-6	1–3	Development of loading factors
MFB-7	1–13	Calculation of Levelized Fixed Charge Rates
MFB-8	1–3	Summary of Marginal Capacity Costs
MFB-9	1	Summary of Marginal Customer Costs
MFB-10	1	Summary of Marginal Cost Estimates

12

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<sup>8</sup> The “right size” is a subjective test to ensure that the slope coefficient is not implausibly large or small.

1                   **2. Marginal Distribution Capacity-related Plant Addition Costs**

2   **Q. Please explain how you prepared regression analyses to estimate the marginal cost**  
3   **of capacity-related distribution plant additions attributed to growth.**

4   A. I prepared regression analyses to estimate the statistical relationship between normalized  
5   peak demand and the following types of growth-related distribution plant addition costs:  
6   (1) capacity-related primary distribution plant additions, (2) capacity-related secondary  
7   distribution plant additions, and (3) capacity-related line transformer plant additions. The  
8   regression results are located on Attachment MFB-1, pages 1 through 3.

9   **Q. In summary, what is the marginal cost of distribution capacity-related plant**  
10   **additions attributed to growth?**

11   A. The total marginal cost of distribution capacity-related plant additions attributed to  
12   growth is summarized in Table 3 below.

13                   **Table 3: Marginal Cost of Distribution Capacity-related Plant Additions**

<b>Marginal Plant additions Component</b>	<b>\$ per MW</b>	<b>Source</b>
Primary	\$115,690	MFB-1 page 1
Secondary	\$82,116	MFB-1 page 2
Line Transformers	\$84,022	MFB-1 page 3
Total cost of Marginal Plant additions	\$281,828	

14

**3. Marginal Customer-related Plant Addition Costs**

**Q. Please explain how you estimated marginal Customer-related plant addition costs.**

A. Marginal Customer-related plant addition costs measure the marginal cost to connect a customer, which includes the current installed cost of a meter and a service. Because the cost of a meter and a service is generally correlated with the size of the customer, I asked the Company to provide an analysis of the current installed cost of a meter and installed cost of a service that is typical for each rate class. The customer-related plant additions analysis is provided in Attachment MFB-2.

**Q. In summary, what is the marginal cost of customer-related plant additions?**

A. The total marginal cost of customer-related plant additions is summarized in Table 4 below.

**Table 4: Marginal Cost of Customer-Related Plant Additions**

	<b>D</b>	<b>D-10</b>	<b>G-1</b>	<b>G-2</b>	<b>G-3</b>	<b>T</b>	<b>V</b>
Service	\$693.29	\$693.29	\$ 759.17	\$759.17	\$ 693.29	\$693.29	\$ 693.29
Meter	\$105.00	\$360.20	\$1,605.00	\$900.80	\$ 630.20	\$195.20	\$ 290.20
Total	\$798.29	\$1,053.49	\$2,364.17	\$1,659.97	\$1,323.49	\$888.49	\$983.49

Source: MFB-2, Page 1, Lines 4, 8, 9

**4. Marginal Outdoor Lighting Costs**

**Q. Please explain how you estimated the total Marginal Cost of Outdoor Lighting.**

A. Marginal outdoor lighting costs measure the marginal cost to provide service to outdoor lighting customers, which includes the current installed costs of the luminaire and of the pole and accessories. Because the cost of a luminaire and of a pole is dependent on the size and type of luminaire and pole that is installed, I asked the Company to provide an

1 analysis of the current installed cost for each size and type of (a) luminaire, and (b) pole  
2 and accessory listed in the Company's tariff. The Company's analysis is provided in  
3 Attachment MFB-3.

4 I estimated the total marginal cost for outdoor lighting by applying the fixed carrying  
5 charge rate (as discussed below) to the marginal cost for each size and type of (a)  
6 luminaire, and (b) pole and accessory to develop a levelized annual cost, which was then  
7 adjusted for inflation. The calculated levelized annual costs were multiplied by the total  
8 number of luminaires and poles and accessories by size and type to arrive at a total  
9 marginal cost for outdoor lighting, which is provided in Attachment MFB-3, pages 1  
10 through 5.

11 **5. Marginal Distribution Capacity-related Operations and Maintenance**  
12 **Expense**

13 **Q. Please explain how you estimated the Marginal Cost of Capacity-related**  
14 **Distribution Operations and Maintenance Expense.**

15 A. I prepared six regression analyses to estimate the statistical relationship between  
16 normalized peak demand and the following types of capacity-related distribution  
17 operations and maintenance expense: (1) primary operations expense, (2) secondary  
18 operations expense, (3) line transformers operations expense, (4) primary maintenance  
19 expense, (5) secondary maintenance expense, and (6) line transformers maintenance  
20 expense. The regression results are summarized on Attachment MFB-4, pages 1 through  
21 6.

1                   **6. Marginal Customer-related Operations and Maintenance Expense**

2   **Q.    Please explain how you estimated Marginal Customer-related Distribution**  
3   **Operations and Maintenance Expenses.**

4   A.    I prepared a regression analysis to estimate the statistical relationship between (a) the  
5   customer-related distribution operations and maintenance expense associated with  
6   operating and maintaining customer meters and services, and (b) the number of annual  
7   customers based on historical data that the Company provided. The regression results are  
8   summarized on Attachment MFB-5, page 1.

9           I prepared an additional analysis, which is provided in Attachment MFB-5, page 2, to  
10   allocate the customer-related O&M expense to rate classes in a way that reflects that the  
11   cost to maintain meters and services is related to the size of the meter and service, which  
12   varies by rate class. As shown in Attachment MFB-5, page 2 column (C), the marginal  
13   customer-related O&M expense was allocated to rate classes based on the marginal  
14   service and meter plant per customer, from Attachment MFB-2, page 1. The results of  
15   this allocation process are shown in Attachment MFB-5, page 2 column (G).

16                   **7. Marginal Customer Accounting Expenses**

17   **Q.    Please explain how you estimated Marginal Customer Accounting Expenses.**

18   A.    I prepared a regression analysis to estimate the statistical relationship between (a)  
19   customer accounting expenses, excluding bad debt expense, and (b) the number of annual  
20   customers, based on historical data that the Company provided. The regression results  
21   are summarized on Attachment MFB-5, page 3.

1 I prepared an additional analysis, which is provided in Attachment MFB-5, page 4, where  
2 the Company provided the relative weighting factors for each rate class to allocate the  
3 customer accounting expenses. The results of this allocation process are shown in  
4 Attachment MFB-5, page 4 column (F).

5 Lastly, I prepared Attachment MFB-5, page 5, to calculate the pro forma bad debt  
6 expense rate by rate class, based on data provided by the Company.

## 7 **8. Marginal Loading Factors and Adjustment Factors**

8 **Q. Please explain how you estimated Marginal Loading Factors.**

9 A. I calculated several loading factors to account for the following four cost components that  
10 are relatively small or for which it is difficult to develop marginal cost-type statistical  
11 relationships: (a) plant-related A&G expense, (b) non-plant-related A&G expense, (c)  
12 M&S and prepayments, and (d) general plant. For each of these loading factors I  
13 prepared regression analyses using the loading factor cost component as the dependent  
14 variable, and an appropriate measure of cost, utility plant, or total O&M expense as the  
15 independent variable. The loading factor analyses are provided in Attachment MFB-6,  
16 pages 1 through 3.

17 **Q. Please explain why you used loss factors to adjust the marginal capacity-related**  
18 **costs.**

19 A. The measures of capacity-related marginal cost that are used in the MCS are calculated  
20 unit costs per kW of normalized peak demand, measured at customers' meters. The total  
21 distribution system demand is greater than the demand measured at customers' meters

1 because some energy is lost in the process of transmitting and distributing electricity to  
2 customers. Losses are greatest for those customers taking service at secondary voltage,  
3 and somewhat less for customers that are taking service at primary or higher voltages.  
4 The Company provided separate loss factors for primary and secondary service. I  
5 developed an analysis to apply the loss factors to the marginal capacity-related costs,  
6 which is provided in Attachment MFB-8, page 2.

### 7 **9. Fixed Carrying Charge Rate**

8 **Q. Please explain how you calculated the Fixed Carrying Charge Rates.**

9 A. The marginal cost that I calculated for primary and secondary capacity-related  
10 distribution plant, line transformers, services, meters, and street lighting is the initial cost  
11 of an asset that is placed into service. Fixed carrying charge rates (“FCCR”) are used to  
12 convert the marginal cost of plant additions from a cost that represents the estimated  
13 marginal investment into the levelized annual cost of that investment. Attachment MFB-  
14 7, page 1, is a summary of the FCCRs for (a) primary and secondary capacity-related  
15 distribution plant, (b) line transformers, (c) services, (d) meters, and (e) street lighting.  
16 This page shows Economist’s and Engineer’s FCCR results.

17 An Economist’s FCCR is based on annual streams of costs that are fixed in real dollars,  
18 and therefore vary in nominal dollars. An Engineer’s FCCR is based on annual streams  
19 of costs that are constant in nominal dollars, and therefore vary in real dollars. However,  
20 the present values of the Economist’s and Engineer’s costs and revenues are identical.  
21 For marginal cost analyses, the Economist’s FCCR calculations are generally accepted as

1 being the appropriate version because the Economist's FCCR appropriately accounts for  
2 the reduced value of the revenue requirements of that plant addition in future years, due  
3 to price inflation, and therefore better reflects the economic and financial implications of  
4 regulated ratemaking.

5 Attachment MFB-7, pages 1 through 13, provides the assumptions that were used in the  
6 calculation of the FCCR and the detailed calculations of the five FCCRs. The  
7 calculations of the FCCR follow standard rate making principles to determine revenue  
8 requirements associated with plant additions, including return, taxes, depreciation,  
9 salvage value, etc.

10 **D. Summary of Marginal Cost Study Results**

11 **Q. Please explain the schedules that you have prepared to summarize the Marginal**  
12 **Cost results.**

13 A. Attachment MFB-8, page 1, shows the calculation of unit marginal distribution capacity  
14 costs, including all loading factors and adjustments.

15 Attachment MFB-8, page 2, shows the calculation of the loss-adjusted marginal capacity  
16 costs.

17 Attachment MFB-8, page 3, shows the calculation of the loss-adjusted marginal capacity  
18 costs by rate class.

19 Attachment MFB-9, page 1, shows the calculation of unit marginal customer costs,  
20 including all loading factors and adjustments.

1 Attachment MFB-10, page 1, shows the calculation of unit marginal customer and  
2 capacity costs, adjusted for bad debts. Attachment MFB-10, page 1, also shows the  
3 calculation of total marginal costs by rate class, which is used in designing the  
4 Company's proposed base distribution rates in this proceeding to allocate the Company's  
5 requested distribution revenue requirement to firm rate classes.

6 **Q. Does this conclude your testimony?**

7 **A.** Yes, it does.

**Liberty Utilities (Granite State Electric) Corp.  
Marginal Cost Study**

**Summary of Marginal Distribution Plant-Related Costs: Primary System**

1 Regression Results

2

3 **Selected Model:** Primary Distribution Plant Additions 2018\$ = F(Normalized Peak Rolling 2 Year Average, Trend, Lag 4)

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Dependent Variable				
Total Cumulative Annual Distribution Capacity Additions 2018\$ <sub>(2002 - 2018)</sub>				
Explanatory Variables	Database variable name	Coefficient value	t test	Significance
Constant	Constant	-10,287,978	-2.81	0.0147
Normalized Peak Rolling 2 Year Average	Norm_pk_R2	115,690	5.72	0.0001
Annual Trend	Trend	2,046,881	79.10	0.0000
Autoregressive Term Lag 4	Lag 4	-0.8825	-7.96	0.0000
Model Statistics	<b>Model 2.0</b>			
R Squared		0.9974		
Adjusted R Squared		0.9967		
Mean Absolute % Error (MAPE)		1.9200		
Passes ACF/PACF		Yes		

Marginal Cost Calculation

$$\text{Primary Distribution Plant Additions} = - \$ 10,287,978 + \$ 115,690 \times \text{Norm\_pk\_R2} + \$ 2,046,881 \times \text{Trend} + - \$ 0.8825 \times \text{Lag 4}$$

$$\partial \text{ Primary Distribution Plant} / \partial \text{ Normalized Peak Demand} = \$ 115,690 \text{ per MW}$$

**Liberty Utilities (Granite State Electric) Corp.  
Marginal Cost Study**

**Summary of Marginal Distribution Plant-Related Costs: Secondary System**

1 Regression Results

2

3 **Selected Model:** Secondary Distribution Plant Additions 2018\$ = F(Normalized Peak Rolling 2 Year Average, Trend<sub>2011-2018</sub>,  
Dummy<sub>2010</sub>, Lag 4)

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Dependent Variable				
Total Cumulative Annual Distribution Capacity Additions 2018\$ (2001 - 2018)				
Explanatory Variables	Database variable name	Coefficient value	t test	Significance
Constant	Constant	-11,133,387	-3.72	0.0026
Normalized Peak Rolling 2 Year Average	Norm_pk_R2	82,116	5.01	0.0002
Interactive: Trend for 2011 to 2018	TrendxD 2011 After	286,528	15.00	0.0000
Dummy: Year 2010	D 2010	1,435,004	2.58	0.0229
Autoregressive Term Lag 4	Lag 4	(0.7068)	-3.12	0.0082
Model Statistics		<b>Model 2.0</b>		
R Squared		0.9646		
Adjusted R Squared		0.9537		
Mean Absolute % Error (MAPE)		8.5215		
Passes ACF/PACF		Yes		

Marginal Cost Calculation

$$\text{Secondary Distribution Plant Additions} = - \$ 11,133,387 + \$ 82,116 \times \text{Norm\_pk\_R2} + \$ 286,528 \times \text{TrendxD\_2011\_After} + \$ 1,435,004 \times \text{D\_2010} - \$ 0.7068 \times \text{Lag 4}$$

$$\partial \text{Secondary Distribution Plant} / \partial \text{Normalized Peak Demand} = \$ 82,116 \text{ per MW}$$

**Liberty Utilities (Granite State Electric) Corp.  
Marginal Cost Study**

**Summary of Marginal Distribution Plant-Related Costs: Line Transformers**

1 Regression Results

2

3 **Selected Model:** Line Transformers Plant Additions 2018\$ = F(Normalized Peak Rolling 2 Year Average, Trend, Dummy<sub>2007</sub>, Dummy<sub>2014</sub>)

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Dependent Variable				
Total Cumulative Annual Distribution Capacity Additions 2018\$ <sub>(2001 - 2018)</sub>				
Explanatory Variables	Database variable name	Coefficient value	t test	Significance
Constant	Constant	-10,407,873	-5.22	0.0002
Normalized Peak Rolling 2 Year Average	Norm_pk_R2	84,022	7.32	0.0000
Annual Trend	Trend	463,545	20.19	0.0000
Dummy: Year 2007	D_2007	901,471	2.31	0.0380
Dummy: Year 2014	D_2014	-1,046,876	-2.62	0.0210
Model Statistics		Model 1.0		
R Squared		0.9890		
Adjusted R Squared		0.9856		
Mean Absolute % Error (MAPE)		3.2888		
Passes ACF/PACF		Yes		

Marginal Cost Calculation

$$\text{Line Transformers Additions} = - \$ 10,407,873 + \$ 84,022 \times \text{Norm\_pk\_R2} + \$ 463,545 \times \text{Trend} + \$ 901,471 \times \text{D\_2007} - \$ 1,046,876 \times \text{D\_2014}$$

$$\partial \text{Line Transformers} / \partial \text{Normalized Peak Demand} = \$ 84,022 \text{ per MW}$$

**Liberty Utilities (Granite State Electric) Corp. Marginal Cost Study  
Services and Meters Plant**

Line No.	Description	Domestic D	Domestic-Opt. Peak D-10	General TOU G-1	General Long Hour G-2	General Service G-3	Outdoor Lighting M	Limited All Electric T	Ltd Comm Space V	Explanation
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)
1	<b>Service Costs</b>									
2	Representative Cost	\$693.29	\$693.29	\$759.17	\$759.17	\$693.29		\$693.29	\$693.29	Company Data
3	Customers per Service	1.00	1.00	1.00	1.00	1.00		1.00	1.00	Company Data
4	Average Service Cost per Customer	\$ 693.29	\$ 693.29	\$ 759.17	\$ 759.17	\$ 693.29		\$ 693.29	\$ 693.29	Line 2 / Line 3
5	<b>Meter Costs</b>									
6	Current Unit Cost for Metering	\$ 105.00	\$ 360.20	\$ 1,605.00	\$ 900.80	\$ 630.20		\$ 195.20	\$ 290.20	Company Data
7	Meters per Customer	1.00	1.00	1.00	1.00	1.00		1.00	1.00	Company Data
8	Average Meter Cost per Customer	\$ 105.00	\$ 360.20	\$ 1,605.00	\$ 900.80	\$ 630.20		\$ 195.20	\$ 290.20	Line 6 x Line 7
9	Total	\$798.29	\$1,053.49	\$2,364.17	\$1,659.97	\$1,323.49		\$888.49	\$983.49	Line 4 + Line 8

**Liberty Utilities (Granite State Electric) Corp.**  
**Marginal Cost Study**  
**Street Lighting - Luminaires**

Line No.	Luminaire Type Size of Street Light Lumens Description Replacement Luminaire Type	Sodium Vapor 4000 LUM HPS RWY 50W LUM HPS RWY 50W	Sodium Vapor 9600 LUM HPS RWY 100W LUM HPS RWY 100W	Sodium Vapor 27500 LUM HPS RWY 250W LUM HPS RWY 250W	Sodium Vapor 50000 LUM HPS RWY 400W LUM HPS RWY 400W	Sodium Vapor 9,600 (Post Top) LUM HPS POST 100W LUM HPS POST 100W
	(A)	(B)	(C)	(D)	(E)	(F)
1	<b>Installation Costs</b>					
2	Equipment, Line Truck Costs					
3	Cost	38.50	38.50	38.50	44.00	55.00
4	Burden	7.41	7.41	7.41	8.47	10.59
5	Total Equipment, Line Truck Costs	\$ 45.91	\$ 45.91	\$ 45.91	\$ 52.47	\$ 65.59
6	Inventory, Street Light Materials Costs					
7	Cost	305.45	309.54	335.09	358.01	304.01
8	Burden	94.69	95.96	103.88	110.98	94.24
9	Total Inventory, Street Light Materials Costs	\$ 400.14	\$ 405.50	\$ 438.97	\$ 468.99	\$ 398.25
10	Payroll, Lineworker Costs					
11	Cost	35.09	35.09	35.09	40.10	50.13
12	Burden	52.11	52.11	52.11	59.55	74.44
13	Total Payroll, Lineworker Costs	\$ 87.20	\$ 87.20	\$ 87.20	\$ 99.65	\$ 124.57
14	Total Installation Costs	\$ 533.25	\$ 538.61	\$ 572.08	\$ 621.11	\$ 588.41
15	Fixed Charge Rate	11.97%	11.97%	11.97%	11.97%	11.97%
16	Annualized Cost	\$ 63.81	\$ 64.46	\$ 68.46	\$ 74.33	\$ 70.42
17	Escalator to Adjust to 2020 Rate Year	3.84%	3.84%	3.84%	3.84%	3.84%
18	Adjusted Annualized Cost	\$ 66.26	\$ 66.93	\$ 71.09	\$ 77.18	\$ 73.12
19	Installed Luminaires	2,426	1,829	497	72	402
20	Total Annual Marginal Cost	\$ 160,753.52	\$ 122,412.83	\$ 35,330.68	\$ 5,556.99	\$ 29,393.07

**Liberty Utilities (Granite State Electric) Corp.**  
**Marginal Cost Study**  
**Street Lighting - Luminaires**

Line No.	Luminaires Type Size of Street Light Lumnes Description Replacement Luminaire Type	Sodium Vapor 27,500 (Flood) LUM HPS FLD 250W	Sodium Vapor 50,000 (Flood) LUM HPS FLD 400W	Incandescent 1000 LUM INC RWY 103W	Mercury Vapor 4000 LUM MV RWY 100W	Mercury Vapor 8000 LUM MV RWY 175W	Mercury Vapor 22000 LUM MV RWY 400W
	(A)	(G)	(H)	(I)	(J)	(K)	(L)
1	<b>Installation Costs</b>						
2	Equipment, Line Truck Costs						
3	Cost	38.50	38.50	38.50	38.50	38.50	38.50
4	Burden	7.41	7.41	7.41	7.41	7.41	7.41
5	Total Equipment, Line Truck Costs	\$ 45.91	\$ 45.91	\$ 45.91	\$ 45.91	\$ 45.91	\$ 45.91
6	Inventory, Street Light Materials Costs						
7	Cost	413.38	497.46	305.45	305.45	309.54	335.09
8	Burden	128.15	154.21	94.69	94.69	95.96	103.88
9	Total Inventory, Street Light Materials Costs	\$ 541.53	\$ 651.67	\$ 400.14	\$ 400.14	\$ 405.50	\$ 438.97
10	Payroll, Lineworker Costs						
11	Cost	35.09	35.09	35.09	35.09	35.09	35.09
12	Burden	52.11	52.11	52.11	52.11	52.11	52.11
13	Total Payroll, Lineworker Costs	\$ 87.20	\$ 87.20	\$ 87.20	\$ 87.20	\$ 87.20	\$ 87.20
14	Total Installation Costs	\$ 674.64	\$ 784.78	\$ 533.25	\$ 533.25	\$ 538.61	\$ 572.08
15	Fixed Charge Rate	11.97%	11.97%	11.97%	11.97%	11.97%	11.97%
16	Annualized Cost	\$ 80.74	\$ 93.92	\$ 63.81	\$ 63.81	\$ 64.46	\$ 68.46
17	Escalator to Adjust to 2020 Rate Year	3.84%	3.84%	3.84%	3.84%	3.84%	3.84%
18	Adjusted Annualized Cost	\$ 83.83	\$ 97.52	\$ 66.26	\$ 66.26	\$ 66.93	\$ 71.09
19	Installed Luminaires	255	420	23	59	111	50
20	Total Annual Marginal Cost	\$ 21,377.21	\$ 40,983.75	\$ 1,524.04	\$ 3,909.50	\$ 7,429.10	\$ 3,554.39

**Liberty Utilities (Granite State Electric) Corp.**  
**Marginal Cost Study**  
**Street Lighting - Luminaires**

Line No.	Luminares Type Size of Street Light Lumnes Description Replacement Luminaire Type	Mercury Vapor 63000 LUM MV RWY 1000W LUM HPS RWY 400W	Mercury Vapor 22,000 (Flood) LUM MV FLD 400W LUM HPS FLD 250W	Total Outdoor Lighting (Luminaires)	Explanation
	(A)	(M)	(N)	(O)	(P)
1	<b>Installation Costs</b>				
2	Equipment, Line Truck Costs				
3	Cost	44.00		38.50	Company Data
4	Burden	8.47		7.41	Company Data
5	Total Equipment, Line Truck Costs	\$ 52.47	\$	45.91	Line 3 + Line 4
6	Inventory, Street Light Materials Costs				
7	Cost	358.01		413.38	Company Data
8	Burden	110.98		128.15	Company Data
9	Total Inventory, Street Light Materials Costs	\$ 468.99	\$	541.53	Line 7 + Line 8
10	Payroll, Lineworker Costs				
11	Cost	40.10		35.09	Company Data
12	Burden	59.55		52.11	Company Data
13	Total Payroll, Lineworker Costs	\$ 99.65	\$	87.20	Line 11 + Line 12
14	Total Installation Costs	\$ 621.11	\$	674.64	Line 5 + Line 9 + Line 13
15	Fixed Charge Rate	11.97%		11.97%	Att MFB-7 p1, Col (C), Line 7
16	Annualized Cost	\$ 74.33	\$	80.74	Line 14 x Line 15
17	Escalator to Adjust to 2020 Rate Year	3.84%		3.84%	$((1 + \text{Att MFB-7 p1, Col (C), Line 19})^2) - 1$
18	Adjusted Annualized Cost	\$ 77.18	\$	83.83	Line 16 x (1 + Line 17)
19	Installed Luminaires	1		20	Company Data
20	Total Annual Marginal Cost	\$ 77.18	\$	1,676.64	Line 18 x Line 19

**Liberty Utilities (Granite State Electric) Corp.**  
**Marginal Cost Study**  
**Street Lighting - Poles and Accessories**

Line No.	Poles and Accessories	Overhead Service	Non-Metallic Standard	Non-Metallic Standard
	Poles and Accessories Type	Wood Poles	Fiberglass - Direct Embedded	Fiberglass with Foundation < 25 ft.
	Description	POLE - WOOD	POLE FIBER PT < 25FT	POLE FIBER RWY < 25FT
	Replacement Pole and Accessory Type	POLE - WOOD	POLE FIBER PT < 25FT	POLE FIBER RWY < 25FT
	(A)	(B)	(C)	(D)
1	<b>Installation Costs</b>			
2	Equipment, Line Truck Costs			
3	Cost	187.00	192.00	175.00
4	Burden	36.00	36.96	33.69
5	Total Equipment, Line Truck Costs	\$ 223.00	\$ 228.96	\$ 208.69
6	Inventory, Street Light Materials Costs			
7	Cost	206.61	613.26	1,033.11
8	Burden	64.05	190.11	320.26
9	Total Inventory, Street Light Materials Costs	\$ 270.66	\$ 803.37	\$ 1,353.37
10	Payroll, Lineworker Costs			
11	Cost	305.60	255.19	259.42
12	Burden	453.81	378.96	385.24
13	Total Payroll, Lineworker Costs	\$ 759.41	\$ 634.15	\$ 644.66
14	Total Installation Costs	\$ 1,253.07	\$ 1,666.48	\$ 2,206.72
15	Fixed Charge Rate	11.97%	11.97%	11.97%
16	Annualized Cost	\$ 149.96	\$ 199.43	\$ 264.08
17	Escalator to Adjust to 2020 Rate Year	3.84%	3.84%	3.84%
18	Adjusted Annualized Cost	\$ 155.71	\$ 207.08	\$ 274.21
19	Installed Luminaires	114	245	142
20	Total Annual Marginal Cost	\$ 17,750.84	\$ 50,734.69	\$ 38,938.07

**Liberty Utilities (Granite State Electric) Corp.**  
**Marginal Cost Study**  
**Street Lighting - Poles and Accessories**

Line No.	Poles and Accessories Type Description Replacement Pole and Accessory Type	Metallic Standard Metal Poles - Direct Embedded POLE METAL EMBEDDED	Metallic Standard Metal Poles with Foundation POLE METAL POLE METAL	Total Outdoor Lighting (Poles and	Explanation
	(A)	(E)	(F)	(G)	(H)
1	<b>Installation Costs</b>				
2	Equipment, Line Truck Costs				
3	Cost	192.00	224.00		Company Data
4	Burden	36.96	43.12		Company Data
5	Total Equipment, Line Truck Costs	\$ 228.96	\$ 267.12		Line 3 + Line 4
6	Inventory, Street Light Materials Costs				
7	Cost	613.26	1,576.77		Company Data
8	Burden	190.11	488.80		Company Data
9	Total Inventory, Street Light Materials Costs	\$ 803.37	\$ 2,065.57		Line 7 + Line 8
10	Payroll, Lineworker Costs				
11	Cost	255.19	186.78		Company Data
12	Burden	378.96	277.37		Company Data
13	Total Payroll, Lineworker Costs	\$ 634.15	\$ 464.15		Line 11 + Line 12
14	Total Installation Costs	\$ 1,666.48	\$ 2,796.84		Line 5 + Line 9 + Line 13
15	Fixed Charge Rate	11.97%	11.97%		Att MFB-7 p1, Col (C), Line 7
16	Annualized Cost	\$ 199.43	\$ 334.70		Line 14 x Line 15
17	Escalator to Adjust to 2020 Rate Year	3.84%	3.84%		$((1 + \text{Att MFB-7 p1, Col (C), Line 19})^2) - 1$
18	Adjusted Annualized Cost	\$ 207.08	\$ 347.54		Line 16 x (1 + Line 17)
19	Installed Luminaires	162	98	761	Company Data
20	Total Annual Marginal Cost	\$ 33,547.02	\$ 34,059.05	\$ 175,030	Line 18 x Line 19

**Liberty Utilities (Granite State Electric) Corp.  
Marginal Cost Study**

**Summary of Marginal Distribution Operations Expense: Primary System**

1 Regression Results

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3 **Selected Model:** Primary Distribution Non-Customer Operations Expense 2018\$ = F(Normalized Peak Rolling 2 Year Average, Dummy<sub>2014</sub>, Dummy<sub>2005</sub>,  
Dummy<sub>2006</sub>, Trend<sub>2001-2012</sub>)

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Dependent Variable Primary Distribution Non-Customer Operations Expense 2018\$ (2001 - 2018)				
Explanatory Variables	Database variable name	Coefficient value	t test	Significance
Constant	Constant	-5,175,908	-4.91	0.0004
Normalized Peak Rolling 2 Year Average	Norm_pk_R2	35,927	6.16	0.0000
Dummy: 2014	D_2014	790,435	3.04	0.0103
Dummy: 2005	D_2005	-1,003,370	-4.30	0.0010
Dummy: 2006	D_2006	-583,428	-2.49	0.0285
Interactive: Trend for 2001 to 2012	Trend_2001_2012	-101,220	-6.98	0.0000
Model Statistics		<b>Model 1.0</b>		
R Squared		0.9211		
Adjusted R Squared		0.8882		
Mean Absolute % Error (MAPE)		20.4350		
Passes ACF/PACF		Yes		

Marginal Cost Calculation

$$\text{Primary Distribution Non-Customer Operations Expense} = - \$ 5,175,908 + \$ 35,927 \times \text{Norm\_pk\_R2} + \$ 790,435 \times \text{D\_2014} - \$ 1,003,370 \times \text{D\_2005} - \$ 583,428 \times \text{D\_2006} + - \$ 101,220 \times \text{Trend\_2001\_2012}$$

$$\partial \text{ Primary Distribution Non-Customer Operations Expense} / \partial \text{ Normalized Peak Demand} = \$ 35,927 \text{ per MW}$$

**Liberty Utilities (Granite State Electric) Corp.  
Marginal Cost Study**

**Summary of Marginal Distribution Operations Expense: Secondary System**

1 Regression Results

2

3 **Selected Model:** Secondary Distribution Non-Customer Operations Expense 2018\$ = F(Normalized Peak Rolling 2 year average, Dummy<sub>2003-2012</sub>,  
Dummy<sub>2014</sub>, Dummy<sub>2002</sub>, Dummy<sub>2001</sub>, Dummy<sub>2013</sub>)

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Dependent Variable				
Secondary Distribution Non-Customer Operations Expense 2018\$ (2001 - 2018)				
Explanatory Variables	Database variable name	Coefficient value	t test	Significance
Constant	Constant	-73,748	-0.24	0.8126
Normalized Peak Rolling 2 year average	Norm_pk_R2	3,410	2.12	0.0576
Dummy: Years 2003 to 2012	D_2003_2012	-430,838	-20.16	0.0000
Dummy: Year 2014	D_2014	490,516	11.45	0.0000
Dummy: Year 2002	D_2002	-393,189	-7.80	0.0000
Dummy: Year 2001	D_2001	-329,723	-4.87	0.0005
Dummy: Year 2013	D_2013	179,078	4.40	0.0011
Model Statistics		Model 1.1		
R_Squared		0.9903		
Adjusted R_Squared		0.9849		
Mean Absolute % Error (MAPE)		12.2651		
Passes ACF/PACF		Yes		

**Marginal Cost Calculation**

$$\text{Secondary Distribution Non-Customer Operations Expense} = - \$ 73,748 + \$ 3,410 \times \text{Norm\_pk\_R2} - \$ 430,838 \times \text{D\_2003\_2012} + \$ 490,516 \times \text{D\_2014} - \$ 393,189 \times \text{D\_2002} - \$ 329,723 \times \text{D\_2001} + \$ 179,078 \times \text{D\_2013}$$

$$\partial \text{Secondary Distribution Non-Customer Operations Expense} / \partial \text{Normalized Peak Demand} = \$ 3,410 \text{ per MW}$$

**Liberty Utilities (Granite State Electric) Corp.  
 Marginal Cost Study**

**Summary of Marginal Distribution Operations Expense: Line Transformers**

1 Regression Results

2

3 **Selected Model:** Line Transformers Non-Customer Operations Expense 2018\$ = F(Normalized Peak Rolling 2 year average, Dummy<sub>2004-2011</sub>, Dummy<sub>2012</sub>,  
 Dummy<sub>2013</sub>, Dummy<sub>2014</sub>, Trend, Lag 2)

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Dependent Variable				
Line Transformers Non-Customer Operations Expense 2018\$ (2002 - 2018)				
Explanatory Variables	Database variable name	Coefficient value	t test	Significance
Constant	Constant	-215,021	-2.39	0.0402
Normalized Peak Rolling 2 year average	Norm_pk_R2	1,458	2.62	0.0276
Dummy: Years 2004 to 2011	D_2004_2011	-39,651	-5.17	0.0006
Dummy: 2012	D_2012	-136,634	-16.53	0.0000
Dummy: 2013	D_2013	96,844	11.76	0.0000
Dummy: 2014	D_2014	195,435	21.24	0.0000
Annual Trend	Trend	1,592	2.04	0.0721
Autoregressive Term Lag 2	Lag 2	-0.7952	-3.90	0.0036
Model Statistics	<b>Model 1.1</b>			
R_Squared	0.9963			
Adjusted R_Squared	0.9934			
Mean Absolute % Error (MAPE)	8.2472			
Passes ACF/PACF	Yes			

Marginal Cost Calculation

$$\text{Line Transformers Non-Customer Operations Expense} = - \$ 215,021 + \$ 1,458 \times \text{Norm\_pk\_R2} - \$ 39,651 \times \text{D\_2004\_2011} + - \$ 136,634 \times \text{D\_2012} + \$ 96,844 \times \text{D\_2013} + \$ 195,435 \times \text{D\_2014} + \$ 1,592 \times \text{Trend} + - \$ 0.795 \times \text{Lag 2}$$

$$\partial \text{Line Transformers Non-Customer Operations Expense} / \partial \text{Normalized Peak Demand} = \$ 1,458 \text{ per MW}$$

**Liberty Utilities (Granite State Electric) Corp.  
Marginal Cost Study**

**Summary of Marginal Distribution Maintenance Expense: Primary System**

1 Regression Results

2

3 **Selected Model:** Primary Distribution Non-Customer Maintenance Expense 2018\$ = F(1 Year Lag in Normal Peak, 1 Year Lag in  
SAIFI, Dummy<sub>2013-2015</sub>, Dummy<sub>2010</sub>, Dummy<sub>2005</sub>)

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Dependent Variable				
Primary Distribution Non-Customer Maintenance Expense 2018\$ (2001 - 2018)				
Explanatory Variables	Database variable name	Coefficient value	t test	Significance
Constant	Constant	-1,792,424	-1.75	0.1060
1 Year Lag in Normal Peak	Norm_pk_L1	16,349	3.09	0.0094
1 Year Lag in SAIFI	SAIFI_L1	307,772	2.22	0.0462
Dummy: Years 2013 to 2015	D_2013_2015	-622,628	-3.20	0.0077
Dummy: 2010	D_2010	-769,943	-2.51	0.0273
Dummy: 2005	D_2005	-688,355	-2.32	0.0386
Model Statistics		<b>Model 1.0</b>		
R Squared		0.6953		
Adjusted R Squared		0.5684		
Mean Absolute % Error (MAPE)		10.7278		
Passes ACF/PACF		Yes		

Marginal Cost Calculation

$$\text{Primary Distribution Non-Customer Maintenance Expense} = - \$ 1,792,424 + \$ 16,349 \times \text{Norm\_pk\_L1} + \$ 307,772 \times \text{SAIFI\_L1} - \$ 622,628 \times \text{D\_2013\_2015} - \$ 769,943 \times \text{D\_2010} - \$ 688,355 \times \text{D\_2005}$$

$$\partial \text{ Primary Distribution Non-Customer Maintenance Expense} / \partial \text{ Normalized Peak Demand} = \$ 16,349 \text{ per MW}$$

**Liberty Utilities (Granite State Electric) Corp.  
Marginal Cost Study**

**Summary of Marginal Distribution Maintenance Expense: Secondary System**

1 Regression Results

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3 **Selected Model:** Secondary Distribution Non-Customer Maintenance Expense 2018\$ = F(2-Year Lag in Normal Peak, 1 Year Lag in SAIFI, Dummy<sub>2013-2015</sub>,  
Dummy<sub>2010</sub>)

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Dependent Variable Secondary Distribution Non-Customer Maintenance Expense 2018\$ (2002 - 2018)				
Explanatory Variables	Database variable name	Coefficient value	t test	Significance
Constant	Constant	-1,401,231	-3.20	0.0076
2 Year Lag in Normal Peak	Norm_pk L2	9,625	4.36	0.0009
1 Year Lag in SAIFI	SAIFI L1	182,684	3.19	0.0078
Dummy: Years 2013 to 2015	D 2013 2015	-287,407	-3.68	0.0032
Dummy: 2010	D 2010	-387,144	-3.15	0.0084
<b>Model Statistics</b>		<b>Model 1.0</b>		
R Squared		0.7502		
Adjusted R Squared		0.6669		
Mean Absolute % Error (MAPE)		11.8537		
Passes ACF/PACF		Yes		

Marginal Cost Calculation

$$\text{Secondary Distribution Non-Customer Maintenance Expense} = - \$ 1,401,231 + \$ 9,625 \times \text{Norm\_pk\_L2} + \$ 182,684 \times \text{SAIFI\_L1} - \$ 287,407 \times \text{D\_2013\_2015} - \$ 387,144 \times \text{D\_2010}$$

$$\partial \text{Secondary Distribution Non-Customer Maintenance Expense} / \partial \text{Normalized Peak Demand} = \$ 9,625 \text{ per MW}$$

**Liberty Utilities (Granite State Electric) Corp.  
Marginal Cost Study**

**Summary of Marginal Distribution Maintenance Expense: Line Transformers**

1 Regression Results

2

3 **Selected Model:** Line Transformers Non-Customer Maintenance Expense 2018\$ = F(2-Year Lag in Normal Peak, 1 Year Lag in SAIFI, Dummy<sub>2012</sub>)

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Dependent Variable				
Line Transformers Non-Customer Maintenance Expense 2018\$ (2002 - 2018)				
Explanatory Variables	Database variable name	Coefficient value	t test	Significance
Constant	Constant	-410,080	-1.50	0.1566
2 Year Lag in Normal Peak	Norm_pk_L2	2,846	2.12	0.0537
1 Year Lag in SAIFI	SAIFI_L1	102,526	2.71	0.0180
Dummy: 2012	D_2012	162,136	2.05	0.0611
Model Statistics	<b>Model 1.0</b>			
R Squared	0.4777			
Adjusted R Squared	0.3572			
Mean Absolute % Error (MAPE)	19.8946			
Passes ACF/PACF	Yes			

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Marginal Cost Calculation

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$$\text{Line Transformers Non-Customer Maintenance Expense} = - \$ 410,080 + \$ 2,846 \times \text{Norm\_pk\_L2} + \$ 102,526 \times \text{SAIFI\_L1} + \$ 162,136 \times \text{D\_2012}$$

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$$\partial \text{ Line Transformers Non-Customer Maintenance Expense} / \partial \text{ Normalized Peak Demand} = \$ 2,846 \text{ per MW}$$

**Liberty Utilities (Granite State Electric) Corp.  
 Marginal Cost Study**

**Summary of Marginal Distribution Operations and Maintenance Expense: Customer Related**

1 Regression Results

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3 **Selected Model:** Customer Related Operations and Maintenance Expense 2018\$ = F(Customers Lagged 1 Year, Trend<sub>2001-2011</sub>,  
 Dummy<sub>2012</sub>, Dummy<sub>2013</sub> )

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Dependent Variable				
Customer Related Operations and Maintenance Expense 2018\$ (2001 - 2018)				
Explanatory Variables	Database variable name	Coefficient value	t test	Significance
Constant	Constant	-2,689,671	-0.95	0.3590
Customers Lagged 1 Year	Customer_L1	132.4	1.91	0.0790
Interactive: Trend for 2001 to 2011	I_Trendx2001_2011	-64,709	-2.34	0.0361
Dummy: 2012	D_2012	-1,380,942	-2.98	0.0107
Dummy: 2013	D_2013	-1,503,282	-3.23	0.0065
Model Statistics	<b>Model 1.0</b>			
R Squared		0.5705		
Adjusted R Squared		0.4384		
Mean Absolute % Error (MAPE)		11.9110		
Passes ACF/PACF		Yes		

Marginal Cost Calculation

Customer Related Operations and Maintenance Expense = - \$ 2,689,671 + \$ 132.4 x Customer\_L1 - \$ 64,709 x  
 I\_Trendx2001\_2011 - \$ 1,380,942 x D\_2012 - \$ 1,503,282 x D\_2013

$\partial$  Customer Related Operations and Maintenance Expense /  $\partial$  Customer = \$ 132.4 per Customer

**Liberty Utilities (Granite State Electric) Corp. Marginal Cost Study**  
**Class Weighted Customer Plant Related Expense**

Customer Weightings					Customer Weightings		
Line No.	Customer Groups	Test Year Number of Customers	Service and Meter Plant per customer	Total Cost	Relative Weight Per Customer	System Average Marginal Cost per Customer	Weighted Marginal Cost Per Customer
	(A)	(B)	(C)	(D)	(E)	(F)	(G)
		Company Data	Att MFB-2 p1, Line 9	Col (B) x Col (C)	Col (C) Line (n) / Line 10	Col (G) Line 9	Col (E) x Col (F)
1	D	35,382	\$ 798.29	\$ 28,244,829	0.893	\$ 132.4	\$118.17
2	D-10	440	\$ 1,053.49	\$ 463,307	1.178	\$ 132.4	\$155.95
3	G-1	138	\$ 2,364.17	\$ 326,728	2.644	\$ 132.4	\$349.96
4	G-2	907	\$ 1,659.97	\$ 1,505,268	1.856	\$ 132.4	\$245.72
5	G-3	5,670	\$ 1,323.49	\$ 7,504,221	1.480	\$ 132.4	\$195.91
6	M	N/A					
7	T	964	\$ 888.49	\$ 856,318	0.994	\$ 132.4	\$131.52
8	V	18	\$ 983.49	\$ 17,301	1.100	\$ 132.4	\$145.58
9	Total	43,518		\$ 38,917,972			\$132.38
10	Avg Cost per Customer		\$894.30				

**Liberty Utilities (Granite State Electric) Corp.  
 Marginal Cost Study**

**Summary of Marginal Customer Accounts**

1 Regression Results

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3 **Selected Model:** Customer Accounts 2018\$ = F(Customers 2 Year Rolling Average, Trend<sub>2003-2011</sub>, Dummy<sub>2015</sub>, Dummy<sub>2012</sub>, Lag 3)

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Dependent Variable				
Customer Accounts 2018\$ <sub>(2003 - 2018)</sub>				
Explanatory Variables	Database variable name	Coefficient value	t test	Significance
Constant	Constant	-2,383,823	-1.74	0.1129
Customers 2 Year Rolling Average	Customer_R2	109.6	3.33	0.0076
Interactive: Trend for 2003 to 2011	I_Trendx2003_2011	-56,906	-4.95	0.0006
Dummy: 2015	D_2015	662,473	4.02	0.0025
Dummy: 2012	D_2012	-842,860	-5.82	0.0002
Autoregressive Term Lag 3	Lag 3	-0.8664	-4.51	0.0011
Model Statistics		<b>Model 1.0</b>		
R_Squared		0.8922		
Adjusted R_Squared		0.8384		
Mean Absolute % Error (MAPE)		6.1611		
Passes ACF/PACF		Yes		

Marginal Cost Calculation

$$\text{Customer Accounts} = - \$ 2,383,823 + \$ 109.6403 \times \text{Customer\_R2} + - \$ 56,906 \times \text{I\_Trendx2003\_2011} + \$ 662,473 \times \text{D\_2015} + - \$ 842,860 \times \text{D\_2012} - \$ 0.866 \times \text{Lag 3}$$

$$\partial \text{Customer Accounts} / \partial \text{Customer} = \$ 109.6 \text{ per Customer}$$

**Liberty Utilities (Granite State Electric) Corp. Marginal Cost Study  
Class Weighted Customer Accounting & Marketing Expense**

Line No.	Customer Groups	Test Year Number of Customers	% of total Customers	Relative Weight Per Customer	Marginal Unit Cost	Marginal Cost Per Customer
	(A)	(B)	(C)	(D)	(E)	(F)
		Att MFB-5 p2, Col (B)	Col (B) Line (n) / Col (B) Line 9	Company Data	Att MFB-5 p3, Line 24	Col (D) x Col (E)
1	D	35,382	81.30%	1.00	\$ 109.64	\$ 109.64
2	D-10	440	1.01%	1.00	\$ 109.64	\$ 109.64
3	G-1	138	0.32%	2.00	\$ 109.64	\$ 219.28
4	G-2	907	2.08%	1.50	\$ 109.64	\$ 164.46
5	G-3	5,670	13.03%	1.00	\$ 109.64	\$ 109.64
6	M	N/A				
7	T	964	2.21%	1.00	\$ 109.64	\$ 109.64
8	V	18	0.04%	1.00	\$ 109.64	\$ 109.64
9	Total	43,518			\$ 109.64	

**Liberty Utilities (Granite State Electric) Corp. Marginal Cost Study**  
**Class Weighted Bad Debt Accounts Expense**

Line No.	Customer Groups	2018 Write Offs	Percent of Total	Bad Debt Accounts Expense	Total Normalized Distribution Revenues	Bad Debt Expense Percentage
	(A)	(B)	(C)	(D)	(E)	(F)
		Company Data	Col (B) Line (n) / Col (B) Line 9	Col (C) Line (n) x Col (D) Line 9	Company Data	Col (D) / Col (E)
1	D	\$ 539,475	89.40%	\$ 218,572	\$ 18,987,618	1.15%
2	D-10	\$ 7,204	1.19%	\$ 2,919	\$ 283,841	1.03%
3	G-1	\$ -	0.00%	\$ -	\$ 8,954,512	0.00%
4	G-2	\$ 25,204	4.18%	\$ 10,212	\$ 4,951,610	0.21%
5	G-3	\$ 28,429	4.71%	\$ 11,518	\$ 4,867,118	0.24%
6	M	\$ 377	0.06%	\$ 153	\$ 940,058	0.02%
7	T	\$ 2,549	0.42%	\$ 1,033	\$ 755,506	0.14%
8	V	\$ 174	0.03%	\$ 70	\$ 17,957	0.39%
9	Total	\$ 603,412	100.00%	\$ 244,477	\$ 39,758,220	0.61%

**Liberty Utilities (Granite State Electric) Corp.  
Marginal Cost Study**

**Summary of Marginal Administrative and General Expense - Marginal Loading Factors**

1 Regression Results

2

3 **Selected Model:** Administrative and General Expense 2018\$ = F(Total O&M Expense Excl. A&G, Real 2018\$, Total Utility Plant, Trend, Dummy<sub>2002</sub>,  
Dummy<sub>2009</sub>, Dummy<sub>2010-2011</sub>, Dummy<sub>2012</sub>, Dummy<sub>2013</sub>, Dummy<sub>2014</sub>)

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Dependent Variable				
Total Administrative and General Expense 2018\$ <sub>(2001 - 2018)</sub>				
Explanatory Variables	Database variable name	Coefficient value	t test	Significance
Constant	Constant	-1,034,594	-0.60	0.5677
Total O&M Expense Excl. A&G, Real 2018\$	OM_Real_xAG	0.0373	2.64	0.0297
Total Utility Plant	Util_Plt	0.0353	2.67	0.0282
Annual Trend	Trend	-370,053	-2.85	0.0216
Dummy: 2002	D_2002	1,196,806	2.49	0.0375
Dummy: 2009	D_2009	2,204,081	4.36	0.0024
Dummy: Years 2010 - 2011	D_2010_2011	3,813,212	7.52	0.0001
Dummy: 2012	D_2012	10,311,674	13.58	0.0000
Dummy: 2013	D_2013	8,505,148	11.87	0.0000
Dummy: 2014	D_2014	2,939,619	6.08	0.0003
<b>Model Statistics</b>		<b>Model 1.0</b>		
R Squared		0.9880		
Adjusted R Squared		0.9745		
Mean Absolute % Error (MAPE)		4.9504		
Passes ACF/PACF		Yes		

**Marginal Cost Calculation**

$$\text{Total Administrative and General Expense} = - \$ 1,034,594 + \$ 0.0373 \times \text{OM\_Real\_xAG} + \$ 0.0353 \times \text{Util\_Plt} + - \$ 370,053 \times \text{Trend} + \\
\$ 1,196,806 \times \text{D\_2002} + \$ 2,204,081 \times \text{D\_2009} + \$ 3,813,212 \times \text{D\_2010\_2011} + \$ 10,311,674 \times \text{D\_2012} + \$ 8,505,148 \times \text{D\_2013} + \\
\$ 2,939,619 \times \text{D\_2014}$$

$$\partial \text{ Total Administrative and General Expense} / \partial \text{ O\&M excl. A\&G} = \$ 0.0373 \text{ per } \$ \text{ of O\&M (2018\$)}$$

$$\partial \text{ Total Administrative and General Expense} / \partial \text{ Plant} = \$ 0.0353 \text{ per } \$ \text{ of Plant (2018\$)}$$

**Liberty Utilities (Granite State Electric) Corp.  
Marginal Cost Study**

**Summary of Marginal Materials and Supplies Expense - Marginal Loading Factors**

1 Regression Results

2  
3 **Selected Model:** Materials and Supplies 2018\$ = F(Total Electric Plant In Service , Dummy<sub>2009</sub>, Dummy<sub>2011</sub>)

Dependent Variable				
Materials and Supplies Expense 2018\$ <sub>(2000 - 2018)</sub>				
Explanatory Variables	Database variable name	Coefficient value	t test	Significance
Constant	Constant	-1,160,105	-3.01	0.0088
Total Electric Plant In Service	Util_Plt	0.0207	7.95	0.0000
Dummy: 2009	D 2009	9,187,554	15.49	0.0000
Dummy: 2011	D 2011	1,733,634	2.93	0.0104
Model Statistics	<b>Model 1.0</b>			
R Squared	0.9510			
Adjusted R Squared	0.9412			
Mean Absolute % Error (MAPE)	56.7788			
Passes ACF/PACF	Yes			

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19 Marginal Cost Calculation  
20 Materials and Supplies Expense = - \$ 1,160,105 + \$ 0.0207 x Util\_Plt + \$ 9,187,554 x D\_2009 + \$ 1,733,634 x D\_2011  
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22  $\partial$  Materials and Supplies Expense /  $\partial$  Plant = \$ 0.0207 per \$ Plant (2018\$)

**Liberty Utilities (Granite State Electric) Corp.  
 Marginal Cost Study**

**Summary of Marginal General Plant - Marginal Loading Factors**

1 Regression Results

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3 **Selected Model:** General Plant = F(Total Utility Plant, excluding General Plant, Dummy<sub>2006-2008</sub>, Dummy<sub>2009-2013</sub>)

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Dependent Variable				
General Plant (2001 - 2018)				
Explanatory Variables	Database variable name	Coefficient value	t test	Significance
Constant	Constant	-3,063,081	-3.86	0.0017
Total Utility Plant, excluding General Plant	Util Plt xGen Plt	0.1016	19.43	0.0000
Dummy: 2006 - 2008	D 2006 2008	-1,954,440	-2.96	0.0103
Dummy: 2009 - 2013	D 2009 2013	-3,724,921	-6.99	0.0000
Model Statistics		Model 2.0		
R Squared		0.9732		
Adjusted R Squared		0.9674		
Mean Absolute % Error (MAPE)		7.0003		
Passes ACF/PACF		Yes		

Marginal Cost Calculation

$$\text{General Plant} = - \$ 3,063,081 + \$ 0.1016 \times \text{Util\_Plt\_xGen\_Plt} - \$ 1,954,440 \times \text{D\_2006\_2008} - \$ 3,724,921 \times \text{D\_2009\_2013}$$

$$\partial \text{ General Plant} / \partial \text{ Plant excl. General Plant} = \$ 0.1016 \text{ per } \$ \text{ Plant}$$

**Liberty Utilities (Granite State Electric) Corp. Marginal Cost Study**

**Summary of Levelized Fixed Charge Rates**

Line No.	Description	Engineer's Fixed Charge Rate	Economist's Fixed charge Rate	Explanation
	(A)	(B)	(C)	(D)
1	Fixed Charge Rate Results			
2	Levelized Cost for:		Over Book Life	
3	Primary and Secondary Cap-related Dist.	13.69%	10.84%	Att MFB-7 p3, Line 13
4	Line Transformers Investment	13.91%	11.21%	Att MFB-7 p4, Line 13
5	Services Investment	13.24%	10.44%	Att MFB-7 p5, Line 13
6	Meters Investment	15.30%	13.15%	Att MFB-7 p6, Line 13
7	Street Lighting Investment	14.47%	11.97%	Att MFB-7 p7, Line 13
8	Cost of Capital			
9	Debt	5.97%	45.00%	WP MFB-7 Page 1, Line 1
10	Preferred	0.00%	0.00%	WP MFB-7 Page 1, Line 2
11	Common	10.00%	55.00%	WP MFB-7 Page 1, Line 3
12	Other	0.00%	0.00%	WP MFB-7 Page 1, Line 4
13	Weighted Cost of Capital		8.19%	
14	After Tax Cost of New Capital		7.46%	WP MFB-7 Page 1, Line 10
15	Incremental Tax Rate		27.08%	WP MFB-7 Page 1, Line 6
16	Tax Effectd Cost of Capital		10.23%	WP MFB-7 Page 1, Line 5
17	Property Tax Rate		3.48%	WP MFB-7 Page 1, Line 9
18	Gross Receipts Tax Rate		0.00%	WP MFB-7 Page 1, Line 11
19	Inflation Rate		1.90%	WP MFB-7 Page 1, Line 12
20	Property Tax Escalation Rate		2.50%	WP MFB-7 Page 1, Line 13

**Liberty Utilities (Granite State Electric) Corp. Marginal Cost Study**  
**Levelized Fixed Charge Analysis, Input Data**

Line No.	Variable	Primary and Secondary Capacity - Related Distribution Plant	Line Transformers	Services	Meters	Street Lighting	Explanation
	(A)	(B)	(C)	(D)	(E)	(F)	(G)
1	Plant Data						
2	Capitalized Cost	\$1,000	\$1,000	\$1,000	\$1,000	\$1,000	
3	Book Life	43	37	45	22	30	Att MFB-7 p13, Col (C)
4	Salvage Value	-39%	-30%	-75%	-10%	-10%	Att MFB-7 p13, Col (D)
5	MACRS Life	20	20	20	20	20	
6	Capital Structure						
7	Debt Ratio	45.00%	45.00%	45.00%	45.00%	45.00%	Att MFB-7 p1, Col (C), Line 9
8	Preferred Ratio	0.00%	0.00%	0.00%	0.00%	0.00%	Att MFB-7 p1, Col (C), Line 10
9	Common Ratio	55.00%	55.00%	55.00%	55.00%	55.00%	Att MFB-7 p1, Col (C), Line 11
10	Other	0.00%	0.00%	0.00%	0.00%	0.00%	Att MFB-7 p1, Col (C), Line 12
11	Cost of Capital						
12	Debt Cost	5.97%	5.97%	5.97%	5.97%	5.97%	Att MFB-7 p1, Col (B), Line 9
13	Preferred Cost	0.00%	0.00%	0.00%	0.00%	0.00%	Att MFB-7 p1, Col (B), Line 10
14	Common Cost	10.00%	10.00%	10.00%	10.00%	10.00%	Att MFB-7 p1, Col (B), Line 11
15	Other	0.00%	0.00%	0.00%	0.00%	0.00%	Att MFB-7 p1, Col (B), Line 12
16	Wtd Cost Of Capital	8.19%	8.19%	8.19%	8.19%	8.19%	(Line 7 x Line 12) + (Line 8 x Line 13) + (Line 9 x Line 14) + (Line 10 x Line 15)
17	After Tax Cost of Capital	7.46%	7.46%	7.46%	7.46%	7.46%	Att MFB-7 p1, Col (C), Line 14
18	Tax Data						
19	Tax Rate	27.08%	27.08%	27.08%	27.08%	27.08%	Att MFB-7 p1, Col (C), Line 15
20	ITC Rate	0.00%	0.00%	0.00%	0.00%	0.00%	WP MFB-7 Page 1, Line 7
21	Revenue Tax Rate	0.00%	0.00%	0.00%	0.00%	0.00%	WP MFB-7 Page 1, Line 8
22	Property Tax Rate	3.48%	3.48%	3.48%	3.48%	3.48%	Att MFB-7 p1, Col (C), Line 17
23	Property Insurance	0.50%	0.50%	0.50%	0.50%	0.50%	WP MFB-7 Page 2, Line 3
24	Property Tax Basis	Dep Bal	Dep Bal	Dep Bal	Dep Bal	Dep Bal	
25	Misc. Data						
26	Inflation Rate	1.90%	1.90%	1.90%	1.90%	1.90%	Att MFB-7 p1, Col (C), Line 19
27	Prop Tax Escalation Rate	2.50%	2.50%	2.50%	2.50%	2.50%	Att MFB-7 p1, Col (C), Line 20
28	Return on Rate Base calculation	EOY	EOY	EOY	EOY	EOY	

**Liberty Utilities (Granite State Electric) Corp. Marginal Cost Study**  
**Levelized Fixed Charge Analysis**  
**Primary and Secondary Capacity Related Distribution**

Line No.	Item	-- Current Dollars -- (Engineer's FCR)		-- Constant Dollars -- (Economist's FCR)	
		Current Levelized Dollars	Percent Of Capital Investment	Constant Levelized Dollars	Percent Of Capital Investment
	(A)	(B) Att MFB-7 p8	(C) Col (B) x 0.001	(D) Att MFB-7 p8	(E) Col (D) x 0.001
1	Interest On Debt	\$15.05	1.50%	\$11.92	1.19%
2	Return On Preferred	\$0.00	0.00%	\$0.00	0.00%
3	Return On Common	\$30.81	3.08%	\$24.41	2.44%
4	Return	\$45.86	4.59%	\$36.33	3.63%
5	Depreciation	\$32.38	3.24%	\$25.65	2.57%
6	Income Tax	\$8.70	0.87%	\$6.89	0.69%
7	Deferred Taxes	\$2.74	0.27%	\$2.17	0.22%
8	Income Tax	\$11.44	1.14%	\$9.06	0.91%
9	Revenue Tax	\$0.00	0.00%	\$0.00	0.00%
10	Property Tax	\$41.59	4.16%	\$32.94	3.29%
11	Property Insurance	\$5.62	0.56%	\$4.45	0.45%
12	Other	\$47.21	4.72%	\$37.40	3.74%
13	Total Revenue Required	\$136.89	13.69%	\$108.44	10.84%

**Liberty Utilities (Granite State Electric) Corp. Marginal Cost Study**  
**Levelized Fixed Charge Analysis**  
**Line Transformers Investment**

Line No.	Item	Current Dollars (Engineer's FCR)		Constant Dollars (Economist's FCR)	
		Current Levelized Dollars	Percent Of Capital Investment	Constant Levelized Dollars	Percent Of Capital Investment
	(A)	(B) Att MFB-7 p9	(C) Col (B) x 0.001	(D) Att MFB-7 p9	(E) Col (D) x 0.001
1	Interest On Debt	\$14.97	1.50%	\$12.07	1.21%
2	Return On Preferred	\$0.00	0.00%	\$0.00	0.00%
3	Return On Common	\$30.65	3.07%	\$24.71	2.47%
4	Return	\$45.63	4.56%	\$36.78	3.68%
5	Depreciation	\$35.14	3.51%	\$28.33	2.83%
6	Income Tax	\$9.02	0.90%	\$7.27	0.73%
7	Deferred Taxes	\$2.37	0.24%	\$1.91	0.19%
8	Income Tax	\$11.38	1.14%	\$9.18	0.92%
9	Revenue Tax	\$0.00	0.00%	\$0.00	0.00%
10	Property Tax	\$41.33	4.13%	\$33.32	3.33%
11	Property Insurance	\$5.60	0.56%	\$4.52	0.45%
12	Other	\$46.93	4.69%	\$37.84	3.78%
13	Total Revenue Required	\$139.08	13.91%	\$112.12	11.21%

**Liberty Utilities (Granite State Electric) Corp. Marginal Cost Study**  
**Levelized Fixed Charge Analysis**  
**Services Investment**

Line No.	Item	Current Dollars (Engineer's FCR)		Constant Dollars (Economist's FCR)	
		Current Levelized Dollars	Percent Of Capital Investment	Constant Levelized Dollars	Percent Of Capital Investment
	(A)	(B) Att MFB-7 p10	(C) Col (B) x 0.001	(D) Att MFB-7 p10	(E) Col (D) x 0.001
1	Interest On Debt	\$13.29	1.33%	\$10.48	1.05%
2	Return On Preferred	\$0.00	0.00%	\$0.00	0.00%
3	Return On Common	\$27.21	2.72%	\$21.45	2.14%
4	Return	\$40.50	4.05%	\$31.92	3.19%
5	Depreciation	\$38.89	3.89%	\$30.65	3.07%
6	Income Tax	\$8.95	0.90%	\$7.06	0.71%
7	Deferred Taxes	\$1.15	0.12%	\$0.91	0.09%
8	Income Tax	\$10.10	1.01%	\$7.96	0.80%
9	Revenue Tax	\$0.00	0.00%	\$0.00	0.00%
10	Property Tax	\$37.80	3.78%	\$29.80	2.98%
11	Property Insurance	\$5.15	0.52%	\$4.06	0.41%
12	Other	\$42.95	4.30%	\$33.86	3.39%
13	Total Revenue Required	\$132.45	13.24%	\$104.39	10.44%

**Liberty Utilities (Granite State Electric) Corp. Marginal Cost Study**  
**Levelized Fixed Charge Analysis**  
**Metering Equipment**

Line No.	Item	Current Dollars (Engineer's FCR)		Constant Dollars (Economist's FCR)	
		Current Levelized Dollars	Percent Of Capital Investment	Constant Levelized Dollars	Percent Of Capital Investment
	(A)	(B) Att MFB-7 p11	(C) Col (B) x 0.001	(D) Att MFB-7 p11	(E) Col (D) x 0.001
1	Interest On Debt	\$15.02	1.50%	\$12.90	1.29%
2	Return On Preferred	\$0.00	0.00%	\$0.00	0.00%
3	Return On Common	\$30.74	3.07%	\$26.41	2.64%
4	Return	\$45.76	4.58%	\$39.31	3.93%
5	Depreciation	\$50.00	5.00%	\$42.96	4.30%
6	Income Tax	\$11.06	1.11%	\$9.50	0.95%
7	Deferred Taxes	\$0.36	0.04%	\$0.31	0.03%
8	Income Tax	\$11.42	1.14%	\$9.81	0.98%
9	Revenue Tax	\$0.00	0.00%	\$0.00	0.00%
10	Property Tax	\$40.31	4.03%	\$34.64	3.46%
11	Property Insurance	\$5.55	0.55%	\$4.76	0.48%
12	Other	\$45.86	4.59%	\$39.40	3.94%
13	Total Revenue Required	\$153.03	15.30%	\$131.49	13.15%

**Liberty Utilities (Granite State Electric) Corp. Marginal Cost Study**  
**Levelized Fixed Charge Analysis**  
**Street Lighting Investment**

Line No.	Item	Current Dollars (Engineer's FCR)		Constant Dollars (Economist's FCR)	
		Current Levelized Dollars	Percent Of Capital Investment	Constant Levelized Dollars	Percent Of Capital Investment
	(A)	(B) Att MFB-7 p12	(C) Col (B) x 0.001	(D) Att MFB-7 p12	(E) Col (D) x 0.001
1	Interest On Debt	\$15.62	1.56%	\$12.93	1.29%
2	Return On Preferred	\$0.00	0.00%	\$0.00	0.00%
3	Return On Common	\$31.99	3.20%	\$26.46	2.65%
4	Return	\$47.61	4.76%	\$39.39	3.94%
5	Depreciation	\$36.67	3.67%	\$30.33	3.03%
6	Income Tax	\$9.53	0.95%	\$7.88	0.79%
7	Deferred Taxes	\$2.35	0.24%	\$1.94	0.19%
8	Income Tax	\$11.88	1.19%	\$9.83	0.98%
9	Revenue Tax	\$0.00	0.00%	\$0.00	0.00%
10	Property Tax	\$42.70	4.27%	\$35.33	3.53%
11	Property Insurance	\$5.80	0.58%	\$4.80	0.48%
12	Other	\$48.50	4.85%	\$40.12	4.01%
13	Total Revenue Required	\$144.66	14.47%	\$119.67	11.97%

Liberty Utilities (Granite State Electric) Corp. - Development of Revenue Requirements Stream  
Primary and Secondary Capacity Related Distribution

Year No.	Rate Base (A)	Interest On Debt (B)	Return On Preferred (C)	Return On Common (D)	Tax Depreciation (E)	Tax Depreciation Rate (F)	Book Depreciation (G)	Deferred Taxes (H)	Taxable Income (I)	Income Tax Payable (J)	Revenue Tax (K)	Property Tax (L)	Property Insurance (M)	Annual	% of	Present	
														Revenue Requirements (N)	Original Investment Revenue (O)	Worth Of Revenue (P)	
1	1000.00						0.00	0.00									
1	966.23	25.96	0.00	53.14	37.50	3.750%	32.38	1.39	67.76	18.35		34.84	5.02	171.07	17.11%	159.20	
2	923.07	24.80	0.00	50.77	72.19	7.219%	32.38	10.78	29.81	8.07		35.71	5.11	167.62	16.76%	145.16	
3	881.38	23.68	0.00	48.48	66.77	6.677%	32.38	9.31	32.09	8.69		36.60	5.21	164.35	16.43%	132.45	
4	841.04	22.59	0.00	46.26	61.77	6.177%	32.38	7.96	34.05	9.22		37.52	5.31	161.24	16.12%	120.92	
5	801.95	21.54	0.00	44.11	57.13	5.713%	32.38	6.70	35.74	9.68		38.45	5.41	158.28	15.83%	110.46	
6	764.03	20.53	0.00	42.02	52.85	5.285%	32.38	5.54	37.16	10.06		39.42	5.51	155.46	15.55%	100.96	
7	727.18	19.54	0.00	39.99	48.88	4.888%	32.38	4.47	38.35	10.38		40.40	5.62	152.78	15.28%	92.34	
8	691.32	18.57	0.00	38.02	45.22	4.522%	32.38	3.48	39.30	10.64		41.41	5.73	150.23	15.02%	84.49	
9	655.63	17.61	0.00	36.06	44.62	4.462%	32.38	3.31	37.21	10.08		42.45	5.83	147.73	14.77%	77.32	
10	619.94	16.65	0.00	34.10	44.61	4.461%	32.38	3.31	34.53	9.35		43.51	5.94	145.25	14.52%	70.74	
11	584.24	15.70	0.00	32.13	44.62	4.462%	32.38	3.31	31.83	8.62		44.59	6.06	142.80	14.28%	64.72	
12	548.55	14.74	0.00	30.17	44.61	4.461%	32.38	3.31	29.15	7.89		45.71	6.17	140.37	14.04%	59.21	
13	512.85	13.78	0.00	28.21	44.62	4.462%	32.38	3.31	26.44	7.16		46.85	6.29	137.98	13.80%	54.16	
14	477.16	12.82	0.00	26.24	44.61	4.461%	32.38	3.31	23.76	6.43		48.02	6.41	135.62	13.56%	49.54	
15	441.46	11.86	0.00	24.28	44.62	4.462%	32.38	3.31	21.06	5.70		49.22	6.53	133.29	13.33%	45.31	
16	405.77	10.90	0.00	22.32	44.61	4.461%	32.38	3.31	18.38	4.98		50.45	6.66	131.00	13.10%	41.44	
17	370.08	9.94	0.00	20.35	44.62	4.462%	32.38	3.31	15.67	4.24		51.72	6.78	128.73	12.87%	37.89	
18	334.38	8.98	0.00	18.39	44.61	4.461%	32.38	3.31	12.99	3.52		53.01	6.91	126.51	12.65%	34.65	
19	298.69	8.02	0.00	16.43	44.62	4.462%	32.38	3.31	10.29	2.79		54.33	7.04	124.31	12.43%	31.69	
20	263.00	7.07	0.00	14.46	44.61	4.461%	32.38	3.31	7.61	2.06		55.69	7.18	122.15	12.22%	28.98	
21	233.34	6.27	0.00	12.83	22.31	2.231%	32.38	(2.73)	27.67	7.49		57.09	7.31	120.65	12.06%	26.63	
22	209.73	5.63	0.00	11.54	0.00		32.38	(8.77)	48.20	13.05		58.51	7.45	119.80	11.98%	24.61	
23	186.12	5.00	0.00	10.24	0.00		32.38	(8.77)	46.42	12.57		59.97	7.59	118.99	11.90%	22.75	
24	162.50	4.37	0.00	8.94	0.00		32.38	(8.77)	44.64	12.09		61.47	7.74	118.21	11.82%	21.03	
25	138.89	3.73	0.00	7.64	0.00		32.38	(8.77)	42.86	11.61		63.01	7.88	117.48	11.75%	19.45	
26	115.28	3.10	0.00	6.34	0.00		32.38	(8.77)	41.08	11.12		64.59	8.03	116.79	11.68%	17.99	
27	91.67	2.46	0.00	5.04	0.00		32.38	(8.77)	39.30	10.64		66.20	8.19	116.15	11.61%	16.65	
28	68.05	1.83	0.00	3.74	0.00		32.38	(8.77)	37.51	10.16		67.86	8.34	115.54	11.55%	15.41	
29	44.44	1.19	0.00	2.44	0.00		32.38	(8.77)	35.73	9.68		69.55	8.50	114.98	11.50%	14.28	
30	20.83	0.56	0.00	1.15	0.00		32.38	(8.77)	33.95	9.19		71.29	8.66	114.47	11.45%	13.22	
31	(2.78)	(0.07)	0.00	(0.15)	0.00		32.38	(8.77)	32.17	8.71		0.00	0.00	32.10	3.21%	3.45	
32	(26.39)	(0.71)	0.00	(1.45)	0.00		32.38	(8.77)	30.39	8.23		0.00	0.00	29.68	2.97%	2.97	
33	(50.01)	(1.34)	0.00	(2.75)	0.00		32.38	(8.77)	28.61	7.75		0.00	0.00	27.27	2.73%	2.54	
34	(73.62)	(1.98)	0.00	(4.05)	0.00		32.38	(8.77)	26.83	7.27		0.00	0.00	24.85	2.49%	2.15	
35	(97.23)	(2.61)	0.00	(5.35)	0.00		32.38	(8.77)	25.05	6.78		0.00	0.00	22.44	2.24%	1.81	
36	(120.84)	(3.25)	0.00	(6.65)	0.00		32.38	(8.77)	23.27	6.30		0.00	0.00	20.02	2.00%	1.50	
37	(144.46)	(3.88)	0.00	(7.95)	0.00		32.38	(8.77)	21.49	5.82		0.00	0.00	17.60	1.76%	1.23	
38	(168.07)	(4.52)	0.00	(9.24)	0.00		32.38	(8.77)	19.70	5.34		0.00	0.00	15.19	1.52%	0.99	
39	(191.68)	(5.15)	0.00	(10.54)	0.00		32.38	(8.77)	17.92	4.85		0.00	0.00	12.77	1.28%	0.77	
40	(215.29)	(5.78)	0.00	(11.84)	0.00		32.38	(8.77)	16.14	4.37		0.00	0.00	10.36	1.04%	0.58	
41	(238.91)	(6.42)	0.00	(13.14)	0.00		32.38	(8.77)	14.36	3.89		0.00	0.00	7.94	0.79%	0.42	
42	(262.52)	(7.05)	0.00	(14.44)	0.00		32.38	(8.77)	12.58	3.41		0.00	0.00	5.53	0.55%	0.27	
43	(392.39)	(10.54)	0.00	(21.58)	392.39		32.38	97.49	(389.60)	(105.50)		0.00	0.00	(7.76)	-0.78%	(0.35)	
Total		\$ 306.12	\$ -	\$ 626.70	\$ 1,392.39		\$ 1,392.39	\$ 0.00	\$ 859.44	\$ 232.74	\$ -	\$ 1,529.45	\$ 200.43	\$ 4,287.83	428.78%	\$ 1,751.97	
Present Worth		\$ 192.60	\$ -	\$ 394.31	\$ 543.95		\$ 414.44	\$ 35.07	\$ 411.23	\$ 111.36	\$ -	\$ 532.26	\$ 71.93	\$ 1,751.97	175.20%	\$ 984.30	
Levelized		\$ 15.05	\$ -	\$ 30.81	\$ 42.50		\$ 32.38	\$ 2.74	\$ 32.13	\$ 8.70	\$ -	\$ 41.59	\$ 5.62	\$ 136.89	13.69%	\$ -	
Payment Current \$																	
Levelized		\$ 11.92	\$ -	\$ 24.41	\$ 33.67		\$ 25.65	\$ 2.17	\$ 25.45	\$ 6.89	\$ -	\$ 32.94	\$ 4.45	\$ 108.44	10.84%	\$ -	
Payment Constant																	

Liberty Utilities (Granite State Electric) Corp. - Development of Revenue Requirements Stream  
Line Transformers Investment

Year No.	Rate Base	Interest On Debt	Return On Preferred	Return On Common	Tax Depreciation	Tax Depreciation Rate	Book Depreciation	Deferred Taxes	Taxable Income	Income Tax Payable	Revenue Tax	Property Tax	Property Insurance	Annual	% of	Present
														Revenue Requirements	Original Investment Revenue	Worth Of Revenue
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)
	1000.00						0.00	0.00								
1	964.22	25.90	0.00	53.03	37.50	3.750%	35.14	0.64	70.36	19.05		34.84	5.02	173.62	17.36%	161.57
2	919.05	24.69	0.00	50.55	72.19	7.219%	35.14	10.03	32.26	8.74		35.71	5.11	169.97	17.00%	147.19
3	875.35	23.52	0.00	48.14	66.77	6.677%	35.14	8.57	34.39	9.31		36.60	5.21	166.49	16.65%	134.17
4	833.01	22.38	0.00	45.82	61.77	6.177%	35.14	7.21	36.19	9.80		37.52	5.31	163.17	16.32%	122.37
5	791.91	21.27	0.00	43.56	57.13	5.713%	35.14	5.96	37.74	10.22		38.45	5.41	160.00	16.00%	111.67
6	751.98	20.20	0.00	41.36	52.85	5.285%	35.14	4.80	39.00	10.56		39.42	5.51	156.98	15.70%	101.95
7	713.12	19.16	0.00	39.22	48.88	4.888%	35.14	3.72	40.04	10.84		40.40	5.62	154.10	15.41%	93.13
8	675.26	18.14	0.00	37.14	45.22	4.522%	35.14	2.73	40.85	11.06		41.41	5.73	151.34	15.13%	85.12
9	637.55	17.13	0.00	35.07	44.62	4.462%	35.14	2.57	38.60	10.45		42.45	5.83	148.63	14.86%	77.79
10	599.85	16.12	0.00	32.99	44.61	4.461%	35.14	2.57	35.77	9.69		43.51	5.94	145.95	14.59%	71.08
11	562.15	15.10	0.00	30.92	44.62	4.462%	35.14	2.57	32.92	8.91		44.59	6.06	143.29	14.33%	64.94
12	524.45	14.09	0.00	28.84	44.61	4.461%	35.14	2.57	30.08	8.15		45.71	6.17	140.66	14.07%	59.33
13	486.75	13.08	0.00	26.77	44.62	4.462%	35.14	2.57	27.23	7.37		46.85	6.29	138.07	13.81%	54.19
14	449.04	12.06	0.00	24.70	44.61	4.461%	35.14	2.57	24.39	6.61		48.02	6.41	135.50	13.55%	49.49
15	411.34	11.05	0.00	22.62	44.62	4.462%	35.14	2.57	21.54	5.83		49.22	6.53	132.97	13.30%	45.20
16	373.64	10.04	0.00	20.55	44.61	4.461%	35.14	2.57	18.71	5.07		50.45	6.66	130.47	13.05%	41.27
17	335.94	9.02	0.00	18.48	44.62	4.462%	35.14	2.57	15.85	4.29		51.72	6.78	128.00	12.80%	37.68
18	298.24	8.01	0.00	16.40	44.61	4.461%	35.14	2.57	13.02	3.53		53.01	6.91	125.56	12.56%	34.39
19	260.53	7.00	0.00	14.33	44.62	4.462%	35.14	2.57	10.17	2.75		54.33	7.04	123.16	12.32%	31.40
20	222.83	5.99	0.00	12.26	44.61	4.461%	35.14	2.57	7.33	1.99		55.69	7.18	120.80	12.08%	28.66
21	191.17	5.14	0.00	10.51	22.31	2.231%	35.14	(3.47)	27.24	7.38		57.09	7.31	119.09	11.91%	26.29
22	165.55	4.45	0.00	9.11	0.00		35.14	(9.51)	47.62	12.90		58.51	7.45	118.03	11.80%	24.25
23	139.93	3.76	0.00	7.70	0.00		35.14	(9.51)	45.69	12.37		59.97	7.59	117.02	11.70%	22.37
24	114.31	3.07	0.00	6.29	0.00		35.14	(9.51)	43.76	11.85		61.47	7.74	116.04	11.60%	20.64
25	88.69	2.38	0.00	4.88	0.00		35.14	(9.51)	41.82	11.33		63.01	7.88	115.10	11.51%	19.06
26	63.07	1.69	0.00	3.47	0.00		35.14	(9.51)	39.89	10.80		64.59	8.03	114.21	11.42%	17.59
27	37.45	1.01	0.00	2.06	0.00		35.14	(9.51)	37.96	10.28		66.20	8.19	113.35	11.34%	16.25
28	11.82	0.32	0.00	0.65	0.00		35.14	(9.51)	36.03	9.76		67.86	8.34	112.54	11.25%	15.01
29	(13.80)	(0.37)	0.00	(0.76)	0.00		35.14	(9.51)	34.09	9.23		0.00	0.00	33.72	3.37%	4.19
30	(39.42)	(1.06)	0.00	(2.17)	0.00		35.14	(9.51)	32.16	8.71		0.00	0.00	31.10	3.11%	3.59
31	(65.04)	(1.75)	0.00	(3.58)	0.00		35.14	(9.51)	30.23	8.19		0.00	0.00	28.48	2.85%	3.06
32	(90.66)	(2.44)	0.00	(4.99)	0.00		35.14	(9.51)	28.30	7.66		0.00	0.00	25.86	2.59%	2.59
33	(116.28)	(3.12)	0.00	(6.40)	0.00		35.14	(9.51)	26.36	7.14		0.00	0.00	23.24	2.32%	2.16
34	(141.90)	(3.81)	0.00	(7.80)	0.00		35.14	(9.51)	24.43	6.62		0.00	0.00	20.62	2.06%	1.79
35	(167.52)	(4.50)	0.00	(9.21)	0.00		35.14	(9.51)	22.50	6.09		0.00	0.00	18.00	1.80%	1.45
36	(193.14)	(5.19)	0.00	(10.62)	0.00		35.14	(9.51)	20.57	5.57		0.00	0.00	15.38	1.54%	1.15
37	(300.00)	(8.06)	0.00	(16.50)	300.00		35.14	71.73	(287.49)	(77.85)		0.00	0.00	4.45	0.44%	0.31
Total	\$ 305.47	\$ -	\$ -	\$ 625.38	\$ 1,300.00		\$ 1,300.00	\$ 0.00	\$ 857.62	\$ 232.24	\$ -	\$ 1,388.61	\$ 183.27	\$ 4,034.96	403.50%	\$ 1,734.34
Present Worth	\$ 186.72	\$ -	\$ -	\$ 382.26	\$ 547.10		\$ 438.15	\$ 29.50	\$ 415.27	\$ 112.45	\$ -	\$ 515.39	\$ 69.87	\$ 1,734.34	173.43%	\$ 989.92
Levelized Payment Current	\$ 14.97	\$ -	\$ -	\$ 30.65	\$ 43.87		\$ 35.14	\$ 2.37	\$ 33.30	\$ 9.02	\$ -	\$ 41.33	\$ 5.60	\$ 139.08	13.91%	
Levelized Payment Constant	\$ 12.07	\$ -	\$ -	\$ 24.71	\$ 35.37		\$ 28.33	\$ 1.91	\$ 26.85	\$ 7.27	\$ -	\$ 33.32	\$ 4.52	\$ 112.12	11.21%	

Liberty Utilities (Granite State Electric) Corp. - Development of Revenue Requirements Stream  
Services Investment

Year No.	Rate Base (A)	Interest On Debt (B)	Return On Preferred (C)	Return On Common (D)	Tax Depreciation (E)	Tax Depreciation Rate (F)	Book Depreciation (G)	Deferred Taxes (H)	Taxable Income (I)	Income Tax Payable (J)	Revenue Tax (K)	Property Tax (L)	Property Insurance (M)	Annual	% of	Present
														Revenue Requirements (N)	Original Investment Revenue (O)	Worth Of Revenue (P)
1	1000.00						0.00	0.00								
1	961.49	25.83	0.00	52.88	37.50	3.750%	38.89	(0.38)	73.91	20.01		34.84	5.02	177.10	17.71%	164.80
2	913.58	24.54	0.00	50.25	72.19	7.219%	38.89	9.02	35.61	9.64		35.71	5.11	173.16	17.32%	149.96
3	867.14	23.30	0.00	47.69	66.77	6.677%	38.89	7.55	37.52	10.16		36.60	5.21	169.40	16.94%	136.52
4	822.06	22.08	0.00	45.21	61.77	6.177%	38.89	6.20	39.12	10.59		37.52	5.31	165.80	16.58%	124.34
5	778.23	20.91	0.00	42.80	57.13	5.713%	38.89	4.94	40.46	10.96		38.45	5.41	162.36	16.24%	113.31
6	735.56	19.76	0.00	40.46	52.85	5.285%	38.89	3.78	41.52	11.24		39.42	5.51	159.06	15.91%	103.30
7	693.96	18.64	0.00	38.17	48.88	4.888%	38.89	2.71	42.35	11.47		40.40	5.62	155.89	15.59%	94.22
8	653.36	17.55	0.00	35.93	45.22	4.522%	38.89	1.71	42.95	11.63		41.41	5.73	152.86	15.29%	85.97
9	612.92	16.47	0.00	33.71	44.62	4.462%	38.89	1.55	40.50	10.97		42.45	5.83	149.86	14.99%	78.44
10	572.48	15.38	0.00	31.49	44.61	4.461%	38.89	1.55	37.46	10.14		43.51	5.94	146.90	14.69%	71.55
11	532.04	14.29	0.00	29.26	44.62	4.462%	38.89	1.55	34.40	9.32		44.59	6.06	143.96	14.40%	65.25
12	491.60	13.21	0.00	27.04	44.61	4.461%	38.89	1.55	31.36	8.49		45.71	6.17	141.06	14.11%	59.50
13	451.16	12.12	0.00	24.81	44.62	4.462%	38.89	1.55	28.30	7.66		46.85	6.29	138.18	13.82%	54.24
14	410.72	11.03	0.00	22.59	44.61	4.461%	38.89	1.55	25.26	6.84		48.02	6.41	135.34	13.53%	49.43
15	370.28	9.95	0.00	20.37	44.62	4.462%	38.89	1.55	22.20	6.01		49.22	6.53	132.52	13.25%	45.04
16	329.84	8.86	0.00	18.14	44.61	4.461%	38.89	1.55	19.16	5.19		50.45	6.66	129.74	12.97%	41.04
17	289.40	7.77	0.00	15.92	44.62	4.462%	38.89	1.55	16.10	4.36		51.72	6.78	126.99	12.70%	37.38
18	248.97	6.69	0.00	13.69	44.61	4.461%	38.89	1.55	13.06	3.54		53.01	6.91	124.28	12.43%	34.04
19	208.52	5.60	0.00	11.47	44.62	4.462%	38.89	1.55	10.00	2.71		54.33	7.04	121.60	12.16%	31.00
20	168.09	4.52	0.00	9.24	44.61	4.461%	38.89	1.55	6.96	1.88		55.69	7.18	118.95	11.90%	28.22
21	133.69	3.59	0.00	7.35	22.31	2.231%	38.89	(4.49)	26.66	7.22		57.09	7.31	116.96	11.70%	25.82
22	105.33	2.83	0.00	5.79	0.00		38.89	(10.53)	46.83	12.68		58.51	7.45	115.63	11.56%	23.75
23	76.97	2.07	0.00	4.23	0.00		38.89	(10.53)	44.69	12.10		59.97	7.59	114.33	11.43%	21.86
24	48.61	1.31	0.00	2.67	0.00		38.89	(10.53)	42.56	11.52		61.47	7.74	113.07	11.31%	20.12
25	20.26	0.54	0.00	1.11	0.00		38.89	(10.53)	40.42	10.94		63.01	7.88	111.86	11.19%	18.52
26	(8.10)	(0.22)	0.00	(0.45)	0.00		38.89	(10.53)	38.28	10.37		0.00	0.00	38.06	3.81%	5.86
27	(36.46)	(0.98)	0.00	(2.01)	0.00		38.89	(10.53)	36.14	9.79		0.00	0.00	35.16	3.52%	5.04
28	(64.82)	(1.74)	0.00	(3.56)	0.00		38.89	(10.53)	34.00	9.21		0.00	0.00	32.26	3.23%	4.30
29	(93.18)	(2.50)	0.00	(5.12)	0.00		38.89	(10.53)	31.86	8.63		0.00	0.00	29.36	2.94%	3.64
30	(121.53)	(3.26)	0.00	(6.68)	0.00		38.89	(10.53)	29.72	8.05		0.00	0.00	26.46	2.65%	3.06
31	(149.89)	(4.03)	0.00	(8.24)	0.00		38.89	(10.53)	27.58	7.47		0.00	0.00	23.56	2.36%	2.53
32	(178.25)	(4.79)	0.00	(9.80)	0.00		38.89	(10.53)	25.44	6.89		0.00	0.00	20.66	2.07%	2.07
33	(206.61)	(5.55)	0.00	(11.36)	0.00		38.89	(10.53)	23.31	6.31		0.00	0.00	17.76	1.78%	1.65
34	(234.96)	(6.31)	0.00	(12.92)	0.00		38.89	(10.53)	21.17	5.73		0.00	0.00	14.85	1.49%	1.29
35	(263.32)	(7.07)	0.00	(14.48)	0.00		38.89	(10.53)	19.03	5.15		0.00	0.00	11.95	1.20%	0.96
36	(291.68)	(7.84)	0.00	(16.04)	0.00		38.89	(10.53)	16.89	4.57		0.00	0.00	9.05	0.91%	0.68
37	(320.04)	(8.60)	0.00	(17.60)	0.00		38.89	(10.53)	14.75	3.99		0.00	0.00	6.15	0.62%	0.43
38	(348.40)	(9.36)	0.00	(19.16)	0.00		38.89	(10.53)	12.61	3.42		0.00	0.00	3.25	0.33%	0.21
39	(376.75)	(10.12)	0.00	(20.72)	0.00		38.89	(10.53)	10.47	2.84		0.00	0.00	0.35	0.04%	0.02
40	(405.11)	(10.88)	0.00	(22.28)	0.00		38.89	(10.53)	8.33	2.26		0.00	0.00	(2.55)	-0.25%	(0.14)
41	(433.47)	(11.65)	0.00	(23.84)	0.00		38.89	(10.53)	6.19	1.68		0.00	0.00	(5.45)	-0.55%	(0.29)
42	(461.83)	(12.41)	0.00	(25.40)	0.00		38.89	(10.53)	4.06	1.10		0.00	0.00	(8.35)	-0.84%	(0.41)
43	(490.18)	(13.17)	0.00	(26.96)	0.00		38.89	(10.53)	1.92	0.52		0.00	0.00	(11.25)	-1.13%	(0.51)
44	(518.54)	(13.93)	0.00	(28.52)	0.00		38.89	(10.53)	(0.22)	(0.06)		0.00	0.00	(14.15)	-1.42%	(0.60)
45	(750.00)	(20.15)	0.00	(41.25)	750.00		38.89	192.57	(767.68)	(207.89)		0.00	0.00	(37.83)	-3.78%	(1.49)
Total	\$ 154.29	\$ -	\$ -	\$ 315.87	\$ 1,750.00		\$ 1,750.00	\$ 0.00	\$ 433.18	\$ 117.30	\$ -	\$ 1,189.97	\$ 158.70	\$ 3,686.14	368.61%	\$ 1,705.91
Present Worth Levelized	\$ 171.18	\$ -	\$ -	\$ 350.45	\$ 555.61		\$ 500.89	\$ 14.82	\$ 425.89	\$ 115.33	\$ -	\$ 486.89	\$ 66.35	\$ 1,705.91	170.59%	\$ 996.25
Payment Current Levelized	\$ 13.29	\$ -	\$ -	\$ 27.21	\$ 43.14		\$ 38.89	\$ 1.15	\$ 33.07	\$ 8.95	\$ -	\$ 37.80	\$ 5.15	\$ 132.45	13.24%	
Payment Constant	\$ 10.48	\$ -	\$ -	\$ 21.45	\$ 34.00		\$ 30.65	\$ 0.91	\$ 26.06	\$ 7.06	\$ -	\$ 29.80	\$ 4.06	\$ 104.39	10.44%	

**Liberty Utilities (Granite State Electric) Corp. - Development of Revenue Requirements Stream  
Metering Equipment**

Year No.	Rate Base	Interest On Debt	Return On Preferred	Return On Common	Tax Depreciation	Tax Depreciation Rate	Book Depreciation	Deferred Tax	Taxable Income	Income Tax Payable	Revenue Tax	Property Tax	Property Insurance	Annual	% of	Present
														Revenue Requirements	Original Investment Revenue	Worth Of Revenue
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)
	1000.00						0.00	0.00								
1	953.39	25.61	0.00	52.44	37.50	3.750%	50.00	(3.39)	84.41	22.86		34.84	5.02	187.38	18.74%	174.37
2	897.38	24.11	0.00	49.36	72.19	7.219%	50.00	6.01	45.49	12.32		35.71	5.11	182.61	18.26%	158.14
3	842.83	22.64	0.00	46.36	66.77	6.677%	50.00	4.54	46.80	12.67		36.60	5.21	178.03	17.80%	143.47
4	789.65	21.21	0.00	43.43	61.77	6.177%	50.00	3.19	47.79	12.94		37.52	5.31	173.60	17.36%	130.19
5	737.72	19.82	0.00	40.57	57.13	5.713%	50.00	1.93	48.51	13.14		38.45	5.41	169.33	16.93%	118.17
6	686.94	18.45	0.00	37.78	52.85	5.285%	50.00	0.77	48.96	13.26		39.42	5.51	165.20	16.52%	107.29
7	637.25	17.12	0.00	35.05	48.88	4.888%	50.00	(0.30)	49.18	13.32		40.40	5.62	161.20	16.12%	97.43
8	588.54	15.81	0.00	32.37	45.22	4.522%	50.00	(1.29)	49.17	13.32		41.41	5.73	157.34	15.73%	88.49
9	540.00	14.51	0.00	29.70	44.62	4.462%	50.00	(1.46)	46.11	12.49		42.45	5.83	153.52	15.35%	80.35
10	491.46	13.20	0.00	27.03	44.61	4.461%	50.00	(1.46)	42.46	11.50		43.51	5.94	149.72	14.97%	72.92
11	442.92	11.90	0.00	24.36	44.62	4.462%	50.00	(1.46)	38.79	10.50		44.59	6.06	145.96	14.60%	66.15
12	394.38	10.59	0.00	21.69	44.61	4.461%	50.00	(1.46)	35.14	9.51		45.71	6.17	142.22	14.22%	59.99
13	345.83	9.29	0.00	19.02	44.62	4.462%	50.00	(1.46)	31.46	8.52		46.85	6.29	138.52	13.85%	54.37
14	297.29	7.99	0.00	16.35	44.61	4.461%	50.00	(1.46)	27.81	7.53		48.02	6.41	134.84	13.48%	49.25
15	248.75	6.68	0.00	13.68	44.62	4.462%	50.00	(1.46)	24.14	6.54		49.22	6.53	131.20	13.12%	44.60
16	200.21	5.38	0.00	11.01	44.61	4.461%	50.00	(1.46)	20.49	5.55		50.45	6.66	127.59	12.76%	40.36
17	151.67	4.07	0.00	8.34	44.62	4.462%	50.00	(1.46)	16.82	4.55		51.72	6.78	124.01	12.40%	36.50
18	103.13	2.77	0.00	5.67	44.61	4.461%	50.00	(1.46)	13.17	3.57		53.01	6.91	120.47	12.05%	33.00
19	54.58	1.47	0.00	3.00	44.62	4.462%	50.00	(1.46)	9.50	2.57		54.33	7.04	116.96	11.70%	29.81
20	6.04	0.16	0.00	0.33	44.61	4.461%	50.00	(1.46)	5.85	1.58		55.69	7.18	113.49	11.35%	26.92
21	(36.46)	(0.98)	0.00	(2.01)	22.31	2.231%	50.00	(7.50)	24.94	6.75		0.00	0.00	46.27	4.63%	10.21
22	(100.00)	(2.69)	0.00	(5.50)	100.00		50.00	13.54	(57.54)	(15.58)		0.00	0.00	39.77	3.98%	8.17
Total		\$ 249.13	\$ -	\$ 510.04	\$ 1,100.00		\$ 1,100.00	\$ 0.00	\$ 699.45	\$ 189.41	\$ -	\$ 889.91	\$120.73	\$ 3,059.22	305.92%	\$ 1,630.15
Present Worth		\$ 159.95	\$ -	\$ 327.46	\$ 546.70		\$ 532.63	\$ 3.81	\$ 435.00	\$ 117.80	\$ -	\$ 429.44	\$ 59.07	\$ 1,630.15	163.02%	\$ 1,011.08
Levelized Payment Current \$		\$ 15.02	\$ -	\$ 30.74	\$ 51.32		\$ 50.00	\$ 0.36	\$ 40.84	\$ 11.06	\$ -	\$ 40.31	\$ 5.55	\$ 153.03	15.30%	
Levelized Payment Constant \$		\$ 12.90	\$ -	\$ 26.41	\$ 44.10		\$ 42.96	\$ 0.31	\$ 35.09	\$ 9.50	\$ -	\$ 34.64	\$ 4.76	\$ 131.49	13.15%	

**Liberty Utilities (Granite State Electric) Corp. - Development of Revenue Requirements Stream**  
**Street Lighting Investment**

Year No.	Rate Base (A)	Interest On Debt (B)	Return On Preferred (C)	Return On Common (D)	Tax Depreciation (E)	Tax Depreciation Rate (F)	Book Depreciation (G)	Deferred Tax (H)	Taxable Income (I)	Income Tax Payable (J)	Revenue Tax (K)	Property Tax (L)	Property Insurance (M)	Annual	% of	Present	
														Revenue Requirements (N)	Original Investment Revenue (O)	Worth Of Revenue (P)	
	1000.00						0.00	0.00									
1	963.11	25.87	0.00	52.97	37.50	3.750%	36.67	0.23	71.81	19.45		34.84	5.02	175.04	17.50%	162.89	
2	916.82	24.63	0.00	50.43	72.19	7.219%	36.67	9.62	33.63	9.11		35.71	5.11	171.27	17.13%	148.32	
3	872.00	23.43	0.00	47.96	66.77	6.677%	36.67	8.15	35.67	9.66		36.60	5.21	167.68	16.77%	135.13	
4	828.54	22.26	0.00	45.57	61.77	6.177%	36.67	6.80	37.39	10.13		37.52	5.31	164.24	16.42%	123.17	
5	786.33	21.12	0.00	43.25	57.13	5.713%	36.67	5.54	38.85	10.52		38.45	5.41	160.97	16.10%	112.34	
6	745.28	20.02	0.00	40.99	52.85	5.285%	36.67	4.38	40.03	10.84		39.42	5.51	157.83	15.78%	102.50	
7	705.31	18.95	0.00	38.79	48.88	4.888%	36.67	3.31	40.98	11.10		40.40	5.62	154.83	15.48%	93.58	
8	666.32	17.90	0.00	36.65	45.22	4.522%	36.67	2.32	41.70	11.29		41.41	5.73	151.96	15.20%	85.47	
9	627.50	16.86	0.00	34.51	44.62	4.462%	36.67	2.15	39.38	10.66		42.45	5.83	149.13	14.91%	78.05	
10	588.69	15.82	0.00	32.38	44.61	4.461%	36.67	2.15	36.46	9.87		43.51	5.94	146.34	14.63%	71.27	
11	549.87	14.77	0.00	30.24	44.62	4.462%	36.67	2.15	33.52	9.08		44.59	6.06	143.56	14.36%	65.07	
12	511.05	13.73	0.00	28.11	44.61	4.461%	36.67	2.15	30.60	8.29		45.71	6.17	140.82	14.08%	59.40	
13	472.23	12.69	0.00	25.97	44.62	4.462%	36.67	2.15	27.66	7.49		46.85	6.29	138.11	13.81%	54.21	
14	433.41	11.64	0.00	23.84	44.61	4.461%	36.67	2.15	24.75	6.70		48.02	6.41	135.43	13.54%	49.47	
15	394.59	10.60	0.00	21.70	44.62	4.462%	36.67	2.15	21.81	5.91		49.22	6.53	132.78	13.28%	45.13	
16	355.77	9.56	0.00	19.57	44.61	4.461%	36.67	2.15	18.89	5.12		50.45	6.66	130.17	13.02%	41.17	
17	316.95	8.51	0.00	17.43	44.62	4.462%	36.67	2.15	15.95	4.32		51.72	6.78	127.59	12.76%	37.56	
18	278.13	7.47	0.00	15.30	44.61	4.461%	36.67	2.15	13.03	3.53		53.01	6.91	125.04	12.50%	34.25	
19	239.31	6.43	0.00	13.16	44.62	4.462%	36.67	2.15	10.10	2.73		54.33	7.04	122.52	12.25%	31.23	
20	200.49	5.39	0.00	11.03	44.61	4.461%	36.67	2.15	7.18	1.94		55.69	7.18	120.04	12.00%	28.48	
21	167.72	4.51	0.00	9.22	22.31	2.231%	36.67	(3.89)	27.01	7.31		57.09	7.31	118.22	11.82%	26.10	
22	140.98	3.79	0.00	7.75	0.00		36.67	(9.93)	47.30	12.81		58.51	7.45	117.05	11.71%	24.05	
23	114.24	3.07	0.00	6.28	0.00		36.67	(9.93)	45.28	12.26		59.97	7.59	115.92	11.59%	22.16	
24	87.50	2.35	0.00	4.81	0.00		36.67	(9.93)	43.27	11.72		61.47	7.74	114.83	11.48%	20.43	
25	60.77	1.63	0.00	3.34	0.00		36.67	(9.93)	41.25	11.17		63.01	7.88	113.78	11.38%	18.84	
26	34.03	0.91	0.00	1.87	0.00		36.67	(9.93)	39.23	10.62		64.59	8.03	112.77	11.28%	17.37	
27	7.29	0.20	0.00	0.40	0.00		36.67	(9.93)	37.22	10.08		66.20	8.19	111.80	11.18%	16.03	
28	(19.45)	(0.52)	0.00	(1.07)	0.00		36.67	(9.93)	35.20	9.53		0.00	0.00	34.68	3.47%	4.63	
29	(46.18)	(1.24)	0.00	(2.54)	0.00		36.67	(9.93)	33.18	8.99		0.00	0.00	31.94	3.19%	3.97	
30	(100.00)	(2.69)	0.00	(5.50)	100.00		36.67	17.15	(70.88)	(19.19)		0.00	0.00	26.44	2.64%	3.05	
<b>Total</b>		\$ 319.66	\$ -	\$ 654.42	\$ 1,100.00		\$ 1,100.00	\$ (0.00)	\$ 897.45	\$ 243.03	\$ -	\$ 1,320.75	\$ 174.92	\$ 3,812.79	381.28%	\$ 1,715.29	
<b>Present Worth</b>		\$ 185.27	\$ -	\$ 379.29	\$ 537.71		\$ 434.78	\$ 27.87	\$ 417.22	\$ 112.98	\$ -	\$ 506.33	\$ 68.76	\$ 1,715.29	171.53%	\$ 991.98	
<b>Levelized Payment Current \$</b>		\$ 15.62	\$ -	\$ 31.99	\$ 45.35		\$ 36.67	\$ 2.35	\$ 35.19	\$ 9.53	\$ -	\$ 42.70	\$ 5.80	\$ 144.66	14.47%		
<b>Levelized Payment Constant \$</b>		\$ 12.93	\$ -	\$ 26.46	\$ 37.51		\$ 30.33	\$ 1.94	\$ 29.11	\$ 7.88	\$ -	\$ 35.33	\$ 4.80	\$ 119.67	11.97%		

**Liberty Utilities (Granite State Electric) Corp. Marginal Cost Study**  
**Development of Weighted Plant Book Lives and Salvage**

Line No.	Description	2018 Plant Balance	Average Service Life	Net Salvage Value
	(A)	(B)	(C)	(D)
		Company Data	Company Data	Company Data
1	<b>Distribution Investment - Primary and Secondary Capacity Related</b>			
2	360 Land and Land Rights	\$ 1,672,947	0	0%
3	361 Structures and Improvements	\$ 1,965,160	44	-5%
4	362 Station Equipment	\$ 30,756,049	40	-20%
5	363 Storage Battery Equipment	\$0	0	0%
6	364 Poles, Towers and Fixtures	\$ 41,667,046	44	-60%
7	365 Overhead Conductors and Devices	\$ 65,174,236	43	-40%
8	366 Underground Conduit	\$ 6,948,378	56	-10%
9	367 Underground Conductors and Devices	\$ 17,274,059	46	-40%
10	Total Distribution Primary and Secondary Capacity-Related	\$165,457,875	43	-39%
11	368 Line Transformers		37	-30%
12	369 Services		45	-75%
13	370 Meters		22	-10%
14	373 Street Lighting and signal systems		30	-10%

Liberty Utilities (Granite State Electric) Corp.  
Marginal Cost Study

Summary of Marginal Capacity Costs

Line No.		Primary - Peak Demand	Source	Secondary - Peak Demand	Source	Transformers - Peak Demand	Source
1	Plant Investment						
2	Marginal Distribution Capacity Costs	\$115,690	Att MFB-1 p1, Line 22	\$82,116	Att MFB-1 p2, Line 22	\$84,022	Att MFB-1 p3, Line 23
3	Marginal General Plant Loading Factor	10.16%	Att MFB-6 p3, Line 22	10.16%	Att MFB-6 p3, Line 22	10.16%	Att MFB-6 p3, Line 22
4							
5	Total Marginal Plant Investment	\$127,439	Line 2 x (1 + Line 3)	\$90,456	Line 2 x (1 + Line 3)	\$92,555	Line 2 x (1 + Line 3)
6							
7	Fixed Carrying Charge Rate	10.84%	Att MFB-7 p1, Col (C), Line 3	10.84%	Att MFB-7 p1, Col (C), Line 3	11.21%	Att MFB-7 p1, Col (C), Line 4
8							
9	Levelized, Annualized Cost of Marginal Plant Investment	\$13,819	Line 5 x Line 7	\$9,809	Line 5 x Line 7	\$10,377	Line 5 x Line 7
10							
11	Operations and Maintenance Expenses						
12	Marginal Operating Expense	\$35,927	Att MFB-4 p1, Line 24	\$3,410	Att MFB-4 p2, Line 25	\$1,458	Att MFB-4 p3, Line 26
13	Marginal Maintenance Expense	\$16,349	Att MFB-4 p4, Line 24	\$9,625	Att MFB-4 p5, Line 23	\$2,846	Att MFB-4 p6, Line 22
14							
15	Total Marginal O&M Expense	\$52,276	Line 12 + Line 13	\$13,035	Line 12 + Line 13	\$4,305	Line 12 + Line 13
16							
17	Administrative and General Expenses						
18	Marginal Plant related A&G per \$ of Marginal Plant Investment	3.53%	Att MFB-6 p1, Line 30	3.53%	Att MFB-6 p1, Line 30	3.53%	Att MFB-6 p1, Line 30
19	Plant related A&G Expense	\$4,505	Line 5 x Line 18	\$3,198	Line 5 x Line 18	\$3,272	Line 5 x Line 18
20							
21	Marginal Non-Plant related A&G per \$ of Marginal O&M Expense	3.73%	Att MFB-6 p1, Line 28	3.73%	Att MFB-6 p1, Line 28	3.73%	Att MFB-6 p1, Line 28
22	Non-Plant related A&G Expense	\$1,947	Line 15 x Line 21	\$486	Line 15 x Line 21	\$160	Line 15 x Line 21
23							
24	Total A&G Expense	\$6,452	Line 19 + Line 22	\$3,683	Line 19 + Line 22	\$3,432	Line 19 + Line 22
25							
26	Marginal Working Capital Calculations						
27	Marginal M&S and Prepayments per \$ of Marginal Plant Investment	2.07%	Att MFB-6 p2, Line 22	2.07%	Att MFB-6 p2, Line 22	2.07%	Att MFB-6 p2, Line 22
28	M&S Cost	\$2,642	Line 5 x Line 27	\$1,875	Line 5 x Line 27	\$1,919	Line 5 x Line 27
29							
30	Cash Working Capital Allowance Rate	6.99%	25.5 Days / 365	6.99%	25.5 Days / 365	6.99%	25.5 Days / 365
31	Working Cash O&M Allowance	\$3,654	Line 15 x Line 30	\$911	Line 15 x Line 30	\$301	Line 15 x Line 30
			(Line 28 + Line 31) x Tax Effectuated Cost of Capital, Att MFB-7 p1, Col (C), Line 16		(Line 28 + Line 31) x Tax Effectuated Cost of Capital, Att MFB-7 p1, Col (C), Line 16		(Line 28 + Line 31) x Tax Effectuated Cost of Capital, Att MFB-7 p1, Col (C), Line 16
32	Revenue Requirement for Working Capital	\$644		\$285		\$227	
33							
34	Total Marginal Cost per MW	\$73,192	∑ Lines 9, 15, 24, 32	\$26,812	∑ Lines 9, 15, 24, 32	\$18,341	∑ Lines 9, 15, 24, 32
35	Escalator to Adjust to 2020 Rate Year	3.84%	((1 + Att MFB-7 p1, Col (C), Line 19) <sup>2</sup> - 1)	3.84%	((1 + Att MFB-7 p1, Col (C), Line 19) <sup>2</sup> - 1)	3.84%	((1 + Att MFB-7 p1, Col (C), Line 19) <sup>2</sup> - 1)
36	<b>Total Adjusted Marginal Cost per MW</b>	<b>\$75,999</b>	Line 34 x (1 + Line 35)	<b>\$27,841</b>	Line 34 x (1 + Line 35)	<b>\$19,045</b>	Line 34 x (1 + Line 35)

**Liberty Utilities (Granite State Electric) Corp.  
 Marginal Cost Study**

**Calculation of Loss-Adjusted Marginal Costs**

Line No.	Description	Marginal Costs	Explanation
1	Loss Factors		
2	Distribution - Primary	3.80%	Company Data
3	Distribution - Secondary	6.90%	Company Data
4			
5	Marginal Costs to Serve - Transmission Level per kW		
6	Distribution - Primary	\$76.00	Att MFB-8 p1, Line 36 / 1000
7	Distribution - Secondary	\$27.84	Att MFB-8 p1, Line 36 / 1000
8	Distribution - Line Transformers	\$19.04	Att MFB-8 p1, Line 36 / 1000
9			
10	Marginal Costs to Serve per kW: Distribution Primary Customer		
11	Distribution - Primary Component	\$78.89	(1 + Line 2) x Line 6
12	<b>Total</b>	<b>\$78.89</b>	
13			
14	Marginal Costs to Serve per kW: Distribution Secondary Customer		
15	Distribution - Primary Component	\$81.24	(1 + Line 3) x Line 6
16	Distribution - Secondary Component	\$29.76	(1 + Line 3) x Line 7
17	Distribution - Line Transformer Component	\$20.36	(1 + Line 3) x Line 8
18	<b>Total</b>	<b>\$131.36</b>	Σ Lines 15 - 17

**Liberty Utilities (Granite State Electric) Corp.  
Marginal Cost Study**

**Calculation of Marginal Capacity Costs by Rate Class (Peak Demand)**

Line No.	Description	Domestic D	Domestic-Opt. Peak D-10	General TOU G-1	General Long Hour G-2	General Service G-3	Outdoor Lighting M	Limited All Electric T	Ltd Comm Space V	Explanation
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)
1	<b>Marginal Capacity Costs</b>									
2	Marginal Costs to Serve per kW: Distribution Primary Customer									
3	Distribution - Primary Component	\$ 78.89	\$ 78.89	\$ 78.89	\$ 78.89	\$ 78.89		\$ 78.89	\$ 78.89	Att MFB-8 p2, Line 11
4	Distribution - Secondary Component	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	
5	Distribution - Line Transformer Component	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	
6	<b>Total</b>	\$ 78.89	\$ 78.89	\$ 78.89	\$ 78.89	\$ 78.89	N/A	\$ 78.89	\$ 78.89	Σ Lines 3 - 5
7	Marginal Costs to Serve per kW: Distribution Secondary Customer									
8	Distribution - Primary Component	\$ 81.24	\$ 81.24	\$ 81.24	\$ 81.24	\$ 81.24		\$ 81.24	\$ 81.24	Att MFB-8 p2, Line 15
9	Distribution - Secondary Component	\$ 29.76	\$ 29.76	\$ 29.76	\$ 29.76	\$ 29.76		\$ 29.76	\$ 29.76	Att MFB-8 p2, Line 16
10	Distribution - Line Transformer Component	\$ 20.36	\$ 20.36	\$ 20.36	\$ 20.36	\$ 20.36		\$ 20.36	\$ 20.36	Att MFB-8 p2, Line 17
11	<b>Total</b>	\$ 131.36	\$ 131.36	\$ 131.36	\$ 131.36	\$ 131.36	N/A	\$ 131.36	\$ 131.36	Σ Lines 8 - 10
12	<b>Voltage Weighting Analysis</b>									
13	Non coincident peak (kW) served at:									
14	Primary Voltage	-	-	28,652	138	-	-	-	-	- Company Data
15	Secondary Voltage	63,104	859	45,066	35,343	22,434	7	2,140	76	Company Data
16	<b>Total</b>	63,104	859	73,718	35,482	22,434	7	2,140	76	Σ Lines 14 - 15
17	Percent of Non coincident peak (kW)									
18	Primary Voltage	0.00%	0.00%	38.87%	0.39%	0.00%	0.00%	0.00%	0.00%	Line 14 / Line 16
19	Secondary Voltage	100.00%	100.00%	61.13%	99.61%	100.00%	100.00%	100.00%	100.00%	Line 15 / Line 16
20	<b>Total</b>	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	Σ Lines 18 - 19
21	<b>Voltage Weighted Marginal Capacity Costs</b>									
22	Marginal Costs to Serve per kW: Distribution Customer									
23	Distribution - Primary Component	\$ 81.24	\$ 81.24	\$ 80.33	\$ 81.23	\$ 81.24		\$ 81.24	\$ 81.24	Line 3 x Line 18 + Line 8 x Line 19
24	Distribution - Secondary Component	\$ 29.76	\$ 29.76	\$ 18.19	\$ 29.65	\$ 29.76		\$ 29.76	\$ 29.76	Line 4 x Line 18 + Line 9 x Line 19
25	Distribution - Line Transformer Component	\$ 20.36	\$ 20.36	\$ 12.45	\$ 20.28	\$ 20.36		\$ 20.36	\$ 20.36	Line 5 x Line 18 + Line 10 x Line 19
26	<b>Total</b>	\$ 131.36	\$ 131.36	\$ 110.97	\$ 131.16	\$ 131.36	N/A	\$ 131.36	\$ 131.36	Σ Lines 23 - 25

**Liberty Utilities (Granite State Electric) Corp.  
Marginal Cost Study**

**Summary of Marginal Customer Costs**

Line No.	Description	Domestic D	Domestic-Opt. Peak D-10	General TOU G-1	General Long Hour G-2	General Service G-3	Outdoor Lighting M	Limited All Electric T	Ltd Comm Space V	Explanation
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)
	<b>Plant Investment</b>									
1	Meters	\$ 105.00	\$ 360.20	\$ 1,605	\$ 900.80	\$ 630.20		\$ 195.20	\$ 290.20	Att MFB-2 p1, Line 8
2	General Plant Loading Factor	10.16%	10.16%	10.16%	10.16%	10.16%		10.16%	10.16%	Att MFB-6 p3, Line 22
3	Unit Costs and Loading Factor	\$ 115.66	\$ 396.78	\$ 1,768	\$ 992.28	\$ 694.20		\$ 215.02	\$ 319.67	Line 1 + (Line 1 x Line 2)
4	Fixed Charge Rate	13.15%	13.15%	13.15%	13.15%	13.15%		13.15%	13.15%	Att MFB-7 p1, Col (C), Line 6
5	Meter Carrying Costs	\$ 15.21	\$ 52.17	\$ 232.47	\$ 130.47	\$ 91.28		\$ 28.27	\$ 42.03	Line 3 x Line 4
6	Services	\$ 693.29	\$ 693.29	\$ 759.17	\$ 759.17	\$ 693.29		\$ 693.29	\$ 693.29	Att MFB-2 p1, Line 4
7	General Plant Loading Factor	10.16%	10.16%	10.16%	10.16%	10.16%		10.16%	10.16%	Att MFB-6 p3, Line 22
8	Unit Costs and Loading Factor	\$ 763.70	\$ 763.70	\$ 836.27	\$ 836.27	\$ 763.70		\$ 763.70	\$ 763.70	Line 6 + (Line 6 x Line 7)
9	Fixed Charge Rate	10.44%	10.44%	10.44%	10.44%	10.44%		10.44%	10.44%	Att MFB-7 p1, Col (C), Line 5
10	Services Carrying Costs	\$ 79.73	\$ 79.73	\$ 87.30	\$ 87.30	\$ 79.73		\$ 79.73	\$ 79.73	Line 8 x Line 9
11	Total Plant Carrying Costs	\$ 94.93	\$ 131.90	\$ 319.77	\$ 217.77	\$ 171.00		\$ 108.00	\$ 121.76	Line 5 + Line 10 + Line
12	A&G Exp Plant-Related Loading Factor	3.53%	3.53%	3.53%	3.53%	3.53%		3.53%	3.53%	Att MFB-6 p1, Line 30
13	Annualized Cost	\$ 126.02	\$ 172.92	\$ 411.83	\$ 282.41	\$ 222.54	N/A	\$ 142.60	\$ 160.06	(Line 12) x (Line 3 + Line 8 + Line ) + Line 11
	<b>Operating Expenses</b>									
14	Plant Related O&M \$/Customer	\$ 118.17	\$ 155.95	\$ 349.96	\$ 245.72	\$ 195.91		\$ 131.52	\$ 145.58	Att MFB-5 p2, Col (G)
15	Customer Acctg & Mkg Expenses	\$ 109.64	\$ 109.64	\$ 219.28	\$ 164.46	\$ 109.64		\$ 109.64	\$ 109.64	Att MFB-5 p4, Col (F)
16	A&G Exp Non-Plant Loading Factor	3.73%	3.73%	3.73%	3.73%	3.73%		3.73%	3.73%	Att MFB-6 p1, Line 28
17	Total O&M Expense	\$ 236.30	\$ 275.48	\$ 590.45	\$ 425.46	\$ 316.94	N/A	\$ 250.15	\$ 264.73	Line 15 + Line 16 + ((Line 15 + Line 16) x Line 17)
	<b>Working Capital- \$/Customer</b>									
18	Materials & Supplies + Prepayments Rate	2.07%	2.07%	2.07%	2.07%	2.07%		2.07%	2.07%	Att MFB-6 p2, Line 22
19	M&S Cost	\$ 18.23	\$ 24.06	\$ 53.99	\$ 37.91	\$ 30.22		\$ 20.29	\$ 22.46	Line 20 x (Line 3 + Line 8 + Line )
20	Working Cash O&M Allowance	\$ 16.52	\$ 19.26	\$ 41.27	\$ 29.74	\$ 22.15		\$ 17.49	\$ 18.50	(Line 18) x (Att MFB-8 p1, Line 30)
21	Total Working Capital	\$ 34.75	\$ 43.31	\$ 95.26	\$ 67.65	\$ 52.38		\$ 37.78	\$ 40.96	Line 21 + Line 22
22	Working Capital Rev. Requirement	\$ 3.55	\$ 4.43	\$ 9.74	\$ 6.92	\$ 5.36	N/A	\$ 3.86	\$ 4.19	Line 23 x (Att MFB-7 p1, Col (C), Line 16)
23	Annual Customer Related Cost \$/Customer	\$ 365.87	\$ 452.83	\$ 1,012.02	\$ 714.80	\$ 544.83	N/A	\$ 396.61	\$ 428.98	Line 13 + Line 18 + Line 24
24	Escalator to Adjust to 2020 Rate Year	3.84%	3.84%	3.84%	3.84%	3.84%		3.84%	3.84%	((1 + Att MFB-7 p1, Col (C), Line 19)^2) - 1
25	<b>Annual Customer Related Cost</b>	\$379.90	\$470.20	\$1,050.85	\$742.22	\$565.74	N/A	\$411.82	\$445.43	Line 25 x (1 + Line 26)

Liberty Utilities (Granite State Electric) Corp.  
Marginal Cost Study

Summary of Marginal Cost Estimates

Line No.	Description	Domestic D	Domestic-Opt. Peak D-10	General TOU G-1	General Long Hour G-2	General Service G-3	Outdoor Lighting M	Limited All Electric T	Ltd Comm Space V	Total Company	Explanation
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)
1	Uncollectible Factor	1.15%	1.03%	0.00%	0.21%	0.24%		0.14%	0.39%		Att MFB-5 p5, Col (F)
2	Customer Charge \$'s per month										
3	Monthly Customer Charge w/o Uncollectibles	\$ 31.66	\$ 39.18	\$ 87.57	\$ 61.85	\$ 47.14		\$ 34.32	\$ 37.12		(Att MFB-9 p1, Line 27)/12
4	Adjustment for Uncollectibles	0.36	0.40	0.00	0.13	0.11		0.05	0.15		Line 1 x Line 3
5	Monthly Customer Charge Incl. Uncollectibles	\$ 32.02	\$ 39.59	\$87.57	\$61.98	\$47.26		\$34.37	\$ 37.27		Line 3 + Line 4
6	Demand Charge \$'s per kW										
7	Distribution Demand Charge - Primary Component	81.24	81.24	80.33	81.23	81.24		81.24	81.24		Att MFB-8 p3, Line 23
8	Distribution Demand Charge - Secondary Component	29.76	29.76	18.19	29.65	29.76		29.76	29.76		Att MFB-8 p3, Line 24
9	Distribution Demand Charge - Line Transformer Component	20.36	20.36	12.45	20.28	20.36		20.36	20.36		Att MFB-8 p3, Line 25
10	Adjustment for Uncollectibles	\$1.51	\$1.35	\$0.00	\$0.27	\$0.31		\$0.18	\$0.52		(Line 7 + Line 8 + Line 9) x Line 1
11	Demand Charge Incl. Uncollectibles	\$132.88	\$132.72	\$110.97	\$131.43	\$131.68		\$131.54	\$131.88		Σ line 7 to Line 10
12	Billing Determinants (2018)										
13	Customers	35,382	440	138	907	5,670	0	964	18	43,518	Company Data
14	Non coincident peak (kW)	63,104	859	73,718	35,482	22,434	7	2,140	76	197,820	Company Data
15	Annual Energy Usage (kWh)	278,824,882	5,629,249	379,184,992	147,993,116	88,095,304	4,156,597	15,352,073	328,389	919,564,602	Company Data
16	<b>Total Marginal Costs</b>										
17	Total Customer-related	\$13,596,389	\$208,913	\$145,227	\$674,432	\$3,215,323		\$397,451	\$7,867	\$18,245,601	Line 5 x Line 13 x 12
18	Total Capacity-related: Demand										
19	Demand Distribution Primary	5,185,761	70,511	5,921,600	2,888,282	1,826,941		174,090	6,170	16,073,355	(1 + Line 1) x Line 7 x Line 14
20	Demand Distribution Secondary	1,899,702	25,830	1,341,253	1,054,059	669,264		63,774	2,260	5,056,142	(1 + Line 1) x Line 8 x Line 14
21	Demand Distribution Line Transformer	1,299,512	17,670	917,499	721,041	457,818		43,626	1,546	3,458,711	(1 + Line 1) x Line 9 x Line 14
22	Total Capacity-related: Demand	\$ 8,384,975	\$ 114,011	\$ 8,180,353	\$ 4,663,381	\$ 2,954,023		\$ 281,490	\$ 9,976	\$ 24,588,209	Σ line 19 to Line 21
23	Customer Subtotal	\$13,596,389	\$208,913	\$145,227	\$674,432	\$3,215,323		\$397,451	\$7,867	\$18,245,601	Line 17
24	Distribution Subtotal	8,384,975	114,011	8,180,353	4,663,381	2,954,023		281,490	9,976	24,588,209	Line 19 + Line 20 + Line 21 + Line 24 + Line 25 + Line 26
25	Marginal Cost for Fixtures						609,009			609,009	Att MFB-3 p1, 2,3, Line 20 + Att MFB-3 p4,5, Line 20
26	<b>Total Annual Marginal Cost Excl. Fixtures</b>	\$ 21,981,365	\$ 322,924	\$ 8,325,580	\$ 5,337,813	\$ 6,169,345	\$ -	\$ 678,940	\$ 17,843	\$ 42,833,810	Σ line 23 to Line 24
27	<b>Share of Total Annual Marginal Cost Excl. Fixtures</b>	51.3%	0.8%	19.4%	12.5%	14.4%	0.0%	1.6%	0.0%	100.00%	Col (n) / Col (J)
28	<b>Total Annual Marginal Cost Incl. Fixtures</b>	\$ 21,981,365	\$ 322,924	\$ 8,325,580	\$ 5,337,813	\$ 6,169,345	\$ 609,009	\$ 678,940	\$ 17,843	\$ 43,442,819	Σ line 23 to Line 25
28	<b>Share of Total Annual Marginal Cost Incl. Fixtures</b>	50.60%	0.74%	19.16%	12.29%	14.20%	1.40%	1.56%	0.04%	100.0%	Col (n) / Col (J)

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**Melissa F. Bartos**  
**Assistant Vice President**

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Ms. Bartos is a financial and economic consultant with more than twenty years of experience in the energy industry. In the last several years, she has focused on natural gas markets issues, including conducting comprehensive market assessments for various clients considering infrastructure investments and developing detailed demand forecasts for a number of gas distribution companies. Ms. Bartos has also designed, built, and enhanced numerous financial and statistical models to support clients in asset-based transactions, energy contract negotiations, reliability studies, asset and business valuations, rate and regulatory matters, cost-of-service analysis, and risk management. Her modeling experience includes building Monte-Carlo simulation models, designing an allocated cost-of-service model, statistical modeling using SPSS, and programming using Visual Basic for Applications (VBA). Ms. Bartos has also provided expert testimony regarding natural gas demand forecasting and supply planning issues, natural gas markets, and marginal cost studies.

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**REPRESENTATIVE PROJECT EXPERIENCE**

**Natural Gas Market Assessments**

- Reviewed and evaluated long-term natural gas supply and demand, existing natural gas pricing dynamics, and future implications associated with new natural gas infrastructure in New England, New York, and New Jersey.
- Provided an analysis of the existing Gulf Coast natural gas market, the client's natural gas pipeline competitors, changing flows, and how those factors may affect transportation values to the client going forward.
- Prepared a comprehensive study examining the costs associated with improving natural gas pipeline access from western Canada and the eastern U.S. to Atlantic Canada.
- Produced a report on the benefits associated with incremental natural gas supplies delivered to New York City.
- Prepared an independent natural gas supply and pipeline transportation route assessment associated with natural gas for the client's proposed LNG export terminal.

**Natural Gas Expansion**

- Conducted a study that examined potential commercial and industrial conversions from oil-based fuels to natural gas in various east coast U.S. markets.

- Produced a report that identified growth potential in off-system stationary and mobile markets in the mid-west that could be served by compressed natural gas or liquefied natural gas.
- Performed an external audit and filed expert testimony associated with two natural gas utilities' hurdle rate/contribution in aid of construction calculations for new off main customers.
- Produced a report that identified and reviewed innovative cost model approaches that utilities and regulators are using across the U.S. that allow expansion of gas distributions systems to new communities.
- Assisted in developing a strategy to identify residential natural gas growth opportunities within the client's franchise area.
- Presented at two Northeast Gas Association conferences regarding "Regulatory Policy and Residential Main Extensions".

### **Demand Forecasting**

- Filed expert testimony regarding the development of demand forecast models and the evaluation of natural gas resource plans for multiple northeast gas utilities.
- Provided litigation support regarding demand forecasting techniques with respect to certain natural gas pipeline and storage decisions for a mid-west gas utility.
- Reviewed demand forecasting practices and procedures and recommended certain changes to improve the methodology and accuracy of the forecast for a multi-state utility.
- For a mid-west gas utility, developed a natural gas demand forecast that was utilized for supply and capacity decisions.

### **Ratemaking and Utility Regulation**

- Participated in the rate case of a large North American gas distribution company, which determined the client's five-year incentive regulation plan, including performing benchmarking and productivity analyses that were filed with the regulator.
- Developed a marginal cost study, including data collection, analysis and testimony development, in support of rate case filings for a number of New England utilities.
- Provided comprehensive analysis, drafted testimony and provided litigation support regarding the appropriate return on equity for a New England water utility, and for proposed wind and coal electric generation facility additions for a mid-west combination utility.
- Performed a detailed analysis of the components included in the client's lost and unaccounted for gas calculation.
- Conducted multiple natural gas portfolio asset optimization analyses to evaluate performance of the client's asset manager for regulatory purposes.

- On behalf of multiple New England gas companies, participated in the 2009 Avoided Energy Supply Cost Study Group (for New England), which worked with third-party consultants to develop the marginal energy supply costs that will be avoided due to reductions in the use of electricity, natural gas, and other fuels resulting from energy efficiency programs.
- Conducted a study to determine the cost of significantly reducing peak day natural gas demand for a northeast gas utility through energy efficiency, conservation and demand management measures. Project involved researching natural gas energy efficiency plans in multiple U.S. states and Canadian provinces, reviewing energy efficiency potential studies, and exploring geothermal, peak pricing and direct load control options.

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## **PROFESSIONAL HISTORY**

### **Concentric Energy Advisors, Inc. (2002 – Present)**

Assistant Vice President  
Project Manager  
Senior Consultant

### **Navigant Consulting, Inc. (1996 – 2002)**

Senior Consultant

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## **PROFESSIONAL ASSOCIATIONS**

Member of the American Statistical Association  
Member of the Northeast Energy and Commerce Association  
Member of the Northeast Gas Association

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## **EDUCATION**

M.S., Mathematics (Statistics), University of Massachusetts at Lowell, 2003  
B.A., Mathematics and Psychology, Computer Science minor, College of the Holy Cross, magna cum laude, 1998

<b>SPONSOR</b>	<b>DATE</b>	<b>CASE/APPLICANT</b>	<b>DOCKET NO.</b>	<b>SUBJECT</b>
<b>Connecticut Public Utilities Regulatory Authority</b>				
Connecticut Natural Gas Corporation & Southern Connecticut Gas Company	2014	Connecticut Natural Gas Corporation & Southern Connecticut Gas Company	Docket No. 13-06-02	CIAC Hurdle Rate Calculation
<b>Federal Energy Regulatory Commission</b>				
PennEast Pipeline Company, LLC	2015	PennEast Pipeline Company, LLC	Docket No. CP15-558	Market Conditions/Need
PennEast Pipeline Company, LLC	2016	PennEast Pipeline Company, LLC	Docket No. CP15-558	Market Conditions/Need
Millennium Pipeline Company, LLC	2017	Millennium Pipeline Company, LLC	Docket No. CP16-486	Market Conditions/Need
Laclede Gas Company	2017	Spire STL Pipeline, LLC	Docket No. CP17-40	Market Conditions/Need
<b>Maine Public Utilities Commission</b>				
Northern Utilities, Inc.	2011	Northern Utilities	Docket No. 2011-526	Integrated Resource Plan; Demand Forecast
<b>Massachusetts Department of Public Utilities</b>				
New England Gas Company	2008	New England Gas Company	D.P.U. 08-11	Integrated Resource Plan; Demand Forecast; Supply Planning
New England Gas Company	2010	New England Gas Company	D.P.U. 10-61	Integrated Resource Plan; Demand Forecast; Supply Planning
Berkshire Gas Company	2010	Berkshire Gas Company	D.P.U. 10-100	Integrated Resource Plan; Demand Forecast
New England Gas Company	2012	New England Gas Company	D.P.U. 12-41	Integrated Resource Plan; Demand Forecast; Supply Planning
Berkshire Gas Company	2012	Berkshire Gas Company	D.P.U. 12-62	Integrated Resource Plan; Demand Forecast
NSTAR Gas Company	2014	NSTAR Gas Company	D.P.U. 14-63	Integrated Resource Plan; Demand Forecast
Berkshire Gas Company	2014	Berkshire Gas Company	D.P.U. 14-98	Integrated Resource Plan; Demand Forecast
Liberty Utilities (New England Gas Company)	2015	Liberty Utilities (New England Gas Company)	D.P.U. 15-75	Marginal Cost of Service Study
Berkshire Gas Company	2016	Berkshire Gas Company	D.P.U. 16-103	Integrated Resource Plan; Demand Forecast

<b>SPONSOR</b>	<b>DATE</b>	<b>CASE/APPLICANT</b>	<b>DOCKET NO.</b>	<b>SUBJECT</b>
Eversource Energy	2017	Eversource Energy (NSTAR Electric and WMECO)	D.P.U. 17-05	Marginal Cost of Service Study
National Grid (Boston Gas Company and Colonial Gas Company)	2017	National Grid (Boston Gas Company and Colonial Gas Company)	D.P.U. 17-170	Marginal Cost of Service Study
Bay State Gas Company d/b/a/ Columbia Gas of Massachusetts	2018	Bay State Gas Company d/b/a/ Columbia Gas of Massachusetts	D.P.U. 18-45	Marginal Cost of Service Study
Berkshire Gas Company	2018	Berkshire Gas Company	D.P.U. 18-40	Marginal Cost of Service Study
Berkshire Gas Company	2018	Berkshire Gas Company	D.P.U. 18-107	Integrated Resource Plan; Demand Forecast
<b>New Hampshire Public Utilities Commission</b>				
Northern Utilities, Inc.	2011	Northern Utilities	DG 2011-290	Integrated Resource Plan; Demand Forecast
Liberty Utilities (EnergyNorth Natural Gas)	2017	Liberty Utilities (EnergyNorth Natural Gas)	DG 17-048	Marginal Cost of Service Study
<b>New Jersey Board of Public Utilities</b>				
South Jersey Gas Company	2015	South Jersey Gas Company	GR15010090	Energy Efficiency Cost Benefit Analysis
<b>Ontario Energy Board</b>				
Enbridge Gas Distribution	2012	Enbridge Gas Distribution	EB-2011-0354	Industry Benchmarking Study
Enbridge Gas Distribution	2013	Enbridge Gas Distribution	EB-2012-0459	Incentive Rate Making
<b>Régie de l'énergie du Québec</b>				
TransCanada Pipelines Ltd.	2014	TransCanada Pipelines Ltd.	R-3900-2014	Natural Gas Market Assessment
<b>Washington Utilities and Transportation Commission</b>				
Puget Sound Energy, Inc.	2015	Puget Sound Energy, Inc.	UG-151663	Distributed LNG Market Assessment