KEEGAN WERLIN LLP

ATTORNEYS AT LAW
99 HIGH STREET, SUITE 2900
BOSTON, MASSACHUSETTS 02110

(617) 951-1400

TELECOPIER:
(617) 951-1354

May 29, 2020

BY E-FILING
Mark D. Marini, Secretary
Commonwealth of Massachusetts
Department of Public Utilities
One South Station
Boston, MA 02110

Re: NSTAR Gas Company d/b/a Eversource Energy, D.P.U. 20-50
2019 Energy Efficiency Plan-Year Report

Dear Secretary Marini:

On behalf of NSTAR Gas Company d/b/a Eversource Energy (the "Company"), enclosed is the Company's 2019 Energy Efficiency Plan-Year Report for filing with the Department of Public Utilities (the "Department").[1] Plan Year 2019 was the first year of implementation under the *2019-2021 Massachusetts Joint Statewide Electric and Gas Three-Year Energy Efficiency Plan*, as reviewed and approved by the Department in D.P.U. 18-110 – D.P.U. 18-119. Please note that Appendix 3 (Technical Reference Manual- 2019 Report Version) and Appendix 4D (Evaluation Studies) are being provided statewide under separate cover.

In 2019, the Massachusetts Energy Efficiency Program Administrators[2] (the "Program Administrators") successfully delivered on very ambitious energy savings goals for the year. Statewide, the electric Program Administrators achieved 94 percent of the lifetime electric savings goal, and 101 percent of planned total benefits. The gas Program Administrators achieved 97 percent of the lifetime gas savings goal, and 100 percent of planned total benefits statewide. The Program Administrators achieved these aggressive savings goals and benefits while maintaining

---

1 This report is being submitted pursuant to the Hearing Officer's Memorandum dated May 2, 2014 adopting the Energy Efficiency Plan-Year Report Template in D.P.U. 11-120-A, Phase II and the Joint Motion of the Program Administrators for Extension of the Deadline for Each Program Administrator to File its 2019 Plan-Year Report granted by the Department on April 29, 2020.

2 The Massachusetts Program Administrators are: Bay State Gas Company, d/b/a Columbia Gas of Massachusetts, The Berkshire Gas Company; Fitchburg Gas and Electric Light Company, d/b/a Unitil (Gas Division); Liberty Utilities (New England Natural Gas Company) Corp., d/b/a Liberty Utilities; Boston Gas Company and Colonial Gas Company, each d/b/a National Grid; NSTAR Gas Company, d/b/a Eversource Energy; Cape Light Compact JPE; Fitchburg Gas and Electric Light Company, d/b/a Unitil (Electric Division); Massachusetts Electric Company and Nantucket Electric Company, each d/b/a National Grid; NSTAR Electric Company, d/b/a Eversource Energy

budgetary control and complying with the directive of the Green Communities Act to seek all available cost-effective energy efficiency opportunities. The Program Administrators took many actions in 2019 to serve customers and achieve energy efficiency goals, and several of these new and optimized offerings are discussed in Appendix 6, including a detailed update on the implementation of Plan enhancements that are designed to address residential and C&I sector barriers.

These savings and benefits achievements and implementation enhancements demonstrate the Program Administrators' continued commitment throughout 2019 to achieving sustainable cost-effective energy efficiency, as well as the Program Administrators' commitment to leveraging relationships with customers, contractors, and other vendors and stakeholders to coordinate efforts, share ideas and best practices, and serve customers.

The Program Administrators look forward to continuing these efforts and achieving additional successes going forward.

Very truly yours,

Ashley S. Wagner, Esq.

Enclosures

cc: Jessica Ellis, Department of Public Utilities
Krista Hawley, Department of Public Utilities
Donald Boecke, Office of the Attorney General
Joseph Dorfler, Office of the Attorney General
Rachel Graham Evans, Department of Energy Resources
Jerrold Oppenheim, Low-Income Energy Affordability Network

THE COMMONWEALTH OF MASSACHUSETTS

DEPARTMENT OF PUBLIC UTILITIES

NSTAR Gas Company d/b/a Eversource Energy	)	D.P.U. 20-50

APPEARANCE OF COUNSEL

In the above-entitled proceeding, I hereby appear for and on behalf of NSTAR Gas Company d/b/a Eversource Energy.

John K. Habib

John K. Habib, Esq.
Keegan Werlin LLP
99 High Street, 29th Floor
Boston, MA 02110
Telephone: 617-951-1400
Fax: 617-951-1354
Email: jhabib@keeganwerlin.com

Date: May 29, 2020

THE COMMONWEALTH OF MASSACHUSETTS

DEPARTMENT OF PUBLIC UTILITIES

NSTAR Gas Company d/b/a Eversource Energy	)	D.P.U. 20-50

APPEARANCE OF COUNSEL

In the above-entitled proceeding, I hereby appear for and on behalf of NSTAR Gas Company each d/b/a Eversource Energy.

Ashley S. Wagner, Esq.
Keegan Werlin LLP
99 High Street, 29th Floor
Boston, MA 02110
Telephone: 617-951-1400
Fax: 617-951-1354
Email: awagner@keeganwerlin.com

Date: May 29, 2020

2019

Energy Efficiency Plan-Year Report

D.P.U. 20-50

NSTAR Gas d/b/a Eversource Energy

May 29, 2020

NSTAR Gas Company d/b/a Eversource Energy

2019 Energy Efficiency Plan-Year Report

D.P.U. 20-50

May 29, 2020

Table of Contents

2019 PLAN YEAR REPORT DATA TABLES

Appendix 1: Significant Core Initiative Variances & Cost-Effectiveness

Appendix 2: Benefit-Cost Ratio Screening Tool

Appendix 3: Technical Reference Manual – 2019 Report Version

Appendix 4: Statewide Evaluation Studies Summary

Appendix 4A - Table of Evaluation Studies

Appendix 4B - Summary of the Studies with the Most Significant Effects

Appendix 4C - Evaluation Study Summaries

Appendix 4D - 2019 Plan-Year Report Evaluation Studies

Appendix 5: Performance Incentives

Appendix 6: 2019 Miscellaneous Implementation Update

Appendix 7: MMBtu Study

Energy Efficiency Data Tables

2019 Plan Year Report Overview

Eversource Gas
May 29, 2020

DATA OVERVIEW

The following data tables provide a summary of the Program Administrator's benefits, costs, savings, and cost-effectiveness for 2019 through 2021. The planned values are consistent with each Program Administrator's 2019-2021 Three-Year Plan. The 2019 preliminary and evaluated values are presented here for the first time as part of each Program Administrator's 2019 Plan Year Report.

The data included in these tables is based on other supporting models. The primary supporting models used by the Program Administrators in the preparation of this 2019 Plan Year Report are the Benefit-Cost Screening model and the Performance Incentive model. These exhibits should be referenced when looking for more detailed analyses, such as measure-level savings. High-level summaries for each of these models are provided below.

USING THE DATA TABLES

These Plan Year Report data tables are in a pivot table format with set outputs based on the Department's direction in D.P.U. 11-120, Phase II. Users can manipulate the data by using either the raw data included on the Master Data tab, or the Slicers shown on the Selections tab. The Slicers will update the comparisons between the planned, preliminary, or evaluated results on the Plan Year Summary tables only.

BENEFIT-COST SCREENING MODEL

The Benefit-Cost Screening model provides measure-level savings and benefits. This model uses the avoided cost values from the 2018 Avoided Energy Supply Cost study prepared by Synapse Energy Economics, Inc.

PERFORMANCE INCENTIVE MODEL

The Performance Incentive model filed as part of the Joint Statewide Three-Year Plan provides support for the performance incentive dollars proposed for collection by the Program Administrator. Final performance incentive amounts will be based on the three-year term and will be subject to review and final approval in the three-year term report; the amounts shown in the Plan Year Report are based on the data available to date and will change as additional years of data are included. Note that performance incentives are not applicable to the Cape Light Compact.

EM&V ACTIVITIES

The Evaluation, Monitoring & Verification (EMV) Section of the Joint Statewide Three-Year Plan describes in detail the EM&V activities planned for 2019-2021. The EMV section of each Program Administrator's 2019 Plan Year Report summarizes the evaluation results completed in 2019 and their impact on the 2019 evaluated results. The Technical Reference Library (TRL) has been updated to account for recent evaluation results.

2019 Plan Year Report Data Tables

Template Version: April 10, 2020

PA-Specific Information

2019 Plan Year Report Filing Detail

Distribution Fuel	Gas
Program Administrator	Eversource
Date of Filing	May 29, 2020
Name of Filing	2019 Plan Year Report

PLAN FILINGS

Reporting Period	Filing Date	DPU Docket #
2019 Plan	February 19, 2019	D.P.U. 18-115
2020 Plan	February 19, 2019	D.P.U. 18-115
2021 Plan	February 19, 2019	D.P.U. 18-115
2019 Preliminary and Evaluated	May 29, 2020	D.P.U. 20-50
2020 Preliminary and Evaluated	TBD	D.P.U. 21-###
2021 Preliminary and Evaluated	TBD	D.P.U. 22-###

RATES FOR ADJUSTMENTS

2020 Nominal Discount Rate	2.33%	
2021 Nominal Discount Rate	2.33%	
Effective Tax Rate	27.32%	PA-specific

PLAN YEARS

Current Plan Year 1	2019
Current Plan Year 2	2020
Current Plan Year 3	2021

GHG EMISSIONS REDUCTION FACTORS (Short Tons)

GHG per:	NOX	SO2	CO2
Electricity (MWh)	0.00016	0.00004	0.49400
Gas (Therm)			0.00585
Oil (MMBTU)			0.08069
Propane (MMBTU)			0.06959
Source:	File named "3-year plan EFs 8-9-18.xlsx"		

Technical Reference Library

TRL Link	https://etrm.anbetrack.com/#/workarea/home?token=6d6c45766e692f527044

2019 Plan Year Report Variances

Variances Summary

Eversource Gas

May 29, 2020

Variances Summary				
Program	Total Program Cost Variances	Lifetime Natural Gas Savings (Therms)	Total Benefits (2019$) Variances	Total Resource Benefits (2019$) Variances
A - Residential	**4%**	**36%**	**30%**	**-4%**
A1 - Residential New Buildings	-22%	49%	31%	-29%
A1a - Residential New Homes & Renovations	**-22%**	49%	31%	**-29%**
A2 - Residential Existing Buildings	8%	34%	30%	0%
A2a - Residential Coordinated Delivery	12%	36%	30%	0%
A2b - Residential Conservation Services (RCS)	-11%			
A2c - Residential Retail	12%	36%	37%	0%
A2d - Residential Behavior	-8%	-15%	-14%	0%
A3 - Residential Hard-to-Measure	**-22%**			
B - Income Eligible	**-2%**	**-1%**	**-2%**	**0%**
B1 - Income Eligible Existing Buildings	-1%	-1%	-2%	0%
B1a - Income Eligible Coordinated Delivery	-1%	-1%	-2%	0%
B2 - Income Eligible Hard-to-Measure	**-33%**			
C - Commercial & Industrial	**-29%**	**-36%**	**-38%**	**-11%**
C1 - C&I New Buildings	-19%	-25%	-26%	-6%
C1a - C&I New Buildings & Major Renovations	**-19%**	**-25%**	**-26%**	-6%
C2 - C&I Existing Buildings	-34%	-40%	-41%	-13%
C2a - C&I Existing Building Retrofit	**-42%**	**-40%**	**-42%**	**-15%**
C2b - C&I New & Replacement Equipment	-14%	**-39%**	**-39%**	-8%
C3 - C&I Hard-to-Measure	13%			
Grand Total	**-6%**	**-9%**	**-7%**	**-6%**

Notes

• Significant variances, which require explanation, are defined as:

(1) variances between *planned and actual* core initiative budget of *15 percent or greater;*
(2) variances between *planned and preliminary* core initiative *total lifetime savings* showing a *decrease of 15 percent or g*
(3) variances between *planned and preliminary* core initiative *total benefits* showing a *decrease of 15 percent or greater;*
(4) variances between *preliminary and evaluated* core initiative *total resource benefits* showing a *decrease of 15 percent*

• Variances are calculated as a percent of the three-year goal, meaning variance are calculated as the percentage difference between the percentage of the Three-Year Plan goals planned to be achieved through the Plan Year Report year compared to the percentage of the Three-Year Plan goals actually achieved through the Plan Year Report year.

• Cells highlighted in the above tables indicate that a variance is significant enough to require explanation. Refer to the Program Administrator's Plan Year Report for explanations of significant variances.

2019 Plan Year Report Variances

Total Program Cost Variances

Eversource Gas

May 29, 2020

Total Program Cost Variances								
Program	Planned				Actual	Planned v. Actual (%)		
	2019	2020	2021	2019-2021	2019	Planned 2019 % Total Plan	Actual 2019 % Total Plan	Planned v Actual (%)
A - Residential	**29,545,000**	**31,175,000**	**32,735,000**	**93,455,000**	**30,691,478**	**32%**	**33%**	**4%**
A1 - Residential New Buildings	2,820,000	2,835,000	2,840,000	8,495,000	2,197,646	33%	26%	-22%
A1a - Residential New Homes & Renovations	2,820,000	2,835,000	2,840,000	8,495,000	2,197,646	33%	26%	**-22%**
A2 - Residential Existing Buildings	25,230,000	26,790,000	28,270,000	80,290,000	27,330,951	31%	34%	8%
A2a - Residential Coordinated Delivery	14,900,000	16,060,000	17,500,000	48,460,000	16,654,409	31%	34%	12%
A2b - Residential Conservation Services (RCS)	3,320,000	3,665,000	3,680,000	10,665,000	2,970,187	31%	28%	-11%
A2c - Residential Retail	6,280,000	6,330,000	6,350,000	18,960,000	7,038,026	33%	37%	12%
A2d - Residential Behavior	730,000	735,000	740,000	2,205,000	668,328	33%	30%	-8%
A3 - Residential Hard-to-Measure	1,495,000	1,550,000	1,625,000	4,670,000	1,162,881	32%	25%	**-22%**
B - Income Eligible	**11,380,000**	**11,855,000**	**12,165,000**	**35,400,000**	**11,181,028**	**32%**	**32%**	**-2%**
B1 - Income Eligible Existing Buildings	11,000,000	11,460,000	11,730,000	34,190,000	10,925,248	32%	32%	-1%
B1a - Income Eligible Coordinated Delivery	11,000,000	11,460,000	11,730,000	34,190,000	10,925,248	32%	32%	-1%
B2 - Income Eligible Hard-to-Measure	380,000	395,000	435,000	1,210,000	255,779	31%	21%	**-33%**
C - Commercial & Industrial	**15,220,000**	**15,840,000**	**16,210,000**	**47,270,000**	**10,794,148**	**32%**	**23%**	**-29%**
C1 - C&I New Buildings	2,125,000	2,150,000	2,160,000	6,435,000	1,717,666	33%	27%	-19%
C1a - C&I New Buildings & Major Renovations	2,125,000	2,150,000	2,160,000	6,435,000	1,717,666	33%	27%	**-19%**
C2 - C&I Existing Buildings	12,255,000	12,805,000	13,105,000	38,165,000	8,126,790	32%	21%	-34%
C2a - C&I Existing Building Retrofit	8,460,000	8,900,000	9,200,000	26,560,000	4,867,263	32%	18%	**-42%**
C2b - C&I New & Replacement Equipment	3,795,000	3,905,000	3,905,000	11,605,000	3,259,526	33%	28%	-14%
C3 - C&I Hard-to-Measure	840,000	885,000	945,000	2,670,000	949,692	31%	36%	13%
Grand Total	**56,145,000**	**58,870,000**	**61,110,000**	**176,125,000**	**52,666,653**	**32%**	**30%**	**-6%**

Notes

Plan year core initiative significant variance explanations are required for: (1) variances between planned and actual core initiative budget of 15 percent or greater.

2019 Plan Year Report Variances

Lifetime Natural Gas Savings (Therms) Variances

Eversource Gas

May 29, 2020

Lifetime Natural Gas Savings (Therms) Variances								
Program	Planned				Preliminary	Planned v. Preliminary (%)		
	2019	2020	2021	2019-2021	2019	Planned 2019 % Total Plan	Preliminary 2019 % Total Plan	Planned v Preliminary (%)
A - Residential	**30,126,614**	**31,305,558**	**32,744,908**	**94,177,080**	**40,986,730**	**32%**	**44%**	**36%**
A1 - Residential New Buildings	4,542,000	4,542,000	4,542,000	13,626,000	6,786,696	33%	50%	49%
A1a - Residential New Homes & Renovations	4,542,000	4,542,000	4,542,000	13,626,000	6,786,696	33%	50%	49%
A2 - Residential Existing Buildings	25,584,614	26,763,558	28,202,908	80,551,080	34,200,034	32%	42%	34%
A2a - Residential Coordinated Delivery	17,033,022	18,206,825	19,640,646	54,880,493	23,148,083	31%	42%	36%
A2b - Residential Conservation Services (RCS)	-	-	-	-	-			
A2c - Residential Retail	7,358,616	7,358,616	7,358,616	22,075,848	10,033,157	33%	45%	36%
A2d - Residential Behavior	1,192,976	1,198,117	1,203,646	3,594,739	1,018,794	33%	28%	-15%
A3 - Residential Hard-to-Measure	-	-	-	-	-			
B - Income Eligible	**9,132,435**	**9,357,085**	**9,616,885**	**28,106,405**	**9,026,624**	**32%**	**32%**	**-1%**
B1 - Income Eligible Existing Buildings	9,132,435	9,357,085	9,616,885	28,106,405	9,026,624	32%	32%	-1%
B1a - Income Eligible Coordinated Delivery	9,132,435	9,357,085	9,616,885	28,106,405	9,026,624	32%	32%	-1%
B2 - Income Eligible Hard-to-Measure	-	-	-	-	-			
C - Commercial & Industrial	**51,576,382**	**51,356,163**	**51,561,162**	**154,493,707**	**32,929,540**	**33%**	**21%**	**-36%**
C1 - C&I New Buildings	12,368,194	12,384,594	12,385,394	37,138,182	9,271,485	33%	25%	-25%
C1a - C&I New Buildings & Major Renovations	12,368,194	12,384,594	12,385,394	37,138,182	9,271,485	33%	25%	**-25%**
C2 - C&I Existing Buildings	39,208,188	38,971,569	39,175,768	117,355,525	23,658,055	33%	20%	-40%
C2a - C&I Existing Building Retrofit	25,860,386	26,156,350	26,452,313	78,469,049	15,569,717	33%	20%	**-40%**
C2b - C&I New & Replacement Equipment	13,347,802	12,815,219	12,723,455	38,886,476	8,088,337	34%	21%	**-39%**
C3 - C&I Hard-to-Measure	-	-	-	-	-			
Grand Total	**90,835,431**	**92,018,806**	**93,922,955**	**276,777,192**	**82,942,894**	**33%**	**30%**	**-9%**

Notes

Plan year core initiative significant variance explanations are required for: (2) variances between planned and preliminary core initiative total lifetime savings showing a decrease of 15 percent or greater.

2019 Plan Year Report Variances

Total Benefits (2019$) Variances

Eversource Gas

May 29, 2020

Total Benefits (2019$) Variances								
Program	Planned				Preliminary	Planned v. Preliminary (%)		
	2019	2020	2021	2019-2021	2019	Planned 2019 % Total Plan	Preliminary 2019 % Total Plan	Planned v Preliminary (%)
A - Residential	**59,739,909**	**62,419,123**	**65,694,498**	**187,853,530**	**77,951,802**	**32%**	**41%**	**30%**
A1 - Residential New Buildings	9,057,321	9,103,226	9,132,170	27,292,717	11,845,954	33%	43%	31%
A1a - Residential New Homes & Renovations	9,057,321	9,103,226	9,132,170	27,292,717	11,845,954	33%	43%	31%
A2 - Residential Existing Buildings	50,682,588	53,315,897	56,562,328	160,560,813	66,105,848	32%	41%	30%
A2a - Residential Coordinated Delivery	35,224,531	37,665,822	40,722,771	113,613,124	45,854,889	31%	40%	30%
A2b - Residential Conservation Services (RCS)	-	-	-	-	-			
A2c - Residential Retail	13,606,985	13,704,407	13,771,234	41,082,626	18,659,831	33%	45%	37%
A2d - Residential Behavior	1,851,072	1,945,668	2,068,323	5,865,063	1,591,129	32%	27%	-14%
A3 - Residential Hard-to-Measure	-	-	-	-	-			
B - Income Eligible	**25,968,573**	**26,952,248**	**28,041,660**	**80,962,481**	**25,358,934**	**32%**	**31%**	**-2%**
B1 - Income Eligible Existing Buildings	25,968,573	26,952,248	28,041,660	80,962,481	25,358,934	32%	31%	-2%
B1a - Income Eligible Coordinated Delivery	25,968,573	26,952,248	28,041,660	80,962,481	25,358,934	32%	31%	-2%
B2 - Income Eligible Hard-to-Measure	-	-	-	-	-			
C - Commercial & Industrial	**75,918,133**	**76,682,605**	**77,648,410**	**230,249,148**	**47,390,933**	**33%**	**21%**	**-38%**
C1 - C&I New Buildings	16,501,177	16,674,979	16,775,768	49,951,924	12,292,845	33%	25%	-26%
C1a - C&I New Buildings & Major Renovations	16,501,177	16,674,979	16,775,768	49,951,924	12,292,845	33%	25%	**-26%**
C2 - C&I Existing Buildings	59,416,956	60,007,626	60,872,642	180,297,224	35,098,089	33%	19%	-41%
C2a - C&I Existing Building Retrofit	42,096,150	43,116,775	43,968,212	129,181,137	24,608,979	33%	19%	**-42%**
C2b - C&I New & Replacement Equipment	17,320,806	16,890,851	16,904,430	51,116,087	10,489,109	34%	21%	**-39%**
C3 - C&I Hard-to-Measure	-	-	-	-	-			
Grand Total	**161,626,615**	**166,053,976**	**171,384,568**	**499,065,159**	**150,701,670**	**32%**	**30%**	**-7%**

Notes

Plan year core initiative significant variance explanations are required for: (3) variances between planned and preliminary core initiative total benefits showing a decrease of 15 percent or greater.

2019 Plan Year Report Variances

Total Resource Benefits (2019$) Variances

Eversource Gas

May 29, 2020

Total Resource Benefits (2019$) Variances			
Program	2019		
	Preliminary	Evaluated	Preliminary v Evaluated (%)
A - Residential	**63,870,267**	**61,180,160**	**-4%**
A1 - Residential New Buildings	9,349,487	6,659,380	-29%
A1a - Residential New Homes & Renovations	9,349,487	6,659,380	**-29%**
A2 - Residential Existing Buildings	54,520,780	54,520,780	0%
A2a - Residential Coordinated Delivery	38,119,346	38,119,346	0%
A2b - Residential Conservation Services (RCS)	-	-	
A2c - Residential Retail	14,810,306	14,810,306	0%
A2d - Residential Behavior	1,591,129	1,591,129	0%
A3 - Residential Hard-to-Measure	-	-	
B - Income Eligible	**13,698,080**	**13,698,080**	**0%**
B1 - Income Eligible Existing Buildings	13,698,080	13,698,080	0%
B1a - Income Eligible Coordinated Delivery	13,698,080	13,698,080	0%
B2 - Income Eligible Hard-to-Measure	-	-	
C - Commercial & Industrial	**46,391,972**	**41,223,841**	**-11%**
C1 - C&I New Buildings	12,352,502	11,578,317	-6%
C1a - C&I New Buildings & Major Renovations	12,352,502	11,578,317	-6%
C2 - C&I Existing Buildings	34,039,470	29,645,524	-13%
C2a - C&I Existing Building Retrofit	23,550,361	19,955,393	**-15%**
C2b - C&I New & Replacement Equipment	10,489,109	9,690,131	-8%
C3 - C&I Hard-to-Measure	-	-	
Grand Total	**123,960,319**	**116,102,082**	**-6%**

Notes

Plan year core initiative significant variance explanations are required for: (4) variances between preliminary and evaluated core initiative total resource benefits showing a decrease of 15 percent or greater.

Program Administrator Budgets, Plan Year Summary

2019 Planned vs. Evaluated

Eversource Gas

May 29, 2020

2019 Planned Program Administrator Budget										
Program	Program Costs						Performance Incentive	Total Program Administrator Budget	Program Cost per Participant	Resource Benefit per Program Cost
	Program Planning and Administration	Marketing and Advertising	Participant Incentive	Sales, Technical Assistance & Training	Evaluation and Market Research	Total Program Costs				
A - Residential	**1,415,000**	**1,025,000**	**20,590,000**	**5,860,000**	**655,000**	**29,545,000**	**514,017**	**30,059,017**	**199**	**1.59**
A1 - Residential New Buildings	115,000	35,000	2,490,000	180,000		2,820,000	82,337	2,902,337	1,226	2.27
A1a - Residential New Homes & Renovations	115,000	35,000	2,490,000	180,000		2,820,000	82,337	2,902,337	1,226	2.27
A2 - Residential Existing Buildings	1,030,000	735,000	17,960,000	5,505,000		25,230,000	431,680	25,661,680	172	1.61
A2a - Residential Coordinated Delivery	595,000	310,000	12,670,000	1,325,000		14,900,000	301,571	15,201,571	1,300	1.87
A2b - Residential Conservation Services (RCS)	155,000	310,000	-	2,855,000		3,320,000	-	3,320,000		-
A2c - Residential Retail	255,000	115,000	5,290,000	620,000		6,280,000	114,010	6,394,010	897	1.72
A2d - Residential Behavior	25,000	-	-	705,000		730,000	16,099	746,099	6	2.54
A3 - Residential Hard-to-Measure	270,000	255,000	140,000	175,000	655,000	1,495,000	-	1,495,000		-
A3a - Residential Statewide Marketing		235,000				235,000	-	235,000		-
A3b - Residential Statewide Database	15,000					15,000	-	15,000		-
A3c - Residential DOER Assessment	150,000					150,000	-	150,000		-
A3d - Residential Sponsorships & Subscriptions	5,000	5,000			5,000	15,000	-	15,000		-
A3e - Residential Workforce Development				50,000		50,000	-	50,000		-
A3f - Residential Evaluation and Market Research					650,000	650,000	-	650,000		-
A3g - Residential EEAC Consultants	80,000					80,000	-	80,000		-
A3h - Residential R&D and Demonstration	20,000			100,000		120,000	-	120,000		-
A3i - Residential HEAT Loan		15,000	140,000	25,000		180,000	-	180,000		-
A3j - Residential Education						-	-	-		
B - Income Eligible	**490,000**	**180,000**	**8,275,000**	**2,180,000**	**255,000**	**11,380,000**	**231,481**	**11,611,481**	**3,965**	**1.21**
B1 - Income Eligible Existing Buildings	390,000	165,000	8,275,000	2,170,000		11,000,000	231,481	11,231,481	3,833	1.25
B1a - Income Eligible Coordinated Delivery	390,000	165,000	8,275,000	2,170,000		11,000,000	231,481	11,231,481	3,833	1.25
B2 - Income Eligible Hard-to-Measure	100,000	15,000		10,000	255,000	380,000	-	380,000		-
B2a - Income Eligible Statewide Marketing		15,000				15,000	-	15,000		-
B2b - Income Eligible Statewide Database	5,000					5,000	-	5,000		-
B2c - Income Eligible DOER Assessment	55,000					55,000	-	55,000		-
B2d - Income Eligible Sponsorships & Subscriptions	-	-		-		-	-	-		
B2e - Income Eligible Workforce Development				10,000		10,000	-	10,000		-
B2f - Income Eligible Evaluation and Market Research					255,000	255,000	-	255,000		-
B2g - Income Eligible Energy Affordability Network	40,000					40,000	-	40,000		-
C - Commercial & Industrial	**1,060,000**	**250,000**	**9,440,000**	**3,955,000**	**515,000**	**15,220,000**	**775,921**	**15,995,921**	**5,350**	**4.72**
C1 - C&I New Buildings	140,000	50,000	1,370,000	565,000		2,125,000	174,074	2,299,074	47,222	7.77
C1a - C&I New Buildings & Major Renovations	140,000	50,000	1,370,000	565,000		2,125,000	174,074	2,299,074	47,222	7.77
C2 - C&I Existing Buildings	795,000	170,000	8,070,000	3,220,000		12,255,000	601,847	12,856,847	4,377	4.52
C2a - C&I Existing Building Retrofit	545,000	120,000	5,860,000	1,935,000		8,460,000	427,607	8,887,607	5,640	4.50
C2b - C&I New & Replacement Equipment	250,000	50,000	2,210,000	1,285,000		3,795,000	174,240	3,969,240	2,919	4.56
C3 - C&I Hard-to-Measure	125,000	30,000		170,000	515,000	840,000	-	840,000		-
C3a - C&I Statewide Marketing		25,000				25,000	-	25,000		-
C3b - C&I Statewide Database	5,000					5,000	-	5,000		-
C3c - C&I DOER Assessment	60,000					60,000	-	60,000		-
C3d - C&I Sponsorships & Subscriptions	15,000	5,000			5,000	25,000	-	25,000		-
C3e - C&I Workforce Development				50,000		50,000	-	50,000		-
C3f - C&I Evaluation and Market Research					510,000	510,000	-	510,000		-
C3g - C&I EEAC Consultants	25,000					25,000	-	25,000		-
C3h - C&I R&D and Demonstration	20,000			120,000		140,000	-	140,000		-
Grand Total	**2,965,000**	**1,455,000**	**38,305,000**	**11,995,000**	**1,425,000**	**56,145,000**	**1,521,418**	**57,666,418**	**364**	**2.36**

Program Administrator Budgets, Plan Year Summary

2019 Planned vs. Evaluated

Eversource Gas

May 29, 2020

2019 Evaluated Program Administrator Budget										
Program	Program Costs						Performance Incentive	Total Program Administrator Budget	Program Cost per Participant	Resource Benefit per Program Cost
	Program Planning and Administration	Marketing and Advertising	Participant Incentive	Sales, Technical Assistance & Training	Evaluation and Market Research	Total Program Costs				
A - Residential	**1,102,694**	**1,325,093**	**23,084,525**	**4,758,296**	**420,869**	**30,691,478**	**691,203**	**31,382,681**	**232**	**1.99**
A1 - Residential New Buildings	87,368	35,140	1,883,029	192,110	-	2,197,646	89,448	2,287,095	1,166	3.03
A1a - Residential New Homes & Renovations	87,368	35,140	1,883,029	192,110	-	2,197,646	89,448	2,287,095	1,166	3.03
A2 - Residential Existing Buildings	793,071	1,070,596	20,939,896	4,527,387	-	27,330,951	601,754	27,932,705	210	1.99
A2a - Residential Coordinated Delivery	461,847	534,913	14,549,863	1,107,787	-	16,654,409	418,676	17,073,086	1,481	2.29
A2b - Residential Conservation Services (RCS)	119,536	321,733	-	2,528,918	-	2,970,187	-	2,970,187		-
A2c - Residential Retail	194,547	213,951	6,390,033	239,494	-	7,038,026	169,020	7,207,045	810	2.10
A2d - Residential Behavior	17,141	-	-	651,188	-	668,328	14,059	682,387	6	2.38
A3 - Residential Hard-to-Measure	222,255	219,357	261,600	38,800	420,869	1,162,881	-	1,162,881		-
A3a - Residential Statewide Marketing	-	197,575	-	-	-	197,575	-	197,575		-
A3b - Residential Statewide Database	1,878	-	-	-	-	1,878	-	1,878		-
A3c - Residential DOER Assessment	147,823	-	-	-	-	147,823	-	147,823		-
A3d - Residential Sponsorships & Subscriptions	2,738	1,200	-	-	1,046	4,983	-	4,983		-
A3e - Residential Workforce Development	-	-	-	12,799	-	12,799	-	12,799		-
A3f - Residential Evaluation and Market Research	-	-	-	-	419,824	419,824	-	419,824		-
A3g - Residential EEAC Consultants	51,992	-	-	-	-	51,992	-	51,992		-
A3h - Residential R&D and Demonstration	17,823	-	-	7,311	-	25,134	-	25,134		-
A3i - Residential HEAT Loan	-	20,582	261,600	18,690	-	300,871	-	300,871		-
A3j - Residential Education	-	-	-	-	-	-	-	-		
B - Income Eligible	**361,708**	**62,851**	**8,779,369**	**1,813,497**	**163,604**	**11,181,028**	**222,641**	**11,403,668**	**4,047**	**1.23**
B1 - Income Eligible Existing Buildings	281,769	50,614	8,779,369	1,813,497	-	10,925,248	222,641	11,147,889	3,954	1.25
B1a - Income Eligible Coordinated Delivery	281,769	50,614	8,779,369	1,813,497	-	10,925,248	222,641	11,147,889	3,954	1.25
B2 - Income Eligible Hard-to-Measure	79,938	12,237	-	-	163,604	255,779	-	255,779		-
B2a - Income Eligible Statewide Marketing	-	12,237	-	-	-	12,237	-	12,237		-
B2b - Income Eligible Statewide Database	650	-	-	-	-	650	-	650		-
B2c - Income Eligible DOER Assessment	55,434	-	-	-	-	55,434	-	55,434		-
B2d - Income Eligible Sponsorships & Subscriptions	-	-	-	-	-	-	-	-		
B2e - Income Eligible Workforce Development	-	-	-	-	-	-	-	-		
B2f - Income Eligible Evaluation and Market Research	-	-	-	-	163,604	163,604	-	163,604		-
B2g - Income Eligible Energy Affordability Network	23,855	-	-	-	-	23,855	-	23,855		-
C - Commercial & Industrial	**419,100**	**229,490**	**6,816,833**	**2,572,129**	**756,596**	**10,794,148**	**413,307**	**11,207,455**	**6,406**	**3.82**
C1 - C&I New Buildings	52,478	42,906	1,371,499	250,783	-	1,717,666	118,034	1,835,700	63,617	6.74
C1a - C&I New Buildings & Major Renovations	52,478	42,906	1,371,499	250,783	-	1,717,666	118,034	1,835,700	63,617	6.74
C2 - C&I Existing Buildings	263,263	159,840	5,445,334	2,258,353	-	8,126,790	295,273	8,422,062	4,902	3.65
C2a - C&I Existing Building Retrofit	185,665	112,615	3,597,820	971,164	-	4,867,263	205,449	5,072,712	4,203	4.10
C2b - C&I New & Replacement Equipment	77,597	47,225	1,847,515	1,287,189	-	3,259,526	89,824	3,349,350	6,519	2.97
C3 - C&I Hard-to-Measure	103,359	26,744	-	62,993	756,596	949,692	-	949,692		-
C3a - C&I Statewide Marketing	-	24,719	-	-	-	24,719	-	24,719		-
C3b - C&I Statewide Database	692	-	-	-	-	692	-	692		-
C3c - C&I DOER Assessment	60,713	-	-	-	-	60,713	-	60,713		-
C3d - C&I Sponsorships & Subscriptions	8,626	2,025	-	-	1,046	11,697	-	11,697		-
C3e - C&I Workforce Development	-	-	-	57,091	-	57,091	-	57,091		-
C3f - C&I Evaluation and Market Research	-	-	-	-	755,551	755,551	-	755,551		-
C3g - C&I EEAC Consultants	15,685	-	-	-	-	15,685	-	15,685		-
C3h - C&I R&D and Demonstration	17,643	-	-	5,902	-	23,545	-	23,545		-
Grand Total	**1,883,501**	**1,617,434**	**38,680,726**	**9,143,922**	**1,341,069**	**52,666,653**	**1,327,151**	**53,993,804**	**385**	**2.20**

Program Administrator Budgets, Plan Year Summary

2019 Planned vs. Evaluated

Eversource Gas

May 29, 2020

2019 Planned v. Evaluated Program Administrator Budget Variances (%)										
Program	Program Costs						Performance Incentive	Total Program Administrator Budget	Program Cost per Participant	Resource Benefit per Program Cost
	Program Planning and Administration	Marketing and Advertising	Participant Incentive	Sales, Technical Assistance & Training	Evaluation and Market Research	Total Program Costs				
A - Residential	**-22%**	**29%**	**12%**	**-19%**	**-36%**	**4%**	**34%**	**4%**	**17%**	**26%**
A1 - Residential New Buildings	-24%	0%	-24%	7%		-22%	9%	-21%	-5%	33%
A1a - Residential New Homes & Renovations	-24%	0%	-24%	7%		-22%	9%	-21%	-5%	33%
A2 - Residential Existing Buildings	-23%	46%	17%	-18%		8%	39%	9%	22%	24%
A2a - Residential Coordinated Delivery	-22%	73%	15%	-16%		12%	39%	12%	14%	22%
A2b - Residential Conservation Services (RCS)	-23%	4%		-11%		-11%		-11%		
A2c - Residential Retail	-24%	86%	21%	-61%		12%	48%	13%	-10%	22%
A2d - Residential Behavior	-31%			-8%		-8%	-13%	-9%	6%	-6%
A3 - Residential Hard-to-Measure	-18%	-14%	87%	-78%	-36%	-22%		-22%		
A3a - Residential Statewide Marketing		-16%				-16%		-16%		
A3b - Residential Statewide Database	-87%					-87%		-87%		
A3c - Residential DOER Assessment	-1%					-1%		-1%		
A3d - Residential Sponsorships & Subscriptions	-45%	-76%			-79%	-67%		-67%		
A3e - Residential Workforce Development				-74%		-74%		-74%		
A3f - Residential Evaluation and Market Research					-35%	-35%		-35%		
A3g - Residential EEAC Consultants	-35%					-35%		-35%		
A3h - Residential R&D and Demonstration	-11%			-93%		-79%		-79%		
A3i - Residential HEAT Loan		37%	87%	-25%		67%		67%		
A3j - Residential Education										
B - Income Eligible	**-26%**	**-65%**	**6%**	**-17%**	**-36%**	**-2%**	**-4%**	**-2%**	**2%**	**1%**
B1 - Income Eligible Existing Buildings	-28%	-69%	6%	-16%		-1%	-4%	-1%	3%	0%
B1a - Income Eligible Coordinated Delivery	-28%	-69%	6%	-16%		-1%	-4%	-1%	3%	0%
B2 - Income Eligible Hard-to-Measure	-20%	-18%		-100%	-36%	-33%		-33%		
B2a - Income Eligible Statewide Marketing		-18%				-18%		-18%		
B2b - Income Eligible Statewide Database	-87%					-87%		-87%		
B2c - Income Eligible DOER Assessment	1%					1%		1%		
B2d - Income Eligible Sponsorships & Subscriptions										
B2e - Income Eligible Workforce Development				-100%		-100%		-100%		
B2f - Income Eligible Evaluation and Market Research					-36%	-36%		-36%		
B2g - Income Eligible Energy Affordability Network	-40%					-40%		-40%		
C - Commercial & Industrial	**-60%**	**-8%**	**-28%**	**-35%**	**47%**	**-29%**	**-47%**	**-30%**	**20%**	**-19%**
C1 - C&I New Buildings	-63%	-14%	0%	-56%		-19%	-32%	-20%	35%	-13%
C1a - C&I New Buildings & Major Renovations	-63%	-14%	0%	-56%		-19%	-32%	-20%	35%	-13%
C2 - C&I Existing Buildings	-67%	-6%	-33%	-30%		-34%	-51%	-34%	12%	-19%
C2a - C&I Existing Building Retrofit	-66%	-6%	-39%	-50%		-42%	-52%	-43%	-25%	-9%
C2b - C&I New & Replacement Equipment	-69%	-6%	-16%	0%		-14%	-48%	-16%	123%	-35%
C3 - C&I Hard-to-Measure	-17%	-11%		-63%	47%	13%		13%		
C3a - C&I Statewide Marketing		-1%				-1%		-1%		
C3b - C&I Statewide Database	-86%					-86%		-86%		
C3c - C&I DOER Assessment	1%					1%		1%		
C3d - C&I Sponsorships & Subscriptions	-42%	-60%			-79%	-53%		-53%		
C3e - C&I Workforce Development				14%		14%		14%		
C3f - C&I Evaluation and Market Research					48%	48%		48%		
C3g - C&I EEAC Consultants	-37%					-37%		-37%		
C3h - C&I R&D and Demonstration	-12%			-95%		-83%		-83%		
Grand Total	**-36%**	**11%**	**1%**	**-24%**	**-6%**	**-6%**	**-13%**	**-6%**	**6%**	**-7%**

Notes

• Where not otherwise indicated, budgets for each year are represented in nominal dollars (2019$, 2020$, 2021$).
• Refer to common definitions for allocation of costs.
• The plan year variances provided above are intended to indicate the Program Administrator's performance in the plan year only. The variances used to determine significant variances are provided separately. The variances above and the significant variances use different calculations to determine variances on an annual basis and over the three-year term, respectively.

Program Administrator Budgets, Three-Year Total

2019-2021 Program Administrator Budget

Eversource Gas
May 29, 2020

2019 Evaluated Program Administrator Budget										
Program	Program Costs						Performance Incentive	Total Program Administrator Budget	Program Cost per Participant	Resource Benefit per Program Cost
	Program Planning and Administration	Marketing and Advertising	Participant Incentive	Sales, Technical Assistance & Training	Evaluation and Market Research	Total Program Costs				
A - Residential	**1,102,694**	**1,325,093**	**23,084,525**	**4,758,296**	**420,869**	**30,691,478**	**691,203**	**31,382,681**	**232**	**1.99**
A1 - Residential New Buildings	87,368	35,140	1,883,029	192,110	-	2,197,646	89,448	2,287,095	1,166	3.03
A1a - Residential New Homes & Renovations	87,368	35,140	1,883,029	192,110	-	2,197,646	89,448	2,287,095	1,166	3.03
A2 - Residential Existing Buildings	793,071	1,070,596	20,939,896	4,527,387	-	27,330,951	601,754	27,932,705	210	1.99
A2a - Residential Coordinated Delivery	461,847	534,913	14,549,863	1,107,787	-	16,654,409	418,676	17,073,086	1,481	2.29
A2b - Residential Conservation Services (RCS)	119,536	321,733	-	2,528,918	-	2,970,187	-	2,970,187		-
A2c - Residential Retail	194,547	213,951	6,390,033	239,494	-	7,038,026	169,020	7,207,045	810	2.10
A2d - Residential Behavior	17,141	-	-	651,188	-	668,328	14,059	682,387	6	2.38
A3 - Residential Hard-to-Measure	222,255	219,357	261,600	38,800	420,869	1,162,881	-	1,162,881		-
A3a - Residential Statewide Marketing	-	197,575	-	-	-	197,575	-	197,575		-
A3b - Residential Statewide Database	1,878	-	-	-	-	1,878	-	1,878		-
A3c - Residential DOER Assessment	147,823	-	-	-	-	147,823	-	147,823		-
A3d - Residential Sponsorships & Subscriptions	2,738	1,200	-	-	1,046	4,983	-	4,983		-
A3e - Residential Workforce Development	-	-	-	12,799	-	12,799	-	12,799		-
A3f - Residential Evaluation and Market Research	-	-	-	-	419,824	419,824	-	419,824		-
A3g - Residential EEAC Consultants	51,992	-	-	-	-	51,992	-	51,992		-
A3h - Residential R&D and Demonstration	17,823	-	-	7,311	-	25,134	-	25,134		-
A3i - Residential HEAT Loan	-	20,582	261,600	18,690	-	300,871	-	300,871		-
A3j - Residential Education	-	-	-	-	-	-	-	-		
B - Income Eligible	**361,708**	**62,851**	**8,779,369**	**1,813,497**	**163,604**	**11,181,028**	**222,641**	**11,403,668**	**4,047**	**1.23**
B1 - Income Eligible Existing Buildings	281,769	50,614	8,779,369	1,813,497	-	10,925,248	222,641	11,147,889	3,954	1.25
B1a - Income Eligible Coordinated Delivery	281,769	50,614	8,779,369	1,813,497	-	10,925,248	222,641	11,147,889	3,954	1.25
B2 - Income Eligible Hard-to-Measure	79,938	12,237	-	-	163,604	255,779	-	255,779		-
B2a - Income Eligible Statewide Marketing	-	12,237	-	-	-	12,237	-	12,237		-
B2b - Income Eligible Statewide Database	650	-	-	-	-	650	-	650		-
B2c - Income Eligible DOER Assessment	55,434	-	-	-	-	55,434	-	55,434		-
B2d - Income Eligible Sponsorships & Subscriptions	-	-	-	-	-	-	-	-		
B2e - Income Eligible Workforce Development	-	-	-	-	-	-	-	-		
B2f - Income Eligible Evaluation and Market Research	-	-	-	-	163,604	163,604	-	163,604		-
B2g - Income Eligible Energy Affordability Network	23,855	-	-	-	-	23,855	-	23,855		-
C - Commercial & Industrial	**419,100**	**229,490**	**6,816,833**	**2,572,129**	**756,596**	**10,794,148**	**413,307**	**11,207,455**	**6,406**	**3.82**
C1 - C&I New Buildings	52,478	42,906	1,371,499	250,783	-	1,717,666	118,034	1,835,700	63,617	6.74
C1a - C&I New Buildings & Major Renovations	52,478	42,906	1,371,499	250,783	-	1,717,666	118,034	1,835,700	63,617	6.74
C2 - C&I Existing Buildings	263,263	159,840	5,445,334	2,258,353	-	8,126,790	295,273	8,422,062	4,902	3.65
C2a - C&I Existing Building Retrofit	185,665	112,615	3,597,820	971,164	-	4,867,263	205,449	5,072,712	4,203	4.10
C2b - C&I New & Replacement Equipment	77,597	47,225	1,847,515	1,287,189	-	3,259,526	89,824	3,349,350	6,519	2.97
C3 - C&I Hard-to-Measure	103,359	26,744	-	62,993	756,596	949,692	-	949,692		-
C3a - C&I Statewide Marketing	-	24,719	-	-	-	24,719	-	24,719		-
C3b - C&I Statewide Database	692	-	-	-	-	692	-	692		-
C3c - C&I DOER Assessment	60,713	-	-	-	-	60,713	-	60,713		-
C3d - C&I Sponsorships & Subscriptions	8,626	2,025	-	-	1,046	11,697	-	11,697		-
C3e - C&I Workforce Development	-	-	-	57,091	-	57,091	-	57,091		-
C3f - C&I Evaluation and Market Research	-	-	-	-	755,551	755,551	-	755,551		-
C3g - C&I EEAC Consultants	15,685	-	-	-	-	15,685	-	15,685		-
C3h - C&I R&D and Demonstration	17,643	-	-	5,902	-	23,545	-	23,545		-
Grand Total	**1,883,501**	**1,617,434**	**38,680,726**	**9,143,922**	**1,341,069**	**52,666,653**	**1,327,151**	**53,993,804**	**385**	**2.20**

Program Administrator Budgets, Three-Year Total

2019-2021 Program Administrator Budget

Eversource Gas
May 29, 2020

2020 Planned Program Administrator Budget										
Program	Program Costs						Performance Incentive	Total Program Administrator Budget	Program Cost per Participant	Resource Benefit per Program Cost
	Program Planning and Administration	Marketing and Advertising	Participant Incentive	Sales, Technical Assistance & Training	Evaluation and Market Research	Total Program Costs				
A - Residential	**1,600,000**	**1,070,000**	**21,600,000**	**6,240,000**	**665,000**	**31,175,000**	**551,860**	**31,726,860**	**208**	**1.57**
A1 - Residential New Buildings	125,000	35,000	2,495,000	180,000		2,835,000	84,991	2,919,991	1,233	2.27
A1a - Residential New Homes & Renovations	125,000	35,000	2,495,000	180,000		2,835,000	84,991	2,919,991	1,233	2.27
A2 - Residential Existing Buildings	1,185,000	775,000	18,965,000	5,865,000		26,790,000	466,869	27,256,869	181	1.59
A2a - Residential Coordinated Delivery	695,000	325,000	13,675,000	1,365,000		16,060,000	331,139	16,391,139	1,296	1.85
A2b - Residential Conservation Services (RCS)	185,000	325,000	-	3,155,000		3,665,000	-	3,665,000		-
A2c - Residential Retail	275,000	125,000	5,290,000	640,000		6,330,000	118,176	6,448,176	904	1.72
A2d - Residential Behavior	30,000	-	-	705,000		735,000	17,554	752,554	6	2.65
A3 - Residential Hard-to-Measure	290,000	260,000	140,000	195,000	665,000	1,550,000	-	1,550,000		-
A3a - Residential Statewide Marketing		235,000				235,000	-	235,000		-
A3b - Residential Statewide Database	15,000					15,000	-	15,000		-
A3c - Residential DOER Assessment	160,000					160,000	-	160,000		-
A3d - Residential Sponsorships & Subscriptions	10,000	5,000			5,000	20,000	-	20,000		-
A3e - Residential Workforce Development				60,000		60,000	-	60,000		-
A3f - Residential Evaluation and Market Research					660,000	660,000	-	660,000		-
A3g - Residential EEAC Consultants	85,000					85,000	-	85,000		-
A3h - Residential R&D and Demonstration	20,000			110,000		130,000	-	130,000		-
A3i - Residential HEAT Loan		20,000	140,000	25,000		185,000	-	185,000		-
A3j - Residential Education	-	-	-	-	-	-	-	-		
B - Income Eligible	**560,000**	**185,000**	**8,515,000**	**2,340,000**	**255,000**	**11,855,000**	**247,118**	**12,102,118**	**3,752**	**1.21**
B1 - Income Eligible Existing Buildings	450,000	170,000	8,515,000	2,325,000		11,460,000	247,118	11,707,118	3,627	1.25
B1a - Income Eligible Coordinated Delivery	450,000	170,000	8,515,000	2,325,000		11,460,000	247,118	11,707,118	3,627	1.25
B2 - Income Eligible Hard-to-Measure	110,000	15,000		15,000	255,000	395,000	-	395,000		-
B2a - Income Eligible Statewide Marketing		15,000				15,000	-	15,000		-
B2b - Income Eligible Statewide Database	5,000					5,000	-	5,000		-
B2c - Income Eligible DOER Assessment	60,000					60,000	-	60,000		-
B2d - Income Eligible Sponsorships & Subscriptions	-	-		-		-	-	-		
B2e - Income Eligible Workforce Development				15,000		15,000	-	15,000		-
B2f - Income Eligible Evaluation and Market Research					255,000	255,000	-	255,000		-
B2g - Income Eligible Energy Affordability Network	45,000					45,000	-	45,000		-
C - Commercial & Industrial	**1,160,000**	**270,000**	**9,660,000**	**4,225,000**	**525,000**	**15,840,000**	**801,399**	**16,641,399**	**5,472**	**4.58**
C1 - C&I New Buildings	155,000	50,000	1,370,000	575,000		2,150,000	180,240	2,330,240	47,778	7.76
C1a - C&I New Buildings & Major Renovations	155,000	50,000	1,370,000	575,000		2,150,000	180,240	2,330,240	47,778	7.76
C2 - C&I Existing Buildings	865,000	185,000	8,290,000	3,465,000		12,805,000	621,159	13,426,159	4,493	4.36
C2a - C&I Existing Building Retrofit	595,000	125,000	6,035,000	2,145,000		8,900,000	447,945	9,347,945	5,933	4.37
C2b - C&I New & Replacement Equipment	270,000	60,000	2,255,000	1,320,000		3,905,000	173,213	4,078,213	2,893	4.33
C3 - C&I Hard-to-Measure	140,000	35,000		185,000	525,000	885,000	-	885,000		-
C3a - C&I Statewide Marketing		25,000				25,000	-	25,000		-
C3b - C&I Statewide Database	5,000					5,000	-	5,000		-
C3c - C&I DOER Assessment	65,000					65,000	-	65,000		-
C3d - C&I Sponsorships & Subscriptions	20,000	10,000			10,000	40,000	-	40,000		-
C3e - C&I Workforce Development				60,000		60,000	-	60,000		-
C3f - C&I Evaluation and Market Research					515,000	515,000	-	515,000		-
C3g - C&I EEAC Consultants	30,000					30,000	-	30,000		-
C3h - C&I R&D and Demonstration	20,000			125,000		145,000	-	145,000		-
Grand Total	**3,320,000**	**1,525,000**	**39,775,000**	**12,805,000**	**1,445,000**	**58,870,000**	**1,600,377**	**60,470,377**	**377**	**2.31**

Program Administrator Budgets, Three-Year Total

2019-2021 Program Administrator Budget

Eversource Gas
May 29, 2020

2021 Planned Program Administrator Budget										
Program	Program Costs						Performance Incentive	Total Program Administrator Budget	Program Cost per Participant	Resource Benefit per Program Cost
	Program Planning and Administration	Marketing and Advertising	Participant Incentive	Sales, Technical Assistance & Training	Evaluation and Market Research	Total Program Costs				
A - Residential	**1,665,000**	**1,110,000**	**22,875,000**	**6,410,000**	**675,000**	**32,735,000**	**598,970**	**33,333,970**	**216**	**1.58**
A1 - Residential New Buildings	120,000	35,000	2,495,000	190,000		2,840,000	87,924	2,927,924	1,235	2.28
A1a - Residential New Homes & Renovations	120,000	35,000	2,495,000	190,000		2,840,000	87,924	2,927,924	1,235	2.28
A2 - Residential Existing Buildings	1,225,000	800,000	20,240,000	6,005,000		28,270,000	511,045	28,781,045	189	1.60
A2a - Residential Coordinated Delivery	740,000	335,000	14,950,000	1,475,000		17,500,000	368,911	17,868,911	1,289	1.84
A2b - Residential Conservation Services (RCS)	185,000	335,000	-	3,160,000		3,680,000	-	3,680,000		-
A2c - Residential Retail	270,000	130,000	5,290,000	660,000		6,350,000	122,685	6,472,685	907	1.73
A2d - Residential Behavior	30,000	-	-	710,000		740,000	19,450	759,450	6	2.80
A3 - Residential Hard-to-Measure	320,000	275,000	140,000	215,000	675,000	1,625,000	-	1,625,000		-
A3a - Residential Statewide Marketing		240,000				240,000	-	240,000		-
A3b - Residential Statewide Database	20,000					20,000	-	20,000		-
A3c - Residential DOER Assessment	170,000					170,000	-	170,000		-
A3d - Residential Sponsorships & Subscriptions	15,000	10,000			5,000	30,000	-	30,000		-
A3e - Residential Workforce Development				70,000		70,000	-	70,000		-
A3f - Residential Evaluation and Market Research					670,000	670,000	-	670,000		-
A3g - Residential EEAC Consultants	90,000					90,000	-	90,000		-
A3h - Residential R&D and Demonstration	25,000			120,000		145,000	-	145,000		-
A3i - Residential HEAT Loan		25,000	140,000	25,000		190,000	-	190,000		-
A3j - Residential Education	-	-	-	-	-	-	-	-		
B - Income Eligible	**580,000**	**200,000**	**8,770,000**	**2,355,000**	**260,000**	**12,165,000**	**265,606**	**12,430,606**	**3,496**	**1.22**
B1 - Income Eligible Existing Buildings	450,000	175,000	8,770,000	2,335,000		11,730,000	265,606	11,995,606	3,371	1.27
B1a - Income Eligible Coordinated Delivery	450,000	175,000	8,770,000	2,335,000		11,730,000	265,606	11,995,606	3,371	1.27
B2 - Income Eligible Hard-to-Measure	130,000	25,000		20,000	260,000	435,000	-	435,000		-
B2a - Income Eligible Statewide Marketing		25,000				25,000	-	25,000		-
B2b - Income Eligible Statewide Database	10,000					10,000	-	10,000		-
B2c - Income Eligible DOER Assessment	70,000					70,000	-	70,000		-
B2d - Income Eligible Sponsorships & Subscriptions	-	-		-		-	-	-		
B2e - Income Eligible Workforce Development				20,000		20,000	-	20,000		-
B2f - Income Eligible Evaluation and Market Research					260,000	260,000	-	260,000		-
B2g - Income Eligible Energy Affordability Network	50,000					50,000	-	50,000		-
C - Commercial & Industrial	**1,220,000**	**300,000**	**9,835,000**	**4,330,000**	**525,000**	**16,210,000**	**831,517**	**17,041,517**	**5,599**	**4.52**
C1 - C&I New Buildings	160,000	45,000	1,370,000	585,000		2,160,000	185,812	2,345,812	48,000	7.77
C1a - C&I New Buildings & Major Renovations	160,000	45,000	1,370,000	585,000		2,160,000	185,812	2,345,812	48,000	7.77
C2 - C&I Existing Buildings	890,000	205,000	8,465,000	3,545,000		13,105,000	645,705	13,750,705	4,598	4.31
C2a - C&I Existing Building Retrofit	620,000	135,000	6,210,000	2,235,000		9,200,000	467,831	9,667,831	6,133	4.31
C2b - C&I New & Replacement Equipment	270,000	70,000	2,255,000	1,310,000		3,905,000	177,874	4,082,874	2,893	4.33
C3 - C&I Hard-to-Measure	170,000	50,000		200,000	525,000	945,000	-	945,000		-
C3a - C&I Statewide Marketing		35,000				35,000	-	35,000		-
C3b - C&I Statewide Database	10,000					10,000	-	10,000		-
C3c - C&I DOER Assessment	75,000					75,000	-	75,000		-
C3d - C&I Sponsorships & Subscriptions	25,000	15,000			10,000	50,000	-	50,000		-
C3e - C&I Workforce Development				70,000		70,000	-	70,000		-
C3f - C&I Evaluation and Market Research					515,000	515,000	-	515,000		-
C3g - C&I EEAC Consultants	35,000					35,000	-	35,000		-
C3h - C&I R&D and Demonstration	25,000			130,000		155,000	-	155,000		-
Grand Total	**3,465,000**	**1,610,000**	**41,480,000**	**13,095,000**	**1,460,000**	**61,110,000**	**1,696,093**	**62,806,093**	**386**	**2.29**

Program Administrator Budgets, Three-Year Total

2019-2021 Program Administrator Budget

Eversource Gas
May 29, 2020

2019-2021 Program Administrator Budget										
Program	Program Costs						Performance Incentive	Total Program Administrator Budget	Program Cost per Participant	Resource Benefit per Program Cost
	Program Planning and Administration	Marketing and Advertising	Participant Incentive	Sales, Technical Assistance & Training	Evaluation and Market Research	Total Program Costs				
A - Residential	**4,367,694**	**3,505,093**	**67,559,525**	**17,408,296**	**1,760,869**	**94,601,478**	**1,842,033**	**96,443,510**	**218**	**1.71**
A1 - Residential New Buildings	332,368	105,140	6,873,029	562,110	-	7,872,646	262,364	8,135,010	1,214	2.49
A1a - Residential New Homes & Renovations	332,368	105,140	6,873,029	562,110	-	7,872,646	262,364	8,135,010	1,214	2.49
A2 - Residential Existing Buildings	3,203,071	2,645,596	60,144,896	16,397,387	-	82,390,951	1,579,669	83,970,619	193	1.73
A2a - Residential Coordinated Delivery	1,896,847	1,194,913	43,174,863	3,947,787	-	50,214,409	1,118,726	51,333,136	1,350	1.99
A2b - Residential Conservation Services (RCS)	489,536	981,733	-	8,843,918	-	10,315,187	-	10,315,187		-
A2c - Residential Retail	739,547	468,951	16,970,033	1,539,494	-	19,718,026	409,880	20,127,906	869	1.86
A2d - Residential Behavior	77,141	-	-	2,066,188	-	2,143,328	51,062	2,194,391	6	2.62
A3 - Residential Hard-to-Measure	832,255	754,357	541,600	448,800	1,760,869	4,337,881	-	4,337,881		
A3a - Residential Statewide Marketing	-	672,575	-	-	-	672,575	-	672,575		
A3b - Residential Statewide Database	36,878	-	-	-	-	36,878	-	36,878		
A3c - Residential DOER Assessment	477,823	-	-	-	-	477,823	-	477,823		
A3d - Residential Sponsorships & Subscriptions	27,738	16,200	-	-	11,046	54,983	-	54,983		
A3e - Residential Workforce Development	-	-	-	142,799	-	142,799	-	142,799		
A3f - Residential Evaluation and Market Research	-	-	-	-	1,749,824	1,749,824	-	1,749,824		
A3g - Residential EEAC Consultants	226,992	-	-	-	-	226,992	-	226,992		
A3h - Residential R&D and Demonstration	62,823	-	-	237,311	-	300,134	-	300,134		
A3i - Residential HEAT Loan	-	65,582	541,600	68,690	-	675,871	-	675,871		
A3j - Residential Education	-	-	-	-	-	-	-	-		
B - Income Eligible	**1,501,708**	**447,851**	**26,064,369**	**6,508,497**	**678,604**	**35,201,028**	**735,365**	**35,936,392**	**3,744**	**1.22**
B1 - Income Eligible Existing Buildings	1,181,769	395,614	26,064,369	6,473,497	-	34,115,248	735,365	34,850,613	3,628	1.26
B1a - Income Eligible Coordinated Delivery	1,181,769	395,614	26,064,369	6,473,497	-	34,115,248	735,365	34,850,613	3,628	1.26
B2 - Income Eligible Hard-to-Measure	319,938	52,237	-	35,000	678,604	1,085,779	-	1,085,779		
B2a - Income Eligible Statewide Marketing	-	52,237	-	-	-	52,237	-	52,237		
B2b - Income Eligible Statewide Database	15,650	-	-	-	-	15,650	-	15,650		
B2c - Income Eligible DOER Assessment	185,434	-	-	-	-	185,434	-	185,434		
B2d - Income Eligible Sponsorships & Subscriptions	-	-	-	-	-	-	-	-		
B2e - Income Eligible Workforce Development	-	-	-	35,000	-	35,000	-	35,000		
B2f - Income Eligible Evaluation and Market Research	-	-	-	-	678,604	678,604	-	678,604		
B2g - Income Eligible Energy Affordability Network	118,855	-	-	-	-	118,855	-	118,855		
C - Commercial & Industrial	**2,799,100**	**799,490**	**26,311,833**	**11,127,129**	**1,806,596**	**42,844,148**	**2,046,223**	**44,890,371**	**5,732**	**4.36**
C1 - C&I New Buildings	367,478	137,906	4,111,499	1,410,783	-	6,027,666	484,086	6,511,753	51,519	7.47
C1a - C&I New Buildings & Major Renovations	367,478	137,906	4,111,499	1,410,783	-	6,027,666	484,086	6,511,753	51,519	7.47
C2 - C&I Existing Buildings	2,018,263	549,840	22,200,334	9,268,353	-	34,036,790	1,562,136	35,598,926	4,626	4.17
C2a - C&I Existing Building Retrofit	1,400,665	372,615	15,842,820	5,351,164	-	22,967,263	1,121,225	24,088,488	5,524	4.29
C2b - C&I New & Replacement Equipment	617,597	177,225	6,357,515	3,917,189	-	11,069,526	440,911	11,510,438	3,459	3.93
C3 - C&I Hard-to-Measure	413,359	111,744	-	447,993	1,806,596	2,779,692	-	2,779,692		
C3a - C&I Statewide Marketing	-	84,719	-	-	-	84,719	-	84,719		
C3b - C&I Statewide Database	15,692	-	-	-	-	15,692	-	15,692		
C3c - C&I DOER Assessment	200,713	-	-	-	-	200,713	-	200,713		
C3d - C&I Sponsorships & Subscriptions	53,626	27,025	-	-	21,046	101,697	-	101,697		
C3e - C&I Workforce Development	-	-	-	187,091	-	187,091	-	187,091		
C3f - C&I Evaluation and Market Research	-	-	-	-	1,785,551	1,785,551	-	1,785,551		
C3g - C&I EEAC Consultants	80,685	-	-	-	-	80,685	-	80,685		
C3h - C&I R&D and Demonstration	62,643	-	-	260,902	-	323,545	-	323,545		
Grand Total	**8,668,501**	**4,752,434**	**119,935,726**	**35,043,922**	**4,246,069**	**172,646,653**	**4,623,620**	**177,270,273**	**383**	**2.27**

Notes

• Where not otherwise indicated, budgets for each year are represented in nominal dollars (2019$, 2020$, 2021$).

• Refer to common definitions for allocation of costs.

Program Savings, Plan Year Summary

2019 Planned vs. Evaluated

Eversource Gas
May 29, 2020

2019 Planned Net Savings

Program	# of Participants	Electric						Natural Gas	
		Annual Capacity (kW)		Electric Energy (MWh)		Electric Energy (MMBTU)		(Therms)	
		Summer	Winter	Annual	Lifetime	Annual	Lifetime	Annual	Lifetime
A - Residential	**148,585**	**300**	**206**	**1,347**	**16,572**			**2,721,732**	**30,126,614**
A1 - Residential New Buildings	2,300	17	13	74	1,380			214,920	4,542,000
A1a - Residential New Homes & Renovations	2,300	17	13	74	1,380			214,920	4,542,000
A2 - Residential Existing Buildings	146,285	283	193	1,273	15,192			2,506,812	25,584,614
A2a - Residential Coordinated Delivery	11,460	233	174	1,129	13,124			871,928	17,033,022
A2b - Residential Conservation Services (RCS)	-	-	-	-	-			-	-
A2c - Residential Retail	7,000	50	19	144	2,068			441,908	7,358,616
A2d - Residential Behavior	127,825	-	-	-	-			1,192,976	1,192,976
B - Income Eligible	**2,870**	**78**	**5**	**157**	**3,769**			**446,023**	**9,132,435**
B1 - Income Eligible Existing Buildings	2,870	78	5	157	3,769			446,023	9,132,435
B1a - Income Eligible Coordinated Delivery	2,870	78	5	157	3,769			446,023	9,132,435
C - Commercial & Industrial	**2,845**	**2**	**-**	**4**	**89**			**4,066,611**	**51,576,382**
C1 - C&I New Buildings	45	-	-	-	-			701,812	12,368,194
C1a - C&I New Buildings & Major Renovations	45	-	-	-	-			701,812	12,368,194
C2 - C&I Existing Buildings	2,800	2	-	4	89			3,364,799	39,208,188
C2a - C&I Existing Building Retrofit	1,500	2	-	3	69			2,459,406	25,860,386
C2b - C&I New & Replacement Equipment	1,300	-	-	1	20			905,393	13,347,802
Grand Total	**154,300**	**380**	**211**	**1,508**	**20,430**			**7,234,366**	**90,835,431**

2019 Evaluated Net Savings

Program	# of Participants	Electric						Natural Gas	
		Annual Capacity (kW)		Electric Energy (MWh)		Electric Energy (MMBTU)		(Therms)	
		Summer	Winter	Annual	Lifetime	Annual	Lifetime	Annual	Lifetime
A - Residential	**132,290**	**507**	**495**	**2,735**	**23,103**	**19,974**	**157,002**	**3,000,918**	**38,998,858**
A1 - Residential New Buildings	1,884	8	14	69	622	499	4,195	207,629	4,798,824
A1a - Residential New Homes & Renovations	1,884	8	14	69	622	499	4,195	207,629	4,798,824
A2 - Residential Existing Buildings	130,406	499	481	2,667	22,481	19,475	152,807	2,793,289	34,200,034
A2a - Residential Coordinated Delivery	11,243	421	427	2,355	19,099	17,199	129,749	1,166,138	23,148,083
A2b - Residential Conservation Services (RCS)	-	-	-	-	-	-	-	-	-
A2c - Residential Retail	8,686	78	29	226	3,297	1,665	22,446	608,357	10,033,157
A2d - Residential Behavior	110,477	-	25	85	85	612	612	1,018,794	1,018,794
B - Income Eligible	**2,763**	**90**	**5**	**180**	**4,371**	**1,337**	**29,365**	**451,906**	**9,026,624**
B1 - Income Eligible Existing Buildings	2,763	90	5	180	4,371	1,337	29,365	451,906	9,026,624
B1a - Income Eligible Coordinated Delivery	2,763	90	5	180	4,371	1,337	29,365	451,906	9,026,624
C - Commercial & Industrial	**1,685**	**-**	**1**	**(8)**	**(135)**	**(59)**	**(915)**	**2,119,092**	**29,164,405**
C1 - C&I New Buildings	27	-	0	(9)	(151)	(65)	(1,013)	505,430	8,682,394
C1a - C&I New Buildings & Major Renovations	27	-	0	(9)	(151)	(65)	(1,013)	505,430	8,682,394
C2 - C&I Existing Buildings	1,658	-	0	1	15	6	98	1,613,662	20,482,012
C2a - C&I Existing Building Retrofit	1,158	-	-	-	-	-	-	1,137,463	13,004,041
C2b - C&I New & Replacement Equipment	500	-	0	1	15	6	98	476,199	7,477,971
Grand Total	**136,738**	**597**	**501**	**2,907**	**27,338**	**21,253**	**185,452**	**5,571,916**	**77,189,887**

Program Savings, Plan Year Summary

2019 Planned vs. Evaluated

Eversource Gas
May 29, 2020

2019 Planned Net Savings						
Program	Other Water (Gallons)		Total Savings MMBTU		Electric Energy, no Fuel Switching or ADR (MWh)	
	Annual	Lifetime	Annual	Lifetime	Annual	Lifetime
A - Residential	**12,595,530**	**88,168,710**	**282,040**	**3,123,952**	**1,347**	**16,572**
A1 - Residential New Buildings	-	-	22,033	463,314	74	1,380
A1a - Residential New Homes & Renovations	-	-	22,033	463,314	74	1,380
A2 - Residential Existing Buildings	12,595,530	88,168,710	260,007	2,660,637	1,273	15,192
A2a - Residential Coordinated Delivery	12,105,642	84,739,497	95,457	1,791,380	1,129	13,124
A2b - Residential Conservation Services (RCS)	-	-	-	-	-	-
A2c - Residential Retail	489,888	3,429,213	45,252	749,959	144	2,068
A2d - Residential Behavior	-	-	119,298	119,298	-	-
B - Income Eligible	**116,335**	**814,345**	**45,766**	**938,560**	**157**	**3,769**
B1 - Income Eligible Existing Buildings	116,335	814,345	45,766	938,560	157	3,769
B1a - Income Eligible Coordinated Delivery	116,335	814,345	45,766	938,560	157	3,769
C - Commercial & Industrial	**9,772,785**	**94,866,042**	**406,691**	**5,158,237**	**4**	**89**
C1 - C&I New Buildings	-	-	70,181	1,236,819	-	-
C1a - C&I New Buildings & Major Renovations	-	-	70,181	1,236,819	-	-
C2 - C&I Existing Buildings	9,772,785	94,866,042	336,510	3,921,417	4	89
C2a - C&I Existing Building Retrofit	9,663,329	93,552,568	245,963	2,586,503	3	69
C2b - C&I New & Replacement Equipment	109,456	1,313,474	90,547	1,334,915	1	20
Grand Total	**22,484,650**	**183,849,097**	**734,497**	**9,220,748**	**1,508**	**20,430**

2019 Evaluated Net Savings						
Program	Other Water (Gallons)		Total Savings MMBTU		Electric Energy, no Fuel Switching or ADR (MWh)	
	Annual	Lifetime	Annual	Lifetime	Annual	Lifetime
A - Residential	**18,050,577**	**126,354,038**	**320,066**	**4,056,888**	**2,735**	**23,103**
A1 - Residential New Buildings	-	-	21,262	484,078	69	622
A1a - Residential New Homes & Renovations	-	-	21,262	484,078	69	622
A2 - Residential Existing Buildings	18,050,577	126,354,038	298,804	3,572,810	2,667	22,481
A2a - Residential Coordinated Delivery	17,866,136	125,062,950	133,813	2,444,558	2,355	19,099
A2b - Residential Conservation Services (RCS)	-	-	-	-	-	-
A2c - Residential Retail	184,441	1,291,088	62,501	1,025,762	226	3,297
A2d - Residential Behavior	-	-	102,491	102,491	85	85
B - Income Eligible	**-**	**-**	**46,528**	**932,027**	**180**	**4,371**
B1 - Income Eligible Existing Buildings	-	-	46,528	932,027	180	4,371
B1a - Income Eligible Coordinated Delivery	-	-	46,528	932,027	180	4,371
C - Commercial & Industrial	**14,342,446**	**138,890,703**	**211,851**	**2,915,525**	**(8)**	**(135)**
C1 - C&I New Buildings	628,179	8,298,435	50,478	867,226	(9)	(151)
C1a - C&I New Buildings & Major Renovations	628,179	8,298,435	50,478	867,226	(9)	(151)
C2 - C&I Existing Buildings	13,714,267	130,592,268	161,372	2,048,299	1	15
C2a - C&I Existing Building Retrofit	12,677,632	118,665,241	113,746	1,300,404	-	-
C2b - C&I New & Replacement Equipment	1,036,635	11,927,027	47,626	747,895	1	15
Grand Total	**32,393,023**	**265,244,741**	**578,444**	**7,904,440**	**2,907**	**27,338**

Program Savings, Plan Year Summary

2019 Planned vs. Evaluated

Eversource Gas
May 29, 2020

2019 Planned v. Evaluated Net Savings Variances (%)									
Program	# of Participants	Electric						Natural Gas	
		Annual Capacity (kW)		Electric Energy (MWh)		Electric Energy (MMBTU)		(Therms)	
		Summer	Winter	Annual	Lifetime	Annual	Lifetime	Annual	Lifetime
A - Residential	**-11%**	**69%**	**140%**	**103%**	**39%**			**10%**	**29%**
A1 - Residential New Buildings	-18%	-52%	9%	-7%	-55%			-3%	6%
A1a - Residential New Homes & Renovations	-18%	-52%	9%	-7%	-55%			-3%	6%
A2 - Residential Existing Buildings	-11%	76%	149%	109%	48%			11%	34%
A2a - Residential Coordinated Delivery	-2%	81%	146%	109%	46%			34%	36%
A2b - Residential Conservation Services (RCS)									
A2c - Residential Retail	24%	56%	54%	57%	59%			38%	36%
A2d - Residential Behavior	-14%							-15%	-15%
B - Income Eligible	**-4%**	**16%**	**2%**	**14%**	**16%**			**1%**	**-1%**
B1 - Income Eligible Existing Buildings	-4%	16%	2%	14%	16%			1%	-1%
B1a - Income Eligible Coordinated Delivery	-4%	16%	2%	14%	16%			1%	-1%
C - Commercial & Industrial	**-41%**	**-100%**		**-298%**	**-252%**			**-48%**	**-43%**
C1 - C&I New Buildings	-40%							-28%	-30%
C1a - C&I New Buildings & Major Renovations	-40%							-28%	-30%
C2 - C&I Existing Buildings	-41%	-100%		-79%	-83%			-52%	-48%
C2a - C&I Existing Building Retrofit	-23%	-100%		-100%	-100%			-54%	-50%
C2b - C&I New & Replacement Equipment	-62%			-16%	-24%			-47%	-44%
Grand Total	**-11%**	**57%**	**137%**	**93%**	**34%**			**-23%**	**-15%**

Notes

• The plan year variances provided above are intended to indicate the Program Administrator's performance in the plan year only. The variances used to determine significant variances are provided separately. The variances above and the significant variances use different calculations to determine variances on an annual basis and over the three-year term, respectively.

• MMBtu savings are calculated consistent with the findings in the Study to Propose a More Refined Method to Account for the Conversion of Electric Savings to MMBtu Savings (see Appendix 7). For more information, see Appendix 6.

Program Savings, Plan Year Summary

2019 Planned vs. Evaluated

Eversource Gas
May 29, 2020

Program	2019 Planned v. Evaluated Net Savings Variances (%)					
	Other Water (Gallons)		Total Savings MMBTU		Electric Energy, no Fuel Switching or ADR (MWh)	
	Annual	Lifetime	Annual	Lifetime	Annual	Lifetime
A - Residential	**43%**	**43%**	**13%**	**30%**	**103%**	**39%**
A1 - Residential New Buildings			-4%	4%	-7%	-55%
A1a - Residential New Homes & Renovations			-4%	4%	-7%	-55%
A2 - Residential Existing Buildings	43%	43%	15%	34%	109%	48%
A2a - Residential Coordinated Delivery	48%	48%	40%	36%	109%	46%
A2b - Residential Conservation Services (RCS)						
A2c - Residential Retail	-62%	-62%	38%	37%	57%	59%
A2d - Residential Behavior			-14%	-14%		
B - Income Eligible	**-100%**	**-100%**	**2%**	**-1%**	**14%**	**16%**
B1 - Income Eligible Existing Buildings	-100%	-100%	2%	-1%	14%	16%
B1a - Income Eligible Coordinated Delivery	-100%	-100%	2%	-1%	14%	16%
C - Commercial & Industrial	**47%**	**46%**	**-48%**	**-43%**	**-298%**	**-252%**
C1 - C&I New Buildings			-28%	-30%		
C1a - C&I New Buildings & Major Renovations			-28%	-30%		
C2 - C&I Existing Buildings	40%	38%	-52%	-48%	-79%	-83%
C2a - C&I Existing Building Retrofit	31%	27%	-54%	-50%	-100%	-100%
C2b - C&I New & Replacement Equipment	847%	808%	-47%	-44%	-16%	-24%
Grand Total	**44%**	**44%**	**-21%**	**-14%**	**93%**	**34%**

Notes

• The plan year variances provided above are intended to indicate the Program Administrator's performance in the plan year only. The variances used to determine significant variances are provided separately. The variances above and the significant variances use different calculations to determine variances on an annual basis and over the three-year term, respectively.

• MMBtu savings are calculated consistent with the findings in the Study to Propose a More Refined Method to Account for the Conversion of Electric Savings to MMBtu Savings (see Appendix 7). For more information, see Appendix 6.

Program Savings, Three-Year Total

2019-2021 Net Savings

Eversource Gas
May 29, 2020

2019 Evaluated Net Savings

Program	# of Participants	Electric						Natural Gas	
		Annual Capacity (kW)		Electric Energy (MWh)		Electric Energy (MMBTU)		(Therms)	
		Summer	Winter	Annual	Lifetime	Annual	Lifetime	Annual	Lifetime
A - Residential	**132,290**	**507**	**495**	**2,735**	**23,103**	**19,974**	**157,002**	**3,000,918**	**38,998,858**
A1 - Residential New Buildings	1,884	8	14	69	622	499	4,195	207,629	4,798,824
A1a - Residential New Homes & Renovations	1,884	8	14	69	622	499	4,195	207,629	4,798,824
A2 - Residential Existing Buildings	130,406	499	481	2,667	22,481	19,475	152,807	2,793,289	34,200,034
A2a - Residential Coordinated Delivery	11,243	421	427	2,355	19,099	17,199	129,749	1,166,138	23,148,083
A2b - Residential Conservation Services (RCS)	-	-	-	-	-	-	-	-	-
A2c - Residential Retail	8,686	78	29	226	3,297	1,665	22,446	608,357	10,033,157
A2d - Residential Behavior	110,477	-	25	85	85	612	612	1,018,794	1,018,794
B - Income Eligible	**2,763**	**90**	**5**	**180**	**4,371**	**1,337**	**29,365**	**451,906**	**9,026,624**
B1 - Income Eligible Existing Buildings	2,763	90	5	180	4,371	1,337	29,365	451,906	9,026,624
B1a - Income Eligible Coordinated Delivery	2,763	90	5	180	4,371	1,337	29,365	451,906	9,026,624
C - Commercial & Industrial	**1,685**	**-**	**1**	**(8)**	**(135)**	**(59)**	**(915)**	**2,119,092**	**29,164,405**
C1 - C&I New Buildings	27	-	0	(9)	(151)	(65)	(1,013)	505,430	8,682,394
C1a - C&I New Buildings & Major Renovations	27	-	0	(9)	(151)	(65)	(1,013)	505,430	8,682,394
C2 - C&I Existing Buildings	1,658	-	0	1	15	6	98	1,613,662	20,482,012
C2a - C&I Existing Building Retrofit	1,158	-	-	-	-	-	-	1,137,463	13,004,041
C2b - C&I New & Replacement Equipment	500	-	0	1	15	6	98	476,199	7,477,971
Grand Total	**136,738**	**597**	**501**	**2,907**	**27,338**	**21,253**	**185,452**	**5,571,916**	**77,189,887**

2020 Planned Net Savings

Program	# of Participants	Electric						Natural Gas	
		Annual Capacity (kW)		Electric Energy (MWh)		Electric Energy (MMBTU)		(Therms)	
		Summer	Winter	Annual	Lifetime	Annual	Lifetime	Annual	Lifetime
A - Residential	**150,045**	**296**	**189**	**1,282**	**16,762**			**2,778,946**	**31,305,558**
A1 - Residential New Buildings	2,300	17	11	68	1,352			214,920	4,542,000
A1a - Residential New Homes & Renovations	2,300	17	11	68	1,352			214,920	4,542,000
A2 - Residential Existing Buildings	147,745	279	178	1,214	15,410			2,564,026	26,763,558
A2a - Residential Coordinated Delivery	12,390	229	159	1,070	13,342			924,001	18,206,825
A2b - Residential Conservation Services (RCS)	-	-	-	-	-			-	-
A2c - Residential Retail	7,000	50	19	144	2,068			441,908	7,358,616
A2d - Residential Behavior	128,355	-	-	-	-			1,198,117	1,198,117
B - Income Eligible	**3,160**	**85**	**5**	**170**	**4,113**			**456,463**	**9,357,085**
B1 - Income Eligible Existing Buildings	3,160	85	5	170	4,113			456,463	9,357,085
B1a - Income Eligible Coordinated Delivery	3,160	85	5	170	4,113			456,463	9,357,085
C - Commercial & Industrial	**2,895**	**2**	**-**	**4**	**89**			**4,051,884**	**51,356,163**
C1 - C&I New Buildings	45	-	-	-	-			702,632	12,384,594
C1a - C&I New Buildings & Major Renovations	45	-	-	-	-			702,632	12,384,594
C2 - C&I Existing Buildings	2,850	2	-	4	89			3,349,252	38,971,569
C2a - C&I Existing Building Retrofit	1,500	2	-	3	69			2,477,903	26,156,350
C2b - C&I New & Replacement Equipment	1,350	-	-	1	20			871,349	12,815,219
Grand Total	**156,100**	**383**	**194**	**1,456**	**20,964**			**7,287,293**	**92,018,806**

Program Savings, Three-Year Total

2019-2021 Net Savings

Eversource Gas
May 29, 2020

2019 Evaluated Net Savings						
Program	Other Water (Gallons)		Total Savings MMBTU		Electric Energy, no Fuel Switching or ADR (MWh)	
	Annual	Lifetime	Annual	Lifetime	Annual	Lifetime
A - Residential	**18,050,577**	**126,354,038**	**320,066**	**4,056,888**	**2,735**	**23,103**
A1 - Residential New Buildings	-	-	21,262	484,078	69	622
A1a - Residential New Homes & Renovations	-	-	21,262	484,078	69	622
A2 - Residential Existing Buildings	18,050,577	126,354,038	298,804	3,572,810	2,667	22,481
A2a - Residential Coordinated Delivery	17,866,136	125,062,950	133,813	2,444,558	2,355	19,099
A2b - Residential Conservation Services (RCS)	-	-	-	-	-	-
A2c - Residential Retail	184,441	1,291,088	62,501	1,025,762	226	3,297
A2d - Residential Behavior	-	-	102,491	102,491	85	85
B - Income Eligible	**-**	**-**	**46,528**	**932,027**	**180**	**4,371**
B1 - Income Eligible Existing Buildings	-	-	46,528	932,027	180	4,371
B1a - Income Eligible Coordinated Delivery	-	-	46,528	932,027	180	4,371
C - Commercial & Industrial	**14,342,446**	**138,890,703**	**211,851**	**2,915,525**	**(8)**	**(135)**
C1 - C&I New Buildings	628,179	8,298,435	50,478	867,226	(9)	(151)
C1a - C&I New Buildings & Major Renovations	628,179	8,298,435	50,478	867,226	(9)	(151)
C2 - C&I Existing Buildings	13,714,267	130,592,268	161,372	2,048,299	1	15
C2a - C&I Existing Building Retrofit	12,677,632	118,665,241	113,746	1,300,404	-	-
C2b - C&I New & Replacement Equipment	1,036,635	11,927,027	47,626	747,895	1	15
Grand Total	**32,393,023**	**265,244,741**	**578,444**	**7,904,440**	**2,907**	**27,338**

2020 Planned Net Savings						
Program	Other Water (Gallons)		Total Savings MMBTU		Electric Energy, no Fuel Switching or ADR (MWh)	
	Annual	Lifetime	Annual	Lifetime	Annual	Lifetime
A - Residential	**12,595,530**	**88,168,710**	**287,292**	**3,241,658**	**1,282**	**16,762**
A1 - Residential New Buildings	-	-	21,992	463,040	68	1,352
A1a - Residential New Homes & Renovations	-	-	21,992	463,040	68	1,352
A2 - Residential Existing Buildings	12,595,530	88,168,710	265,300	2,778,618	1,214	15,410
A2a - Residential Coordinated Delivery	12,105,642	84,739,497	100,236	1,908,993	1,070	13,342
A2b - Residential Conservation Services (RCS)	-	-	-	-	-	-
A2c - Residential Retail	489,888	3,429,213	45,252	749,813	144	2,068
A2d - Residential Behavior	-	-	119,812	119,812	-	-
B - Income Eligible	**116,335**	**814,345**	**46,913**	**963,152**	**170**	**4,113**
B1 - Income Eligible Existing Buildings	116,335	814,345	46,913	963,152	170	4,113
B1a - Income Eligible Coordinated Delivery	116,335	814,345	46,913	963,152	170	4,113
C - Commercial & Industrial	**9,772,785**	**94,866,042**	**405,219**	**5,136,210**	**4**	**89**
C1 - C&I New Buildings	-	-	70,263	1,238,459	-	-
C1a - C&I New Buildings & Major Renovations	-	-	70,263	1,238,459	-	-
C2 - C&I Existing Buildings	9,772,785	94,866,042	334,955	3,897,751	4	89
C2a - C&I Existing Building Retrofit	9,663,329	93,552,568	247,812	2,616,096	3	69
C2b - C&I New & Replacement Equipment	109,456	1,313,474	87,143	1,281,655	1	20
Grand Total	**22,484,650**	**183,849,097**	**739,423**	**9,341,020**	**1,456**	**20,964**

Program Savings, Three-Year Total

2019-2021 Net Savings

Eversource Gas
May 29, 2020

2021 Planned Net Savings									
Program	# of Participants	Electric						Natural Gas	
		Annual Capacity (kW)		Electric Energy (MWh)		Electric Energy (MMBTU)		(Therms)	
		Summer	Winter	Annual	Lifetime	Annual	Lifetime	Annual	Lifetime
A - Residential	**151,800**	**291**	**172**	**1,210**	**17,503**			**2,848,896**	**32,744,908**
A1 - Residential New Buildings	2,300	16	10	63	1,315			214,920	4,542,000
A1a - Residential New Homes & Renovations	2,300	16	10	63	1,315			214,920	4,542,000
A2 - Residential Existing Buildings	149,500	275	162	1,147	16,188			2,633,976	28,202,908
A2a - Residential Coordinated Delivery	13,575	225	143	1,003	14,120			988,422	19,640,646
A2b - Residential Conservation Services (RCS)	-	-	-	-	-			-	-
A2c - Residential Retail	7,000	50	19	144	2,068			441,908	7,358,616
A2d - Residential Behavior	128,925	-	-	-	-			1,203,646	1,203,646
B - Income Eligible	**3,480**	**93**	**5**	**184**	**4,457**			**468,923**	**9,616,885**
B1 - Income Eligible Existing Buildings	3,480	93	5	184	4,457			468,923	9,616,885
B1a - Income Eligible Coordinated Delivery	3,480	93	5	184	4,457			468,923	9,616,885
C - Commercial & Industrial	**2,895**	**2**	**-**	**4**	**89**			**4,063,926**	**51,561,162**
C1 - C&I New Buildings	45	-	-	-	-			702,672	12,385,394
C1a - C&I New Buildings & Major Renovations	45	-	-	-	-			702,672	12,385,394
C2 - C&I Existing Buildings	2,850	2	-	4	89			3,361,254	39,175,768
C2a - C&I Existing Building Retrofit	1,500	2	-	3	69			2,496,401	26,452,313
C2b - C&I New & Replacement Equipment	1,350	-	-	1	20			864,853	12,723,455
Grand Total	**158,175**	**386**	**177**	**1,398**	**22,049**			**7,381,745**	**93,922,955**

2019-2021 Net Savings									
Program	# of Participants	Electric						Natural Gas	
		Annual Capacity (kW)		Electric Energy (MWh)		Electric Energy (MMBTU)		(Therms)	
		Summer	Winter	Annual	Lifetime	Annual	Lifetime	Annual	Lifetime
A - Residential	**434,135**	**1,094**	**856**	**5,227**	**57,368**			**8,628,760**	**103,049,324**
A1 - Residential New Buildings	6,484	41	35	200	3,289			637,469	13,882,824
A1a - Residential New Homes & Renovations	6,484	41	35	200	3,289			637,469	13,882,824
A2 - Residential Existing Buildings	427,651	1,053	821	5,028	54,079			7,991,291	89,166,500
A2a - Residential Coordinated Delivery	37,208	875	729	4,428	46,561			3,078,561	60,995,554
A2b - Residential Conservation Services (RCS)	-	-	-	-	-			-	-
A2c - Residential Retail	22,686	178	67	514	7,433			1,492,173	24,750,389
A2d - Residential Behavior	367,757	-	25	85	85			3,420,557	3,420,557
B - Income Eligible	**9,403**	**268**	**15**	**534**	**12,941**			**1,377,292**	**28,000,594**
B1 - Income Eligible Existing Buildings	9,403	268	15	534	12,941			1,377,292	28,000,594
B1a - Income Eligible Coordinated Delivery	9,403	268	15	534	12,941			1,377,292	28,000,594
C - Commercial & Industrial	**7,475**	**4**	**1**	**0**	**43**			**10,234,902**	**132,081,730**
C1 - C&I New Buildings	117	-	0	(9)	(151)			1,910,734	33,452,382
C1a - C&I New Buildings & Major Renovations	117	-	0	(9)	(151)			1,910,734	33,452,382
C2 - C&I Existing Buildings	7,358	4	0	9	193			8,324,168	98,629,349
C2a - C&I Existing Building Retrofit	4,158	4	-	6	138			6,111,767	65,612,704
C2b - C&I New & Replacement Equipment	3,200	-	0	3	55			2,212,401	33,016,645
Grand Total	**451,013**	**1,366**	**872**	**5,761**	**70,351**			**20,240,954**	**263,131,648**

Notes

• MMBtu savings are calculated consistent with the findings in the Study to Propose a More Refined Method to Account for the Conversion of Electric Savings to MMBtu Savings (see Appendix 7). For more information, see Appendix 6.

Program Savings, Three-Year Total

2019-2021 Net Savings

Eversource Gas
May 29, 2020

2021 Planned Net Savings						
Program	Other Water (Gallons)		Total Savings MMBTU		Electric Energy, no Fuel Switching or ADR (MWh)	
	Annual	Lifetime	Annual	Lifetime	Annual	Lifetime
A - Residential	**12,595,530**	**88,168,710**	**293,715**	**3,389,197**	**1,210**	**17,503**
A1 - Residential New Buildings	-	-	21,954	462,712	63	1,315
A1a - Residential New Homes & Renovations	-	-	21,954	462,712	63	1,315
A2 - Residential Existing Buildings	12,595,530	88,168,710	271,761	2,926,485	1,147	16,188
A2a - Residential Coordinated Delivery	12,105,642	84,739,497	106,150	2,056,459	1,003	14,120
A2b - Residential Conservation Services (RCS)	-	-	-	-	-	-
A2c - Residential Retail	489,888	3,429,213	45,247	749,661	144	2,068
A2d - Residential Behavior	-	-	120,365	120,365	-	-
B - Income Eligible	**116,335**	**814,345**	**48,257**	**991,223**	**184**	**4,457**
B1 - Income Eligible Existing Buildings	116,335	814,345	48,257	991,223	184	4,457
B1a - Income Eligible Coordinated Delivery	116,335	814,345	48,257	991,223	184	4,457
C - Commercial & Industrial	**9,772,785**	**94,866,042**	**406,423**	**5,156,706**	**4**	**89**
C1 - C&I New Buildings	-	-	70,267	1,238,539	-	-
C1a - C&I New Buildings & Major Renovations	-	-	70,267	1,238,539	-	-
C2 - C&I Existing Buildings	9,772,785	94,866,042	336,155	3,918,166	4	89
C2a - C&I Existing Building Retrofit	9,663,329	93,552,568	249,662	2,645,689	3	69
C2b - C&I New & Replacement Equipment	109,456	1,313,474	86,493	1,272,477	1	20
Grand Total	**22,484,650**	**183,849,097**	**748,394**	**9,537,126**	**1,398**	**22,049**

2019-2021 Net Savings						
Program	Other Water (Gallons)		Total Savings MMBTU		Electric Energy, no Fuel Switching or ADR (MWh)	
	Annual	Lifetime	Annual	Lifetime	Annual	Lifetime
A - Residential	**43,241,637**	**302,691,458**			**5,227**	**57,368**
A1 - Residential New Buildings	-	-			200	3,289
A1a - Residential New Homes & Renovations	-	-			200	3,289
A2 - Residential Existing Buildings	43,241,637	302,691,458			5,028	54,079
A2a - Residential Coordinated Delivery	42,077,420	294,541,944			4,428	46,561
A2b - Residential Conservation Services (RCS)	-	-			-	-
A2c - Residential Retail	1,164,217	8,149,514			514	7,433
A2d - Residential Behavior	-	-			85	85
B - Income Eligible	**232,670**	**1,628,690**			**534**	**12,941**
B1 - Income Eligible Existing Buildings	232,670	1,628,690			534	12,941
B1a - Income Eligible Coordinated Delivery	232,670	1,628,690			534	12,941
C - Commercial & Industrial	**33,888,016**	**328,622,787**			**0**	**43**
C1 - C&I New Buildings	628,179	8,298,435			(9)	(151)
C1a - C&I New Buildings & Major Renovations	628,179	8,298,435			(9)	(151)
C2 - C&I Existing Buildings	33,259,837	320,324,352			9	193
C2a - C&I Existing Building Retrofit	32,004,290	305,770,377			6	138
C2b - C&I New & Replacement Equipment	1,255,547	14,553,975			3	55
Grand Total	**77,362,323**	**632,942,935**			**5,761**	**70,351**

Notes

• MMBtu savings are calculated consistent with the findings in the Study to Propose a More Refined Method to Account for the Conversion of Electric Savings to MMBtu Savings (see Appendix 7). For more information, see Appendix 6.

Program Benefits, Plan Year Summary

2019 Planned vs. Evaluated

Eversource Gas
May 29, 2020

2019 Planned Benefits

Program	Electric Benefits									
	Capacity						Electric Energy			
	Summer Generation	Capacity DRIPE	Transmission	Distribution	Reliability	Total Capacity Benefits	Electric Energy	Electric Energy DRIPE	Electric Energy Environmental Compliance	Total Electric Energy Benefits
A - Residential	**348,692**	**2,051**	**428,626**	**695,787**	**27,306**	**1,502,463**	**1,026,886**	**235,328**	**576,854**	**1,839,069**
A1 - Residential New Buildings	30,761	-	33,623	54,580	1,734	120,699	88,068	15,596	47,675	151,339
A1a - Residential New Homes & Renovations	30,761	-	33,623	54,580	1,734	120,699	88,068	15,596	47,675	151,339
A2 - Residential Existing Buildings	317,931	2,051	395,003	641,207	25,572	1,381,764	938,818	219,732	529,179	1,687,730
A2a - Residential Coordinated Delivery	269,301	1,248	326,387	529,823	20,014	1,146,773	818,926	186,378	456,434	1,461,738
A2b - Residential Conservation Services (RCS)	-	-	-	-	-	-	-	-	-	-
A2c - Residential Retail	48,630	803	68,616	111,384	5,558	234,991	119,892	33,354	72,745	225,992
A2d - Residential Behavior	-	-	-	-	-	-	-	-	-	-
B - Income Eligible	**166,541**	**26**	**174,579**	**283,394**	**8,637**	**633,178**	**229,092**	**38,940**	**128,175**	**396,206**
B1 - Income Eligible Existing Buildings	166,541	26	174,579	283,394	8,637	633,178	229,092	38,940	128,175	396,206
B1a - Income Eligible Coordinated Delivery	166,541	26	174,579	283,394	8,637	633,178	229,092	38,940	128,175	396,206
C - Commercial & Industrial	**3,615**	**5**	**3,953**	**6,416**	**214**	**14,202**	**5,309**	**1,000**	**3,036**	**9,345**
C1 - C&I New Buildings	-	-	-	-	-	-	-	-	-	-
C1a - C&I New Buildings & Major Renovations	-	-	-	-	-	-	-	-	-	-
C2 - C&I Existing Buildings	3,615	5	3,953	6,416	214	14,202	5,309	1,000	3,036	9,345
C2a - C&I Existing Building Retrofit	3,231	5	3,474	5,639	182	12,531	4,091	744	2,331	7,166
C2b - C&I New & Replacement Equipment	384	-	479	777	32	1,671	1,218	256	705	2,179
Grand Total	**518,848**	**2,082**	**607,158**	**985,597**	**36,157**	**2,149,843**	**1,261,287**	**275,268**	**708,065**	**2,244,620**

2019 Evaluated Benefits

Program	Electric Benefits									
	Capacity						Electric Energy			
	Summer Generation	Capacity DRIPE	Transmission	Distribution	Reliability	Total Capacity Benefits	Electric Energy	Electric Energy DRIPE	Electric Energy Environmental Compliance	Total Electric Energy Benefits
A - Residential	**395,963**	**14,039**	**541,696**	**879,334**	**37,579**	**1,868,611**	**1,429,635**	**389,628**	**810,262**	**2,629,524**
A1 - Residential New Buildings	4,095	40	6,491	10,537	489	21,652	39,259	10,734	22,017	72,010
A1a - Residential New Homes & Renovations	4,095	40	6,491	10,537	489	21,652	39,259	10,734	22,017	72,010
A2 - Residential Existing Buildings	391,868	13,999	535,205	868,797	37,091	1,846,959	1,390,376	378,894	788,245	2,557,514
A2a - Residential Coordinated Delivery	315,378	12,806	427,578	694,086	28,402	1,478,249	1,193,405	324,803	669,212	2,187,419
A2b - Residential Conservation Services (RCS)	-	-	-	-	-	-	-	-	-	-
A2c - Residential Retail	76,490	1,193	107,627	174,711	8,688	368,710	191,436	52,440	115,895	359,771
A2d - Residential Behavior	-	-	-	-	-	-	5,535	1,651	3,138	10,324
B - Income Eligible	**195,723**	**-**	**204,611**	**332,145**	**10,054**	**742,534**	**265,749**	**44,825**	**148,553**	**459,127**
B1 - Income Eligible Existing Buildings	195,723	-	204,611	332,145	10,054	742,534	265,749	44,825	148,553	459,127
B1a - Income Eligible Coordinated Delivery	195,723	-	204,611	332,145	10,054	742,534	265,749	44,825	148,553	459,127
C - Commercial & Industrial	**-**	**-**	**-**	**-**	**-**	**-**	**(7,866)**	**(1,862)**	**(4,713)**	**(14,441)**
C1 - C&I New Buildings	-	-	-	-	-	-	(8,871)	(2,038)	(5,250)	(16,158)
C1a - C&I New Buildings & Major Renovations	-	-	-	-	-	-	(8,871)	(2,038)	(5,250)	(16,158)
C2 - C&I Existing Buildings	-	-	-	-	-	-	1,004	176	537	1,717
C2a - C&I Existing Building Retrofit	-	-	-	-	-	-	-	-	-	-
C2b - C&I New & Replacement Equipment	-	-	-	-	-	-	1,004	176	537	1,717
Grand Total	**591,686**	**14,039**	**746,307**	**1,211,479**	**47,634**	**2,611,145**	**1,687,517**	**432,592**	**954,101**	**3,074,211**

Program Benefits, Plan Year Summary

2019 Planned vs. Evaluated

Eversource Gas
May 29, 2020

Program	2019 Planned Benefits									2019 Planned Benefits
	Natural Gas Benefits				Water	Total Energy Benefits	Total Environmental Compliance Benefits	Non-Energy Impacts	Total TRC Test Benefits	Total Resource Benefits per Participant
	Natural Gas	Natural Gas DRIPE	Natural Gas Environmental Compliance	Total Natural Gas Benefits						
A - Residential	**26,979,558**	**3,488,208**	**11,677,565**	**42,145,333**	**1,440,443**	**46,927,307**	**12,254,419**	**12,812,601**	**59,739,909**	**316**
A1 - Residential New Buildings	3,997,355	383,451	1,749,686	6,130,492	-	6,402,530	1,797,361	2,654,790	9,057,321	2,784
A1a - Residential New Homes & Renovations	3,997,355	383,451	1,749,686	6,130,492	-	6,402,530	1,797,361	2,654,790	9,057,321	2,784
A2 - Residential Existing Buildings	22,982,203	3,104,757	9,927,879	36,014,841	1,440,443	40,524,777	10,457,058	10,157,811	50,682,588	277
A2a - Residential Coordinated Delivery	15,493,633	1,798,386	6,576,757	23,868,777	1,384,419	27,861,706	7,033,191	7,362,825	35,224,531	2,431
A2b - Residential Conservation Services (RCS)	-	-	-	-	-	-	-	-	-	
A2c - Residential Retail	6,556,253	869,908	2,868,831	10,294,992	56,024	10,811,999	2,941,576	2,794,986	13,606,985	1,545
A2d - Residential Behavior	932,317	436,463	482,291	1,851,072	-	1,851,072	482,291	-	1,851,072	14
B - Income Eligible	**8,284,979**	**928,040**	**3,527,884**	**12,740,904**	**13,304**	**13,783,592**	**3,656,059**	**12,184,981**	**25,968,573**	**4,803**
B1 - Income Eligible Existing Buildings	8,284,979	928,040	3,527,884	12,740,904	13,304	13,783,592	3,656,059	12,184,981	25,968,573	4,803
B1a - Income Eligible Coordinated Delivery	8,284,979	928,040	3,527,884	12,740,904	13,304	13,783,592	3,656,059	12,184,981	25,968,573	4,803
C - Commercial & Industrial	**41,967,538**	**8,085,320**	**20,234,756**	**70,287,614**	**1,540,089**	**71,851,250**	**20,237,792**	**4,066,883**	**75,918,133**	**25,255**
C1 - C&I New Buildings	10,241,337	1,446,589	4,813,250	16,501,177	-	16,501,177	4,813,250	-	16,501,177	366,693
C1a - C&I New Buildings & Major Renovations	10,241,337	1,446,589	4,813,250	16,501,177	-	16,501,177	4,813,250	-	16,501,177	366,693
C2 - C&I Existing Buildings	31,726,201	6,638,731	15,421,506	53,786,437	1,540,089	55,350,073	15,424,542	4,066,883	59,416,956	19,768
C2a - C&I Existing Building Retrofit	21,257,949	5,032,983	10,199,766	36,490,697	1,518,873	38,029,267	10,202,097	4,066,883	42,096,150	25,353
C2b - C&I New & Replacement Equipment	10,468,252	1,605,748	5,221,740	17,295,740	21,216	17,320,806	5,222,445	-	17,320,806	13,324
Grand Total	**77,232,075**	**12,501,568**	**35,440,205**	**125,173,851**	**2,993,836**	**132,562,149**	**36,148,270**	**29,064,465**	**161,626,615**	**859**

Program	2019 Evaluated Benefits									2019 Evaluated Benefits
	Natural Gas Benefits				Water	Total Energy Benefits	Total Environmental Compliance Benefits	Non-Energy Impacts	Total TRC Test Benefits	Total Resource Benefits per Participant
	Natural Gas	Natural Gas DRIPE	Natural Gas Environmental Compliance	Total Natural Gas Benefits						
A - Residential	**35,123,059**	**4,398,265**	**15,096,409**	**54,617,733**	**2,064,291**	**61,180,160**	**15,906,671**	**14,081,535**	**75,261,695**	**462**
A1 - Residential New Buildings	4,313,093	410,382	1,842,242	6,565,717	-	6,659,380	1,864,259	2,496,467	9,155,847	3,535
A1a - Residential New Homes & Renovations	4,313,093	410,382	1,842,242	6,565,717	-	6,659,380	1,864,259	2,496,467	9,155,847	3,535
A2 - Residential Existing Buildings	30,809,966	3,987,882	13,254,168	48,052,016	2,064,291	54,520,780	14,042,412	11,585,068	66,105,848	418
A2a - Residential Coordinated Delivery	21,069,314	2,412,011	8,929,154	32,410,479	2,043,198	38,119,346	9,598,366	7,735,543	45,854,889	3,390
A2b - Residential Conservation Services (RCS)	-	-	-	-	-	-	-	-	-	
A2c - Residential Retail	8,944,459	1,203,135	3,913,140	14,060,733	21,093	14,810,306	4,029,034	3,849,524	18,659,831	1,705
A2d - Residential Behavior	796,193	372,737	411,874	1,580,804	-	1,591,129	415,012	-	1,591,129	14
B - Income Eligible	**8,104,353**	**900,585**	**3,491,481**	**12,496,420**	**-**	**13,698,080**	**3,640,034**	**11,660,854**	**25,358,934**	**4,958**
B1 - Income Eligible Existing Buildings	8,104,353	900,585	3,491,481	12,496,420	-	13,698,080	3,640,034	11,660,854	25,358,934	4,958
B1a - Income Eligible Coordinated Delivery	8,104,353	900,585	3,491,481	12,496,420	-	13,698,080	3,640,034	11,660,854	25,358,934	4,958
C - Commercial & Industrial	**23,556,931**	**4,016,520**	**11,410,783**	**38,984,234**	**2,254,048**	**41,223,841**	**11,406,070**	**935,773**	**42,159,614**	**24,465**
C1 - C&I New Buildings	7,083,229	996,280	3,381,466	11,460,975	133,500	11,578,317	3,376,217	(53,387)	11,524,930	428,827
C1a - C&I New Buildings & Major Renovations	7,083,229	996,280	3,381,466	11,460,975	133,500	11,578,317	3,376,217	(53,387)	11,524,930	428,827
C2 - C&I Existing Buildings	16,473,702	3,020,240	8,029,317	27,523,259	2,120,548	29,645,524	8,029,854	989,159	30,634,683	17,880
C2a - C&I Existing Building Retrofit	10,673,637	2,241,310	5,112,699	18,027,646	1,927,747	19,955,393	5,112,699	989,159	20,944,552	17,233
C2b - C&I New & Replacement Equipment	5,800,065	778,930	2,916,618	9,495,613	192,801	9,690,131	2,917,155	-	9,690,131	19,380
Grand Total	**66,784,343**	**9,315,370**	**29,998,674**	**106,098,387**	**4,318,339**	**116,102,082**	**30,952,775**	**26,678,161**	**142,780,243**	**849**

Program Benefits, Plan Year Summary

2019 Planned vs. Evaluated

Eversource Gas

May 29, 2020

2019 Planned v. Evaluated Total Benefits Variances (%)										
Program	Electric Benefits									
	Capacity						Electric Energy			
	Summer Generation	Capacity DRIPE	Transmission	Distribution	Reliability	Total Capacity Benefits	Electric Energy	Electric Energy DRIPE	Electric Energy Environmental Compliance	Total Electric Energy Benefits
A - Residential	**14%**	**584%**	**26%**	**26%**	**38%**	**24%**	**39%**	**66%**	**40%**	**43%**
A1 - Residential New Buildings	-87%		-81%	-81%	-72%	-82%	-55%	-31%	-54%	-52%
A1a - Residential New Homes & Renovations	-87%		-81%	-81%	-72%	-82%	-55%	-31%	-54%	-52%
A2 - Residential Existing Buildings	23%	583%	35%	35%	45%	34%	48%	72%	49%	52%
A2a - Residential Coordinated Delivery	17%	926%	31%	31%	42%	29%	46%	74%	47%	50%
A2b - Residential Conservation Services (RCS)										
A2c - Residential Retail	57%	49%	57%	57%	56%	57%	60%	57%	59%	59%
A2d - Residential Behavior										
B - Income Eligible	**18%**	**-100%**	**17%**	**17%**	**16%**	**17%**	**16%**	**15%**	**16%**	**16%**
B1 - Income Eligible Existing Buildings	18%	-100%	17%	17%	16%	17%	16%	15%	16%	16%
B1a - Income Eligible Coordinated Delivery	18%	-100%	17%	17%	16%	17%	16%	15%	16%	16%
C - Commercial & Industrial	**-100%**	**-100%**	**-100%**	**-100%**	**-100%**	**-100%**	**-248%**	**-286%**	**-255%**	**-255%**
C1 - C&I New Buildings										
C1a - C&I New Buildings & Major Renovations										
C2 - C&I Existing Buildings	-100%	-100%	-100%	-100%	-100%	-100%	-81%	-82%	-82%	-82%
C2a - C&I Existing Building Retrofit	-100%	-100%	-100%	-100%	-100%	-100%	-100%	-100%	-100%	-100%
C2b - C&I New & Replacement Equipment	-100%		-100%	-100%	-100%	-100%	-18%	-31%	-24%	-21%
Grand Total	**14%**	**574%**	**23%**	**23%**	**32%**	**21%**	**34%**	**57%**	**35%**	**37%**

Notes

• Benefits for each year are presented in real dollars (2019$).

• Total Energy Benefits are the sum of electric benefits, natural gas benefits, and other resource benefits.

Program Benefits, Plan Year Summary

2019 Planned vs. Evaluated

Eversource Gas
May 29, 2020

Program	2019 Planned v. Evaluated Total Benefits Variances (%)					2019 Planned v. Evaluated Total Benefits Variances (%)				
	Natural Gas Benefits									
	Natural Gas	Natural Gas DRIPE	Natural Gas Environmental Compliance	Total Natural Gas Benefits	Water	Total Energy Benefits	Total Environmental Compliance Benefits	Non-Energy Impacts	Total TRC Test Benefits	Total Resource Benefits per Participant
A - Residential	**30%**	**26%**	**29%**	**30%**	**43%**	**30%**	**30%**	**10%**	**26%**	**46%**
A1 - Residential New Buildings	8%	7%	5%	7%		4%	4%	-6%	1%	27%
A1a - Residential New Homes & Renovations	8%	7%	5%	7%		4%	4%	-6%	1%	27%
A2 - Residential Existing Buildings	34%	28%	34%	33%	43%	35%	34%	14%	30%	51%
A2a - Residential Coordinated Delivery	36%	34%	36%	36%	48%	37%	36%	5%	30%	39%
A2b - Residential Conservation Services (RCS)										
A2c - Residential Retail	36%	38%	36%	37%	-62%	37%	37%	38%	37%	10%
A2d - Residential Behavior	-15%	-15%	-15%	-15%		-14%	-14%		-14%	-1%
B - Income Eligible	**-2%**	**-3%**	**-1%**	**-2%**	**-100%**	**-1%**	**0%**	**-4%**	**-2%**	**3%**
B1 - Income Eligible Existing Buildings	-2%	-3%	-1%	-2%	-100%	-1%	0%	-4%	-2%	3%
B1a - Income Eligible Coordinated Delivery	-2%	-3%	-1%	-2%	-100%	-1%	0%	-4%	-2%	3%
C - Commercial & Industrial	**-44%**	**-50%**	**-44%**	**-45%**	**46%**	**-43%**	**-44%**	**-77%**	**-44%**	**-3%**
C1 - C&I New Buildings	-31%	-31%	-30%	-31%		-30%	-30%		-30%	17%
C1a - C&I New Buildings & Major Renovations	-31%	-31%	-30%	-31%		-30%	-30%		-30%	17%
C2 - C&I Existing Buildings	-48%	-55%	-48%	-49%	38%	-46%	-48%	-76%	-48%	-10%
C2a - C&I Existing Building Retrofit	-50%	-55%	-50%	-51%	27%	-48%	-50%	-76%	-50%	-32%
C2b - C&I New & Replacement Equipment	-45%	-51%	-44%	-45%	809%	-44%	-44%		-44%	45%
Grand Total	**-14%**	**-25%**	**-15%**	**-15%**	**44%**	**-12%**	**-14%**	**-8%**	**-12%**	**-1%**

Notes
• Benefits for each year are presented in real dollars (2019$).
• Total Energy Benefits are the sum of electric benefits, natural gas benefits, and other resource benefits.

Notes
• Benefits for each year are presented in real dollars (2019$).
• Total Energy Benefits are the sum of electric benefits, natural gas benefits, and other resource benefits.

Program Benefits, Three-Year Total

2019-2021 Benefits

Eversource Gas

May 29, 2020

2019 Evaluated Benefits										
Program	Electric Benefits									
	Capacity						Electric Energy			
	Summer Generation	Capacity DRIPE	Transmission	Distribution	Reliability	Total Capacity Benefits	Electric Energy	Electric Energy DRIPE	Electric Energy Environmental Compliance	Total Electric Energy Benefits
A - Residential	**395,963**	**14,039**	**541,696**	**879,334**	**37,579**	**1,868,611**	**1,429,635**	**389,628**	**810,262**	**2,629,524**
A1 - Residential New Buildings	4,095	40	6,491	10,537	489	21,652	39,259	10,734	22,017	72,010
A1a - Residential New Homes & Renovations	4,095	40	6,491	10,537	489	21,652	39,259	10,734	22,017	72,010
A2 - Residential Existing Buildings	391,868	13,999	535,205	868,797	37,091	1,846,959	1,390,376	378,894	788,245	2,557,514
A2a - Residential Coordinated Delivery	315,378	12,806	427,578	694,086	28,402	1,478,249	1,193,405	324,803	669,212	2,187,419
A2b - Residential Conservation Services (RCS)	-	-	-	-	-	-	-	-	-	-
A2c - Residential Retail	76,490	1,193	107,627	174,711	8,688	368,710	191,436	52,440	115,895	359,771
A2d - Residential Behavior	-	-	-	-	-	-	5,535	1,651	3,138	10,324
B - Income Eligible	**195,723**	**-**	**204,611**	**332,145**	**10,054**	**742,534**	**265,749**	**44,825**	**148,553**	**459,127**
B1 - Income Eligible Existing Buildings	195,723	-	204,611	332,145	10,054	742,534	265,749	44,825	148,553	459,127
B1a - Income Eligible Coordinated Delivery	195,723	-	204,611	332,145	10,054	742,534	265,749	44,825	148,553	459,127
C - Commercial & Industrial	**-**	**-**	**-**	**-**	**-**	**-**	**(7,866)**	**(1,862)**	**(4,713)**	**(14,441)**
C1 - C&I New Buildings	-	-	-	-	-	-	(8,871)	(2,038)	(5,250)	(16,158)
C1a - C&I New Buildings & Major Renovations	-	-	-	-	-	-	(8,871)	(2,038)	(5,250)	(16,158)
C2 - C&I Existing Buildings	-	-	-	-	-	-	1,004	176	537	1,717
C2a - C&I Existing Building Retrofit	-	-	-	-	-	-	-	-	-	-
C2b - C&I New & Replacement Equipment	-	-	-	-	-	-	1,004	176	537	1,717
Grand Total	**591,686**	**14,039**	**746,307**	**1,211,479**	**47,634**	**2,611,145**	**1,687,517**	**432,592**	**954,101**	**3,074,211**

2020 Planned Benefits										
Program	Electric Benefits									
	Capacity						Electric Energy			
	Summer Generation	Capacity DRIPE	Transmission	Distribution	Reliability	Total Capacity Benefits	Electric Energy	Electric Energy DRIPE	Electric Energy Environmental Compliance	Total Electric Energy Benefits
A - Residential	**397,654**	**2,051**	**440,103**	**714,419**	**27,404**	**1,581,631**	**1,060,679**	**218,186**	**582,199**	**1,861,065**
A1 - Residential New Buildings	32,772	-	33,249	53,973	1,696	121,690	88,247	14,668	46,656	149,571
A1a - Residential New Homes & Renovations	32,772	-	33,249	53,973	1,696	121,690	88,247	14,668	46,656	149,571
A2 - Residential Existing Buildings	364,882	2,051	406,854	660,446	25,708	1,459,941	972,432	203,518	535,543	1,711,494
A2a - Residential Coordinated Delivery	310,708	1,248	338,238	549,062	20,150	1,219,406	851,776	170,164	462,798	1,484,738
A2b - Residential Conservation Services (RCS)	-	-	-	-	-	-	-	-	-	-
A2c - Residential Retail	54,174	803	68,616	111,384	5,558	240,535	120,656	33,354	72,745	226,756
A2d - Residential Behavior	-	-	-	-	-	-	-	-	-	-
B - Income Eligible	**194,696**	**26**	**191,937**	**311,571**	**9,490**	**707,721**	**257,649**	**42,430**	**139,826**	**439,905**
B1 - Income Eligible Existing Buildings	194,696	26	191,937	311,571	9,490	707,721	257,649	42,430	139,826	439,905
B1a - Income Eligible Coordinated Delivery	194,696	26	191,937	311,571	9,490	707,721	257,649	42,430	139,826	439,905
C - Commercial & Industrial	**3,866**	**5**	**3,953**	**6,416**	**214**	**14,454**	**5,456**	**1,000**	**3,036**	**9,493**
C1 - C&I New Buildings	-	-	-	-	-	-	-	-	-	-
C1a - C&I New Buildings & Major Renovations	-	-	-	-	-	-	-	-	-	-
C2 - C&I Existing Buildings	3,866	5	3,953	6,416	214	14,454	5,456	1,000	3,036	9,493
C2a - C&I Existing Building Retrofit	3,447	5	3,474	5,639	182	12,747	4,219	744	2,331	7,295
C2b - C&I New & Replacement Equipment	419	-	479	777	32	1,707	1,237	256	705	2,198
Grand Total	**596,216**	**2,082**	**635,993**	**1,032,406**	**37,108**	**2,303,806**	**1,323,784**	**261,616**	**725,061**	**2,310,463**

Program Benefits, Three-Year Total

2019-2021 Benefits

Eversource Gas
May 29, 2020

Program	2019 Evaluated Benefits									
	Natural Gas Benefits									
	Natural Gas	Natural Gas DRIPE	Natural Gas Environmental Compliance	Total Natural Gas Benefits	Water	Total Energy Benefits	Total Environmental Compliance Benefits	Non-Energy Impacts	Total TRC Test Benefits	Total Resource Benefits per Participant
A - Residential	**35,123,059**	**4,398,265**	**15,096,409**	**54,617,733**	**2,064,291**	**61,180,160**	**15,906,671**	**14,081,535**	**75,261,695**	**462**
A1 - Residential New Buildings	4,313,093	410,382	1,842,242	6,565,717	-	6,659,380	1,864,259	2,496,467	9,155,847	3,535
A1a - Residential New Homes & Renovations	4,313,093	410,382	1,842,242	6,565,717	-	6,659,380	1,864,259	2,496,467	9,155,847	3,535
A2 - Residential Existing Buildings	30,809,966	3,987,882	13,254,168	48,052,016	2,064,291	54,520,780	14,042,412	11,585,068	66,105,848	418
A2a - Residential Coordinated Delivery	21,069,314	2,412,011	8,929,154	32,410,479	2,043,198	38,119,346	9,598,366	7,735,543	45,854,889	3,390
A2b - Residential Conservation Services (RCS)	-	-	-	-	-	-	-	-	-	
A2c - Residential Retail	8,944,459	1,203,135	3,913,140	14,060,733	21,093	14,810,306	4,029,034	3,849,524	18,659,831	1,705
A2d - Residential Behavior	796,193	372,737	411,874	1,580,804	-	1,591,129	415,012	-	1,591,129	14
B - Income Eligible	**8,104,353**	**900,585**	**3,491,481**	**12,496,420**	**-**	**13,698,080**	**3,640,034**	**11,660,854**	**25,358,934**	**4,958**
B1 - Income Eligible Existing Buildings	8,104,353	900,585	3,491,481	12,496,420	-	13,698,080	3,640,034	11,660,854	25,358,934	4,958
B1a - Income Eligible Coordinated Delivery	8,104,353	900,585	3,491,481	12,496,420	-	13,698,080	3,640,034	11,660,854	25,358,934	4,958
C - Commercial & Industrial	**23,556,931**	**4,016,520**	**11,410,783**	**38,984,234**	**2,254,048**	**41,223,841**	**11,406,070**	**935,773**	**42,159,614**	**24,465**
C1 - C&I New Buildings	7,083,229	996,280	3,381,466	11,460,975	133,500	11,578,317	3,376,217	(53,387)	11,524,930	428,827
C1a - C&I New Buildings & Major Renovations	7,083,229	996,280	3,381,466	11,460,975	133,500	11,578,317	3,376,217	(53,387)	11,524,930	428,827
C2 - C&I Existing Buildings	16,473,702	3,020,240	8,029,317	27,523,259	2,120,548	29,645,524	8,029,854	989,159	30,634,683	17,880
C2a - C&I Existing Building Retrofit	10,673,637	2,241,310	5,112,699	18,027,646	1,927,747	19,955,393	5,112,699	989,159	20,944,552	17,233
C2b - C&I New & Replacement Equipment	5,800,065	778,930	2,916,618	9,495,613	192,801	9,690,131	2,917,155	-	9,690,131	19,380
Grand Total	**66,784,343**	**9,315,370**	**29,998,674**	**106,098,387**	**4,318,339**	**116,102,082**	**30,952,775**	**26,678,161**	**142,780,243**	**849**

Program	2020 Planned Benefits									
	Natural Gas Benefits									
	Natural Gas	Natural Gas DRIPE	Natural Gas Environmental Compliance	Total Natural Gas Benefits	Water	Total Energy Benefits	Total Environmental Compliance Benefits	Non-Energy Impacts	Total TRC Test Benefits	Total Resource Benefits per Participant
A - Residential	**28,478,322**	**3,602,090**	**12,130,698**	**44,211,110**	**1,440,443**	**49,094,249**	**12,712,897**	**13,324,874**	**62,419,123**	**327**
A1 - Residential New Buildings	4,044,506	383,451	1,749,686	6,177,644	-	6,448,905	1,796,342	2,654,321	9,103,226	2,804
A1a - Residential New Homes & Renovations	4,044,506	383,451	1,749,686	6,177,644	-	6,448,905	1,796,342	2,654,321	9,103,226	2,804
A2 - Residential Existing Buildings	24,433,816	3,218,639	10,381,012	38,033,466	1,440,443	42,645,344	10,916,555	10,670,553	53,315,897	289
A2a - Residential Coordinated Delivery	16,763,493	1,910,387	7,027,811	25,701,692	1,384,419	29,790,255	7,490,609	7,875,567	37,665,822	2,404
A2b - Residential Conservation Services (RCS)	-	-	-	-	-	-	-	-	-	
A2c - Residential Retail	6,647,368	869,908	2,868,831	10,386,106	56,024	10,909,421	2,941,576	2,794,986	13,704,407	1,558
A2d - Residential Behavior	1,022,955	438,344	484,370	1,945,668	-	1,945,668	484,370	-	1,945,668	15
B - Income Eligible	**8,588,601**	**950,456**	**3,614,383**	**13,153,440**	**13,304**	**14,314,370**	**3,754,209**	**12,637,878**	**26,952,248**	**4,530**
B1 - Income Eligible Existing Buildings	8,588,601	950,456	3,614,383	13,153,440	13,304	14,314,370	3,754,209	12,637,878	26,952,248	4,530
B1a - Income Eligible Coordinated Delivery	8,588,601	950,456	3,614,383	13,153,440	13,304	14,314,370	3,754,209	12,637,878	26,952,248	4,530
C - Commercial & Industrial	**42,680,451**	**8,085,884**	**20,148,378**	**70,914,714**	**1,540,089**	**72,478,750**	**20,151,414**	**4,203,855**	**76,682,605**	**25,036**
C1 - C&I New Buildings	10,407,033	1,448,345	4,819,600	16,674,979	-	16,674,979	4,819,600	-	16,674,979	370,555
C1a - C&I New Buildings & Major Renovations	10,407,033	1,448,345	4,819,600	16,674,979	-	16,674,979	4,819,600	-	16,674,979	370,555
C2 - C&I Existing Buildings	32,273,418	6,637,539	15,328,778	54,239,735	1,540,089	55,803,771	15,331,814	4,203,855	60,007,626	19,580
C2a - C&I Existing Building Retrofit	21,986,291	5,072,320	10,315,394	37,374,005	1,518,873	38,912,920	10,317,725	4,203,855	43,116,775	25,942
C2b - C&I New & Replacement Equipment	10,287,127	1,565,219	5,013,384	16,865,730	21,216	16,890,851	5,014,089	-	16,890,851	12,512
Grand Total	**79,747,374**	**12,638,430**	**35,893,459**	**128,279,264**	**2,993,836**	**135,887,369**	**36,618,520**	**30,166,607**	**166,053,976**	**871**

Program Benefits, Three-Year Total

2019-2021 Benefits

Eversource Gas
May 29, 2020

2021 Planned Benefits

Program	Electric Benefits									
	Capacity						Electric Energy			
	Summer Generation	Capacity DRIPE	Transmission	Distribution	Reliability	Total Capacity Benefits	Electric Energy	Electric Energy DRIPE	Electric Energy Environmental Compliance	Total Electric Energy Benefits
A - Residential	**453,504**	**2,051**	**460,411**	**747,385**	**28,209**	**1,691,560**	**1,126,642**	**220,199**	**607,214**	**1,954,056**
A1 - Residential New Buildings	34,688	-	32,757	53,175	1,646	122,266	87,650	13,491	45,317	146,458
A1a - Residential New Homes & Renovations	34,688	-	32,757	53,175	1,646	122,266	87,650	13,491	45,317	146,458
A2 - Residential Existing Buildings	418,816	2,051	427,654	694,210	26,563	1,569,294	1,038,992	206,708	561,897	1,807,598
A2a - Residential Coordinated Delivery	358,705	1,248	359,038	582,826	21,005	1,322,823	917,366	173,354	489,152	1,579,873
A2b - Residential Conservation Services (RCS)	-	-	-	-	-	-	-	-	-	-
A2c - Residential Retail	60,111	803	68,616	111,384	5,558	246,471	121,626	33,354	72,745	227,725
A2d - Residential Behavior	-	-	-	-	-	-	-	-	-	-
B - Income Eligible	**225,184**	**26**	**209,295**	**339,749**	**10,343**	**784,598**	**287,332**	**45,920**	**151,477**	**484,729**
B1 - Income Eligible Existing Buildings	225,184	26	209,295	339,749	10,343	784,598	287,332	45,920	151,477	484,729
B1a - Income Eligible Coordinated Delivery	225,184	26	209,295	339,749	10,343	784,598	287,332	45,920	151,477	484,729
C - Commercial & Industrial	**4,124**	**5**	**3,953**	**6,416**	**214**	**14,712**	**5,597**	**1,000**	**3,036**	**9,634**
C1 - C&I New Buildings	-	-	-	-	-	-	-	-	-	-
C1a - C&I New Buildings & Major Renovations	-	-	-	-	-	-	-	-	-	-
C2 - C&I Existing Buildings	4,124	5	3,953	6,416	214	14,712	5,597	1,000	3,036	9,634
C2a - C&I Existing Building Retrofit	3,669	5	3,474	5,639	182	12,969	4,345	744	2,331	7,421
C2b - C&I New & Replacement Equipment	455	-	479	777	32	1,743	1,252	256	705	2,213
Grand Total	**682,812**	**2,082**	**673,659**	**1,093,550**	**38,766**	**2,490,870**	**1,419,571**	**267,119**	**761,727**	**2,448,419**

2019-2021 Benefits

Program	Electric Benefits									
	Capacity						Electric Energy			
	Summer Generation	Capacity DRIPE	Transmission	Distribution	Reliability	Total Capacity Benefits	Electric Energy	Electric Energy DRIPE	Electric Energy Environmental Compliance	Total Electric Energy Benefits
A - Residential	**1,247,121**	**18,141**	**1,442,210**	**2,341,138**	**93,192**	**5,141,802**	**3,616,956**	**828,013**	**1,999,675**	**6,444,645**
A1 - Residential New Buildings	71,555	40	72,497	117,685	3,831	265,608	215,156	38,893	113,990	368,039
A1a - Residential New Homes & Renovations	71,555	40	72,497	117,685	3,831	265,608	215,156	38,893	113,990	368,039
A2 - Residential Existing Buildings	1,175,566	18,101	1,369,713	2,223,453	89,362	4,876,194	3,401,800	789,120	1,885,685	6,076,606
A2a - Residential Coordinated Delivery	984,791	15,302	1,124,854	1,825,974	69,557	4,020,478	2,962,547	668,321	1,621,162	5,252,030
A2b - Residential Conservation Services (RCS)	-	-	-	-	-	-	-	-	-	-
A2c - Residential Retail	190,775	2,799	244,859	397,479	19,804	855,716	433,718	119,148	261,385	814,252
A2d - Residential Behavior	-	-	-	-	-	-	5,535	1,651	3,138	10,324
B - Income Eligible	**615,603**	**52**	**605,843**	**983,465**	**29,887**	**2,234,853**	**810,730**	**133,175**	**439,856**	**1,383,761**
B1 - Income Eligible Existing Buildings	615,603	52	605,843	983,465	29,887	2,234,853	810,730	133,175	439,856	1,383,761
B1a - Income Eligible Coordinated Delivery	615,603	52	605,843	983,465	29,887	2,234,853	810,730	133,175	439,856	1,383,761
C - Commercial & Industrial	**7,990**	**10**	**7,906**	**12,832**	**428**	**29,166**	**3,187**	**138**	**1,359**	**4,686**
C1 - C&I New Buildings	-	-	-	-	-	-	(8,871)	(2,038)	(5,250)	(16,158)
C1a - C&I New Buildings & Major Renovations	-	-	-	-	-	-	(8,871)	(2,038)	(5,250)	(16,158)
C2 - C&I Existing Buildings	7,990	10	7,906	12,832	428	29,166	12,057	2,176	6,609	20,844
C2a - C&I Existing Building Retrofit	7,116	10	6,948	11,278	364	25,716	8,564	1,488	4,662	14,716
C2b - C&I New & Replacement Equipment	874	-	958	1,554	64	3,450	3,493	688	1,947	6,128
Grand Total	**1,870,714**	**18,203**	**2,055,959**	**3,337,435**	**123,508**	**7,405,821**	**4,430,872**	**961,327**	**2,440,889**	**7,833,093**

Notes

• Benefits for each year are presented in real dollars (2019$).
• Total Energy Benefits are the sum of electric benefits, natural gas benefits, and other resource benefits.

Program Benefits, Three-Year Total

2019-2021 Benefits

Eversource Gas
May 29, 2020

Program	2021 Planned Benefits					2021 Planned Benefits				
	Natural Gas Benefits									
	Natural Gas	Natural Gas DRIPE	Natural Gas Environmental Compliance	Total Natural Gas Benefits	Water	Total Energy Benefits	Total Environmental Compliance Benefits	Non-Energy Impacts	Total TRC Test Benefits	Total Resource Benefits per Participant
A - Residential	**30,155,550**	**3,742,604**	**12,684,160**	**46,582,315**	**1,440,443**	**51,668,376**	**13,291,374**	**14,026,122**	**65,694,498**	**340**
A1 - Residential New Buildings	4,076,367	383,451	1,749,686	6,209,505	-	6,478,229	1,795,003	2,653,941	9,132,170	2,817
A1a - Residential New Homes & Renovations	4,076,367	383,451	1,749,686	6,209,505	-	6,478,229	1,795,003	2,653,941	9,132,170	2,817
A2 - Residential Existing Buildings	26,079,183	3,359,153	10,934,474	40,372,810	1,440,443	45,190,147	11,496,371	11,372,181	56,562,328	302
A2a - Residential Coordinated Delivery	18,230,543	2,048,878	7,579,038	27,858,460	1,384,419	32,145,576	8,068,190	8,577,195	40,722,771	2,368
A2b - Residential Conservation Services (RCS)	-	-	-	-	-	-	-	-	-	
A2c - Residential Retail	6,707,288	869,908	2,868,831	10,446,027	56,024	10,976,248	2,941,576	2,794,986	13,771,234	1,568
A2d - Residential Behavior	1,141,352	440,367	486,605	2,068,323	-	2,068,323	486,605	-	2,068,323	16
B - Income Eligible	**8,897,273**	**977,177**	**3,714,560**	**13,589,010**	**13,304**	**14,871,641**	**3,866,037**	**13,170,019**	**28,041,660**	**4,273**
B1 - Income Eligible Existing Buildings	8,897,273	977,177	3,714,560	13,589,010	13,304	14,871,641	3,866,037	13,170,019	28,041,660	4,273
B1a - Income Eligible Coordinated Delivery	8,897,273	977,177	3,714,560	13,589,010	13,304	14,871,641	3,866,037	13,170,019	28,041,660	4,273
C - Commercial & Industrial	**43,397,194**	**8,117,612**	**20,228,344**	**71,743,150**	**1,540,089**	**73,307,584**	**20,231,380**	**4,340,827**	**77,648,410**	**25,322**
C1 - C&I New Buildings	10,507,427	1,448,431	4,819,910	16,775,768	-	16,775,768	4,819,910	-	16,775,768	372,795
C1a - C&I New Buildings & Major Renovations	10,507,427	1,448,431	4,819,910	16,775,768	-	16,775,768	4,819,910	-	16,775,768	372,795
C2 - C&I Existing Buildings	32,889,767	6,669,181	15,408,434	54,967,382	1,540,089	56,531,816	15,411,470	4,340,827	60,872,642	19,836
C2a - C&I Existing Building Retrofit	22,545,444	5,111,657	10,431,022	38,088,123	1,518,873	39,627,386	10,433,353	4,340,827	43,968,212	26,418
C2b - C&I New & Replacement Equipment	10,344,323	1,557,524	4,977,412	16,879,259	21,216	16,904,430	4,978,117	-	16,904,430	12,522
Grand Total	**82,450,017**	**12,837,393**	**36,627,064**	**131,914,475**	**2,993,836**	**139,847,601**	**37,388,791**	**31,536,968**	**171,384,568**	**884**

Program	2019-2021 Benefits					2019-2021 Benefits				
	Natural Gas Benefits									
	Natural Gas	Natural Gas DRIPE	Natural Gas Environmental Compliance	Total Natural Gas Benefits	Water	Total Energy Benefits	Total Environmental Compliance Benefits	Non-Energy Impacts	Total TRC Test Benefits	Total Resource Benefits per Participant
A - Residential	**93,756,931**	**11,742,959**	**39,911,267**	**145,411,158**	**4,945,177**	**161,942,785**	**41,910,942**	**41,432,531**	**203,375,316**	**373**
A1 - Residential New Buildings	12,433,966	1,177,284	5,341,614	18,952,866	-	19,586,514	5,455,604	7,804,729	27,391,243	3,021
A1a - Residential New Homes & Renovations	12,433,966	1,177,284	5,341,614	18,952,866	-	19,586,514	5,455,604	7,804,729	27,391,243	3,021
A2 - Residential Existing Buildings	81,322,965	10,565,674	34,569,654	126,458,292	4,945,177	142,356,271	36,455,338	33,627,802	175,984,073	333
A2a - Residential Coordinated Delivery	56,063,350	6,371,276	23,536,003	85,970,631	4,812,036	100,055,177	25,157,165	24,188,305	124,243,482	2,689
A2b - Residential Conservation Services (RCS)	-	-	-	-	-	-	-	-	-	
A2c - Residential Retail	22,299,115	2,942,951	9,650,802	34,892,866	133,141	36,695,975	9,912,186	9,439,496	46,135,472	1,618
A2d - Residential Behavior	2,960,500	1,251,448	1,382,849	5,594,795	-	5,605,120	1,385,987	-	5,605,120	15
B - Income Eligible	**25,590,227**	**2,828,218**	**10,820,424**	**39,238,870**	**26,608**	**42,884,091**	**11,260,280**	**37,468,751**	**80,352,842**	**4,561**
B1 - Income Eligible Existing Buildings	25,590,227	2,828,218	10,820,424	39,238,870	26,608	42,884,091	11,260,280	37,468,751	80,352,842	4,561
B1a - Income Eligible Coordinated Delivery	25,590,227	2,828,218	10,820,424	39,238,870	26,608	42,884,091	11,260,280	37,468,751	80,352,842	4,561
C - Commercial & Industrial	**109,634,576**	**20,220,016**	**51,787,505**	**181,642,098**	**5,334,226**	**187,010,175**	**51,788,864**	**9,480,455**	**196,490,629**	**25,018**
C1 - C&I New Buildings	27,997,689	3,893,056	13,020,976	44,911,722	133,500	45,029,064	13,015,727	(53,387)	44,975,677	384,864
C1a - C&I New Buildings & Major Renovations	27,997,689	3,893,056	13,020,976	44,911,722	133,500	45,029,064	13,015,727	(53,387)	44,975,677	384,864
C2 - C&I Existing Buildings	81,636,887	16,326,960	38,766,529	136,730,376	5,200,726	141,981,111	38,773,138	9,533,841	151,514,951	19,296
C2a - C&I Existing Building Retrofit	55,205,372	12,425,287	25,859,115	93,489,774	4,965,493	98,495,699	25,863,777	9,533,841	108,029,539	23,688
C2b - C&I New & Replacement Equipment	26,431,515	3,901,673	12,907,414	43,240,602	235,233	43,485,412	12,909,361	-	43,485,412	13,589
Grand Total	**228,981,734**	**34,791,193**	**102,519,197**	**366,292,126**	**10,306,011**	**391,837,052**	**104,960,086**	**88,381,736**	**480,218,787**	**869**

Notes
• Benefits for each year are presented in real dollars (2019$).
• Total Energy Benefits are the sum of electric benefits, natural gas benefits, and other resource benefits.

Notes
• Benefits for each year are presented in real dollars (2019$).
• Total Energy Benefits are the sum of electric benefits, natural gas benefits, and other resource benefits.

Cost-Effectiveness, Plan Year Summary

2019 Planned vs. Evaluated

Eversource Gas

May 29, 2020

2019 Planned Total Resource Cost Test (2019$)							
Program	Benefit-Cost Ratio	Net Benefits	Total TRC Test Benefits	Costs			
				Total Program Costs	Performance Incentive	Participant Costs	Total TRC Test Costs
A - Residential	**1.51**	**20,150,071**	**59,739,909**	**29,545,000**	**514,017**	**9,530,821**	**39,589,838**
A1 - Residential New Buildings	2.17	4,892,584	9,057,321	2,820,000	82,337	1,262,400	4,164,737
A1a - Residential New Homes & Renovations	2.17	4,892,584	9,057,321	2,820,000	82,337	1,262,400	4,164,737
A2 - Residential Existing Buildings	1.49	16,752,487	50,682,588	25,230,000	431,680	8,268,421	33,930,101
A2a - Residential Coordinated Delivery	1.74	15,003,920	35,224,531	14,900,000	301,571	5,019,040	20,220,611
A2b - Residential Conservation Services (RCS)	0.00	(3,320,000)	-	3,320,000	-	-	3,320,000
A2c - Residential Retail	1.41	3,963,594	13,606,985	6,280,000	114,010	3,249,381	9,643,391
A2d - Residential Behavior	2.48	1,104,973	1,851,072	730,000	16,099	-	746,099
A3 - Residential Hard-to-Measure	0.00	(1,495,000)	-	1,495,000	-	-	1,495,000
B - Income Eligible	**2.24**	**14,357,092**	**25,968,573**	**11,380,000**	**231,481**	**-**	**11,611,481**
B1 - Income Eligible Existing Buildings	2.31	14,737,092	25,968,573	11,000,000	231,481	-	11,231,481
B1a - Income Eligible Coordinated Delivery	2.31	14,737,092	25,968,573	11,000,000	231,481	-	11,231,481
B2 - Income Eligible Hard-to-Measure	0.00	(380,000)	-	380,000	-	-	380,000
C - Commercial & Industrial	**3.33**	**53,131,695**	**75,918,133**	**15,220,000**	**775,921**	**6,790,517**	**22,786,438**
C1 - C&I New Buildings	5.66	13,586,503	16,501,177	2,125,000	174,074	615,600	2,914,674
C1a - C&I New Buildings & Major Renovations	5.66	13,586,503	16,501,177	2,125,000	174,074	615,600	2,914,674
C2 - C&I Existing Buildings	3.12	40,385,192	59,416,956	12,255,000	601,847	6,174,917	19,031,764
C2a - C&I Existing Building Retrofit	3.12	28,620,779	42,096,150	8,460,000	427,607	4,587,764	13,475,371
C2b - C&I New & Replacement Equipment	3.12	11,764,413	17,320,806	3,795,000	174,240	1,587,153	5,556,393
C3 - C&I Hard-to-Measure	0.00	(840,000)	-	840,000	-	-	840,000
Grand Total	**2.18**	**87,638,859**	**161,626,615**	**56,145,000**	**1,521,418**	**16,321,338**	**73,987,756**

Cost-Effectiveness, Plan Year Summary

2019 Planned vs. Evaluated

Eversource Gas

May 29, 2020

2019 Evaluated Total Resource Cost Test (2019$)							
Program	Benefit-Cost Ratio	Net Benefits	Total TRC Test Benefits	Costs			
				Total Program Costs	Performance Incentive	Participant Costs	Total TRC Test Costs
A - Residential	**1.59**	**27,836,799**	**75,261,695**	**30,691,478**	**691,203**	**16,042,215**	**47,424,896**
A1 - Residential New Buildings	3.44	6,493,254	9,155,847	2,197,646	89,448	375,498	2,662,593
A1a - Residential New Homes & Renovations	3.44	6,493,254	9,155,847	2,197,646	89,448	375,498	2,662,593
A2 - Residential Existing Buildings	1.52	22,506,426	66,105,848	27,330,951	601,754	15,666,718	43,599,423
A2a - Residential Coordinated Delivery	1.65	18,056,986	45,854,889	16,654,409	418,676	10,724,817	27,797,903
A2b - Residential Conservation Services (RCS)	0.00	(2,970,187)	-	2,970,187	-	-	2,970,187
A2c - Residential Retail	1.54	6,510,885	18,659,831	7,038,026	169,020	4,941,900	12,148,946
A2d - Residential Behavior	2.33	908,742	1,591,129	668,328	14,059	-	682,387
A3 - Residential Hard-to-Measure	0.00	(1,162,881)	-	1,162,881	-	-	1,162,881
B - Income Eligible	**2.22**	**13,955,266**	**25,358,934**	**11,181,028**	**222,641**	**-**	**11,403,668**
B1 - Income Eligible Existing Buildings	2.27	14,211,045	25,358,934	10,925,248	222,641	-	11,147,889
B1a - Income Eligible Coordinated Delivery	2.27	14,211,045	25,358,934	10,925,248	222,641	-	11,147,889
B2 - Income Eligible Hard-to-Measure	0.00	(255,779)	-	255,779	-	-	255,779
C - Commercial & Industrial	**3.06**	**28,370,899**	**42,159,614**	**10,794,148**	**413,307**	**2,581,260**	**13,788,715**
C1 - C&I New Buildings	5.58	9,460,877	11,524,930	1,717,666	118,034	228,353	2,064,053
C1a - C&I New Buildings & Major Renovations	5.58	9,460,877	11,524,930	1,717,666	118,034	228,353	2,064,053
C2 - C&I Existing Buildings	2.84	19,859,714	30,634,683	8,126,790	295,273	2,352,907	10,774,969
C2a - C&I Existing Building Retrofit	3.00	13,963,931	20,944,552	4,867,263	205,449	1,907,909	6,980,621
C2b - C&I New & Replacement Equipment	2.55	5,895,783	9,690,131	3,259,526	89,824	444,998	3,794,349
C3 - C&I Hard-to-Measure	0.00	(949,692)	-	949,692	-	-	949,692
Grand Total	**1.97**	**70,162,964**	**142,780,243**	**52,666,653**	**1,327,151**	**18,623,475**	**72,617,279**

Cost-Effectiveness, Plan Year Summary

2019 Planned vs. Evaluated

Eversource Gas

May 29, 2020

2019 Planned v. Evaluated Total Resource Cost Test (2019$) Variances (%)							
Program	Benefit-Cost Ratio	Net Benefits	Total TRC Test Benefits	Costs			
				Total Program Costs	Performance Incentive	Participant Costs	Total TRC Test Costs
A - Residential	**5%**	**38%**	**26%**	**4%**	**34%**	**68%**	**20%**
A1 - Residential New Buildings	58%	33%	1%	-22%	9%	-70%	-36%
A1a - Residential New Homes & Renovations	58%	33%	1%	-22%	9%	-70%	-36%
A2 - Residential Existing Buildings	2%	34%	30%	8%	39%	89%	28%
A2a - Residential Coordinated Delivery	-5%	20%	30%	12%	39%	114%	37%
A2b - Residential Conservation Services (RCS)		-11%		-11%			-11%
A2c - Residential Retail	9%	64%	37%	12%	48%	52%	26%
A2d - Residential Behavior	-6%	-18%	-14%	-8%	-13%		-9%
A3 - Residential Hard-to-Measure		-22%		-22%			-22%
B - Income Eligible	**-1%**	**-3%**	**-2%**	**-2%**	**-4%**		**-2%**
B1 - Income Eligible Existing Buildings	-2%	-4%	-2%	-1%	-4%		-1%
B1a - Income Eligible Coordinated Delivery	-2%	-4%	-2%	-1%	-4%		-1%
B2 - Income Eligible Hard-to-Measure		-33%		-33%			-33%
C - Commercial & Industrial	**-8%**	**-47%**	**-44%**	**-29%**	**-47%**	**-62%**	**-39%**
C1 - C&I New Buildings	-1%	-30%	-30%	-19%	-32%	-63%	-29%
C1a - C&I New Buildings & Major Renovations	-1%	-30%	-30%	-19%	-32%	-63%	-29%
C2 - C&I Existing Buildings	-9%	-51%	-48%	-34%	-51%	-62%	-43%
C2a - C&I Existing Building Retrofit	-4%	-51%	-50%	-42%	-52%	-58%	-48%
C2b - C&I New & Replacement Equipment	-18%	-50%	-44%	-14%	-48%	-72%	-32%
C3 - C&I Hard-to-Measure		13%		13%			13%
Grand Total	**-10%**	**-20%**	**-12%**	**-6%**	**-13%**	**14%**	**-2%**

Notes

• Costs and benefits for each year are presented in real dollars (2019$).

• The Total TRC Costs are the sum of the Total Program Costs, Performance Incentives, and Participant Costs.

• The plan year variances provided above are intended to indicate the Program Administrator's performance in the plan year only. The variances used to determine significant variances are provided separately. The variances above and the significant variances use different calculations to determine variances on an annual basis and over the three-year term, respectively.

Cost-Effectiveness, Three-Year Total

2019-2021 Total Resource Cost Test (2019$)

Eversource Gas
May 29, 2020

2019 Evaluated Total Resource Cost Test (2019$)							
Program	Benefit-Cost Ratio	Net Benefits	Total TRC Test Benefits	Costs			
				Total Program Costs	Performance Incentive	Participant Costs	Total TRC Test Costs
A - Residential	**1.59**	**27,836,799**	**75,261,695**	**30,691,478**	**691,203**	**16,042,215**	**47,424,896**
A1 - Residential New Buildings	3.44	6,493,254	9,155,847	2,197,646	89,448	375,498	2,662,593
A1a - Residential New Homes & Renovations	3.44	6,493,254	9,155,847	2,197,646	89,448	375,498	2,662,593
A2 - Residential Existing Buildings	1.52	22,506,426	66,105,848	27,330,951	601,754	15,666,718	43,599,423
A2a - Residential Coordinated Delivery	1.65	18,056,986	45,854,889	16,654,409	418,676	10,724,817	27,797,903
A2b - Residential Conservation Services (RCS)	0.00	(2,970,187)	-	2,970,187	-	-	2,970,187
A2c - Residential Retail	1.54	6,510,885	18,659,831	7,038,026	169,020	4,941,900	12,148,946
A2d - Residential Behavior	2.33	908,742	1,591,129	668,328	14,059	-	682,387
A3 - Residential Hard-to-Measure	0.00	(1,162,881)	-	1,162,881	-	-	1,162,881
B - Income Eligible	**2.22**	**13,955,266**	**25,358,934**	**11,181,028**	**222,641**	**-**	**11,403,668**
B1 - Income Eligible Existing Buildings	2.27	14,211,045	25,358,934	10,925,248	222,641	-	11,147,889
B1a - Income Eligible Coordinated Delivery	2.27	14,211,045	25,358,934	10,925,248	222,641	-	11,147,889
B2 - Income Eligible Hard-to-Measure	0.00	(255,779)	-	255,779	-	-	255,779
C - Commercial & Industrial	**3.06**	**28,370,899**	**42,159,614**	**10,794,148**	**413,307**	**2,581,260**	**13,788,715**
C1 - C&I New Buildings	5.58	9,460,877	11,524,930	1,717,666	118,034	228,353	2,064,053
C1a - C&I New Buildings & Major Renovations	5.58	9,460,877	11,524,930	1,717,666	118,034	228,353	2,064,053
C2 - C&I Existing Buildings	2.84	19,859,714	30,634,683	8,126,790	295,273	2,352,907	10,774,969
C2a - C&I Existing Building Retrofit	3.00	13,963,931	20,944,552	4,867,263	205,449	1,907,909	6,980,621
C2b - C&I New & Replacement Equipment	2.55	5,895,783	9,690,131	3,259,526	89,824	444,998	3,794,349
C3 - C&I Hard-to-Measure	0.00	(949,692)	-	949,692	-	-	949,692
Grand Total	**1.97**	**70,162,964**	**142,780,243**	**52,666,653**	**1,327,151**	**18,623,475**	**72,617,279**

2020 Planned Total Resource Cost Test (2019$)							
Program	Benefit-Cost Ratio	Net Benefits	Total TRC Test Benefits	Costs			
				Total Program Costs	Performance Incentive	Participant Costs	Total TRC Test Costs
A - Residential	**1.53**	**21,700,931**	**62,419,123**	**30,465,162**	**539,294**	**9,713,736**	**40,718,192**
A1 - Residential New Buildings	2.23	5,024,861	9,103,226	2,770,449	83,056	1,224,861	4,078,365
A1a - Residential New Homes & Renovations	2.23	5,024,861	9,103,226	2,770,449	83,056	1,224,861	4,078,365
A2 - Residential Existing Buildings	1.52	18,190,778	53,315,897	26,180,006	456,238	8,488,875	35,125,119
A2a - Residential Coordinated Delivery	1.77	16,334,419	37,665,822	15,694,322	323,600	5,313,481	21,331,403
A2b - Residential Conservation Services (RCS)	0.00	(3,581,550)	-	3,581,550	-	-	3,581,550
A2c - Residential Retail	1.45	4,227,659	13,704,407	6,185,869	115,485	3,175,394	9,476,748
A2d - Residential Behavior	2.65	1,210,250	1,945,668	718,264	17,154	-	735,418
A3 - Residential Hard-to-Measure	0.00	(1,514,707)	-	1,514,707	-	-	1,514,707
B - Income Eligible	**2.28**	**15,125,689**	**26,952,248**	**11,585,068**	**241,491**	**-**	**11,826,559**
B1 - Income Eligible Existing Buildings	2.36	15,511,695	26,952,248	11,199,062	241,491	-	11,440,553
B1a - Income Eligible Coordinated Delivery	2.36	15,511,695	26,952,248	11,199,062	241,491	-	11,440,553
B2 - Income Eligible Hard-to-Measure	0.00	(386,006)	-	386,006	-	-	386,006
C - Commercial & Industrial	**3.35**	**53,766,239**	**76,682,605**	**15,479,332**	**783,151**	**6,653,883**	**22,916,366**
C1 - C&I New Buildings	5.79	13,796,214	16,674,979	2,101,046	176,136	601,583	2,878,765
C1a - C&I New Buildings & Major Renovations	5.79	13,796,214	16,674,979	2,101,046	176,136	601,583	2,878,765
C2 - C&I Existing Buildings	3.13	40,834,874	60,007,626	12,513,437	607,015	6,052,299	19,172,752
C2a - C&I Existing Building Retrofit	3.16	29,485,474	43,116,775	8,697,352	437,746	4,496,203	13,631,301
C2b - C&I New & Replacement Equipment	3.05	11,349,400	16,890,851	3,816,085	169,269	1,556,096	5,541,451
C3 - C&I Hard-to-Measure	0.00	(864,849)	-	864,849	-	-	864,849
Grand Total	**2.20**	**90,592,859**	**166,053,976**	**57,529,561**	**1,563,937**	**16,367,618**	**75,461,117**

Cost-Effectiveness, Three-Year Total

2019-2021 Total Resource Cost Test (2019$)

Eversource Gas
May 29, 2020

2021 Planned Total Resource Cost Test (2019$)							
Program	Benefit-Cost Ratio	Net Benefits	Total TRC Test Benefits	Costs			
				Total Program Costs	Performance Incentive	Participant Costs	Total TRC Test Costs
A - Residential	**1.57**	**23,896,283**	**65,694,498**	**31,261,254**	**572,004**	**9,964,957**	**41,798,215**
A1 - Residential New Buildings	2.29	5,139,091	9,132,170	2,712,142	83,966	1,196,971	3,993,079
A1a - Residential New Homes & Renovations	2.29	5,139,091	9,132,170	2,712,142	83,966	1,196,971	3,993,079
A2 - Residential Existing Buildings	1.56	20,309,034	56,562,328	26,997,271	488,038	8,767,986	36,253,294
A2a - Residential Coordinated Delivery	1.79	17,993,434	40,722,771	16,712,141	352,302	5,664,894	22,729,337
A2b - Residential Conservation Services (RCS)	0.00	(3,514,325)	-	3,514,325	-	-	3,514,325
A2c - Residential Retail	1.48	4,486,860	13,771,234	6,064,120	117,161	3,103,092	9,284,374
A2d - Residential Behavior	2.85	1,343,064	2,068,323	706,685	18,574	-	725,259
A3 - Residential Hard-to-Measure	0.00	(1,551,842)	-	1,551,842	-	-	1,551,842
B - Income Eligible	**2.36**	**16,170,686**	**28,041,660**	**11,617,326**	**253,648**	**-**	**11,870,974**
B1 - Income Eligible Existing Buildings	2.45	16,586,102	28,041,660	11,201,910	253,648	-	11,455,558
B1a - Income Eligible Coordinated Delivery	2.45	16,586,102	28,041,660	11,201,910	253,648	-	11,455,558
B2 - Income Eligible Hard-to-Measure	0.00	(415,416)	-	415,416	-	-	415,416
C - Commercial & Industrial	**3.41**	**54,878,921**	**77,648,410**	**15,480,218**	**794,082**	**6,495,189**	**22,769,489**
C1 - C&I New Buildings	5.93	13,947,680	16,775,768	2,062,756	177,447	587,885	2,828,088
C1a - C&I New Buildings & Major Renovations	5.93	13,947,680	16,775,768	2,062,756	177,447	587,885	2,828,088
C2 - C&I Existing Buildings	3.20	41,833,697	60,872,642	12,515,006	616,635	5,907,304	19,038,945
C2a - C&I Existing Building Retrofit	3.22	30,329,197	43,968,212	8,785,811	446,769	4,406,434	13,639,015
C2b - C&I New & Replacement Equipment	3.13	11,504,500	16,904,430	3,729,195	169,866	1,500,870	5,399,930
C3 - C&I Hard-to-Measure	0.00	(902,456)	-	902,456	-	-	902,456
Grand Total	**2.24**	**94,945,890**	**171,384,568**	**58,358,798**	**1,619,734**	**16,460,146**	**76,438,678**

2019-2021 Total Resource Cost Test (2019$)							
Program	Benefit-Cost Ratio	Net Benefits	Total TRC Test Benefits	Costs			
				Total Program Costs	Performance Incentive	Participant Costs	Total TRC Test Costs
A - Residential	**1.57**	**73,434,013**	**203,375,316**	**92,417,894**	**1,802,501**	**35,720,909**	**129,941,303**
A1 - Residential New Buildings	2.55	16,657,206	27,391,243	7,680,237	256,471	2,797,330	10,734,037
A1a - Residential New Homes & Renovations	2.55	16,657,206	27,391,243	7,680,237	256,471	2,797,330	10,734,037
A2 - Residential Existing Buildings	1.53	61,006,237	175,984,073	80,508,227	1,546,031	32,923,579	114,977,836
A2a - Residential Coordinated Delivery	1.73	52,384,839	124,243,482	49,060,873	1,094,578	21,703,192	71,858,643
A2b - Residential Conservation Services (RCS)	0.00	(10,066,061)	-	10,066,061	-	-	10,066,061
A2c - Residential Retail	1.49	15,225,404	46,135,472	19,288,015	401,666	11,220,387	30,910,067
A2d - Residential Behavior	2.62	3,462,055	5,605,120	2,093,278	49,787	-	2,143,065
A3 - Residential Hard-to-Measure	0.00	(4,229,430)	-	4,229,430	-	-	4,229,430
B - Income Eligible	**2.29**	**45,251,641**	**80,352,842**	**34,383,421**	**717,780**	**-**	**35,101,202**
B1 - Income Eligible Existing Buildings	2.36	46,308,842	80,352,842	33,326,220	717,780	-	34,044,000
B1a - Income Eligible Coordinated Delivery	2.36	46,308,842	80,352,842	33,326,220	717,780	-	34,044,000
B2 - Income Eligible Hard-to-Measure	0.00	(1,057,202)	-	1,057,202	-	-	1,057,202
C - Commercial & Industrial	**3.30**	**137,016,060**	**196,490,629**	**41,753,697**	**1,990,540**	**15,730,332**	**59,474,569**
C1 - C&I New Buildings	5.79	37,204,771	44,975,677	5,881,468	471,617	1,417,821	7,770,906
C1a - C&I New Buildings & Major Renovations	5.79	37,204,771	44,975,677	5,881,468	471,617	1,417,821	7,770,906
C2 - C&I Existing Buildings	3.09	102,528,285	151,514,951	33,155,233	1,518,923	14,312,510	48,986,666
C2a - C&I Existing Building Retrofit	3.15	73,778,603	108,029,539	22,350,426	1,089,964	10,810,546	34,250,936
C2b - C&I New & Replacement Equipment	2.95	28,749,683	43,485,412	10,804,807	428,959	3,501,964	14,735,730
C3 - C&I Hard-to-Measure	0.00	(2,716,997)	-	2,716,997	-	-	2,716,997
Grand Total	**2.14**	**255,701,713**	**480,218,787**	**168,555,012**	**4,510,822**	**51,451,240**	**224,517,074**

Notes

• Costs and benefits for each year are presented in real dollars (2019$).
• The Total TRC Costs are the sum of the Total Program Costs, Performance Incentives, and Participant Costs.

Core Initiatives, Plan Year Summary

Residential Programs

Eversource

May 29, 2020

A1 - Residential New Buildings, 2019 Summary

A1a - Residential New Homes & Renovations

Metric	Units	Planned	Preliminary	Evaluated	Plan v Preliminary	Plan v Evaluated	Preliminary v Evaluated
Annual Energy	MWh	74	53	69	-29%	-7%	30%
Lifetime Energy	MWh	1,380	506	622	-63%	-55%	23%
Annual Natural Gas	Therms	214,920	296,371	207,629	38%	-3%	-30%
Lifetime Natural Gas	Therms	4,542,000	6,786,696	4,798,824	49%	6%	-29%
Total Benefits	2019$	9,057,321	11,845,954	9,155,847	31%	1%	-23%
Total Program Costs	nominal$	2,820,000	2,197,646	2,197,646	-22%	-22%	0%
Total Resource Costs	2019$	4,164,737	2,662,593	2,662,593	-36%	-36%	0%
Benefit Cost Ratio	B/C	2.17	4.45	3.44	105%	58%	-23%

A2 - Residential Existing Buildings, 2019 Summary

A2a - Residential Coordinated Delivery

Metric	Units	Planned	Preliminary	Evaluated	Plan v Preliminary	Plan v Evaluated	Preliminary v Evaluated
Annual Energy	MWh	1,129	2,355	2,355	109%	109%	0%
Lifetime Energy	MWh	13,124	19,099	19,099	46%	46%	0%
Annual Natural Gas	Therms	871,928	1,166,138	1,166,138	34%	34%	0%
Lifetime Natural Gas	Therms	17,033,022	23,148,083	23,148,083	36%	36%	0%
Total Benefits	2019$	35,224,531	45,854,889	45,854,889	30%	30%	0%
Total Program Costs	nominal$	14,900,000	16,654,409	16,654,409	12%	12%	0%
Total Resource Costs	2019$	20,220,611	27,797,903	27,797,903	37%	37%	0%
Benefit Cost Ratio	B/C	1.74	1.65	1.65	-5%	-5%	0%

A2c - Residential Retail

Metric	Units	Planned	Preliminary	Evaluated	Plan v Preliminary	Plan v Evaluated	Preliminary v Evaluated
Annual Energy	MWh	144	226	226	57%	57%	0%
Lifetime Energy	MWh	2,068	3,297	3,297	59%	59%	0%
Annual Natural Gas	Therms	441,908	608,357	608,357	38%	38%	0%
Lifetime Natural Gas	Therms	7,358,616	10,033,157	10,033,157	36%	36%	0%
Total Benefits	2019$	13,606,985	18,659,831	18,659,831	37%	37%	0%
Total Program Costs	nominal$	6,280,000	7,038,026	7,038,026	12%	12%	0%
Total Resource Costs	2019$	9,643,391	12,148,946	12,148,946	26%	26%	0%
Benefit Cost Ratio	B/C	1.41	1.54	1.54	9%	9%	0%

A2d - Residential Behavior

Metric	Units	Planned	Preliminary	Evaluated	Plan v Preliminary	Plan v Evaluated	Preliminary v Evaluated
Annual Energy	MWh	-	85	85			0%
Lifetime Energy	MWh	-	85	85			0%
Annual Natural Gas	Therms	1,192,976	1,018,794	1,018,794	-15%	-15%	0%
Lifetime Natural Gas	Therms	1,192,976	1,018,794	1,018,794	-15%	-15%	0%
Total Benefits	2019$	1,851,072	1,591,129	1,591,129	-14%	-14%	0%
Total Program Costs	nominal$	730,000	668,328	668,328	-8%	-8%	0%
Total Resource Costs	2019$	746,099	682,387	682,387	-9%	-9%	0%
Benefit Cost Ratio	B/C	2.48	2.33	2.33	-6%	-6%	0%

Core Initiatives, Plan Year Summary

Income Eligible Programs

Eversource

May 29, 2020

B1 - Income Eligible Existing Buildings, 2019 Summary							
B1a - Income Eligible Coordinated Delivery							
Metric	Units	Planned	Preliminary	Evaluated	Plan v Preliminary	Plan v Evaluated	Preliminary v Evaluated
Annual Energy	MWh	157	180	180	14%	14%	0%
Lifetime Energy	MWh	3,769	4,371	4,371	16%	16%	0%
Annual Natural Gas	Therms	446,023	451,906	451,906	1%	1%	0%
Lifetime Natural Gas	Therms	9,132,435	9,026,624	9,026,624	-1%	-1%	0%
Total Benefits	2019$	25,968,573	25,358,934	25,358,934	-2%	-2%	0%
Total Program Costs	nominal$	11,000,000	10,925,248	10,925,248	-1%	-1%	0%
Total Resource Costs	2019$	11,231,481	11,147,889	11,147,889	-1%	-1%	0%
Benefit Cost Ratio	B/C	2.31	2.27	2.27	-2%	-2%	0%

Core Initiatives, Plan Year Summary

C&I Programs

Eversource

May 29, 2020

C1 - C&I New Buildings, 2019 Summary

C1a - C&I New Buildings & Major Renovations

Metric	Units	Planned	Preliminary	Evaluated	Plan v Preliminary	Plan v Evaluated	Preliminary v Evaluated
Annual Energy	MWh	-	(10)	(9)			-12%
Lifetime Energy	MWh	-	(169)	(151)			-11%
Annual Natural Gas	Therms	701,812	543,569	505,430	-23%	-28%	-7%
Lifetime Natural Gas	Therms	12,368,194	9,271,485	8,682,394	-25%	-30%	-6%
Total Benefits	2019$	16,501,177	12,292,845	11,524,930	-26%	-30%	-6%
Total Program Costs	nominal$	2,125,000	1,717,666	1,717,666	-19%	-19%	0%
Total Resource Costs	2019$	2,914,674	2,064,053	2,064,053	-29%	-29%	0%
Benefit Cost Ratio	B/C	5.66	5.96	5.58	5%	-1%	-6%

C2 - C&I Existing Buildings, 2019 Summary

C2a - C&I Existing Building Retrofit

Metric	Units	Planned	Preliminary	Evaluated	Plan v Preliminary	Plan v Evaluated	Preliminary v Evaluated
Annual Energy	MWh	3	-	-	-100%	-100%	
Lifetime Energy	MWh	69	-	-	-100%	-100%	
Annual Natural Gas	Therms	2,459,406	1,363,170	1,137,463	-45%	-54%	-17%
Lifetime Natural Gas	Therms	25,860,386	15,569,717	13,004,041	-40%	-50%	-16%
Total Benefits	2019$	42,096,150	24,608,979	20,944,552	-42%	-50%	-15%
Total Program Costs	nominal$	8,460,000	4,867,263	4,867,263	-42%	-42%	0%
Total Resource Costs	2019$	13,475,371	6,980,621	6,980,621	-48%	-48%	0%
Benefit Cost Ratio	B/C	3.12	3.53	3.00	13%	-4%	-15%

C2b - C&I New & Replacement Equipment

Metric	Units	Planned	Preliminary	Evaluated	Plan v Preliminary	Plan v Evaluated	Preliminary v Evaluated
Annual Energy	MWh	1	1	1	-16%	-16%	0%
Lifetime Energy	MWh	20	15	15	-24%	-24%	0%
Annual Natural Gas	Therms	905,393	511,496	476,199	-44%	-47%	-7%
Lifetime Natural Gas	Therms	13,347,802	8,088,337	7,477,971	-39%	-44%	-8%
Total Benefits	2019$	17,320,806	10,489,109	9,690,131	-39%	-44%	-8%
Total Program Costs	nominal$	3,795,000	3,259,526	3,259,526	-14%	-14%	0%
Total Resource Costs	2019$	5,556,393	3,794,349	3,794,349	-32%	-32%	0%
Benefit Cost Ratio	B/C	3.12	2.76	2.55	-11%	-18%	-8%

Core Initiatives, Three-Year Total

Residential Programs

Eversource

May 29, 2020

A1 - Residential New Buildings, 2019-2021 Summary

A1a - Residential New Homes & Renovations

Metric	Units	2019 Evaluated	2020 Planned	2021 Planned	2019-2021 Total
Annual Energy	MWh	69	68	63	200
Lifetime Energy	MWh	622	1,352	1,315	3,289
Annual Natural Gas	Therms	207,629	214,920	214,920	637,469
Lifetime Natural Gas	Therms	4,798,824	4,542,000	4,542,000	13,882,824
Total Benefits	2019$	9,155,847	9,103,226	9,132,170	27,391,243
Total Program Costs	nominal$	2,197,646	2,835,000	2,840,000	7,872,646
Total Resource Costs	2019$	2,662,593	4,173,391	4,181,324	11,017,308
Benefit Cost Ratio	B/C	3.44	2.23	2.29	2.49

A2 - Residential Existing Buildings, 2019-2021 Summary

A2a - Residential Coordinated Delivery

Metric	Units	2019 Evaluated	2020 Planned	2021 Planned	2019-2021 Total
Annual Energy	MWh	2,355	1,070	1,003	4,428
Lifetime Energy	MWh	19,099	13,342	14,120	46,561
Annual Natural Gas	Therms	1,166,138	924,001	988,422	3,078,561
Lifetime Natural Gas	Therms	23,148,083	18,206,825	19,640,646	60,995,554
Total Benefits	2019$	45,854,889	37,665,822	40,722,771	124,243,482
Total Program Costs	nominal$	16,654,409	16,060,000	17,500,000	50,214,409
Total Resource Costs	2019$	27,797,903	21,828,424	23,800,864	73,427,191
Benefit Cost Ratio	B/C	1.65	1.77	1.79	1.69

A2c - Residential Retail

Metric	Units	2019 Evaluated	2020 Planned	2021 Planned	2019-2021 Total
Annual Energy	MWh	226	144	144	514
Lifetime Energy	MWh	3,297	2,068	2,068	7,433
Annual Natural Gas	Therms	608,357	441,908	441,908	1,492,173
Lifetime Natural Gas	Therms	10,033,157	7,358,616	7,358,616	24,750,389
Total Benefits	2019$	18,659,831	13,704,407	13,771,234	46,135,472
Total Program Costs	nominal$	7,038,026	6,330,000	6,350,000	19,718,026
Total Resource Costs	2019$	12,148,946	9,697,557	9,722,066	31,568,568
Benefit Cost Ratio	B/C	1.54	1.45	1.48	1.46

A2d - Residential Behavior

Metric	Units	2019 Evaluated	2020 Planned	2021 Planned	2019-2021 Total
Annual Energy	MWh	85	-	-	85
Lifetime Energy	MWh	85	-	-	85
Annual Natural Gas	Therms	1,018,794	1,198,117	1,203,646	3,420,557
Lifetime Natural Gas	Therms	1,018,794	1,198,117	1,203,646	3,420,557
Total Benefits	2019$	1,591,129	1,945,668	2,068,323	5,605,120
Total Program Costs	nominal$	668,328	735,000	740,000	2,143,328
Total Resource Costs	2019$	682,387	752,554	759,450	2,194,391
Benefit Cost Ratio	B/C	2.33	2.65	2.85	2.55

Core Initiatives, Three-Year Total

Income Eligible Programs

Eversource

May 29, 2020

B1 - Income Eligible Existing Buildings, 2019-2021 Summary					
B1a - Income Eligible Coordinated Delivery					
Metric	**Units**	**2019 Evaluated**	**2020 Planned**	**2021 Planned**	**2019-2021 Total**
Annual Energy	MWh	180	170	184	534
Lifetime Energy	MWh	4,371	4,113	4,457	12,941
Annual Natural Gas	Therms	451,906	456,463	468,923	1,377,292
Lifetime Natural Gas	Therms	9,026,624	9,357,085	9,616,885	28,000,594
Total Benefits	2019$	25,358,934	26,952,248	28,041,660	80,352,842
Total Program Costs	nominal$	10,925,248	11,460,000	11,730,000	34,115,248
Total Resource Costs	2019$	11,147,889	11,707,118	11,995,606	34,850,613
Benefit Cost Ratio	B/C	2.27	2.36	2.45	2.31

Core Initiatives, Three-Year Total

C&I Programs

Eversource

May 29, 2020

C1 - C&I New Buildings, 2019-2021 Summary

C1a - C&I New Buildings & Major Renovations

Metric	Units	2019 Evaluated	2020 Planned	2021 Planned	2019-2021 Total
Annual Energy	MWh	(9)	-	-	(9)
Lifetime Energy	MWh	(151)	-	-	(151)
Annual Natural Gas	Therms	505,430	702,632	702,672	1,910,734
Lifetime Natural Gas	Therms	8,682,394	12,384,594	12,385,394	33,452,382
Total Benefits	2019$	11,524,930	16,674,979	16,775,768	44,975,677
Total Program Costs	nominal$	1,717,666	2,150,000	2,160,000	6,027,666
Total Resource Costs	2019$	2,064,053	2,945,840	2,961,412	7,971,305
Benefit Cost Ratio	B/C	5.58	5.79	5.93	5.64

C2 - C&I Existing Buildings, 2019-2021 Summary

C2a - C&I Existing Building Retrofit

Metric	Units	2019 Evaluated	2020 Planned	2021 Planned	2019-2021 Total
Annual Energy	MWh	-	3	3	6
Lifetime Energy	MWh	-	69	69	138
Annual Natural Gas	Therms	1,137,463	2,477,903	2,496,401	6,111,767
Lifetime Natural Gas	Therms	13,004,041	26,156,350	26,452,313	65,612,704
Total Benefits	2019$	20,944,552	43,116,775	43,968,212	108,029,539
Total Program Costs	nominal$	4,867,263	8,900,000	9,200,000	22,967,263
Total Resource Costs	2019$	6,980,621	13,948,910	14,281,997	35,211,528
Benefit Cost Ratio	B/C	3.00	3.16	3.22	3.07

C2b - C&I New & Replacement Equipment

Metric	Units	2019 Evaluated	2020 Planned	2021 Planned	2019-2021 Total
Annual Energy	MWh	1	1	1	3
Lifetime Energy	MWh	15	20	20	55
Annual Natural Gas	Therms	476,199	871,349	864,853	2,212,401
Lifetime Natural Gas	Therms	7,477,971	12,815,219	12,723,455	33,016,645
Total Benefits	2019$	9,690,131	16,890,851	16,904,430	43,485,412
Total Program Costs	nominal$	3,259,526	3,905,000	3,905,000	11,069,526
Total Resource Costs	2019$	3,794,349	5,670,566	5,654,499	15,119,414
Benefit Cost Ratio	B/C	2.55	3.05	3.13	2.88

Greenhouse Gas Reductions, Plan Year Summary

GHG reductions are provided for information purposes only. They are not included in the TRC test.

Eversource Gas

May 29, 2020

2019 Planned Greenhouse Gas Reductions					
Sector	Adjusted Gross Annual Savings		Annual Emissions Reductions (Short Tons)		
	Electric Energy (MWh)	Natural Gas (Therm)	NOX	SO2	CO2
A - Residential	1,420	2,708,718	0.23	0.06	16,547
B - Income Eligible	157	446,023	0.03	0.01	2,687
C - Commercial & Industrial	4	5,156,630	0.00	0.00	30,168
Grand Total	**1,581**	**8,311,371**	**0.26**	**0.07**	**49,403**

2019 Evaluated Greenhouse Gas Reductions					
Sector	Adjusted Gross Annual Savings		Annual Emissions Reductions (Short Tons)		
	Electric Energy (MWh)	Natural Gas (Therm)	NOX	SO2	CO2
A - Residential	2,982	2,992,940	0.49	0.13	18,982
B - Income Eligible	180	451,906	0.03	0.01	2,732
C - Commercial & Industrial	(11)	2,739,811	(0.00)	(0.00)	16,022
Grand Total	**3,151**	**6,184,657**	**0.52**	**0.13**	**37,737**

2019 Planned v. Evaluated Greenhouse Gas Reductions Variances (%)					
Sector	Adjusted Gross Annual Savings		Annual Emissions Reductions (Short Tons)		
	Electric Energy (MWh)	Natural Gas (Therm)	NOX	SO2	CO2
A - Residential	110%	10%	110%	110%	15%
B - Income Eligible	14%	1%	14%	14%	2%
C - Commercial & Industrial	-380%	-47%	-380%	-380%	-47%
Grand Total	**99%**	**-26%**	**99%**	**99%**	**-24%**

Notes

The Program Administrators have worked with the Department of Environmental Protection ("DEP") to properly capture the full impact of energy efficiency measures on GHG emissions. These reductions are calculated using factors prepared by DEP, which are based on adjusted gross annual electric energy, natural gas, oil, and propane savings. For projected emissions reductions in future years for the electric sector, Program Administrators are using values that are consistent with the values used in the Massachusetts Clean Energy and

Greenhouse Gas Reductions, Three-Year Total

GHG reductions are provided for information purposes only. They are not included in the TRC test.

Eversource Gas

May 29, 2020

2019 Evaluated Greenhouse Gas Reductions					
Sector	Adjusted Gross Annual Savings		Annual Emissions Reductions (Short Tons)		
	Electric Energy (MWh)	Natural Gas (Therm)	NOX	SO2	CO2
A - Residential	2,982	2,992,940	0.49	0.13	18,982
B - Income Eligible	180	451,906	0.03	0.01	2,732
C - Commercial & Industrial	(11)	2,739,811	(0.00)	(0.00)	16,022
Grand Total	**3,151**	**6,184,657**	**0.52**	**0.13**	**37,737**

2020 Planned Greenhouse Gas Reductions					
Sector	Adjusted Gross Annual Savings		Annual Emissions Reductions (Short Tons)		
	Electric Energy (MWh)	Natural Gas (Therm)	NOX	SO2	CO2
A - Residential	1,379	2,756,782	0.23	0.06	16,808
B - Income Eligible	170	456,463	0.03	0.01	2,754
C - Commercial & Industrial	4	5,127,050	0.00	0.00	29,995
Grand Total	**1,553**	**8,340,295**	**0.26**	**0.07**	**49,558**

2021 Planned Greenhouse Gas Reductions					
Sector	Adjusted Gross Annual Savings		Annual Emissions Reductions (Short Tons)		
	Electric Energy (MWh)	Natural Gas (Therm)	NOX	SO2	CO2
A - Residential	1,344	2,816,051	0.22	0.06	17,138
B - Income Eligible	184	468,923	0.03	0.01	2,834
C - Commercial & Industrial	4	5,147,197	0.00	0.00	30,113
Grand Total	**1,532**	**8,432,171**	**0.25**	**0.06**	**50,085**

2019-2021 Greenhouse Gas Reductions					
Sector	Adjusted Gross Annual Savings		Annual Emissions Reductions (Short Tons)		
	Electric Energy (MWh)	Natural Gas (Therm)	NOX	SO2	CO2
A - Residential	5,705	8,565,773	0.94	0.24	52,928
B - Income Eligible	534	1,377,292	0.09	0.02	8,321
C - Commercial & Industrial	(3)	13,014,058	(0.00)	(0.00)	76,131
Grand Total	**6,236**	**22,957,123**	**1.02**	**0.26**	**137,380**

Notes

The Program Administrators have worked with the Department of Environmental Protection ("DEP") to properly capture the full impact of energy efficiency measures on GHG emissions. These reductions are calculated using factors prepared by DEP, which are based on adjusted gross annual electric energy, natural gas, oil, and propane savings. For projected emissions reductions in future years for the electric sector, Program Administrators are using values that are consistent with the values used in the Massachusetts Clean Energy and

Calculated Fields

Formulas used in pivot tables

Eversource Gas

May 29, 2020

Field	Formula
B/C Ratio	='Total Benefits '/'Total Resource Costs (First Yr$)'
Net Benefits	='Total Benefits '-'Total Resource Costs (First Yr$)'
Avg Measure Life	=ROUND('Net Lifetime Electric Energy (MWh) No FS or DR'/'Net Annual Electric Energy (MWh) No FS or DR',0)
PA Budget (First Yr$)	='Total Program Costs (First Yr$)'+'Performance Incentive (First Yr$)'
Summer Cost (TRC Cost First Yr$/Summer kW)	='Total Resource Costs (First Yr$)'/'Net Summer Capacity (kW)'
Energy Cost (TRC Cost First Yr$/Annual MWh)	='Total Program Costs (First Yr$)'/'Net Annual Electric Energy (MWh)'
Natural Gas Costs (PA Cost First Yr$/Annual Therm)	='PA Budget (First Yr$)'/'Net Annual Natural Gas (Therms)'
Summer Cost (PA Cost First Yr$/Summer kW)	='PA Budget (First Yr$)'/'Net Summer Capacity (kW)'
Energy Cost (PA Cost First Yr$/Annual MWh)	='PA Budget (First Yr$)'/'Net Annual Electric Energy (MWh)'
Natural Gas Costs (TRC Cost First Yr$/Annual Therm)	='Total Program Costs (First Yr$)'/'Net Annual Natural Gas (Therms)'
Total Savings Cost (PA Cost First Yr$/Annual MMBTU)	='PA Budget (First Yr$)'/'Total Net Annual Adjusted (MMBTU)'
Total Savings Cost (TRC Cost First Yr$/Annual MMBTU)	='Total Resource Costs (First Yr$)'/'Total Net Annual Adjusted (MMBTU)'
Total PA Budget (Programs + PI + Benefit Burden)	='Total Program Costs'+'Performance Incentive'+'Benefit Burden'
Total Resource Benefits per Participant	='Total Resource Benefits'/Participants
Total PA Budget	='Total Program Costs'+'Performance Incentive'
Program Cost per Participant	='Total Program Costs'/Participants
Resource Benefit per Program Cost	='Total Resource Benefits'/'Total Program Costs'

Notes

• The above calculations are used to prepare the previous data tables.

• This table is provided consistent with the Department's directives in D.P.U. 18-110 through D.P.U. 18-119, at 75 to provide a detailed list of calculated fields used in creating the pivot tables.

APPENDIX 1

Significant Core Initiative Variances & Cost-Effectiveness

Program Administrator-Specific Narrative Explanations for NSTAR Gas Program Administrator d/b/a Eversource Energy (the "Program Administrator" or "Company") are as follows. Please note any projections regarding term goals and cost-effectiveness do not take into account the economic and implementation impacts of COVID-19. The Program Administrator will discuss any COVID-19 related impacts in the 2020 Plan-Year Report.

I. RESIDENTIAL PROGRAMS

The actual 2019 benefit-cost ratio for the Residential sector is 1.59.

A. RESIDENTIAL NEW BUILDINGS

The actual 2019 benefit-cost ratio for the Residential New Buildings program is 3.44. The projected benefit-cost ratio for the 2019-2021 plan term is 2.55 after accounting for actual results from 2019.

1. Residential New Homes & Renovations

a. Significant Variances [1]

Significant variances exist between: (1) planned and actual budget; and (2) between preliminary and evaluated total resource benefits. The primary reason(s) for such variances are:

(1) Planned and Actual Expenditures

Actual spending is 22 percent lower than planned. Lower than anticipated spending in the Residential New Homes & Renovations core initiative is due primarily to less spending on incentives than planned. The planned incentives were informed by 2017 data, the last full year of program data available when developing the plan and were higher than incentives paid on a savings basis in

[1] Plan-year core initiative significant variances are defined in the D.P.U. 11-120, Phase II Plan-Year Report Template as: (1) variances between planned and actual core initiative budget of 15 percent or greater; (2) variances between planned and preliminary core initiative total lifetime savings showing a decrease of 15 percent or greater; (3) variances between planned and preliminary core initiative total benefits showing a decrease of 15 percent or greater; and (4) variances between preliminary and evaluated core initiative total resource benefits showing a decrease of 15 percent or greater.

2018 and 2019. This resulted in less spending than planned; however, both the lifetime savings and benefits targets were achieved for this core initiative.

(2) Preliminary and Evaluated Total Resource Benefits

A significant variance exists between preliminary and evaluated total resource benefits for the Residential New Homes & Renovations core initiative. Evaluated total resource benefits are 29 percent lower than preliminary. The decrease in resource benefits is due to a reduction in attributable energy savings as a result of the 2019 Residential New Construction Baseline and Code Compliance Study (2019 Plan-Year Report D.P.U. 20-50 Appendix 4D, Study 19-27). The evaluation study updated the User Defined Reference Home ("UDRH"), last updated in 2016, based on current common installation practices for non-participating homes. The study found that program homes are significantly more efficient than non-program homes, but the difference between the two is decreasing.

The Program Administrator is projecting to achieve its savings and benefits goals by the end of the Three-Year Plan term for this core initiative.

b. Cost-Effectiveness

The actual 2019 benefit-cost ratio for the Residential New Homes & Renovations core initiative is 3.44. The projected benefit-cost ratio for the 2019-2021 plan term is 2.55 after accounting for actual results from 2019.

B. RESIDENTIAL EXISTING BUILDINGS

The actual 2019 benefit-cost ratio for the Residential Existing Buildings Program is 1.52. The projected benefit-cost ratio for the 2019-2021 plan term is 1.53 after accounting for actual results from 2019.

1. Residential Coordinated Delivery

a. Significant Variances

There are no significant variances to report for this core initiative.

The Program Administrator is projecting to achieve its savings and benefits goals by the end of the Three-Year Plan term for this core initiative.

b. Cost-Effectiveness

The actual 2019 benefit-cost ratio for the Residential Coordinated Delivery core initiative is 1.65. The projected benefit-cost ratio for the 2019-2021 plan term is 1.73 after accounting for actual results from 2019.

2. Residential Conservation Services

a. Significant Variances

There are no significant variances to report for this core initiative.

3. Residential Retail

a. Significant Variances

There are no significant variances to report for this core initiative.

The Program Administrator is projecting to achieve its savings and benefits goals by the end of the Three-Year Plan term for this core initiative.

b. Cost-Effectiveness

The actual 2019 benefit-cost ratio for the Residential Retail core initiative is 1.52. The projected benefit-cost ratio for the 2019-2021 plan term is 1.49 after accounting for actual results from 2019.

4. Residential Behavior

a. Significant Variances

There are no significant variances to report for this core initiative.

The Program Administrator is not projecting to achieve its savings and benefits goals by the end of the Three-Year Plan term for this core initiative. The residential behavior initiative goal is made up of two components (home energy reports "HERs" and temperature optimization).

The Program Administrator has made a strategic decision to no longer send out HERs in favor of ramping up alternative communications that will utilize behavioral science techniques beyond normative social comparisons. The communications will deliver customized usage insights via a highly-tailored experience designed to motivate program participation and behavior change.

Even though the Program Administrator will no longer be sending out HERs, it is expected that savings from HERs will persist for the next couple years. In addition, once ramped up the Program Administrator plans to claim savings from the new delivered energy insights approach.

In addition to the change to the HER approach, the Program Administrator will no longer be able to claim savings from temperature optimization. The vendor has decided to offer that service to all customers, irrespective of program incentives, beginning in Summer 2020. Therefore, the Program Administrator will not be able to claim savings from Winter temperature optimization in 2021. The table below shows that the Program Administrator is projecting to achieve 76 percent of its three-year initiative savings and benefits goal and expects the costs to be lower as well.

	2019 (actual)	2020 (projected)	2021 (projected)	2019-2021 (projected)
Filed Goal	1,192,976	1,198,117	1,203,646	3,594,739
Actual / Projected	1,018,794	940,000	765,000	2,723,794
Percent of Goal	85%	78%	64%	76%

b. Cost-Effectiveness

The actual 2019 benefit-cost ratio for the Residential Behavior core initiative is 2.33. The projected benefit-cost ratio for the 2019-2021 plan term is 2.62 after accounting for actual results from 2019.

II. INCOME ELIGIBLE PROGRAMS

The actual 2019 benefit-cost ratio for the Income Eligible sector is 2.22.

A. INCOME ELIGIBLE EXISTING BUILDINGS

The actual 2019 benefit-cost ratio for the Income Eligible Existing Buildings program is 2.27. The projected benefit-cost ratio for the 2019-2021 plan term is 2.36 after accounting for actual results from 2019.

1. Income Eligible Coordinated Delivery

a. Significant Variances

There are no significant variances to report for this core initiative.

The Program Administrator is projecting to achieve its savings and benefits goals by the end of the Three-Year Plan term for this core initiative.

b. Cost-Effectiveness

The actual 2019 benefit-cost ratio for the Income Eligible Coordinated Delivery core initiative is 2.27. The projected benefit-cost ratio for the 2019-2021 plan term is 2.36 after accounting for actual results from 2019.

III. COMMERCIAL & INDUSTRIAL ("C&I") PROGRAMS

The actual 2019 benefit-cost ratio for the C&I sector is 3.06.

A. C&I NEW BUILDINGS

The actual 2019 benefit-cost ratio for the C&I New Buildings program is 5.58. The projected benefit-cost ratio for the 2019-2021 plan term is 5.79 after accounting for actual results from 2019.

1. C&I New Buildings & Major Renovations

a. Significant Variances

Significant variances exist between: (1) planned and actual budget; (2) planned and preliminary total lifetime savings; and (3) planned and preliminary total benefits. The primary reason(s) for such variances are:

(1) Planned and Actual Expenditures

Actual spending is 19 percent lower than planned. The primary reason is less activity than anticipated in the C&I new construction market, which caused spending on participant incentives to be lower than planned.

(2) Planned and Preliminary Total Lifetime Savings

Preliminary total lifetime savings are 25 percent lower than planned. As described above, the primary reason for this variance is less C&I new construction activity than was planned for. While the Program Administrator made adjustments to incentive structures to try to drive

higher savings, an overall dip in C&I construction activity limited savings opportunities.

(3) Planned and Preliminary Total Benefits

Preliminary total benefits are 26 percent lower than planned. The variance between planned and preliminary total benefits is due to the deviations in lifetime savings, and thus is explained above.

The Program Administrator is projecting to achieve its savings and benefits goals by the end of the Three-Year Plan term for this core initiative.

b. Cost-Effectiveness

The actual 2019 benefit-cost ratio for the C&I New Buildings & Major Renovations core initiative is 5.58. The projected benefit-cost ratio for the 2019-2021 plan term is 5.79 after accounting for actual results from 2019.

B. C&I EXISTING BUILDINGS

The actual 2019 benefit-cost ratio for the C&I Existing Buildings program is 2.84. The projected benefit-cost ratio for the 2019-2021 plan term is 3.09 after accounting for actual results from 2019.

1. C&I Existing Building Retrofit

a. Significant Variances

Significant variances exist between: (1) planned and actual budget; (2) planned and preliminary total lifetime savings; (3) planned and preliminary total benefits; and (4) between preliminary and evaluated total resource benefits. The primary reason(s) for such variances are:

(1) Planned and Actual Expenditures

Actual spending is 42 percent lower than planned. This is due to under-spending in all cost categories but was driven primarily by spending in incentives. For this initiative, spending is directly correlated to achieved savings, as most incentives are paid on a per-therm basis. Since the initiative saw fewer savings than originally planned for, spending was lower. The overall volume of custom projects was in line with planning assumptions; however, the Program Administrator experienced a lower average savings per custom project. While the Program Administrator worked to keep savings high, each individual project is difficult to acquire, requiring dedicated staff and willing customers. The Program Administrator anticipates that maintaining high levels of savings in the face of reduced savings per project will continue to be a challenge going forward. In the face of declining gas savings per project, the Program Administrator will continue to promote gas savings opportunities with customers and to look for new areas of opportunity.

(2) Planned and Preliminary Total Lifetime Savings

Preliminary total lifetime savings are 40 percent lower than planned. The primary reason for this variance as explained above is due to fewer savings opportunities than was assumed during planning.

(3) Planned and Preliminary Total Benefits

Preliminary total benefits are 42 percent lower than planned. The variance between planned and preliminary total benefits is due to the deviations in lifetime savings, and thus is explained above.

(4) Preliminary and Evaluated Total Resource Benefits

Evaluated total resource benefits are 15 percent lower than preliminary. The variance between preliminary and evaluated total resource benefits is due to a lower custom gas realization rate than planned with as found in the *Impact Evaluation of PY2017 Custom Gas Installations* study (2019 Plan-Year Report, D.P.U. 20-50 Appendix 4D, Study 19-19). The evaluation study updated the Eversource gas custom realization rate from 92 percent, as planned, to 75 percent.

The Program Administrator is projecting to achieve its savings and benefits goals by the end of the Three-Year Plan term for this core initiative.

b. Cost-Effectiveness

The actual 2019 benefit-cost ratio for the C&I Existing Building Retrofit core initiative is 3.00. The projected benefit-cost ratio for the 2019-2021 plan term is 3.15 after accounting for actual results from 2019.

2. C&I New & Replacement Equipment

a. Significant Variances

Significant variances exist between: (1) planned and preliminary total lifetime savings; and (2) planned and preliminary total benefits. The primary reason(s) for such variances are:

(1) Planned and Preliminary Total Lifetime Savings

Preliminary total lifetime savings are 39 percent lower than planned. Similar to the C&I Existing Building Retrofit core initiative described above, the overall volume of custom projects was in line with planning assumptions; however, the Program Administrator saw a lower average savings per custom project. While the Program Administrator worked to keep savings high, each individual project is difficult to acquire, requiring dedicated staff and willing customers. The Program Administrator anticipates that maintaining high levels of savings in the face of reduced savings per project will continue to be a challenge going forward. The savings from the upstream gas water heater initiative were also 53 percent lower than planned due to substantially lower program volume than planned for. The Program Administrator is looking at program design changes to help increase volume in future years.

(2) Planned and Preliminary Total Benefits

Preliminary total benefits are 39 percent lower than planned. The variance between planned and preliminary total benefits is due to the deviations in lifetime savings, and thus is explained above.

The Program Administrator is projecting to achieve its savings and benefits goals by the end of the Three-Year Plan term for this core initiative.

b. Cost-Effectiveness

The actual 2019 benefit-cost ratio for the C&I New & Replacement Equipment core initiative is 2.55. The projected benefit-cost ratio for the 2019-2021 plan term is 2.95 after accounting for actual results from 2019.

APPENDIX 2

Benefit-Cost Ratio Screening Tool

Please see the Microsoft Excel file accompanying this report for the Benefit-Cost Ratio Screening Tool.

APPENDIX 3

Statewide Technical Reference Manual – 2019 Report Version

Please see Statewide Appendix 3: Technical Reference Manual – 2019 Report Version, filed under separate cover. The electronic version, the Technical Reference Library, is available at: http://www.masssavedata.com/Public/TechnicalReferenceLibrary.

APPENDIX 4

Statewide Evaluation Studies Summary

A. Table of Evaluation Studies

STUDY NAME	STUDY LOCATION AND NUMBER	FUEL	EM&V CONTRACTOR
Residential Studies			
Residential Lighting Turn-in/Exchange	Appendix 4D, Study 19-1	Electric	NMR Group, Inc.
Delta Watt Update	Appendix 4D, Study 19-2	Electric	NMR Group, Inc.
Lighting Sales Data Analysis	Appendix 4D, Study 19-3	Electric	NMR Group, Inc.
Lighting Hours of Use Update	Appendix 4D, Study 19-4	Electric	NMR Group, Inc.
Residential New Construction Passive House Assessment	Appendix 4D, Study 19-5	Electric and Gas	NMR Group, Inc.
Renovations and Additions Market Characterization and Potential Savings	Appendix 4D, Study 19-6	Electric and Gas	NMR Group, Inc.
Residential New Construction Incremental Cost Update	Appendix 4D, Study 19-7	Electric and Gas	NMR Group, Inc.
2018-2019 Winter Thermostat Optimization	Appendix 4D, Study 19-8	Electric and Gas	Navigant Consulting, Inc.
2019 Massachusetts Summer Thermostat Optimization	Appendix 4D, Study 19-9	Electric	Navigant Consulting, Inc.
HES Realization Rate Assessment	Appendix 4D, Study 19-10	Electric and Gas	Navigant Consulting, Inc.
RCD Logic Model Development	Appendix 4D, Study 19-11	Electric and Gas	Navigant Consulting, Inc
Residential Energy Optimization Model Update	Appendix 4D, Study 19-12	Electric and Gas	Navigant Consulting, Inc.
Residential Nonparticipant Market Characterization and Barriers	Appendix 4D, Study 19-13	Electric and Gas	Navigant Consulting, Inc.
Residential Baseline Phase 4 Comprehensive Report	Appendix 4D, Study 19-14	Electric and Gas	Navigant Consulting, Inc.
Commercial & Industrial Studies			
Gross Impact Framework - Decision Guide	Appendix 4D, Study 19-15	Electric and Gas	DNV GL
C&I Measure Life	Appendix 4D, Study 19-16	Electric	DNV GL
Impact Evaluation of PY 2017 Small Business Initiative Non-Lighting Measures	Appendix 4D, Study 19-17	Electric	DNV GL

STUDY NAME	STUDY LOCATION AND NUMBER	FUEL	EM&V CONTRACTOR
C&I Energy Optimization Study Task 3 Methodology Memo	Appendix 4D, Study 19-18	Electric	Navigant Consulting, Inc.
Impact Evaluation of PY2017 Custom Gas Installations	Appendix 4D, Study 19-19	Gas	DNV GL
Impact Evaluation of PY2017-2018 Custom Electric Installations	Appendix 4D, Study 19-20	Electric	DNV GL
C&I Early Replacement Study - Interview Findings Memo	Appendix 4D, Study 19-21	Gas	Cadeo
New Construction Energy Use Intensity Baseline	Appendix 4D, Study 19-22	Electric and Gas	DNV GL
Indoor Cannabis Lighting ISP Prior to 935 CMR 500	Appendix 4D, Study 19-23	Electric	DNV GL
2019 C&I Lighting Inventory & Market Model Update	Appendix 4D, Study 19-24	Electric	DNV GL
Special & Cross Sector Studies			
Analysis of Residential HVAC Sales Data from HARDI Distributors	Appendix 4D, Study 19-25	Electric and Gas	NMR Group, Inc.
Evidence for Market Effects from Support for Mini-split Heat Pump Integrated Controls	Appendix 4D, Study 19-26	Electric and Gas	NMR Group, Inc.
Residential New Construction Baseline/Compliance	Appendix 4D, Study 19-27	Electric and Gas	NMR Group, Inc.
C&I NEI Update Scoping Study	Appendix 4D, Study 19-28	Electric and Gas	NMR Group, Inc.
Immediate and Follow-up Surveys for the Cross-Cutting Code Compliance Support Initiative	Appendix 4D, Study 19-29	Electric and Gas	NMR Group, Inc.
C&I New Construction Market Effects/Spillover	Appendix 4D, Study 19-30	Electric and Gas	NMR Group, Inc.
Commercial and Industrial Small Business Nonparticipant Customer Profile Study	Appendix 4D, Study 19-31	Electric and Gas	NMR Group, Inc.
Massachusetts Statewide Residential and Commercial 2019 Awareness Survey	Appendix 4D, Study 19-32	Electric and Gas	NMR Group, Inc.
2019 Residential Wi-Fi Thermostat Direct Load Control Offering Evaluation	Appendix 4D, Study 19-33	Electric	Navigant Consulting, Inc.
Cross-State C&I Demand Response Program Summer 2019 Evaluation Report	Appendix 4D, Study 19-34	Electric	Energy & Resource Solutions
Daily Dispatch Battery Project Evaluation	Appendix 4D, Study 19-35	Electric	Energy & Resource Solutions
2019 Residential Energy Storage Demand Response Demonstration Evaluation - Summer Season	Appendix 4D, Study 19-36	Electric	Navigant Consulting, Inc.
2019 Small and Medium Business Wi-Fi Thermostat Direct Load Control Demonstration Evaluation	Appendix 4D, Study 19-37	Electric	Navigant Consulting, Inc.

STUDY NAME	STUDY LOCATION AND NUMBER	FUEL	EM&V CONTRACTOR
2019 Consolidated Demand Demonstration Project Evaluation Report	Appendix 4D, Study 19-38	Electric	Energy & Resource Solutions
Residential Nonparticipant Customer Profile Study	Appendix 4D, Study 19-39	Electric and Gas	DNV GL
C&I Customer Profile Study Dashboard User Guide	Appendix 4D, Study 19-40	Electric and Gas	DNV GL

APPENDIX 4

Statewide Evaluation Studies Summary

B. Summary of the Studies with the Most Significant Effects

The Massachusetts Program Administrators completed 40 evaluation studies for the 2019 Energy Efficiency Plan-Year Report. The studies that produced the most significant results in 2019 were the:

1. Residential Non-Participant Studies (Residential Nonparticipant Customer Profile Study and Residential Nonparticipant Market Characterization and Barriers Study)
2. 2019 C&I Lighting Inventory & Market Model Update
3. Impact Evaluations of C&I Custom Installations (Impact Evaluation of PY2017 Custom Gas Installations and Impact Evaluation of PY2017-2018 Custom Electric Installations)
4. Renovations and Additions Market Characterization and Potential Savings Study
5. Cross-State C&I Demand Response Program Summer 2019 Evaluation Report

1. Residential Non-Participant Studies

These studies were designed to characterize residential nonparticipants of Mass Save programs and investigate barriers to participation. As part of the 2019-2021 Energy Efficiency Plan, PAs agreed to conduct tailored evaluations in 2019 that address participation levels and potential unaddressed barriers for residential customers in certain groups of interest, including renters, moderate income customers, and customers with limited English proficiency. These studies fulfill that commitment and identify ways in which program designs may be refined to make efficiency programs more accessible to all customers.

Residential Nonparticipant Customer Profile Study

The purpose of this study was to assess the relationship between rates of customer participation in Mass Save residential programs between 2013-2017 and certain customer characteristics, including income levels, home ownership status, and English language. The study analysed existing data, including demographic data from the U.S. Census American Community Survey ("ACS"), program tracking data which identifies program participants between 2013 and 2017, and Tax Assessor data which identifies multifamily properties and year of home construction. The study also considered additional data on income and language from Experian (available only for Eversource). The study identified four different metrics of participation: Location participation, Consumption-weighted location participation, Account participation, and Savings/consumption.

The researchers conducted two levels of analysis, at the Census block-group level and at the individual customer level. The block-group analysis included correlations and ordinary least squares regression models. Dependent variables for these models were location participation rate

and the ratio of savings to consumption (savings/consumption); independent variables were proportions of households in block groups with certain characteristics such as moderate income. The independent variables were based on ACS data. The individual level analyses were parallel to the block group-level analyses but used individual-level data. The dependent variables for these models were account participation and savings/consumption. Independent variables were individual-level variables reflecting demographic characteristics drawn either from Tax Assessor data or Experian.

The study found that moderate-income households, renter households, and limited English-speaking households participated at a lower rate than other populations in 2013-2017. However, there is evidence that the PAs have had some success in getting low-income and multifamily locations to participate, based on an analysis of participation measured as the ratio of 2013-2017 savings to consumption (depth of savings). In particular, 2013-2017 savings/consumption metric is positively correlated with the concentration of low-income customers and customers living in multifamily buildings at the block group level. Additional analysis revealed that savings from the low-income multifamily programs account for these positive correlations.

The study also found that populations of interest tend to cluster together geographically. For example, populations of renters, moderate-income customers, and customers with limited English proficiency are geographically clustered in urban areas. In addition, the study found that analysis conducted at the level of individual customers is largely consistent with analysis conducted at the level of Census block groups. Therefore, it is valid to focus on Census tracts as the unit of analysis.

The study provides tools that may be helpful to target program offerings, such as maps that show concentrations of populations of interest and bivariate maps that show areas with low past participation overlaid with high concentrations of certain populations of interest. A copy of the complete study can be found in Appendix 4D, Study 19-40.

Residential Nonparticipant Market Characterization and Barriers Study

The purpose of this study was to collect primary data to characterize residential nonparticipants and provide insight into market barriers for renters, moderate income customers, and customers with limited English proficiency. The study relied on a combination of data collection activities with a focus on gathering data and perspectives from non-participants. These activities included over 1,600 surveys via multi-mode web, telephone, mail, and door-to-door approaches, as well as qualitative research including intercept, door-to-door, and in-depth telephone interviews. In addition to customers, the study also included perspectives from Massachusetts Program Administrators and community organizations that service the groups of interest. The research coordinated closely with the Residential Nonparticipant Customer Profile Study completed by DNV-GL.

The study found that non-participants tend to have different characteristics than participants. For example, non-participants are more likely than participants to live in rental units. Among those surveyed, 30% of renters participated compared to 40% of homeowners. Non-participants are also

more likely to have no more than a high school education and to have low-to-moderate incomes. Non-participants are generally harder to reach than participants for the purpose of survey research, even when efforts were made to make surveys available through multiple modes and in multiple languages, and even when incentives are offered for participation.

Researchers found that many barriers prevent customers from participating in Mass Save programs. Non-participants often expressed lack of trust in government and their landlords and have a fear of scams. These customers also prioritized their time and resources on needs that they considered more fundamental to living (e.g., food and shelter). Many non-participants needed more information on Mass Save offerings, participation processes, and a better understanding of how the program would benefit them. These customers perceived energy efficiency as irrelevant or not applicable to them. In addition, some customers believed Mass Save is government-funded, which deterred participation.

The evaluation study identified several program design and implementation opportunities, such as engaging trusted community organizations, reinforcing that denial in any assistance program does not mean lack of eligibility for Mass Save, and providing personal and step-by-step guidance through program process, particularly for those who speak a language other than English. A copy of the complete study can be found in Appendix 4D, Study 19-14.

2. 2019 C&I Lighting Inventory & Market Model Update

The primary goal of the 2019 Lighting Inventory and Market Model Update study was to produce adjusted measure lives ("AMLs") for major commercial and industrial ("C&I") lighting applications using lighting market data collected to improve the Lighting Market Model (the Model). As part of updating the Model, the study analyzed market trends in C&I lighting, including saturation (the percentage of fixtures of different types installed across the C&I sector) and market share (the percentage of sales of different lighting types in the C&I sector).

The research conducted during this study to support the Model and AML updates focused on three main C&I lighting applications: ambient linear, high & low bay, and building exterior & outdoor lighting. This study also presents AMLs for traditional screw-based lighting categories (a-line, downlight/track, and decorative lighting). This study did not research this equipment and instead presents AMLs based on market share forecasts from the April 2019 version of the Model.

The evaluation team used a variety of methods to research C&I lighting market indicators which were used to refine the Model's saturation and market share forecasts and the resulting AML calculations. Methods included onsite lighting inventories, distributor and manufacturer interviews, ER/ROF customer surveys, reviewing program tracking data, reviewing secondary data sources, and comparing model results to national and regional forecasts.

The study found that AMLs for ambient linear LED lighting ranged from 10.98 to 11.39 years for 2019. AMLs for high/low bay LED lighting ranged from 13.02 to 13.25 years for 2019. AMLs for exterior/outdoor LED lighting ranged from 10.10 to 10.45 years in 2019. AMLs for screw-

based LED lighting ranged from 4.07 to 4.99 years in 2019. AML values decreased for all lighting types between 2019-2021.

The study concluded that the LED C&I Market is continuing to advance, and it will become increasingly difficult to fund opportunities for program savings. With regard to ambient linear lighting, the study found that TLEDs and LED integrated fixtures continue to replace fluorescent technologies at a rapid pace, with LED integrated fixtures growing at a faster rate than TLEDs as a result of PA program support. It appears that many LEDs are replacing T8s. With regard to high/low bay lighting, the dominant technology type is linear, so the largest opportunity in this market is for TLEDs and LED integrated fixtures to continue to replace the T8s and the T12s that continue to persist in the market. With regard to building exterior/outdoor lighting, there is considerable diversity of products within this submarket, but opportunities to replace metal halide and high-pressure sodium lamps remain. A copy of the complete study can be found in Appendix 4D, Study 19-25.

3. Impact Evaluations of C&I Custom Installations

These studies were conducted to verify the savings generated through C&I custom electric and gas installations, which account for approximately 15% of planned lifetime electric savings and 7% of planned lifetime gas savings. Impact studies for C&I custom installations are conducted on a rolling basis, with updates to the sample of facilities evaluated each year. Impact evaluations produce realization rates, which are used to calibrate savings estimates. In addition, these evaluations produce recommendations for program improvements, including opportunities to bring estimated savings more in line with evaluated savings.

Impact Evaluation of 2017-2018 Custom Electric Installations

The objective of this impact evaluation is to provide verification or re-estimation of electric energy and demand savings estimates for a sample of custom lighting and non-lighting electric projects through site-specific inspection, monitoring, and analysis.

The study approach involved selecting a representative sample of large C&I custom electric projects from 2017 and 2018. Evaluators then conducted comprehensive data collection at each sample site to support an independent analysis of achieved gross electric savings realization rates. The site level evaluation results were aggregated using the final adjusted case weights. The sample for the 2017-18 impact evaluation was generated with the intention of pooling the annual evaluation results with the prior 2016 results to produce a rolling updated result.

The results of this study are realization rates for custom lighting and non-lighting electric energy efficiency measures. Realization rates were determined at the statewide level as well as separately for Cape Light Compact, Eversource, and National Grid. Statewide, two-year pooled realization rates for gross annual MWh savings were 100% ±7.2% for custom lighting, and 71% ±8.7% for custom non-lighting measures. Realization rates are reported at a 90% confidence level. Realization rates for both lighting and non-lighting measures improved from the prior year analysis. Statewide, the improvements in realization rates between the two-year pooled results

and 2016 for gross annual MWh are + 6.5% for custom lighting and + 6.0% for custom non-lighting. A copy of the complete study can be found in Appendix 4D, Study 19-21.

Impact Evaluation of 2017 Custom Gas Installations

The primary objective of this impact evaluation was to verify and re-estimate the energy savings for a sample of statistically selected 2017 custom gas projects through site-specific inspection, monitoring, and analysis.

The study approach was consisted of desk reviews, on-site visits, and metering of a randomly selected sample of projects at participating facilities. The sample for the 2017 impact evaluation was generated with the intention of pooling the annual evaluation results with the prior 2016 results to produce a rolling updated result.

The study produced statewide realization rates, as well as specific realization rates for Columbia Gas, Eversource, and National Grid. The statewide realization rate for the two -year pooled sample (2016 and 2017) was 85% ±6.5% at an 80% confidence level. This realization rate represented an improvement compared to the prior year analysis. The study results increase the 2017 reported gross savings for statewide by 3%, for Columbia Gas by 4%, for Eversource by 3%, and for National Grid by 3%. A copy of the complete study can be found in Appendix 4D, Study 19-20.

4. Renovations and Additions Market Characterization and Potential Savings Study

The purpose of this study was to understand the state and size of the market for single-family (one-unit attached and detached) renovations and additions in Massachusetts and to inform the design of the PAs' current additions and renovations offering that operates within the Residential New Homes and Renovations Initiative. In particular, the study sought to: (1) measure the market size by developing an estimate of the number projects occurring in a given year; (2) identify the typical scope associated with these renovations and addition projects; and (3) assess the gross technical potential savings associated with program-eligible projects.

To conduct the research, evaluators reviewed building department websites for the 351 municipalities in Massachusetts. The researchers also conducted a web survey of general contractors to estimate the number of projects completed without permit, in-depth interviews with HVAC contractors, in-person focus groups with contractors, and web surveys of homeowners.

The study found that there are approximately 130,000 single-family renovations and additions projects per year in Massachusetts. Of these projects, approximately 43% included at least 500 sq. ft. of floor area, which would make them eligible for program participation. Walls, lighting, and windows are the most commonly affected measures. Contractors indicated that when renovation projects are permitted (which is true for the vast majority of major projects), insulating exposed cavities is a typical practice. When heating systems are part of project scopes, they are often replaced, rather than repaired. Heat pumps commonly replace combustion heating systems. The technical potential savings with the single-family renovations and additions market are substantial. The potential savings for the renovations and additions program is more than four times the electric

savings and nearly three times the gas savings claimed by the 2018 Residential New Construction Initiative. The potential savings are equivalent to 64% and 63% of electric and gas savings, respectively, claimed by the Home Energy Services program.

The study recommended that the PAs adopt a baseline similar to the Industry Standard Practice ("ISP") baseline that was used in this study's potential modeling assessment starting in 2020.

The findings from this study provide insight into how residential renovations and additions projects affect energy usage and the potential energy savings that may be realized from these projects. This information may inform the design of the PAs' current additions and renovations offering that operates within the Residential New Homes and Renovations Initiative. A copy of the complete study can be found in Appendix 4D, Study 19-7.

5. Cross-State C&I Demand Response Program Summer 2019 Evaluation Report

The purpose of this study was to measure the average demand reduction achieved by two active demand reduction ("ADR") initiatives – C&I interruptible and C&I targeted storage – which were offered for the first time at full scale in 2019. In addition, the study assessed customer experience, barriers to implementation, and PA and vendor success in delivering these two initiatives. The evaluation also examined the overlap between the PA ADR initiatives and the ISO-NE Forward Capacity Market ("FCM") and provided input on other opportunities for peak demand management.

The evaluation approach varied depending on the ADR initiative. For C&I interruptible participants, the impact evaluation was based on account-level analysis of interval data of all available participants. First the reported results were validated. After validation, the counterfactual (i.e., baseline behavior, or the hypothetical behavior of customers absent the initiative) was characterized using five different approaches including the settlement approach used by the initiative, three alternative settlement-type methods, and a weather-based regression analysis. For C&I targeted storage participants, impact was measured based on battery system-level charge and discharge data. For both ADR initiatives, the process evaluation was based on review of initiative materials and in-depth phone interviews with PA program managers, ISO-NE Price Responsive Demand program managers, and curtailment service providers ("CSPs"). In addition, the evaluators conducted an online and phone survey of participating customers.

The study found that National Grid, Eversource, and Unitil collectively enrolled 206 Massachusetts customers in the C&I interruptible ADR initiative, and that together these customers reduced their load by an average of 75 MW during demand reduction events. The ratio between reported MW reduction and evaluated MW reduction was 81%; the difference between these two figures was largely due to differences in baseline adjustment approaches and calculation methodologies. The study also found that Eversource enrolled two targeted battery storage systems in the initiative, for an average of 0.3 MW reduction during demand reduction events. The realization rates for the targeted dispatch systems was 1.01, because the reported MW reduction was slightly lower than the evaluated MW reduction.

The study recommended a series of program adjustments based on the findings of this study. These include, for example, accelerating the incentive payment process with centralized program tracking and management systems, reminding and educating the CSPs of the shutdown allowance requirement and reporting rule, and formally standardizing all rules related to data quality, baseline calculation methods, and aggregation. A copy of the complete study can be found in Appendix 4D, Study 19-34.

APPENDIX 4

Statewide Evaluation Studies Summary

C. Evaluation Study Summaries

Table of Contents

Study 19-1: Residential Lighting Turn-in/Exchange Study 3
Study 19-2: Delta Watt Update 5
Study 19-3: Lighting Sales Data Analysis 8
Study 19-4: Residential Lighting Hours-of-Use 11
Study 19-5: Residential New Construction Passive House Assessment 15
Study 19-6: Renovations & Additions Market Characterization & Potential Savings 17
Study 19-7: Residential New Construction Incremental Cost Update 19
Study 19-8: 2018-2019 Winter Temperature Optimization Evaluation 21
Study 19-9: 2019 Summer Thermostat Optimization Evaluation 25
Study 19-10: Home Energy Services Realization Rate Assessment 30
Study 19-11: Residential Coordinated Delivery Logic Model Creation 34
Study 19-12: Energy Optimization Measures and Assumptions Update 36
Study 19-13: Residential Nonparticipant Market Characterization & Barriers Study 38
Study 19-14: Residential Baseline Phase 4 Comprehensive Report 41
Study 19-15: Gross Impact Framework – Decision Guide 44
Study 19-16: C&I Measure Life Study 47
Study 19-17: Impact Evaluation of PY2017 Small Business Initiative Non-Lighting Measures. 52
Study 19-18: C&I Energy Optimization Study Task 3 Methodology Memo 55
Study 19-19: Impact Evaluation of PY2017 Custom Gas Installations 58
Study 19-20: Impact Evaluation of PY2017-2018 Custom Electric Installations 63
Study 19-21: C&I Early Replacement Study – Interview Findings Memo 67
Study 19-22: New Construction Energy Use Intensity Baseline 69
Study 19-23: Indoor Cannabis Lighting ISP Prior to 935 CMR 500 71
Study 19-24: 2019 C&I Lighting Inventory & Market Model Update 74

Study 19-25: Analysis of Residential HVAC Sales Data from HARDI Distributors..... 77
Study 19-26: Market Effects from Ductless Mini-Split Heat Pump Integrated Controls..... 80
Study 19-27: Residential New Construction Baseline/Compliance Study..... 82
Study 19-28: C&I NEI Update Scoping Study..... 85
Study 19-29: Codes and Standards Compliance and Support Initiative Residential and Commercial Immediate and Follow-up Surveys..... 88
Study 19-30: C&I New Construction Program Planning & Market Effects/Spillover..... 90
Study 19-31: C&I Small Business Non-Participant Customer Profile Study..... 92
Study 19-32: Statewide Residential and Commercial 2019 Awareness Survey..... 95
Study 19-33: 2019 Residential Wi-Fi Thermostat Direct Load Control Offering Evaluation 97
Study 19-34: Cross-State C&I Active Demand Reduction Initiative Summer 2019..... 103
Study 19-35: Eversource Daily Dispatch Battery Project Evaluation Report..... 109
Study 19-36: 2019 Residential Energy Storage Demand Response Demonstration Evaluation – Summer Season..... 112
Study 19-37: 2019 Small and Medium Business Wi-Fi Thermostat Direct Load Control Demonstration Evaluation..... 116
Study 19-38: Eversource Consolidated Year 2 Demand Demonstration Project Evaluation Report..... 120
Study 19-39: Residential Nonparticipant Customer Profile Study..... 124
Study 19-40: C&I Customer Profile Study Dashboard Project..... 128

Study 19-1: Residential Lighting Turn-in/Exchange Study

Type of Study: Impact Evaluation

Net-to-Gross Evaluation

Evaluation Conducted by: NMR Group

Date Evaluation Completed: 3/22/2020

Study Objective and Summary of Results:

The Program Administrators ("Pas") introduced a Residential Lighting Turn-In/Exchange Program (the program) in April 2019. This program is designed to facilitate customer exchange of inefficient bulbs or fixtures for new light emitting diode ("LEDs") bulbs. Recent studies have found that, while customers are inclined to replace inefficient bulbs with LEDs, most of those bulbs are still replaced upon failure rather than replaced early. Incandescent bulbs made up the plurality (45%) of stored bulbs in Massachusetts homes in 2019 and some of these inefficient bulbs do get installed. The program objective would be to accelerate adoption of LEDs by reducing the large stockpiles of stored inefficient bulbs or to encourage customers to change out inefficient bulbs before failure.

To support the development of this new program, the PAs and the Energy Efficiency Advisory Council ("EEAC") consultants requested that NMR Group, Inc. ("NMR"), facilitate a process to (1) come to a consensus agreement on considerations for impact factors related to the program including Net-to-Gross Ratios ("NTGR), Delta Watt, Adjusted Measure Life ("AML"), Lifetime In-Service Rate ("ISR"), and Hours of Use ("HOU"), and (2) establish deemed savings values for the program.

A consensus process yielded the following impact factors:

Program Year	**2019**	**2020**	**2021**
Net-to-Gross Ratio[1] (NTGR)	62%	55%	46%
Delta Watt[2]	46.4	46.4	46.4
Adjusted Measure Life (AML)	3	2	2
Lifetime In-Service Rate (ISR)	91%	89%	88%
Hours-of-Use per Day[3] (HOU)	2.7	2.7	2.7

[1] Assumes upstream program continues through 2021

[2] Based on combined incandescent and halogen – excluding CFLs.

[3] Value may change due to results of a pending study.

Core Initiatives or End Uses to which the Results of the Study Apply:

- Residential
- Residential Retail
- Lighting
- Electric Only

Evaluation Recommendations:

No formal recommendations were made in this evaluation.

Explain Whether or Not the PAs Decided to Adopt the Recommendations from the Study:

N/A (no formal recommendations were made in this evaluation)

How the Study Affects Program Results and Its Significance:

The PAs will use the consensus-derived impact factors to guide program planning and filings, unless/until other studies are completed to update the impact factors.

Overview of Study Method:

NMR reviewed existing data sources, developed draft impact factors, and updated deemed savings values. For this study, NMR was interested in providing data to help inform the establishment of prospective impact factor values for LEDs that will be distributed as part of the program (Net-to-Gross Ratios ("NTGRs"), Delta Watts, Lifetime In-Service Rate ("ISR"), and Adjusted Measure Life ("AML")). Given the consensus basis for the project, NMR sought to develop a method that allowed both the PAs and EEAC consultants to provide input into developing these estimates. To this end, NMR prepared a memo outlining the proposed impact factors and then held a call with the PAs and EEAC consultants to discuss the proposed values and build consensus around which values to use in the program. The group was able to come to consensus during this call. After the call, NMR revised the final impact factor values based on the feedback from the PAs and EEAC consultants.

Application of Results: Retrospectively and Prospectively

A copy of the complete study can be found in Appendix 4D, Study 19-1.

Study 19-2: Delta Watt Update

Type of Study: Impact Evaluation

Evaluation Conducted by: NMR Group

Date Evaluation Completed: 3/26/2020

Study Objective and Summary of Results:

This evaluation was developed for the Program Administrators to update some of the inputs used to calculate LED delta watts in the Lighting Market Adoption Models ("MAMs"). Replicating an approach first applied in E-Delta Watt Update, for this current study, the PAs and EEAC consultants agreed to update equivalent wattage and sales weights based on 2019 program tracking data, which ties the delta watts directly to program sales. However, they also agreed to retain the estimated future market share values from the 2017 MAMs. The decision to keep the same future market share estimates reflected the continued market uncertainty related to federal standards, which existed when the estimates were developed in 2017 and remains in place now. The study also updated delta watts for linear fixtures sold through the program in 2019, based on planning assumptions reported in TED Product Impact Factor Estimation.

The study objectives included the following:

- Update the sales weights and wattage bins
- Update the following 2017 Annual Report MAMs:
    - Standard (GSL) model – update
    - Reflector model – update
    - Other Specialty model – update
- Update the delta watts for linear fixtures

Key findings in this study include:

Updating the wattage by bulb type and sales share based on actual 2019 screw-based LED sales, resulted in decreased delta watts for Reflector and Specialty and increased delta watts for GSLs. The changes in first-year delta watts are summarized in the table below, with the number representing the years between 2019 and 2025 in which delta watts changed in the direction shown:

	GSL	**Reflector**	**Specialty**
Gross delta watts	Increased	Decreased	Decreased
Net delta watts	Increased	Decreased	Decreased

The delta watts for linear fixtures increased from 17.9 to 19.2 based on the mix of products sold through the program in 2019.

Core Initiatives or End Uses to which the Results of the Study Apply:

- Residential
- Residential Retail
- Existing Building Retrofit
- Lighting
- Electric Only

Evaluation Recommendations:

No formal recommendations were made in this evaluation.

Explain Whether or Not the PAs Decided to Adopt the Recommendations from the Study:

N/A (no formal recommendations were made in this evaluation)

How the Study Affects Program Results and Its Significance:

The increase in delta watts for GSLs increases first-year program savings. The decrease in delta watts for Reflectors and Specialties reduces first-year program savings.

Overview of Study Method:

NMR reviewed and cleaned the January through October 2019 sales data obtained from EFI via TRC. In total, the data contained sales records for 10,811,487 LEDs. After cleaning, NMR grouped LEDs into three types: General Service (GSL) (63%), reflector (23%), and specialty (14%). As the EFI data do not include equivalent incandescent wattage, after categorizing LEDs by type, NMR leveraged web scraping and shelf stocking data from Massachusetts and Rhode Island to look up manufacturer-specified equivalent incandescent wattage. A statistical model provided predictions of halogen reflector and specialty equivalents, as the variety of bulbs among these shapes do not lend themselves to simple rules of thumb about wattage equivalence. The resulting equivalent incandescent wattages across all bulb shapes and technologies were used to assign LEDs to the appropriate 2017 MAM equivalent wattage bins. After binning LEDs, we updated sales weights, which are equivalent to the proportions of 2019 program-supported bulbs in each wattage bin.

NMR also estimated delta watts for tubular (linear) LEDs. The tracking data indicated that the program only sold linear fixtures between January through October of 2019. During this time period the 350,925 fixtures collectively contained 536,086 lamps, which NMR binned by length (24”, 36”, 48” 96”). Using the planning assumptions reported in RLPNC 18-7 for binned delta watts for T8 linear lamps with a ballast bypass (the most comparable to the linear fixtures sold through the program), NMR produced sales weighted estimates of delta watts for 2019.

Application of Results: Retrospectively

A copy of the complete study can be found in Appendix 4D, Study 19-2.

Study 19-3: Lighting Sales Data Analysis

Type of Study: Market Characterization or Assessment Evaluation

Evaluation Conducted by: NMR Group

Date Evaluation Completed: 10/24/2019

Study Objective and Summary of Results:

For this study, NMR analyzed third-party light bulb sales data (LightTracker) obtained on behalf of the Program Administrators ("PAs") from the Consortium for Retail Energy Efficiency Data ("CREED"). It compares market conditions in Massachusetts to the nation, other states with upstream lighting programs, and states without upstream lighting programs. The objectives of this study were:

- Examine current market share, bulb sales, and bulb shipments in Massachusetts, states with upstream programs, states without upstream lighting programs, and the entire nation.
- Provide breakdowns of market share by bulb type (i.e., light emitting diodes ("LEDs"), compact fluorescent lamps ("CFLs"), halogens, and incandescents), shape (A-line, reflector, globe, and candelabra), and ENERGY STAR® status, when data quality allow.
- Explore trends in bulb market share from 2009 to 2018 and NEMA reported quarterly bulb shipment share from 2011 to the most recent quarter available, including a comparison and assessment of NEMA's revised methodology.
- Compare average prices of LEDs to halogens in the bulb price analysis.
- Assess market share in very low (<310) and very high lumen bins (>3,300), which roughly coincide with ranges that will remain exempt if Phase II of the EISA goes into effect.

Key findings in this study include:

- The sales data analysis suggests that the Massachusetts Residential Lighting Core Initiative still matters and has positive impacts on the residential lighting market, but market transformation is progressing in Massachusetts and across the nation. The sales data analysis suggests that the Program continued to increase the adoption of energy-efficient bulbs in 2018. However, non-program areas experienced a more rapid increase in LED sales market share compared to Massachusetts and states with upstream lighting programs more generally.
- Efficient lamp (LEDs and CFLs) market share in Massachusetts was slightly higher (57%) compared to the nation, but the same as in 2017. LED market share broke 50% in Massachusetts, the United States, and all program states. Massachusetts saw its LED market share increase from 49% in 2017 to 53% in 2018, while the national LED market share increased from 35% to 51% across the same period.

- Massachusetts customers purchased a higher proportion of LEDs within each bulb shape compared to the nation and non-program areas, but reflector and A-line market shares across all areas considered showed strong progress towards transformation. The LightTracker data suggest that LEDs made up 78% of reflector, 54% of A-line, 51% of globe, and 34% of candelabra bulbs in Massachusetts. However, reflector LED market share was at 73% and A-line 48% in non-program areas, which are not much lower than those of Massachusetts.
- A greater portion of LED bulbs sold in Massachusetts in 2018 were ENERGY STAR qualified compared to the non-program comparison areas. Nearly four out of five LEDs (77%) sold in Massachusetts in discount, dollar, drug, grocery, mass merchandise, and some membership stores qualified for the ENERGY STAR label. Non-program states had only a 60% ENERGY STAR market share.
- Residential lighting program spending is associated with higher LED market share, but natural market adoption of LEDs progressed the most in non-program areas between 2017 and 2018. The rate of increase in market share between 2017 and 2018 was higher in non-program states than in all states with moderate or aggressive program activity.
- In Massachusetts, LEDs garnered the majority of the A-line bulbs market in the 60-watt equivalent range (750 to 1,049 lumens), while incandescents dominated lumen bins that were exempted from EISA per the original legislation. While they were a majority (64%) in the 750 to 1,049 lumen bin in Massachusetts (this bin accounts for nearly one-half of all A-line bulb sales), LEDs still had significant growth potential in all other lumen bins. Halogens had the largest market share in four of the five lumen bins currently subject to EISA.
- LED prices were higher than halogens in all regions examined – but prices for efficient bulbs were lowest in Massachusetts. Massachusetts had the lowest average LED prices ($2.56 compared to $2.59 or higher in other areas) despite having a higher proportion of ENERGY STAR LEDs than the comparison areas. The substantial program incentives in Massachusetts certainly help explain the lower average.

Core Initiatives or End Uses to which the Results of the Study Apply:

- Residential
- Residential Retail
- Lighting
- Electric Only

Evaluation Recommendations:

No formal recommendations were made in this evaluation.

Explain Whether or Not the PAs Decided to Adopt the Recommendations from the Study:

N/A (no formal recommendations were made in this evaluation)

How the Study Affects Program Results and Its Significance:

The Study provided valuable context as the PAs continue to monitor the residential lighting market and the impact of the Residential Lighting Initiative. The results suggest that, in 2018, the Residential Lighting Initiative contributed to increased market share and lower shelf prices of ENERGY STAR LEDs, but the impact of the program on the market as a whole appears to be dwindling as the market naturally progresses towards LEDs.

Overview of Study Method:

Using lighting bulb sales data compiled by CREED as part of the LightTracker Initiative (2009 to 2018), shipment data (2011-2018) from NEMA, and program activity data, NMR employed a series of descriptive analysis tasks. The CREED data were generated from point-of-sale (POS) sales data (from grocery, drug, dollar, discount, mass merchandiser, and selected club stores), and National Consumer Panel state sales data (from home improvement, hardware, online, and selected club stores).

Application of Results: Retrospectively and Prospectively

A copy of the complete study can be found in Appendix 4D, Study 19-3.

Study 19-4: Residential Lighting Hours-of-Use

Type of Study: Impact Evaluation

Evaluation Conducted by: NMR Group

DNV GL

Date Evaluation Completed: 3/31/2020

Study Objective and Summary of Results:

The purpose of this study was to explore the relationship between saturation and HOU and, based on that, help the PAs and EEAC Consultants agree on updated HOU estimates for program supported LEDs for the 2019, 2020, and 2021 program periods.

The study provides the following key findings:

- HOU distribution was right skewed and bounded between zero and 24 hours of use per day. While the validity of ordinary least squares (OLS) regression does not hinge on the normality of the underlying distribution, significant departures from a normal distribution can yield estimates and inferences that lack the typically assumed characteristics of OLS regression. Therefore, a transformation was performed on the 2014 HOU data to find a transformation which would allow the HOU distribution to more closely approximate normality.
- Updated model found smaller difference between efficient and inefficient HOU. The 2014 Northeast HOU study provided a point estimate for inefficient lamps (2.3) that was 23% lower than efficient lamps (3.0). Using the model created as part of this study and the 2018 saturation values, the difference was smaller with a 10% difference in HOU between inefficient (2.58) and efficient (2.86).
- Saturation and demographic factors significant in model. Room type, education, tenure, the total number of sockets, and efficient lamp saturation variables for each room type were all found to be significant in the model and were used in the final model.
- Changes in saturation by room type decreased HOU. When the revised model was applied to the most recent lighting inventory data, estimated efficient HOU decreased relative to original lighting data included in the 2014 study. This was driven by relative changes in and the inventory of efficient lamps across room types. The number of efficient lamps in rooms with lower HOU is higher in the 2018 saturation data compared to the data used for the 2014 study.
- HOU appears to increase as energy efficient saturation by room type increases. Models prepared as part of this study to explore the relationship between HOU and saturation revealed a positive and significant relationship between saturation and HOU. This relationship persisted across a variety of models and variable combinations. This finding

is counterintuitive and runs counter to a previous study conducted in California, and it highlights the complexity of the relationship between HOU and individual behavior. Possible explanations include customers with higher overall HOU tending to purchase more energy efficient lamps, and snapback behavior with customers increasing the use of lamps as saturation increases and the cost to operate lamps decreases. With no strong or compelling reasoning behind this phenomenon, care must be taken when drawing any conclusions. Additional work needs to be performed to develop a more complete understanding of the relationship.

- Inefficient lamps comprised a greater proportion of rarely used lamps (less than 0.5 daily HOU). Overall, 20% of lamps were used for less than 30 minutes a day, based on weighted metering data (pre-modeled). Efficient lamps accounted for 45% of the low-use lamps, which was lower than their portion of the entire sample of metered lamp (52%). Not surprisingly, closets had the highest proportion of low-use lamps (66%), and kitchens and the home's exterior tied for the lowest proportion of low-use lamps (10%). Inefficient lamps accounted for the majority of low-use lamps in all room types except kitchens and basements.
- Efficient lamps account for a sizeable portion of replaced lamps. Based on lamp replacement behavior observed as part of the 2018-19 Market Assessment Study, 43% of replaced medium screw-base lamps were efficient (33% CFLs and 10% LEDs) and 57% were inefficient (46% incandescent and 11%).[1]
- Consensus process considered both inefficient and efficient HOU, adjusted for saturation rates in the 2018 to 2019 Lighting Market Assessment. At a meeting led by the DNV GL team, the PAs and EEAC Consultants agreed to the use of the rounded inefficient HOU (2.6) for direct install and turn-in programs and combined efficient and inefficient HOU (2.7 – unadjusted for cross-sector sales and 3.0 after adjusting for cross-sector sales) for upstream programs for the full 2019 to 2021 program cycle.

Core Initiatives or End Uses to which the Results of the Study Apply:

- Residential
- Residenital Coordinated Delivery & Residential Retail
- Lighting
- Electric Only

Evaluation Recommendations:

The following recommendations were made by the evaluators conducting this study.

[1] Excludes empty sockets, linear fluorescents, and pin-based lamps.

Recommendation 1: The PAs and EEAC Consultants should apply the consensus-derived HOU for the 2019 to 2021 program cycle.

Rationale: The re-analysis of the original 2014 metering data considered additional factors and relied on modeling approach more appropriate to the distribution of HOU. The PAs and EEAC Consultants carefully considered the results and reached consensus on recommended values.

The table below provides the recommended HOU impact factor updates by measure and initiative. For context, the table also includes the assumed values from the 2019-2021 plan and the percentage change in HOU.

Hours-of-use impact factors (planned and updated)

Measure	Delivery Method	Initiatives	Year	Residential Daily HOU****		
				2019 -21 TRM	Updated Value	% Change (decrease)
LED Lamp – General Service Lamp	Direct Install	RES_NH, RCD, & IECD**	2019 2020 2021	2.7	**2.6**	(3.7%)
LED Lamp – Reflector	Direct Install	RES_NH, RCD, & IECD**	2019 2020 2021	2.7	**2.6**	(3.7%)
LED Lamp – Specialty	Direct Install	RES_NH, RCD, & IECD**	2019 2020 2021	2.7	**2.6**	(3.7%)
LED Lamp – General Service Lamp	Upstream	RES_RETAIL	2019 2020 2021	3.2 3.1 3.0	**3.0**	(6.3%) (3.2%) 0
LED Lamp - Reflector	Upstream	RES_RETAIL	2019 2020 2021	3.2 3.1 3.0	**3.0**	(6.3%) (3.2%) 0
LED Lamp - Specialty	Upstream	RES_RETAIL	2019 2020 2021	3.2 3.1 3.0	**3.0**	(6.3%) (3.2%) 0
LED Lamp – General Service Lamp	Turn in	RES_RETAIL***	2019 2020 2021	2.7	**2.6**	(3.7%)
LED Lamp - Reflector	Turn in	RES_ RETAIL	2019 2020 2021	2.7	**2.6**	(3.7%)
LED Lamp - Specialty	Turn in	RES_ RETAIL	2019 2020 2021	2.7	**2.6**	(3.7%)

*Source: https://www.masssavedata.com/Public/TechnicalReferenceLibrary.

**Single-family only for RES NH&R = Residential New Homes & Renovations; RCD = Residential Coordinated Delivery (excluding High Rise measures), IECD = Income Eligible Coordinated Delivery, RES_RETAIL = Residential Retail

***The turn-in program was not included in the three-year plan and was new to the portfolio for 2019. The turn-in program was using the HOU for direct install as a placeholder awaiting results from this study.

****Residential Retail hours have been adjusted for assumed cross-sector sales of 7% with 7 HOU per bulb. Without this adjustment planned values were 2.9, 2.8, and 2.7 for 2019, 2020, and 2021, respectively. The revised value was 2.7 for all three years.

Explain Whether or Not the PAs Decided to Adopt the Recommendations from the Study:

The PAs are considering all recommendations for adoption at this time. The PAs have not formally adopted or rejected any recommendations that require changes to program design and operations.

How the Study Affects Program Results and Its Significance:

The findings from the study decrease the hours of use that are used to derive claimable savings for the 2019-2021 term for LED lighting measures supported as part of the Residential Retail, Residential Coordinated Delivery (RCD), Income Eligible Coordinated Delivery (IECD), and Residential New Homes and Renovations (NH&R) programs. For RCD, IECD, and NH&R, HOU decreased by 3.7% in all 3 years. For Residential Retail, HOU decreased by 6.3% for 2019, by 3.2% for 2020, and are unaffected for 2021.

Overview of Study Method:

Evaluators identified and assembled existing data sources, transformed data to provide approximately normal data, fit a regression model to the transformed data, and applied the new model to recent inventory data. Evaluators then facilitated a consensus process during which the PAs and EEAC Consultants arrived at agreement on what HOU to use moving forward.

The study relied on data from the 2014 Northeast HOU Study and more recent lighting saturation data collected as part of the 2018-19 Residential Lighting Market Assessment. The 2014 HOU study estimated HOU as a function of lamp, application, and household characteristics. The model constructed for this study has been applied in the original study and subsequent analysis to estimate program lamp average HOU using onsite inventory data from the 2014 HOU study and the 2018-19 Market Assessment.

Application of Results: Retrospectively and Prospectively

A copy of the complete study can be found in Appendix 4D, Study 19-4.

Study 19-5: Residential New Construction Passive House Assessment

Type of Study: Market Characterization or Assessment Evaluation

Evaluation Conducted by: NMR Group

Date Evaluation Completed: 1/6/2020

Study Objective and Summary of Results:

The purpose of this study was to assist in the design of a new Passive House offering within the Residential New Construction Program by understanding the extent to which various energy modeling tools can handle the inputs and detail associated with Passive House, as well as the opportunities, barriers, incremental costs, and incentive issues associated with a new Passive House offering. The study provided preliminary energy savings from Passive House models for three types of buildings:

- Multifamily high-rise—multifamily buildings four stories or greater in size, or any multifamily buildings with a central HVAC system
- Multifamily low-rise
- Single family

The study provides the following key findings:

- Passive House provides substantial savings over the current Residential New Construction Program for all housing types.
- Incremental cost estimates, covering both construction costs and certification costs, ranged from 2% to 15% over homes built to code for single family and multifamily low-rise buildings.
- Most market actors interviewed for the study suggested an incentive amount between $4,000 and $5,000 per unit. Most respondents recommended this level for high-rise multifamily buildings; they also believe that single-family buildings may require additional incentives to overcome perceived increases in incremental costs.

Core Initiatives or End Uses to which the Results of the Study Apply:

- Residential
- New Homes & Renovations
- Envelope & All End Uses
- Electric & Gas

Evaluation Recommendations:

The following recommendations were made by the evaluators conducting this study.

Recommendation 1: The Passive House offering should use one modeling tool per project to assess savings; projects pursuing PHIUS certification should use WUFI Passive models, while projects pursuing PHI certification should use PHPP models.

Recommendation 2: Monitor the energy performance of early program participants as this proof of performance may help recruit additional builders and developers into the programs.

Explain Whether or Not the PAs Decided to Adopt the Recommendations from the Study:

The PAs are considering all recommendations for adoption at this time. The PAs have not formally adopted or rejected any recommendations that require changes to program design and operations.

How the Study Affects Program Results and Its Significance:

The findings from this study provide insight into probable energy savings, modeling, incremental costs, and incentive issues associated with a new Passive House offering within the Residential New Construction Program. This information may inform the design, marketing, and administration of such an offering.

Overview of Study Method:

NMR modeled five high-rise multifamily Passive House projects that had met pre-certification or final certification requirements using three tools: WUFI Passive, PHPP, and the ICF multifamily modeling tool. Two low-rise multifamily and five single family projects were modeled using REM/Rate and Ekotrope. NMR also reviewed 62 high-rise multifamily participant projects from 2018 to understand the energy consumption of the proposed and baseline conditions from recent high-rise multifamily participant projects. The study included 25 in-depth interviews of architects, builders, industry experts, owners or occupants, and developers.

Application of Results: Prospectively

A copy of the complete study can be found in Appendix 4D, Study 19-5.

Study 19-6: Renovations & Additions Market Characterization & Potential Savings

Type of Study: Market Characterization or Assessment Evaluation

Evaluation Conducted by: NMR Group

Date Evaluation Completed: 3/27/2020

Study Objective and Summary of Results:

The purpose of this study was to understand the state and size of the market for single-family (one-unit attached and detached) renovations and additions in Massachusetts and to inform the design of the Program Administrators' current additions and renovations offering that operates within the Residential New Homes and Renovations Initiative. The study had three goals:

- Measure market size by developing an estimate of the number projects occurring in a given year.
- Identify the typical scope associated with these projects.
- Assess the gross technical potential savings associated with program-eligible projects.

The study provides the following key findings:

- There are approximately 130,000 single-family renovations and additions projects per year. The study estimated approximately 55,500 projects affect at least 500 sq. ft. of floor area, which would make them eligible for program participation.
- Walls, lighting, and windows are the most commonly affected measures. Contractors indicated that when renovation projects are permitted (97% of major projects), insulating exposed cavities is a typical practice.
- When heating systems are part of project scopes, they are often replaced, rather than repaired. Heat pumps commonly replace combustion heating systems.
- The technical potential savings with the single-family renovations and additions market are substantial, representing 445% of the electric savings and 270% of the gas evaluated net savings claimed by the 2018 RNC initiative, and 64% and 63% of electric and gas savings, respectively, claimed by the HES program.

Core Initiatives or End Uses to which the Results of the Study Apply:

- Residential
- New Homes & Renovations
- Envelope & All End Uses
- Electric & Gas

Evaluation Recommendations:

The following recommendations were made by the evaluators conducting this study.

> **Recommendation 1:** The PAs should adopt a baseline similar to the Industry Standard Practice ("ISP") baseline that was used in this study's potential modeling assessment starting in 2020.

Explain Whether or Not the PAs Decided to Adopt the Recommendations from the Study:

The PAs plan to adopt the recommendations.

How the Study Affects Program Results and Its Significance:

The findings from this study provide insight into how residential renovations and additions projects affect energy usage and the potential energy savings that may be realized from these projects. This information may inform the design of the PAs' current additions and renovations offering that operates within the Residential New Homes and Renovations Initiative. Further, this study identifies areas for further evaluation research and should help PAs and the EEAC determine if such work is justified.

Overview of Study Method:

NMR reviewed building department websites for the 351 municipalities in Massachusetts. Fifty-six had online databases that included permit records with project descriptions; permit counts for the municipalities without online databases were estimated using regression models. NMR conducted a web survey of 77 general contractors to estimate the number of projects completed without permits. The study also included in-depth interviews with ten HVAC contractors, five in-person contractor focus groups, and 207 homeowner web surveys.

Application of Results: Prospectively

A copy of the complete study can be found in Appendix 4D, Study 19-6.

Study 19-7: Residential New Construction Incremental Cost Update

Type of Study: Market Characterization or Assessment Evaluation

Evaluation Conducted by: NMR Group

Date Evaluation Completed: 3/27/2020

Study Objective and Summary of Results:

The purpose of this study was to provide an updated estimate of the incremental costs associated with participating in the Massachusetts low-rise Residential New Construction ("RNC") program. The original study was finalized in July of 2018. This study applies to single-family homes and low-rise (three stories or less) multifamily housing units. Incremental costs were calculated on a per square foot of conditioned floor area ("CFA") basis to move from baseline construction practices to construction practices commonly found in recent RNC program projects.

The study provides the following key findings:

- Incremental costs range from $0.83 to $1.23 per square foot of CFA across all housing types, depending on the methodology used. The average is an incremental cost of $1.03 per square foot of CFA.
- The incremental costs for all home types have decreased from the original incremental cost study. Non-program home performance has increased for nearly all measures since the original study at a faster rate than program homes. This yields lower incremental costs to participate, given that it takes limited labor and materials to achieve program performance relative to a rising baseline.

Core Initiatives or End Uses to which the Results of the Study Apply:

- Residential
- New Homes & Renovations
- Envelope & All End Uses
- Electric & Gas

Evaluation Recommendations:

The following recommendations were made by the evaluators conducting this study.

Recommendation 1: The PAs should apply the overall average incremental cost of $1.03 per CFA for the low-rise RNC program. If the PAs' cost-effectiveness testing requires the incremental costs to be broken out by home type, the average incremental cost per CFA by home type should be applied.

Explain Whether or Not the PAs Decided to Adopt the Recommendations from the Study:

The PAs plan to adopt the recommendations.

How the Study Affects Program Results and Its Significance:

The findings from this study provide insight into the incremental costs currently faced by builders or owners who decide to participate in the RNC Program. This information may inform the incentives offered to participants.

Overview of Study Method:

NMR had used estimated measure-level incremental costs associated with participating in the RNC program based on pricing quotes provided by Massachusetts contractors in the original study. In this study, NMR developed new incremental cost estimates that assessed costs for recently-built program homes against the most recent non-program baseline, to provide a more up-to-date estimate of the incremental costs associated with program participation using two approaches.

The first approach relied on the contractor estimates of incremental costs that were provided as a part of the original study and adjusted them to reflect the improvements to various measures found in the most recent non-program baseline. The second approach relied on cost data from the National Renewable Energy Laboratory's ("NREL") National Residential Efficiency Measures Database ("NREMD"), which were, again, applied to the most recent non-program baseline.

Application of Results: Retrospectively and Prospectively

A copy of the complete study can be found in Appendix 4D, Study 19-7.

Study 19-8: 2018-2019 Winter Temperature Optimization Evaluation

Type of Study: Impact Evaluation

Evaluation Conducted by: Guidehouse

Date Evaluation Completed: 2/28/2020

Study Objective and Summary of Results:

The purpose of this study was to assess the technical feasibility of the winter thermostat optimization program (called Seasonal Savings, hereafter SS) deployed in Cape Light Compact ("CLC"), Eversource ("ES"), and National Grid ("NGrid") service territories in winter 2018-2019, and to estimate associated energy and demand savings and calculate realization rates.

The study provides the following key findings:

- Over half of thermostats in the ITT group opted into the program — 53%.
- The heating setpoint schedules for the treated thermostats were adjusted downward during the program period — 0.73°F.
- The largest setpoint adjustments took place during the middle of the night, when customers were likely to asleep — 1.50°F. This is different than the 2018 summer SS program which saw the largest adjustments during the middle of the weekdays.
- The average energy savings per treated thermostat between January 14, 2019 and April 30, 2019 were 13.6 therms and 10.7 kWh.
- The program yielded average energy savings of 4.1% of fuel heating load and 5.1% of electric heating load between January 14, 2019 and April 30, 2019.
- The program yielded no statistically significant peak demand savings between January 14, 2019 and January 31, 2019
- The program achieved energy savings between January 14, 2019 and April 30, 2019 of 68,684 MMBtu and 559 MWh.
- Compared to vendor reported savings, the program achieved 98% of Natural Gas heating fuel savings, 98% of Natural Gas heating electric savings, 99% for Non-Natural Gas heating fuel savings, and 104% for Non-Natural Gas heating electric savings

Core Initiatives or End Uses to which the Results of the Study Apply:

- Residential
- New Buildings & Major Renovations
- Behavior & HVAC
- Electric & Gas

Evaluation Recommendations:

The following recommendations were made by the evaluators conducting this study.

Recommendation 1: For the current 2018-2019 winter season, the Massachusetts PA should use a realization rate of:

- 97% for Natural Gas heating fuel savings
- 98% for Natural Gas heating electric savings
- 98% for Non-Natural Gas (Oil and Propane) heating fuel savings
- 100% for Non-Natural Gas (Electric, Oil, and Propane) heating electric savings

These realization rates can be applied to the vendor reported estimates of total savings or per thermostat savings.

Explain Whether or Not the PAs Decided to Adopt the Recommendations from the Study:

The PAs have adopted the recommendation as part of the 2019 annual report.

How the Study Affects Program Results and Its Significance:

The study found average energy savings of approximately 13.6 therms and 10.7 kWh per treated thermostat in winter 2018-2019 validating the technical feasibility of the thermostat optimization program.

All Massachusetts PAs will deploy the SS program during winter 2019-2020 to better inform a PA-specific savings value or realization rate for inclusion in the Technical Reference Manual.

Overview of Study Method:

The study relied on thermostat telemetry data and thermostat-level participation data. A total of 139,626 thermostats (22,343 in National Grid's electric service territory, 61,691 in National Grid's electric service territory, 21,476 in ES's electric service territory, 29,571 in ES's gas service territory, and 4,545 in CLC's service territory) were included in the study (4% of the 139,626 thermostats in the PAs combined service territories were excluded from the analysis due to data quality).

1. An exploratory analysis of the data was performed to:
    - Analyse setpoint schedules and thermostat heating runtime during the pre-period, tune-up period, and post tune-up period to assess whether the impact of temperature optimization was evident in the data.
    - Compare data across several groups, including ITT versus control and treated versus untreated versus control.

- Conduct a time differentiated analysis by comparing differences between weekdays/weekends, and the hour-of-the-day.
- Compare actual setpoints to scheduled setpoints.

2. A regression-based modeling approach was used to estimate energy savings and demand impacts over the cooling season. The SS program uses a randomized encouragement design ("RED") in which all customers in a PA's service territory with a Nest thermostat were randomly assigned into one of two groups. These two groups are the intent to treat ("ITT") group, where participants are randomly assigned to receive the program offering, and the control group, where participants are randomly assigned to *not* receive the program offering.[2]

   All qualified customers were provided the program offering on the thermostat itself and through Nest's mobile app. Some portion of ITT customers chose to opt in and enrolled into the program, while others did not. The group of customers that opted in is referred to as the treated group. Thermostats that were part of the ITT group but either did not qualify or did not opt in are referred to as the untreated group.

   SS savings are evaluated by comparing the ITT group (both treated and untreated thermostats) to the control group using a linear fixed effects (or difference-in-differences) regression model to estimate energy and demand savings. The estimate of savings is then scaled by the program opt-in rate to calculate savings per treated thermostat.

   Due to the design of the program, targeted thermostats could not be linked directly to customers and their billing data. Therefore, the study relied exclusively on thermostat telemetry data to estimate impacts after converting thermostat runtime to energy consumption. Based on a combination of geographic location, self-reported heating types, and thermostat wiring, each Nest thermostat was assigned a heating fuel and equipment type. To develop conversion factors for each heating and equipment type, Guidehouse leveraged various data sources to obtain accurate estimates of average capacity and operating efficiency, including previous potential studies, the RES 1 Baseline Load Shape Study, past DOE regulatory analyses and the Massachusetts Technical Reference Manual.

   The study estimated statewide electric and fuel energy savings and electric demand savings for natural gas and combined non-natural gas heating fuel types. Energy savings were estimated for the following periods: winter, effective winter, winter on-peak (electric-only), winter off-peak (electric-only), tune-up, and post tune-up[3]; demand savings were

[2] For each PA, 70% of thermostats were randomly assigned to the ITT group while the remaining 30% were assigned to the control group.

[3] Winter – all hours December 1 through April 30 while SS program is active; Effective Winter – all hours December 1 through April 30, assuming the SS program were active the entire period; Winter On-Peak – weekdays, non-holidays from 7 AM to 11 PM, October 1 through May 30 while SS program is active; Winter Off-Peak – all hours not on-peak; Tune-Up – all hours January 14 through February 13; Post Tune-Up – all hours February 14 through April 30

estimated for the winter on-peak period[4], as well as an adjusted winter period which assumes zero demand savings prior to program launch. The study developed realization rates for fuel and electric energy savings for natural gas and combined non-natural gas heating types.

Application of Results: Retrospectively and Prospectively

A copy of the complete study can be found in Appendix 4D, Study 19-8.

[4] Winter Demand – weekdays, non-holidays from 5 PM to 7 PM, December 1 through January 31 while the SS program is active; Adjusted Winter Demand - weekdays, non-holidays from 5 PM to 7 PM, December 1 through January 31 assuming zero savings prior to program launch

Study 19-9: 2019 Summer Thermostat Optimization Evaluation

Type of Study: Impact Evaluation

Evaluation Conducted by: Navigant Consulting

Date Evaluation Completed: 3/26/2020

Study Objective and Summary of Results:

The purpose of this study was to estimate energy and demand savings and calculate realization rates for the summer thermostat optimization program (called Seasonal Savings, hereafter SS) deployed in Cape Light Compact ("CLC"), Eversource ("ES"), and National Grid ("NGrid") service territories in summer 2019. A secondary objective was to assess the persistence of program as this is the third summer it ran for NGrid and the second summer for CLC.

The study provides the following key findings:

- 40% of ITT thermostats and 56% of qualified ITT thermostats enrolled in the program.
- Enrollment and qualifications rates are lower for CLC than NGrid and ES (~30% compared to ~40%), likely due to different home usage and cooling needs on the Cape.
- Enrollment rates have been steady across years for NGrid (~40%) and CLC (~30%). Customers are more likely than not to maintain their most recent treatment status from one year to the next.
- Clear evidence of persistence exists in early summer 2019 in scheduled setpoints for the NGrid ITT devices from one year to the next. This is especially true for those treated for multiple years of the three-year study period: 1.25°F for three years treated and 0.25°F for two years treated.
- There is also evidence of persistence in actual setpoints and runtime for the devices opting in for three years over the three-year study period: 0.75°F in actual setpoints and approximately 3 minutes less runtime. However, based on the entire pre-period no evidence of persistence exists in actual setpoints and runtime for those treated two years of the three-year study period.
- The time differentiated setpoint analyses and the runtime both suggest that the devices treated three years over the three-year study period are manually overriding their thermostat setpoints on the hottest days of the summer. This suggests that these customers may be reaching the limits of what is comfortable in their homes on these very hot days.
- The average energy savings per treated thermostat was 19.7 kWh (3% of electric cooling load) between July 18 and September 30, 2019.
- The average demand savings per treated thermostat was 46 W (7% of electric cooling load) between July 18 and September 30, 2019.

- The program achieved 669 MWh of total energy savings (495 on-peak and 174 off-peak) and 1.3 MW of total demand savings between July 18 and September 30, 2019.
- Compared to vendor-reported savings, the program achieved 99% of electric energy savings.
- The demand-to-energy (W to kWh) factor was 2, the on-peak savings percentage was 74%, and the off-peak savings percentage was 26%.

Core Initiatives or End Uses to which the Results of the Study Apply:

- Residential
- Residential Behavior
- Behavior & HVAC
- Electric Only

Evaluation Recommendations:

The following recommendations were made by the evaluators conducting this study.

Recommendation 1: The PAs should claim the electric energy and demand savings listed in the following table.

PA	Measure Life	No. of Participating Thermostats (Google)†	Total Energy (kWh) Savings‡	On-Peak Energy (kWh) Savings§	Off-Peak Energy (kWh) Savings††	Total Demand (kW) Savings‡‡
CLC	1	2,052	40,424	29,914	10,510	81
ES	1	19,802	390,099	288,674	101,426	780
NGrid	1	12,087	238,114	176,204	61,910	476
Statewide	**1**	**33,941**	**668,638**	**494,792**	**173,846**	**1,337**

Recommendation 2: For 2019 and future years when an evaluation is not conducted, Navigant recommends the PAs claim energy savings based on a realization rate of 99%.

- PAs should claim energy savings using the following formula:

  Claimable total energy (kWh) savings by PA = Google's statewide weighted average per treated thermostat energy savings (kWh) * Google's treated thermostat count by PA * 99% (realization rate)

Recommendation 3: For 2019 and future years, Navigant recommends the PAs claim on-peak and off-peak energy savings based on an on-peak savings percentage of 74% and off-peak savings of 26%.

- PAs should claim on-peak and off-peak savings using the following formulas:

  Claimable on-peak energy (kWh) savings by PA = Claimable total energy (kWh) savings by PA * 74% (on-peak savings percentage)

  Claimable off-peak energy (kWh) savings by PA = Claimable total energy (kWh) savings by PA - Claimable on-peak energy (kWh) savings by PA

Recommendation 4: For 2019 and future years, Navigant recommends the PAs claim demand savings based on a realization rate of 99% and a demand-to-energy (W to kWh) factor of 2.

- PAs should claim demand savings using the following formula:

  Claimable demand (kW) savings by PA = (Google's statewide weighted average per treated thermostat energy savings (kWh) * Google's treated thermostat count by PA * 99% (realization rate) * 2 (demand-to-energy factor)) / 1,000

Recommendation 5: The realization rate should be reassessed within 3-5 years or if new vendors join the program, Google changes its method of estimating savings, the groups are re-randomized in future deployments, or the PAs want to reduce the size of past control groups.

Explain Whether or Not the PAs Decided to Adopt the Recommendations from the Study:

The PAs have adopted recommendations 1 through 4. The PAs are considering recommendation 5 at this time. The PAs have not formally adopted or rejected any recommendations that require future evaluation studies.

How the Study Affects Program Results and Its Significance:

The study found average energy savings of approximately 19.7 kWh and average demand savings of 46 W per treated thermostat in summer 2019. This led to a statewide realization rate of 99%. The PAs can use the realization rate found in this study for the next 3-5 years if the program design remains the same.[5] As the vendor will no longer provide the data needed to estimate hourly values, the study also calculated an on-peak savings percentage of 74%, an off-peak savings percentage of 26%, and a demand-to-energy (W to kWh) factor of 2 for use in future years.

Overview of Study Method:

The study relied on thermostat telemetry data and thermostat-level participation data. A total of 108,903 thermostats (40,617 in NGrid's service territory, 8,831 in CLC's service territory, 59,455 in ES's electric service territory) were included in the study (3% of the 108,903 thermostats in the PAs combined service territories were excluded from the analysis due to data quality).

[5] In terms of program vendor, vendor savings estimation method, and ITT and control group assignments of existing thermostats.

1. An exploratory analysis of the data was performed to:
   a) Assess program eligibility and opt-in rates, providing insight into customer acceptance of the thermostat optimization solution;
   b) Assess opt-in rates over time for CLC and NGrid, the PAs in the program for multiple years;
   c) Analyze setpoint (scheduled and actual) and runtime changes from 2017 to 2019 for NGrid (the PA in the program the longest); and
   d) Compare time differentiated actual and scheduled setpoints by hour-of-the-day on weekdays and weekends across all cohorts
2. A regression-based modeling approach was used to estimate energy savings and demand impacts over the cooling season. The SS program uses a randomized encouragement design ("RED") in which all customers in a PA's service territory with a Google Nest thermostat were randomly assigned into one of two groups. These two groups are the intent to treat ("ITT") group, where participants are randomly assigned to receive the program offering, and the control group, where participants are randomly assigned to *not* receive the program offering.[6]

   All qualified customers were provided the program offering on the thermostat itself and through a mobile app. Some portion of ITT customers chose to opt in and enrolled into the program, while others did not. The group of customers that opted in is referred to as the treated group. Thermostats that were part of the ITT group but either did not qualify or did not opt in are referred to as the untreated group.

   SS savings are evaluated by comparing the ITT group (both treated and untreated thermostats) to the control group using a linear fixed effects (or difference-in-differences) regression model to estimate energy and demand savings. The estimate of savings is then scaled by the program opt-in rate to calculate savings per treated thermostat.

   Due to the design of the program, targeted thermostats could not be linked directly to customers and their billing data. Therefore, the study relied exclusively on thermostat telemetry data to estimate impacts after converting thermostat runtime to power. The thermostat runtime to power conversion was based on an analysis of metering data from Phase 2 of the 2017 Massachusetts Baseline Study (n=92) and assumptions regarding average size (3.0 tons) and efficiency (10.7 Energy Efficiency Ratio) of air conditioners based on a field study (n=52) of DR program participants conducted in October 2017.

   The study estimated energy and demand savings for each PA cohort (2017, 2018, and 2019 NGrid; 2018 and 2019 CLC, All ES[7]) separately and aggregated to the statewide level.

[6] For each PA, in 2019, 80% of thermostats were randomly assigned to the ITT group while the remaining 20% were assigned to the control group. In 2017 and 2018, 70% of thermostats were randomly assigned to the ITT group and 30% to the control group.

[7] The ES cohort formally launched in 2019 but is referred to as All because approximately 20% of the devices in this cohort were in the program in 2017 and/or 2018 and assigned to NGrid.

Energy savings were estimated for the following periods: summer, summer on peak, and summer off peak;[8] demand savings were estimated for the summer on-peak period. The study developed realization rates for energy (summer) and factors to be applied to calculate savings for summer on-peak energy, summer off-peak energy, and demand (summer on-peak).

Application of Results: Retrospectively

A copy of the complete study can be found in Appendix 4D, Study 19-9.

[8] Summer – all hours June 1 through September 30 while SS program is active; Summer On-Peak – weekdays, non-holidays from 7 AM to 11 PM, June 1 through September 30 while SS program is active; Summer Off-Peak – all hours not on-peak; Tune-Up – all hours July 2 through July 29; Post Tune-Up – all hours July 30 through September 30.

Study 19-10: Home Energy Services Realization Rate Assessment

Type of Study: Process Evaluation

Evaluation Conducted by: Guidehouse

Cadeo Group

Date Evaluation Completed: 3/19/2020

Study Objective and Summary of Results:

The goal of RES 39 was to better understand potential causes for the disparity between ex ante and ex post weatherization savings apparent in the last two evaluations and to recommend specific actions that the PAs and/or Lead Vendors (LVs) can take that could minimize the difference in future evaluations. The study sought answers to the following two key research questions:

1. Why are the evaluation realization rates not closer to 1.0?
2. What changes would improve vendor savings estimates?

The evaluation team offered the following key findings:

- Independent of impact evaluation regression models, a direct comparison of modeled and actual consumption reveals that both whole-home simulation models over predict total consumption and/or savings.
- Both whole-home simulations less accurately estimated the consumption of older homes, which typically receive more insulation than newer homes.
- All three LVs use robust models that rely on MA-specific data. There does not appear to be meaningful differences in how Energy Specialists (ESs) or Home Performance Contractors (HPCs) use these tools in the field; most shared a similar data collection and modeling approach and reported they infrequently change model default values.
- ESs and HPCs do not typically utilize customer-specific billing data when modeling a participant's home and estimating weatherization savings. However, assessors typically have access to participant's usage information (i.e., the participant shares a copy of their bill). In these instances, some assessors will use the bill to do a "sanity check" on the model's estimated savings.
- Rebound effect is not a meaningful contributor to the realization rate disparity observed in the previous two HES impact evaluations

Core Initiatives or End Uses to which the Results of the Study Apply:

- Residential
- Residenital Coordinated Delivery
- Envelope & HVAC
- Electric & Gas

Evaluation Recommendations:

The following recommendations were made by the evaluators conducting this study.

Recommendation 1: Integrate Participant Consumption Data

Our model reviews and LV interviews determined that none of the HES LVs currently use a participant's pre-program energy consumption data to model their potential weatherization savings in a formal or systematic way. Not using participant-specific consumption data means the weatherization savings modeled for each participant are disconnected from that participant's actual energy usage. Our team believes this fundamental disconnect is likely a significant contributor to observed disparity in historical weatherization realization rates.

Since improving realization rates requires the HES LV models to accurately characterize energy consumption pre- and post-intervention, we recommend that PAs and LVs work together to formally integrate participant's actual historical energy consumption into the weatherization modeling process. We recognize that PAs and LVs have different legacy data management infrastructures and policies and, as such, also recognize the importance of providing each PA and LV with room for operationalizing this consideration.

Ideally, the LVs can load participant's consumption data into their models in an automated way prior to each assessment. This would prevent assessors from relying on participants to share a copy of their bill or from manually retrieving consumption data. However, if automated integration of consumption data into the modeling software is not technically possible—or requires significant time to implement—the PAs and LVs should take simpler, near-term steps toward integrating participant's consumption history. As an example, PAs could ensure that assessors have access to participant's consumption records and require them to review that information prior to the assessment.

Recommendation 2: Formalize Sanity Checks

Our assessor interviews also determined that some assessors perform an informal "sanity check" to confirm that their modeled total consumption and savings values are reasonable using a copy of the participant's bill. However, this practice is assessor-specific and only occurs when a participant proactively provides a copy of their bill or can provide one upon request.

Consistent with the concept of better leveraging participant-specific consumption data to improve model accuracy, we recommend formalizing these sanity checks. There is variation in the capabilities of PA billing systems and LVs modeling systems, thus the sanity check could happen through either an automated or manual process. As an example, it may be possible to add an automated alert to the modeling software itself notifies the assessor if modeled consumption is beyond +/-10% of the home's actual consumption or the modeled weatherization savings exceed 35% of a participant's actual pre-program consumption. (Our team has offered placeholder values for these alert thresholds, but we suggest the PAs and LVs work together to select the appropriate values.) Alternatively, an example of a manual sanity check is a program requirement for the assessor to confirm that the model's consumption and/or savings fall within the designated range before the LV software produces a final assessment (and, if it does not, document

Whether implemented using an automated or manual approach, the formalization of these sanity checks will require all assessors to adopt this best practice and mitigate outlier savings estimates.

Recommendation 3: Revisit Existing R-value Assumptions

Our team found meaningful differences between modeled and actual consumption for Eversource and National Grid participants across all types of insulation, particularly in older homes that received multiple types of insulation. (Our team was unable to complete a similar analysis for the other PAs.) Through the team's literature review and an interview with a building simulation industry expert, the team found anecdotal evidence that under-characterizing the R-value of the uninsulated building shell (especially in older homes) can be a source of overestimation of heating system energy use. Our team attempted to assess the default R-values associated with air films and the non-insulation portions of the building shell in each model (including wall assemblies, e.g. sheathing, siding, drywall), but we did not have access to this specific information. This and other background assumptions and/or engineering calculations were unavailable behind the model's user interface. For this reason, we recommend the LVs closely review all default R-value assumptions and consider using, at a minimum, a default of R-3 to reflect the thermal properties of a completely uninsulated wall.

Explain Whether or Not the PAs Decided to Adopt the Recommendations from the Study:

The PAs are considering all recommendations for adoption at this time. The PAs have not formally adopted or rejected any recommendations that require changes to program design and operations.

How the Study Affects Program Results and Its Significance:

This study does not directly adjust savings estimated for 2019 or 2020 but instead provides recommendations for improving program estimates based on Lead Vendor modeling techniques.

Overview of Study Method:

To understand how these factors are impacting realization rates and answer the two overarching research questions above, the evaluation team undertook the following four, complementary tasks.

- **Task 1. Engineering Review of LV Modeling Software.** Our team began the study by reviewing the modeling tools used by HES LVs. The review included an independent assessment of the model itself (i.e., reviewing model inputs, data sources, and model functionality), as well as in-depth interviews with each LV's modeling teams. We used the interview to build upon our initial review and identify any potential systemic causes of savings overestimation. Given the technical nature of the discussion, the team summarized its discussion and confirmed the key takeaways with the interviewee following each interview. Our contact with the LV modeling teams did not end with these interviews; our team exchanged e-mails and phone calls throughout the study.
- **Task 2. Interviews with Assessors.** Following our interviews with the LV modeling teams, we interviewed 20 Energy Specialists (n=14) and HPCs (n=6) that, collectively, estimate weatherization savings using every LV tool. The interviews complemented the top-down perspective offered by the LV modeling teams and provided our team with insight into how assessors use the tools "in the field" (i.e., the inputs they update and ones they do not).
- **Task 3. Survey Participants.** Rebound effect (i.e., participants changing their behavior after weatherizing their home in a way that diminishes savings) is another potential contributor to the observed disparity between ex ante and ex post savings estimates. To assess the extent to which recent HES participants took actions that produce a rebound effect, our team surveyed 321 HES participants that weatherized their home in 2018. These surveys, completed online, includes participants from all seven PAs and focused on behavioral changes to participant's heating and cooling practices following weatherization.
- **Task 4. Compare Modeled Consumption and Billing Data.** To understand how participant's LV modeled consumption compared to their actual consumption (i.e., PA billing data), our team analyzed LV and PA data for over 3,000 2017 HES participants. Our team compared each participant's actual pre- 2016 and post- 2018 HES annual consumption with modeled annual estimates provided by the HES LVs. In addition to looking at overall trends, our team also investigated whether the relationship between actual and modeled consumption differed for specific participant and/or building types (e.g., home size, type, and size, as well the type of insulation the participant installed and their heating fuel).

Application of Results: Prospectively

A copy of the complete study can be found in Appendix 4D, Study 19-10.

Study 19-11: Residential Coordinated Delivery Logic Model Creation

Type of Study: Process Evaluation

Evaluation Conducted by: Guidehouse Cadeo Group

Date Evaluation Completed: 3/17/2020

Study Objective and Summary of Results:

The objective of this study was to create a logic model for the Program Administrator's new Residential Coordinated Delivery ("RCD") initiative. Specifically, the logic model sought to document answers to the following key questions about RCD evolution out of the Home Energy Services ("HES") initiative:

1. What are the barriers, activities, outputs and outcomes associated with the new RCD initiative?
2. What initiative, market, and customer information do the PAs and their implementation teams need to collect to inform ongoing internal and periodic external (third party) evaluations of RCD's effectiveness?

To provide greater context for the RCD logic model, the study also included the creation of a participation pathway diagram. The diagram depicts the core steps in most residential customers' participation in RCD.

The key result, or, more accurately output, of this study was the creation of the RCD logic model and participation pathway diagram. Both diagrams were provided in the study's final memo.

Core Initiatives or End Uses to which the Results of the Study Apply:

- Residential
- Residenital Coordinated Delivery
- Electric & Gas

Evaluation Recommendations:

No formal recommendations were made in this evaluation.

Explain Whether or Not the PAs Decided to Adopt the Recommendations from the Study:

N/A (no formal recommendations were made in this evaluation)

How the Study Affects Program Results and Its Significance:

The study does not directly affect savings estimated for 2019 or other program years. This study provides a logic model diagram for the statewide RCD program, serving existing residential buildings throughout Massachusetts under the Mass Save brand. The logic model diagram provides a graphical representation of the activities, outputs, and outcomes expected from successful execution of RCD. The accompanying tables and explanatory text in the memo provide additional detail for reviewers and provide examples for how the PAs could potentially measure RCD's progress toward these outputs and outcomes over time. The memo also includes a supplementary participation path diagram that depicts, at a high-level, how participants move through RCD delivery process.

Overview of Study Method:

This project was designed to support the work of the Program Administrators by documenting progress toward the transition to RCD and developing an agreed-upon vision for the program through graphical representations of both process and objectives. To achieve these objectives the team sought to:

- Obtain information on progress to-date implementing changes towards achieving the goals of RCD
- Develop a logic model diagram that reviewers and program stakeholders agree represents the aspirational objectives of RCD
- Identify a set of outputs and near-term outcomes that could potentially signal progress on achieving the overarching RCD objectives
- Develop a participation path diagram that reflects the expected intake, screening, and triage steps expected to funnel customers into the most appropriate service path

The logic and participation path diagrams provide different types of information and perspectives regarding a program. A logic model provides a map of a program's hypothesis: if the program does x, y will happen. A participation path diagram maps the steps a customer follows to access and benefit from a program's services. Together, these two complementary diagrams are expected to document the changes underway for RCD and enable internal and external assessments of RCD's progress as measured by progress indicators. In the tables provided in the memo, the team provides a set of suggested preliminary indicators that should be reviewed and tested prior to adopting them.

Application of Results: Prospectively

A copy of the complete study can be found in Appendix 4D, Study 19-11.

Study 19-12: Energy Optimization Measures and Assumptions Update

Type of Study: Market Characterization or Assessment Evaluation

Evaluation Conducted by: Guidehouse

Date Evaluation Completed: 3/2/2020

Study Objective and Summary of Results:

This study updated the previously developed Energy Optimization Model ("EOM") for residential energy optimization measures in Massachusetts. The evaluation team initially developed the EOM in October 2018 to estimate the costs and benefits associated with a variety of energy efficiency measures that use electric heat pumps and natural gas heating equipment to displace the consumption of delivered fuels. The PAs have used this model to develop prescribed savings values used for energy efficiency measures that involve fuel switching.

The study included updates to the model, including revised input values, new installation parameters, and new measures covering ground-source heat pumps ("GSHPs"). In addition, the study implemented further improvements in the model as part of the C&I Energy Optimization Study conducted for the Massachusetts commercial PAs.

Core Initiatives or End Uses to which the Results of the Study Apply:

- Residential
- Residenital Coordinated Delivery
- HVAC & Hot Water
- Electric & Gas

The PAs have used this model to develop prescribed savings values used for energy efficiency measures that involve fuel switching.

Evaluation Recommendations:

No formal recommendations were made in this evaluation.

Explain Whether or Not the PAs Decided to Adopt the Recommendations from the Study:

N/A (no formal recommendations were made in this evaluation)

How the Study Affects Program Results and Its Significance:

The findings of this study help inform an update of the Residential Coordinated Delivery rebate offerings. The study provides information that will help PAs make informed decisions about the

replacement scenarios for which rebates are offered, and the rebate amounts that are offered. This study updated a spreadsheet tool that PAs may use to evaluate the costs and savings available from different user-input operating assumptions, including different equipment capacities, balance points, and cooling and heating loads.

Overview of Study Method:

The goal of this study was to update the existing EOM with more recent data sources and to implement additional features of interest to the PAs and EEAC consultants. The original EOM was developed in 2018 and allowed users to estimate the savings, costs, peak demand, and lifetimes for a focused group of energy optimization measures for space heating and water heating end uses.

The evaluation team used the following publicly available data sources throughout the analyses conducted for the EOM update:

- Massachusetts Technical Reference Manual (TRM), 2019-2021 Plan Version
- Residential Evaluation Studies Conducted on Behalf of the EEAC
- Northeast Energy Efficiency Partnerships (NEEP) Cold Climate Air-Source Heat Pump
- ISO-NE Electricity Generation Fuel Mix
- Massachusetts Clean Energy Center (MassCEC) GSHP Rebate Data

Application of Results: Retrospectively and Prospectively

A copy of the complete study can be found in Appendix 4D, Study 19-12.

Study 19-13: Residential Nonparticipant Market Characterization & Barriers Study

Type of Study: Market Characterization or Assessment Evaluation

Evaluation Conducted by: Illume Advising

Cadeo Group

Guidehouse

Date Evaluation Completed: 2/27/2020

Study Objective and Summary of Results:

The purpose of this study was to characterize residential nonparticipants and provide insight into market barriers for three key customer segments of interest: renters, limited English speakers, and low-to-moderate income customers.

The study provides the following key findings

- Nonparticipants are more likely than participants to:
    - Live in rental units. Specifically, among those surveyed, 30% of renters participated compared to 40% of homeowners.
    - Only have a high school education or no secondary school degree
    - Be low-to-moderate income households
    - Report lower awareness of Mass Save
    - Be harder to reach, even with greater effort and financial incentives
- Participation barriers identified by the research indicate that nonparticipants:
    - Often expressed lack of trust in government and their landlords, and have a fear of scams
    - Prioritized their time and resources on needs that they considered more fundamental to living (e.g., food and shelter)
    - Needed more information or understanding of Mass Save offerings, participation processes, and benefits
    - Perceived energy efficiency as irrelevant or not applicable to them
    - Believed Mass Save is government-funded, deterring participation
- Program design and implementation opportunities included:
    - Engaging trusted community organizations

- Shifting focus from raising awareness to increasing understanding of Mass Save benefits and linking program services to everyday needs and value to customers.
- Countering the perception that participating takes a lot of time
- Conveying that Mass Save is available to all PA customers
- Designing a multi-faceted, multi-modal outreach strategy that meets the needs of target customer groups
- Messaging to impress the relevance of programs and services to customers, accounting for their unique circumstances
- Reinforcing that denial in any assistance program does not mean lack of eligibility for Mass Save
- Providing personal and step-by-step guidance through program process, particularly for those who speak a language other than English
- Reinforcing cross-program promotion between assistance programs and Mass Save
- Designing and/or implementing programs that directly overcome the barriers identified in this research

Core Initiatives or End Uses to which the Results of the Study Apply:

- Residential & Income-Eligible

Evaluation Recommendations:

No formal recommendations were made in this evaluation.

Explain Whether or Not the PAs Decided to Adopt the Recommendations from the Study:

N/A (no formal recommendations were made in this evaluation)

How the Study Affects Program Results and Its Significance:

This research provided insight into program outreach and design opportunities. It characterized nonparticipants, and challenges of and challenges to reaching nonparticipants, as evidenced through the research.

Overview of Study Method:

The study relied on a combination of primary data collection activities. These activities included over 1,600 surveys via multi-mode web, telephone, mail, and door-to-door approaches, as well as qualitative research including intercept, door-to-door, and in-depth telephone interviews. In addition to customers, the study also included perspectives from Massachusetts Program Administrators and community organizations that service the groups of interest. The research

coordinated closely with the Residential Nonparticipant Customer Profile Study completed by DNV GL.

Application of Results: Prospectively

A copy of the complete study can be found in Appendix 4D, Study 19-13.

Study 19-14: Residential Baseline Phase 4 Comprehensive Report

Type of Study: Impact Evaluation

Evaluation Conducted by: Guidehouse

Date Evaluation Completed: 3/31/2020

Study Objective and Summary of Results:

The primary goal of the Residential Baseline Study was to collect data on saturation, characterization, consumption, peak demand, and key explanatory variables for all major electric and gas appliances, mechanical equipment, and electronics in Massachusetts homes. This data provides the foundation for updating the Massachusetts TRM, informing future energy efficiency and demand response potential studies, and designing programs. The secondary goal of this study is to support other research that the PAs are undertaking—such as energy efficiency potential studies and market effects research—by providing comprehensive data for the sampled customers.

The study provides the following key findings:

- The saturations of cooling end uses are increasing, potentially driven by hot temperatures in recent summer seasons.
- Emerging technologies such as EVs, solar PV systems, and heat pump water heaters are increasing in saturation.
- Gas end uses have increased in saturation from 2018 to 2019, while oil end uses have remained constant.
- While HVAC is the most seasonally variable end use category, refrigerators, water heaters, dehumidifiers, and pool pumps all contribute seasonal variation.
- Statewide electricity consumption from certain high consumption, low saturation end uses like ductless heat pumps and central AC increased in 2019 as compared to 2018. This consumption could increase dramatically with increased adoption over time.
- Cooling is responsible for half of summer peak demand.
- Refrigerators, dehumidifiers, clothes dryers, TVs and their peripherals, and pool pumps also contribute to the summer peak demand in Massachusetts.
- The higher temperatures in Massachusetts in summer 2018 resulted in higher average consumption for all cooling end uses.
- The relative contribution of end uses to overall peak demand varies depending on the year.
- The top contributors to summer peak demand across all homes in Massachusetts are central ACs and room ACs.

- Lighting and other unmetered loads contributed most to Massachusetts' winter peak demand. These end uses include lighting and various small plug loads. On winter peak days, HVAC loads are large but relatively flat. Miscellaneous loads are driven by primary and secondary TVs and peripherals.
- When the major end uses are disaggregated further, no single HVAC end use dominates winter peak demand. Hardwired electric heat, plug-in electric heat, boiler distribution, furnace fans, and mini-split heat pumps all contribute about the same to winter peak, adding up to HVAC as a whole presenting significant savings opportunities. Savings opportunities may also exist for clothes dryers and water heaters.
- If saturation of ductless heat pumps continues to rise, they could quickly become the single most important driver of winter peak aside from lighting.
- The average natural gas demand is approximately 70% larger on the peak day than the typical winter day. Hourly residential natural gas demand peaks in the morning hours between 5 a.m. and 9 a.m. with a secondary peak between 3 p.m. and 9 p.m. The morning peak is approximately 25% larger than the evening peak.
- Approximately 10 kW of electric demand would be added per home during the morning peak on the winter peak day for each home that converts from all existing gas end uses to electric resistance heat and hot water.

Core Initiatives or End Uses to which the Results of the Study Apply:

- Residential
- Residenital Coordinated Delivery
- Envelope & HVAC
- Electric & Gas

Evaluation Recommendations:

No formal recommendations were made in this evaluation.

Explain Whether or Not the PAs Decided to Adopt the Recommendations from the Study:

N/A (no formal recommendations were made in this evaluation)

How the Study Affects Program Results and Its Significance:

The PAs are reviewing considerations from this comprehensive report and will appropriately incorporate the results into all residential initiatives.

Overview of Study Method:

Guidehouse conducted a large multiyear residential baseline saturation and load shape study using data collected via online survey, onsite validation, and long-term metering. Through this research, the Guidehouse team provided the Massachusetts PAs and Energy EEAC consultants more granular data about the energy consumption of residential buildings and their occupants. The PAs and EEAC also want to learn more about relevant opportunities for reducing overall energy consumption and consumption during peak periods/hours. This report reflects all study findings to date, including all survey and metered data collected from January 2017 through winter 2019-2020.

Application of Results: Retrospectively and Prospectively

A copy of the complete study can be found in Appendix 4D, Study 19-14.

Study 19-15: Gross Impact Framework – Decision Guide

Type of Study: Impact Evaluation

Evaluation Conducted by: DNV GL

Energy and Resource Solutions (ERS)

Date Evaluation Completed: 3/18/2020

Study Objective and Summary of Results:

The purpose of this study was to document and summarize decisions related to key processes and issues that the DNV GL team has addressed since the implementation of the Gross Impact Evaluation Framework ("Framework") adopted in February 2017. The current focus is on documenting specific custom electric and gas impact evaluation methods developed to date; some of the principles discussed here also apply more broadly to the MA CIEC portfolio. In addition, the memo documents specific emerging issues for which decisions have not yet been reached.

The study provides the following key findings:

- **Gas Precision Targets.** Columbia, Eversource, and National Grid have PA-specific targets, while Berkshire, Liberty, and Unitil do not currently have specific sampling targets and rely on statewide results.
    - Statewide: ±10% relative precision (RP) at the 80% confidence level (CL)
    - PA-specific: ±20% RP at the 80% confidence level
    - Precision targets are for the full three-year rolling sample
- **Electric Precision Targets.** Cape Light Compact, National Grid, and Eversource have PA-specific targets, while Unitil does not currently have a specific sampling target and relies on statewide results.
    - Statewide overall: energy ±10% RP @ 90%
    - Statewide lighting/non-lighting: energy ±10% RP @ 90%
    - PA-specific overall: energy ±15% RP @ 90%
    - PA-specific lighting/non-lighting: ±15% RP @ 90%
    - Precision targets are for the full three-year rolling sample
- **Pooled Sampling Approach.** Custom studies are designed using rolling samples to achieve statewide and PA-specific precision targets over a three-year period. The combined three-year realization rate is a weighted average of separate realization rates, weighted by tracked savings in each year.

- **Choosing between PA or Statewide Results.** The preference is to use PA-specific results when they are reliable, even if they are similar. Current agreement is when sample size is > 10 and the PA-precision targets noted above are met.
- **Prioritization for Custom Sites.** Establish a scheme for prioritizing custom electric sites based on sample characteristics and with the purpose of minimizing and avoiding bias in the sample in case not all site reports are finalized in time for the PAs' annual filing deadline.
- **Outlier Review.** Calculate the mean (m) and standard deviation (SD) of the relative residuals (u), then look for values that are more than t standard deviations from the mean. That is, we test for: |uj -m| > t SD, where t is the t-statistic we want to use as a criterion for extreme.
- **Gross realization Rate Reweighting for Cases with an Evaluated Baseline equal to Installed Equipment.** Retain the case in the GRR calculation but multiply savings by the case implicit net-to-gross Rate (NTGR).
- **Prospective Evaluation Results.** Systematic updates to engineering assumptions or tracking adjustments that are implemented may result in gross savings differences that make it inappropriate to apply a retrospective realization rate. In these cases, evaluators should prepare prospective realization rates that account for systematic changes and therefore do not double count for adjustments.

Core Initiatives or End Uses to which the Results of the Study Apply:

- Commercial & Industrial
- All Initiatives
- All End Uses
- Electric & Gas

While the memo focuses on documenting specific custom electric and gas impact evaluation methods developed to date, some of the principles also apply more broadly to the C&I portfolio.

Evaluation Recommendations:

No formal recommendations were made in this evaluation.

Explain Whether or Not the PAs Decided to Adopt the Recommendations from the Study:

N/A (no formal recommendations were made in this evaluation)

How the Study Affects Program Results and Its Significance:

The study findings do not directly affect the savings estimated for 2019 and projected for 2020. The study results help serve as a framework to help refine and document the approach used to

determine which Massachusetts C&I impact evaluation studies to undertake, at what level of rigor, and when. The results will be used to update impact evaluation methodologies in the face of changing needs of programs, the PAs, and the role of evaluation in responding to those needs.

Overview of Study Method:

This study did not include any primary research and instead compiled decisions, emerging issues, and supporting documentation from existing sources. Sources included working group discussions, memos, study plans, and reports.

Application of Results: Retrospectively and Prospectively

A copy of the complete study can be found in Appendix 4D, Study 19-15.

Study 19-16: C&I Measure Life Study

Type of Study: Impact Evaluation

Evaluation Conducted by: DNV GL

Date Evaluation Completed: 3/31/2020

Study Objective and Summary of Results:

The purpose of this study was to inform Effective Useful Lives ("EULs") and Remaining Useful Lives ("RULs") for key C&I energy efficiency measures, including lighting, HVAC, custom projects, and gas heating equipment.

The study provides the following key findings:

- Lighting
    - **Product quality concerns.** Two representatives claimed that DLC quality specifications, which most rebate programs require, are not tough enough and have only set a floor above which there are many variations in product quality.
    - **Manufacturer defined measure lives.** Almost all the manufacturers base their measure life estimates on how long their LED products take to depreciate to 70% of their original lumen level. Tests have shown that some LED lighting components can fail catastrophically long before this 70% lumen depreciation level is reached, but it has been difficult for the industry to devise an alternate measure life definition based on failure rates.
    - **Manufacturer testing procedures.** All but one of the manufacturer representatives said they use the Illuminating Engineering Society's (IES) LM-80 testing protocols. LM-80 is a method for measuring the lumen maintenance of LED packages, arrays, and modules (i.e., the LED light source) at various temperatures.
- Commercial Heating
    - **Contractor estimated early replacement rates.** The average estimate of the contractors for early replacement of commercial boilers was 21% and their average estimate for the early replacement of commercial furnaces was 20%.
    - **Contractors amenable to photo-based verification**. The team asked the contractors if they were interested in a program that would pay them to email in pictures of the manufacturer nameplates of the commercial HVAC equipment they removed, along with brief descriptions of the equipment's condition. Two thirds of the contractors said they would participate in such a program, with another 20% saying that their participation would depend on program requirements. When asked about the minimum amount the program could pay them per emailed nameplate photo to get them to participate, the average incentive estimate was $36.

  - **Contractor defined EUL.** Contractors defined EUL based on a mix of factors including age, cost to repair, safety concerns, and reduced performance.

- Custom Projects
  - **Custom screening tool (CST) uses correct measure life assumptions with few exceptions.** The evaluation team determined that the CST lifetime savings calculations correctly followed the Framework guidance for dual baseline lifetime savings at the measure and project (all measure) level. The combination of program and measure type led to the correct measure event type. However, the CST classified add-on measures as a single baseline only, while the Baseline Framework requires dual baseline treatment for add-on measures with an EUL that exceeds 2/3 the RUL of the host equipment.
  - **Inconsistency in EULs used by the CST, the eTRM, and the TRM.** When the team compared the EUL estimates being used by the CST, the eTRM, and the TRM for selected measures, they found some inconsistencies. Similar inconsistencies were found for the AMLs. For example, the CST EUL is less than the eTRM for chillers, while greater for furnaces.
  - **Flexibility of CST EUL assignment option may lead to mis-assignments.** Users of the CST are typically offered a choice of two or more EULs for a given measure. This flexibility is necessary given the range of measures that could be included within a measure category in the CST. However, this flexibility means that CST users who are not carefully consulting the 2019-2021 MA electronic Technical Reference Manual (eTRM) could assign the wrong EUL to a given measure. There is a similar risk that AMLs would be mis-assigned.
  - **Gap exists in evaluation of second period baselines and out-year factors (OYF).** While the custom impact evaluation teams are focusing more attention on individual implementer measure life assumptions and how they align with TRM and eTRM sources, an evaluation gap exists for second period baselines since current impact evaluations do not include that task. Since the determination of the second period baseline is a derivative of baseline research, determining the second period baseline and the OYF could logically fall under the scope of future measure baseline research and maintained in the Baseline Repository.

- Unitary HVAC, add-on, and O&M measures
  - **Revised EUL values slightly higher than those produced previously under Project 73 Track D.** The revised analysis, which used a new cooling installation index and updated imputations for unitary HVAC equipment with missing manufacture dates, gives an EUL of 8.6 years. Estimates using the cooling installation index with the prior study's alternative imputation method give an EUL of 9.8 years. These EULs are slightly higher than those from the Project 73 Track D analysis which were mostly in the 6-8-year range. However, the updated estimates are still lower than the current TRM EUL (12 years).

- **It is difficult to apply EUL or RUL estimates based on project tracking data and documentation.** While adjusting EUL or RUL based on site-specific condition should, in theory, produce more accurate EUL estimates for add-on measures, project tracking data and documentation often do not provide enough data. Interviews are needed to collect the EUL and RUL estimates for the host and add-on equipment.
- **Deemed values most frequently used methods for assigning EULs to add-on and Operations and Maintenance (O&M) measures.** Over 80% of the TRMs the team reviewed used deemed values for add-on and O&M EULs. For the add-on measures there was a narrower range of deemed EUL values across TRMs for the same types of equipment. In contrast, the deemed EUL values for the O&M measures had more variation across TRMs for the same equipment types.
- **Deemed value EULs for add-on and O&M measures may be overstating the actual lifetimes of these measures.** A 2017 DNV GL study which applied an interview-based method for determining measure lives for add-on measures and O&M measures in 30 C&I sites found an average ex post EUL of 9.1 years compared to a ex ante EUL of 16.6 years. The most common reason for the reduction in the EULs was that the remaining useful life of the host equipment was shorter than the ex-ante EULs of the add-on equipment and it was unlikely the add-on equipment would be reused on another piece of host equipment. Over two-thirds of the states which used deemed EULs for add-on and O&M measures derived these measures from the same four studies. Not only were these sources dated (most were 10-15 years old), but most of the EULs in them were derived from even older secondary sources rather than primary research such as persistence studies.

Core Initiatives or End Uses to which the Results of the Study Apply:

- Commercial & Industrial
- All Initiatives
- Custom & HVAC & Lighting & Other
- Electric & Gas

Evaluation Recommendations:

The following recommendations were made by the evaluators conducting this study.

Recommendation 1: Keep the EUL for commercial unitary HVAC equipment at 12 years. When the EUL for commercial unitary HVAC equipment was reduced from 15 to 12 years in 2018 in response to the EUL analysis conducted under Project 73 Track D, the reduction was conditional on improvements in the EUL analysis method that were to be conducted in 2019. The revised EUL analysis conducted under Project MA19C02-B-EUL did estimate EULs that were slightly higher (9-10 years) than those estimated under Project 73 Track D (6-8 years).

However, the updated estimates are still lower than the current TRM EUL of 12 years. The improved EUL estimation method still has some limitations as discussed in the detailed findings of this report. For this reason, the evaluation team is not advocating it be reduced below 12 years. However, the team believes that the 9-10-year EULs that emerged from the improved 2019 analysis also suggest that this EUL should not revert to the 15-year estimate that was used prior to 2018.

Recommendation 2: Keep the EUL for commercial furnaces at 18 years. The HVAC contractors estimated the average age of the commercial furnaces they removed which still had some useful life remaining to be 17 years. They estimated the average age of the commercial furnaces they removed which were at or near failure to be 19 years. Since the 19-year average is close to the current EUL in the TRM of 18 years, the evaluation team recommends that this EUL remain unchanged.

Recommendation 3: Change the assumed ER rate for commercial boilers from 0% to 20% and for commercial furnaces from 0% to 15%. As noted, this study found an ER rate of 21% for commercial boilers and 20% for commercial furnaces. Another recent Massachusetts study which involved interviews with both HVAC contractors and end users found an ER rate of 18% for commercial boilers and 11% for commercial furnaces. Since two different evaluation studies have come out with similar results that are well above the default assumption of 0%, the team recommends that the PAs should change this ER rate to 20% for commercial boilers and 15% for commercial furnaces, which is the average of the ER rates from the two studies.

Recommendation 4: The impact evaluation team should continue reviewing site-specific EUL assumptions. The impact evaluation team should continue to provide meaningful feedback regarding EUL assumptions observed at individual sites and communicate those findings through the Monthly BAG meetings with stakeholders and in the final evaluation report.

Explain Whether or Not the PAs Decided to Adopt the Recommendations from the Study:

The PAs are considering all recommendations for adoption at this time. The PAs have not formally adopted or rejected any recommendations that require changes to program design and operations.

How the Study Affects Program Results and Its Significance:

If the PAs adopt the recommended Early Replacement ("ER") rates of 20% for commercial boilers and 15% for commercial furnaces, it should increase the savings for these measures. This is because ER measures require the use of a dual baseline, and during the first period (Remaining Useful Life – RUL) of the dual baseline the baseline is the efficiency of the existing equipment. This allows for greater savings than would be the case for Replace on Failure ("ROF") measures where the baseline is not the energy efficiency of the existing equipment but is based on the efficiency of the equipment that would have been installed under Industry Standard Practices ("ISPs").

As the PAs increase consistency between EULs and AMLs they are using in the CST, the eTRM, and the TRM, lifetime savings estimates will shift on a measure-by-measure basis.

The recommendation to keep the EUL for unitary HVAC equipment at 12 years will impact savings because currently while the eTRM is using the recommended 12 years, the CST and the TRM are still using the old (pre-2018) value of 15 years.

Overview of Study Method:

Overall study methods included in-depth interviews, surveys, review of tools, cross-checks of assumptions, literature reviews, and TRM reviews. The methods for each specific end-use are briefly summarized here.

> **Lighting.** For lighting, the primary source of data was 11 in-depth interviews with lighting manufacturers who accounted for about two-thirds (64%) of 2018-2019 C&I Upstream Initiative sales. In addition, the team completed a literature review of LED testing methods.
>
> **HVAC.** For HVAC, the team completed interviews with a sample of 15 HVAC contractors who participated in the C&I Upstream HVAC Initiative in 2018.
>
> **Custom Projects.** The assessment of EUL for custom projects included three primary data collection activities: interviews with PA staff and evaluators, review of the custom screening tool, and cross-check of assumptions.
>
> **Unitary HVAC Equipment.** For unitary HVAC equipment, the team updated EUL estimates by updating the prior (P73-D) analysis with revised inputs.
>
> **Add-on and O&M Measures.** For add-on and O&M measures, the team reviewed over 20 TRMs as well as recent measure life studies commissioned by PAs and other stakeholders that focused on the measure lives of add-on or O&M measures.

Application of Results: Retrospectively and Prospectively

A copy of the complete study can be found in Appendix 4D, Study 19-16.

Study 19-17: Impact Evaluation of PY2017 Small Business Initiative Non-Lighting Measures

Type of Study: Impact Evaluation

Evaluation Conducted by: DNV GL

DMI

Date Evaluation Completed: 3/20/2020

Study Objective and Summary of Results:

The purpose of this study was to provide annual energy kWh savings and realization rates, summer and winter peak kW realization rates, and lifetime kWh realization rates for HVAC and refrigeration measures installed through the small business program in the 2017 program year. Additional objectives include providing the primary drivers of the annual energy savings, establishing the proper baselines for lifetime savings (including dual baselines), and providing recommendations on how to apply study results.

The study provides the following key findings:

- At the program level, the tracking estimates of annual energy impacts were observed to be reasonably accurate with realization rates of near 90% for both refrigeration and HVAC measures.
- Among the HVAC sample, the performance of franchise sites and non-franchise sites were very different from one another, resulting in two sets of factors: one for combined refrigeration and non-franchise HVAC results and one for overall refrigeration and HVAC results. These results are provided below.

Impact Result Summary

	Energy (kWh)	Summer (kW)	Winter (kW)
Combined Refrigeration and HVAC			
Tracked savings	7,376,462	612	551
Statewide evaluated savings	6,979,214	774	779
Realization rate	94.6%	126.5%	141.5%
Relative precision	±20.6%†	33.9%*	37.0%*
Combined Refrigeration and non-franchise HVAC			
Tracked savings	5,480,531	612	551
Statewide evaluated savings	5,751,339	576	647
Realization rate	104.9%	94.1%	117.4%
Relative precision	19.1%†	28.1%*	31.7%*

† provided at the 90% confidence interval * Provided at the 80% confidence interval

- Summer and winter peak kW savings are not being fully populated in tracking estimates of small business projects, as evidenced by instances of either blank or zero savings in these categories among the samples examined.
- Lifetime savings are similarly not tracked regularly, though we found reasonably accurate use of lifetime values when present.
- The 2015 NEEP Commercial Refrigeration Loadshape Report contains the conclusion that EC motors use 61% less power than shaded-pole motors, on average, compared to the MA TRM value of 65%. The MA TRM cites a 2007 study to support the 65% reduction. The NEEP study is the more recent study and is based on a larger sample size of pre/post measurements, so the 61% reduction appears to be a better value to represent average power reductions for this measure type.

Core Initiatives or End Uses to which the Results of the Study Apply:

- Commercial & Industrial
- Existing Building Retrofit
- HVAC & Refrigeration
- Electric Only

Evaluation Recommendations:

The following recommendations were made by the evaluators conducting this study.

Recommendation 1: Use the retrospective and prospective realization rates as provided in the table below with two important notes:

1. Application of the prospective energy savings realization rates are dependent on implementation of the recommended calculation change in the MA TRM regarding a new adjustment factor that reflects shaded pole motor power when only EC motor power is measured (recommended below).
2. Due to missing tracking summer peak kW and winter peak kW estimates in both the HVAC and refrigeration samples influencing the realization rate around these results, we do not recommend a prospective realization rate for these items. The concern is that such realization rates will not be appropriate for application when summer and winter values are fully populated.

Factor	Retrospective	Prospective
Combined refrigeration and HVAC applied when franchise served in Turnkey (Eversource, Unitil)		
Energy Realization rate (kWh)	94.6%	94.8%
Summer peak kW Realization Rate	126.5%	N/A
Winter peak kW Realization Rate	141.5%	N/A
Combined refrigeration and non-franchise HVAC applied when franchise not served in Turnkey (National Grid, Cape Light Compact)		
Energy Realization rate (kWh)	104.9%	105.2%
Summer peak kW Realization Rate	94.1%	N/A
Winter peak kW Realization Rate	117.4%	N/A

Recommendation 2: Revise the MA TRM to accommodate a demand reduction factor of 61% in its calculation when replacing shaded pole motors with ECM motors.

Recommendation 3: Work with program vendors to ensure that summer and winter peak demand estimates are fully populated in the tracking system when appropriate.

Explain Whether or Not the PAs Decided to Adopt the Recommendations from the Study:

The PAs plan to adopt and/or are considering some of the recommendations, as described below.

The PAs are adopting Recommendation 1 and all other Recommendations are under consideration at this time.

How the Study Affects Program Results and Its Significance:

The study results decrease the PY2017 small business HVAC and refrigeration annual energy savings by 5.4% for Eversource and Unitil and increase small business HVAC and refrigeration annual energy savings by 4.9% for National Grid and Cape Light Compact.

Overview of Study Method:

DNV GL conducted full metering and verification at 16 HVAC and 14 refrigeration sites. Metered data were used by engineers to develop energy and peak demand impacts. Data collection was compliant with ISO NE MMVDR standards and analysis with IPMVP protocols. Metering was timed to occur depending on measure type and season of operation. Metering was performed between June and December of 2019.

Application of Results: Retrospectively and Prospectively

A copy of the complete study can be found in Appendix 4D, Study 19-17.

Study 19-18: C&I Energy Optimization Study Task 3 Methodology Memo

Type of Study: Impact Evaluation

Evaluation Conducted by: Cadeo Group

Navigant Consulting

Date Evaluation Completed: 1/31/2020

Study Objective and Summary of Results:

The purpose of this study was to develop a spreadsheet model that characterizes and estimates the savings, costs, and lifetimes for a set of Commercial & Industrial ("C&I") energy optimization measures that use fuel switching to reduce customers' total energy usage across multiple fuel types.

The results of this study will be used to develop a C&I Energy Optimization program targeted at commercial customers in smaller commercial buildings that operate their own heating system (i.e., are not part of a larger centralized system). Specifically, the PAs are considering offering tailored incentives for electric heat pump systems that replace (or displace) existing oil space heating equipment. To facilitate the calculation of savings for C&I energy optimization measures, the study expanded the Energy Optimization Model (developed for the Residential offering in October 2018) to estimate savings for different sizes and types of C&I buildings up to 10,000 sq.ft. in size.

The Energy Optimization Model spreadsheet describes the energy consumption and demand savings, the energy cost savings, and the incremental installation costs for each of the fuel switching measures analyzed in this study. The outputs of the model vary depending on the replacement scenario (early replacement, partial displacement, or replace on failure) and the size and type of building selected. An example output table, describing the savings for small office buildings in a Partial Displacement scenario, is provided below.

	Partial Displacement							
	Measure ID	MEAS34	MEAS42	MEAS45	MEAS39	MEAS36	MEAS44	MEAS46
	Baseline Name	Ducted AC+Oil Furnace	Oil Furnace	Room AC+Oil Furnace	Ducted AC+Oil Boiler	Non-Ducted AC+Oil Boiler	Oil Boiler	Room AC +Oil Boiler
	Replacement Name	Central HP+Oil Furnace	Central HP+Oil Furnace	Central HP+Oil Furnace	Central HP+Oil Boiler	DMSHP +Oil Boiler	DMSHP +Oil Boiler	DMSHP +Oil Boiler
High Measure Level	Energy Cost Savings (USD/yr)	-65	-245	70	9	91	-78	238
	Oil Annual Consumption	54	54	54	57	57	57	57
	Electric Annual	-5,062	-6,195	-4,213	-4,838	-4,328	-5,386	-3,403
	Annual Energy Savings on	37	33	40	41	42	39	46
	Carbon Emissions	2.1	1.6	2.5	2.4	2.6	2.2	3.1

Core Initiatives or End Uses to which the Results of the Study Apply:

- Commercial & Industrial
- Existing Building Retrofit
- HVAC
- Electric Only

Evaluation Recommendations:

No formal recommendations were made in this evaluation.

Explain Whether or Not the PAs Decided to Adopt the Recommendations from the Study:

N/A (no formal recommendations were made in this evaluation)

How the Study Affects Program Results and Its Significance:

This study produced a spreadsheet tool that the PAs are using to assess the potential costs and savings for various energy optimization scenarios and measures based on user-defined inputs such as building type, size, cooling load, and heating load. It will help inform and prioritize the PAs' plans for deploying these measures under a C&I Energy Optimization program offering.

Overview of Study Method:

This study involved modeling oil-to-electric fuel conversions in small commercial buildings, based on research of heating loads and equipment configurations. The team gathered heat load and equipment information by conducting a customer survey and referencing the 2016 Massachusetts C&I Market Characterization Study and the U.S. EIA's Commercial Buildings Energy Consumption Survey ("CBECS").

Our team leveraged the residential Energy Optimization Model developed by the MA Residential PAs in Oct 2018. We added measures to the model to estimate savings and costs of oil-to-electric fuel switching for C&I customers with buildings smaller than 10,000 sq.ft. We also added analysis oil-to-gas and electric resistance-to-heat pumps. The table below summarizes the C&I measures analyzed in the updated Energy Optimization Model.

Baseline Equipment Type	**Replacement Equipment Type, by Replacement Scenario**	
	Partial Displacement	**Early Replacement or Replace on Failure**
Oil Furnace (no A/C)	Central HP + Oil Furnace	Central HP
Oil Furnace + Room A/C	Central HP + Oil Furnace	*(not modeled)*
Oil Furnace + Ducted A/C	Central HP + Oil Furnace	Central HP
Oil Boiler (no A/C)	DMSHP + Oil Boiler	DMSHP
Oil Boiler + Room A/C	DMSHP + Oil Boiler	*(not modeled)*
Oil Boiler + Ductless A/C	DMSHP + Oil Boiler	DMSHP
Oil Boiler + Ducted A/C	Central HP + Oil Boiler	*(not modeled)*
Oil Boiler	*(not modeled)*	Natural Gas Boiler
Oil Furnace	*(not modeled)*	Natural Gas Furnace
Electric Baseboard	*(not modeled)*	DMSHP
Non-Ducted A/C + Electric Baseboard	*(not modeled)*	DMSHP
Room A/C + Electric Baseboard	*(not modeled)*	DMSHP

For each of the measures listed above, our model estimates the energy consumption, demand, and costs at the baseline level and the measure level. These values are calculated using generalized assumptions about the capacity, efficiency, and performance of the baseline and measure-level equipment. The model then calculates the savings associated with each measure as the difference between the baseline level and the measure level.

The results from the Energy Optimization Model may be used for savings evaluation where site-specific calculations and measurements are not economical.

Application of Results: Prospectively

A copy of the complete study can be found in Appendix 4D, Study 19-18.

Study 19-19: Impact Evaluation of PY2017 Custom Gas Installations

Type of Study: Impact Evaluation

Evaluation Conducted by: DNV GL

Energy and Resource Solutions (ERS)

Date Evaluation Completed: 3/16/2020

Study Objective and Summary of Results:

The primary objective of this impact evaluation was to verify and re-estimate the energy savings for a sample of statistically selected PY2017 custom gas projects through site-specific inspection, monitoring, and analysis.

The study provides the following key findings:

- **PY2017 Performance.** The program continues to generate significant natural gas savings. The statewide PY2017 participation consisted of 630 distinct accounts, with adjusted gross savings of over 8 million therms annually. Until PY2016, the impact evaluation cycles were not conducted every year; they were determined by stakeholders based on an assessment of program stability.
- **Implementation of the Baseline Framework.** Since the rollout of the Baseline Framework, both the PAs and evaluators have been working to implement a more rigorous review of baselines and to prepare for the application of dual baseline methods in the 2019 program implementation.

  The Team commends the PAs for their selection of baselines for lost opportunity measures. We anticipate that the deployment of the Baseline Repository will help maintain this exemplary practice.

  Starting with PY2019, program gross lifetime savings could be modestly reduced by around 1% for dual baseline methods and by around 4% for adjustments to effective useful lives ("EULs") for both retrofit and lost opportunity measures to better reflect TRM-recommended EULs.
- **Future Evaluation.** Starting with the evaluation of PY2017, results from current and previous cycles will be rolled in to calculate a gross RR. The error ratio has been improving over time, with the exception of steam trap measures. The improved error ratio allows for smaller sample sizes for future impact evaluations.

Combined PA results and statewide summary

Results	Columbia Gas	Eversource	National Grid	Statewide
Two-year pooled RR	84%±11.7%	75%±14.5%	91%±8.6%	85%±6.5%
PY2017 RR	91% ±27%	77% ±16%	94% ±15%	87% ±10%
PY2016 RR	80% ±6%	72% ±25%	88% ±9%	82% ±9%

Core Initiatives or End Uses to which the Results of the Study Apply:

- Commercial & Industrial
- Custom
- Gas Only

Evaluation Recommendations:

The following recommendations were made by the evaluators conducting this study.

Recommendation 1: Use appropriate realization rates. The Team recommends that Columbia Gas, Eversource, and National Grid use their individual pooled RRs. Berkshire Gas, Liberty Gas, and Unitil should use the statewide pooled RR. The Team recommends using these RRs for planning and program reporting, starting with PY2019 and continuing to subsequent years until a new impact evaluation study is conducted and those results are rolled in.

Recommendation 2: Use protocol to determine error ratio. The Team has recommended a protocol for determining error ratios for future custom gas studies, as follows:

1. Average the actual and assumed error ratio from the previous impact evaluation for steam traps and non-steam-trap projects.
2. Round up to the nearest 0.05.
3. Establish a hard floor of 0.25.

The protocol incorporates the historical error ratio, which is embodied in the assumed error ratio, and the actual error ratio of the most recent study. Rounding the value up helps ensure that the target is met or exceeded.

Recommendation 3: Use current sampling methodology. The Team recommends using the current sample design method, as follows:

1. Plan for 20% for a three-year pooled relative precision at 80% confidence interval for Columbia Gas, Eversource, and National Grid results calculated for each program year.
2. Plan for 10% for a three-year pooled relative precision at 80% confidence interval for statewide results calculated for each program year.

3. The stakeholders will decide if for the next cycles, steam trap projects will be treated separately in the sample design.

Recommendation 4: Research methods for measures impacting steam traps and heat load. During the PY2017 evaluation, methodological questions were raised about steam traps and best practices for incorporating boiler efficiency into measures impacting the heating load (like steam traps and insulation). Steam traps constitute a large share of custom program savings and had a poorer realization rate in this evaluation. This raises the issue of whether steam trap measures should be treated as a separate segment within the custom program or even evaluated separately entirely. In addition, a statewide calculator is used to estimate steam trap savings. In 2016, this tool was vetted and calibrated using participant billing data. Potentially, the steam trap calculator could benefit from another round of calibration incorporating additional sites from recent evaluations. Measures such as insulation and steam traps reduce the heating load served by a boiler. Converting the heat load reduction from these measures to natural gas savings requires a boiler efficiency.

The Team recommends conducting a two-phase approach to resolving these issues. The purpose of the first phase is to use readily available data, best practices research, and interviews of knowledgeable staff to produce a clear problem statement and to conduct a high-level assessment of the potential value of additional research and the scope of that research. Phase two will execute the approved research recommended by the first phase.

Recommendation 5: Use lifetime impacts methods. The PAs have done a commendable job adopting correct ISP baselines. Stakeholders regularly referencing the new Baseline Repository should be helpful in continuing this practice. Application of dual baselines requires new lifetime savings calculation methods and includes closer scrutiny of EULs for both retrofit and lost opportunity measures. The Team recommends the following:

1. PAs adopt the recommendation made in the "Memorandum on Dual Baseline Calculation Practices and Assumptions, November 27, 2019" to maximize the accuracy of lifetime savings.
2. Starting with subsequent impact studies, evaluate lifetime savings impacts and calculate an adjustment factor to be applied to tracking lifetime savings. This factor should be applied to PY2020 tracking savings reported in the 2020 Plan Year Report in the spring of 2021.
3. Expand the in-progress PY2018 Custom Gas workplan to include the scope to provide the technical support and facilitation for implementing the lifetime savings adjustment.

Explain Whether or Not the PAs Decided to Adopt the Recommendations from the Study:

The PAs plan to adopt and/or are considering some of the recommendations, as described below.

The PAs have adopted Recommendation 1 and are considering all other Recommendations at this time.

How the Study Affects Program Results and Its Significance:

The study results increase the PY2017 reported gross savings for statewide by 3%, for Columbia Gas by 4%, for Eversource by 3%, and for National Grid by 3%.

Overview of Study Method:

The study approach was consistent with the procedures and protocols developed during the previous round of custom gas impact evaluation conducted for PY2016. The impact evaluation consisted of desk reviews, on-site visits, and metering of a randomly selected sample of projects at participating facilities.

The sample for the PY2017 impact evaluation was generated with the intention of pooling the annual evaluation results with the prior PY2016 results to produce a rolling updated result.[9] This allowed the sampling precision to meet the targets at the statewide level, as well as at the PA level for Columbia Gas, Eversource, and National Grid. The RRs will be updated each year as part of this custom gas evaluation framework. PY2016, PY2017, and PY2018 results will be pooled and applied to PY2020 savings in the 2021 term year report. In subsequent years, the realization rate will reflect pooling of the three most recent impact results.

PY2016 and PY2017 combined expected precision at 80% confidence interval

Program Administrator	PY2017 Sample(n)	PY2016 Actual RP	PY2017 Estimated RP	Overall Estimated RP
Berkshire Gas	1	N/A	N/A	N/A
Columbia Gas	6	17%	34%	17%
Eversource	14	23%	20%	15%
Liberty	1	N/A	N/A	N/A
National Grid	8	15%	27%	15%
Unitil	1	N/A	N/A	N/A
Statewide	**31**	**10%**	**16%**	**9%**

N/A = Not applicable

To support the findings of the study, the study was conducted using the following data sources:

- PY2017 tracking data provided by all six PAs that offer the program
- PY2016 tracking data
- PY2016 impact evaluation results

[9] This study is the second custom gas study completed under the impact evaluation framework. The intention is to eventually maintain a rolling three-year pooling of results so that when the fourth year is completed, the first year (PY2016) will be removed entirely.

- Project files, which typically include the following: applications, BCR screenings, invoices, technical assistance studies, applicant savings calculations, and post-installation reports
- On-site observations and data collection including inspection and verifications of equipment, nameplate data, staff interviews, vendor interviews, spot measurements of various parameters including kW, and combustion efficiency
- Metered and/or energy management system ("EMS") trend data from each of the 31 sites that participated in the study

The study results included the gross RRs (and associated precision levels) calculated using the results from PY2017 and PY2016. PY2016 impact evaluation results have been presented in the "Impact Evaluation of 2016 Custom Gas Installations" report issued in March 2019.

Application of Results: Retrospectively and Prospectively

A copy of the complete study can be found in Appendix 4D, Study 19-19.

Study 19-20: Impact Evaluation of PY2017-2018 Custom Electric Installations

Type of Study: Impact Evaluation

Evaluation Conducted by: DNV GL

Energy and Resource Solutions (ERS)

NMR Group

Second Law Engineers (DMI)

Date Evaluation Completed: 3/26/2020

Study Objective and Summary of Results:

The objective of this impact evaluation is to provide verification or re-estimation of electric energy and demand savings estimates for a sample of custom lighting and non-lighting electric projects through site-specific inspection, monitoring, and analysis.

The results of this study are realization rates for custom lighting and non-lighting electric energy efficiency measures. Realization rates were determined at the statewide level as well as separately for Cape Light Compact, Eversource, and National Grid.

This Interim Results Memo is intended to lock in evaluation results for Custom Lighting and Custom Non-Lighting for the 2019 plan year report (PYR). In order to meet the PA-requested interim deadline for this memo, the sites were systematically prioritized and 83 of the total 93 sampled sites were included in this memo. Results for the remaining 10 sites not included in the Interim Results Memo will be included in the final report in April 2020 and are intended to be part of the rolling evaluation data set going forward.

The study provides the following key findings:

Custom Lighting		Statewide (n=23)*	Cape Light Compact (n=4)	Eversource (n=9)	National Grid (n=8)
Gross Annual MWh Savings - Realization Rates @ 90% Confidence	Two-year pooled RR	100% @ ±7.2%	93% @ ±4.2%	103.2% @ ±9.8%	96.4% @ ±10.5%
	PY2017/18 RR	107.3% @ ±13.7%	91.6% @ ±1.5%	116.8% @ ±15.8%	90.7% @ ±23.5%
	PY2016 RR	93.9% @ ±6.7%	93.9% @ ±6.7%	88.3% @ ±10.9%	99.8% @ ±9.1%
Gross Summer On-Peak kW Savings - Realization Rates @ 80% Confidence	Two-year pooled RR	93% @ ±9.8%	94.2% @ ±5.8%	85.1% @ ±16%	101.9% @ ±12%
	PY2017/18 RR	98.8% @ ±16.4%	99.3% @ ±3.5%	99.7% @ ±21.8%	96.2% @ ±28.5%
	PY2016 RR	88.4% @ ±11.7%	88.4% @ ±11.7%	67.1% @ ±23.4%	104% @ ±12.7%
Gross Winter On-Peak kW Savings - Realization Rates @ 80% Confidence	Two-year pooled RR	82.7% @ ±9.6%	78.1% @ ±5%	78.8% @ ±15.4%	93.1% @ ±11.7%
	PY2017/18 RR	82.5% @ ±18.1%	73.8% @ ±5.4%	78.5% @ ±26.8%	105% @ ±25.4%
	PY2016 RR	82.9% @ ±8.8%	82.9% @ ±8.8%	79.2% @ ±14.9%	85.2% @ ±9.8%
* The statewide results include two Unitil samples					

Custom Non-Lighting		Statewide (n=58)*	Cape Light Compact (n=16)	Eversource (n=21)	National Grid (n=19)
Gross Annual MWh Savings - Realization Rates @ 90% Confidence	Two-year pooled RR	71% @ ±8.7%	77.5% @ ±3.7%	73% @ ±10.8%	67.9% @ ±14.3%
	PY2017/18 RR	75.4% @ ±15.5%	84.6% @ ±1.9%	79.3% @ ±19.2%	72.5% @ ±27%
	PY2016 RR	67% @ ±8.7%	67% @ ±8.7%	67.1% @ ±10.9%	64.2% @ ±14.4%
Gross Summer On-Peak kW Savings - Realization Rates @ 80% Confidence	Two-year pooled RR	79.7% @ ±9.3%	76.1% @ ±5.3%	83.1% @ ±13.2%	77.5% @ ±12.3%
	PY2017/18 RR	92.4% @ ±14.6%	79.1% @ ±5.3%	104.6% @ ±21.8%	87.2% @ ±19.2%
	PY2016 RR	69.8% @ ±11.9%	69.8% @ ±11.9%	67.6% @ ±16.4%	69.5% @ ±15.8%
Gross Winter On-Peak kW Savings - Realization Rates @ 80% Confidence	Two-year pooled RR	73.5% @ ±14.1%	60.9% @ ±5.2%	85.4% @ ±19%	64.3% @ ±18.5%
	PY2017/18 RR	96.7% @ ±31.2%	63.4% @ ±2%	137% @ ±43.1%	61.9% @ ±40.7%
	PY2016 RR	58% @ ±10.9%	58% @ ±10.9%	52% @ ±14.4%	66% @ ±12.9%
* The statewide results include four Unitil samples and exclude two National Grid franchise samples					

Core Initiatives or End Uses to which the Results of the Study Apply:

- Commercial & Industrial
- Custom
- Electric Only

Evaluation Recommendations:

The following recommendations were made by the evaluators conducting this study.

Recommendation 1: The realization rates from this study should be applied retrospectively to custom lighting and non-lighting projects installed in 2019.

1. Cape Light Compact, Eversource, and National Grid should use their own two-year pooled PA specific realization rates for lighting and non-lighting projects, respectively.

2. Unitil should use the statewide two-year pooled realization rates for lighting and non-lighting projects, respectively.

Recommendation 2: A concurrent ISP study on lighting in indoor cannabis growing facilities determined the ISP baseline at the time of these projects was 1,000 watt high pressure sodium lamps with electronic ballasts. However, the Cannabis Control Commission (CCC) has set new regulations which establish a maximum allowable lighting power density that all growers will have to meet going forward, which is expected to impact all lighting projects done at these facilities. It is recommended that the PAs adopt the cannabis ISP once it is made available in early 2020. The full custom electric study report will adapt this recommendation following the finalization of the cannabis ISP study.

Recommendation 3: The evaluation team recognizes that the PAs have been making improvements to how they approach making baseline decisions. Similar to the PY2016 custom electric study, this study also recommends the PAs provide more supporting information on baseline selection in the project documentation. Given the impact that baseline changes had in this study, particularly for non-lighting projects, the program should document how the measure event type and baseline selection decision was made. The evaluation team also recognizes that the PAs and EEAC have developed a policy for performing ex-ante reviews by the evaluators. This process should help support the PAs with their baseline decision making process.

Explain Whether or Not the PAs Decided to Adopt the Recommendations from the Study:

The PAs plan to adopt and/or are considering some of the recommendations, as described below.

The PAs have adopted Recommendation 1 and are considering Recommendations 2 and 3.

How the Study Affects Program Results and Its Significance:

This is the second rolling evaluation of full custom electric installations covering both lighting and all other custom electric end-uses, excluding CDA and CHP. Overall, the statewide realization rates have improved as compared to the results from the study covering PY2016. Statewide, the improvements in realization rates between the two-year pooled results and PY2016 for gross annual MWh are:

- Custom Lighting: + 6.5%
- Custom Non-Lighting: + 6.0%

Overview of Study Method:

- Examined the 2017 and 2018 large C&I custom electric population to determine summer dependent and non-summer dependent projects for sampling purposes. 2017 summer dependent sites and 2018 non-summer dependent and 2018 census strata (largest) sites were included in the sample design.
- Designed an efficient sampling plan for the selection of custom lighting and non-lighting projects to achieve the agreed relative precision targets using the error ratios determined in the previous custom electric evaluations. The primary sample design for this study was expected to achieve a statewide lighting and non-lighting electric energy savings realization rate results with ±10% relative precision at the 90% confidence interval when combined with PY2016 results. Cape Light Compact, National Grid, and Eversource lighting and non-lighting electric energy savings precision targets were each set at ±15% for each PA at the 90% confidence interval.
- Reviewed the TA studies, model files, and calculations used to develop the tracking savings for each sampled participant to develop site specific M&V plans.
- Performed comprehensive data collection, including metering and trend data, at each sample site to support an independent analysis of achieved gross electric energy savings realization rates.
- Established baselines for each sampled project based on the materials reviewed and additional data collected.
- Documented the evaluation activities completed in comprehensive site-specific M&V reports.
- The site level evaluation results were aggregated using the final adjusted case weights. The PA realization rates were calculated and then applied to each PA's total tracking savings to determine their total evaluated savings. The statewide realization rate is the ratio of the total evaluated savings to the total tracking savings, each of which is calculated by summing across the PAs.

A**pplication of Results:** Retrospectively and Prospectively

A copy of the complete study can be found in Appendix 4D, Study 19-20.

Study 19-21: C&I Early Replacement Study – Interview Findings Memo

Type of Study: Market Characterization or Assessment Evaluation

Evaluation Conducted by: Cadeo Group Navigant Consulting

Date Evaluation Completed: 2/4/2020

Study Objective and Summary of Results:

The primary goal of the study was to determine the proportion of C&I natural gas furnace, boiler, and water heater installations associated with the three following baseline event types: early replacement ("ER"), replace on failure ("ROF"), and new construction ("NC"). Information about these proportions would allow PAs to update the existing assumptions related to the frequency of early replacement for these three C&I natural gas measures and, if desired, tailor incentive amounts and reported savings for specific C&I gas equipment and baseline event types.

Based on 172 interviews with recent C&I participants that collectively installed 1,078 program units, the study determined following early replacement rates for each measure and/or measure type:

Measure	Type	ER	ROF/NC
Boilers	All	13%	87%
Furnaces	All	6%	94%
Water Heaters	Volume/Indirect	24%	76%
	Storage/Tankless	1%	99%

Core Initiatives or End Uses to which the Results of the Study Apply:

- Commercial & Industrial
- C&I New & Replacement Equipment
- HVAC & Hot Water
- Gas Only

Evaluation Recommendations:

The following recommendations were made by the evaluators conducting this study.

- **Recommendation 1:** Based on the team's analysis of the interview results, we recommended the PAs use the values shown in the table above if they decide to account for early replacement rates when developing incentives or reporting savings for these three C&I measures.

Please note that the team recommends two rates for water heaters, depending on the water heater type. Aggregating the results across water heater types helps offset the potential effects of sampling error (i.e., the chance that sampled units do not accurately represent the program overall) and increases the reliability of the results.

Explain Whether or Not the PAs Decided to Adopt the Recommendations from the Study:

The PAs are considering all recommendations for adoption at this time. The PAs have not formally adopted or rejected any recommendations that require changes to program design and operations.

How the Study Affects Program Results and Its Significance:

The effect of the recommendations is expected to increase annual savings for relevant units as ER baselines would be blended with traditional, ROF baseline assumptions. However, evaluation stakeholders will need to discuss exactly how to fold these recommendations into program assumptions.

Overview of Study Method:

To determine the proportion of PA-incented units associated with each event type, our team completed 172 short interviews with recent C&I gas equipment program participants.

The table below summarizes the number of completed interviews by measure and, since some participants installed more than one measure and/or were associated with more than one project, the total number of program units represented by those interviews. The table also denotes the year that interview respondents participated in the program, as well as the source of program data that our team used to develop the interview call list.

Measure	Interviews	Units	Units/Interview	Program Data
Boilers	75	86	1.1	2017 (via PAs' C&I Data Management team)
Furnaces	14	18	1.3	
Water Heaters	83	974	11.7	2018 and Q1 2019 (via PAs' upstream program implementer)
Total	**172**	**1,078**	**6.3**	

Prior to launching the interviews, our team collaborated with the PAs and Energy Efficiency Advisory Council consultants to apply the PAs' existing C&I Baseline Framework methodology to the three measures of interest and to develop an algorithm to associate each interviewee's collective responses with a specific event type.

Application of Results: Prospectively

A copy of the complete study can be found in Appendix 4D, Study 19-21.

Study 19-22: New Construction Energy Use Intensity Baseline

Type of Study: Market Characterization or Assessment Evaluation

Evaluation Conducted by: DNV GL

Date Evaluation Completed: 2/10/2020

Study Objective and Summary of Results:

The purpose of this study was to assess whether the MA Data Warehouse maintained by DNV GL could be used to:

- Estimate energy use intensity ("EU"I) baselines for various building types participating in the PAs' new construction initiatives
- Identify supplemental information that may be needed to support the creation of EUI baselines

The study provides the following key findings:

- DNV GL was able to generate average EUI estimates for most building-use size categories using square footage from tax data and building level energy consumption from the PAs; however, the estimates for some categories were extremely variable or represented very few buildings.
- Building-use size categories with less variable EUI estimates that might be used to develop baselines included large (>50,000 sq ft) education, outpatient healthcare, office, multifamily, food sales, lodging, and warehouse and storage. The study found that the PAs should consider collecting additional information for these categories to refine the EUI estimates.
- Development of EUI estimates using tax and consumption data is complicated by four issues:
    - There is sometimes not a direct relationship between tax parcel square footage and account consumption. This is especially prevalent for large campuses that fall on a single tax parcel (e.g. some universities, healthcare, manufacturing). If it is not possible to associate the correct consumption with the correct square footage, it is not possible to calculate an accurate EUI.
    - The land-use types in the tax data are occasionally too broad to develop accurate EUIs without additional information. For example, primary care physicians and medical imaging centers would both fall under "medical office buildings" but would have vastly different EUI estimates.
    - For buildings in Massachusetts with net-metered on-site generation, it is not possible to calculate an accurate EUI using consumption data, since it is not

possible to know the full extent of a building's consumption without additional information.

- For buildings in Massachusetts using an energy source not provided by the PAs (propane, fuel oil, steam, etc.), it is not possible to calculate an accurate EUI, since we have no information regarding a large part of the building's consumption.

Core Initiatives or End Uses to which the Results of the Study Apply:

- Commercial & Industrial
- New Buildings & Major Renovations
- All End Uses
- Electric & Gas

Evaluation Recommendations:

No formal recommendations were made in this evaluation.

Explain Whether or Not the PAs Decided to Adopt the Recommendations from the Study:

N/A (no formal recommendations were made in this evaluation)

How the Study Affects Program Results and Its Significance:

This study does not affect program results. It served as an informational research effort to determine whether the PAs could develop EUI baselines for use by their C&I new construction initiatives using information from state tax records and the PAs' customer consumption data. Specifically, the PAs wished to develop EUI baselines to calculate savings resulting from their new Deep Energy Savings and Whole Building Modeled pathways, under which incentives are based on achieving low EUIs. Based on one of the study findings that the PAs should consider collecting additional information for certain building-use size categories to refine estimates, there will likely be a follow-on study in 2020 to collect that information.

Overview of Study Method:

DNV GL used square footage and land use information from the MA L3 tax database and Boston tax database, along with consumption information from the MA PAs, to develop average EUI estimates for new construction buildings by dividing total building consumption by total building square footage. To allow comparison of the results with other data sources, we cross walked the land use types in the tax data to CBECS building classes. To make our estimates as applicable as possible to new construction buildings, we limited our analysis of buildings in the tax data to those built beginning in 2010.

Application of Results: Prospectively

A copy of the complete study can be found in Appendix 4D, Study 19-22.

Study 19-23: Indoor Cannabis Lighting ISP Prior to 935 CMR 500

Type of Study: Impact Evaluation

Evaluation Conducted by: DNV GL

Energy and Resource Solutions (ERS)

Date Evaluation Completed: 3/5/2020

Study Objective and Summary of Results:

The primary objective of the Cannabis ISP study is to define industry standard practice ("ISP") for indoor cannabis cultivation in Massachusetts. This memo considers only retrospective horticultural lighting ISP for cannabis facilities. The full report, to be completed in 2020, will consider prospective ISP as well as systems beyond lighting. The full study considers processes and equipment related to the cultivation and preparation of medical and adult-use cannabis including horticultural lighting, cultivation area HVAC, and extraction process equipment.

The study provides the following key findings:

- ISP is greatly impacted by lighting power density limitations enacted by the Massachusetts Cannabis Control Commission (CCC) that went into effect in November 2016. Therefore, the study looked at ISP prior to November 2016. Pre-November 2016 ISP findings are presented in the table below. Post-November 2016 ISP will be addressed in the full report.

ISP conclusions for horticultural lighting prior to 2016 CCC regulations

Stage	Industry Standard Practice
Flower/bloom	1,000-watt double-ended HPS, with electronic ballast
Vegetative	1,000-watt single-ended metal halide
Clone/seedling	4LT5HO fluorescent
Mother	1,000-watt single-ended metal halide

Core Initiatives or End Uses to which the Results of the Study Apply:

- Commercial & Industrial
- All Initiatives
- Lighting
- Electric Only

Evaluation Recommendations:

The following recommendations were made by the evaluators conducting this study.

Recommendation 1: The PAs should adopt electronic ballasts for double-ended high pressure sodium fixtures as ISP for retrospective lighting applications in cannabis facilities. The Team recommends an ISP of electronic ballasts for double-ended high pressure sodium fixtures.

Recommendation 2: Ensure baseline and proposed designs produce equivalent PPFD. The Team recommends that applicants model the baseline and proposed lighting designs to ensure equivalent photosynthetic photon flux density ("PPFD"). Academic studies on non-cannabis crops have shown a strong (nearly 1-to-1) relationship between intensity of PAR light and photosynthesis.[10] Since PAR is a major factor in photosynthesis and plant growth, it is important to ensure that comparisons between lighting technologies or designs produce equivalent PAR delivered to the canopy. PAR at the canopy is expressed as photosynthetic photon flux density (PPFD, µmol/m2/s) and is the appropriate metric for comparing lighting designs in terms of equivalent light intensity. While numerous factors influence plant growth, including the different spectrum output of various lighting technologies, establishing equivalent PPFD for baseline and proposed systems currently provides the best method for ensuring equivalency of light intensity delivered to the plants.

A comparison of different horticultural lighting designs requires modeling to ensure equal PPFD at the canopy, considering the lighting technology and its unique light distribution, fixture spacing, mounting height, and the canopy footprint.

Recommendation 3: Adopt horticultural lighting technology ISPs provided by this study. The Team recommends using the fixture technologies provided in the table above as ISP for projects prior to November 2016 for the various phases of growth.

Recommendation 4: Adopt a consistent methodology for calculating horticultural lighting impacts based on ISP. For retrospective projects prior to CCC regulation, adopt the following methodology for calculating horticultural lighting impacts.

- Identify the phase of cultivation and select the appropriate baseline technology per the table above.
- Identify the project's target PPFD for that phase of growth. This value will differ based on the cultivator's preference for lighting design.
- Model the base-case, using the technology identified in the table above, and the proposed case to validate PPFD equivalency of the two designs. Most LED vendors and many service providers can generate this modeling. Modeling can be performed or validated with AGi32 lighting analysis software.
- Calculate the connected wattage of the PPFD-equivalent base-case and proposed designs. The difference in wattage is the demand reduction.

[10] Bugbee, *Effects of Radiation Quality, Intensity, and Duration on Photosynthesis and Growth*, International Lighting in Controlled Environments Workshop.

- Calculate the annual lighting energy impacts based on fixture run hours, a value specific to each phase and project and referred to as the photoperiod. The flower phase photoperiod is 12 hours. The vegetative, mother, and clone photoperiods are either 18 or 24 hours, depending on cultivator preference.
- Calculate the interactive HVAC impacts of the proposed lighting design.

Explain Whether or Not the PAs Decided to Adopt the Recommendations from the Study:

The PAs are considering all recommendations for adoption at this time. The PAs have not formally adopted or rejected any recommendations that require changes to program design and operations.

How the Study Affects Program Results and Its Significance:

The study results reduce savings for two PY2019 custom electric sites that included cannabis cultivation related projects based on new baselines for lighting.

Overview of Study Method:

Data sources on this project include expert interviews from cannabis professionals with experience working in Massachusetts facilities. These fall into two groups, cultivators and service providers. Service providers consist of all supporting vendor and consulting professionals that assist in the design and construction of a cannabis facility.

In addition to the interviews, the Team made use of the Resource Innovation Institute ("RII") Cannabis PowerScore database, a national self-reported database on cannabis facility equipment, energy use, and production to assess national ISP for lighting technologies. Secondary research was also performed as part of the study.

Application of Results: Retrospectively

A copy of the complete study can be found in Appendix 4D, Study 19-23.

Study 19-24: 2019 C&I Lighting Inventory & Market Model Update

Type of Study: Market Characterization or Assessment Evaluation

Evaluation Conducted by: DNV GL

NMR Group

Date Evaluation Completed: 4/6/2020

Study Objective and Summary of Results:

The primary goal of the 2019 Lighting Inventory and Market Model Update study was to produce adjusted measure lives ("AMLs") for major commercial and industrial ("C&I") lighting applications using lighting market data collected to improve the Lighting Market Model (the Model). The research conducted during this study to support the Model and AML updates focused on three main C&I lighting applications: ambient linear, high & low bay, and building exterior & outdoor lighting. This study also presents AMLs for traditional screw-based categories (a-line, downlight/track, and decorative lighting). DNV GL did not research this equipment on this study and thus presents AMLs based on market share forecasts from the April 2019 version of the Model. The final recommended AMLs are listed in the table below.

Recommended AMLs

Application	Equipment Type	2019	2020	2021
Ambient Linear	TLED	10.98	10.68	10.53
Ambient Linear	LED Fixture	11.39	11.13	10.99
High/Low Bay	TLED	13.22	12.96	12.81
High/Low Bay	LED Fixture	13.25	12.99	12.84
High/Low Bay	LED Lamp	13.02	12.73	12.56
Exterior/Outdoor	TLED	10.45	10.32	10.12
Exterior/Outdoor	LED Fixture	10.50	10.37	10.18
Exterior/Outdoor	LED Lamp	10.10	9.96	9.74
Screw-Based	A-Line	4.99	4.82	4.69
Screw-Based	Downlight/Track	5.89	5.88	5.86
Screw-Based	Decorative	4.07	3.99	3.78

In addition to AMLs, the study provides the following key findings on the state of the C&I lighting market:

- Ambient Linear: TLEDs and LED integrated fixtures continue to replace fluorescent technologies at a rapid pace, with LED integrated fixtures growing at a faster rate than TLEDs as a result of PA program support. It appears that many LEDs are replacing T8s.

- High/Low Bay: the dominant technology type in high/low bay lighting is linear, so the largest opportunity in this market is for TLEDs and LED integrated fixtures to continue to replace the T8s and the T12s that continue to persist in the market.
- Building Exterior/Outdoor: there is a lot of diversity of products within this submarket, but opportunities to replace metal halide and high-pressure sodium lamps remain.

Core Initiatives or End Uses to which the Results of the Study Apply:

- Commercial & Industrial
- All Initiatives
- Lighting
- Electric Only

Evaluation Recommendations:

The following recommendations were made by the evaluators conducting this study.

> **Recommendation 1:** We recommend the PAs adopt the PY2019 retrospective AMLs for all ER and ROF measures reflected in the table above for upstream, prescriptive, and custom lighting program installations.
>
> **Recommendation 2:** We recommend the PAs examine the AML assumptions as they apply to the ROF component of the calculations. Currently, the current AML calculations for ambient linear, high/low bay, and building exterior/outdoor use the same EUL for ROF in LED and non-LED technologies based on the lighting systems values in the Massachusetts electronic Technical Reference Manual.

Explain Whether or Not the PAs Decided to Adopt the Recommendations from the Study:

The PAs plan to adopt and/or are considering some of the recommendations, as described below.

The PAs are adopting Recommendation 1 and considering Recommendation 2.

How the Study Affects Program Results and Its Significance:

Gross lifetime savings for the Program Administrators C&I lighting programs are assessed as a product of the first-year annualized savings and the AML. Since early replacement ("ER") measures are subject to dual baseline savings methods, the AML is used to account for both replace-on-failure ("ROF") and ER. For ROF, the lifetime savings are equal to the product of first-year savings and the effective useful life ("EUL"), whereas the lifetime savings for ER are equal to the sum of the first- and second-period lifetime savings. Using an AML instead of the EUL will reduce the gross lifetime savings for all upstream and downstream prescriptive and custom lighting measures.

Overview of Study Method:

To support the AML updates, the DNV GL team used a variety of methods to research C&I lighting market indicators which were used to refine the Model's saturation and market share forecasts and the resulting AML calculations. Methods included:

On-Site Lighting Inventories (n=107)	Distributor and Manufacturer Interviews (n=30)	ER/ROF Customer CATI Surveys (n=511)	Additional Research
•Estimated the stock of installed fixtures by application and equipment type in 2019 •Compared current saturation estimates to 2015 and 2018 saturation estimates	•Estimated market share by application and equipment type in 2019, 2021, and 2023 •Created a counterfactual for the Model scenarios by asking about sales with continued program support versus program support ending after 2018	•Asked a series of questions to inform an algorithm which assigned lighting projects and replacements to New Construction, ER, and ROF event types •Included updated ROF fraction in AML calculation	•Aggregated program tracking sales data to compare Model results to gross and net program sales •Reviewed secondary data sources to validate or qualify Model input assumptions •Compared Model results to national and regional forecasts

Application of Results: Retrospectively and Prospectively

A copy of the complete study can be found in Appendix 4D, Study 19-24.

Study 19-25: Analysis of Residential HVAC Sales Data from HARDI Distributors

Type of Study: Market Characterization or Assessment Evaluation

Evaluation Conducted by: NMR Group

Date Evaluation Completed: 11/15/2019

Study Objective and Summary of Results:

The purpose of this study was to purchase and analyze HARDI residential HVAC sales data on behalf of the PAs to assess the market share represented by Mass Save programs from 2013 to 2018, the potential for using these data to quantify market effects, and how the HARDI market size estimates compared to estimates collected from distributors via the 2018 Residential HVAC Efficient Market Share Estimates study. The HARDI data are derived from sales invoices from HVAC distributors that are members of Heating, Air-conditioning, & Refrigeration Distributors International ("HARDI"). The data span from 2013 into 2019 for central air conditioners ("CAC"), air source heat pumps ("ASHP"), gas and oil furnaces, and boilers.

The study provides the following key findings:

- Sales of most equipment types increased modestly from 2013 to 2018, with only central ASHP sales staying flat.
- More than half of annual CAC sales from 2013 to 2018 were 13 SEER, the least efficient units allowed by federal standards. In contrast, nearly 60% of annual gas furnace sales were high efficiency (95 AFUE or better). The mini-split ASHP market grew over this period and has increasingly shifted toward higher-efficiency models; the least efficient models (below 15 SEER) all but disappeared from the market in 2015 as federal standards increased.
- From 2014 through the first half of 2017, the PA programs incentivized about 10% of all gas furnaces, central ASHP, and CAC systems sold in Massachusetts, just over 25% of gas boilers, and over 75% of all mini-split ASHP systems.
- The HARDI data appear to be useful for market effects quantification via cross-sectional analysis using direct comparison or modeling approaches. Should the PAs choose to use the HARDI data to quantify market effects in future, it would be best to first explore the viability of modeling, and if modeling proves to be a viable approach, to undertake both direct comparison and modeling to triangulate the market effects.
- There is a role for both primary data collection from HVAC distributors like that conducted for the study and for HARDI data. HARDI time series data provide estimates of market share by efficiency from a large and stable group of distributors and can serve the backbone of market effects studies, while TXC52-style data collection efforts are useful for triangulating estimates of market size and obtaining market insights to inform market effects and other studies.

- The HARDI data include only the cooling performance of ASHP systems, not their heating performance. The study team developed regression models to estimate heating performance based on the cooling specifications included in the HARDI data.
- There is no reason the PAs to purchase additional custom reports from D+R to meet PA evaluation needs.

Core Initiatives or End Uses to which the Results of the Study Apply:

- Residential
- All Program Paths
- HVAC
- Electric & Gas

Evaluation Recommendations:

No formal recommendations were made in this evaluation.

Explain Whether or Not the PAs Decided to Adopt the Recommendations from the Study:

N/A (no formal recommendations were made in this evaluation)

How the Study Affects Program Results and Its Significance:

The study has no quantitative recommendations or findings from the research conducted but did explore the residential HVAC market by equipment efficiency and capacity in Massachusetts and comparison states. The study found that the data may support market effects quantification which opens the possibility of future studies to quantify savings from PA programs' indirect effects on the Massachusetts markets for residential CAC equipment, ASHPs, and gas and oil furnaces. The data can also be used to estimate the market share represented by interview and survey respondents for other HVAC studies, and so determine the extent to which a given sample of respondents reflects the broader market.

Overview of Study Method:

The study team conducted a high-level review of how D+R compiles HARDI data from its distributor partners and scales up the results to represent the market and compiled and compared 2014-2017 program records with HARDI sales to estimate the PAs' market share (i.e., the percentage of units sold that received incentives from PA programs).

As HARDI data do not include ASHP heating capacity or efficiency values, which are necessary to assign the data into program bins, the study team approximated these missing values. To estimate the heating performance of those systems, the team used the Air-Conditioning, Heating, and Refrigeration Institute ("AHRI") product specification data to investigate the correlation

between cooling performance and heating performance for ASHP systems and applied those correlations to the cooling-only data included in the HARDI dataset. After testing multiple modeling approaches, the NMR team generated average HSPF values based on cooling capacity and SEER for nearly 800,000 heat pump systems from the AHRI directory and ran regressions on the results.

Application of Results: Prospectively

A copy of the complete study can be found in Appendix 4D Study 19-25.

Study 19-26: Market Effects from Ductless Mini-Split Heat Pump Integrated Controls

Type of Study: Market Effects Evaluation

Evaluation Conducted by: NMR Group

DNV GL

Date Evaluation Completed: 3/31/2020

Study Objective and Summary of Results:

The objective of this study was to assess whether the PAs' support of Ductless Mini-Split Heat Pump ("DMSHP") integrated controls has made a substantial, lasting impact on the market for these integrated controls and for cold-climate DMSHPs. The study provides a qualitative assessment of the degree of market effects.

The study provides the following key findings:

- The research confirms the underlying program theory that a major barrier to more widespread adoption and use of cold-climate DMSHPs for heating is the lack of an easy way for customers to optimize using DMSHPs efficiently in combination with fossil fuel heating equipment. The research also validates the program logic.
- The integrated controls market in Massachusetts is at the beginning of the early adopters stage of the innovation adoption curve. The target market is Massachusetts homes heated with delivered fuels that could conceivably use DMSHPs for heating and benefit from an integrated control. A rough estimate of the rate of adoption of DMSHPs with integrated controls in 2019 by the target market is 0.4%.
- There are substantial opportunities for progress in this market. A rough estimate of the remaining number of Massachusetts homes in the target market as of January 2020 is about 338,000.
- The evaluation team calculated a preliminary estimate of 2019 Massachusetts market share of DMSHPs sold in conjunction with integrated controls of 13%. The quarterly data suggest that market share increased from 0% in Q1 to 34% in Q4. The estimate should be recalculated with final rebate data when these data become available.
- The PAs were partly responsible for accelerating the development of the market for DMSHP integrated controls in Massachusetts—but not for establishing it, as the market is still in the process of being established. The PAs' share of responsibility for raising manufacturer awareness of DMSHP integrated controls is at least one-third. The PAs' share of responsibility for motivating manufacturers to offer these products is at least one-half.
- The research suggests that there could be savings from market effects due to the PAs' early activities helping to accelerate the market for integrated controls and the PAs' ongoing program support for this product. These market effects could be quantified through a

market-focused approach to measuring NTG using the supply-side market actor self-reported counterfactual analysis method and the steps described in the report.

Core Initiatives or End Uses to which the Results of the Study Apply:

- Residential & Commercial & Industrial (the primary focus is on Residential)
- Existing Building Retrofit
- HVAC
- Electric & Gas
- Energy Optimization

Evaluation Recommendations:

No formal recommendations were made in this evaluation.

Explain Whether or Not the PAs Decided to Adopt the Recommendations from the Study:

N/A (no formal recommendations were made in this evaluation)

How the Study Affects Program Results and Its Significance:

This study's findings offer evidence that the PAs' support of integrated controls for DMSHPs may result in—or have already resulted in—market effects that are large enough to warrant measuring. The study laid out a plan for quantifying market effects in future and identified additional market effects indicators.

Overview of Study Method:

The evaluation team used the evaluation approach of historical tracing to assess the validity of the predefined theory of how and why the initiative should work, or the program logic. The sources of data for historical tracing included structured in-depth interviews with program administrator staff and implementation staff (2); market actors (19); and selected energy-efficiency organizations (5). The research also relied on the implementation contractor's documentation of outreach activities with market actors, 2018 US Census data, the PAs' 2019 Key Progress Indicator data, 2019 Massachusetts residential HVAC sales data (HARDI data) from D+R International, and various evaluation reports.

Application of Results: Prospectively

A copy of the complete study can be found in Appendix 4D, Study 19-26.

Study 19-27: Residential New Construction Baseline/Compliance Study

Type of Study: Market Characterization or Assessment Evaluation

Evaluation Conducted by: NMR Group

Date Evaluation Completed: 4/1/2020

Study Objective and Summary of Results:

The primary objective of this study was to update the User-Defined Reference Home ("UDRH") used by the Residential New Construction Program ("RNC") in Massachusetts. The program determines a home's efficiency over a baseline by comparing an energy model of the home to an energy model of a baseline home or UDRH. Other objectives included identifying statewide baseline efficiencies for measures included in the UDRH; assessing code compliance and measure-level efficiency of program and non-program homes under the base code (2015 International Energy Conservation Code ("IECC")) and stretch code that were current at the time of the study; and identifying which measures could provide the largest savings opportunities for the low-rise RNC program and Codes and Standards Compliance Support ("CSCS") moving forward. The 2015 IECC base code and the 2015 stretch code both went into effect on January 1, 2017. This is the first study to assess the efficiency of homes built under these new codes.

The study provides the following key findings:

- New non-program homes are about 14% more efficient than homes built in 2015, when the last baseline study was conducted. Non-program homes built under the new stretch code are about 11% more efficient than those built under the old stretch code.
- Program homes are about 7% more efficient than non-program homes, but the difference in efficiency between program and non-program homes is decreasing.
- The program comprised 70% of the single-family new construction market in 2019.
- Including program homes, the average overall code compliance for base code towns has increased from 86% to 94% since 2015. During this time, the average for stretch code towns stayed relatively constant, at 96% in 2015 and 98% in 2019.
- Efficient builders are changing their practices to address building energy consumption more holistically. The share of homes with insulated basements has increased from 29% to 40% since 2015. The share of homes with sealed attics has increased from 10% to 39% over that same time.
- Homes increasingly use heat pumps as a primary source of heating, cooling, and water heating. Compared to the previous evaluation, the share of homes with heat pumps as their primary equipment type increased from 2% in 2015 to 14% in 2019 for heating, from 5% to 16% for cooling, and from 11% to 17% for water heating.

- The use of spray foam as insulation increased since the previous evaluation, especially in vaulted ceilings (from 14% in 2015 to 60% in 2019), walls (from 8% to 31%), and foundation walls (from 30% to 40%).

Core Initiatives or End Uses to which the Results of the Study Apply:

- Residential
- New Homes & Renovations
- Envelope & All End Uses
- Electric & Gas

Evaluation Recommendations:

The following recommendations were made by the evaluators conducting this study.

Recommendation 1: The RNC program should adopt the UDRH inputs as the baseline values for modeling energy savings for low-rise RNC projects in Massachusetts. This study finds that market transformation effects created by past RNC efforts have created a situation where the savings gap between program homes and non-program homes has shrunk considerably in the three years since the previous baseline evaluation. Specifically, the updated UDRH represents a significant improvement in home energy intensity compared with the current UDRH. Based on a sample of 2018-2019 program projects, the average home participating in the program was 25% less energy intensive than the current UDRH home, but only 7% less energy intensive than the updated UDRH. This dramatic shift warrants comprehensive consideration by program implementors of how the new baseline will affect participation, claimable savings, and program cost-effectiveness. It will be critical for program implementors to consider whether any changes to program design are necessary to enable the program's continued pursuit of all cost-effective energy efficiency.

Explain Whether or Not the PAs Decided to Adopt the Recommendations from the Study:

The PAs plan to adopt the recommendations.

How the Study Affects Program Results and Its Significance:

The updated UDRH from this study which will be used to determine a program home's incremental efficiency by comparing an energy model of the program home to an energy model of a baseline home. The study may also be used to develop key inputs and background information to inform future net-to-gross, passive design, and incremental cost evaluations for the RNC program and CSCS.

Overview of Study Method:

NMR conducted 100 on-site energy inspections of single-family, non-program homes built between 2017 and 2019 in Massachusetts. The inspections included full Home Energy Rating System ("HERS") ratings. The study sample included 51 homes built under the 2015 IECC base code and 49 homes built under the stretch code. NMR created full energy models in both REM/Rate and Ekotrope for each home. The program adopted Ekotrope as its modeling software in 2017. Prior to this, HERS raters and the program used REM/rate for modeling. NMR used the REM/rate models to compare the results from this study to previous studies, and the Ekotrope models to compare the sample to program homes.

Application of Results: Retrospectively and Prospectively

A copy of the complete study can be found in Appendix 4D, Study 19-27.

Study 19-28: C&I NEI Update Scoping Study

Type of Study: Impact Evaluation

Evaluation Conducted by: NMR Group

DNV GL

Three Cubed

Date Evaluation Completed: 3/31/2020

Study Objective and Summary of Results:

The objectives of this study were to identify NEIs currently claimed by the PAs for C&I Retrofit and New Construction measures that require updates; identify C&I measures and initiatives that lack NEIs; identify gaps in previous C&I NEI research for Massachusetts; determine the most appropriate and cost-effective methods for developing or updating estimates of the NEIs identified ; and provide prioritized considerations for future research to quantify and monetize NEI values.

The study provides the following key findings:

The NEI gap analysis found that:

- More than half (57%) of the C&I electric measures in the 2019 BCR have NEI values assigned.
- While all NEI values could be considered outdated due to their use of 2010 program tracking data for application to 2019-2020 measures, lighting and HVAC end uses are most significantly outdated because both the LED and ductless mini-split heat pump markets have changed drastically since 2010.

Interviews with PA implementation staff and EEAC consultants yielded the following insights:

- Interview respondents expressed a desire for NEI research to reduce uncertainty around NEIs used in cost-effectiveness testing.
- Interview respondents look to NEIs to help them present more comprehensive solutions to customers by clearly demonstrating the value of program participation.
- Interview respondents seek NEIs for specific measures, projects, and programs. They want more clarity regarding how and when to apply NEIs.
- Interview respondents desire broader NEI coverage across current and proposed measures.
- Interview respondents desire additional types of NEIs, including those resulting from changes to facility costs or revenues, health- and safety-related NEIs, education-sector NEIs, and durability, comfort, productivity, and resiliency NEIs.

The literature review identified a variety of potential C&I NEIs related to health and safety:

- LED lighting potentially reduces worker injuries, supports productivity impacts, and reduces depressive symptoms among workers.
- HVAC potentially decreases costs from OSHA compliance (by avoiding non-compliance fees) and reduces missed days at work from poor indoor air quality (IAQ) and hearing loss due to lower ambient noise levels.
- Pipe insulation potentially reduces burns.
- Primary data collection is required to measure all these NEIs.
- Primary data should be collected through surveys of management and workers/occupants of C&I buildings.

Three studies, together, could quantify all the NEI needs identified by this research. These are (1) an O&M Cost savings study, (2) a Non-O&M NEIs study, and (3) a health and safety NEIs study. All three would address NEIs among both large C&I and small C&I participants. The study approaches and data sources, and the algorithms for the health and safety NEIs, are described in detail.

Core Initiatives or End Uses to which the Results of the Study Apply:

- Commercial & Industrial
- New Buildings & Major Renovations & Existing Building Retrofit & C&I New & Replacement Equipment
- All End Uses
- Electric & Gas

Evaluation Recommendations:

No formal recommendations were made in this evaluation.

Explain Whether or Not the PAs Decided to Adopt the Recommendations from the Study:

N/A (no formal recommendations were made in this evaluation)

How the Study Affects Program Results and Its Significance:

Previous NEI research performed for the PAs, such as the 2018 NEI Framework Study, found gaps in NEIs for C&I program offerings, did not adequately address C&I health and safety NEIs, and did not address a class of NEIs that can be considered “secondary impacts,” such as improved economic viability of businesses and jobs. The results of this study offer a clear path forward for conducting research that would reduce the uncertainty around C&I NEIs used in cost-effectiveness

testing, quantify previously unmeasured C&I NEIs, and enable program staff to clearly demonstrate to customers the full value of program participation.

Overview of Study Method:

This research is based on an NEI gap analysis, interviews with PA staff, and a literature review of potential health and safety NEIs from three common energy upgrades in the C&I sector (LED lighting, HVAC, and pipe insulation). The gap analysis involved reviewing the PAs' current C&I programs, initiatives, and measures and the PAs' 2019 electric and gas benefit cost ratio models to identify measures for which there is either no NEI value or for which the NEI value is aging or outdated. The Team conducted seven interviews with 21 respondents. Twenty respondents were PA implementation and evaluation staff and one respondent represented the EEAC Consultants. For the literature review of health and safety NEIs, the team identified and examined peer-reviewed manuscripts, publicly available databases, and other secondary sources.

Application of Results: Prospectively

A copy of the complete study can be found in Appendix 4D, Study 19-28.

Study 19-29: Codes and Standards Compliance and Support Initiative Residential and Commercial Immediate and Follow-up Surveys

Type of Study: Process Evaluation

Evaluation Conducted by: NMR Group

The Cadmus Group

Date Evaluation Completed: 3/10/2020

Study Objective and Summary of Results:

The objective of this study was to assess the quality and effectiveness of the trainings offered by the Codes and Standards Compliance and Support Initiative (CSCS) in 2019 and how well they are meeting the needs of code officials, builders, and other market actors to enable enhanced compliance with the current energy codes.

The study provides the following key findings:

- Classroom training attendees continued to provide positive feedback on the quality of the trainings including quality of presentation slides, quality of handouts, presenter's skills, and handling of participant questions. On a scale of 1 to 6, where 1 is poor and 6 is excellent, all areas received mean ratings of 5 or above.
- Classroom training attendees found most of the subjects covered to be useful to their work with at least two-thirds giving the most often covered subjects ratings or 5 or 6.
- Most classroom and web training attendees who responded to follow-up surveys four months after the trainings reported making some changes to their work as a result of these events. Eighty-three percent of municipal building code employees and 62% of building professionals reported making such changes after attending residential trainings. Changes were reported by 85% of municipal building code employees and 54% of building professionals who attended commercial trainings.
- Most classroom and web training attendees who responded to follow-up surveys also report sharing what they have learned with others. Eighty-seven percent of municipal building code employees and 79% of building professionals who attended residential trainings had shared some of the information from the trainings with other parties, most often homeowners, contractors, and colleagues. Eighty-nine percent of municipal building code employees and 68% of building professionals who attended commercial trainings had shared information.

Core Initiatives or End Uses to which the Results of the Study Apply:

- Residential & Commercial & Industrial
- New Homes & Renovations
- Envelope & All End Uses
- Electric & Gas

Evaluation Recommendations:

No formal recommendations were made in this evaluation.

Explain Whether or Not the PAs Decided to Adopt the Recommendations from the Study:

N/A (no formal recommendations were made in this evaluation)

How the Study Affects Program Results and Its Significance:

Previous findings from similar studies have been used to help assess net-to-gross savings for the Residential New Construction Program, and the findings from this study may be used in a similar fashion in the future for various Mass Save new construction programs. The study also helps inform the design of the CSCS classroom and webinar trainings by providing insights about the effectiveness of the trainings and actionable feedback from attendees.

Overview of Study Method:

The study used data gathered via two sets of surveys. The first set of surveys was given to classroom training attendees at the end of each training. In 2019, 458 classroom training attendees—286 residential and 172 commercial—out of a total of 1047 filled out these paper surveys. This represents an overall response rate of 44% (41% for residential surveys and 50% for commercial surveys).

Approximately four months after attending a classroom or webinar training, attendees received the second set of surveys as a link. This web-based survey explored if, and how, attendees were using what they had learned. The web surveys replaced telephone interviews that had been conducted in past years, and for the first time included attendees of webinar trainings. In 2019, 154 trainees—86 residential and 68 commercial—out of a total of 729 filled out the second set of surveys. This represents an overall response rate of 21% (20% for residential surveys and 22% for commercial surveys).

Application of Results: Retrospectively and Prospectively

A copy of the complete study can be found in Appendix 4D, Study 19-29.

Study 19-30: C&I New Construction Program Planning & Market Effects/Spillover

Type of Study: Process Evaluation

Evaluation Conducted by: NMR Group

EMI Consulting

Date Evaluation Completed: 3/31/2020

Study Objective and Summary of Results:

The objectives of this study were to facilitate the redesign of the C&I New Buildings and Major Renovations initiative and to help the PAs prepare to measure and claim market effects and spillover from the redesigned initiative.

The study provides the following key findings:

- Best design and implementation practices for C&I new construction programs.
- A proposed redesign of the C&I New Construction program that emphasizes low EUIs, technical assistance, early engagement, incentives based on actual energy consumption, and bonus incentives. The redesigned program consists of four paths with differing objectives, activities, incentive structures, and targeted project types. The first two paths focus on optimized design and low EUIs, and the second two paths follow a more traditional measure-based incentive structure.
- A program theory and logic model (PTLM) and indicators for measuring expected outcomes from the redesigned initiative over the short term (1-3 years), medium term (4-6 years), and long term (7-10 years).
- Suggestions for when to measure baselines for the indicators and how to measure each indicator.

Core Initiatives or End Uses to which the Results of the Study Apply:

- Commercial & Industrial
- New Buildings & Major Renovations
- Process
- Electric & Gas

Evaluation Recommendations:

The following recommendations were made by the evaluators conducting this study.

Recommendation 1: The program should field surveys with market actors and conduct additional research as soon as possible to establish market baselines for the indicators.

Explain Whether or Not the PAs Decided to Adopt the Recommendations from the Study:

The PAs plan to adopt the recommendations.

How the Study Affects Program Results and Its Significance:

The study has facilitated a fundamental redesign of program that preserves traditional measure-level incentive options so as not to create barriers to participation while also shifting the program's focus to reducing observed energy consumption. The study lays a foundation to reimagine program energy savings in terms of both observed changes in EUIs of participating buildings and optimization of building design that can create market effects, enhancing program performance. With input from program staff and stakeholders the study identified market effects indicators and proposed ways to measure them. Measuring these indicators early in the life of the redesigned initiative and periodically afterwards will help ensure that PAs can capture the information needed to attribute to the initiative market effects quantified in the future.

Overview of Study Method:

The evaluation team led four design charrettes; conducted a review of C&I new construction programs design and implementation best practices; conducted in-depth interviews with implementation staff and ten other entities, including participating market actors, implementers in other jurisdictions, and industry experts; and led two focus groups with program participants.

Application of Results: Prospectively

A copy of the complete study can be found in Appendix 4D, Study 19-30.

Study 19-31: C&I Small Business Non-Participant Customer Profile Study

Type of Study: Market Characterization or Assessment Evaluation

Evaluation Conducted by: DNV GL

Date Evaluation Completed: 4/15/2020

Study Objective and Summary of Results:

This purpose of this study was to better understand small business participation and identify which small business segments have relatively low participation and savings rates.

This study's two objectives were to:

1. Compare performance metrics (participation and savings rates) of small business customers to those of other C&I customers (as analyzed in the 2017 C&I Customer Profile Study).
2. Identify differences in performance metrics across sub- segments of the C&I small business population. Sub-segments included business size (micro, small, and non-small), seasonal businesses, and industry (educational services, hospitals, etc.).

The study provides the following key findings:

- Microbusinesses have consistent patterns of lower population savings and account participation rates than small and non-small businesses.
- While microbusiness participation rates are relatively low at the account level, viewing participation at the location level reveals that over half of gas microbusiness locations have been served over the analysis period.
- Extracting microbusinesses from the small business population shows that the small business group and large business group obtain comparable population savings achieved.
- Upstream lighting initiatives have driven a substantial increase in the number of microbusiness participants over the analysis period, but other initiatives, especially turnkey, provided deeper savings for participants and for the population as a whole.
- Breaking out microbusiness by industry segment shows that across PAs, some industries perform better than others.
- While seasonal microbusinesses have lower participation rates than non-seasonal microbusinesses, they have higher population savings achieved.

Core Initiatives or End Uses to which the Results of the Study Apply:

- Commercial & Industrial
- All Initiatives
- All End Uses
- Electric & Gas

Evaluation Recommendations:

The following recommendations were made by the evaluators conducting this study.

> **Recommendation 1:** DNV GL recommends that all PAs consistently provide BCR IDs in their tracking data. Having these IDs in the data will allow for a direct link to the PAs' BCR models, which will provide a consistent framework across all PAs and customers for end use classifications, program and core initiative classifications, savings calculations, incentives, etc. This will allow these classifications to be consistently defined across all PAs and the information to be available for analysis.[11] Some PAs are already doing this, and when they do, it provides more useful data for program tracking, resulting in fewer end uses classified as "Unknown."

Explain Whether or Not the PAs Decided to Adopt the Recommendations from the Study:

Some PAs have adopted this recommendation and others are considering the recommendation for adoption at this time.

How the Study Affects Program Results and Its Significance:

The study found that over the analysis period, microbusinesses had consistent patterns of lower population savings and participation rates than larger small and non-small businesses and may hold opportunities for the PAs to achieve more savings. The PAs are using these findings to explore the unique needs of microbusinesses, the most effective delivery pathways and marketing practices for this group, and potential barriers to participation.

Overview of Study Method:

DNV GL used PA provided C&I billing and tracking data from 2012-2017 to develop an analysis focused on comparing participation patterns for micro-, small and non-small businesses. Business size was determined by consumption breakpoints (kWh for electric and therms for gas). DNV GL analyzed seven business subsegments and three program activity categories using three performance metrics: participation rate, population savings achieved, and participant savings

[11] For example, BCR ID G16C1b26 is Indirect Water Heater under the C&I Initial Purchase and End of Useful life core initiative, saving 190 therms per unit (according to 2017 BCR models). Anytime this ID is in the PAs' tracking data, we will have this consistent information about the ID.

achieved. To define business size, DNV GL first underwent a data cleaning process to remove tracking accounts that did not link to the billing data. DNV GL also removed accounts with zero consumption, negative consumption, or savings greater than consumption. For participating New Construction accounts, most of which do not have sufficient consumption in the billing data to generate a useful performance metric, a consumption proxy was used. The cleaned data was then analyzed at the appropriate level for the different analysis metrics in the report.

Application of Results: Retrospectively

A copy of the complete study can be found in Appendix 4D, Study 19-31.

Study 19-32: Statewide Residential and Commercial 2019 Awareness Survey

Type of Study: Market Characterization or Assessment Evaluation

Evaluation Conducted by: Illume Advising

Date Evaluation Completed: 3/30/2020

Study Objective and Summary of Results:

The goals of this current study were to:

- Continue the longitudinal assessment of key awareness metrics, such as overall awareness and Mass Save brand familiarity;
- Assess whether changes in awareness are due to Mass Save campaign changes;
- Measure customer awareness of specific energy efficiency programs;
- Explore the relationship between customers' brand and program awareness, their intention to make behavior changes, and actual behavior changes and participation in energy efficiency programs;
- Explore customers' understanding of Mass Save sponsorship; and
- Continue to gather feedback on the Mass Save website, which was redesigned in 2017.

Key findings included the following:

- Finding 1. Brand awareness holds steady and there was a marked increase in awareness among Latino residential customers.
- Finding 2. Website awareness is leveling off, but engagement with the website is increasing.
- Finding 3. Marketing outreach effectively reaches customers in a variety of ways and contributes to message clarity and customer favorability.
- Finding 4. There was a downward shift in residential customers reporting that Mass Save promotes energy efficiency, and an upward shift in those reporting that their utilities or energy efficiency service providers promote energy efficiency, from last year to this year.
- Finding 5. Familiarity with the Mass Save brand corresponds with higher awareness of energy efficiency programs and program participation.

Core Initiatives or End Uses to which the Results of the Study Apply:

- All Sectors
- All Initiatives
- All End Uses
- Electric & Gas

Evaluation Recommendations:

No formal recommendations were made in this evaluation.

Explain Whether or Not the PAs Decided to Adopt the Recommendations from the Study:

N/A (no formal recommendations were made in this evaluation)

How the Study Affects Program Results and Its Significance:

This study has implications for planning and marketing the Mass Save brand, but no specific implications for program savings.

Overview of Study Method:

Primary data collection included a general population survey of residential and small business customers. In total, we surveyed 609 residential and 308 business customers.

Application of Results: Prospectively

A copy of the complete study can be found in Appendix 4D, Study 19-32.

Study 19-33: 2019 Residential Wi-Fi Thermostat Direct Load Control Offering Evaluation

Type of Study: Impact Evaluation

Evaluation Conducted by: Navigant Consulting

Date Evaluation Completed: 4/1/2020

Study Objective and Summary of Results:

This evaluation's objectives included verifying that the 2019 residential Wi-Fi thermostat direct load control ("DLC") solution successfully enables demand reductions (and if so, by how much) and assessing the customer experience and acceptance of the solution. These objectives were achievable through the investigation of several research questions relating to (1) Customer Experience, (2) DR Impacts, and (3) Program Design and Implementation. Where appropriate, these research questions were explored by PA (i.e., Eversource MA and CT, National Grid MA, and Unitil MA). The evaluation also sought to compare select metrics for this National Grid offering across 2016 to 2019.

The study provides the following key findings:

Customer Experience Research Findings

- **Overall, 96% of thermostats that enrolled since September 30, 2018 remained enrolled through the end of the evaluated 2019 DR season.** The rate of sustained enrollment for thermostats enrolled after September 30, 2018 was 97%, 94%, and 99% for Eversource, National Grid, and Unitil, respectively.
- **The annualized rate at which thermostats leave the ConnectedSolutions offering ("annualized attrition") ranges from 5 to 11% per year.** For National Grid, annual attrition ranges from 6% to 10% depending on the period of enrollment, reflecting National Grid's device management plan. For Eversource, attrition ranges from 10 to 14%, depending on the period of enrollment. However, for both Eversource and National Grid, implementation vendor transitions impact the ability to fully analyze the extent to which thermostats have left the programs over time. For Unitil, annualized attrition is 5%.
- **Across all PAs and cohorts, more than 85% of survey respondents reported that they are likely or very likely to participate again in the future.** Respondents were generally satisfied with event characteristics in 2019, including the number, length, and timing of events.
- **Bill savings is a perceived offering benefit.** Bill savings is the most commonly cited motivation for participating, including among returning National Grid customers. Although this offering achieved energy savings in 2019, the primary goal of the offering is to achieve peak demand reductions. As a result, any given participant may or may not experience bill savings by participating in the offering. The perception that participation

will lead to bill savings may be a consequence of co-marketing the offering with Wi-Fi thermostat rebates.

- **55% of respondents were satisfied with the mode of notification received.** Overall, approximately 73% of survey respondents reported receiving event notification, and 75% of these respondents received their preferred mode of notification.
- **About 20% of respondents would like more flexibility in terms of how they are notified of events.** 25% of respondents *who reported receiving event notifications* would like to receive a different mode of event notification than what they received in 2019. Of these, a majority would like notifications by email.
- **Overall 17% of respondents reported not receiving event notifications and 10% were unsure whether or not they received event notifications.** 80% of Unitil and Eversource respondents reported receiving advance notifications for events while only about 62% of National Grid new participant respondents and 70% of National Grid returning participant respondents reported receiving advance notifications. The remaining participants either reported receiving no event notification or they were unsure whether or not they received notifications. Eversource and Unitil elected to send event notification emails to participants with device types that allowed this. National Grid elected not to send advance notification emails. For device types where email notification was an option the PAs could select, participants that received event notifications *only* through the thermostat provider's app had lower rates of event notification recall than those who also received an email. For respondents who reported not receiving any event notification, a majority would like to receive email notification, at a minimum.
- **Approximately two-thirds of participants reported noticing temperature changes during events but only 40% reported ever opting out**. Most of those who reported having opted out stated that they did so only sometimes (30-40%) or rarely (50-65%). When looking at thermostat telemetry data, the percentage of devices that opted out at least once over the course of the season, and the frequency with which they opted out, is somewhat higher than what survey respondents reported (see section 4.2).[12,13] Notably, 16% of National Grid returning participants reported not knowing if they ever opted-out of an event. Relatedly, over 40% of survey respondents indicated they did not recall pre-cooling happening prior to events. In open-ended feedback, three respondents noted that it was too easy to override events inadvertently.
- **Approximately 10% of survey respondents are interested in seeing changes to or the ability to customize offering design parameters.** Some survey respondents would like to see changes to or to be able to specify their preferences related to: pre-cooling temperature adjustment and/or duration (26), event duration and/or timing (16), event setpoint

[12] The thermostat usage assessment (section 4.2) shows that 45% of Eversource devices, 54% of National Grid devices, and 43% of Unitil devices opted-out for at least one event during the 2019 season.

[13] The thermostat usage assessment shows that 47% and 45% of participants who opted of at least one event during the summer, for Eversource and National respectively, opted out of over half of events (see Section 4.2).

maximum (3). Three survey respondents would like to be able to opt back into the event after opting-out.

Thermostat Usage Assessment Findings

- **2019 full participation rates exceeded 50% on average and across the season.** Eversource MA and CT had the highest full participation at 60%, followed by Unitil MA at 56% and National Grid MA at 52%. The primary reason for devices not fully participating in events was not being in cooling mode.
- **A significant number of devices were never in cooling mode for any event.** Over 60% of system off/heat mode issues for Eversource MA and CT, National Grid MA, and Unitil MA stem from devices that were in system off/heat mode for the entire season.
- **Connectivity was a small issue overall during events for Eversource MA and CT, National Grid MA, and Unitil MA.** A large portion of connectivity issues stem from devices that were disconnected for the entire season.
- **Participants exhibited no evidence of event participation fatigue (increased opt-out rates) due to back-to-back events or a higher event dispatch frequency.** Devices in the experimental design groups participated at similar rates regardless of the number of events for which they were dispatched.

Impact Analysis Findings

- **Eversource and National Grid had very similar average treatment effects for the 2019 season, 0.60 kW and 0.59 kW per thermostat, respectively.** Unitil's average treatment effect was lower, 0.38 kW per thermostat, which uses the savings adjustment factor and EnergyHub's estimates of load shed**.**
- **As a percent of baseline usage, average demand savings were 58% and 59% for Eversource and National Grid, respectively.** For National Grid, this reduction in cooling load is slightly higher than 2018 (likely due to the higher temperature setback during events), but consistent with the previous two implementation seasons.
- **Fully participating devices have average event savings across the 2019 season that are over 35% higher than the average across all dispatched participants.** Impacts for full participants show the technical potential of the offering. As opt-outs and other forms of non-participation are reduced, average and total event impacts should increase.
- **National Grid's average demand savings per event in 2019 was 0.59 kW, a decrease from the average savings found in 2018 (0.71 kW).** The lower savings likely stem from the later event times and the fewer number of event days exceeding 90°F in 2019 compared to 2018, which resulted in a lower baseline cooling load.

Core Initiatives or End Uses to which the Results of the Study Apply:

- Residential
- Residential Behavior
- HVAC
- Electric Only
- Wi-Fi Thermostat-Based Direct Load Control

Evaluation Recommendations:

The following recommendations were made by the evaluators conducting this study.

Recommendation 1: Unenroll thermostats from the offering that frequently opt out of events, do not have connectivity, and/or are consistently in a non-cooling mode. This will lower the costs of the Direct Load Control Offering and increase average savings per thermostat. In parallel, ensure that the enrollment tracking system allows for the tracking of unenrollment reasons related to the opt outs, connectivity and AC system mode behavior.

Recommendation 2: Include the count of all residential and non-residential devices and participants enrolled as of August 31 in the Massachusetts ADR BCR model. For 2019, the count of thermostats is 8,020, 11,503, and 70 for Eversource MA, National Grid MA, and Unitil, respectively. The count of participants is 5,158, 7,814, and 45 for Eversource MA, National Grid MA, and Unitil, respectively.

Recommendation 3: Calculate ex-post savings by applying the savings adjustment factor to vendor-reported savings. Use ex-post savings for claiming savings in 2019 and in future years. For the event period, the savings adjustment factor is an equation based on average outdoor temperature: -3.06 + (0.05 x Avg Temp °F). For pre-cooling and recovery hours, the savings adjustment factors are constants, 0.72 and 0.68, respectively.

The adjustment factor can apply when the ISO-NE or PJM baseline is used, pre-cooling and event duration conditions are met, the assumed AC nameplate capacity continues to be 3.5 kW in the EnergyHub portal, and the average outdoor temperature is 75 degrees F or higher. When these conditions are not met, the savings adjustment factor does not apply.

Explain Whether or Not the PAs Decided to Adopt the Recommendations from the Study:

The PAs have adopted Recommendations 2 and 3. The PAs are still considering Recommendation 1 at this time. The PAs have not formally adopted or rejected any recommendations that require changes to program design and operations.

How the Study Affects Program Results and Its Significance:

Navigant developed a savings adjustment factor to be applied to vendor-reported savings estimates by comparing the hourly evaluated impacts for National Grid in 2018 and 2019 and Eversource in 2019 to the hourly impacts estimated by the implementer, EnergyHub, where the average outdoor temperature was greater than 75 degrees. Looking at event hours, Navigant found that the comparison had a positive correlation, indicating that EnergyHub was overestimating impacts for lower event temperatures and underestimating impacts for higher event temperatures. Due to the correlation observed, Navigant recommends an adjustment factor equation where the adjustment factor is a function of hourly temperature.

Navigant also compared the evaluated pre-cooling impacts to EnergyHub's impacts. There was no strong correlation between outdoor air temperature and the resulting adjustment factor. For the pre-cooling hours, Navigant recommends a single average value.

Navigant compared the evaluated post-event recovery impacts to EnergyHub's impacts. Similar to the pre-cooling hours, there was no strong correlation between outdoor air temperature and the resulting adjustment factor. For the post-event recovery hours (the 3 hours following the event period), Navigant also recommends a single average value.

Navigant recommends that all the PAs apply the savings adjustment factors in the table below to Energy Hub-reported savings to generate *ex post* savings values for the purposes of claiming savings in 2019 and in future years.

Demand Savings Adjustment Factors

Period	Conditions	Hourly Load Adjustment Factor
Pre-cooling	Average Temperature ≥ 75°F 30 to 90 Minute Duration ISO-NE or PJM Baseline	0.72
Event	Average Temperature ≥ 75°F 3-Hour Duration ISO-NE or PJM Baseline	-3.06 + (0.05 x Average Temperature °F)
Recovery	Average Temperature ≥ 75°F ISO-NE or PJM Baseline	0.68

Overview of Study Method:

This evaluation assessed demand and energy savings for the 2019 offering and focused on the development of a savings adjustment factor for use by the PAs in future years. The evaluation also assessed the customer experience with the offering. The key elements of the study method include the following:

Participant Survey: Navigant developed, fielded, and analyzed the results of an online survey of 316 participants at the end of the DR season.

Analysis of Enrollment Data: Navigant analyzed offering enrollment data to calculate attrition rates for those enrolled in 2019 (all PAs) and prior to 2019 (for National Grid and Eversource CT).

Thermostat Usage Assessment: The team analyzed thermostat telemetry data and thermostat-level participation data to assess participation status (including opt-out and connectivity rates) during events and throughout the DR season.

Experimental Design: Navigant randomized devices into one of three groups (A, B, C). Once implemented, either the A group or B group was withheld from the event dispatch to serve as the control group, while the C group was always dispatched. For events prior to the experimental design implementation, Navigant employed within-subject approach using non-event days to estimate impacts.

Data Management: Prior to conducting its analysis, Navigant performed a QA/QC of the 15-minute thermostat telemetry for 20,737 participants. The review included screening for gaps in the data, logic errors, and confirming the experimental design group assignment. The team also reviewed the National Weather Service hourly temperature data to confirm that the relevant Massachusetts and Connecticut weather stations were not missing hourly data on days of interest and had reasonable temperature and humidity readings across weather stations.

Runtime to Energy: The team relied on thermostat telemetry data, converting thermostat runtime into power based on data from the 2017 MA residential baseline study and 2017 National Grid MA DR field study.

Regression Analysis: For National Grid and Eversource, the evaluation measured demand and energy impacts during pre-cooling, event, and recovery hours using regression analysis with the experimental design and a within-subject approach. The team did not measure impacts for Unitil using regression analysis due to low program enrollment.

Savings Adjustment Factor: Navigant developed a savings adjustment factor to apply to vendor-reported savings to calculate *ex post* savings that would be claimed by the PAs, including savings to be claimed in 2019 and in future years.[14] The savings adjustment factor was informed by (1) analysis of evaluation results in 2018 and 2019 for National Grid and Eversource, and (2) developing an understanding of EnergyHub's approach to calculating savings.

Application of Results: Retrospectively and Prospectively

A copy of the complete study can be found in Appendix 4D, Study 19-33.

[14] For the Massachusetts PAs, *ex post* savings values will be the input to the Massachusetts Demand Reduction Benefit Cost Ratio model via the DR Impact Factor Calculator tool developed by Synapse Energy Economics.

Study 19-34: Cross-State C&I Active Demand Reduction Initiative Summer 2019

Type of Study: Impact Evaluation and Process Evaluation

Evaluation Conducted by: Energy and Resource Solutions (ERS)

DNV GL

Date Evaluation Completed: 4/15/2020 (revised draft)

Study Objective and Summary of Results:

The purpose of this study was to measure the average demand reduction achieved by two active demand reduction ("ADR") initiatives — C&I interruptible and C&I targeted storage — and to assess customer experience, barriers to implementation, and PA and vendor success in delivering these two offers. The evaluation also examined the overlap between the PA ADR initiatives and the ISO-NE Forward Capacity Market ("FCM") and provided input on other opportunities for peak demand management.

The research covers ADR initiatives offered by Eversource, National Grid, and Unitil in Massachusetts, Connecticut, and New Hampshire. This summary focuses solely on Massachusetts.

C&I Interruptible Impact.

The C&I interruptible initiative enrolled 206 Massachusetts customers with 517 accounts using 7 different curtailment service providers (CSPs). The impact evaluation measures average demand reduction during specified events and during the annual peak installed capacity (ICAP) hour. Table 1 shows the Summer 2019 initiative demand reduction goals, reported and evaluated results by PA as well as reported demand reduction and participation. Eversource results are based on three called event days, one of which covered the ICAP hour. National Grid and Unitil called a single event on July 30th, the ICAP day.

The evaluation team recommends using a symmetrically adjusted baseline to estimate the 2019 summer event period load reduction (see Evaluated – Symmetric in the tables below). This estimate adjusted for the likelihood of unreported shutdowns is the evaluators' best estimate of expected load reduction by these resources for future years (see Evaluated – Forecast in the tables below).

In Table 1, the "unadjusted" baseline is the average demand during event hours on 10 non-holiday weekdays that precede the event day. "Symmetric" adjusts the prior baseline up or down to account for the fact that the event day weather or customer behavior may cause the starting point for load reduction to differ from preceding days, such as the event day being much hotter than preceding days. "Asymmetric" is the same as symmetric except that the adjustment is not made if the baseline adjustment would cause load to decrease. "Forecast" is the same as symmetric except that it adds a factor to account for likely customer shutdowns on random future summer weekdays. The "regression" baseline doesn't use the 10-day criteria. Instead it uses the full month in which the

event occurs to estimate likely load as a function of outside temperature and time. "Validation" refers to the evaluators replicating the program's reported (asymmetric) baseline calculations.

Table 1. Average Demand Reduction During Event Period and ICAP Hour

Result	**Eversource MA**		**National Grid MA**		**Unitil MA**		**Total MA**	
	Event (MW)	**ICAP Hour (MW)**	**Event (MW)**	**ICAP Hour (MW)**	**Event (MW)**	**ICAP Hour (MW)**	**Event (MW)**	**ICAP Hour (MW)**
Goal	30.0		62.0		0.9		92.9	
Enrolled Capacity	37.2	36.7	93.1	93.1	0.95	0.95	131.3	130.8
Reported - Asymmetric	22.3	N/A	71.4	N/A	0.85	N/A	94.5	N/A
Evaluated - Validation	21.5	N/A	71.6	N/A	0.84	N/A	94.0	N/A
Evaluated - Unadjusted	6.6	7.4	42.5	36.1	0.59	0.60	49.6	44.1
Evaluated - Asymmetric	19.9	21.8	70.0	63.2	0.84	0.86	90.3	85.8
Evaluated - Symmetric	**17.4**	**20.6**	**58.5**	**52.2**	**0.78**	**0.79**	**76.7**	**73.5**
Evaluated - Forecast	**16.5**	**19.4**	**57.3**	**51.3**	**0.78**	**0.79**	**74.6**	**71.4**
Evaluated - Regression	12.7	15.4	48.8	42.5	0.67	0.69	62.2	58.6
Accounts	*161*	*151*	*357*	*357*	*3*	*3*		

Table 2 shows four key performance ratios that quantify the initiative's performance:

(1) The **enrollment ratio** shows the percentage of the enrolled capacity that was reported as load reduction, which is meaningful for planning and sales purposes (the value is not expected to be near 100%);

(2) The **asymmetric ratio** shows the effect that differences in calculation rules have on the reductions by comparing the evaluated and reported asymmetric reductions;

(3) The **retrospective realization rate** shows how the choice of baseline adjustment and calculation methodologies impacts the load reduction estimates. This rate is what evaluators believe to be most representative of reported to evaluated performance; and

(4) The **prospective realization rate** is the same as (3) except that it also adjusts for unreported shutdowns to provide insight into likelihood of availability of the resources on a future unknown event day.

Table 2. Key Performance Ratios

PA and State	Enrollment Ratio	Asymmetric Ratio	Retrospective Realization Rate	Prospective Realization Rate
	Reported Asymmetric / Enrolled Capacity	Evaluated Asymmetric / Reported Asymmetric	Evaluated Symmetric / Reported Asymmetric	Evaluated Forecast / Reported Asymmetric
Eversource MA	59.8%	89.4%	78.3%	74.2%
National Grid MA	76.7%	97.4%	81.9%	80.2%
Unitil MA	89.8%	98.8%	90.8%	90.8%
MA – All 3 PAs	72.0%	95.5%	81.1%	78.9%

Targeted Battery Storage Impact

Eversource enrolled two targeted battery storage systems in the initiative during summer 2019 season. One of the two battery storage systems included daily dispatch as well as targeted dispatch in response to demand response calls. For that battery storage system evaluators measured targeted response as the demand reduction beyond their known daily goal. Results are in Table 3.

Table 3. Targeted Dispatch Results for Battery Systems

	Site 1 (1,500 kW, 3,000 kWh, with 500 kW daily DR goal)		Site 2 (1,300 kW, 5,600 kWh)	
	Utility Weekday Event Average Reduction (kW)	ISO-NE ICAP Hour Reduction (kW)	Utility Weekday Event Average Reduction (kW)	ISO-NE ICAP Hour Reduction (kW)
Committed	400	N/A	N/A	N/A
Reported	283	800	1,033	1,290
Evaluated	295	800	1,033	1,290

The targeted battery realization rate for the two systems together is 1.01.

The ratio of charging to discharging energy was 0.67 for site 1 and unable to be evaluated but reported as 0.90 for site 2.

Process Evaluation Results

Customers reported general satisfaction with all aspects of the two DR initiatives except for the event payments. Key challenges in administration varied by utility company.

- **Eversource:** Challenges were material, but largely attributed to it being the first year of the initiative: (1) There were administrative challenges due to having different systems for application submittals, sending notifications, and event monitoring, and variations across states. Use of a single distributed energy resource management system (DERMS) platform will reduce this challenge. (2) Annual incentive payments were late relative to customer expectations, although the PA stated that the customers were notified of more accurate timeline estimates. The DERMS platform also is expected to improve payment processing. (3) The Terms and Conditions (T&C) on the customer application changed during the first sales season, resulting in multiple versions of the application with different T&Cs being in circulation and CSPs re-negotiating T&Cs and program rules well into the summer.
- **National Grid:** While 2019 was the first year of the full-scale ADR initiative, National Grid has had a predecessor program for two years. Their challenges largely center on burdens of expansion. As with Eversource, payment processing is challenging, but for different reasons. Delays were described as being predominantly due to new procurement requirements. Recruitment is National Grid's second challenge. A significant percentage of the PA's largest commercial and industrial customers had already signed-up for the program prior to 2019. More sales effort was required in 2019 to achieve the same amount of MW reduction that had been reached in prior years. The PA anticipates this need for increased promotion to continue.
- **Unitil:** Unitil had three enrolled participants and few challenges in Massachusetts. Participants were mainly recruited by one CSP for the summer 2019 season. To meet their summer 2020 demand reduction targets, Unitil staff are considering several changes to their promotional efforts including developing content on their website and working with an additional CSP.

Other/Integrated Findings and Results

- **Shutdown Days:** Customers are failing to report shutdown days to the PAs even though the initiative rules include a shutdown day allowance, which could have a negative impact on customer payments if they fell within their baseline period and went unreported, and also interferes with evaluation analysis.
- **Pre-Cooling, Gaming, and Snapback:** None of the load shapes point toward pre-event activity (pre-cooling, load shifting, or gaming) and snapback would be non-existent with any of the shapes adjusted to event-day load levels.
- **ISO Overlap:** Scenarios in which PA DR Initiative events and ISO-NE scarcity conditions overlap or are called coincidently are rare, as scarcity conditions occur because of a supply constraint (at the transmission level) while utility DR events are typically called in response to expected peak demand conditions on the distribution grid. The PAs reached out to ISO-NE to coordinate during the initiative development, however, at the time it was determined that the PA initiatives were too small to warrant collaboration. The magnitude of reductions through the initiatives is expected to keep growing. ISO-NE staff is concerned that participation in utility DR events could result in eroding the ISO-NE baseline calculation and same-day adjustment for performance, or vice versa, and that the ISO could over-

designate reserves if Demand Response Resources that participate in utility DR programs do not revise their Forward Capacity Market bids. The utility rules ease customer overlap concerns regarding utility payment but do not address those of the ISO. Interviewed ISO staff indicated a willingness to discuss overlap concerns and solutions with the PAs.

Core Initiatives or End Uses to which the Results of the Study Apply:

- Commercial & Industrial
- C&I Active Demand Reduction
- Active Demand Reductions
- Electric Only

Evaluation Recommendations:

The following recommendations were made by the evaluators conducting this study.

Recommendation 1: Continue to seek solutions to accelerate the incentive payment process with centralized program tracking and management systems and by allowing CSPs to access their online day-after data and daily performance summaries.

Recommendation 2: Remind and educate the CSPs of the shutdown allowance requirement and reporting rule. The PAs could ask for pre-planned shutdown information during the application/enrollment process.

Recommendation 3: Adapt the shutdown rule to account for unexpected facility shutdown events, such as by reducing the advance notification requirement from seven days to 24 hours in advance of the shutdown.

Recommendation 4: Formally standardize all rules related to data quality, baseline calculation methods, and aggregation.

Recommendation 5: Establish data quality rules with clear outcomes for poor quality and/or insufficient data.

Recommendation 6: Use the retrospective realization rate to determine past season performance.

Recommendation 7: Use the prospective realization rate to estimate future load reduction.

Recommendation 8: In the short-term, representatives from ISO-NE, the PAs, and, if feasible, the CSPs should come together at a Demand Resources Working Group (DRWG) meeting and brainstorm mutually beneficial design solutions that would minimize the impact of one entity on the other.

Explain Whether or Not the PAs Decided to Adopt the Recommendations from the Study:

The PAs are considering all recommendations for adoption at this time. The PAs have not formally adopted or rejected any recommendations that require changes to program design and operations.

How the Study Affects Program Results and Its Significance:

The results reduce overall reported impact by 18.9% for the C&I interruptible offering and increase the reported impact by 1% for the targeted battery offering. Evaluators recommend use of a different metric for reporting demand reduction for C&I interruptible in the future.

Overview of Study Method:

For battery participants, impact was measured based on battery system-level charge and discharge data. For C&I interruptible participants, the impact evaluation was based on account-level analysis of interval data of all available participants. First the reported results were validated. After validation, the counterfactual (i.e., baseline behavior, or the hypothetical behavior of customers absent the initiative) was characterized using five different approaches including the settlement approach used by the initiative, three alternative settlement-type methods, and a weather-based regression analysis.

The process evaluation was based on review of initiative materials and in-depth phone interviews with PA program managers, ISO-NE Price Responsive Demand program managers, and CSPs, and a mixed-mode (online and phone) participant of a sample of 61 customers to meet the target of 10% relative precision at 90% confidence.

Application of Results: Retrospectively and Prospectively

A copy of the complete study can be found in Appendix 4D, Study 19-34.

Study 19-35: Eversource Daily Dispatch Battery Project Evaluation Report

Type of Study: Impact Evaluation and Process Evaluation

Evaluation Conducted by: Energy and Resource Solutions (ERS)

DNV GL

Date Evaluation Completed: 2/3/2020

Study Objective and Summary of Results:

This study evaluated the performance of the commercial and industrial daily dispatch battery demonstration project. The project included three battery installations in Massachusetts which were dispatched during summer weekday afternoons to reduce customer electric load at the time of the regional system peak. All three participants are Eversource customers. The overall evaluation of the daily dispatch battery project has spanned two years, covering the performance in the summers of 2018 and 2019 and the 2018/2019 winter season. This evaluation report summarizes the findings from the 2019 summer season.

The evaluation scope included both impact and process evaluations, including measuring how much load reduction each battery installation delivered and describing customer recruitment, delivery, and satisfaction.

The results of this three-site study affirm several of the hypotheses regarding the value of batteries as demand management devices. The findings from this study also point to the fact that installation and optimization of controls take longer and have more potential obstacles than typically accounted for. Once the battery systems are installed, operational, and optimized, they are reliable, predictable, and easy to measure. Straightforward and defensible data produced by the vendors' battery systems was available and demonstrated the batteries' exact impact on facility load. Occasional anomalous errant data occurred no more frequently than with other equipment logging or utility-grade premise-level interval metering systems.

The evaluation resulted in the following key findings:

- The installation and "shakedown" period required to refine operation is long and complex.
- Once functional, seasonal average performance is good. Daily dispatch systems are almost meeting their committed levels. The three battery systems' committed average load reduction during the daily dispatch period was 1,070 kW. Evaluated average load reduction during the dispatch periods was 972 kW, 91% of the commitment. The evaluated average daily dispatch reductions were found to be 4% higher than the reported reductions for one site. Evaluators did not receive reported average daily dispatch reductions for the remaining two sites.

- Daily dispatch battery systems can escalate load reduction during the annual regional system peak hour (also known as the installed capacity, or ICAP hour). The ISO-NE ICAP hour occurred on July 30th, 2019 from 5 to 6 p.m. The two battery systems that were installed and operational at this time had committed 695 kW as their average daily dispatch load reduction. During the ICAP hour they concentrated the battery discharge and markedly increased their performance, discharging energy at a rate of 1,090 kW, a 56% boost.
- Controls optimization of batteries is critical in facilities with other distributed energy resources such as combined heat and power systems.
- Customers are satisfied with their vendors and are optimistic about future performance.

Core Initiatives or End Uses to which the Results of the Study Apply:

- Commercial & Industrial
- Existing Building Retrofits
- Active Demand Reductions
- Electric Only

Evaluation Recommendations:

The following recommendations were made by the evaluators conducting this study.

1. The vendor should clearly define DR objectives for each customer and educate customers regarding realistic financial expectations for their systems.
2. Require more gradual recharging of the batteries.

In addition, to aid future evaluation the evaluators recommend**:**

1. Collect additional contextual information to help the evaluation team characterize daily dispatch battery operation.
2. Have vendors communicate site control objectives to Eversource and evaluators.
3. Eversource should carefully design future demonstration projects to prioritize different DR objectives at each demonstration project site.

Explain Whether or Not the PAs Decided to Adopt the Recommendations from the Study:

The PAs are considering all recommendations for adoption at this time. The PAs have not formally adopted or rejected any recommendations that require changes to program design and operations.

How the Study Affects Program Results and Its Significance:

The results in this evaluation report provides the data necessary to test cost effectiveness of daily dispatch batteries and inform the design of full-scale programs. Performance was consistent and reliable once the systems were installed and operational.

Overview of Study Method:

Impact was measured based on battery system-level charge and discharge data.

The process evaluation was based on review of marketing materials and in-depth phone interviews with the PA program manager, vendor project manager, and pre- and post-installation surveys of participants.

Application of Results: The quantitative results should be applied retrospectively.

A copy of the complete study can be found in Appendix 4D, Study 19-35.

Study 19-36: 2019 Residential Energy Storage Demand Response Demonstration Evaluation – Summer Season

Type of Study: Pilot Evaluation and Demonstration Projects

Evaluation Conducted by: Navigant Consulting

Date Evaluation Completed: 2/10/2020

Study Objective and Summary of Results:

The purpose of this study was to assess the technical feasibility, customer acceptance, and scalability of using residential energy storage systems (battery) to reduce peak demand for National Grid and to flatten the solar output curve for Unitil as part of their broader active demand response initiatives. This study confirmed this feasibility; however, it has not looked at whether that control will be cost-effective for the electric system, program administrators, and/or customers. National Grid provided a performance incentive to customers in exchange for control of their existing battery as part of a "Bring Your Own Battery" demonstration, while Unitil provided each participant with a battery at no cost to them. Between July and September of 2019, National Grid called 27 events for 50 participating customers[15] and between August 1 and September 30 Unitil called 61 events for 4 participating customers.

The study provides the following key findings for National Grid:

- Access to backup power is a primary motivation for purchasing a battery system.
- Survey respondents reported extremely low opt-out rates, with 94% reporting they never opted out of an event.
- Ninety-seven percent of respondents would recommend the program to other National Grid customers, and 97% are likely or very likely to continue with the program should it be offered in the future.
- Events called by National Grid during the summer season saved 139 kW per event on average, including 126 kW during the 2019 ISO-NE Peak Hour.
- Battery devices that successfully participated in 2-hour events saved an average of 5.5 kW per unit.
- On average, called events had 64% of the expected maximum impact given the maximum expected discharge of the batteries operational at the time of the event. This is affected by some batteries opting out of events and also by lower relative performance by some devices, especially DC coupled batteries.
- 50 devices participated in at least one event this season.

[15] Number of Massachusetts customers that participated in at least one event as of August 31.

- Consecutive event days appeared to have a negligible effect on impacts this season. Weather had a larger effect on devices not being fully charged in time for the next event. The small effects that could be seen were instead caused by weather conditions that prevented some devices from fully charging in time for the next event.
- Successfully participating devices dispatched at a constant rate for the length of the event. This includes DC coupled batteries.
- The conventions (e.g., sign, time zone) associated with the telemetry data varied across manufacturers. Navigant made informed corrections to align the telemetry data for all devices into a single convention.

The study provides the following key findings for Unitil:

- Access to backup power is a primary motivation for participation.
- Participants displayed limited understanding of the program's design, such as when events are called, the existence of a battery reserve, and the degree of control they have over their batteries.
- Half of the current participants report they are unlikely to remain enrolled.
- According to the battery installer, many participants expressed safety concerns, in part due to several highly publicized battery fires in the last several years.
- Combining battery storage with solar PV achieved a flattened output profile during portions of events.
- The combined solar PV plus battery storage performed better during the 1 p.m. to 5 p.m. events than the 3 p.m. to 7 p.m. events, due to greater solar PV output during the earlier period.
- The site with a smaller solar PV array facing south did not perform as well as sites with larger solar PV arrays facing southeast.
- The average output from the battery storage during the four-hour events was 1.3 kW and 5.2 kWh.

Core Initiatives or End Uses to which the Results of the Study Apply:

- Residential
- Residential Behavior
- HVAC
- Electric Only
- Summer Battery Storage

Evaluation Recommendations:

The following recommendations were made by the evaluators conducting this study.

Recommendation 1: Ensure customers are aware National Grid knows backup is important to them. Two manufacturers include the existence of a battery reserve in their marketing materials, and one offers the option, but National Grid does not make this clear in the marketing materials. Create a consistent battery reserve level and publicize both the battery reserve and the restriction of events prior to storms. This will help alleviate customer concern about batteries being depleted when they are being relied upon to provide power in an emergency

Recommendation 2: National Grid to encourage EnergyHub to work with manufacturers and/or integrators to align all details of the telemetry data so the data fields are consistent.

Recommendation 3: Unitil to discuss with the battery manufacturer why the battery charging stopped at 1 p.m. for events that occurred from 3 p.m. to 7 p.m.

Explain Whether or Not the PAs Decided to Adopt the Recommendations from the Study:

The PAs are considering all recommendations for adoption at this time. The PAs have not formally adopted or rejected any recommendations that require changes to program design and operations.

How the Study Affects Program Results and Its Significance:

For participant motivations and lessons learned, the study found that backup power is a primary motivation for customer participation. This should be reflected clearly in marketing materials for any future program. In addition, the program design should be communicated clearly to participants, such as how often the battery will be called upon and whether there is a battery reserve requirement.

Regarding energy storage system performance, the study found that most batteries successfully performed in the majority of called events. This implies that daily dispatch is a viable option for consistent peak reduction or load shifting throughout the summer. National Grid should further explore the factors that negatively affected fleet performance, including underperformance of devices (especially DC coupled batteries) and opt outs. Unitil should continue to work with the battery manufacturer to improve the flattening of the solar output, and should consider different approaches to increase event success, such as reducing the duration of events.

Overview of Study Method:

The study relied on several methods:

1. An online survey was administered to National Grid customers participating in the demonstration. The surveys were administered via the Qualtrics platform from October 10

through October 20, 2019. Navigant obtained 41 completes out of a population of 65 participants[16] for a response rate of 63%.

2. Phone interviews were conducted with all four of the Unitil participants enrolled in the demonstration and with a representative from Unitil's energy storage system installer.
3. Impact analysis was performed using whole-home, solar PV, and energy storage system telemetry data along with event participation data. Interval data was collected for all participating devices during the summer season. This was used to calculate the energy storage system dispatch during each called event and to assess the shape of the combined solar and battery output.

Application of Results: Retrospectively and Prospectively

A copy of the complete study can be found in Appendix 4D, Study 19-36.

[16] Survey population was the subset of devices confirmed as installed in either Massachusetts or Rhode Island that were accepted into the program prior to August 6, 2019 to ensure participants had sufficient experience with the program.

Study 19-37: 2019 Small and Medium Business Wi-Fi Thermostat Direct Load Control Demonstration Evaluation

Type of Study: Process Evaluation

Evaluation Conducted by: Navigant Consulting

Date Evaluation Completed: 3/30/2020

Study Objective and Summary of Results:

This evaluation assessed the experiences and program acceptance of participants in the 2019 small and medium business Wi-Fi thermostat direct load control demonstration to understand whether current design and implementation are suitable for this customer segment and whether participants will continue to participate going forward. The scalability of the demonstration was also assessed through general SMB customer population (non-participant) research aimed at understanding the size of the SMB population with Wi-Fi thermostats connected to cooling as well as willingness to participate in a cooling DR program. The initial evaluation scope of work included assessment of impacts and event participation for the SMB customer segment. However, ultimately, DR impacts and event participation were not evaluated in 2019 due to low enrollment by non-residential customers.

The study provides the following key findings:

> **Comfort and operational impacts to customers were limited in 2019.** A majority of respondents recalled fewer than the actual number of events that occurred in 2019. Only four respondents felt less comfortable than usual during events. Ten of eleven respondents who were in the air-conditioned space during at least one event reported that the events had no impact on business operations. Only two respondents reported having ever opted out of events and did so infrequently.
>
> **All post-season survey respondents are very satisfied with their ConnectedSolutions experience.** Survey respondents did not encounter any challenges during the enrollment process and were generally satisfied with event notification, and the length, timing, and frequency of events in 2019. All 13 post-season survey respondents are likely to continue with the program in future years.
>
> **There are fewer than 20 confirmed SMB participants within the ConnectedSolutions program of over 9,000 customers.**[17] Through the post-enrollment and post-season survey efforts, Navigant confirmed there are 19 ConnectedSolutions participants with non-residential accounts enrolled; 11 only have non-residential accounts enrolled while eight have both non-residential and residential accounts enrolled in the program.
>
> **Bill savings is a perceived benefit of program participation.** Nine of 15 SMB survey respondents believe program participation will lead to bill savings. This perception is one

[17] Including residential customers in Massachusetts and Connecticut.

of the biggest motivators for program participation among survey respondents. Although direct load control Wi-Fi thermostat programs can achieve energy savings on a program-level, the primary goal of the program is to achieve peak demand reductions. As a result, any given participant may or may not experience bill savings.

Penetration of Wi-Fi thermostats is low among SMB customers. Around 60% have cooling connected to some kind of thermostat(s). However, only 9% have a Wi-Fi thermostat.

An estimated 5,700 (4%) SMB customer-locations have 13,000 ACs connected to Wi-Fi thermostats and are open to participating in a DR program. 4% of the SMB population has an AC connected to a smart thermostat and is open to participating in cooling DR. Customers with Wi-Fi thermostats have an average of 2.3 AC units connected to thermostats.

Considerably more SMB customers are willing to participate in ConnectedSolutions but do not have the required technology. Apart from those with Wi-Fi thermostats, the remaining population of willing DR participants with (non-smart) thermostats represents an additional potential of approximately 33,000 (26%) customer-locations and 58,000 ACs (if conversion from non-Wi-Fi thermostats to Wi-Fi thermostats happens).

Many customers with Wi-Fi thermostats are unaware of ConnectedSolutions. Of survey respondents with Wi-Fi thermostats (24), only three were aware of the ConnectedSolutions program, indicating most respondents had not viewed or received marketing emails.

SMB customers are conscious energy users. A majority of SMB customers (80%) with thermostats connected to cooling are concerned about managing their energy use; 91% try to operate in ways that reduce energy all or some of the time. Those who report concern for managing energy use are more likely to participate in an AC load management program.

Customers with annual energy use between 8 MWh and 200 MWh are more likely to have cooling connected to thermostats and are more likely to have Wi-Fi thermostats than smaller and larger energy users.

Healthcare, institution, and retail customers are more likely to have cooling connected to thermostats than other business types. Healthcare customers are more willing to participate in DR than other segments.

Past energy efficiency program participation is not an indicator for willingness to participate in DR.

Core Initiatives or End Uses to which the Results of the Study Apply:

- Commercial & Industrial
- New Homes & Renovations
- HVAC
- Electric Only
- Small and Medium Business; Wi-Fi Thermostat-Based Direct Load Control

Evaluation Recommendations:

The following recommendations were made by the evaluators conducting this study.

Recommendation 1: Without taking additional steps to target Wi-Fi thermostat and DR program marketing specifically to the SMB customer population, an explicit Wi-Fi thermostat based non-residential demonstration/offering should not be a priority.

If growth of an explicit non-residential offering is desired, the following recommendation applies:

Recommendation 2: In DLC program marketing, emphasize the customer maintains control during events to alleviate concerns raised by some survey respondents in the General Population survey.

Explain Whether or Not the PAs Decided to Adopt the Recommendations from the Study:

The PAs are considering all recommendations for adoption at this time. The PAs have not formally adopted or rejected any recommendations that require changes to program design and operations.

How the Study Affects Program Results and Its Significance:

The study finds that, without taking additional steps to target Wi-Fi thermostat and DR program marketing specifically to the SMB customer population, an explicit Wi-Fi thermostat based non-residential demonstration/offering should not be a priority.

Overview of Study Method:

Participant Enrollment Survey: To inform future program marketing efforts and potential adjustments to the enrollment process, the evaluation team developed, fielded, and analyzed online surveys of customers following enrollment in the program. The survey was used to gain insights into the effectiveness of program marketing and explore any challenges encountered by customers during the enrollment process.

Participant Post-Season Survey: The team also developed, fielded, and analyzed online surveys of participants at the end of the DR season to solicit feedback regarding actions taken during DR

events, customer acceptance of the technology and program offering, and likelihood to participate in the future.

SMB General Population Survey: To assess level of openness to participating in cooling DR as well as barriers to participation in a Wi-Fi thermostat-based program among the general population of nonparticipating SMB customers, the team conducted a survey of a representative sample of nonparticipating SMB customers (based on annual energy usage) using Eversource customer data. Using survey fielding and response results, Navigant conducted a segmentation analysis to develop rough estimates for potential program scalability. The analysis provides insight into the types and attributes of interested customers.

Application of Results: Prospectively

A copy of the complete study can be found in Appendix 4D, Study 19-37.

Study 19-38: Eversource Consolidated Year 2 Demand Demonstration Project Evaluation Report

Type of Study: Impact Evaluation and Process Evaluation

Evaluation Conducted by: Energy and Resource Solutions (ERS)

DNV GL

Date Evaluation Completed: 4/15/2020

Study Objective and Summary of Results:

This study evaluated six medium and large commercial/industrial demand demonstration projects. These demonstration projects were designed to test a variety of different technologies and dispatch approaches to reduce peak demand. Eversource contracted with vendors to test performance and market acceptance of different solutions. The vendors are using a variety of technologies (BMS controls, batteries, thermal energy storage, manual curtailment), controlling for different objectives (e.g. reducing annual system peak loads and customer monthly peak loads), and using different recruitment and financial strategies to enroll customers. The evaluation effort has spanned two years, covering the performance of the demonstration project in summers of 2018 and 2019 and the 2018/2019 winter season.

The evaluation scope includes both impact—measuring how much load reduction each vendor delivers—and process related elements including documenting customer recruitment, delivery, and satisfaction.

The evaluation resulted in the following key findings:

- **System peak hour reduction:** The evaluated demand reduction at the annual system peak hour (ICAP) (July 30, 2019, from 5- 6 p.m.) was 8,685 kW. The manual curtailment demonstration represented 91% of the system peak demand reduction and 38% of participating customers.

Evaluated	System Peak Reduction (kW)	Number of Customers
Manual Curtailment	7,914	16
Targeted Battery	108	2
BMS Controls 1	0	7
BMS Controls 2	0	1
Thermal Storage 1	86	8
Thermal Storage 2	**577**	**8**
Total	**8,685**	**42**

- **Event Performance:**
    - The evaluated impacts for the targeted battery and manual curtailment demonstrations met vendor reported impacts.
    - The software BMS control solutions did not provide a verifiable reduction of customer monthly peak loads and did not successfully reduce summer system peak loads. Both BMS control solutions appear to have opportunities for optimization that might reduce customer or system peak demand, and this demand reduction could be verified through a combination of engineering and load analysis in future seasons.
    - Thermal Storage 1 was successful in offsetting the rooftop unit ("RTU") cooling load during the dispatch window; however, a majority of the RTUs selected for control were oversized and underutilized, resulting in low demand reduction. While this does not reflect a lack of potential for this technology to reduce peak demand, it does mean DR for demonstration participants was lower than committed. This vendor did not revise predicted demand reductions based on actual summer performance.
    - Thermal Storage 2 was reliable and successful in shedding load during the dispatch window. The lower-than-reported demand reductions are entirely due to differences in the calculation methodology between the vendor and the evaluators. Vendor 2 used actual load data but used a calculation methodology that systematically overstated reductions.
- **Winter event performance:** The 2018-2019 winter season did not have any events triggered as intended (by locational marginal prices for electricity exceeding a preset threshold), so a winter test event was conducted for the manual curtailment and targeted battery solutions. Both solutions performed as expected during the test event.
- **Customer monthly peak impacts:** Some of the demonstration projects (targeted batteries, BMS Controls, and one of the thermal storage solutions) sought to reduce customer monthly peak loads. Vendor estimates of customer billed monthly peak demand impacts for targeted batteries and BMS Controls 1 have shortcomings that prevent them from accurately estimating these impacts. Thermal Storage 2 reduced customer billed monthly peak demand by 252.6 kW across all 8 customers.
- **Net energy impacts:** Some of the demonstration projects (one of the thermal storage solutions and targeted batteries) were expected to have either a positive or negative impact on overall energy used. Thermal Storage 2 resulted in energy savings of 126,420 kWh during the 2019 summer season. Targeted batteries resulted in a net energy increase of 2,520 kWh during the 2019 summer season at an average efficiency of 66.1%.
- **Recruiting.** A mix of recruiting approaches were employed for these projects, ranging from almost entirely vendor-driven to almost entirely account executive (AE)-driven. AE involvement was beneficial but not consistently available due to competing responsibilities, such as other programs and customer support during winter storms.

- **Customer Satisfaction:** Overall, customers participating with manual curtailment, targeted batteries, and thermal storage solutions were satisfied with the projects. The BMS Controls customers rated their project satisfaction at 3 out of 5, indicating that while they were not dissatisfied with the projects, there is room for improvement.
- **Storage technology education:** The energy storage (thermal and battery) market is nascent in Massachusetts and requires significant customer education. For thermal storage projects in particular, it was valuable to have a demonstration facility to show other customers.
- **Customer screening process:** The initial customer screening process was too lenient for the Thermal Storage solutions and BMS Controls solutions, leading to failed applications at the time of installation for the thermal storage vendors and to longer-than-anticipated installation processes for the BMS controls vendors.

Core Initiatives or End Uses to which the Results of the Study Apply:

- Commercial & Industrial
- Existing Building Retrofits
- Active Demand Reductions
- Electric Only

Evaluation Recommendations:

The following recommendations were made by the evaluators conducting this study.

1. Provide feedback to vendors with calculation shortcomings identified in these studies that would improve their demand reduction calculation methodologies for future projects.
2. Collect sufficient data to ensure project feasibility early in the participation process.
3. M&V plans should be vetted during project development to ensure that the performance metrics are quantifiable.
4. Require quantifiable and clear goals and performance metrics, and standardize reporting of DR strategies and delivered performance.
5. Either require that out-of-state vendors of nascent technologies have a local marketing representative or plan on longer ramp-up times.
6. Involve evaluators during DR feasibility testing to minimize customer touch points.

Explain Whether or Not the PAs Decided to Adopt the Recommendations from the Study:

The PAs are considering all recommendations for adoption at this time. The PAs have not formally adopted or rejected any recommendations that require changes to program design and operations.

How the Study Affects Program Results and Its Significance:

The results in this consolidated report and the technology-specific evaluation reports provide the data necessary to enable cost effectiveness testing, facilitate continued demonstration project improvements, and inform the design of full-scale programs. Performance has varied by demonstration, including some where it could not be fully quantified.

Overview of Study Method:

For battery participants, impact was measured based on battery system-level charge and discharge data. For manual curtailment and BMS Controls 1 participants, the impact evaluation was based on account-level analysis of interval data of all available participants. Impacts were calculated against settlement baselines (e.g. ISO-NE adjusted "10-of-10") and regression baselines, depending on vendor goals. BMS Controls 2 did not have any significant claimed or evaluated demand reductions.

For both thermal storage solutions, impact evaluation was based on equipment-level power data and engineering calculations.

The process evaluation was based on review of marketing materials and in-depth phone interviews with PA program managers, vendor project managers, and pre- and post-installation surveys of participants.

Application of Results: The quantitative results should be applied retrospectively. A prospective realization rate is provided for manual curtailment.

A copy of the complete study can be found in Appendix D, Study 19-38.

Study 19-39: Residential Nonparticipant Customer Profile Study

Type of Study: Market Characterization or Assessment Evaluation

Evaluation Conducted by: DNV GL

Date Evaluation Completed: 2/28/2020

Study Objective and Summary of Results:

The purpose of the Residential Nonparticipant Customer Profile Study is to assess the relationship between rates of customer participation in Mass Save residential programs and certain customer characteristics, including income levels, home ownership status, and English language proficiency, as described in the October 19, 2018 term sheet.[18] The specific study objectives are to:

1. Quantify recent (2013-2017) levels of participation in PA programs for renters, moderate-income customers, and non-English-speaking customers
2. Quantify how various customer characteristics are associated with participation in Mass Save residential programs
3. Compare analytical results at the Census block group level and at the individual customer level to address the possibility of ecological fallacy[19] when using block group-level variables
4. Establish a baseline level of participation that can be used to assess the effectiveness of PA efforts to increase outreach to non-participants

The study provides the following key findings:

- Location participation rates for 2013-2017 are negatively associated with the percentage of moderate-income households, renter households, and limited English-speaking households.
- An analysis of participation measured as the ratio of 2013-2017 savings to consumption provides evidence that the PAs have had some success in getting low-income and multifamily locations to participate. In particular, 2013-2017 savings/consumption metric is positively correlated with the concentration of low-income customers and customers living in multifamily buildings at the block group level. Additional analysis revealed that savings from the low-income multifamily programs account for these positive correlations.
- Location participation for 2013-2017 is negatively correlated with the following characteristics: concentrations of low income and homes built before 1950. Location

[18] http://ma-eeac.org/wordpress/wp-content/uploads/Term-Sheet-10-19-18-Final.pdf

[19] Ecological fallacy occurs when one makes conclusions about an individual based on group-level variables.

participation for 2013-2017 positively correlated with average or higher income and post-1950 construction.

- Most of the variables investigated are correlated with each other, especially in the Census block group data.
- Populations of renters, moderate-income customers, and customers with limited English proficiency are geographically clustered in urban areas.
- Limited English speakers are more likely to rent, and renters are less likely to participate.
- The effects of the examined variables on participation are similar in both electric and gas markets.
- Analysis conducted at the level of individual customers is largely consistent with analysis conducted at the level of Census block groups.
- The study provides tools that may be helpful to target program offerings, including maps that show concentrations of populations of interest and bivariate maps that show areas with low past participation overlaid with high concentrations of certain populations of interest. The study also provides a metric that identifies towns with relatively low historic participation and high concentration of populations of interest; this metric was provided to help assess municipal applications to the Mass Save Municipal and Community Partnership Strategy.

Core Initiatives or End Uses to which the Results of the Study Apply:

- Residential & Income-Eligible
- All Initiatives
- All End Uses
- Electric & Gas
- Excludes savings from upstream, behavioral and delivered fuel projects.

Evaluation Recommendations:

The following recommendations were made by the evaluators conducting this study.

Recommendation 1: Continue working closely with the Low-Income Energy Affordability Network (LEAN) to incorporate their extensive data resources into this analysis.

Recommendation 2: Future analyses of the types of questions examined in this study should utilize more readily accessible Census block-group-level data from the American Community Survey (ACS). Future analyses should remain aware of the strengths and limitations of each way of measuring participation, and carefully choose which definition to use in each analysis based on the conceptual question being asked.

Recommendation 3: All PAs tracking participation at the individual unit level would increase the accuracy of evaluation results for multifamily buildings. For implementers, knowing at a finer granularity what they did in a building would help identify opportunities to revisit buildings that participated in the past.

Recommendation 4: The PAs should continue to share program successes and setbacks with each other so that electric and gas implementers continue to learn from each other's experiences.

Recommendation 5: The PAs should use the metric provided for the Mass Save Municipal and Community Partnership Strategy as the baseline for assessing the effectiveness of future PA efforts to address the term sheet populations. In general, examine multiyear trends rather than focusing on singular years.

Explain Whether or Not the PAs Decided to Adopt the Recommendations from the Study:

The PAs are considering all recommendations for adoption at this time. The PAs have not formally adopted or rejected any recommendations that require changes to program design and operations.

How the Study Affects Program Results and Its Significance:

This study provides insights and tools to help programs identify which groups of residential customers have historically participated in Mass Save at lower rates to assist in future program targeting. In addition, the study provides a foundational analysis of participation patterns that informed subsequent research that explored barriers to participation for residential customers with historically lower participation rates.

Overview of Study Method:

DNV GL conducted the following tasks:

1. **Define participation.** The analysis identified four different metrics of participation: Location participation, Consumption-weighted location participation, Account participation, and Savings/consumption.
2. **Prepare data.** These analyses utilized three different data sets to analyse patterns of participation: block group data, individual-level data, and enhanced individual-level data.

   The block group data combined program participation records with ACS variables covering additional income categories, construction date, heating fuel type, and urban/rural status.

   The study also prepared a list of program participants and non-participants from 2013 – 2017. The evaluation team developed a methodology to identify which customers were likely renters based on the number of calculated renter flag.
3. **Conduct block group-level analyses.** These analyses included correlations and ordinary least squares ("OLS") regression models. Dependent variables for these models were location participation rate and the ratio of savings to consumption (savings/consumption);

independent variables were proportions of households in block groups with certain characteristics such as moderate income. The independent variables were based on ACS data.

4. **Conduct individual-level analyses.** These analyses were parallel to the block group-level analyses but used individual-level data. The dependent variables for these models were account participation and savings/consumption. Independent variables were individual-level variables reflecting demographic characteristics available statewide through sources such as the Tax Assessor data (multifamily, year of construction) and additional data on income and language from Experian (available only for Eversource).

The analysis conducted in this study contains similar analyses to that in the 2013-2017 Residential Customer Profile Study report. When discrepancies were found, the evaluators conducted extra analysis to resolve the differences.

Application of Results: Prospectively

A copy of the complete study can be found in Appendix 4D, Study 19-39.

Study 19-40: C&I Customer Profile Study Dashboard Project

Type of Study: Market Characterization or Assessment Evaluation

Evaluation Conducted by: DNV GL

Date Evaluation Completed: 12/20/2019

Study Objective and Summary of Results:

The annual Customer Profile Studies provide analysis summaries of the energy efficiency program tracking and billed usage data for all gas and electric customers served by the Massachusetts Program Administrators (PAs) to characterize the Massachusetts energy efficiency market. Over the years, the traditional "paper" Customer Profile Study reports have expanded in scope and length to include hundreds of report pages, along with volumes of supplemental Excel Workbooks of charts, tables, and geographic outputs.

The purpose of this study was to transition C&I Customer Profile Study ("CCPS") reporting from the MS Word and MS Excel format to a web-based platform with dashboard functionality hosted on DNV GL's Veracity data platform. The dashboard presents data visualizations and data extracts previously available via the CCPS reports in a transparent and easy-to-use format while maintaining existing customer confidentiality rules. This project increased data accessibility and shortened the time frame between DNV GL's receipt of PA data and public availability of summary reports.

The C&I Customer Profile Study Dashboard is now publicly available via the Mass Save Data website.[20] There is also an interactive version of the C&I Customer Profile Study Dashboard User Guide available via the dashboard.

Core Initiatives or End Uses to which the Results of the Study Apply:

- Commercial & Industrial
- All Initiatives
- All End Uses
- Electric & Gas

Evaluation Recommendations:

No formal recommendations were made in this evaluation.

[20] https://www.masssavedata.com/Public/CICustomerProfileDashboard

Explain Whether or Not the PAs Decided to Adopt the Recommendations from the Study:

N/A (no formal recommendations were made in this evaluation)

How the Study Affects Program Results and Its Significance:

The dashboard facilitates accessibility of statewide C&I participation, savings and usage data allowing interested stakeholders to:

- Accurately quantify and report on trends and time series evolution in the Massachusetts C&I customer population and program participation; and
- Provide access to summary data and enable exporting to Excel.

The platform also allows the PAs to evaluate how their standardized data compares to other PAs' standardized data, and compares to the state as a whole, while always maintaining PAs' customer and IT system confidentiality.

Overview of Study Method:

DNV GL worked closely with the PAs and EEAC Consultants to develop a user-friendly web-based dashboard tool that provides users with access to the data prepared for the 2017 Commercial & Industrial Customer Profile Study (2017 CCPS). The dashboards allow users to:

- View data by category (e.g., fuel, end use, industry segment, etc.);
- Filter data on selected variables (e.g., program year, city, upstream sales, etc.);
- View data at increasingly granular levels (e.g., broad end use to specific end use to measure); and
- Export data from any screen to an Excel file.

The primary steps in the development included:

1. Transfer and verifying of historical data (2011-2017) to new data warehouse to facilitate connection of PAs' data to the dashboard.
2. Development of semantic model to program most of the analytics in the existing CCPS.
3. Development of dashboard front-end to present data visualizations and data extracts currently available via paper reports.
4. Comparison of the results in the dashboard to those in the final 2017 CCPS as part of the quality control review.

Throughout the development process PA and EEAC stakeholders were provided secure access to the Veracity application and provided feedback on the layout, functionality, and implementation of new ideas. DNV GL provided updated versions of the dashboard and facilitated stakeholder review as part of the on-going agile process.

Additionally, DNV GL developed a user guide to accompany the C&I Customer Profile Dashboard. The user guide had two main objectives:

1. Provide users who are new to Power BI with a primer on how to use the basic functionality.
2. Show users how to navigate and locate information on the MA C&I Customer Profile dashboard.

Application of Results: Prospectively

A copy of the complete study can be found in Appendix 4D, Study 19-40.

APPENDIX 4

Statewide Evaluation Studies Summary

D. Evaluation Studies

Please see Statewide Appendix 4D: Evaluation Studies, filed under separate cover.

APPENDIX 5

Performance Incentives

Please see the attached Performance Incentive calculation tables for calculations of performance incentives based on 2019 achievement.

Please note that on February 19, 2019, the Program Administrators petitioned the Department of Public Utilities ("Department") for clarification and reconsideration of certain limited findings in the Department's 2019-2021 Three-Year Plans Order, D.P.U. 18-110 through D.P.U. 18-115 and D.P.U. 18-117 through D.P.U. 18-119. Specifically, the Program Administrators sought: (1) clarification that the new cost-effectiveness standard for performance incentives requires that the Companies remove performance incentives based on actual performance associated with non-cost-effective core initiatives only if the respective program is not cost-effective over the full term; and (2) reconsideration of the application of the Department's new cost-effectiveness standard to the value component of the performance incentive model. To date, the Department has not ruled on the Program Administrators' Motions.

All of the Program Administrator's core initiatives were cost-effective in 2019. Accordingly, the new cost-effectiveness standard for standard for performance incentives is not implicated.

Eversource Gas
2019 Energy Effiency Performance Incentives (PI)
($2019)

Line #	Performance Incentive Component		Total	Comment
	SAVINGS COMPONENT			
1	Plan Benefits	$	161,626,615	D.P.U. 18-110 through 18-119, Exh. Comm-1, App. R (updated February 19, 2019)
2	Threshold Benefits	$	121,219,961	Line 1 * 75%
3	Evaluated Benefits	$	142,780,243	Cost-Effectiveness (2019$): Total Evaluated Benefits
4	Savings Payout Rate 2019-2021	$	0.0058264	D.P.U. 18-110 through 18-119, Exh. Comm-1, App. R (updated February 19, 2019)
5	Plan Savings Incentives	$	941,697	Line 1 * Line 4
6	Cap on Savings Incentives	$	1,177,121	Line 5 * 125%
7	Evaluated Savings Incentives	$	831,891	Line 3 * Line 4 if Line 3 is greater than or equal to Line 2. Otherwise, $0.
8	Claimed Savings Incentives	**$**	**831,891**	Minimum of lines 6 and 7.
	VALUE COMPONENT			
9	Plan Program Costs (2019$)	$	56,145,000	D.P.U. 18-110 through 18-119, Exh. Comm-1, App. R (updated February 19, 2019)
10	Plan Net Benefits (Benefits - Program Costs) (2019$)	$	105,481,615	Line 1 - Line 9
11	Threshold Net Benefits (Benefits - Program Costs) (2019$)	$	79,111,211	Line 10 * 75%
12	Actual Program Costs (2019$)	$	52,666,653	Cost-Effectiveness (2019$): Total Program Costs
13	Evaluated Net Benefits (Benefits - Program Costs) (2019$)	$	90,113,590	Line 3 - Line 12
14	Value Payout Rate 2019-2021	$	0.0054959	D.P.U. 18-110 through 18-119, Exh. Comm-1, App. R (updated February 19, 2019)
15	Plan Value Incentives	$	579,721	Line 10 * Line 14
16	Cap on Value Incentives	$	724,651	Line 15 * 125%
17	Evaluated Value Incentives	$	495,259	Line 13 * Line 14 if Line 13 is greater than or equal to Line 10. Otherwise, $0.
18	Claimed Value Incentives	**$**	**495,259**	Minimum of lines 16 and 17.
19	Total Planned Peformance Incentive (2019$)	**$**	**1,521,418**	Line 5 + Line 15
20	Total Claimed Peformance Incentive (2019$)	**$**	**1,327,151**	Line 8 + Line 18
21	Percent Earned		87%	Line 20 / Line 19

APPENDIX 6

2019 Miscellaneous Implementation Update

A. Minimizing Administrative Costs

Prior to the 2019-2021 Three-Year Energy Efficiency Plan, the Program Administrators worked with a third-party vendor to study best practices for minimizing administrative costs. The Best Practices for Minimizing Program Planning and Administrative Costs (PP&A) for the Massachusetts Utilities and Energy Efficiency Services Providers report was finalized on October 25, 2018 ("PP&A Report") and was provided to the Department. The PP&A Report: (1) identified best practices, both in Massachusetts and nationwide, for tracking and assessing administrative costs; (2) identified potential benchmarks, metrics, and/or indicators for measuring administrative costs; and (3) provided specific recommendations, as appropriate, for reducing administrative costs. To continue to minimize administrative costs, the PP&A Report made the following overall recommendations: (1) Continue to Focus on Ways to Improve Consistency in Accounting Practices; (2) Formalize and Seek to Streamline Further the Reporting and Data Request Process; (3) Follow Cost Accounting Best Practices in Allocation, Tracking and Control; (4) Seek New Ways to Minimize the Regulatory / Collaboration / Facilitation/ Reporting and Ad hoc Requests Burden Without Compromising Goal Obtainment; and (5) Implement an Annual Process to Stress-Test Status Quo Processes and Spending. Consistent with the Department's directives in the 2019-2021 Plan Order, below is a summary of how the Program Administrator's adopted recommendations from the Report.

The Program Administrators have reviewed accounting practices and have determined that they are consistent. PAs allocate costs based on budgets, assigning the same percentage of an allocated cost to an initiative as the percentage of the sector or portfolio budget (as appropriate) planned for that initiative. The manner of allocation is the same among PAs, even though the actual percentages necessarily differ based on the spending needs for each initiative in each service area.

The PAs have sought to formalize and streamline data reporting requests in 2019-2021 through the Key Performance Indicators ("KPIs") and other data points described in the Term Sheet. As set forth in the Term Sheet, the PAs agreed to provide up to six KPIs quarterly in the quarterly reports. This practice is intended to create regular, known reporting obligations and reduce ad hoc requests. PAs continue to receive requests regularly from many parties, including at the management committees and EEAC meetings, which can increase administrative costs. As the study recommends, PAs look to find ways to balance what is essential and valuable from what is excessive and/or non-critical. PAs are working to raise awareness with all parties that every data request, meeting, committee, and point of contact results in additional administrative costs. PAs will continue to work with stakeholders on finding the right balance of providing information,

utilizing existing information, and understanding the purpose of a data request in order to seek to minimize administrative costs where possible.

In order to use best practices for cost allocation, tracking, and control, PAs have an internal working group to review costs. PAs regularly communicate to ensure that costs are allocated in accordance with a common methodology and are allocated consistently. PAs maintain spreadsheets documenting cost allocation decisions. Each PA has specific employees dedicated to reviewing costs. PAs have not sought to establish targets for cost reduction, as spending is related to program implementation, but are continuing to review costs (e.g., sponsorships and subscriptions) to ensure that they provide a direct energy efficiency benefit, and to collaborate to reduce costs (e.g., statewide vendor procurement).

While PAs continuously review spending and possible efficiencies, the study recommends an annual stress test. The PAs review spending at the time of the Term Report/Plan-Year Report. The PAs performed a detailed review of 2016-2018 costs in connection with the preparation of the 2016-2018 Term Reports, and have reviewed spending again in detail in connection with this 2019 Plan-Year Report. As discussed above, one of the largest unforeseeable drivers of administrative costs continues to be Council requests for additional data tracking, information, and reporting. As shown by comparing the 2015 and 2020 EEAC's Priorities, the amount of information requested by the Council has increased exponentially in the last few years. The 2015 Council Priorities was a one page document that highlighted five specific items for the Council to undertake. The 2020 Council Priorities, however, are four pages and contain dozens of new data and information requests to be included in quarterly reports. The Program Administrators have provided comments to the Council regarding the significant administrative costs associated with the requests. DOER and the Program Administrators continue to discuss these issues and how to prioritize these types of requests. Additionally, PAs continuously work on reviewing committees, program design efficiencies, and third-party administrative costs through management committees and other groups.

B. MMBtu Study Update

In the 2019-2021 Three-Year Plans Order, the Department requested that the Program Administrators refine the method used to calculate the all fuels MMBtu savings metric. Specifically, the Department found that (1) electricity used on-site, but generated offsite, contains embedded energy with heat values from a mix of fuels that generate the electricity; however, the Program Administrators failed to consider this embedded energy during the unit conversion; and (2) the energy savings for combined heat and power plants inappropriately mixed heat values with GHG emission rates. 2019-2021 Three-Year Plans Order, at 156-157. The Department directed the Program Administrators to further study and propose a more refined method to account for the conversion of electric savings to MMBtu savings. Id.

Consistent with the Department's directives, the Program Administrators completed a study to identify an appropriate methodology to calculate energy savings. The study is enclosed as Appendix 7. The MMBtu savings included in this report are calculated consistent with the

findings in the study. The study includes emission factors and conversion factors. The conversion factors have been included in each Program Administrator's benefit-cost models (Appendix 2). The Program Administrators continue to use the emission factors provided by the Department of Environmental Protection consistent with the Plan.

All Program Administrators will continue providing MMBtu savings using this study for 2019-2021 term reporting. As technologies, areas of emphasis, and delivery models evolve for energy efficiency plans, the PAs will continue to ensure they provide appropriate, meaningful measurements of success for programs in future plans.

C. Participation Barrier Update

In the 2019-2021 Three-Year Plans Order, the Department requested that the Program Administrators provide an update on the implementation of Plan enhancements that are designed to address residential and C&I sector barriers. The 2019-2021 Plan is a comprehensive plan designed to encourage participation and deliver cost-effective services. Since participation is voluntary, all elements of the programs are designed to remove barriers and attract participation among those who have not adopted energy efficient measures and behaviors. Below is an update on select enhancements.

Residential Coordinated Delivery

The Program Administrators' 2019-2021 Residential Plan builds on our history of successful innovation. The program design represents a realignment of the residential portfolio. This realignment, along with multiple enhancements and innovations, is intended to meet the challenge posed by the decline of residential lighting savings by increasing participation across all customer segments, driving broader penetration of energy efficiency and demand reduction to new participants, and securing deeper savings from existing program participants. The new Residential Coordinated Delivery initiative represents one of the significant enhancements in the 2019-2021 that improves customer experience and participation.

Residential Coordinated Delivery facilitates comprehensive weatherization and home energy efficiency upgrades in existing homes in order to reduce whole-home energy consumption. The initiative provides access to the information, technical support services, and implementation contractors who can assist customers from the identification of cost-effective energy efficiency opportunities through final implementation of energy-efficient measures. The Residential Coordinated Delivery initiative is fuel blind, providing incentives and services to customers regardless of their primary heating fuel.

The goal of this initiative is to deliver a seamless experience and maximum energy savings to every customer, regardless of unit type or ownership structure. By focusing the delivery of services on building science, opportunity, customer choice, and what each customer has the authority to implement, the new design aims to put customers in control of their energy future and reduce the number of customer confusion points along the way. Focusing on clear, uncomplicated

participation pathways will result in a more equitable distribution of benefits by making it easier for all customers to engage in our programs

Since approval of the 2019-2021 Plan, the Program Administrators have been working diligently towards the enhancements outlined in the Plan. While some of these changes are relatively straightforward and can be implemented quickly, others are more challenging, requiring changes that affect all components of program delivery, including database structure, vendor contracts, processes, and customer messaging. Some of the most sensitive work that the PAs are tackling include how to best shift from promoting the in-person home energy assessment as the best first step for all customers to focusing on connecting customers to the next best action based on their specific needs and context. Of course, the Program Administrators must continue to work towards the filed ambitious goals while making some of the above changes. This adds to the challenges, as PAs must ensure they continue to operate the programs, minimize disruption and uncertainty for the network of contractors that PAs rely on to help deliver savings, and maintain confidence and engagement with customers, all while planning for and implementing change. As such, during 2019, the Program Administrators implemented several incremental changes, including new rebates, energy savings packages, and tweaks to program roles and testing hypotheses, while preparing for larger changes in 2020.

A key step in implementation of the Plan is coordination between the PAs and vendors directly responsible for delivering services to customers. In May 2019, the PAs convened a two-day meeting including lead vendors and PA staff from all market rate residential programs to further progress towards implementing Plan enhancements. A key focus was the reduction of administrative, customer-facing barriers between programs. Achieving this requires greater coordination between different PA staff and vendors. For example, discussions at the meeting included how to ensure that customers are directed either to the Renovations and Additions or Residential Coordinated Delivery paths, and, more importantly, how a customer might benefit from both paths in certain circumstances.

The PAs have also devoted substantial time and resources to modifications to program delivery for customers in multi-family properties. Serving customers on these properties is inherently more complex. The PAs and their vendors continue to advance plans for improving service to multi-family properties, with an eye towards aligning services to the opportunities in a building and the preferences and decision-making authority of the customers. The PAs have worked with their vendors to map out paths for customers based on these and other characteristics. Some steps the PAs have taken to improve multi-family services include granting greater access to more building types to more vendors, providing energy savings packages, and modifying intake and engagement approaches.

During the first quarter of 2019, the Program Administrators introduced a new savings opportunity for customers who participate in online energy assessments. Through this offer, customers, who may not be good candidates for an in-home energy assessment, are able to receive a no-cost tailored package of energy saving measures, including LED bulbs, thermostats, smart strips, and water saving devices. The first phase was focused on customers using the online

assessment. The PAs are monitoring this offering to determine whether refinements to this approach to designing and delivering packages as necessary. Also, the PAs are developing a process to enable Lead Vendors and Home Performance Contractors to order energy savings packages on behalf of customers contacting them who are not good candidates for an in-home assessment.

The Program Administrators also continue to make progress on the customer intake process. The PAs engaged with and received recommendations from a consultant working specifically in the design and implementation of world-class interactive voice response systems. As discussed above, a key challenge and goal of the Plan is to better use data to determine whether an in-person visit is the most appropriate next step for customers looking for services. While this is a complex issue for single-family buildings, the complexity increases significantly when looking at larger buildings and facilities. The PAs and vendors are looking at how to use data, sensible program rules and processes, and good customer communication to address this challenge.

As part of modifying the in-take process, the PAs delved more deeply into how changes to the program would affect marketing messaging and the content of program materials. For instance, many of the design changes being made focus on customer opportunity, authority, and interest, and the traditional in-person home energy assessment may not be the best first step for all customers. As a result, it is critical to ensure that marketing materials indicate that there are program on-ramps outside of an in-person home energy assessment. Previously, program collateral made sharp distinctions between the Home Energy Services and Multi-family core initiatives in customer-facing collateral. Now, program materials will reflect the Residential Coordinated Delivery program design and delivery that is based on opportunity, and not the former 1-4 vs. 5+ unit building distinction.

The Program Administrators presented additional details on planned changes to the Residential Coordinated Delivery initiative during the September 18, 2019 EEAC meeting.

C&I Enhancements

Equipment and Systems Performance Optimization

In the 2019-2021 Plan, the Program Administrators committed to several strategic program enhancements including providing customers with expanded paths to HVAC Optimization, particularly Retro-commissioning ("RCx") and Operations and Maintenance ("O&M") opportunities. Consistent with this commitment, the Program Administrators have completed a broad redesign of this statewide offering, which is now known as Equipment and Systems Performance Optimization ("ESPO"). The Program Administrators performed a deep review of historic utilization of the pay-for-performance model in relation to RCx as well as completed extensive research on best practices and comparable programs that exist throughout the country. ESPO features greater optionality for customers based on both size and scope of energy savings

opportunity, customer-specific resource needs and customer preference for engagement. ESPO has four pathways available to customers, shown below.

A particularly innovative component of the ESPO offering is the Low Cost Tuning Measures pathway, the goal of which is to provide a simplified approach to non-capital intensive measures that are common, are relatively easy to calculate savings from and reasonably easy to implement, and which can therefore be captured through a prescriptive-like approach. That is, a customer can pick from a predefined list of measures, provide a handful of site-specific inputs and receive an incentive that is transparent and tied to the actions the customer chooses to take. This measure list both simplifies and educates customers on savings opportunities that can be considered "no brainers" from an energy efficiency professional's perspective. The Program Administrators are attempting to disseminate and have the customer benefit from accumulated institutional knowledge. Additionally, statewide custom express tools have been created for each measure to ease the administrative burden related to program engagement, hopefully improving the customer experience. The PAs have continued to focus considerable resources on furthering the adoption of high efficiency lighting and HVAC equipment and associated controls, including making available training and education opportunities. Other ESPO highlights include improved pre-implementation resource offerings and revised incentive levels.

Strategic Energy Management

National Grid is leading the statewide implementation of the Continuous Energy Improvement (also known as Strategic Energy Management or "SEM") demonstration effort with Cascade Energy. Cascade has recruited a mixed cohort of wastewater and industrial sites from a targeted list based on electric and gas consumption, participation in energy efficiency programs, staff bandwidth, and corporate commitment, particularly those with industrial and process loads.

The cohort kicked off in the spring of 2019 with initial workshops focused on establishing energy teams and identifying strategies for saving energy. Over the summer, the participants convened internal energy teams and Cascade staff conducted site visits. Additionally, Cascade facilitated "treasure hunts" in which they and facility staff, as well as other cohort participants, conducted walk-throughs of sites and identified instances where energy waste is occurring, either from old, outdated, or poorly-functioning equipment, or through operational practices. They also began gathering data and building regression models to identify the factors within the facility that drive energy consumption. Another workshop on tracking energy savings was held in October and during the third and fourth quarters, the sites continued to identify and log energy saving interventions and participated in frequent coaching calls with Cascade staff. The initiative will continue into 2020 and the expectation is that savings will be claimed in late spring or early summer.

Kitchen Measures

During 2019, the Program Administrators began using the Food Service Technology Center ("FSTC") methodology as the basis for their upstream point of sale food service offerings and associated savings assumptions. This switch from ENERGY STAR to FSTC, guided by support from the PAs' internal engineering and evaluation teams, provides several improvements and benefits including:

1. The FSTC methodology utilizes standard test methods from the American Society of Testing and Materials ("ASTM") to provide unbiased third-party energy efficiency test results for commercial food service equipment.

2. FSTC is the primary data source for ENERGY STAR. They have also contracted with the state of California for several years to create commercial food service technical work papers and update commercial foodservice qualified products lists.

3. FSTC updates the equipment specifications used for baseline and measure efficiency more frequently than Energy Star. FSTC typically updates their qualified product list ("QPL") monthly while ENERGY STAR does not have a regular update schedule for their QPLs and some of their equipment specifications have not been updated in years.

4. FSTC utilizes measure specific savings assumptions that more accurately reflect the high efficiency equipment installed through energy efficiency programs.

5. FSTC baseline assumptions more accurately reflect the baseline equipment available on the market.

Additionally, the Program Administrators added several refrigeration and freezer measures to their portfolio of commercial food service offerings, providing more tailored measures to meet customers' needs.

Advanced Lighting and Controls Trainings

With the considerable advancement of lighting technology and controls in recent years, additional opportunities beyond daylight harvesting and occupancy controls are now available to provide even greater efficiency of LED lighting systems. During the 2019-2021, advanced lighting controls are an area of focus. Specifically, the Program Administrators have undertaken a number of education and training approaches, in collaboration with manufacturers, distributors, lighting designers, and installers/contractors to promote proper specification, installation and operation of modern lighting systems to maximize energy savings. Influencing these early design decisions can fundamentally shape the energy costs of a building for its entire lifecycle. For many participants, the greatest value of the New Buildings and Major Renovations initiative is the access to expert, unbiased technical assistance provided by Program Administrators and the network of technical experts that is made available through the program.

The Program Administrators have hosted several training sessions on Advanced Lighting Controls for both union and non-union installers, designers, and engineers. The PAs have also been working with Design Lights Consortium and others developing online training for those unable to attend in-person trainings. The Program Administrators have been proactive about standardizing, streamlining the requirements and promoting training for customers, designers, engineers and building operators to complement the installation of these advanced systems. The trainings support optimizing and right-sizing of systems and provide critical tools for maximizing realized savings through understanding of proper system operation and management. These trainings will also help influence the types of operator behavior change required to ensure buildings operate as designed once completed and occupied.

Renters, Moderate Income, and Limited English Proficient Customers

The Program Administrators continue to evaluate opportunities to serve all customers more effectively. As discussed above, the Program Administrators recognize that customers have different opportunities, needs, priorities, and barriers. Expecting the same services through the same pathways for all customers is not realistic, nor does it recognize the diversity amongst the customers (even among customers in similar sub-segments). In-home coordinated delivery works best for some customers but not all. Some customers may be better served through upstream, retail rebates, online or other service pathways (even if they are not aware of their participation). In order to pursue all cost-effective energy efficiency, the Program Administrators' 2019-2021 Plan is designed to provide multiple pathways that meet an individual customer's needs.

The Program Administrators continue to study participation rates of different customer segments and barriers to participation. Recent non-participant studies have found that between 2013 and 2017, renters, moderate income, and limited English-speaking households participated in certain Mass Save® programs at lower rates than other households. The differences in participation were largest between renters and homeowners. A survey of customers found that 30% of renters had participated in Mass Save programs, compared to 40% of homeowners. These studies, as well as prior studies, identify several barriers to participation. A significant finding of

the studies is that non-participants are harder to reach, even when evaluators made substantial efforts to engage non-participants using financial incentives, multiple methods of outreach (e.g., web, phone, mail, door to door), and multiple languages. Specific barriers to participation include: lack of trust in government and landlords; fear of scams; other priorities such as meeting fundamental needs for food and shelter; perception that energy efficiency is not relevant or applicable to them; belief that Mass Save is a government program which deters participation; and need more information about how programs would benefit them. Several of the enhancements in the 2019-2021 seek to address these barriers, in particular the residential program redesign discussed above. The Program Administrators are continuing to review the studies' findings and will continue to look at opportunities to address barriers to participation.

As noted above, in 2019, the Program Administrators have adopted several enhancements, in addition to significant program realignments, to provide pathways for all customers. Below is a summary of those enhancements for renters, moderate income, and limited English proficient customers.

For renters, the Program Administrators worked with vendors to realize changes proposed in the Plan. In-person renter visits that do not lead to larger measures can be a burden to renters, and, for some, staying at home for an assessment may not be a viable option. The introduction of customized energy packages has enabled the PAs to reach renters in a new way, addressing opportunities that renters do have control over (such as lighting and water saving measures), while working with the appropriate party to pursue larger opportunities in the building that renters may not have the authority to pursue major measures. The decision to encourage customized energy packages is informed by data pertaining to past program participation, building type, and the customer's preference. For example, a renter in a large apartment building that has already benefited from improvements to common-area measures may be a good candidate for an energy savings package, while a renter in a smaller, older building that is likely to have a weatherization opportunity is likely a better candidate for an in-home visit. Additionally, the PA efforts discussed above in regard to serving larger buildings is of critical importance to serving renters. The PAs are committed to recruiting landlords to participate in program offerings, and are expanding tiered incentives to encourage participation by more units within a building, which is likely to benefit renters. During the fourth quarter of 2019, the PAs discussed co-hosting sessions with landlord groups within Massachusetts to gather feedback from landlords about additional modifications the PAs may consider to better serve landlords and renters. The PAs and vendors have also revisited the customer journey for renters to take advantage of this new opportunity to serve them and in the context of other changes, such as changes in the types of buildings that Home Performance Contractors are allowed to serve.

Based on an evaluation of the moderate income market, in the 2019-2021 Plan the Program Administrators modified their approach to encouraging moderate income customer participation. The study found that "time and availability, perception of their need for energy efficiency, and the need for more information are the greatest barriers to participation in the Moderate Income

offering."[1] To address these barriers and serve all customers, including moderate income customers, the Program Administrators focused the residential program redesign on simplifying communications and providing seamless, uncomplicated pathways to mitigate structural barriers. The program also began providing no-cost weatherization for moderate income customers. The PAs also continue to look for ways to ensure that moderate income customers are aware of and can take advantage of the no-cost insulation for which they are eligible.

During 2019, the Program Administrators promoted the moderate income offerings in emails to all energy assessment recipients, and improved income screening documents, as well as examining the income verification processes and considering new partners that may be interacting with moderate income customers who may benefit from the moderate income weatherization incentive and can assist those customers in moving forward with income verification and energy efficiency. Additionally, the Program Administrators, vendors and LEAN continue to meet to ensure coordination between market rate and income eligible programs as planned changes on the market rate side are rolled out. Because customers can fluctuate between income eligible and moderate income status, and because moderate income customers may be co-located in buildings occupied predominantly by income eligible customers, this coordination is critical to serving both income eligible and market rate customers. Further, the PAs and LEAN have begun to implement a mixed-income protocol (a streamlined process for serving buildings with more than 0% and less than 50% income-eligible customers) and are looking at ways to continue to improve this process and expand its use.

Following the completion of the moderate income demonstration (commenced during the 2016-2018 term), LEAN raised a concern about the ability of moderate income households to afford new heating systems. The PAs and LEAN have discussed two continued challenges with increasing incentives for heating equipment for moderate income customers: (1) market rate programs (which serve moderate income customers) do not have multiple funding sources for heating system replacements like the income-eligible programs do, and (2) total resource costs for heating system replacements do not equal what a customer would pay out of pocket for the replacement of a system, limiting the level of incentive that the PAs could provide. The PAs and LEAN will continue to discuss how best to address some of these challenges.

For limited English proficient customers, the Program Administrators have sought to optimize the customer journey for customers by providing more consistent language services via the Mass Save phone line and in follow-up communications for those customers who communicated that English is not a primary language. The Program Administrators have translated the Mass Save website into the most common languages spoken across the Commonwealth, including English, Spanish and Portuguese. Further improvements will expand the statewide Mass Save phone line to five different language options (English, Spanish, Portuguese, Russian, and Mandarin). Income-eligible flyers are translated into English, Spanish,

[1] 2018 Moderate Income Market Characterization Survey, Finding 7, at 7 http://ma-eeac.org/wordpress/wp-content/uploads/Moderate-Income-Market-Characterization-Report-Final-16Mar2018.pdf

Portuguese, Cape Verdean Creole, Chinese (traditional and simplified), Haitian Creole, Vietnamese, Russian, Arabic, Khmer, Turkish, Hindi, Urdu, and Somali.

The Program Administrators also worked with outside vendors to benchmark current services to limited English proficient households and to see how best practices across various industries could inform improvements. While appropriate language services are available to customers in most interactions, the Program Administrators are looking for ways to provide greater consistency and fluidity as non-English speaking customers transition between different vendors and aspects of the programs. One key question the PAs are seeking to understand is the extent to which language serves as primarily a communication barrier (*i.e.*, customers don't participate because they don't have the language support needed to navigate available programs) or a trust barrier (*i.e.*, customers don't participate because they perceive that programs are only intended for English-speakers and are not responsive to their own needs). The Program Administrators are reviewing the findings to identify ways to improve service to limited English proficient customers.

Municipal and Community Partnership Strategy

During 2019, the Program Administrators began implementing the proposed Municipal and Community Partnership strategy, as outlined in the Plan. The PAs engaged with a number of stakeholders to develop an implementation plan, including over 40 municipalities and stakeholder organizations, the Metropolitan Area Planning Council (MAPC), the Massachusetts Association of Regional Planning Agencies (MARPA), MassCEC, and the EEAC consultants. After a competitive application process in November 2019, the PAs selected seven municipalities to participate in the 2020 Municipal Partnership based on the quality of their applications and action plans for their communities to reach hard to reach customers. The seven municipalities selected include: Chelsea, Framingham, Lancaster, Lawrence, Methuen, New Bedford, and Pittsfield. The PAs held a kick-off event on December 10, 2019 that was attended by all of the municipalities, their volunteer teams, LEAN, and the PAs. At the kick-off event the participants learned more about the structure of RCD, Small Business Turnkey, and Income Eligible programs, reviewed the goals of the Municipal Partnership, reviewed roles and expectations, and discussed marketing and outreach strategies. The PAs held one-on-one meetings with each municipality and will host monthly conference calls for the participants during 2020.

Non-Profit Partnership Strategy

During 2019, the Program Administrators began collaborating with PowerOptions consistent with the Order for the 2019-2021 Plan to examine opportunities to enhance outreach to non-profit customers. The PAs and PowerOptions have discussed the overlaps of customers, services, and segments and identified areas of collaboration. The PAs and PowerOptions jointly identified two discrete sub-segments of the expansive nonprofit segment that we can target together for a tailored marketing approach that complements existing efforts. The PAs and PowerOptions have been jointly developing specific marketing messages and held additional discussions regarding a tailored marketing approach that complements existing efforts. Marketing materials and process mechanics are still being finalized.

D. Additional Data Requests

Below is a table showing additional data related to renters, income level, and language.

2019 Renter Data

Renter Vs. Owner

Reporting Category	Number of Renters/Units
Residential Coordinated Delivery	616
Innovation - Tailored Energy Savings Packages	-
Income Eligible Coordinated Delivery	2,675
Total	**3,291**

Reporting Category	Number of Rental Units	Number of C&I
C&I, Residential End Use	652	16

Income Level

Income Designation	Number of Renters/Units
Market Rate	616
Moderate Income Qualified and Received Weatherization*	-
Income Eligible	2,675
Total	**3,291**

*The moderate income participants include customers who voluntairily income qualified and are served through the market rate program.

Mass Save Language Data

Language	Mass Save Hotline Language	MassSave.com Page Views
English	137,156	5,154,923
Mandarin	158	N/A
Portuguese	313	9,603
Russian	212	N/A
Spanish	2,900	44,195
Total	**140,739**	**5,208,721**

E. Residential Conservation Services Scorecards Update

During 2019, the Program Administrators worked closely with vendors and DOER to determine a pathway to integrate Home Energy Scorecards into home energy assessments. Home energy scorecards are intended to be an educational component of the home energy assessments, with no requirement for disclosure as part of a real estate transaction, as emphasized by DOER in its Reply Brief in the 2019-2021 Plan.

In Q1 2019, the parties began working with the Department of Energy ("DOE"), to discuss using the Department of Energy's Home Energy Score as the methodology underlying the scorecards. DOE has a number of requirements, associated with specific data fields to collect, quality control, and training requirements, which the PAs, vendors, DOER, and DOE discussed

extensively. The PAs used the outcomes of these discussions to work with vendors to estimate costs for implementing the scorecards, including software set up and maintenance, training, incremental quality control, incremental time at the home energy assessment, providing updated scores after upgrades are made, and other requirements. Initial estimates would have added considerable expense to RCS budgets, very likely triggering the need for a mid-term modification. For this reason, the PAs and DOER began discussing alternative approaches that might be able to achieve the same goals with lower costs. The Program Administrators also reviewed studies on similar scorecard programs in other states, including Connecticut. Ultimately, DOER did not approve of the alternative approaches proposed by the Program Administrators. A primary concern was DOER's desire for a uniform scorecard methodology across the state, including in municipal light plant territories.

After further discussions with DOER, the PAs and DOER have agreed to a staggered roll out of scorecards using DOE's Home Energy Score. Currently, the Program Administrators anticipate that some PAs will be able to rollout scorecards before others, allowing them to share lessons learned that might help mitigate costs and other implementation challenges encountered by the initial adopters. The Program Administrators are still working on details of and budgets for this rollout, including customer communications and reporting, and will continue to work with DOER moving forward. Exact timing of this rollout is dependent upon software updates, which are being implemented by the same vendors making changes for improvements to RCD. Subject to the capacity of these vendors, the PAs anticipate that at least some PAs will be able to start delivering scorecards in late 2020. At this time, the Program Administrators do not anticipate that the increase in the RCS budget will be greater than 20 percent of the planned 2019-2021 RCS budget.

APPENDIX 7

Study to Propose a More Refined Method to Account for the Conversion of Electric Savings to MMBtu Savings

NAVIGANT
A Guidehouse Company

Study to Propose a More Refined Method to Account for the Conversion of Electric Savings to MMBtu Savings

Final Report

Prepared for:

The Electric and Gas Program Administrators of Massachusetts

Submitted by:
Navigant Consulting, Inc., n/k/a Guidehouse, Inc.
1375 Walnut Street
Suite 100
Boulder, CO 80302
www.guidehouse.com

Reference No.: 212040
March 23, 2020

NAVIGANT
A Guidehouse Company

Study to Propose a More Refined Method to Account for the Conversion of Electric Savings to MMBtu Savings

TABLE OF CONTENTS

Executive Summary ii

1. Introduction 1

2. Methodology 1

2.1 Market Modeling 1
2.1.1 Electric Market Simulation 2
2.1.2 Extrapolation through 2050 2
2.1.3 Model Validation 3
2.2 Average Heat Rates and Marginal Heat Rates 4
2.2.1 Average Heat Rate Approach 5
2.2.2 Marginal Heat Rate Approach 5
2.3 Heat Rate Assumptions for Non-Combustion Renewables 6
2.3.1 Heat Rates for Hydroelectric, Solar, and Wind Sources 6
2.3.2 Heat Rates for Nuclear Sources 7
2.4 Benefit Cost Ratio (BCR) Model Updates 7
2.4.1 Calculations Prior to Update 7
2.4.2 New Tables of Annual and Lifetime Factors for MMBtu and Emissions 8
2.4.3 Incorporating MMBtu and Emissions Factors in BC Calculations 9

3. Results 11

3.1 Forecast of Electric Generation Mix 11
3.2 Forecast of Marginal Generation by Plant Type 11
3.3 Forecast of Heat Rates by Plant Type 13
3.4 Results from Marginal Heat Rate and Average Heat Rate Approaches 13
3.5 Tables of MMBtu, NOx, SOx, and CO2 per MWh for 2020-2050 15
3.6 Impacts of Updated Factors 18
3.7 Limitations of This Analysis 19

Appendix A. Detailed Total Generation Mix Forecast A-1

Appendix B. Detailed Marginal Generation Mix Forecast B-1

NAVIGANT
A Guidehouse Company

Study to Propose a More Refined Method to Account for the Conversion of Electric Savings to MMBtu Savings

EXECUTIVE SUMMARY

The Massachusetts Program Administrators (PAs) that sponsor Mass Save are required by the state to provide energy efficiency services to their customers, and they have annual energy efficiency goals. In the course of measuring progress towards those goals, the PAs calculate the total energy savings across all fuels and the greenhouse gas reductions that result from individual energy efficiency measures. The purpose of this study is to refine the method used by the PAs to convert site savings of electricity (in kWh) into source fuel savings (in MMBtu) and to estimate the emissions reductions (of NOx, SOx, and CO_2) that result from electric consumption savings.

For this study, our team used a market modeling approach to forecast the average generation mix, the marginal generation mix, and the typical heat rates and emission rates of different generation plants in the ISO New England region. We forecast these values for the 2020-2040 period using Navigant's proprietary Portfolio Optimization Model (POM) and PROMOD, a commercially available software model. We extrapolated these results to estimate values for the period from 2041-2050, reflecting Massachusetts' policy goal that 80% of electricity generation come from clean energy sources by the year 2050. Then, we compared the results from our market model forecast to observations from different data sources to verify that our forecasting tools are properly calibrated to current market conditions.

Using the market model results and extrapolations for the last decade of the analysis, we calculated heat rate and emissions factors for four costing periods (summer and winter, on- and off-peak) on an annual basis for the period 2020-2050. These factors enable the PAs to calculate the source fuel savings (in MMBtu) and the emissions reductions (in tons of NOx, SOx, and CO_2) for individual energy efficiency measures, based on the PAs' estimates of electricity savings (in MWh). We calculated two separate sets of factors using an average heat rate approach and a marginal heat rate approach. These factors are presented in Table 1 and Table 2 of this report, and our calculations that support these factors are detailed in the spreadsheet submitted with this report. We recommend that the PAs use factors calculated with an average heat rate approach, since (compared to marginal heat rate forecasts) average heat rate forecasts have less associated uncertainty and volatility and are less sensitive to fuel prices and individual plant activity.

Our team updated the Benefit-Cost Ratio (BCR) model to include the MMBtu and emissions factors developed in this study. Prior to this study, the BCR model calculations used static conversion factors to estimate source energy savings and emissions reductions based on electric consumption savings. Our team updated the BCR model to calculate MMBtu and emissions factors specific to each measure, accounting for the measure life and load shape of individual measures. A version of the BCR model that includes these recommended changes is attached to this report.

Updating the BCR model's MMBtu and emissions factors with the results of this study will not affect the benefit-cost ratios calculated for individual measures, since net MMBtu savings and greenhouse gas reductions are not included in the calculation of the B/C ratio. The new MMBtu/MWh factors are higher than the factors used in the 2019-2021 plan version of the model, because the new factors account for the efficiency of fuel-fired generating plants. As a result, the new MMBtu factors will lead to a relative increase in the net annual energy savings and the net lifetime energy savings calculated for each measure in the BCR model. The emissions factors calculated in this study are lower than the factors used in the 2019-2021 plan version of the model, since the factors in this study account for the future shift toward zero emissions power sources (such as wind, solar, and hydropower). The new factors will lead to a relative decrease in the GHG reductions calculated for each measure in the BCR model.

NAVIGANT
A Guidehouse Company

Study to Propose a More Refined Method to Account for the Conversion of Electric Savings to MMBtu Savings

1. INTRODUCTION

The Massachusetts Program Administrators (PAs) requested that the Navigant Consulting, Inc., n/k/a Guidehouse Inc. (Navigant) develop a methodology to estimate the source energy consumption and emissions reductions (NOx, SOx, and CO_2) associated with electricity consumption in Massachusetts. The purpose of this study is to refine the method used by the PAs to convert site savings of electricity (in kWh) into source fuel savings (in MMBtu) and to estimate emissions reductions resulting from electric consumption savings. This report describes the methodology and results of our analysis.

The source energy usage and emissions from electric generation at any given time depend on the mix of plants that generate electricity and their relative contributions to the electric supply. Electric customers in Massachusetts are served by ISO New England (ISO NE). In the ISO NE region, electricity is generated from combustion of fuels (natural gas, coal, oil), hydroelectricity, nuclear power, and various renewable sources. The mix of electric generation sources supplying the ISO NE electric grid varies throughout the year, depending on the availability and cost of different sources. Additionally, the electric generation mix will change over time, as older generation plants are retired and newer plants are brought online.

Our team used electricity market modeling tools to forecast the annual average mix of generation fuels and the mix of generation fuels used at the margin to generate electricity for Massachusetts customers for the period from 2020 through 2050 in four costing periods, defined as follows:[1]

- **Winter on-peak** is October through May, weekdays from 7am to 11pm;
- **Winter off-peak** is October through May, weekdays from 11pm to 7am, plus weekends and holidays;
- **Summer on-peak** is June through September, weekdays from 7am to 11pm; and
- **Summer off-peak** is June through September, weekdays from 11pm to 7am, plus weekends and holidays.

The following section describes the methodology used in this study.

[1] These costing period were recommended by the PAs, to align with the costing periods used in Synapse (2018) "Avoided Energy Supply Components in New England: 2018 Report." p.66

NAVIGANT
A Guidehouse Company

Study to Propose a More Refined Method to Account for the Conversion of Electric Savings to MMBtu Savings

2. METHODOLOGY

This section describes the market modeling approach that our team used to forecast the average generation mix, the marginal generation mix, and the typical heat rates and emission rates of different generation plants serving the ISO NE region. This section also provides a discussion and comparison of two separate approaches to developing the MMBtu and emissions factors: one approach using average heat rates and one approach using marginal heat rates. The section concludes with a discussion regarding the assumed heat rates of non-combustion renewable power generators and a description of suggested updates to the BCR model.

2.1 Market Modeling

At a high level, our approach consisted of the following steps:

1. We used the most recent Navigant Reference Case, which is the company's independent view of plant additions, retirements, and operations over time in the ISO NE power system. The Reference Case is developed using a suite of market modeling tools, including Navigant's proprietary Portfolio Optimization Model (POM) and PROMOD, a commercially available software model.[2]
    a. POM is used to model the change in electric generation capacity from different types of generating plants through the year 2040.
    b. PROMOD is used to develop wholesale energy market prices and plant performance forecasts through 2040.
2. We extrapolated the market model results to estimate the fuel mix from 2041-2050, reflecting Massachusetts' policy goal of sourcing 80% of electric generation from clean energy sources by 2050.
3. We compared the results from the PROMOD forecast to current observations from different data sources to ensure the market modeling tools are properly calibrated to current market conditions.
    a. We compared dispatch fuel mix and daily generation mix data from ISO New England[3] to the generation mix forecast by the market modeling tools.
    b. We compared heat rates of different generation technologies reported in generator's NERC filings to the heat rates forecast by the market modeling tools.

The following sub-sections describe these steps in more detail.

[2] Navigant's Reference Case is used by market participants including developers, IPPs, investors, utilities, and regulatory bodies to understand trends in wholesale power markets. Our team provided the ISO-NE market report for Navigant's Fall 2019 Reference Case to the PAs.
[3] ISO-NE publishes data on the regional electricity generation mix for its service region, at: https://www.iso-ne.com/isoexpress/web/reports/operations/-/tree/gen-fuel-mix

NAVIGANT
A Guidehouse Company

Study to Propose a More Refined Method to Account for the Conversion of Electric Savings to MMBtu Savings

2.1.1 Electric Market Simulation

Navigant forecasted the electric generation mix using a combination of two tools: our proprietary Portfolio Optimization Model (POM) and the commercially available PROMOD software. POM is a linear optimization model used for capacity expansion. POM simulates economic investment decisions and power plant dispatch on a zonal basis subject to capital costs, reserve margin planning requirements, renewable portfolio standards (RPS), fuel costs, fixed and variable operations and maintenance costs, emissions allowance costs, and zonal transmission interface limits. This model incorporates the same generation base, demand forecasts, fuel prices, other operating costs, and plant parameters that are utilized throughout the market simulation modeling process. The model simultaneously performs least-cost optimization of the electric power system expansion and dispatch in multi-decade time horizons. The generation expansion results from POM are used in the fundamental energy price forecast.

Navigant used PROMOD to develop its wholesale energy market price and plant performance forecasts. PROMOD is a detailed energy production cost model that simulates hourly chronological operation of generation and transmission resources on a nodal basis in wholesale electric markets. PROMOD dispatches generating resources to match hourly electricity demand, dispatching the least expensive generation first. The choice of generation is determined by the generator's total variable cost given operating constraints such as ramp rates (for fossil resources) or water availability (for hydraulic resources), and transmission constraints. The total variable cost of the marginally dispatched unit in each hour sets the hourly market clearing price. We have provided further details on our market modeling approach to the PAs in the form of an ISO NE market report.

2.1.2 Extrapolation through 2050

In its current configuration, the PROMOD tool only forecasts electric market activity through 2040. However, for this study, the PA technical leads requested that source energy and emissions factors be provided through the year 2050, since the PAs offer several energy efficiency measures with lifetimes that extend past 2040. To estimate the generation fuel mix for the period 2041-2050, the team referenced the requirements of the Clean Energy Standard (CES) promulgated by the Massachusetts Department of Environmental Protection (DEP). The CES sets a minimum percentage of electricity sales that utilities and competitive retail suppliers must procure from clean energy sources. The minimum percentage begins at 16% in 2018 and increases 2% annually to 80% in 2050.[4]

Our forecast assumes the following generation sources count towards the CES: nuclear, hydroelectric, wind, solar, and other renewable sources. In 2040, the ending year of the PROMOD forecast, we project that generation from these sources will sum to 71.8% of total electricity generation. Therefore, generation from clean energy sources will need to increase over the 2041-2050 period to meet the minimum CES requirement of 80% in 2050. We estimated that total electric generation will steadily increase in the 2041-2050 period following the same linear trend forecasted for the preceding ten-year period, 2031-2040. We assume that generation from nuclear and hydroelectric sources will remain constant in the 2041-2050 period at the same levels projected for the preceding ten years, and that the required increase in clean energy generation will result from increased generation from solar, wind, and other renewable sources. To model this increased generation, we assume that solar, wind, and other renewable generation will

[4] Summaries of Massachusetts' Renewable and Alternative Energy Portfolio Standard programs, including the CES, are available online at: https://www.mass.gov/service-details/program-summaries

NAVIGANT
A Guidehouse Company

Study to Propose a More Refined Method to Account for the Conversion of Electric Savings to MMBtu Savings

increase proportionally from 2041 to 2050 such that they meet the 80% CES requirement in 2050, and that generation from natural gas and other non-CES sources will decrease proportionally through 2050.

To estimate the annual heat generation (in MMBtus), we assumed heat rates forecast for each plant type in 2040 will remain constant for the years 2041 through 2050. Combining these heat rates with the extrapolated generation fuel mix, we calculated the total heat output by plant type for 2041 through 2050.

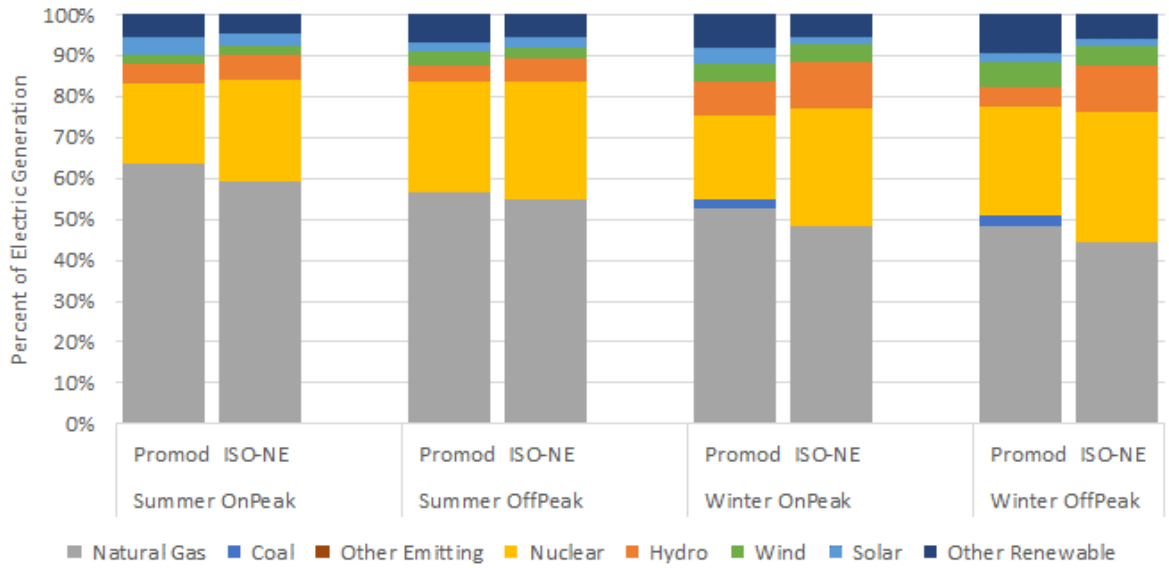
2.1.3 Model Validation

To verify that the POM and PROMOD tools are calibrated to represent the regional electricity market, we compared the models' output to available historical data regarding the generation mix and the heat rates by generator technology.

ISO New England provides data on hourly dispatch rates by fuel type and the daily generation fuel mix for the period 2015-2019. We gathered this data and processed it to determine the average generation fuel mix during the four costing periods for the 2015-2019 period. Since ISO New England has not yet published data for 2020, we used trends observed for the 2015-2019 period to estimate the generation fuel mix for the costing periods in 2020. We compared the 2020 generation mix predicted by our market modeling described above to the projected ISO New England 2020 generation mix, and we found the results to be closely aligned, as illustrated in Figure 1. Our current analysis focuses on the total shares from emitting sources (coal, natural gas, oil) versus non-emitting sources (nuclear, hydro, renewables).

The comparison in Figure 1 provides additional context for the market modeling results, and we are confident that our market modeling represents a sound electric generation mix forecast for electric supply in Massachusetts. Nevertheless, Navigant recommends that the PAs continue to monitor ISO NE actual generation data and periodically update the supply volumes as conditions warrant.

Figure 1. Generation Mix without Imports: Comparison of PROMOD Market Model and ISO New England Dispatch Fuel Mix, 2020

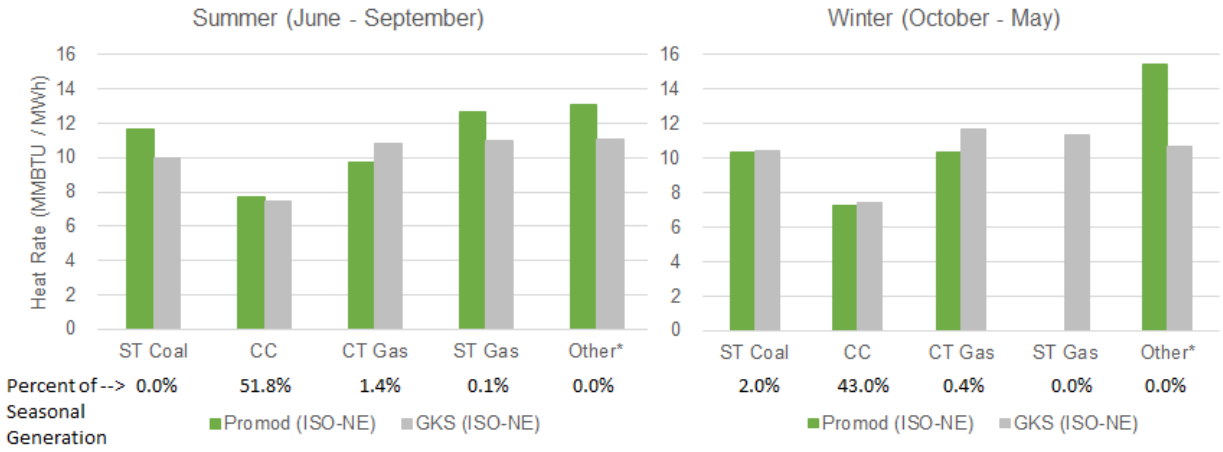


NAVIGANT
A Guidehouse Company

Study to Propose a More Refined Method to Account for the Conversion of Electric Savings to MMBtu Savings

We also compared the heat rates from the market model's output to data from specific ISO NE generating units that Navigant tracks through our GKS Fossil benchmarking service. GKS Fossil calculates heat rates using data that utilities report in monthly intervals to the North American Electric Reliability Corporation's (NERC) Generating Availability Data System (GADS). GKS Fossil currently has data through June 2019, and we calculated a weighted average of seasonal heat rates by plant type (weighted by total plant generation) for the most recent data submitted by each of the 65 generating units that we track in ISO NE. We compared the market models' MMBtu consumption forecast for 2020 to the GKS weighted average heat rate calculations, and we found the results to be comparable. Figure 2 shows that the natural gas combined cycle (CC) plant type comprises the vast majority of combustion-based generation, and that PROMOD's heat rate estimates for combined cycle plants deviate by less than 2% from the heat rates observed in GKS. This comparison provides additional context for the market modeling results, and we are confident they accurately represent the typical heat rates of plants that supply electricity to Massachusetts.

Figure 2. Comparison of PROMOD Market Modeling Outputs (2020) and GKS Fossil Heat Rates (2019) for Combustion Plants



** The "Other" category in GKS Fossil contains oil-fired steam turbine plants and oil-fired simple-cycle combustion turbine plants (including fuel oil, diesel, jet fuel and kerosene). The distribution of "other" plant technologies in GKS Fossil may not align exactly with the distribution of plant technologies in PROMOD. This could explain why there is a larger gap between the GKS and PROMOD heat rate estimates in the winter months, when some plants operate less efficiently due to increased cycling.*

2.2 Average Heat Rates and Marginal Heat Rates

A guiding principle of Massachusetts' energy efficiency programs is that these programs operate on the margin. Consistent with that, the PAs requested that this study produce MMBtu and emissions factors that represent the heat rates and emissions plants operating at the margin in each of the four costing periods.

There is some uncertainty as to how to define the marginal plant. In theory, a marginal approach considers the heat rate and emissions of the single generating plant that is on the margin in each time period so that the last kW generated can be compared with the marginal customer energy efficiency, electrification, or other demand-side resource. However, it is not clear how to define the marginal demand

side resource. Is it any measure being considered in the BCR model, where that measure on the margin has virtually no effect on avoided costs or which plant is the last unit called by ISO-NE? Or is there a "set" of demand-side measures on the margin from Massachusetts—and the rest of New England—that comprises enough of a share that the system is materially affected along with the so-called marginal plant? If so, is the average heat rate and emissions a better estimate for planning purposes?

In the course of our analysis, we observed that the marginal heat rate analysis is more sensitive to individual plant outcomes than the average heat rate approach is. The Results section of this report describes these observations in more detail and weighs the benefits and drawbacks of each approach. In this report, we provide the PAs with separate sets of outputs that result from modeling using the marginal heat rate approach and the average heat rate approach. We also incorporate both sets of outputs in the BCR model to allow the PAs to consider both approaches, and the differences that result, in their analyses.

2.2.1 Average Heat Rate Approach

The results of the market modeling described above include the following values for each costing period for each year from 2020 through 2050: total electric generation (in MWh), total heat output (in MMBtu), and total emissions outputs from electric generation (in tons of NOx, SOx, and CO_2). To calculate MMBtu factors using an average heat rate approach, our team divided the total heat output by the total electric generation for each period. To calculate emissions factors using an average heat rate approach, our team divided the total emissions output for each greenhouse gas (NOx, SOx, and CO_2) by the total electric generation for each period.

2.2.2 Marginal Heat Rate Approach

In addition to average heat rates, Navigant determined approximate marginal heat rates for each costing period based on its estimation of which plant technology (nuclear, renewable, etc.) is at the margin in each hour of the 20-year PROMOD forecast.

To determine the marginal technology type for every hour, Navigant used its standard assumptions from PROMOD of heat rates by technology type, together with forecasted fuel prices and emissions prices from the Reference Case and assumptions about variable operations and maintenance (O&M) costs. Our team used these assumptions to back-calculate energy prices by marginal technology and compared these prices to actual forecasted energy prices to identify the marginal technology type for each hour of our forecast.

We then aggregated all hours by costing period to arrive at a forecast of the proportion of time in each costing period that each technology type is at the margin. We used these proportions to weight the heat rates and emissions rate of individual plant types when we calculated the overall marginal heat rates and emissions rates for each costing period.[5]

[5] Our forecasts of marginal plant selection are unable to differentiate between marginal hours served by hydroelectric plants and marginal hours served by nuclear plants. To address this, we forecast the number of marginal hours served by either nuclear or hydroelectric plants and assumed those hours would be evenly (i.e., 50/50) split between nuclear and hydroelectric plants.

NAVIGANT
A Guidehouse Company

Study to Propose a More Refined Method to Account for the Conversion of Electric Savings to MMBtu Savings

2.3 Heat Rate Assumptions for Non-Combustion Renewables

2.3.1 Heat Rates for Hydroelectric, Solar, and Wind Sources

This study developed summary MMBtu/MWh factors based on typical heat rates of various electric generator types. It is straightforward to estimate the heat rates for combustion-based sources such as natural gas-fired power plants. A combustion plant's heat rate is equal to the thermal efficiency of the plant's conversion of fuel into electricity. However, the estimation of heat rates for non-combustion renewable sources (such as wind, solar, and hydroelectric plants) is less straightforward. There are several conventions for estimating heat rates of non-combustion renewables, and different approaches may serve different analytic, policy, or statistical needs.

The U.S. Energy Information Administration (EIA) describes several approaches for calculating non-combustible heat rates in Appendix E of their January 2017 Monthly Energy Review:[6]

- The **captured energy approach** reflects the primary energy captured for economic use and does not include losses. This approach uses a simple 3,412 Btu/kWh conversion factor.
- The **incident energy approach** measures the gross energy that first strikes an energy conversion device. In other words, it measures the energy in the water, wind, or sunlight and accounts for conversion efficiency of the turbines or photovoltaic panels.
- The **fossil fuel equivalency approach** represents the energy that would have been consumed if electricity had been generated by fossil fuels.

The California Energy Commission uses a different approach, reporting heat rates for California plants as fuel consumed at each plant divided by each plant's energy output.[7] The CEC reports heat rates of zero MMBtu/MWh for hydroelectric, geothermal, solar photovoltaic, and wind power plants, because these plants do not consume fuel.

Our team reviewed ISO NE documentation on heat rates and could not determine what heat rates ISO NE uses for non-combustible renewable sources.

We understand that the PAs intend to use the MMBtu/MWH factors from this study to account for heat that was generated by consuming non-renewable sources. The Massachusetts Department of Public Utilities (DPU) order that prompted this study stated the following:

> "Electricity used on-site, but generated offsite, contains embedded energy with heat values from a mix of fuels that generate the electricity; however, the Program Administrators failed to consider this embedded energy during the unit conversion."[8]

[6] U.S. Energy Information Administration (2017). "January 2017 Monthly Energy Review." Available at: http://large.stanford.edu/courses/2017/ph241/sheu1/docs/eia-0035-1-2017.pdf
[7] California Energy Commission. "Heat Rates." Available at: https://ww2.energy.ca.gov/almanac/electricity_data/web_qfer/Heat_Rates_cms.php
[8] Massachusetts Department of Public Utilities (2019). "D.P.U. 18-110 through D.P.U. 18-119." p.156-157. Available at: https://fileservice.eea.comacloud.net/FileService.Api/file/FileRoom/10317061

NAVIGANT
A Guidehouse Company

Study to Propose a More Refined Method to Account for the Conversion of Electric Savings to MMBtu Savings

Non-combustion renewable sources do not consume fuel nor produce emissions, so they do not contain embedded energy beyond the energy that is delivered for site consumption. Therefore, we recommend that the PAs follow guidance from the EIA, which states:

> "Users who need renewable primary energy in terms of final energy consumed should multiply the annual generation (in kWh) for the wind, solar, hydro, or geothermal resource of interest by 3,412 Btu/kWh to obtain an estimate of primary energy consumption for renewables."[9]

The analysis conducted in this study therefore assumes a heat rate of 3.41 MMBtu/MWh for wind, solar photovoltaic, and hydroelectric sources.[10]

2.3.2 Heat Rates for Nuclear Sources

Nuclear generating sources do not generate power from fuel combustion, nor do they produce GHG emissions. They do, however, produce heat as they consume uranium fuel. In this study, we assume a typical heat rate of 10.46 MMBtu/MWh to estimate the embedded energy in the electricity generated from nuclear sources. This is consistent with the average operating heat rate that the EIA reports for nuclear plants.[11]

2.4 Benefit Cost Ratio (BCR) Model Updates

2.4.1 Calculations Prior to Update

Prior to this study, the BCR model's calculations used static conversion factors to estimate source energy savings and emissions reductions based on electric consumption savings. The BCR Model ***Lookups*** tab contains a MMBtu factor in range D35:F35 (equal to 3.412 MMBtu/MWh) and emissions factors in range D29:F31 (equal to 0.00016 tons NOx/MWh, 0.00004 tons SOx/MWh, and 0.49400 tons CO_2/MWh).

The MMBtu/MWh factor is referenced in columns R-U of the calculation tabs of the model (tabs ***EECalcsYr1***, ***EECalcsYr2***, and ***EECalcsYr3***), which calculate the following:

- Column R: Adj Gross Annual Energy (MMBTU)
- Column S: Adj Gross Lifetime Energy (MMBTU)
- Column T: Net Annual Energy (MMBTU)
- Column U: Net Lifetime Energy (MMBTU)

Each of these columns calculates MMBtu savings by multiplying the universal named variable "MWhtoMMBTU" (from the ***Lookups*** tab) by the MWh savings values calculated in columns N-Q of the calculation tabs.

[9] U.S. EIA (2019). "Average Fossil Fuel Heat Rates for Electricity Generation." Available at: https://www.eia.gov/outlooks/aeo/heat_rates.php

[10] Note that we assume non-zero heat rates for combustion-based renewable energy sources, such as landfill gas, refuse, and biomass, since these sources consume fuel and have embedded energy beyond the energy that is delivered for site consumption.

[11] U.S. EIA (2019). "Average Operating Heat Rate for Selected Energy Sources." Available at: https://www.eia.gov/electricity/annual/html/epa_08_01.html

NAVIGANT
A Guidehouse Company

Study to Propose a More Refined Method to Account for the Conversion of Electric Savings to MMBtu Savings

The greenhouse gas reductions for each measure are calculated in columns EF-EH of the calculation tabs, which reference the static emissions factors from the ***Lookups*** tab and calculate the following:

- Column EF: Annual NOx (Short Tons)
- Column EG: Annual SO_2 (Short Tons)
- Column EH: Annual CO_2 (Short Tons)

The annual NOx and SOx reduction values are calculated by multiplying the "Adj Gross Annual MWh" (column N) by static values for GHG_Elec_NOX and GHG_Elec_SO2, respectively. The annual CO_2 reduction value is calculated as a sum of CO_2 reductions due to electric savings ("Adj Gross Annual MWh" multiplied by the factor GHG_Elec_CO2) and CO_2 reductions due to site savings of natural gas, oil, and propane.

The current approach in the BCR model uses the same MMBtu and emissions factors for all measures, even though individual measures have different load shapes and different values for measure life. The following sections describe how the BCR model may be changed to incorporate the findings of this study and to account for different measure lifetimes and load shapes.

2.4.2 New Tables of Annual and Lifetime Factors for MMBtu and Emissions

The analysis in this study developed average and marginal heat rate and emissions factors for each of the four costing periods, for each year from 2020-2050. These values are contained in range T8:BB42 of a new ***SourceFactors*** tab added to the BCR spreadsheet. In cell A5 of the ***SourceFactors*** tab, users can specify whether they want the analysis to use an average heat rate approach or a marginal heat rate approach. Users may also choose to use the original MMBtu and emissions factors used in the 2019-2021 plan version of the BCR model.[12] The user input in cell A5 determines which set of heat rate and emissions factors is selected and used in the BCR model. In both the AVERAGE table and the MARGINAL table, the MMBtu and emissions factors change over time since the proportion of different fuels in the electric generation mix is forecast to evolve over time.

Energy efficiency measures with measure life longer than one year should use MMBtu and emissions factors that account for changes in the generation fuel mix over the lifetime of the measure. The ***SourceFactors*** tab contains tables that calculate average lifetime MMBtu and emissions factors for measures in program years 1, 2, and 3, with measure life ranging from 1 to 25 years. The average lifetime factors are calculated separately in the ***SourceFactors*** tab for program year 1 (range A45:R77), program year 2 (range A79:R110), and program year 3 (range A112:R142). These lifetime factors are calculated as an unweighted average of factors from the program year through the end of the measure life. For example, the lifetime MMBtu factor for a 2020 measure with 20-year life is calculated as the average MMBtu factor over the period 2020-2039.

These lifetime average factors are then referenced by the calculations for individual measures, as described in the following section. The tables of average lifetime factors in the ***SourceFactors*** tab are divided into named ranges to make any equation references to these tables easier to comprehend and quality check. For example, the ***SourceFactors*** range C43:F74 is assigned the name "Tbl_MMBtu_MWh_Yr1," indicating that it is a table of MMBtu/MWh factors for use with Year 1 measures.

[12] If users choose to model the ORIGINAL values, the model uses the following values for all years: a heat rate of 3.412 MMBtu/MWh and emissions factors of 0.00016 tons NOx/MWh, 0.00004 tons SOx/MWh, and 0.49400 tons CO2/MWh.

NAVIGANT
A Guidehouse Company

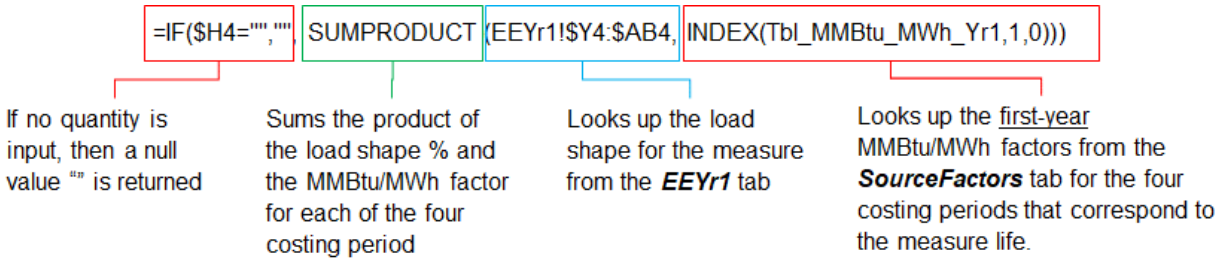
Study to Propose a More Refined Method to Account for the Conversion of Electric Savings to MMBtu Savings

2.4.3 Incorporating MMBtu and Emissions Factors in BC Calculations

As noted above, individual measures have different load shapes and different values for measure life. The MMBtu and emissions factors used for each measure should reflect the measure's load shape and measure life. The team suggests adding five columns to each calculation tab (tabs ***EECalcsYr1***, ***EECalcsYr2***, and ***EECalcsYr3***) to calculate the first-year MMBtu factor, the lifetime average MMBtu factor, and the lifetime average emissions factors unique to each measure. In the edited BCR model submitted with this report, the team has added these five columns to each calculation tab and indicated the new columns using a yellow fill color.

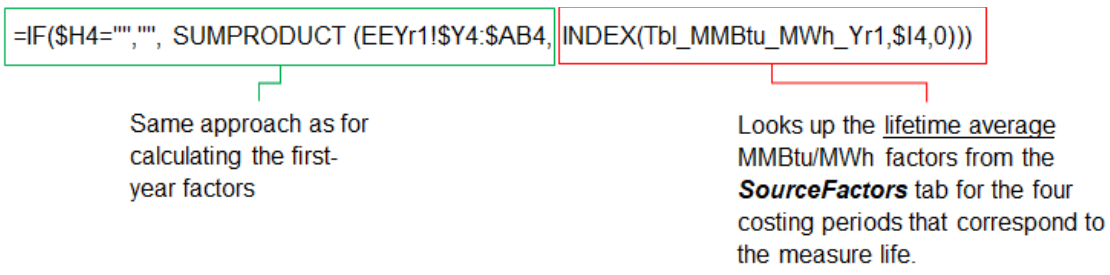
The new column R calculates a first-year MMBtu/MWh factor for each measure, using a formula that (1) looks up the load shape for the measure from the corresponding ***EEYr1***, ***EEYr2***, or ***EEYr3*** tab, (2) looks up the MMBtu factors for the first year of the measure life, and (3) calculates the first-year annual factor as the summed product of (1) and (2). The suggested formula to calculate first-year annual MMBtu/MWh is detailed in Figure 4.

Figure 3. Excel Formula for Calculating the First-Year Annual MMBtu/MWh Factor



The new column S calculates a lifetime average MMBtu/MWh factor for each measure, and the new columns EH, EI, and EJ calculate lifetime average factors for tons of NOx/MWh, tons of SOx/MWh, and tons of CO_2/MWh. The formulas in these columns all use a similar syntax. In each of the new lifetime average columns, the formula (1) looks up the load shape for the measure from the corresponding ***EEYr1***, ***EEYr2***, or ***EEYr3*** tab, (2) looks up the lifetime average MMBtu or emission factor corresponding with the measure life, and (3) calculates the average annual factor as the summed product of (1) and (2). The suggested formula to calculate average annual MMBtu/MWh is detailed in Figure 4.

Figure 4. Excel Formula for Calculating the Lifetime Average Annual MMBtu/MWh Factor



In each of the BCR calculation tabs, the formulas that previously referred to static MMBtu and emissions factors have been updated to refer to the five new factor columns, as described below:

NAVIGANT
A Guidehouse Company

Study to Propose a More Refined Method to Account for the Conversion of Electric Savings to MMBtu Savings

- References to the static MWHtoMMBTU variable from annual energy savings calculations have been updated to refer to column R. This applies to columns T and V, which calculate Adjusted Gross Annual Electric Energy and Net Annual Electric Energy.
- References to the static MWHtoMMBTU variable from lifetime energy calculations have been updated to refer to column S. This applies to columns U and W, which calculate Adjusted Gross Lifetime Energy and Net Lifetime Energy.
- References to the static GHG_Elec_NOX variable have been updated to refer to column EH. This applies to column EK, which calculates Annual NOX (Short Tons).
- References to the static GHG_Elec_SO2 variable have been updated to refer to column EI. This applies to column EL, which calculates Annual SOx (Short Tons).
- References to the static GHG_Elec_CO2 variable have been updated to refer to column EJ. This applies to column EM, which calculates Annual CO_2 (Short Tons).

NAVIGANT
A Guidehouse Company

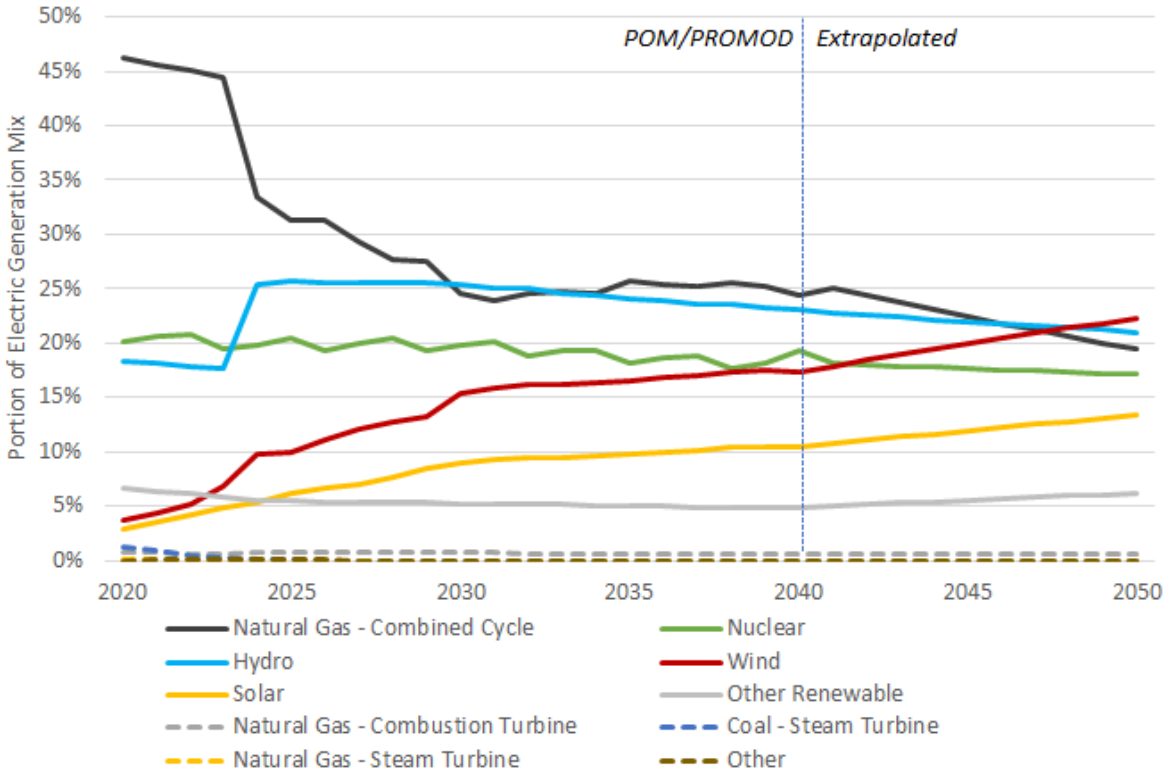
Study to Propose a More Refined Method to Account for the Conversion of Electric Savings to MMBtu Savings

3. RESULTS

3.1 Forecast of Electric Generation Mix

The results of our forecast of the annual electricity generation mix are illustrated in Figure 5, which shows the portion of annual electric generation contributed by each fuel. The total generation mix shown here is used in the analysis to calculate the average heat rate and average emissions values. Appendix A provides detailed tables showing the annual generation mix by costing period at five-year intervals.

Figure 5. Forecast of Total Generation Fuel Mix for ISO New England, 2020-2050



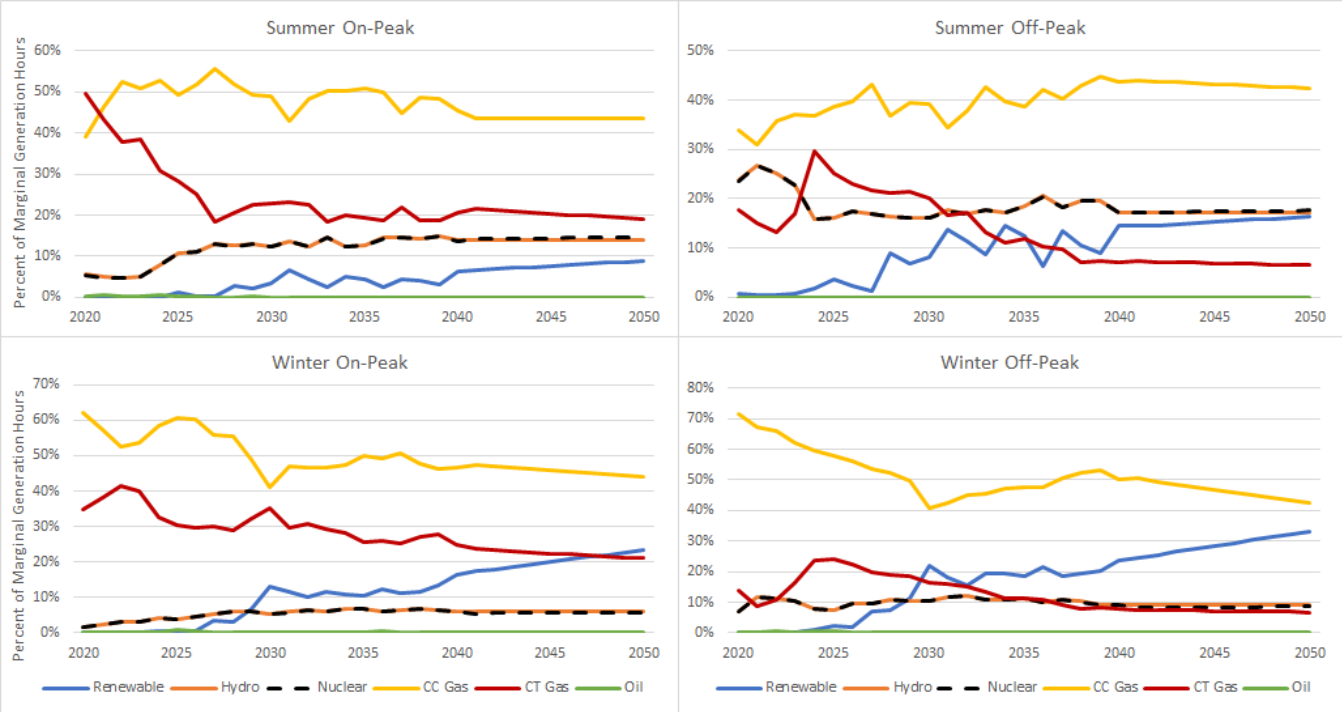
3.2 Forecast of Marginal Generation by Plant Type

The marginal generation analysis forecasts the portion of the time that each plant type is designated as the marginal electric generator in each of the four costing periods from 2020-2050. The results of this analysis are illustrated in Figure 6. The marginal generation mix shown here is used in the analysis to calculate the marginal heat rate and marginal emissions values for each costing period. Appendix B provides detailed tables showing the marginal generation mix by costing period at five-year intervals.

NAVIGANT
A Guidehouse Company

Study to Propose a More Refined Method to Account for the Conversion of Electric Savings to MMBtu Savings

Figure 6. Forecast of Marginal Generation Fuel Mix for ISO New England in Four Costing Periods, 2020-2050



Our team offers the following notes on these forecasts:

- The summer off-peak and winter off-peak charts show that the share of off-peak marginal hours met by natural gas combustion turbines increases sharply in 2024. This is likely the result of a combination of factors (including anticipated plant closures) that in 2024 combine in a way that favors marginal production from natural gas combustion turbine plants.
- As noted previously, our methodology for forecasting shares of marginal generation does not distinguish between generation from nuclear and hydroelectric plants. To address this, we forecast the number of marginal hours served by either nuclear or hydroelectric plants and assumed those hours would be evenly (i.e., 50/50) split between nuclear and hydroelectric plants. As a result, our forecasts for nuclear and hydroelectric shares of marginal generation are identical, and their lines overlap in the Figure 6 charts.
- Our team forecast marginal generation for the period 2020-2040 using energy price forecasts from PROMOD. We extrapolated our forecast to cover the period 2041-2050 on the assumption that the electric generation mix gradually shifts to meet the clean energy requirements of the Massachusetts CES. This extrapolation yields upward trends in the renewable share of marginal generation, downward trends in the fossil fuel share of marginal generation, and nearly constant shares for nuclear and hydroelectric generation for the 2041-2050 period.

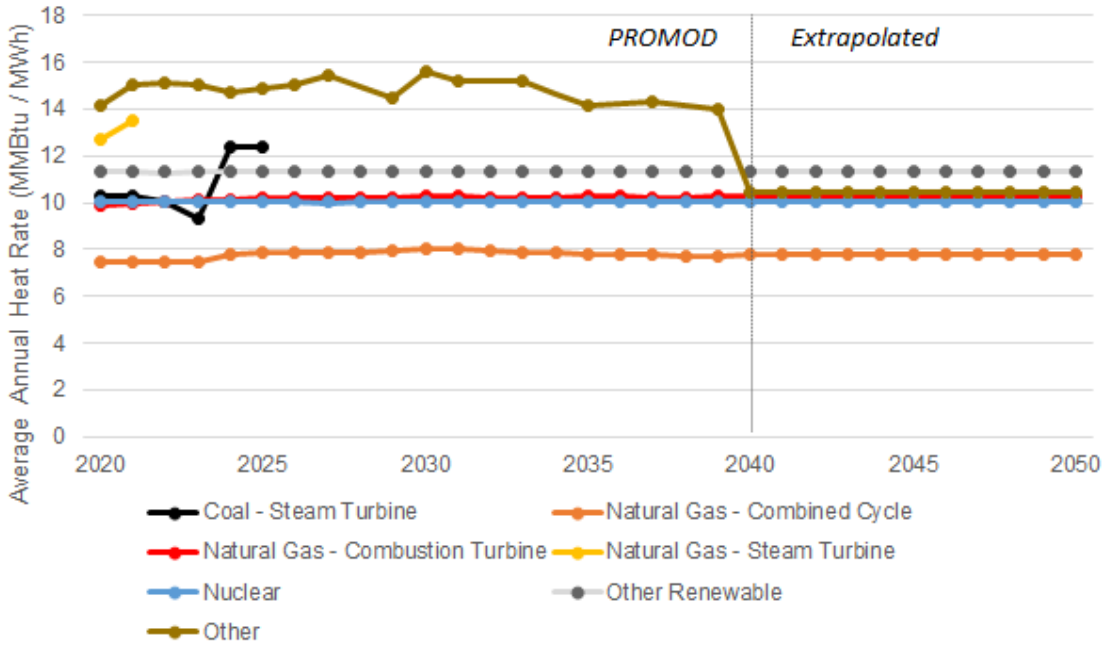
NAVIGANT
A Guidehouse Company

Study to Propose a More Refined Method to Account for the Conversion of Electric Savings to MMBtu Savings

3.3 Forecast of Heat Rates by Plant Type

The analysis produced an annual forecast of the typical heat rate by plant type in the four costing periods, for the years 2020-2050. Figure 7 summarizes the forecast of typical heat rates by plant type. Year-on-year fluctuations in the heat rate forecasts are driven by forecasts of plant retirements and plant construction. For instance, the average heat rate of the "Other" category will decline in 2039-2040 due to the closure of a less-efficient oil-fired generation plant. Conversely, there is an increase in the average heat rate for coal plants due to the expected closure in 2023 of a plant with higher-than-average efficiency. The total capacity in the "Coal – Steam Turbine" category is very small, and the average heat rate in the coal-fired category is driven by just a small number of units. The heat rates presented here are combined with the generation mix forecasts to estimate the average and marginal heat rates over time, described in the following section.

Figure 7. Typical Heat Rate by Generation Type, in MMBtu/MWh, 2020-2050



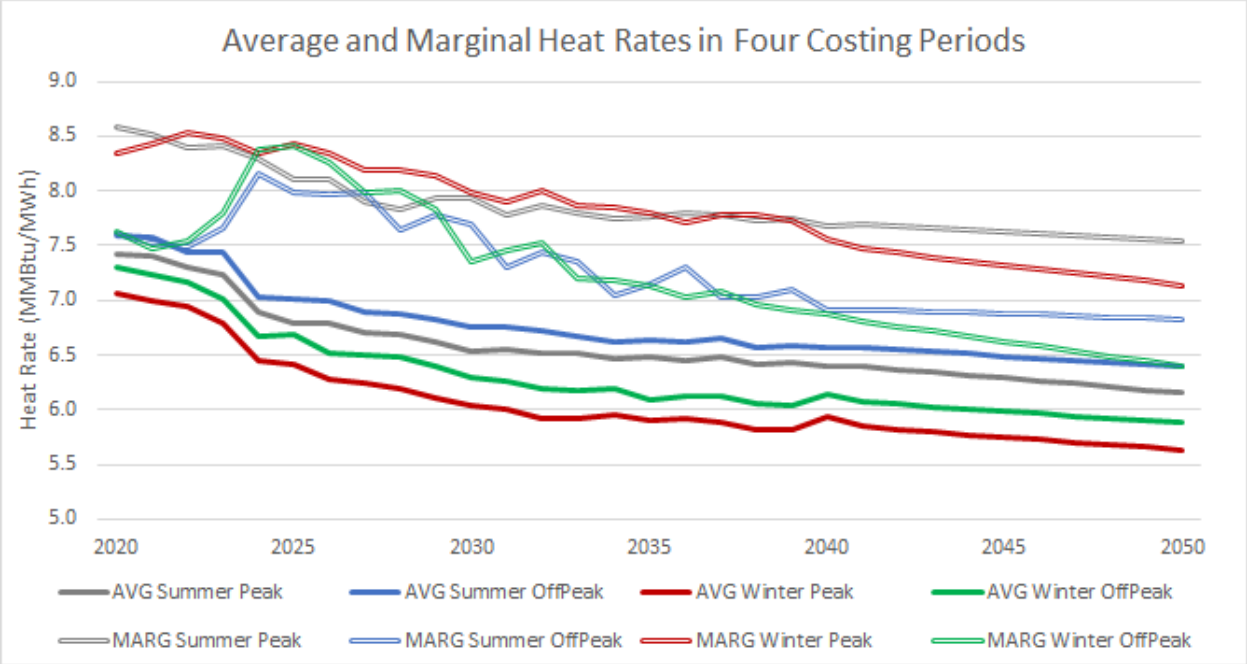
3.4 Results from Marginal Heat Rate and Average Heat Rate Approaches

As described in Section 2.2, this report provides the PAs with separate sets of outputs: one set derived using the marginal heat rate approach and a separate set derived using an average heat rate approach. Figure 8 compares the average and marginal heat rates for the four costing periods over the period 2020-2050, showing average heat rates with solid lines and marginal heat rates with hollow lines.

NAVIGANT
A Guidehouse Company

Study to Propose a More Refined Method to Account for the Conversion of Electric Savings to MMBtu Savings

Figure 8. Average and Marginal Heat Rates by Costing Period, in MMBtu/MWh, 2020-2050



Our team offers the following observations on these forecasts:

- Fossil fuel generators have a higher share of marginal generation than total generation. Conversely, renewable generators have a lower share of marginal generation than total generation. As a result, marginal heat rates are forecast to be higher than average heat rates throughout the 2020-2050 period. Using marginal heat rates as a benefit-cost model input will result in a lower calculated "total MMBtu savings" for fuel switching measures (compared to savings calculated using average heat rates).
- There is a general downward trend in the average and marginal heat rates for all periods. This is due to the steady increase in renewable generation as a percent of total generation and a steady increase in the amount of time that renewable generators operate at the margin.
- The forecast suggests that the average heat rates will drop sharply in 2024 due to an increase in hydroelectric generation from the Northeast Energy Connect coming online and delivering hydro power to the ISO NE grid.
- In that same period, 2023-2024, the marginal heat rates in the off-peak periods increase sharply. This is due to an increase in the share of marginal hours for gas combustion turbine plants, likely resulting from a combination of factors (including anticipated plant closures). The forecast indicates that natural gas combustion turbine plants would increase their share of off-peak marginal production starting in 2024. This will lead to a higher marginal heat rate, since combustion turbine plants have a higher heat rate (~10.2 MMBtu/MWh) than combined cycle plants (~7.7 MMBtu/MWh).
- Beyond the PROMOD forecast period ending in 2040, average and marginal heat rates are forecasted to decline over the 2041-2050 period as the renewable share of the electric generation mix increases to comply the requirements of the Massachusetts Clean Energy Standard.

This study provides complete sets of MMBtu/MWh and emissions factors calculated using the average generation mix and the marginal generation mix. The PAs need to select one set of factors to use in their benefit-cost calculations. Factors calculated using the marginal generation mix are better aligned with the assumptions in other energy efficiency calculations. For example, the MA Department of Environmental Protection (DEP) uses a marginal approach to calculate the emissions rates, and the Avoided Energy Supply Costs (AESC) study uses a marginal approach to calculate avoided costs. However, as illustrated above, marginal heat rate analyses can be sensitive to different factors such as the retirement of individual plants. Fluctuations in fuel prices can also influence the selection of different plant types for marginal generation. Fuel markets are somewhat predictable in the near-term, but long-term forecasts of fuel prices are typically less accurate.

Factors calculated using the average generation mix (as opposed to the marginal generation mix) are less sensitive to fuel prices and individual plant closures. Our team expects that heat rate and emission rate forecasts based on average heat rates would provide better accuracy with less sensitivity and uncertainty. We therefore recommend that the PAs conduct benefit-cost calculations using MMBtu and emissions factors based on average heat rates.

3.5 Tables of MMBtu, NOx, SOx, and CO2 per MWh for 2020-2050

The tables in this section show the MMBtu and emissions factors developed using an average heat rate approach and a marginal heat rate approach. These tables are included in the updated BCR model attached to this report. In the updated BCR model, users may select which set of factors (average or marginal) to use in the BCR model, or users may choose to use the static values included in the 2019-2021 plan version of the BCR model.

NAVIGANT
A Guidehouse Company

Study to Propose a More Refined Method to Account for the Conversion of Electric Savings to MMBtu Savings

Table 1. MMBtu and Emissions Factors from Average Heat Rates

Factor	Average Heat Rate (MMBtu/MWh)				NOx (short tons / MWh)				SOx (short tons / MWh)				CO_2 (short tons / MWh)			
Season	Summer		Winter		Summer		Winter		Summer		Winter		Summer		Winter	
Peak	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off
2020	7.423	7.589	7.058	7.304	7.37E-05	7.59E-05	9.38E-05	1.08E-04	3.87E-07	9.19E-08	2.43E-05	2.94E-05	0.302	0.277	0.275	0.270
2021	7.411	7.568	7.002	7.240	7.06E-05	7.35E-05	8.61E-05	9.75E-05	4.39E-07	3.93E-08	1.87E-05	2.03E-05	0.295	0.269	0.264	0.257
2022	7.299	7.447	6.941	7.171	6.92E-05	7.37E-05	8.10E-05	9.02E-05	4.85E-07	9.32E-09	1.01E-05	1.05E-05	0.291	0.266	0.251	0.241
2023	7.242	7.433	6.784	7.013	6.76E-05	7.34E-05	7.68E-05	8.35E-05	3.16E-07	7.45E-09	5.61E-06	4.61E-06	0.281	0.256	0.249	0.239
2024	6.893	7.036	6.451	6.669	6.55E-05	7.00E-05	6.57E-05	7.13E-05	9.31E-07	9.60E-08	2.94E-06	2.57E-06	0.251	0.224	0.196	0.180
2025	6.797	7.019	6.416	6.686	6.37E-05	7.03E-05	6.43E-05	7.02E-05	9.44E-07	2.79E-07	2.62E-06	2.39E-06	0.239	0.220	0.184	0.175
2026	6.787	6.994	6.274	6.520	6.12E-05	6.80E-05	6.26E-05	6.88E-05	4.54E-07	1.11E-08	1.19E-07	1.06E-07	0.230	0.209	0.185	0.178
2027	6.699	6.896	6.246	6.497	5.99E-05	6.85E-05	6.00E-05	6.59E-05	7.40E-08	1.40E-08	3.52E-08	2.48E-08	0.224	0.203	0.172	0.165
2028	6.688	6.873	6.199	6.491	5.88E-05	6.76E-05	5.96E-05	6.63E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.220	0.195	0.163	0.160
2029	6.616	6.833	6.111	6.402	5.94E-05	6.86E-05	5.93E-05	6.56E-05	1.73E-07	7.88E-08	0.00E+00	0.00E+00	0.217	0.197	0.164	0.160
2030	6.536	6.759	6.034	6.290	5.79E-05	6.74E-05	5.78E-05	6.33E-05	6.53E-08	2.57E-08	0.00E+00	0.00E+00	0.211	0.193	0.149	0.140
2031	6.545	6.752	6.011	6.254	5.68E-05	6.59E-05	5.69E-05	6.30E-05	9.21E-08	3.04E-08	0.00E+00	0.00E+00	0.205	0.186	0.144	0.139
2032	6.517	6.722	5.922	6.194	5.65E-05	6.58E-05	5.71E-05	6.29E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.204	0.183	0.148	0.145
2033	6.516	6.676	5.924	6.169	5.65E-05	6.53E-05	5.57E-05	6.15E-05	8.17E-09	3.34E-09	0.00E+00	0.00E+00	0.204	0.182	0.144	0.142
2034	6.462	6.625	5.950	6.193	5.66E-05	6.51E-05	5.54E-05	6.03E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.209	0.192	0.138	0.136
2035	6.488	6.643	5.897	6.087	5.51E-05	6.36E-05	5.56E-05	6.10E-05	8.78E-08	1.00E-07	0.00E+00	0.00E+00	0.206	0.188	0.149	0.145
2036	6.442	6.614	5.912	6.126	5.57E-05	6.38E-05	5.51E-05	6.00E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.208	0.195	0.143	0.137
2037	6.475	6.648	5.888	6.125	5.55E-05	6.33E-05	5.35E-05	5.92E-05	1.18E-07	1.64E-07	0.00E+00	0.00E+00	0.206	0.190	0.139	0.140
2038	6.422	6.565	5.817	6.051	5.51E-05	6.25E-05	5.45E-05	6.00E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.207	0.191	0.142	0.142
2039	6.428	6.586	5.824	6.044	5.35E-05	6.10E-05	5.44E-05	5.99E-05	5.86E-08	8.10E-08	0.00E+00	0.00E+00	0.203	0.188	0.139	0.140
2040	6.394	6.562	5.931	6.133	5.31E-05	6.05E-05	5.42E-05	5.85E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.205	0.192	0.134	0.131
2041	6.399	6.569	5.846	6.078	5.45E-05	6.25E-05	5.51E-05	6.06E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.205	0.191	0.139	0.139
2042	6.372	6.549	5.821	6.055	5.54E-05	6.38E-05	5.60E-05	6.18E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.202	0.190	0.138	0.138
2043	6.343	6.529	5.796	6.030	5.63E-05	6.51E-05	5.70E-05	6.29E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.200	0.188	0.136	0.136
2044	6.317	6.509	5.772	6.008	5.71E-05	6.64E-05	5.79E-05	6.40E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.197	0.186	0.135	0.135
2045	6.288	6.489	5.747	5.984	5.80E-05	6.77E-05	5.88E-05	6.51E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.194	0.184	0.133	0.134
2046	6.262	6.470	5.724	5.962	5.88E-05	6.90E-05	5.97E-05	6.62E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.192	0.182	0.131	0.133
2047	6.237	6.452	5.702	5.941	5.97E-05	7.02E-05	6.05E-05	6.72E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.190	0.181	0.130	0.132
2048	6.211	6.433	5.680	5.920	6.05E-05	7.14E-05	6.14E-05	6.82E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.187	0.179	0.129	0.131
2049	6.184	6.414	5.657	5.899	6.13E-05	7.27E-05	6.22E-05	6.92E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.185	0.177	0.127	0.129
2050	6.159	6.396	5.636	5.879	6.21E-05	7.39E-05	6.30E-05	7.02E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.182	0.176	0.126	0.128

NAVIGANT
A Guidehouse Company

Study to Propose a More Refined Method to Account for the Conversion of Electric Savings to MMBtu Savings

Table 2. MMBtu and Emissions Factors from Marginal Heat Rates

Factor	Average Heat Rate (MMBtu/MWh)				NOx (short tons / MWh)				SOx (short tons / MWh)				CO2 (short tons / MWh)			
Season	Summer		Winter		Summer		Winter		Summer		Winter		Summer		Winter	
Peak	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off
2020	8.577	7.609	8.340	7.621	9.95E-05	3.71E-05	7.21E-05	4.61E-05	7.2E-06	0.0E+00	5.5E-07	1.4E-06	0.464	0.259	0.480	0.395
2021	8.577	7.609	8.340	7.621	9.95E-05	3.71E-05	7.21E-05	4.61E-05	7.2E-06	0.0E+00	5.5E-07	1.4E-06	0.464	0.259	0.480	0.395
2022	8.519	7.523	8.433	7.477	9.49E-05	3.21E-05	7.84E-05	4.12E-05	1.0E-05	0.0E+00	4.0E-06	7.6E-06	0.466	0.231	0.480	0.350
2023	8.395	7.488	8.524	7.534	8.74E-05	3.39E-05	8.35E-05	4.71E-05	7.6E-06	0.0E+00	4.1E-06	8.1E-06	0.459	0.240	0.479	0.355
2024	8.418	7.665	8.476	7.792	8.72E-05	3.99E-05	8.15E-05	5.38E-05	8.7E-06	0.0E+00	1.1E-06	6.1E-06	0.457	0.271	0.474	0.378
2025	8.290	8.154	8.346	8.379	8.01E-05	6.48E-05	7.41E-05	7.12E-05	1.2E-05	0.0E+00	4.7E-06	1.2E-05	0.428	0.352	0.459	0.433
2026	8.103	7.978	8.427	8.410	6.79E-05	5.55E-05	8.35E-05	7.35E-05	2.9E-06	0.0E+00	1.8E-05	9.0E-06	0.392	0.335	0.467	0.434
2027	8.101	7.973	8.346	8.258	6.75E-05	5.29E-05	7.41E-05	6.35E-05	7.1E-06	0.0E+00	7.3E-06	2.4E-06	0.390	0.327	0.456	0.408
2028	7.896	7.982	8.198	7.989	5.28E-05	5.18E-05	6.89E-05	5.55E-05	0.0E+00	0.0E+00	4.8E-06	8.9E-07	0.363	0.334	0.435	0.380
2029	7.838	7.638	8.186	8.002	5.47E-05	4.93E-05	6.47E-05	5.53E-05	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.358	0.301	0.428	0.373
2030	7.941	7.776	8.132	7.838	5.79E-05	5.08E-05	6.83E-05	5.38E-05	2.6E-06	0.0E+00	0.0E+00	0.0E+00	0.361	0.317	0.418	0.358
2031	7.940	7.698	7.980	7.359	5.73E-05	4.97E-05	7.21E-05	4.64E-05	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.365	0.309	0.404	0.308
2032	7.786	7.308	7.899	7.464	5.41E-05	4.09E-05	6.55E-05	4.56E-05	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.338	0.264	0.396	0.311
2033	7.871	7.437	8.007	7.532	5.51E-05	4.39E-05	6.53E-05	4.44E-05	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.357	0.282	0.402	0.317
2034	7.801	7.353	7.860	7.193	4.95E-05	3.77E-05	6.20E-05	4.05E-05	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.340	0.275	0.392	0.299
2035	7.755	7.050	7.857	7.183	5.20E-05	3.32E-05	5.99E-05	3.93E-05	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.349	0.250	0.388	0.298
2036	7.760	7.142	7.798	7.132	5.04E-05	3.31E-05	5.74E-05	3.86E-05	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.348	0.249	0.384	0.294
2037	7.795	7.295	7.714	7.030	4.97E-05	3.31E-05	5.87E-05	3.86E-05	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.341	0.254	0.381	0.293
2038	7.775	7.027	7.784	7.075	5.22E-05	3.09E-05	5.67E-05	3.65E-05	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.335	0.242	0.385	0.293
2039	7.724	7.024	7.784	6.967	4.99E-05	2.86E-05	5.85E-05	3.45E-05	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.334	0.237	0.382	0.290
2040	7.738	7.103	7.736	6.917	4.96E-05	2.92E-05	5.97E-05	3.59E-05	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.332	0.246	0.380	0.295
2041	7.685	6.907	7.556	6.868	5.12E-05	2.88E-05	5.58E-05	3.49E-05	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.331	0.241	0.365	0.285
2042	7.696	6.915	7.467	6.807	5.15E-05	2.89E-05	5.43E-05	3.44E-05	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.328	0.242	0.361	0.284
2043	7.680	6.910	7.431	6.761	5.10E-05	2.87E-05	5.37E-05	3.39E-05	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.327	0.241	0.357	0.279
2044	7.663	6.899	7.394	6.716	5.06E-05	2.85E-05	5.31E-05	3.33E-05	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.325	0.240	0.354	0.275
2045	7.647	6.889	7.358	6.670	5.02E-05	2.83E-05	5.25E-05	3.28E-05	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.323	0.239	0.350	0.270
2046	7.630	6.878	7.321	6.624	4.98E-05	2.81E-05	5.19E-05	3.23E-05	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.321	0.237	0.347	0.265
2047	7.614	6.868	7.285	6.579	4.94E-05	2.79E-05	5.13E-05	3.17E-05	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.320	0.236	0.343	0.260
2048	7.597	6.857	7.248	6.533	4.89E-05	2.77E-05	5.07E-05	3.12E-05	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.318	0.235	0.339	0.256
2049	7.581	6.847	7.212	6.487	4.85E-05	2.75E-05	5.01E-05	3.06E-05	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.316	0.233	0.336	0.251
2050	7.564	6.836	7.175	6.441	4.81E-05	2.73E-05	4.96E-05	3.01E-05	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.315	0.232	0.332	0.246

NAVIGANT
A Guidehouse Company

Study to Propose a More Refined Method to Account for the Conversion of Electric Savings to MMBtu Savings

3.6 Impacts of Updated Factors

This section describes how replacing the static MMBtu and emissions factors in the BCR model with the factors calculated in this study will impact the results of the B/C model.

Section 2.4.1 describes the static MMBtu and emissions factors that are currently used in the BCR model. Table 3 compares these current BCR factors to a selection of factor values derived in this study using the average heat rate approach and the marginal heat rate approach. As illustrated, the average and marginal heat rates calculated in this study decline over time and are higher than the static heat rate value currently used in the BCR model. The CO_2 emissions factors calculated in this study decline over time and are lower than the current assumption in the BCR model.

Table 3. Comparison of Select MMBtu and Emissions Factors to Current BCR Factors, Summer Peak Period

Year	Heat Rate (MMBtu/MWh)			NOx Emissions Factor (1,000 tons NOx/MWh)			CO_2 Emissions Factor (1,000 tons NOx/MWh)		
	2019 BCR Factors	Average Method	Marginal Method	2019 BCR Factors	Average Method	Marginal Method	2019 BCR Factors	Average Method	Marginal Method
2020	3.412	7.423	8.577	0.160	0.074	0.100	0.494	0.302	0.464
2030	3.412	6.536	7.940	0.160	0.058	0.057	0.494	0.211	0.365
2040	3.412	6.394	7.685	0.160	0.053	0.051	0.494	0.205	0.331
2050	3.412	6.159	7.548	0.160	0.062	0.048	0.494	0.182	0.313

Updating the BCR model's MMBtu and emissions factors with the results of this study will not affect the benefit-cost ratios calculated for individual measures, since net MMBtu savings and greenhouse gas reductions are not included in the calculation of the B/C ratio. The new MMBtu factors will lead to an increase in the net annual energy savings and the net lifetime savings calculated in the BCR model. Table 4 illustrates the magnitude of this increase for a handful of measures included in the BCR model.

Table 4. Comparison of Net Lifetime and Net Annual Energy Savings for Selected Measures

Measure Description	Net Annual Energy Savings (MMBtu)			Net Lifetime Energy Savings (MMBTU)		
	2019 BCR Factors	Average Heat Rate Approach	Percent Change	2019 BCR Factors	Average Heat Rate Approach	Percent Change
Insulation, Electric (Single Family)	1,893	3,994	+111%	47,329	87,964	+86%
Insulation, Oil (Single Family)	1,661	3,566	+115%	41,525	79,495	+91%
Heat Pump SEER 18.0 HSPF 9.6, Replacing Existing EUL Heat Pump	975	2,074	+113%	14,627	28,505	+95%
Central Ducted Heat Pump Fully Displacing Existing Furnace, Oil	-213	-457	+115%	-3,407	-6,707	+97%
Water Heater, Heat Pump, <55 gallon, Energy Star	3,337	7,103	+113%	43,380	85,660	+97%

3.7 Limitations of This Analysis

As with any analysis involving forecasting, the results of this study depend on assumptions about the future. Our team has developed forecasts of generating capacity and the total and marginal mixes of generating fuels using the most current information available as of March 2020. Below, we identify several assumptions that could limit the precision of our estimate.

- **Nuclear plant lifetimes** – Our forecast assumes that nuclear generating capacity in the ISO NE region stays constant throughout the forecast period of 2020-2050. In other words, we assume that the nuclear plants supplying the ISO NE region today are not retired or decommissioned prior to 2050. Our analysis uses a heat rate of 10.08 MMBtu/MWh for nuclear generators, and in 2050 we forecast that about 35% of the heat output for power generation will come from nuclear plants. If one or more nuclear plants were to retire prior to 2050, the retired capacity would likely be replaced by another clean energy source (such as wind, solar, or other renewables) such that Massachusetts meets its target of 80% clean energy generation by 2050. If nuclear capacity is retired and replaced with non-combustion renewables, then our forecast in this report would overestimate average heat rates forecast in the later years of the analysis period.
- **New hydroelectric capacity** – The New England Clean Energy Connect is a proposed project to install a transmission line to deliver hydroelectric power from Canada to the ISO NE region. The project was scheduled to be complete in 2022, but it has encountered resistance and its completion will likely be delayed. Our forecast assumes that the project will finish with a two-year delay and that the hydroelectric capacity will be available to the New England grid beginning in 2024. If the project is delayed for more than two years or is cancelled altogether, then our forecast in this report would show an underestimate of average heat rates for any period that the transmission line is not complete after 2024.
- **Marginal plant selection** – As described in Section 2.2.2 of this report, we identified the marginal generating plant in each time period using forecast fuel prices and emissions prices from the Reference Case and assumptions about variable O&M costs. Power markets could develop in ways we have not foreseen, or new rules could impose emissions costs we have not anticipated. Such changes would impact the precision of our marginal plant forecasts, and we suggest that the PAs revisit this analysis on a regular basis to maintain up-to-date forecasts.

NAVIGANT
A Guidehouse Company

Study to Propose a More Refined Method to Account for the Conversion of Electric Savings to MMBtu Savings

APPENDIX A. DETAILED TOTAL GENERATION MIX FORECAST

This analysis produced an annual forecast of the total generation by plant type in the four costing periods, for the years 2020-2050. Full results are provided in the spreadsheet enclosed with this memo. The enclosed spreadsheet also provides the POM-generated forecast of electric capacity through 2040. The tables below summarize the generation fuel mix by plant type on 5-year increments.

Table 5. Summer On-Peak, Percent of Total Generation by Plant Type, 2020-2050

Generation Type	2020	2025	2030	2035	2040	2045	2050
Coal - Steam Turbine	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Natural Gas - Combined Cycle	54.5	42.5	36.7	36.1	36.2	32.6	28.9
Natural Gas - Combustion Turbine	1.9	1.2	0.8	0.9	1.1	1.0	0.9
Natural Gas - Steam Turbine	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Other (e.g., oil-fired)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nuclear	17.5	16.8	16.6	16.8	15.5	15.5	15.3
Hydro	15.2	21.3	21.0	20.1	19.2	18.5	18.1
Wind	2.1	5.5	7.9	8.2	8.7	10.3	11.8
Solar	3.9	8.5	12.7	14.0	15.4	17.5	19.9
Other Renewable (e.g., landfill gas, refuse, wood)	4.8	4.3	4.3	4.0	3.8	4.5	5.2
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 6. Summer Off-Peak, Percent of Total Generation by Plant Type, 2020-2050

Generation Type	2020	2025	2030	2035	2040	2045	2050
Coal - Steam Turbine	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Natural Gas - Combined Cycle	48.4	35.3	29.7	30.6	32.4	29.0	25.7
Natural Gas - Combustion Turbine	0.7	0.8	0.7	0.4	0.4	0.4	0.4
Natural Gas - Steam Turbine	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other (e.g., oil-fired)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nuclear	23.6	22.2	22.2	21.8	20.2	20.2	19.9
Hydro	16.3	24.2	24.0	22.4	21.3	20.9	20.3
Wind	3.1	7.8	11.8	12.9	13.6	15.6	17.7
Solar	1.9	4.0	6.1	6.6	7.1	8.1	9.2
Other Renewable (e.g., landfill gas, refuse, wood)	6.0	5.6	5.6	5.2	4.9	5.9	6.7
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

NAVIGANT
A Guidehouse Company

Study to Propose a More Refined Method to Account for the Conversion of Electric Savings to MMBtu Savings

Table 7. Winter On-Peak, Percent of Total Generation by Plant Type, 2020-2050

Generation Type	2020	2025	2030	2035	2040	2045	2050
Coal - Steam Turbine	1.9	0.0	0.0	0.0	0.0	0.0	0.0
Natural Gas - Combined Cycle	45.2	29.5	22.0	22.6	19.6	18.4	15.8
Natural Gas - Combustion Turbine	0.3	0.4	0.6	0.5	0.6	0.5	0.4
Natural Gas - Steam Turbine	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other (e.g., oil-fired)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nuclear	17.9	19.2	18.1	16.2	18.7	16.2	15.5
Hydro	20.4	27.2	26.7	25.4	24.5	23.0	21.8
Wind	3.8	10.1	15.8	17.4	18.2	21.0	23.3
Solar	3.7	8.0	11.6	12.9	13.5	15.5	17.1
Other Renewable (e.g., landfill gas, refuse, wood)	6.8	5.5	5.1	4.9	4.9	5.4	6.0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 8. Winter Off-Peak, Percent of Total Generation by Plant Type, 2020-2050

Generation Type	2020	2025	2030	2035	2040	2045	2050
Coal - Steam Turbine	2.3	0.0	0.0	0.0	0.0	0.0	0.0
Natural Gas - Combined Cycle	40.5	24.0	16.8	19.9	17.5	16.8	14.5
Natural Gas - Combustion Turbine	0.5	1.0	0.8	0.6	0.5	0.4	0.4
Natural Gas - Steam Turbine	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other (e.g., oil-fired)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nuclear	22.5	23.5	22.3	19.2	22.0	19.3	18.6
Hydro	19.4	28.0	27.5	26.2	24.9	23.6	22.4
Wind	5.1	13.6	21.7	23.0	24.0	27.0	29.9
Solar	1.7	3.6	5.0	5.6	5.8	6.7	7.4
Other Renewable (e.g., landfill gas, refuse, wood)	8.2	6.2	5.9	5.6	5.4	6.1	6.8
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 9. Annual Total, Percent of Total Generation by Plant Type, 2020-2050

Generation Type	2020	2025	2030	2035	2040	2045	2050
Coal - Steam Turbine	1.3	0.0	0.0	0.0	0.0	0.0	0.0
Natural Gas - Combined Cycle	46.2	31.4	24.6	25.8	24.3	22.4	19.5
Natural Gas - Combustion Turbine	0.8	0.8	0.7	0.6	0.6	0.6	0.5
Natural Gas - Steam Turbine	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other (e.g., oil-fired)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nuclear	20.1	20.5	19.8	18.2	19.3	17.7	17.1
Hydro	18.4	25.8	25.4	24.1	23.1	22.0	21.0
Wind	3.7	9.9	15.4	16.6	17.4	19.9	22.3
Solar	2.8	6.1	8.9	9.8	10.4	11.9	13.4
Other Renewable (e.g., landfill gas, refuse, wood)	6.7	5.5	5.3	5.0	4.8	5.6	6.2
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

NAVIGANT
A Guidehouse Company

Study to Propose a More Refined Method to Account for the Conversion of Electric Savings to MMBtu Savings

APPENDIX B. DETAILED MARGINAL GENERATION MIX FORECAST

The analysis produced an annual forecast of the marginal generation by plant type in the four costing periods, for the years 2020-2050. Full results are provided in the spreadsheet enclosed with this memo. The tables below summarize the marginal generation fuel mix by plant type on 5-year increments.

Table 10. Summer On-Peak, Percent of Marginal Generation Hours by Plant Type, 2020-2050

Generation Type	2020	2025	2030	2035	2040	2045	2050
Renewables	0.0	1.1	3.4	4.5	6.3	7.6	8.9
Hydroelectric	5.5	10.6	12.3	12.7	13.8	14.0	14.0
Nuclear	5.5	10.6	12.2	12.7	13.8	14.4	14.6
Natural Gas - Combined Cycle	39.1	49.3	49.1	50.8	45.4	43.6	43.4
Natural Gas - Combustion Turbine	49.6	28.2	23.0	19.3	20.6	20.4	19.1
Oil	0.3	0.1	0.0	0.0	0.1	0.0	0.0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 11. Summer Off-Peak, Percent of Marginal Generation Hours by Plant Type, 2020-2050

Generation Type	2020	2025	2030	2035	2040	2045	2050
Renewables	0.8	3.7	8.2	12.3	14.5	15.3	16.4
Hydroelectric	23.7	16.2	16.2	18.5	17.3	17.1	17.1
Nuclear	23.7	16.2	16.1	18.5	17.2	17.4	17.6
Natural Gas - Combined Cycle	33.9	38.8	39.3	38.8	43.8	43.3	42.4
Natural Gas - Combustion Turbine	17.8	25.2	20.2	11.9	7.2	6.9	6.5
Oil	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 12. Winter On-Peak, Percent of Marginal Generation Hours by Plant Type, 2020-2050

Generation Type	2020	2025	2030	2035	2040	2045	2050
Renewables	0.0	0.3	13.0	10.6	16.4	20.1	23.4
Hydroelectric	1.5	4.0	5.2	6.9	6.0	6.0	6.0
Nuclear	1.5	4.0	5.2	6.9	6.0	5.5	5.6
Natural Gas - Combined Cycle	62.0	60.5	41.0	49.9	46.5	45.9	43.9
Natural Gas - Combustion Turbine	34.9	30.2	35.4	25.7	25.0	22.4	21.0
Oil	0.0	1.0	0.2	0.0	0.0	0.0	0.0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

NAVIGANT
A Guidehouse Company

Study to Propose a More Refined Method to Account for the Conversion of Electric Savings to MMBtu Savings

Table 13. Winter Off-Peak, Percent of Marginal Generation Hours by Plant Type, 2020-2050

Generation Type	2020	2025	2030	2035	2040	2045	2050
Renewables	0.3	2.2	22.0	18.7	23.8	28.5	33.3
Hydroelectric	7.0	7.5	10.3	11.2	9.1	9.1	9.1
Nuclear	7.0	7.5	10.3	11.1	9.1	8.4	8.6
Natural Gas - Combined Cycle	71.7	57.9	40.9	47.6	50.2	46.9	42.4
Natural Gas - Combustion Turbine	13.9	24.3	16.5	11.4	7.9	7.2	6.7
Oil	0.1	0.5	0.0	0.0	0.0	0.0	0.0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 14. Annual Total, Percent of Marginal Generation Hours by Plant Type, 2020-2050

Generation Type	2020	2025	2030	2035	2040	2045	2050
Renewables	0.3	1.8	12.7	12.2	16.2	19.5	22.8
Hydroelectric	8.8	9.1	10.6	11.9	11.0	11.0	11.0
Nuclear	8.8	9.1	10.5	11.9	11.0	10.5	10.6
Natural Gas - Combined Cycle	54.3	52.7	42.2	46.9	46.8	44.9	42.4
Natural Gas - Combustion Turbine	27.7	26.9	23.8	17.0	15.0	14.1	13.2
Oil	0.1	0.5	0.1	0.0	0.0	0.0	0.0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0