COMMONWEALTH OF MASSACHUSETTS

DEPARTMENT OF PUBLIC UTILITIES

Petition of The Berkshire Gas Company to the Department of Public Utilities for review and Approval of its Long-Range Forecast and Supply Plan for the split years 2016/17 to 2020/21, pursuant to G.L. c. 164, § 69I	)))))))	D.P.U. 16-103

DIRECT TESTIMONY OF KENJI TAKAHASHI

ON BEHALF OF THE TOWN OF MONTAGUE

March 8, 2017

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INTRODUCTION AND QUALIFICATIONS

Q. Please state your name, title, and employer.

A. My name is Kenji Takahashi. I am a Senior Associate at Synapse Energy Economics ("Synapse"), located at 485 Massachusetts Avenue, Cambridge, MA 02139.

Q. On whose behalf are you submitting testimony in this proceeding?

A. I am submitting testimony on behalf of the Town of Montague.

Q. Please describe Synapse Energy Economics.

A. Synapse Energy Economics is a research and consulting firm specializing in electricity and gas industry regulation, planning, and analysis. Synapse's work covers a range of issues, including: economic and technical assessments of demand-side and supply-side energy resources, energy efficiency policies and programs, integrated resource planning, energy market modeling and assessment, renewable resource technologies and policies, and climate change strategies. Synapse works for a wide range of clients, including attorneys general, offices of consumer advocates, public utility commissions, environmental advocates, the U.S. Environmental Protection Agency, U.S. Department of Energy, U.S. Department of Justice, the Federal Trade Commission, and the National Association of Regulatory Utility Commissioners. Synapse has over 25 professional staff with extensive experience in the gas and electricity industry.

Q. Please summarize your professional experience.

A. Since joining Synapse in 2004, I have conducted numerous economic, environmental, and policy analysis of energy system technologies, policies, and regulations associated with both supply- and demand-side resources. I have reviewed, analyzed, and critiqued energy efficiency policies and programs in over 30 U.S. states and half a dozen Canadian provinces. This includes testimony regarding natural gas energy efficiency plans, program designs, and policies for both the New Jersey Division of Public Advocate and Ontario Energy Board. In Massachusetts, I have done work for the Department of Energy Resources on projects related to demand-side management and community energy-reduction efforts. My resume is attached as Exhibit KT-2.

Q. What is the purpose of your testimony?

A. The purpose of my testimony is to review the Forecast and Supply Plan filed by the Berkshire Gas Company ("Berkshire Gas" or "Company") with a focus on the Company's load forecast, its assessment of demand-side resources, and the feasibility of lifting the moratorium placed in the Eastern Division on accepting new customers. More specifically, this testimony focuses on the Company's load forecast results, forecasting methodologies, and impacts of various factors on the peak day load forecast in the Eastern Division. These factors include gas demand-side resources such as energy efficiency and demand response, as well as new technologies and regulatory policies. My testimony also focuses on a quantitative assessment of alternative load forecasts with expanded, but reasonable levels of demand-side resources. Finally, the testimony includes recommendations for improving the Company's load forecast, and expanding the Company's demand-side management programs.

1. SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

Q. Please summarize your primary conclusions.

A. My primary conclusions are as follows:

1. Berkshire Gas could end its existing moratorium on new gas heating and non-heating customers as early as 2017/18, without the need for any new gas infrastructure, by combining these two measures: (a) adjusting its own energy efficiency savings estimates and (b) renegotiating curtailable agreements with two large customers in the Eastern Division. Future gas load would be even lower if it accounted for the impacts from heat pumps as well as existing climate change and clean energy regulations.

2. Berkshire Gas's load forecast is too high because:

    a) The load forecast underestimates energy savings expected to be achieved through the implementation of its current 2016–2018 Three-Year Energy Efficiency Plan ("Current EE Plan") and the next three-year plan.

b) The forecast fails to consider the impacts from a critical new technology, electric heat pumps.

c) The forecast fails to consider the impacts from existing and expected critical laws and regulations, such as the Global Warming Solutions Act. The state's climate change and clean energy regulatory policies are likely to shape natural gas use in the region to a considerable degree.

3. Berkshire Gas's load forecast suffers from a critical methodological flaw: The Company used an econometric model that combined both the Eastern and the Western divisions, despite substantially different customer mixes (and thus load profiles) for these two divisions.

4. Berkshire Gas could reduce its future demand even further by expanding the current efficiency programs under the Current EE Plan. First, the Company's efficiency programs' savings show ample room for improvement when compared to the efficiency savings that New England's leading gas utilities have been achieving for the past several years. Second, the Berkshire Gas energy efficiency potential study conducted by GDS ("GDS Study"), which was used to set the 2016–2018 goal, significantly underestimated potential savings due to shortcomings such as limited measure selection, conservative participation rates, and low avoided costs.

5. Berkshire Gas could tap into a number of demand response programs to reduce peak load requirements further, including—among other things—programs that use internet-connected smart thermostats.

6. Future load could be even lower with the implementation of expanded energy efficiency and demand response programs. The daily peak load in 2020/21 for the Eastern Division with this expansion of demand-side resources will be about 2,500 Dth or 10.5 percent below the firm sendout forecast in that year—or about 660 Dth or 3 percent less than today's peak day sendout.

Q. Please summarize your primary recommendations.

A. My primary recommendations are as follows:

1. Berkshire Gas should correct its load forecast based on two separate load forecast models for the Eastern and Western Divisions.

2. Berkshire Gas should revise its load forecast to properly include:

   a) energy efficiency savings from the Current EE Plan and the next three-year plan;

   b) additional potential curtailable agreements with large customers;

   c) impacts from the heat pump market; and

   d) impacts from existing and anticipated state climate change and clean energy policies.

3. Berkshire Gas should submit within six months a more aggressive energy efficiency and demand-response program beyond the level of the Current EE Plan. This plan would include:

    a) increasing its annual incremental gas savings gradually to 1.2 percent per year relative to its total projected sales by 2020;

    b) expanding its efficiency program in the Eastern Division (e.g., targeting more measures and customers) within the current three-year program cycle budget, regardless of whether or not Berkshire Gas can expand its entire efficiency program in this timeframe;

    c) a new demand response program plan in the Eastern Division that includes implementation of a demand-response pilot program using internet-connected smart thermostats;

    d) seeking new curtailment agreements with large customers, including the two large customers who previously had curtailment agreements with Berkshire Gas.

4. Berkshire Gas should reach out to other program administrators and to technical advisors who may be available through the DOER and Energy Efficiency Advisory Council for information on state-of-the-art strategies for demand reduction that other utilities are employing.

5. Berkshire should revise its Forecast and Supply Plan as set forth below and plan to lift the moratorium without any new gas infrastructure.

2. SUMMARY OF BERKSHIRE GAS'S LOAD FORECAST AND DEMAND-SIDE RESOURCES

Q. Please provide the objectives and intention of Berkshire Gas's filing.

A. Berkshire Gas submitted its July 2016 Long Range Forecast and Supply Plan ("F&SP") to consider among other things, two specific issues. The first issue is what the Company characterizes as "a deficiency in gas supply to procure so-called "Citygate" suppliers in an amount sufficient to meet the requirements for all relevant planning standards" (F&SP, p. 2). The second issue is described as "the Company's capacity constraints and projected inability to serve requests for new or expanded service in the Eastern Division" (F&SP, p. 2).

In December 2014, Berkshire Gas declared a moratorium on new load additions in the Eastern Division to temporarily address the distribution capacity issue.[1] Thus, in its July 2016 F&SP, Berkshire Gas is seeking "to identify and evaluate other potential alternatives to provide both a needed gas supply resource, as well as to explore potential remedies to the Eastern Division capacity and distribution constraints" (F&SP, p.21).

[1] Includes existing customers who switch from the non-heating service to the heating service.

Q. Please briefly summarize Berkshire Gas's load forecast methodology and key assumptions.

A. The F&SP filing consists of several parts, the first containing a summary of the forecast and a resource plan. Attachment A of the filing contains five-year demand forecasts for the split years from 2016/2017 through 2020/2021 under various growth scenarios.[2] Demand forecasts were made for two different load requirements, namely "planning load" and "firm sendout," over three different time periods within the planning horizon.[3] These time periods are the entire year, cold snap days, and a design day. The filing described two key scenarios:

- The **"Base Case" scenario** assumes a continuation of the moratorium in the Eastern Division.
- The **"No Moratorium" scenario** is a counter-factual scenario that assumes that the moratorium is not in effect.

The F&SP also assessed a "High Growth" scenario that estimates a higher load growth based on more optimistic projections for economic and demographic data, but it did not

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[2] A split year starts in October and ends in September of the following calendar year.

[3] Planning load is the load that the Company is required to plan for pursuant to mandatory capacity assignment, including firm sales and non-exempt firm transportation. Firm sendout represents firm sales and firm transportation load including capacity-exempt customers. These two load estimates exclude interruptible and special contract load.

assess any lower growth scenario. The forecast is econometrically based, using such variables as weather, natural gas prices, income levels, household size, employment levels, etc. as were deemed statistically significant using historical data since 1994 and forward-looking forecasts.

Q. Please briefly summarize key assumptions in the load forecast as it relates to energy efficiency and demand response.

A. The F&SP assumed the same level of energy efficiency savings as planned under the Company's Current EE Plan.[4] For the rest of the planning period through 2020, it assumed the planned 2018 level of savings (F&SP, Appendix 8). By design, the Company's forecasting econometric model reflects the effects of historical energy efficiency savings. The Company made an out-of-model adjustment to incorporate forecasted incremental energy efficiency savings from the new higher savings level for 2016 through 2020 beyond the historical level of energy efficiency savings (F&SP, Attachment A, p. 21 and Appendix 8). For demand response (or load management), Berkshire Gas assumed that just two large customers offer load curtailment services in the Eastern Division (Company response to Montague IR 2-20).[5] The Company's

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[4] Energy efficiency includes end-use technologies, measures, or practices that reduce energy consumption throughout a year.

[5] Demand response technologies, measures, or practices reduce energy consumption during peak times.

forecast did not otherwise include any demand response program, or any new load curtailment customers.

On October 2016, Berkshire Gas submitted a status report by Woodard & Curran on its analysis of resource alternatives—including expanded energy efficiency and demand response—to lift the moratorium. However, this report did not provide any detailed or substantive analysis of energy efficiency or demand response; nor did it provide any quantitative estimates of expanded energy efficiency or demand response.

Q. Please summarize Berkshire Gas's annual load forecast results.

A. Overall, the Base Case forecast predicts a modest increase in the number of customers and also in natural gas demand as follows.

- The total number of customers increases in the base case from 39,780 in 2016/17 to 40,840 in 2020/21 for a net increase of 1,060 customers or 2.7 percent (F&SP, Attachment A, p. 17).
- The total annual planning load increases from 6,541,942 to 6,644,627 Dth with an annual growth rate of 0.4 percent. The total increase of 102,685 Dth represents 1.57 percent relative to the first year (F&SP, Attachment A, p. 1).[6]

[6] Table on page 1 of the Demand Forecast report.

The key changes in the No Moratorium case are as follows:

- The annual planning load increases with an annual growth rate of about 0.8 percent.
- The total load in 2020/21 is 6,847,688 Dth, which adds 203,061 Dth of load relative to the Base Case as shown in Table 1 below. This additional load represents about 3 percent of the Base Case in 2020/2021.

Table 1 also provides the Company's firm sendout forecast for the Base Case and No Moratorium scenarios. Firm sendout adds loads from capacity-exempt business customers. The differences between these two scenarios for the planning load and firm sendout estimates represent the growth in the Eastern Division without the moratorium.

Table 1. Planning Load and Firm Sendout Forecast under the Base Case and No Moratorium Scenarios (Dth)

	Planning Load - Base Case: Moratorium	Planning Load - No Moratorium	Difference – Growth in Eastern Division	Firm Sendout – Base Case: Moratorium	Firm Sendout - No Moratorium	Difference - Growth in Eastern Division
	A	B	C = B - A	D	E = D + C	F = E - D
2016/17	6,541,942	6,636,141	94,199	7,690,035	7,784,234	94,199
2017/18	6,592,395	6,713,090	120,695	7,726,844	7,847,539	120,695
2018/19	6,624,804	6,774,885	150,081	7,740,942	7,891,023	150,081
2019/20	6,631,311	6,808,881	177,570	7,730,450	7,908,020	177,570
2020/21	6,644,627	6,847,688	203,061	7,730,326	7,933,387	203,061
Ann. Growth	0.39%	0.79%		0.13%	0.48%	

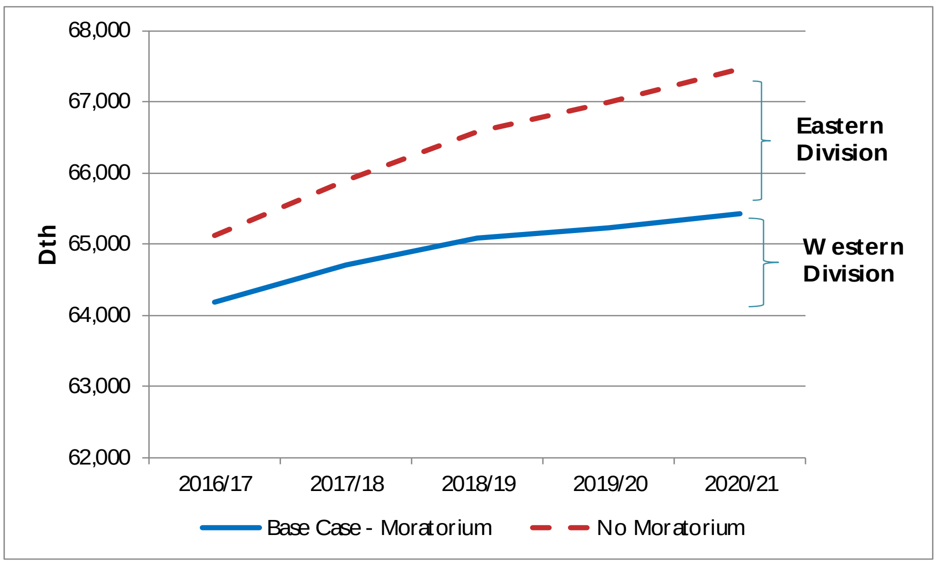
Source: BGC F&SP (July 2016). Att. A, p. 1, 34.

Q. Please summarize Berkshire Gas's design day load forecast results.

A. The Company stated that its current total peak firm sendout on a design day is 21,393 Dth for the Eastern Division (Montague 3-7). Under the Base Case scenario, this peak load level is expected to be sustained through the planning period. While a forecast of daily firm sendout is not available in the F&SP, design day planning load forecasts are available for the two scenarios for the Company's entire service territory in the filing.

Figure 1 below shows the Company's design day planning load forecast for the Base Case (or the Moratorium Case) and the No Moratorium scenarios. The Base Case (blue solid line in the figure) assumes no increase in natural gas consumption on peak days or throughout the year in the Eastern Division. Thus, the increase is expected to occur just in the Western Division with an annual growth rate of 0.5 percent. The No Moratorium scenario (red dotted line in the figure) increases gas load further with an annual growth rate of 0.9 percent due to increased gas use in the Eastern Division. The difference between these two scenarios essentially represents the increased load in the Eastern Division.

Figure 1. Berkshire Gas's Daily Planning Load Forecast: Total of Eastern and Western Divisions



Source: F&SP, Attachment A, p. 30, 33.

Table 2 below includes a forecast of design day firm sendout based on Berkshire Gas's forecast of increased planning load in the Eastern Division (as discussed above) and the current total design day firm sendout of 21,393 (Attachment Montague 3-7). The increased load in the Eastern Division is about 2,000 Dth on a design day for 2020/2021 or about 8.7 percent of the projected firm sendout in 2020/2021.

Table 2. Design Day Planning Load Forecasts for the Entire Service Territory and Design Day Firm Sendout Forecast for the Eastern Division (Dth)

	Entire Service Territory			Eastern Division		
Split Year	Planning Load - Base Case	Planning Load - No Moratorium	Difference	Firm Sendout - Base Case	Firm Sendout - No Moratorium	Difference
	A	B	C = B - A	D	E = D + C	F = E - D
2015/16 (present)				21,393		
2016/17	64,182	65,115	933	21,393	22,326	933
2017/18	64,705	65,902	1,197	21,393	22,590	1,197
2018/19	65,081	66,573	1,492	21,393	22,885	1,492
2019/20	65,229	66,998	1,769	21,393	23,162	1,769
2020/21	65,432	67,458	2,026	21,393	23,419	2,026
Ann. Growth	0.48%	0.89%		0.00%	1.20%	

Source: F&SP, Attachment A, p. 30, 33; Attachment Montague 3-7.

3. ASSESSMENT OF BERKSHIRE GAS'S LOAD FORECAST AND ENERGY EFFICIENCY AND DEMAND RESPONSE FORECASTS

Overall Analysis

Q. Have you identified any problems or areas for improvements with the Company's load forecast methodology or key assumptions?

A. Yes. There are five key areas where the Company can and should make improvements in its forecast, as described below.

1) Berkshire Gas can adjust its energy efficiency forecast to more accurately capture impacts from the implementation of its Current EE Plan and the next three-year plan.

2) Berkshire Gas can expand its energy efficiency programs further to attain savings beyond the current three-year plan level.

3) Berkshire Gas can expand its peak load demand response programs.

4) Berkshire Gas should revise its load forecast to include impacts of a critical emerging energy efficiency technology, electric heat pumps, and policy developments such as the Commonwealth's climate change and clean energy regulatory policies.

5) Berkshire Gas should correct its econometric model to forecast the Eastern and the Western Divisions individually to account for substantially different customer mixes (and thus load profiles) for these two divisions.

Q. Have you quantified any impacts on the Company's' forecasts based on any deficiencies you identified in the Company's forecast?

A. Yes. Figure 2 analyzes an alternative design day firm sendout forecast for Berkshire Gas. It is based on a number of adjustments to the No Moratorium scenario forecast to address some of the deficiencies identified above. The "Adj. No Moratorium" in the figure is the same as the forecast called "Firm Sendout - No Moratorium" in Table 2 above except that it assumes that the moratorium will be lifted in 2017/2018. The purpose of this is to develop a realistic load forecast instead of using the counter-factual forecast represented by the No Moratorium scenario.[7]

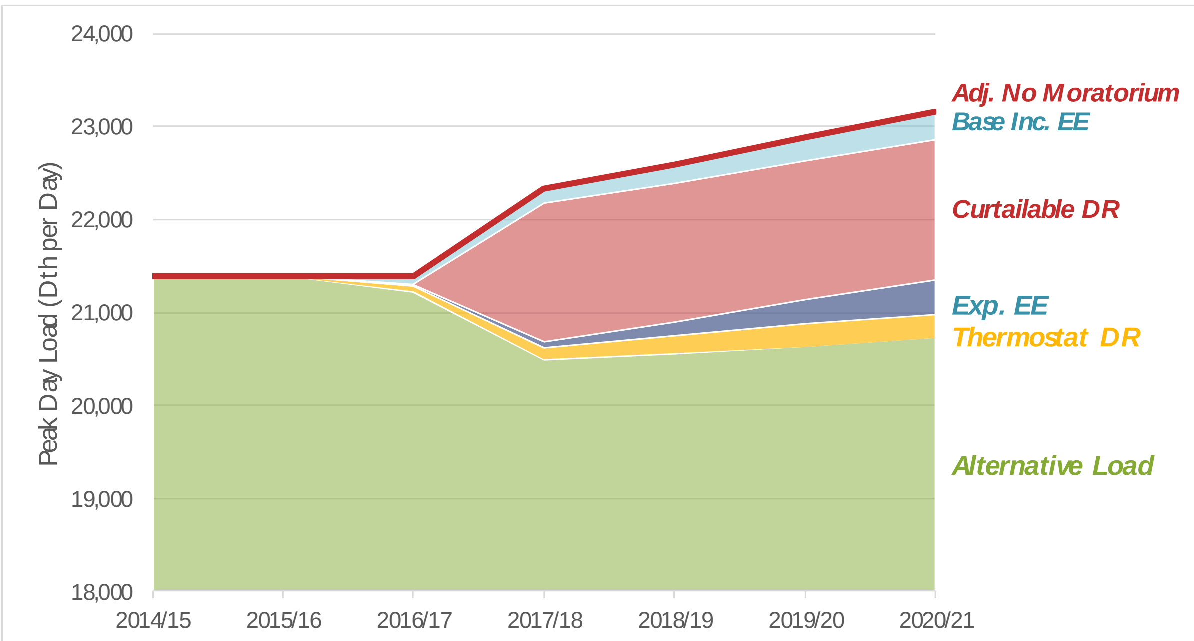
Overall, just correcting Berkshire Gas's own energy efficiency savings estimates and renegotiating curtailable agreements with two large customers in the Eastern Division ("Base Inc. EE" and "Curtailable EE" in Figure 2 below) should reduce the projected design day firm sendout to 7.5 percent (or 1,700 Dth) below the current level in early years. Further, these measures will keep the design day firm sendout through 2020/21 below or at the current level of about 21,000 Dth. In addition, future load could be even lower with the implementation of expanded energy efficiency and demand response programs ("Exp. EE" and "Thermostat DR" in Figure 2). The daily peak load in 2020/21 for the Eastern Division with this expansion of demand-side resources will be about 2,430 Dth or 10.5 percent below the firm sendout forecast in that year—or about 660 Dth or 3 percent less than today's peak day sendout.

It is important to note that this estimate does not include any adjustments that may result from implementation of the Commonwealth's climate change and clean energy policies, as set forth in Section 4, which are likely to lead to substantial electrification for the

[7] The Company's counter-factual forecast simply assumes the moratorium never existed and cannot answer questions related to lifting the moratorium in the future.

building, industrial, and transportation sectors, and thus to lower overall gas consumption.

Figure 2. Alternative Daily Peak Load Forecast for Berkshire Gas



A quick overview of each of these resources is presented as follows:

- **Base Inc. EE**: The base incremental energy efficiency labeled as “Base Inc. EE” includes the impacts of the Company’s currently planned energy efficiency program for 2016–2018, plus the same level of annual savings for 2019 through 2021. The total impact in 2020/21 is about 300 Dth or 1.3 percent of the Adjusted No Moratorium load forecast.

- **Exp. EE**: The expanded energy efficiency represents additional reasonable peak load savings from the expanded energy efficiency case beyond the level of savings achieved under the Base Inc. EE case. This case increases the total annual incremental savings to a level equal to 1.2 percent of "annual gas savings" relative to the adjusted base load projection of firm sendout in 2020. The total impact in 2020/21 is about 375 Dth or 1.6 percent of the Adjusted No Moratorium load forecast.
- **Thermostat DR**: This represents a new demand response program employing NEST smart thermostats or similar products for households and businesses. The expected impact from this measure is about 250 Dth by 2020/2021 or 1 percent of the Adjusted No Moratorium load forecast.
- **Curtailable DR**: This resource represents curtailable load service to two large customers in the Eastern Division with dual fuel capability who previously had load curtailment agreements with Berkshire Gas until around 2012 or 2013.

Details of each of these resources will be discussed below in this section.

Q. Given your analysis of the Company's demand response forecast assumptions, is the moratorium justified?

A. No. As demonstrated above in Figure 2, the daily peak load—more specifically, the design day firm sendout—is not expected to increase through 2020/2021 if Berkshire Gas corrects its energy efficiency savings forecast and enters into new curtailment agreements with the two customers whose curtailment agreements terminated. In addition, if Berkshire Gas implements an expanded energy efficiency and demand response program, the daily load can be expected to decline in the future. This load reduction will be more pronounced if the impacts of heat pumps and ongoing and expected state climate change and clean energy policies are taken into account.

Assessment of Energy Efficiency Potential

Q. Please define demand-side resources.

A. Demand-side resources consist of energy efficiency and demand response resources. Such resources include end-use technologies, measures, and practices that reduce energy consumption in general (energy efficiency) or during peak times (demand response). Energy efficiency improves efficiency of end-use energy consuming equipment (e.g., water heaters, space heating boilers and furnaces) and buildings (e.g., air sealing and insulation). Demand response (also called load management) resources reduce peak demand through a variety of approaches. These can include remotely controlled programmable thermostat settings or switches installed on end-use equipment, rate designs that reward lower consumption during peak times, and fuel switching for water- or space-heating equipment during peak times.

Q. Please describe how and to what extent Berkshire Gas is underestimating impacts from the currently planned energy efficiency programs.

A. As discussed in Section 2 above, Berkshire Gas's base case load forecast includes historical levels of energy efficiency savings. Thus, the Company made an out-of-model adjustment to its econometric model outputs to incorporate incremental energy efficiency savings beyond the historical level of energy efficiency savings already embedded in the model (F&SP, Attachment A, p. 21 and Appendix 8). The Company's adjustment is flawed.

Berkshire Gas used the average energy efficiency savings from its program activities over the past six years, going back to 2010. This time period is too short to capture a reasonable level of historical savings. The rest of the key variables, especially utility gas billing data for Berkshire Gas's econometric model, use historical data over a longer period of time (e.g., over the past 16 years since 2000 for the billing data) (F&SP, Attachment A, p. 4). Ideally historical efficiency savings data over the past 16 years should be used as the historical energy usage data used to construct the model span over the past 16 years. However, given that such long-term savings data are not available, it would be better to use the average savings over the past 11 years (since 2005) that are provided by the Company (Attachment Montague 2-1). These data are a better indicator of historical usage than the six-year savings data the Company used and should be used to adjust Berkshire Gas's forecast for the base incremental energy efficiency.

As shown in Table 3 below, a longer-term average over the 2005 to 2015 period is about 17 percent lower than Berkshire Gas's estimates of average historical savings. Lower average historical savings mean that the incremental annual savings from the planned annual energy savings level will be larger than estimated by Berkshire Gas. Table 4 compares Berkshire Gas's cumulative energy efficiency annual gas savings less historical average savings. As set forth in Table 4, the original estimate underestimates the incremental impact of ongoing and future efficiency programs not embedded in the econometric model output by more than 60 percent. This flaw could feasibly be even more pronounced if a full 16-year trend in energy efficiency programs were used, instead of the 11-year trend used in this calculation. The reason for this is that energy efficiency savings in earlier times are likely to be fewer than for the past 5 to 10 years.[8]

Table 3. Comparison of Average Annual Energy Efficiency (EE) Savings over Two Different Time Periods

	Residential	**Commercial & Industrial**	**Total**
Berkshire Gas's Approach: 2010 – 2015	24,414	18,485	42,899
Longer Term Data: 2005 – 2015	21,680	14,123	35,803
Difference	2,734	4,362	7,096
	11%	24%	17%

[8] Berkshire Gas stated it does not maintain any program data prior to 2005 in response to Montague 6-2.b requesting program data from 1994 to 2004.

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Table 4. Cumulative Forecasted EE Annual Gas Savings Less Historical Trend (Dth)

	Original Estimate: Berkshire Gas's Incremental EE Forecast	EE with Longer-Term Historical Data	Difference	
			Dth	%
2016	13,496	20,591	7,095	53%
2017	23,884	38,075	14,191	59%
2018	34,801	56,087	21,286	61%
2019	45,718	74,099	28,381	62%
2020	56,635	92,111	35,476	63%
2021	67,552	110,123	42,571	63%
2022	78,469	128,136	49,667	63%
2023	89,386	146,148	56,762	64%

Q. Please explain the design day gas savings calculations and the annual gas savings values?

A. The design day (or peak day) savings from energy efficiency is based on a design day energy efficiency (EE) savings factor derived from (a) Berkshire Gas's own estimate of planning load annual EE savings and (b) planning load design day EE savings as shown in Table 5 below. The planning load annual EE estimates in the table excludes EE savings for capacity exempt customers.

Table 5. Calculation of Design Day Energy Efficiency (EE) Savings Factor

	Total Annual EE Savings (Dth)	Planning Load Annual EE Savings (Dth)	Planning Load Design Day EE (Dth)	Design Day EE Factor (% of Annual EE)
2016/17	15,358	12,991	120	0.9
2017/18	26,156	22,167	201	0.9
2018/19	37,073	31,480	283	0.9

2019/20	47,990	40,786	365	0.9
2020/21	58,906	50,097	448	0.9

Source: F&SP, Att. A, p. 1; Montague 6-4.

Applying these design day EE factors to the projected annual EE savings for firm sendout customers in Table 4 results in the following peak day EE savings by calendar year.

Table 6. Entire Territory: Design Day EE Savings for the Original Scenario and for the EE with Longer-Term Historical Data by Calendar Year (Dth)

	Original BG EE Forecast	EE with Longer-Term Historical Data	Difference to Original Estimate (%)
2016	122	186	53
2017	216	344	59
2018	315	507	61
2019	413	670	62
2020	512	832	63
2021	610	995	63
2022	709	1,158	63
2023	808	1,321	64

Finally, design day EE savings for the Eastern Division were estimated based on the current ratio of the historical maximum daily sendout in 2012/2015 between the Eastern Division and the Western Division where the Eastern Division accounts for about 33 percent of the total territory maximum daily peak (Montague 2-23). The results are shown in Table 7 below.

Table 7. Eastern Division: Design Day EE Savings for the Original Scenario and for the EE with Longer-Term Historical Data by Calendar Year (Dth)

	Original BG EE Forecast	EE with Longer-Term Historical Data
2016	40	62
2017	72	114
2018	104	168
2019	137	222
2020	170	276
2021	202	330
2022	235	384
2023	268	438

Source: Montague 2-23.

Q. Please explain your estimates of the expanded energy efficiency resources.

A. The analysis assumes that Berkshire Gas expands its energy efficiency program beyond the currently planned level for 2016–2018, which is about 0.73 percent of total firm sendout. It further assumes that the annual incremental gas savings increase gradually to 1.2 percent of total forecasted firm sendout over the period from 2016 to 2021. This 1.2 percent number is a reasonable estimate of savings from energy efficient programs, and it is consistent with the performance of leading gas energy efficiency programs in New England. It is also supported by an assessment of gas energy efficiency potential studies for Berkshire, National Grid, and other program opportunities not captured in the current program designs or potential studies discussed below. Table 8 compares the cumulative savings impacts from the expanded energy efficiency program (under “Expanded EE”) to the original cumulative savings.[9] The estimated savings for 2020/2021 are nearly 300 percent larger than Berkshire Gas's original estimate.

Table 8. Entire Territory: Cumulative EE Annual Savings beyond Historical Trends—Original vs. Expanded EE Estimates

	Original BG EE Forecast (Dth)	Expanded EE (Dth)	Difference	
			Dth	%
2016	13,496	20,591	7,095	53
2017	23,884	50,803	26,919	113
2018	34,801	90,202	55,401	159
2019	45,718	139,957	94,239	206
2020	56,635	197,496	140,861	249
2021	67,552	255,034	187,482	278

Applying these percentage differences to the original peak reduction forecast for the Eastern Division presented in Table 9 results in design day load reductions for the expanded energy efficiency for the Eastern Division. Table 9 provides a comparison of three different design day savings from energy efficiency programs in the Eastern Division.

Table 9. Eastern Division: Comparison of Total Design Day EE Savings Estimates for the Eastern Division (Dth)

	Original BG EE Forecast	Adjusted EE	Expanded EE
2016/17	56	88	107
2017/18	88	141	211
2018/19	121	195	345
2019/20	153	249	505

[9] Note both estimates are incremental savings beyond historical trends.

2020/21	186	303	678

Q. Should Berkshire Gas expand its energy efficiency programs and save more natural gas?

A. Yes. In Massachusetts, all electric and natural gas energy efficiency program administrators must develop a plan to capture all available cost-effective energy efficiency opportunities.[10] However, there is ample evidence that the level of savings assumed in the Company's plan does not represent all available cost-effective energy efficiency opportunities. The Company should expand its efficiency programs and save more natural gas for several reasons.

1) There are many other natural gas companies in New England that have achieved a higher level of energy savings. These include gas companies located in rural areas, similar to Berkshire Gas.

2) The GDS Study employed conservative assumptions on participation rates.

3) There are numerous other gas efficiency measures that are not implemented by the Company or analyzed in the GDS Study.

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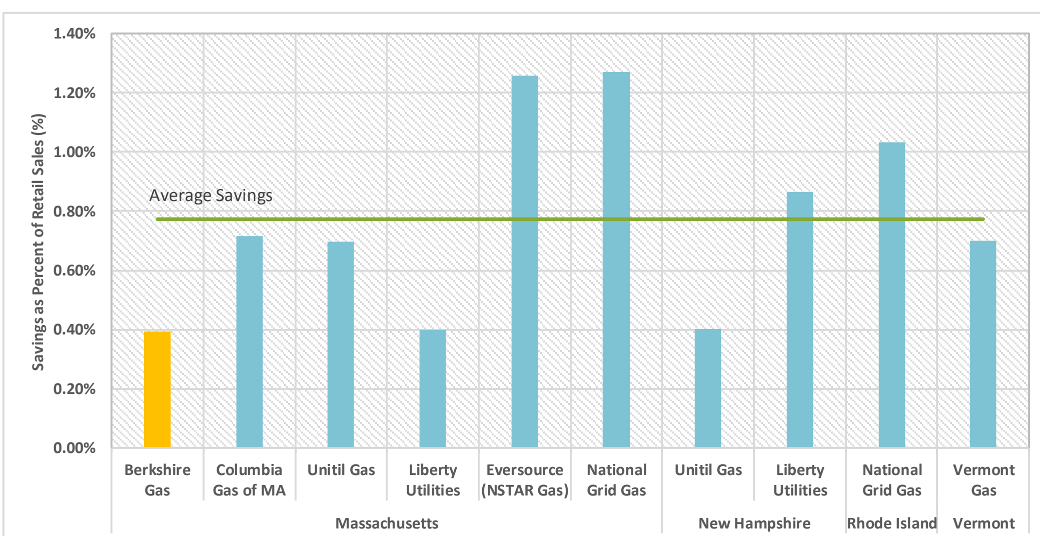
[10] MA G.L. c 25 § 21(a).

4) The value of end-use gas savings for Berkshire Gas is substantially greater than for other gas companies because these savings provide Berkshire Gas with an opportunity to defer or avoid expensive supply-side investments.

Q. How does Berkshire Gas's energy efficiency program compare with programs implemented by other gas companies in the region?

A. In 2015, Berkshire Gas saved about 40,000 Dth of gas, or about 0.4 percent of its total retail sales.[11] In contrast, all but two of the region's natural gas companies saved nearly two to three times that amount. Their savings ranged from 0.75 percent to 1.3 percent relative to their sales, as shown in Figure 3 below.

Figure 3. Annual Natural Gas Energy Efficiency Savings by New England Gas Companies in 2015



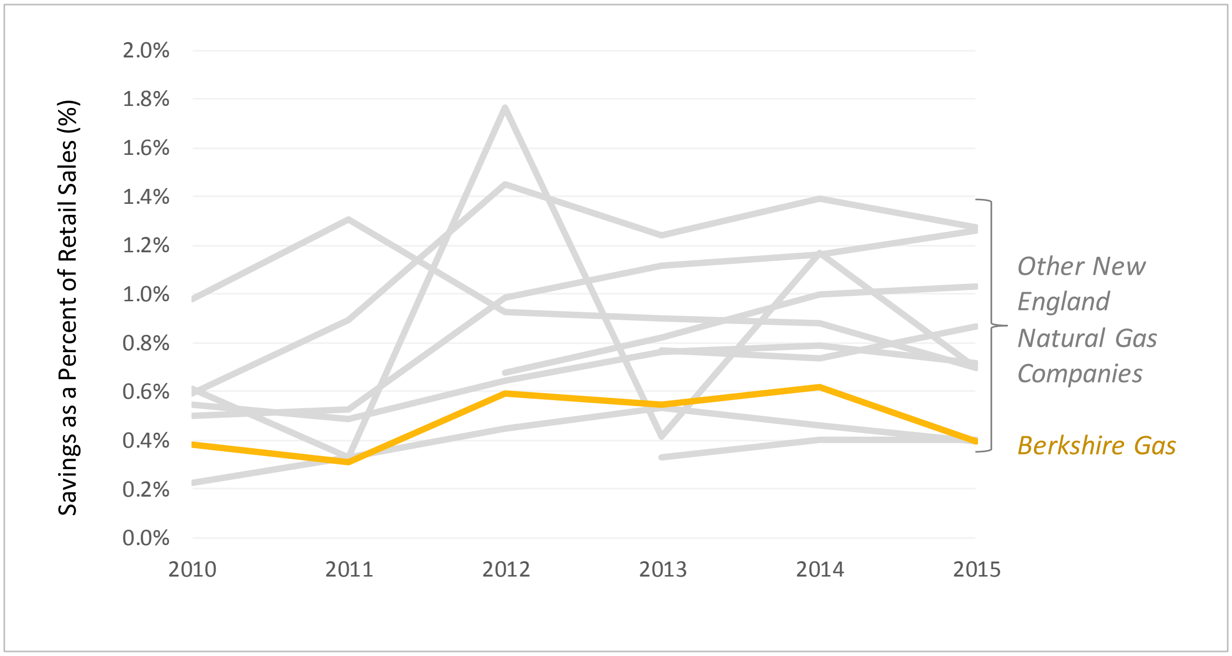
[11] When compared with total sendout, this level of savings represents about 0.56 percent.

Note: Average savings are estimated across all utilities.

Sources: Natural Gas Savings— Massachusetts, All Utilities: Mass Save Energy Efficiency Program Data, available at http://masssavedata.com/Public/Home; New Hampshire, All Utilities: New Hampshire CORE Energy Efficiency Programs 4th Quarter Reports, Docket DE 14-216, available at: https://www.puc.nh.gov/Electric/coreenergyefficiencyprograms.htm; Rhode Island: National Grid Electric and Gas Energy Efficiency Programs Year-End Reports, Docket 4527, available at: http://www.ripuc.org/eventsactions/docket.html; Vermont: Vermont Gas Annual Reports, emailed by Keith Levenson on February 8, 2017. Natural Gas Sales—All States, All Utilities: EIA, Form 176, available at: http://www.eia.gov/cfapps/ngqs/ngqs.cfm?f_report=RP1.

Berkshire Gas's underperformance relative to other gas companies is not just for 2015. Historically it has consistently achieved lower than average savings compared to other gas utilities in the region, as shown in Figure 4 below. The only utilities that achieved lower savings as a percent of sales than Berkshire Gas were Liberty Utilities in Massachusetts and Unitil Gas in New Hampshire. Over the past six years, the rest of seven gas utilities consistently saved more natural gas relative to their sales than Berkshire Gas saved (with an exception of one utility for one year).

Figure 4. Annual Natural Gas Energy Efficiency Savings by New England Gas Companies from 2010 to 2015



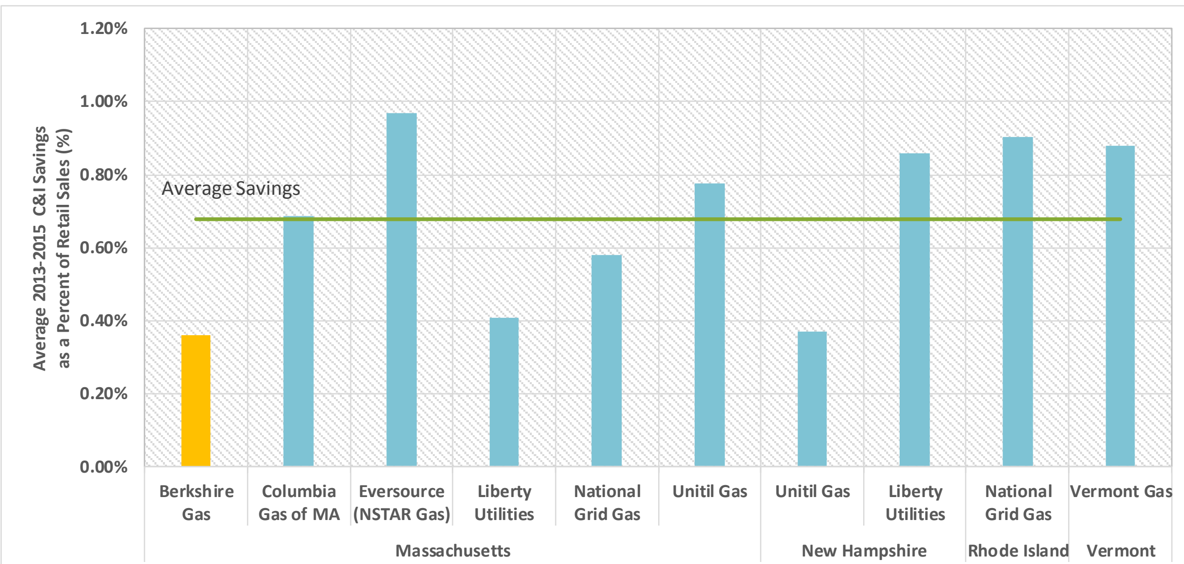
Note: 2015 sales data from U.S. EIA for the residential, commercial, and industrial sectors are used as proxy sales to estimate percentage savings from 2010 to 2015.

Sources: Natural Gas Savings—Massachusetts, All Utilities: Mass Save Energy Efficiency Program Data, available at http://masssavedata.com/Public/Home; New Hampshire, All Utilities: New Hampshire CORE Energy Efficiency Programs 4th Quarter Reports, Dockets DE 12-262 (2013 & 2014) and DE 14-216 (2015), available at: https://www.puc.nh.gov/Electric/coreenergyefficiencyprograms.htm; Rhode Island: National Grid Electric and Gas Energy Efficiency Programs Year-End Reports, Dockets 4295 (2012), 4366 (2013), 4451 (2014), and 4527 (2015), available at: http://www.ripuc.org/eventsactions/docket.html; Vermont: Vermont Gas Annual Reports, emailed by Keith Levenson on February 8, 2017. Natural Gas Sales—All States, All Utilities: EIA, Form 176, available at: http://www.eia.gov/cfapps/ngqs/ngqs.cfm?f_report=RP1.

A sector-specific analysis found that Berkshire Gas's low savings as a percent of sales is mainly due to low savings for the commercial and industrial (C&I) sector. Figure 5 below compares gas savings for the C&I sector from 2013 to 2015 across the same utilities in New England as presented in Figure 3 above. Berkshire Gas saved just 0.36 percent, half of the average savings across all gas utilities while six others saved two to three times more gas relative to their sales. This comparison, along with the long-term trend in Figure

4, clearly demonstrates there is plenty of untapped natural gas savings potential for Berkshire Gas. Further, this is especially applicable to the C&I sector.

Figure 5. Commercial and Industrial Annual Natural Gas Energy Efficiency Average Savings by New England Gas Companies from 2013 to 2015



Sources: Natural Gas Savings—Massachusetts, All Utilities: Mass Save Energy Efficiency Program Data, available at http://masssavedata.com/Public/Home; New Hampshire, All Utilities: New Hampshire CORE Energy Efficiency Programs 4th Quarter Reports, Dockets DE 12-262 (2013 & 2014) and DE 14-216 (2015), available at: https://www.puc.nh.gov/Electric/coreenergyefficiencyprograms.htm; Rhode Island: National Grid Electric and Gas Energy Efficiency Programs Year-End Reports, Dockets 4366 (2013), 4451 (2014), and 4527 (2015), available at: http://www.ripuc.org/eventsactions/docket.html; Vermont: Vermont Gas Annual Reports, emailed by Keith Levenson on February 8, 2017. Natural Gas Sales—All States, All Utilities: EIA, Form 176, available at: http://www.eia.gov/cfapps/ngqs/ngqs.cfm?f_report=RP1.

Q. How does Berkshire's Current EE Plan compare with historical savings and the GDS Study results?

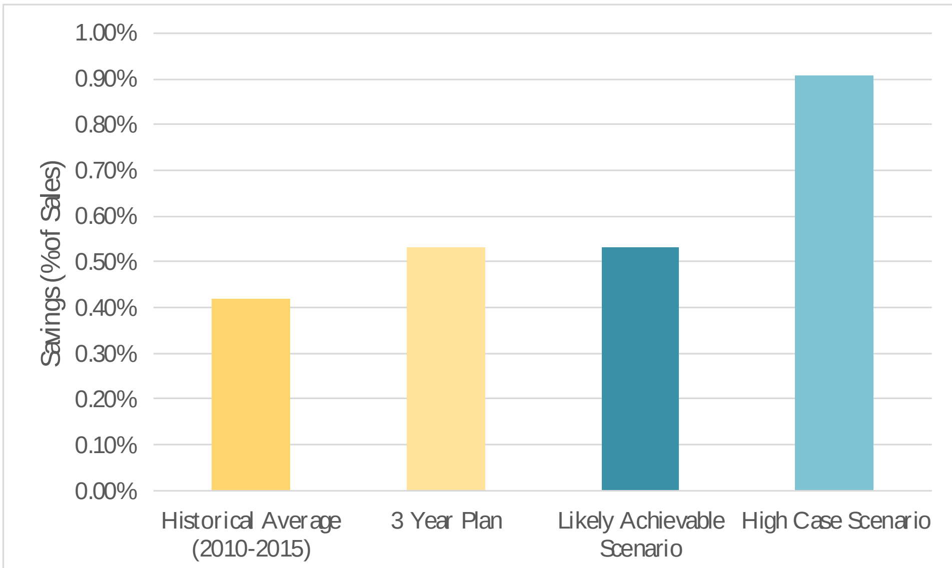
A. The Company is currently operating its three-year program for 2016–2018 based on the target developed and approved under the Massachusetts 2016–2018 Three-Year Plan in dockets D.P.U. 15-160 through D.P.U. 15-169. This three-year plan examined Berkshire

Gas's natural gas potential estimates provided by the GDS Study as submitted in that docket, as well as other data submissions. The Commission approved the Company's proposed savings target. The approved three-year savings target is about 0.7 percent per year on average using a level of sales data for firm sendout, or 0.53 percent using all sector sales data.[12] This level of savings is close to the "Likely Achievable" scenario in the GDS Study, but does not show much improvement relative to the historical level of savings. The historical level of savings ranges from 0.3 percent to 0.6 percent with an average of 0.47 percent from 2010 through 2015 using the 2015 total sales data, as shown in Figure 4 above. In essence, Berkshire Gas's target is still lower than the levels of savings achieved by the region's leading gas utilities, whose savings ranged from 0.7 to 1.3 percent relative to total sales with an average of 0.9 percent per year in 2015.[13] The GDS Study also estimated a higher savings potential under a "High Case" scenario where the average annual savings is about 0.9—equal to the average historical savings achieved by the region's leading gas utilities (See Figure 6 below).

[12] Firm sendout sales, which exclude sales for interruptible customers and special contract customers, are about 7 million Dth. All-sector sales are about 10 million Dth.

[13] Eversource, National Grid Massachusetts, National Grid Rhode Island, and Liberty Utilities in New Hampshire are the four gas companies whose savings exceeded the regional annual average savings. Columbia Gas, Unitil Gas of Massachusetts, and Vermont Gas—despite not being in the top ranks—are saving close to twice the amount of gas saved by Berkshire Gas in 2015.

Figure 6. Historical, Planned, and Potential Savings (relative to Total Sales)



Note: Using the level of sales for firm sendout, the Likely Achievable Scenario and High Case Scenario save about 0.73 percent and 1.26 percent per year on average, respectively.

Q. Please explain how the GDS Study underestimated efficiency program participation rates.

A. When GDS analyzed the Likely Achievable potential, it essentially assumed a status quo approach to Berkshire Gas's efficiency programs. It assumed no improvement to customer outreach, program design, and/or marketing approaches to increase program participation rates. GDS based the participation rate for each measure on "the percent of survey respondents who installed any gas measure for the subset of surveyed respondents who said they were aware of [*sic*] Berkshire had efficiency programs" (Company Response to Montague 2-10). This effectively ignores any potential participants who would be willing to participate if any aspects of the program design were improved (e.g., higher incentives, more effective customer outreach, marketing approach, program delivery approach, etc.). This further ignores any customers who installed measures but were unaware that Berkshire Gas had efficiency programs. In addition, participation rates are constrained by sector budget amounts. This means that participation rates are reduced for all measures within a sector if the entire sector budget is expected to exceed a predetermined sector budget level. For this downward adjustment, Berkshire Gas used a ratio between the predetermined sector budget and the High Case program administrator cost by sector (Montague 2-10).

Q. Please provide examples of delivery and incentive approaches that Berkshire Gas can adopt to increase program participation.

A. There are several innovative, but proven, delivery and incentive approaches Berkshire Gas can adopt to increase program participation and energy savings:

a) Enhanced incentives: While incentives in Massachusetts are typically standardized across all program administrators such as Berkshire Gas, efficiency aggregator Cape Light Compact has been offering enhanced incentives to increase program participation.[14]

[14] Mass Save. 2015. *2016-2018 Massachusetts Joint Statewide Three-Year Electric and Gas Energy Efficiency Plan*, Appendix L.

b) Program optimization with ICT: Recent information and communication technologies (ICT) capabilities such as new data analytics that track and analyze granular and timely end-use consumption data allow utilities to increase program participants. With this technology, utilities can easily identify and engage program participants. They can then provide rapid and continuous feedback to customers on changes in energy consumption and know whether their programs are on track to meet annual goals. Utilities and implementers can also identify why measures are not performing as predicted so they can fix them within the existing program or come up with further measures to meet the target.[15] For example, Con Edison in New York uses advanced data analytics software to analyze meter data to disaggregate end uses to identify business customers with high savings potential in targeted areas and engage them with building-specific savings opportunities. With this approach, Con Edison found a four-fold increase in project interest from its customers relative to their traditional sales and marketing results.[16]

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[15] ACEEE. 2015. *How Information and Communications Technologies Will Change the Evaluation, Measurement, and Verification of Energy Efficiency Programs*, p. 27.

[16] DNV GL. 2015. The Changing EM&V Paradigm, prepared for Northeastern Energy Efficiency Partnership, p. 66 – 67, available at http://www.neep.org/sites/default/files/resources/NEEP-DNV%20GL%20EMV%202.0.pdf

c) Community energy efficiency initiatives: National Grid has been implementing a geotargeting and community initiative to increase program participation. National Grid found that targeted marketing to specific towns resulted in a measurable increase in the energy efficiency participation in the cities, above and beyond what would have otherwise been expected.[17]

d) Innovative financing mechanism: Upfront cost is one of the major barriers to energy efficiency measures. On-bill financing or the Property Assessed Clean Energy ("PACE)" bond that require zero upfront costs are new financial mechanisms that could increase program participation. Commercial PACE was passed as part of the energy legislation signed by Governor Baker in August 2016.[18]

e) Upstream incentives on gas HVAC measures: The availability of high efficiency equipment is one of the key barriers in the HVAC market. Massachusetts electric program administrators launched an upstream HVAC program in April 2013. In just a year, nearly all manufacturers and distributors in Massachusetts signed up

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[17] Mass Save. 2015. *2016-2018 Massachusetts Joint Statewide Three-Year Electric and Gas Energy Efficiency Plan*, Appendix L.

[18] MassDevelopment. n.d. "Property Assessed Clean Energy (PACE). Available at: www.massdevelopment.com/what-we-offer/key-initiatives/pace/.

for this program.[19] This same approach can be taken for gas HVAC measures to increase the stock of efficient equipment by distributors and manufactures.

Q. What kind of natural gas savings measures are overlooked in the GDS Study?

A. The GDS Study reviewed and analyzed a total of 93 measures for all sectors (Attachment Montague 2-3, page 111). In contrast, a recent potential study by National Grid had a much greater scope on efficiency measures, with particular focus on the commercial and industrial sector. National Grid's study reviewed and analyzed about 160 commercial measures and 100 industrial measures. A comparison of analyzed measures between these two studies for the commercial and industrial sector identified numerous measures that were overlooked in the GDS Study. Such measures and services include, but are not limited to, retrocommissioning, energy management systems, heat recovery systems, process optimization, flue gas heat recovery, demand controlled ventilation, boiler tune-ups, improved sensors and process control, strategic energy management ("SEM") and Superior Energy Performance certification, boiler maintenance, fouling reduction, and even envelope measures such as building insulation and duct and pipe insulation.

All of these measures are important to implement, particularly given the extent to which Berkshire Gas's C&I efficiency programs have been underperforming. Among these,

[19] Sondhi, R., Strong, N., & G. Arnold. 2014. *The End of Prescriptive Rebate Forms? Massachusetts Moves Upstream Introduction to Upstream*.

SEM is emerging as a promising energy efficiency practice to continuously seek and identify energy savings with a focus on operational improvements in commercial and industrial facilities. According to the Consortium for Energy Efficiency ("CEE"), SEM takes "a holistic approach to managing energy use in order to continuously improve energy performance, by achieving persistent energy and cost savings over the long term."[20] More specifically, SEM "focuses on business practice change from senior management through shop floor staff, affecting organizational culture to reduce energy waste and improve energy intensity [and] emphasizes equipping and enabling plant management and staff to impact energy consumption through behavioral and operational change."[21]

Currently, 28 CEE-member operating companies are offering industrial SEM or pilot programs, including National Grid.[22] Massachusetts Energy Efficiency Advisory Council recently issued a memo on SEM and recommended adoption of SEM for the program

[20] Consortium for Energy Efficiency, *CEE^{SM} Strategic Energy Management Minimum Elements*, p. 1. Available at: https://library.cee1.org/content/cee-strategic-energy-management-minimum-elements/.

[21] Ibid.

22 CEE. 2015. *2015 CEE Annual Report*. Available at: https://2015annualreport.cee1.org/initiatives/strategic-energy-management-initiative/.

administrators in the state.[23] Energy savings from SEM are substantial. For example, U.S. Department of Energy's SEM program called Superior Energy Performance ("SEP") found that industrial customers saved 4 to 26 percent of natural gas, with an average of 7 percent across several companies.[24] U.S. DOE reported the payback for most SEP projects are less than one year for large facilities.[25]

In addition, gas companies can promote solar hot water installations, ultra-low energy buildings, or net zero energy buildings. In fact, the former KeySpan Energy used to offer rebates for solar hot water systems before it was acquired by National Grid. National Grid and Eversource are also currently offering incentives for solar hot water systems within their electric energy efficiency programs. Further, some natural gas utilities in other jurisdictions, including Vermont Gas, promote this technology.

Finally net zero energy ("NZE") buildings or ultra-low energy buildings for new construction (e.g., Passive house, LEED Gold/Platinum) is another area that Berkshire

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[23] Optimal Consultant Team. 2016. *Increasing Energy Productivity through Strategic Energy Management*. Prepared for the Massachusetts Energy Efficiency Advisory Council (EEAC). Available at http://ma-eeac.org/wordpress/wp-content/uploads/Energy-Productivity-Memo-3-10-16-1.pdf.

[24] Lawrence Berkeley National Laboratory and Synapse Energy Economics. 2015. *Superior Energy Performance: Guide for the Development of Energy Efficiency Program Plans*. Prepared for the U.S. Department of Energy, page 13. Available at: https://www.energy.gov/sites/prod/files/2015/09/f26/SEP%20program%20planning%20guide.pdf.

[25] U.S. Department of Energy. 2016. "Introduction to the Superior Energy Performance Program," slide 18. Available at: www.energy.gov/sites/prod/files/2016/07/f33/SEP%20slides_7-18-2016_web_0.pdf.

Gas can promote by providing financial incentives. An NZE building achieves zero net energy use by combining various deep energy savings measures and insulation with the on-site production of electricity generated from renewable sources such as solar photovoltaics. A 2014 study by the National Renewable Energy Laboratory reviewed literature on the costs of NZE buildings and noted that "[t]he prevailing perception is that NZE is cost prohibitive and suitable only for showcase projects with atypical, large budgets; however, there is mounting evidence that NZE can, in many case, be achieved with typical budgets."[26] The new Greenfield High School was recently renovated to a LEED Gold building with electric heat pumps and thereby achieved large reductions in natural gas use.[27] If Berkshire Gas were to promote NZE, Passive house, or LEED programs, it could reduce substantial amounts of natural gas use from the new construction customers who currently seek or are expected to seek access to natural gas service from the Company.

[26] National Renewable Energy Laboratory. 2014. *Cost Control Best Practices for Net Zero Energy Building Projects*, p. 1.

[27] Town of Greenfield. 2016. *Green Communities Annual Report Executive Summary for FY2016*.

Q. Please explain why the value of end-use gas savings for Berkshire Gas is significantly greater than for other gas companies.

A. As mentioned above, Berkshire Gas is facing a unique and pivotal situation. It needs to consider whether to invest in large supply and distribution infrastructure or to pursue more aggressive demand-side resources. Based on my analysis, aggressive demand-side programs will help defer or avoid the supply-side investment. This means that the economic value of reducing 1 Dth of gas for Berkshire Gas is likely greater than a 1 Dth reduction for gas companies in less constrained service areas. Therefore, the costs of any supply and distribution investment that could be avoided or deferred should be used as avoided costs for evaluating the cost-effectiveness of energy efficiency programs.

A review of the cost of proposed supply side infrastructure reveals that the avoided costs of such infrastructure investment is substantial. By way of illustration, one of the recommended supply options - a new, larger liquefied natural gas facility in the northern portion of the Eastern Division option is expected to cost $110 million, and have 10,000 to 18,000 Dth per day capacity. The avoided cost estimate based on this facility could range from $6 to $11 per Dth, assuming (a) the cost is amortized over 20 years with an 8 percent weighted average cost of capital; (b) the facility would be fully utilized based on the system load factor.[28] This cost range is exceedingly high as it is very close to the range of total natural gas prices in Massachusetts. This demonstrates how much more valuable demand side resources are to avoid a large supply infrastructure project in the Eastern Division for Berkshire Gas. Although somewhat less, the cost range would also be high for the Company's other supply option.

Q. Is this higher value reflected in either the Company's program benefit-cost analyses for the 2016–2018 program cycle or in the GDS Study?

A. No.

Q. What are the key implications of including the avoided cost of potential supply-side investment options?

A. The Company would likely find more natural gas energy efficiency measures cost-effective and could thus increase the level of and the incentives for its energy efficiency programs. As mentioned above, the GDS Study is very limited in many ways, and one of the limitations is that it included a meager number of currently planned measures (Montague 2-13). If the study expanded its scope and included other measures, it would have found a higher level of achievable energy savings potential.

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[28] A daily peak to annual total load factor for the entire system is 1 percent based on the design day and annual planning load data provided on F&SP, Attachment A, p. 1 and 30.

Q. What are your recommendations regarding Berkshire Gas on energy efficiency programs?

A. Berkshire Gas should revise its load forecast using a more accurate energy efficiency savings level based on the Current EE Plan by using a longer-term historical energy savings. In addition, the Company should implement a more aggressive energy efficiency program so that its annual incremental gas savings reach 1.2 percent per year relative to its total projected sales by 2020. Berkshire Gas should also expand its energy efficiency program in the Eastern Division within the current three-year program cycle budget. The Company should do this regardless of whether or not it can expand its entire efficiency program in this timeframe, so that Berkshire Gas can reduce the peak load in the Eastern Division. Finally, Berkshire Gas should reach out to other program administrators and to technical advisors who may be available through the DOER and Energy Efficiency Advisory Council for information on state-of-the-art strategies for energy efficiency programs that other utilities are employing.

Assessment of Demand Response Potential

Q. Please describe Berkshire Gas's plan on demand response measures and programs.

A. Berkshire Gas has not articulated any plan to implement new demand response measures or programs in its service area.

Q. Should Berkshire Gas implement new demand response measures and programs?

A. Yes. In fact, Massachusetts energy efficiency program administrators have put in place a new framework for implementing demand response programs. Berkshire Gas should take advantage of this framework and start to implement its demand response programs. It has good reason to be an early adopter of the framework because of the factors mentioned above: The value of reducing natural gas on winter peak days is greater for Berkshire Gas than for other in-state gas companies due to a possibility of (a) avoiding a large supply infrastructure investment and (b) lifting the moratorium in the Eastern Division as a result of aggressive demand-side programs.

Q. Please describe the demand response program framework and the status of demand response programs of other Massachusetts program administrators.

A. Consistent with their commitment in the 2016–2018 Massachusetts Joint Statewide Three-Year Electric and Gas Energy Efficiency Plan, Massachusetts program administrators have been exploring creative demand reduction approaches to reach beyond the established demand savings goals. Working with experts in the Demand Savings Group, program administrators are researching new cost-effective electric and gas demand reduction initiatives to potentially deploy during the 2016–2018 period. Gas program administrators have been planning and continue to explore cost-effective active demand reduction approaches.[29]

In December 2016, the Massachusetts program administrators presented an overview of their potentially viable cost-effective peak demand reduction demonstration projects, both planned and current, to the Energy Efficiency Advisory Committee Demand Reduction subcommittee. The demonstration projects include measures such as direct load control (e.g., of internet-connected thermostats, dryers, and water heaters), energy management systems, permanent load shifting, and programs targeting behavior and training.[30] While these programs are focused on electricity savings, programs can be designed to encourage adoption of these measures to target either electricity or gas savings.

Q. What specific demand response measures and programs can Berkshire Gas implement?

A. Berkshire Gas could potentially implement a number of different demand response programs and measures, as listed above. The ones that appear to be the most promising and viable at this time are (a) expanded load curtailment agreements with large business

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[29] Massachusetts EEAC. 2016. *Initial Report on Scope, Tasks, and Timelines for the Demand Savings Group*. Available at http://ma-eeac.org/wordpress/wp-content/uploads/Initial-Report-of-the-Demand-Savings-Group-w-App-3-31-16-1.pdf.

[30] Massachusetts EEAC. 2016. *Overview of Proposed/Approved Peak Demand Reduction Demonstration Projections: Memorandum to EEAC Peak Demand Reduction Subcommittee*. Available at http://ma-eeac.org/wordpress/wp-content/uploads/Matrix-Memorandum-12-2-16.pdf.

customers and (b) load control programs for various customers through smart thermostats. Berkshire Gas should assess new gas demand reduction technologies and programs without delay.

Q. Please explain load curtailment agreements.

A. Gas load curtailment agreements allow utilities to interrupt participating customers' gas supply during periods of high demand and/or low supply, generally in exchange for a lower rate. Usually, curtailment customers have the ability to shift operations from natural gas to an alternative fuel, such as oil. Similarly, existing gas demand reduction programs are usually designed around the assumption that participants (generally large business customers) will switch fuels.[31] For example, in New York City National Grid has implemented a program that automatically switches participants from natural gas to an alternative fuel when outdoor temperatures fall below a certain level.[32] The program allows National Grid to manage its gas supply portfolio more actively during the winter heating season. In 2012, the program had roughly 4,000 commercial, industrial, and institutional customers and has seen relatively modest customer attrition over time.[33]

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[31] Massachusetts EEAC. 2016. *Initial Report on Scope, Tasks, and Timelines for the Demand Savings Group*. March 31, 2016.

[32] EnerNOC. 2012. "National Grid Selects EnerNOC to Manage Natural Gas Consumption in New York City." Press release available at http://investor.enernoc.com/releasedetail.cfm?releaseid=664769.

[33] Communication with National Grid, January 26, 2017.

Q. What has Berkshire Gas said about the potential for expanding load curtailment agreements in its service territory?

A. Berkshire Gas is currently aware of only four customers/meters with dual fuel capability in the Eastern Division. The Company currently has curtailment agreements with two of these customers; the other two curtailment agreements are no longer in effect (Berkshire Gas, response to Montague 2-20). While the Company stated it is not aware of any other customers that have dual fuel capability and can enter into load curtailment agreements, it provided no evidence that it conducted any meaningful investigation into potential load curtailment agreements with new customers or any other demand response potential (Berkshire Gas, response to Montague 2-20). The Company should conduct a comprehensive assessment of the potential for load response in its service area through data analysis and customer outreach.

Q. Have you quantified any impacts from additional curtailment agreements with customers?

A. Yes. The alternative new design day load as presented in Figure 2 in the beginning of this section, assumes that the two large customers who ceased their curtailment agreements will re-enter into new curtailment agreements with Berkshire Gas. The sum of maximum daily load for the two customers is [redacted] Dth. Berkshire Gas noted that these "customers were no longer interested in being subject to curtailment once firm service became available" (Montague 4-5). However, it appears Berkshire Gas made no attempt to ask them to come back to a curtailment service after Berkshire Gas had to place the moratorium in the Eastern Division. The analysis assumes that Berkshire Gas provides an additional financial incentive or more generous curtailment agreements to the customers so that they enter into new curtailment agreements.

Q. Please describe demand response programs using smart thermostats.

A. Programs can promote adoption of smart thermostats that use special algorithms to reduce heating demand during winter peaking periods by learning consumers' behavior and optimizing thermostat settings. As another alternative, the utility can enter into agreements with participating customers that allow it to control internet-connected smart thermostats remotely.

Q. Are you aware of any evaluations of smart thermostats to reduce peak usage?

A. Yes. The DOER commissioned an impact evaluation of energy savings from thermostats using Nest's Seasonal Savings algorithm. Over half (54 percent) of eligible thermostats participated and completed the Seasonal Savings term.[34] These participating thermostats represent a total of 20,104 thermostats, approximately 73 percent of which are for natural gas heated homes (14,756 homes). Over the course of the winter, participants

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[34] Some customers have more than one thermostat per home. (Nest Seasonal Savings: MA DOER Heating Season Impact Evaluation. 2015. Available as Attachment B, at https://www.mcecleanenergy.org/wp-content/uploads/2016/08/MCE-AL-17-E-Seasonal-Savings-Pilot.pdf.)

experienced reductions in heating system usage of 3.5 percent on average relative to usage by the comparison group. The study found an aggregate reduction of about 315 Dth for the 14,756 natural gas heated homes participating in the program over 10 peak days in early 2015.[35]

Q. Have you quantified any impacts from smart thermostat customers?

A. Yes. Information from DOER's Nest Seasonal Savings algorithm pilot program is available to quantify the impact from the use of smart thermostats to reduce winter peak load. My analysis of an alternative new design day load forecast as presented in Figure 2 employs a set of aggressive but realistic assumptions on program participation rates as follows:

- Residential customers: 50 percent penetration over the next the next five years.
- Business customers: 25 penetration over the next five years.

The residential participant rate is based on (a) the fact that 54 percent of eligible thermostats participated in the DOER pilot program in just one year,[36] and (b) industry research shows the smart thermostats penetration reaches 30 percent by 2019 for the

[35] Nest Seasonal Savings: MA DOER Heating Season Impact Evaluation. 2015.

[36] Some customers have more than one thermostat per home.

entire U.S. market.[37] Assuming Berkshire Gas would promote smart thermostats, the penetration is expected to be higher than the U.S. average. For business customers, 25 percent participation is assumed to be conservative (as the DOER pilot did not test on business customers). Finally, I assumed that each participating residential and business customer saves 3.5 percent of peak natural gas on average, based on the DOER pilot. The results of this analysis show that this program could be expected to reduce daily peak by 1 percent by 2020/2021, as shown in Table 10 below.

Table 10. Peak Day Impact from Smart Thermostat Program for Berkshire Gas

	RES Thermostat DR (Dth)	C&I Thermostat DR (Dth)	Total (Dth)	Savings (% of Forecast Load)
2016/17	25	33	59	0.3
2017/18	52	68	121	0.5
2018/19	77	100	177	0.8
2019/20	101	132	233	1.0
2020/21	99	129	228	1.0

Finally, it is important to note that this impact excludes any effects from direct load control measures with smart thermostats. National Grid is currently testing direct control pilots with smart thermostats in Massachusetts, New York, and Rhode Island, and it is

[37] IHS Markit. 2015. *Growth Projections and Smart Thermostats: What Makes Sense?* Available at https://technology.ihs.com/551796/growth-projections-and-smart-thermostats-what-makes-sense.

finding a significant summer peak electricity savings. National Grid is now planning to test this approach for winter seasons.[38]

Q. Do you have any recommendations regarding demand response measures for Berkshire Gas?

A. Yes. Berkshire Gas should seek new curtailment agreements with large customers, particularly with the two large customers who previously had curtailment agreements with Berkshire Gas. In addition, Berkshire Gas should design and propose a demand response pilot program using internet-connected smart thermostats. Further, the Company should reach out to other program administrators and to technical advisors who may be available through the DOER and Energy Efficiency Advisory Council for information on state-of-the-art strategies for demand response programs that other utilities are employing.

Assessment of Load Forecasting Methodology

Q. Please describe in detail the flaws in the Company's combined load forecast model.

A. Based on historical trends and near-term expectations, the Company's five-year forecast methodology has one critical flaw with respect to analyzing the Eastern Division needs.

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[38] National Grid. 2017. "Connected Solutions–Demand Response Demonstration." Presented at Rhode Island Energy Efficiency and Resource Management Council meeting on February 20, 2017.

Berkshire Gas's forecast analysis aggregates both divisions' loads and customers and estimates average use per customer for the entire division by customer segment. A review of the historical data provided in the discovery responses however, indicates that the customer mix and usage are very different in each division. Figure 7 below shows that the C&I gas sales in the Eastern Division account for 70 percent of the total sales, while the C&I sales in the Western Division account for just slightly over 50 percent. Further, sales from the C&I High Load Factor in the Eastern Division takes a substantially higher fraction of the Division sales than that in the Western Division.

Figure 7. Share of Annual Firm Sales in 2015 by Division

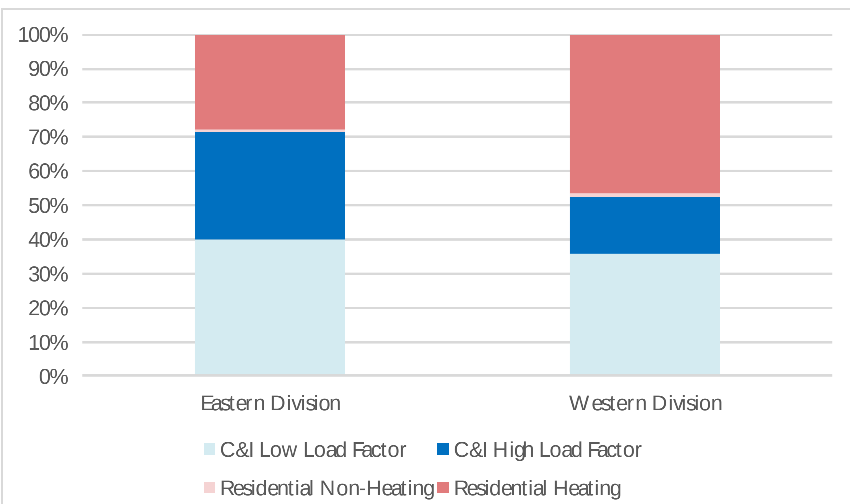

Table 11 below reveals that average customer use is substantially different between the two regions, especially for the Residential Heating customers and C&I High Load Factor customers. It is also important to note that Berkshire Gas is predicting a significant number of increased residential heating customers in the Eastern Division (935 customers or 13 percent increase, as shown in

Table *12* below). This heightens the importance of using the Eastern Division-specific average use data for the residential sector as well.

Table 11. Average Customer Use in 2015 (Dth per customer)

	East	West	% Difference
Residential Heating Customers	85	109	-22
Residential Non-heating Customers	17	19	-7
C&I Low Load Factor	657	677	-3
C&I High Load Factor	1,982	1,280	55

Source: Attachment Montague 4-1.

Table 12. Projection of Customer Changes in the Eastern Division

Split Year	Residential Non-Heating	Residential Heating	C&I LLF	C&I HLF	Total
2016/17	-157	356	64	6	269
2017/18	-223	478	87	6	349
2018/19	-288	631	112	6	460
2019/20	-354	787	136	5	575
2020/21	-419	935	159	4	679
2020/2012 % of Current Total	-53%	13%	12%	1%	3%
Current Total	785	7,165	1,334	349	23,263

Source: AG 2-4; Attachment Montague 4-1.

These factors indicate that when predicting the incremental requirements specifically for the Eastern Division, those differences need to be taken into account. Instead, the Company used average use per customer data for the entire territory and applied them to customer count projections to estimate Division specific demand (F&SP, Attachment A, p. 33; Appendix 13, p. 1). This methodology is appropriate to estimate demand for the entire territory, but is not appropriate to estimate Division-specific demand because as discussed above the historical average use per customer data for each customer segment are so different between the two Divisions. The approach that was used does not reflect the customer differences between the divisions, which the historical data show are significant.

Q. Do other Massachusetts gas utilities prepare load forecasts by operating division?

A. Yes. Several Massachusetts companies prepare separate load forecasts by operating division for the Forecast and Supply Plans that are submitted to the Department.

- NSTAR Gas prepares separate load forecasts for four divisions: Cambridge, Framingham, New Bedford, and Worcester (D.P.U. 16-181).
- National Grid prepares separate load forecasts for four divisions: Boston, Essex, Lowell, and Cape Cod (D.P.U. 16-40).

- Bay State Gas prepares separate load forecasts for three divisions: Brockton, Springfield, and Lawrence (D.P.U. 15-143).

By contrast, Berkshire Gas aggregates the end-use consumption data per customer for its two separate divisions, with a likely result of less accurate forecasting.

Q. Do you have any recommendations regarding Berkshire Gas's load forecasting approach to estimate customer load on an aggregated basis?

A. Yes. Berkshire Gas should revise its load forecast based on two separate load forecast models for the two divisions. A separate Eastern Division forecast will enable the Company to project more accurately how much of demand side resources will be needed to end the moratorium.

4. ASSESSMENT OF IMPACTS FROM EMERGING TECHNOLOGIES AND STATE CLIMATE CHANGE POLICIES

Q. Please explain the emerging technology that Berkshire Gas did not consider in its load forecast model.

The Company stated it evaluated any impacts from emerging technologies and considered the possibility of new large electric generators and distributed generation development in its service territory (Berkshire Gas July 8 filing, Attachment A, p. 22). However, it overlooked any impact of fuel switching from fossil fuels, including natural gas to electric heat pumps for space and water heating.

Because an electric heat pump utilizes energy in ambient air using a vapor compression cycle, it is an extremely energy efficient heating and cooling system. Its efficiency for current products sold in the United States can be as high as 300 percent, technically expressed in a coefficient of performance (COP) of 3.[39,40] This means that a system can produce three units of energy with one unit of energy input.

While the penetration of heat pumps in the Northeast has been very low to date, the recent introduction to the United States of cold climate heat pumps capable of operating reliably under freezing temperatures (below 17 F) has caused a notable increase.[41] At the same time, northeastern states have started to implement programs and policies to promote cold climate heat pumps along with other clean energy thermal systems. For example, Massachusetts Clean Energy Center (MassCEC) has been operating its Clean Heating and Cooling programs, which offer incentives to adopters of cold climate heat pumps and other clean heating and cooling HVAC measures. These programs result from growing recognition that the heat pumps can eventually become zero emission heating

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[39] Northeast Energy Efficiency Partnership (NEEP). 2017. *Northeast/Mid-Atlantic Air-Source Heat Pump Market Strategies Report 2016 Update*, p. 36.

[40] Cold climate heat pump systems have been sold in Asia and Europe for a long time. Products sold in Japan now exceed a COP of 6. Hirose Yukinobu. 2016. "Heat Pump Technologies in Japan" presented at the International Energy Agency's workshop titled "Re-defining Climate Ambition To "Well-below 2°C" on June 20, 2016, available at www.iea.org/workshops/re-defining-climate-ambition-to-well-below-2c-.html.

[41] NEEP. 2017. p. 13.

systems as renewable energy on the grid increases.[42] Given these new trends, Berkshire Gas's failure to incorporate the likely impacts from this technology in its load forecast is a glaring omission.

Q. In Massachusetts, are there any regulations or policies to promote electric heat pumps?

A. Yes. Massachusetts developed the Commonwealth Accelerated Renewable Thermal Strategy in 2014 which identified policies and programs the Commonwealth can deploy in order to grow the market for renewable heating and cooling appliances. These include ground source and air source heat pumps, and also solar hot water and biomass heating systems. A report published in 2014 titled "Commonwealth Accelerated Renewable Thermal Strategy" concluded that renewable energy heating potentially could reach 30–32 percent of overall thermal energy use in the state by 2030.[43] The MassCEC Clean Heating and Cooling program mentioned above is one of the Commonwealth's initiatives to increase renewable energy heating and cooling systems. Starting at the end of 2014,

42 According to NEEP (2017), the current estimated emission rates from ASHP are already lower than the emission rates from natural gas furnaces or boilers. They range from 8 percent to 46 percent lower relative to natural gas (NEEP 2017, p. 38). The comparison ignores any upstream methane leaks from wells through natural gas pipeline systems.

43 Navigant and Meister Consultants Group. 2014. *Commonwealth Accelerated Renewable Thermal Strategy*. Prepared for Massachusetts DOER. Available at www.mass.gov/eea/energy-utilities-clean-tech/renewable-energy/renewable-thermal/.

the program has already promoted a large number of heat pump systems—close to 4,000 projects over the past two years.[44] Furthermore, MassCEC recently announced a $30 million commitment to increase the use of clean, cost-effective heating and cooling systems across the Commonwealth through 2020.[45]

In addition, the Massachusetts DOER recently filed draft regulations to include renewable heating and cooling in the Massachusetts Alternative Portfolio Standard (APS), pursuant to Chapter 251 of the Acts of 2014. The APS was established in 2009 under the Green Communities Act of 2008 and requires a certain percentage of the state's electric load to be met by eligible alternative technologies. The proposed draft regulations aim to increase the APS obligations by including renewable heating and cooling systems such as heat pumps.[46]

Q Please provide an industry forecast for heat pumps.

A. In 2013, the Northeast Energy Efficiency Partnership (NEEP) launched a regional market transformation initiative to accelerate the market adoption of heat pumps (more

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[44] MassCEC. n.d. "Air-Source Heat Pump." Available at www.masscec.com/get-clean-energy/residential/air-source-heat-pumps.

[45] MassCEC. n.d. "Clean Heating and Cooling." Available at www.masscec.com/residential/clean-heating-and-cooling.

[46] Massachusetts DOER. n.d. "Renewable Heating and Cooling in the Alternative Portfolio Standard." Available at www.mass.gov/eea/energy-utilities-clean-tech/renewable-energy/renewable-thermal/renewable-heating-and-cooling-alternative-portfolio-std.html.

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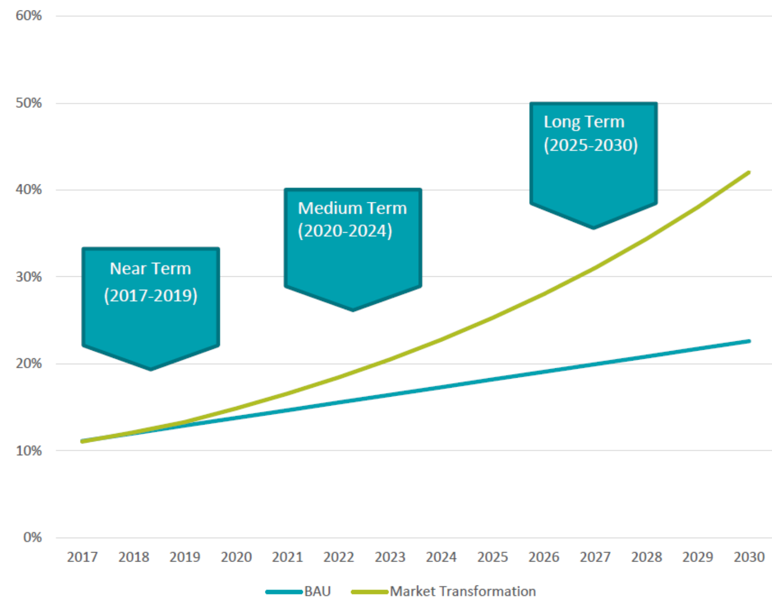
specifically, air-source heat pumps or ASHP) in the region. NEEP produced a report to provide a “roadmap” to effectively transform the market. NEEP’s regional ASHP initiative started to re-evaluate the market in 2016 and issued a new report titled “Northeast/Mid-Atlantic Air-Source Heat Pump Market Strategies Report 2016 Update” in January 2017. This report provides a forecast of ASHP penetration as primary heating systems, as shown in Figure 8 below. NEEP expects that the penetration rate of ASHP will increase from 11 percent to about 13 or 14 percent by 2020/21 and to 22 percent by 2030 under a business as usual (BAU) case that uses the recent annual growth rate. NEEP goes on to predict that the region could increase the penetration further by implementing various market strategies to promote the technology. In this scenario called “Market Transformation” the penetration rate increases to about 18 percent by 2020/2021 and 40 percent by 2030.

Figure 8. NEEP Forecast of ASHP in the Northeast/Mid-Atlantic Region



Source: NEEP (2017). p. 9.

Q. Please explain how the increased penetration of heat pumps impacts natural gas consumption.

A. For space heating, heat pumps can be installed by any type of customer, including single family and multi-family households as well as commercial and industrial customers. Heat pump technologies can also be used to provide domestic hot water. When customers that currently use fossil fuels such as oil, propane, and natural gas install electric heat pumps, they drastically reduce their fossil fuel use. As mentioned above, the new Greenfield High School installed electric heat pumps when it was renovated to a LEED Gold building, and achieved large reductions in natural gas use.[47] While existing gas customers who use gas for space heating are less likely to switch to heat pumps because gas prices are currently extremely low, it's a different story for new customers. Any gas use increase that Berkshire Gas is considering from new customers— including existing non-heating customers switching to a heating customer class—could potentially be offset by new cold climate heat pumps.

That said, even some existing gas heating customers are likely to install heat pumps and reduce their gas use. This is because heat pumps are more efficient and provide cooling services that some of those customers do not currently have. A case in point is MassCEC's Clean Heating and Cooling program. The program provides incentives to various renewable energy based heating and cooling systems, including heat pumps. From December 2014 to August 2016, the program had over 3,800 participants who were using oil, propane, or natural gas for space heating. Its database shows that 34 percent of program participants used natural gas as their primary heating fuel, as shown in Table 13 below.

[47] Town of Greenfield. 2016. *Green Communities Annual Report Executive Summary for FY2016*.

Table 13. Summary of MassCEC Heat Pump Program from Dec 2014 through August 2016 by Fuel

	2014 (Dec)	2015 (Full year)	2016 (through Aug)	Total	Share
Natural gas	1	716	584	1,301	34%
Oil	4	999	579	1,582	41%
Other	5	217	86	308	8%
Electricity	4	410	258	672	17%
Total	**14**	**2,342**	**1,507**	**3,863**	

Source: MassCEC. n.d. "Air-Source Heat Pump Program- Residential Projects- Last Updated August 2016", Available at http://files.masscec.com/get-clean-energy/residential/air-source-heat-pumps/ResidentialASHPProjectDatabase2016.xlsx

There are 174 households who installed heat pumps in 2015 and 2016 in Berkshire Gas's Eastern Division, as shown in Table 14 below. One tenth of the participants switched from natural gas to electric heat pumps as the primary heating source. These data clearly show that switching to electric heat pumps is already happening. The impact of this switch is an emerging trend that is not reflected in Berkshire Gas's load forecast.

Table 14. MassCEC Heat Pump Program Participants in Berkshire Gas's Eastern Division by Fuel

	Electric	Natural Gas	Oil & Propane	Other	Total
Amherst	18	8	39	6	71
Deerfield	1		2	1	4
Greenfield	3	7	35	7	52
Hadley	3		16	1	20
Hatfield		3	5		8
Montague			5		5
Sunderland			9	2	11
Whately			1	2	3
Grand Total	**25**	**18**	**112**	**19**	**174**
Share (%)	**14%**	**10%**	**64%**	**11%**	

Q. Are there any other factors influencing the adoption of electric heat pumps?

A. Yes. Over the past six years, the rate of increase for solar photovoltaics (PV) installed by households and businesses has increased year by year, resulting in 1465 MW as of January 2017 spread over 66,600 projects.[48] This recent rapid increase of solar PV systems among households and businesses is likely to be one of the key factors that have driven the adoption of electric heat pumps. The reason for this is that on-site electricity

[48] Massachusetts DOER. n.d. "Renewable Energy Snapshot." Available at www.mass.gov/eea/grants-and-tech-assistance/guidance-technical-assistance/agencies-and-divisions/doer/renewable-energy-snapshot.html.

production with solar PV will make the use of heat pumps more cost-effective because energy from solar PV is now cheaper than grid electricity in Massachusetts.

Q. What Massachusetts clean energy and climate change regulations and policies are likely to reduce natural gas use in the thermal sector in the future?

A. There are several existing and expected regulations and policies that are expected to influence end-use natural gas use and address distribution-level natural gas leaks. In Massachusetts, the Global Warming Solutions Act requires greenhouse gas (GHG) emissions to be reduced by 80 percent by 2050 across all sectors. On May 17, 2016, the Supreme Judicial Court of Massachusetts ruled that the GWSA requires the Massachusetts Department of Environmental Protection (MassDEP) to promulgate new regulations to impose limits on greenhouse gas emissions. In response, on September 16, 2016, Governor Baker signed Executive Order 569. Part of the Order directed MassDEP to promulgate regulations to reduce emissions and meet the 2020 statewide emissions limit mandated by the GWSA. Draft regulations recently released by the MassDEP aim to reduce emissions from various industry sectors including transportation, electricity generation, and natural gas pipelines.[49]

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[49] Massachusetts DOER. n.d. “Reducing GHG Emissions under Section 3(d) of the Global Warming Solutions Act.” Available at www.mass.gov/eea/agencies/massdep/air/climate/section3d-comments.html.

Synapse Energy Economics recently summarized the likely impacts of these and other policies in a report titled "New England's Shrinking Need for Natural Gas."[50] This study evaluated policy impacts on natural gas needs for the entire New England region in all sectors. It assumed that all New England states need to meet their own state GHG regulations or reduction goals, as well as other regulations such as renewable energy portfolio standards. The study found that existing laws and regulations will cumulatively require New England's use of natural gas for electric generation to decrease by 27 percent by 2023 and by 41 percent by 2030. The study further identified the need for an additional 12 million short tons of GHG reductions from other sectors to meet the existing regulations. By allocating the additional emission reductions need among the rest of the sectors, Synapse found out that decreased natural gas use will account for one-quarter of this reduction. This translates into a reduction of 50 trillion Btu by 2030, or an average annual reduction of 0.8 percent.[51]

Furthermore, there are currently numerous legislative drafts/bills that aim to reduce the state's GHGs, including S. 1821, An Act combating climate change,[52] and S.1849, An

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[50] Knight, P. et al. 2017. *New England's Shrinking Need for Natural Gas*. Prepared by Synapse Energy Economics. Available at www.synapse-energy.com/sites/default/files/New-Englands-Shrinking-Need-for-Natural-Gas-16-109.pdf.

[51] Ibid.

[52] The final energy bill can be read at: https://malegislature.gov/Bills/190/S1821.

Act transitioning Massachusetts to 100 percent renewable energy.[53] All combined, these policy developments suggest that natural gas fuel use in the end-use natural gas thermal sector can be expected to gradually decline on an absolute basis over the next decade or so.

Q. Do you have any recommendations regarding the impacts from the heat pump technology and state climate change and clean energy policies?

A. Yes. It is clear from the evidence above that the emergence of the heat pump market and state climate change and clean energy policies can reasonably be expected to reduce natural gas use even for the current planning horizon. Berkshire Gas should incorporate this factor and adjust its customer count forecasts for new customers and for customer average energy use for both the Eastern and Western Divisions.

Q. Does this conclude your pre-filed testimony?

A. Yes, it does.

[53] The final energy bills can be read at: https://malegislature.gov/Bills/190/S1849